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file ..................................... Read and write text and binary files
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H2O intro ................................ Introduction to integration with H2O
html2docx ............................. Convert an HTML file to a Word (.docx) document
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Java integration ........................ Java integration for Stata
Java intro ................................ Introduction to Java in Stata
Java plugin ................................ Introduction to Java plugins
Java utilities ............................ Java utilities
javacall .................................. Call a Java plugin
LinearProgram( ) ........................ Linear programming
macro .................................... Macro definition and manipulation
macro lists ................................ Manipulate lists
markdown .............................. Convert Markdown document to HTML file or Word (.docx) document
ml ........................................ Maximum likelihood estimation
moptimize( ) ............................ Model optimization
optimize( ) ............................ Function optimization
Pdf*( ) ................................. Create a PDF file
### Combined subject table of contents

| [P]  | plugin | ................................................................. | Load a plugin |
| [P]  | postfile | ................................................................. | Post results in Stata dataset |
| [P]  | _predict | Obtain predictions, residuals, etc., after estimation programming command |
| [P]  | program properties | ................................................................. | Properties of user-defined programs |
| [RPT]  | putdocx begin | ................................................................. | Create an Office Open XML (.docx) file |
| [RPT]  | putdocx collect | ................................................................. | Add a table from a collection to an Office Open XML (.docx) file |
| [RPT]  | putdocx intro | ................................................................. | Introduction to generating Office Open XML (.docx) files |
| [RPT]  | putdocx pagebreak | ................................................................. | Add breaks to an Office Open XML (.docx) file |
| [RPT]  | putdocx paragraph | ................................................................. | Add text or images to an Office Open XML (.docx) file |
| [RPT]  | putdocx table | ................................................................. | Add tables to an Office Open XML (.docx) file |
| [RPT]  | putexcel | ................................................................. | Export results to an Excel file |
| [RPT]  | putexcel advanced | ................................................................. | Export results to an Excel file using advanced syntax |
| [D]  | putmata | ................................................................. | Put Stata variables into Mata and vice versa |
| [RPT]  | putpdf begin | ................................................................. | Create a PDF file |
| [RPT]  | putpdf collect | ................................................................. | Add a table from a collection to a PDF file |
| [RPT]  | putpdf intro | ................................................................. | Introduction to generating PDF files |
| [RPT]  | putpdf pagebreak | ................................................................. | Add breaks to a PDF file |
| [RPT]  | putpdf paragraph | ................................................................. | Add text or images to a PDF file |
| [RPT]  | putpdf table | ................................................................. | Add tables to a PDF file |
| [P]  | PyStata intro | ................................................................. | Introduction to using Python and Stata together |
| [P]  | PyStata integration | ................................................................. | Call Python from Stata |
| [P]  | PyStata module | ................................................................. | Python package pystata to call Stata from Python |
| [M-5]  | Quadrature( ) | ................................................................. | Numerical integration |
| [P]  | _return | ................................................................. | Preserve stored results |
| [P]  | _rmcoll | ................................................................. | Remove collinear variables |
| [P]  | _robust | ................................................................. | Robust variance estimates |
| [P]  | serset | ................................................................. | Create and manipulate sersets |
| [D]  | snapshot | ................................................................. | Save and restore data snapshots |
| [P]  | unab | ................................................................. | Unabbreviate variable list |
| [P]  | unabcmd | ................................................................. | Unabbreviate command name |
| [D]  | unicode collator | ................................................................. | Language-specific Unicode collators |
| [D]  | unicode convertfile | ................................................................. | Low-level file conversion between encodings |
| [P]  | varabbrev | ................................................................. | Control variable abbreviation |
| [P]  | viewsource | ................................................................. | View source code |
| [M-5]  | xl( ) | ................................................................. | Excel file I/O class |

### Special-interest programming commands

| [R]  | bstat | ................................................................. | Report bootstrap results |
| [MV]  | cluster programming subroutines | ................................................................. | Add cluster-analysis routines |
| [MV]  | cluster programming utilities | ................................................................. | Cluster-analysis programming utilities |
| [R]  | fvrevar | ................................................................. | Factor-variables operator programming command |
| [P]  | matrix dissimilarity | ................................................................. | Compute similarity or dissimilarity measures |
| [MI]  | mi select | ................................................................. | Programmer’s alternative to mi extract |
| [ST]  | st_is | ................................................................. | Survival analysis subroutines for programmers |
| [SVY]  | svymarkout | ................................................................. | Mark observations for exclusion on the basis of survey characteristics |
| [MI]  | Technical | ................................................................. | Details for programmers |
| [TS]  | tsrevar | ................................................................. | Time-series operator programming command |

### Projects

| [P]  | Project Manager | ................................................................. | Organize Stata files |
File formats

[P] File formats .dta .......................................................... Description of .dta file format
[D] unicode convertfile ........................................... Low-level file conversion between encodings
[D] unicode translate ............................................... Translate files to Unicode

Mata


Automated document and report creation

[U] Chapter 21 ................................................................. Creating reports
[RPT] Appendix for putdocx .............................................. Appendix for putdocx entries
[RPT] Appendix for putpdf ............................................... Appendix for putpdf entries
[RPT] Intro .......................................................... Introduction to reporting manual
[RPT] docx2pdf ................................................ Convert a Word (.docx) document to a PDF file
[RPT] Dynamic documents intro ................................ Introduction to dynamic documents
[RPT] Dynamic tags ................................................ Dynamic tags for text files
[RPT] dynmdoc ................................................ Convert dynamic Markdown document to HTML or Word (.docx) document
[RPT] dynntext ................................................ Process Stata dynamic tags in text file
[RPT] html2docx ................................................ Convert an HTML file to a Word (.docx) document
[RPT] markdown ................................................ Convert Markdown document to HTML file or Word (.docx) document
[RPT] putdocx begin ................................................. Create an Office Open XML (.docx) file
[RPT] putdocx collect ........................................... Add a table from a collection to an Office Open XML (.docx) file
[RPT] putdocx intro ................................................ Introduction to generating Office Open XML (.docx) files
[RPT] putdocx pagebreak ........................................... Add breaks to an Office Open XML (.docx) file
[RPT] putdocx paragraph ........................................ Add text or images to an Office Open XML (.docx) file
[RPT] putdocx table ................................................ Add tables to an Office Open XML (.docx) file
[RPT] putexcel .................................................. Export results to an Excel file
[RPT] putexcel advanced ........................................ Export results to an Excel file using advanced syntax
[RPT] putpdf begin ................................................ Create a PDF file
[RPT] putpdf collect ........................................... Add a table from a collection to a PDF file
[RPT] putpdf intro ................................................ Introduction to generating PDF files
[RPT] putpdf pagebreak ........................................... Add breaks to a PDF file
[RPT] putpdf paragraph ........................................ Add text or images to a PDF file
[RPT] putpdf table ................................................ Add tables to a PDF file
[RPT] set docx ................................................ Format settings for blocks of text

Interface features

[GS] Chapter 1 (GSM, GSU, GSW) .................................. Introducing Stata—sample session
[GS] Chapter 2 (GSM, GSU, GSW) .................................. The Stata user interface
[GS] Chapter 3 (GSM, GSU, GSW) .................................. Using the Viewer
[GS] Chapter 6 (GSM, GSU, GSW) .................................. Using the Data Editor
[GS] Chapter 7 (GSM, GSU, GSW) .................................. Using the Variables Manager
[GS] Chapter 13 (GSM, GSU, GSW) ......................... Using the Do-file Editor—automating Stata
[GS] Chapter 15 (GSM, GSU, GSW) ............................ Editing graphs
[P] Dialog programming ................................................ Dialog programming
[R] doedit ........................................................... Edit do-files and other text files
[D] edit .......................................................... Browse or edit data with Data Editor
[P] set locale ui ................................................ Specify a localization package for the user interface
Combined subject table of contents

[P] sleep ..................................................  Pause for a specified time
[P] smcl .................................................  Stata Markup and Control Language
[D] unicode locale ........................................ Unicode locale utilities
[D] varmanage ................................. Manage variable labels, formats, and other properties
[P] viewsource .............................................. View source code
[P] window fopen ................................. Display open/save dialog box
[P] window manage ................................. Manage window characteristics
[P] window menu .......................................... Create menus
[P] window programming ......................... Programming menus and windows
[P] window push ................................. Copy command into History window
[P] window stopbox ................................. Display message box
Cross-referencing the documentation

When reading this manual, you will find references to other Stata manuals, for example, [U] 27 Overview of Stata estimation commands; [R] regress; and [D] reshape. The first example is a reference to chapter 27, Overview of Stata estimation commands, in the User’s Guide; the second is a reference to the regress entry in the Base Reference Manual; and the third is a reference to the reshape entry in the Data Management Reference Manual.

All the manuals in the Stata Documentation have a shorthand notation:

<table>
<thead>
<tr>
<th>Shorthand</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>[GSM]</td>
<td>Getting Started with Stata for Mac</td>
</tr>
<tr>
<td>[GSU]</td>
<td>Getting Started with Stata for Unix</td>
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<td>[GSW]</td>
<td>Getting Started with Stata for Windows</td>
</tr>
<tr>
<td>[U]</td>
<td>Stata User’s Guide</td>
</tr>
<tr>
<td>[R]</td>
<td>Stata Base Reference Manual</td>
</tr>
<tr>
<td>[BAYES]</td>
<td>Stata Bayesian Analysis Reference Manual</td>
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<tr>
<td>[FN]</td>
<td>Stata Functions Reference Manual</td>
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<td>[XT]</td>
<td>Stata Longitudinal-Data/Panel-Data Reference Manual</td>
</tr>
<tr>
<td>[MI]</td>
<td>Stata Multiple-Imputation Reference Manual</td>
</tr>
<tr>
<td>[SVY]</td>
<td>Stata Survey Data Reference Manual</td>
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<td>[TABLES]</td>
<td>Stata Customizable Tables and Collected Results Reference Manual</td>
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<tr>
<td>[TE]</td>
<td>Stata Treatment-Effects Reference Manual:</td>
</tr>
<tr>
<td></td>
<td>Potential Outcomes/Counterfactual Outcomes</td>
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<td>[I]</td>
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</tbody>
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Description

In this manual, you will find

- matrix-manipulation commands, which are available from the Stata command line and for ado-programming (for advanced matrix functions and a complete matrix programming language, see the *Mata Reference Manual*),
- commands for programming Stata, and
- commands and discussions of interest to programmers.

This manual is referred to as [P] in cross-references and is organized alphabetically.

If you are new to Stata’s programming commands, we recommend that you first read the chapter about programming Stata in the *User’s Guide*; see [U] 18 Programming Stata. After you read that chapter, we recommend that you read the following sections from this manual:

- [P] program Define and manipulate programs
- [P] sortpreserve Sorting within programs
- [P] byable Making programs byable
- [P] macro Macro definition and manipulation

You may also find the subject table of contents helpful; it immediately follows the table of contents.

We also recommend the Stata NetCourses®. At the time this introduction was written, our current offerings of Stata programming NetCourses included

- NC-151 Introduction to Stata programming
- NC-152 Writing Your Own Stata Commands

You can learn more about NetCourses and view the current offerings of NetCourses by visiting https://www.stata.com/netcourse/.

Stata also offers classroom and web-based training courses. Visit https://www.stata.com/training/classroom-and-web/ for details.


References

Baum, C. F. 2016. *An Introduction to Stata Programming*. 2nd ed. College Station, TX: Stata Press.


Also see

- [U] 18 Programming Stata
- [U] 1.3 What’s new
- [R] Intro — Introduction to base reference manual
Description

Automation (formerly known as OLE Automation) is a communication mechanism between Microsoft Windows applications. It provides an infrastructure whereby Windows applications (automation clients) can access and manipulate functions and properties implemented in another application (automation server). A Stata Automation object exposes internal Stata methods and properties so that Windows programmers can write automation clients to directly use the services provided by Stata.

Remarks and examples

A Stata Automation object is most useful for situations that require the greatest flexibility to interact with Stata from community-contributed applications. A Stata Automation object enables users to directly access Stata macros, scalars, stored results, and dataset information in ways besides the usual log files.

For documentation on using a Stata Automation object, see https://www.stata.com/automation/.

Note that the standard Stata end-user license agreement (EULA) does not permit Stata to be used as an embedded engine in a production setting. If you wish to use Stata in such a manner, please contact StataCorp at service@stata.com.

Also see

[P] plugin — Load a plugin
break — Suppress Break key

Description

nobreak temporarily turns off recognition of the Break key. It is seldom used. break temporarily reestablishes recognition of the Break key within a nobreak block. It is even more seldom used.

Syntax

nobreak stata_command

break stata_command

Typical usage is

    nobreak {
    ...
        capture noisily break ...
    ...
    }

Remarks and examples

Stata commands honor the Break key. This honoring is automatic and, for the most part, requires no special code, as long as you follow these guidelines:

1. Obtain names for new variables from tempvar; see [U] 18.7.1 Temporary variables.
2. Obtain names for other memory aggregates, such as scalars and matrices, from tempfile; see [U] 18.7.2 Temporary scalars and matrices.
3. If you need to temporarily change the user’s data, use preserve to save it first; see [U] 18.6 Temporarily destroying the data in memory.
4. Obtain names for temporary files from tempfile; see [U] 18.7.3 Temporary files.

If you follow these guidelines, your program will be robust to the user pressing Break because Stata itself will be able to put things back as they were.

Still, sometimes a program must commit to executing a group of commands that, if Break were honored in the midst of the group, would leave the user’s data in an intermediate, undefined state. nobreak is for those instances.
Example 1

You are writing a program and following all the guidelines listed above. In particular, you are using temporary variables. At a point in your program, however, you wish to list the first five values of the temporary variable. You would like, temporarily, to give the variable a pretty name, so you temporarily rename it. If the user were to press Break during the period, the variable would be renamed; however, Stata would not know to drop it, and it would be left behind in the user’s data. You wish to avoid this. In the code fragment below, ‘myv’ is the temporary variable:

```stata
nobreak {
    rename 'myv' Result
    list Result in 1/5
    rename Result 'myv'
}
```

It would not be appropriate to code the fragment as

```stata
nobreak rename ‘myv’ Result
nobreak list Result in 1/5
nobreak rename Result ‘myv’
```

because the user might press Break during the periods between the commands.

Also see

- [P] capture — Capture return code
- [P] continue — Break out of loops
- [P] quietly — Quietly and noisily perform Stata command
- [P] varabbrev — Control variable abbreviation
- [U] 9 The Break key
Description

Most Stata commands allow the use of the by prefix; see [D] by. For example, the syntax diagram for the regress command could be presented as

```
[ by varlist: ] regress ...
```

This entry describes the writing of programs (ado-files) so that they will allow the use of Stata’s by varlist: prefix; see [D] by. If you take no special actions and write the program myprog, then by varlist: cannot be used with it:

```
. by foreign: myprog
myprog may not be combined with by r(190);
```

By reading this entry, you will learn how to modify your program so that by does work with it:

```
. by foreign: myprog

--> foreign = Domestic
    (output for first by-group appears)

--> foreign = Foreign
    (output for first by-group appears)
    .
```

Syntax

```
program [ define ] program_name
    [, ... byable(recall[, noheader] | onecall) ... ]
```

Option

byable(recall[, noheader] | onecall) specifies that the program is to allow the by prefix to be used with it and specifies the style in which the program is coded.

There are two supported styles, known as byable(recall) and byable(onecall). byable(recall) programs are usually—not always—easier to write and byable(onecall) programs are usually—not always—faster.

byable(recall) programs are executed repeatedly, once per by group. byable(onecall) programs are executed only once and it is the program’s responsibility to handle the implications of the by prefix if it is specified.

byable(recall, noheader) programs are distinguished from byable(recall) programs in that by will not display a by-group header before each calling of the program.

byable(onecall) programs are required to handle the by...: prefix themselves, including displaying the header should they wish that. See Remarks and examples for details.
Remarks and examples

Remarks are presented under the following headings:

byable(recall) programs
Using sort in byable(recall) programs
Byable estimation commands
byable(onecall) programs
Using sort in byable(onecall) programs
Combining byable(onecall) with byable(recall)
The by-group header

If you have not read [P] sortpreserve, please do so.

Programs that are written to be used with by varlist: are said to be “byable”. Byable programs do not require the use of by varlist:; they merely allow it. There are two ways that programs can be made byable, known as byable(recall) and byable(onecall).

byable(recall) is easy to use and is sufficient for programs that report the results of calculation (class-1 programs as defined in [P] sortpreserve). byable(recall) is the method most commonly used to make programs byable.

byable(onecall) is more work to program and is intended for use in all other cases (class-2 and class-3 programs as defined in [P] sortpreserve).

byable(recall) programs

Say that you already have written a program (ado-file) and that it works; it merely does not allow by. If your program reports the results of calculations (such as summarize, regress, and most of the other statistical commands), then probably all you have to do to make your program byable is add the byable(recall) option to its program statement. For instance, if your program statement currently reads

```
program myprog, rclass sortpreserve
   ... 
end
```

change it to read

```
program myprog, rclass sortpreserve byable(recall)
   ... 
end
```

The only change you should need to make is to add byable(recall) to the program statement. Adding byable(recall) will be the only change required if

- Your program leaves behind no newly created variables. Your program might create temporary variables in the midst of calculation, but it must not leave behind new variables for the user. If your program has a generate() option, for instance, some extra effort will be required.
- Your program uses marksample or mark to restrict itself to the relevant subsample of the data. If your program does not use marksample or mark, some extra effort will be required.

Here is how byable(recall) works: if your program is invoked with a by varlist: prefix, your program will be executed \( K \) times, where \( K \) is the number of by-groups formed by the by-variables. Each time your program is executed, marksample will know to mark out the observations that are not being used in the current by-group.
Therein is the reason for the two guidelines on when you need to include only `byable(recall)` to make `by varlist: work`:

- If your program creates permanent, new variables, then it will create those variables when it is executed for the first by-group, meaning that those variables will already exist when it is executed for the second by-group, causing your program to issue an error message.
- If your program does not use `marksample` to identify the relevant subsample of the data, then each time it is executed, it will use too many observations—it will not honor the by-group—and will produce incorrect results.

There are ways around both problems, and here is more than you need:

**Function**

- `_by()`
  - Takes no arguments; returns 0 when program is not being by’d; returns 1 when program is being by’d.
- `_byindex()`
  - Takes no arguments; returns 1 when program is not being by’d; returns 1, 2, ... when by’d and 1st call, 2nd call, ... .
- `_bylastcall()`
  - Takes no arguments; returns 1 when program is not being by’d and is being called with the last by-group; returns 0 otherwise.
- `_byn1()`
  - Takes no arguments; returns the beginning observation number of the by-group currently being executed; returns 1 if `_by() == 0`. The value returned by `_byn1()` is valid only if the data have not been re-sorted since the original call to the by program.
- `_byn2()`
  - Takes no arguments; returns the ending observation number of the by-group currently being executed; returns 1 if `_by() == 0`. The value returned by `_byn2()` is valid only if the data have not been re-sorted since the original call to by program.

**Macro**

- `'_byindex'`
  - Contains nothing when program is not being by’d; contains name of temporary variable when program is being by’d: variable contains 1, 2, ... for each observation in data and recorded value indicates to which by-group each observation belongs.
- `'_byvars'`
  - Contains nothing when program is not being by’d; contains names of the actual by-variables otherwise.
- `'_byrc0'`
  - Contains “, rc0” if the rc0 option is specified; contains nothing otherwise.

So let’s consider the problems one at a time, beginning with the second problem. Your program does not use `marksample`, and we will assume that your program has good reason for not doing so, because the easy fix would be to use `marksample`. Still, your program must somehow be determining which observations to use, and we will assume that you are creating a ‘touse’ temporary variable containing 0 if the observation is to be omitted from the analysis and 1 if it is to be used. Somewhere, early in your program, you are setting the ‘touse’ variable. Right after that, make the following addition (shown in bold):

```plaintext
program ..., ... byable(recall)
    ...
    if `_by() {
        quietly replace `touse' = 0 if `_byindex' != `_byindex()
    }
    ...
end
```

The fix is easy: you ask if you are being by’d and, if so, you set ‘touse’ to 0 in all observations for which the value of ‘byindex’ is not equal to the by-group you are currently considering, namely, `_byindex()`.
The first problem is also easy to fix. Say that your program has a `generate(newvar)` option. Your code must therefore contain

```stata
program ..., ...
    ...
    if "'generate'" != "" {
        ...
    }
    ...
end
```

Change the program to read

```stata
program ..., ... byable(recall)
    ...
    if "'generate'" != "" & _bylastcall() {
        ...
    }
    ...
end
```

 `_bylastcall()` will be 1 (meaning true) whenever your program is not being by’d and, when it is being by’d, whenever the program is being executed for the last by-group. The result is that the new variable will be created containing only the values for the last by-group, but with a few exceptions, that is how all of Stata works. Alternatives are discussed under `byable(onecall)`.

All the other macros and functions that are available are for creating special effects and are rarely used in `byable(recall)` programs.

### Using sort in `byable(recall)` programs

You may use `sort` freely within `byable(recall)` programs, and in fact, you can use any other Stata command you wish; there are simply no issues. You may even use `sortpreserve` to restore the sort order at the conclusion of your program; see `[P] sortpreserve`.

We will discuss the issue of `sort` in depth just to convince you that there is nothing with which you must be concerned.

When a `byable(recall)` program receives control and is being by’d, the data are guaranteed to be sorted by `byvars` only when `_byindex() = 1`—only on the first call. If the program re-sorts the data, the data will remain re-sorted on the second and subsequent calls, even if `sortpreserve` is specified. This may sound like a problem, but it is not. `sortpreserve` is not being ignored; the data will be restored to their original order after the final call to your program. Let’s go through the two cases: either your program uses `sort` or it does not.

1. If your program needs to use `sort`, it will probably need a different sort order for each by-group. For instance, a typical program that uses `sort` will include lines such as

   ```stata
   sort 'touse' 'id' ...
   ```

   and so move the relevant sample to the top of the dataset. This `byable(recall)` program makes no reference to the `byvars` themselves, nor does it do anything differently when the by prefix is specified and when it is not. That is typical; `byable(recall)` programs rarely find it necessary to refer to the `byvars` directly.

   In any case, because this program is sorting the data explicitly every time it is called (and we know it must be because `byable(recall)` programs are executed once for each by-group), there is no reason for Stata to waste its time restoring a sort order that will just be undone anyway. The original sort order needs to be reestablished only after the final call.
2. The other alternative is that the program does not use `sort`. Then it is free to exploit that the data are sorted on `'_byvars'`. Because the data will be sorted on the first call, the program does no `sort`s, so the data will be sorted on the second call, and so on. `byable(recall)` programs rarely exploit the sort order, but the program is free to do so.

Byable estimation commands

Estimation commands are natural candidates for the `byable(recall)` approach. There is, however, one issue that requires special attention. Estimation commands really have two syntaxes: one at the time of estimation,

```
[prefix_command:] estcmd varlist ... [, estimation_options replay_options]
```

and another for redisplaying results:

```
estcmd [, replay_options]
```

With estimation commands, `by` is not allowed when results are redisplayed. We must arrange for this in our program, and that is easy enough. The general outline for an estimation command is

```
program estcmd, ... 
  if replay() {
    if "e(cmd)" != "estcmd" error 301
    syntax [, replay_options]
  } 
  else {
    syntax ... [, estimation_options replay_options]
    ...estimation logic...
  } 
  ...display logic...
```

and to this, we make the changes shown in bold:

```
program estcmd, ... byable(recall)
  if replay() {
    if "e(cmd)" != "estcmd" error 301
    if _by() error 190
    syntax [, replay_options]
  } 
  else {
    syntax ... [, estimation_options replay_options]
    ...estimation logic...
  } 
  ...display logic...
```

In addition to adding `byable(recall)`, we add the line

```
if _by() error 190
```

in the case where we have been asked to redisplay results. If we are being `by`d (if `_by()` is true), then we issue error 190 (request may not be combined with `by`).
byable(onecall) programs

byable(onecall) requires more work to use. We strongly recommend using byable(recall) whenever possible.

The main use of byable(onecall) is to create programs such as generate and egen, which allow the by prefix but operate on all the data and create a new variable containing results for all the different by-groups.

byable(onecall) programs are, as the name implies, executed only once. The byable(onecall) program is responsible for handling all the issues concerning the by, and it is expected to do that by using

function _by() takes no arguments
returns 0 when program is not being by’d
returns 1 when program is being by’d

macro ‘_byvars’ contains nothing when program is not being by’d
contains names of the actual by-variables otherwise

macro ‘_byrc0’ contains nothing or “rc0”
contains “, rc0” if by’s rc0 option was specified

In byable(onecall) programs, you are responsible for everything, including the output of by-group headers if you want them.

The typical candidates for byable(onecall) are programs that do something special and odd with the by-variables. We offer the following guidelines:

1. Ignore that you are going to make your program byable when you first write it. Instead, include a by() option in your program. Because your program cannot be coded using byable(recall), you already know that the by-variables are entangled with the logic of your routine. Make your program work before worrying about making it byable.

2. Now go back and modify your program. Include byable(onecall) on the program statement line. Remove by(varlist) from your syntax statement, and immediately after the syntax statement, add the line

   local by “‘_byvars’”

3. Test your program. If it worked before, it will still work now. To use the by() option, you put the by varlist: prefix out front.

4. Ignore the macro ‘_byrc0’. Byable programs rarely do anything different when the user specifies by’s rc0 option.

Using sort in byable(onecall) programs

You may use sort freely within byable(onecall) programs. You may even use sortpreserve to restore the sort order at the conclusion of your program.

When a byable(onecall) program receives control and is being by’d, the data are guaranteed to be sorted by ‘_byvars’.
Combining `byable(onecall)` with `byable(recall)`

`byable(onecall)` can be used as an interface to other `byable` programs. Let's pretend that you are writing a command—we will call it `switcher`—that calls one of two other commands based perhaps on some aspect of what the user typed or, perhaps, based on what was previously estimated. The rule by which `switcher` decides to call one or the other does not matter for this discussion; what is important is that `switcher` switches between what we will call `prog1` and `prog2`. `prog1` and `prog2` might be actual Stata commands, Stata commands that you have written, or even subroutines of `switcher`.

We will further imagine that `prog1` and `prog2` have been implemented using the `byable(recall)` method and that we now want `switcher` to allow the `by` prefix, too. The easy way to do that is

```stata
program switcher, byable(onecall)
    if _by() {
        local by "by `_byvars' `_byrc0':"
    }
    if (whatever makes us decide in favor of prog1) {
        'by' prog1 '0'
    } else 'by' prog2 '0'
end
```

`scheduler` works by re-creating the `by` `varlist`: prefix in front of `prog1` or `prog2` if `by` was specified. `switcher` will be executed only once, even if `by` was specified. `prog1` and `prog2` will be executed repeatedly.

In the above outline, it is not important that `prog1` and `prog2` were implemented using the `byable(recall)` method. They could just as well be implemented using `byable(onecall)`, and `switcher` would change not at all.

The by-group header

Usually, when you use a command with `by`, a header is produced above each by-group:

```
. by foreign: summarize mpg weight

-> foreign = Domestic
    (output for first by-group appears )

-> foreign = Foreign
    (output for first by-group appears )
```

The by-group header does not always appear:

```
. by foreign: generate new = sum(mpg)
```

When you write your own programs, the header will appear by default if you use `byable(recall)` and will not appear if you use `byable(onecall)`.

If you want the header and use `byable(onecall)`, you will have to write the code to output it.
If you do not want the header and use `byable(recall)`, you can specify `byable(recall, noheader)`:

```
program ..., ... byable(recall, noheader)
    ...
end
```

Also see

[P] `program` — Define and manipulate programs
[P] `sortpreserve` — Sort within programs
[D] `by` — Repeat Stata command on subsets of the data
**Description**

`capture` executes `command`, suppressing all its output (including error messages, if any) and issuing a return code of zero. The actual return code generated by `command` is stored in the built-in scalar `_rc`.

`capture` can be combined with `{}` to produce capture blocks, which suppress output for the block of commands. See the technical note following example 6 for more information.

**Syntax**

```plaintext
capture [ : ] command

capture {
    stata_commands
}
```

**Remarks and examples**

`capture` is useful in do-files and programs because their execution terminates when a command issues a nonzero return code. Preceding sensitive commands with the word `capture` allows the do-file or program to continue despite errors. Also do-files and programs can be made to respond appropriately to any situation by conditioning their remaining actions on the contents of the scalar `_rc`.

**Example 1**

You will never have cause to use `capture` interactively, but an interactive experiment will demonstrate what `capture` does:

```plaintext
    . drop _all
    . list myvar
    no variables defined
    r(111);
    . capture list myvar
    . display _rc
    111
```
When we said `list myvar`, we were told that we had no variables defined and got a return code of 111. When we said `capture list myvar`, we got no output and a zero return code. First, you should wonder what happened to the message “no variables defined”. `capture` suppressed that message. It suppresses all output produced by the command it is capturing. Next we see no return code message, so the return code was zero. We already know that typing `list myvar` generates a return code of 111, so `capture` suppressed that, too.

`capture` places the return code in the built-in scalar `_rc`. When we display the value of this scalar, we see that it is 111.

### Example 2

Now that we know what `capture` does, let’s put it to use. `capture` is used in programs and do-files. Sometimes you will write programs that do not care about the outcome of a Stata command. You may want to ensure, for instance, that some variable does not exist in the dataset. You could do so by including `capture drop result`.

If `result` exists, it is now gone. If it did not exist, `drop` did nothing, and its nonzero return code and the error message have been intercepted. The program (or do-file) continues in any case. If you have written a program that creates a variable named `result`, it would be good practice to begin such a program with `capture drop result`. This way, you could use the program repeatedly without having to worry whether the `result` variable already exists.

### Technical note

When combining `capture` and `drop`, never say something like `capture drop var1 var2 var3`. Remember that Stata commands do either exactly what you say or nothing at all. We might think that our command would be guaranteed to eliminate `var1`, `var2`, and `var3` from the data if they exist. It is not. Imagine that `var3` did not exist in the data. `drop` would then do nothing. It would not drop `var1` and `var2`. To achieve the desired result, we must give three commands:

```stata
capture drop var1
capture drop var2
capture drop var3
```

### Example 3

Here is another example of using `capture` to dispose of nonzero return codes: When using do-files to define programs, it is common to begin the definition with `capture program drop progname` and then put `program progname`. This way, you can rerun the do-file to load or reload the program.

### Example 4

Let’s consider programs whose behavior is contingent upon the outcome of some command. You write a program and want to ensure that the first argument (the macro `’1’`) is interpreted as a new variable. If it is not, you want to issue an error message:
You use the `confirm` command to determine if the variable already exists and then condition your error message on whether `confirm` thinks ‘1’ can be a new variable. We did not have to go to the trouble here. `confirm` would have automatically issued the appropriate error message, and its nonzero return code would have stopped the program anyway.

Example 5

As before, you write a program and want to ensure that the first argument is interpreted as a new variable. This time, however, if it is not, you want to use the name `_answer` in place of the name specified by the user:

```bash
capture confirm new variable '1'
if _rc!=0 {
    local 1 _answer
    confirm new variable '1'
}
(program continues...)
```

Example 6

There may be instances where you want to capture the return code but not the output. You do that by combining `capture` with `noisily`. For instance, we might change our program to read

```bash
capture noisily confirm new variable '1'
if _rc!=0 {
    local 1 _answer
    display "I'll use _answer"
}
(program continues...)
```

`confirm` will generate some message such as “...already exists”, and then we will follow that message with “I’ll use _answer”.

Technical note

`capture` can be combined with `{}` to produce `capture blocks`. Consider the following:

```bash
capture {
    confirm var '1'
    confirm integer number '2'
    confirm number '3'
}
if _rc!=0 {
    display "Syntax is variable integer number"
    exit 198
}
(program continues...)
```
If any of the commands in the capture block fail, the subsequent commands in the block are aborted, but the program continues with the if statement.

Capture blocks can be used to intercept the Break key, as in

```stata
capture {
    stata_commands
}
if _rc==1 {
    Break key cleanup code
    exit 1
}
(program continues...)
```

Remember that Break always generates a return code of 1. There is no reason, however, to restrict the execution of the cleanup code to Break only. Our program might fail for some other reason, such as insufficient room to add a new variable, and we would still want to engage in the cleanup operations. A better version would read

```stata
capture {
    stata_commands
}
if _rc!=0 {
    local oldrc = _rc
    Break key and error cleanup code
    exit 'oldrc'
}
(program continues...)
```

- Technical note

If, in our program above, the `stata_commands` included an `exit` or an `exit 0`, the program would terminate and return 0. Neither the cleanup nor the program continues code would be executed. If `stata_commands` included an `exit 198`, or any other `exit` that sets a nonzero return code, however, the program would not exit. `capture` would catch the nonzero return code, and execution would continue with the cleanup code.

- Reference


- Also see

[P] break — Suppress Break key
[P] confirm — Argument verification
[P] quietly — Quietly and noisily perform Stata command
[U] 18.2 Relationship between a program and a do-file
**Description**

The dataset itself and each variable within the dataset have associated with them a set of characteristics. Characteristics are named and referred to as `varname[charname]`, where `varname` is the name of a variable or `_dta`. The characteristics contain text. Characteristics are stored with the dataset in the Stata-format `.dta` dataset, so they are recalled whenever the dataset is loaded.

Characteristics are sometimes used in Stata programs to store additional metadata for variables. See [U] 12.8 Characteristics for more details.

**Syntax**

Define characteristics

```
char [ define] evarname[charname] ["text"]
```

List characteristics

```
char list [ evarname[ [charname] ]]
```

Rename characteristics

```
char rename oldvar newvar [, replace]
```

Also related is

```
{local|global} mname: char evarname[[ charname ]]
```

`evarname` is a variable name or `_dta` and `charname` is a characteristic name. In the syntax diagrams, distinguish carefully between `[]`, which you type, and `[ ]`, which indicates that the element is optional.

**Option**

`replace` (for use only with `char rename`) specifies that if characteristics of the same name already exist, they are to be replaced. `replace` is a seldom-used, low-level, programmer's option.

`char rename oldvar newvar` moves all characteristics of `oldvar` to `newvar`, leaving `oldvar` with none and `newvar` with all the characteristics `oldvar` previously had. `char rename oldvar newvar` moves the characteristics, but only if `newvar` has no characteristics with the same name. Otherwise, `char rename` produces the error message that `newvar[whatever]` already exists.
Remarks and examples

We begin by showing how the commands work mechanically and then continue to demonstrate the commands in more realistic situations.

**char define** sets and clears characteristics, although there is no reason to type `define`:

- `. char _dta[one] this is char named one of _dta`
- `. char _dta[two] this is char named two of _dta`
- `. char mpg[one] this is char named one of mpg`
- `. char mpg[two] "this is char named two of mpg"
- `. char mpg[three] "this is char named three of mpg"

Whether we include the double quotes does not matter. You clear a characteristic by defining it to be nothing:

- `. char mpg[three]

**char list** is used to list existing characteristics; it is typically used for debugging:

- `. char list
  _dta[two] : this is char named two of _dta
  _dta[one] : this is char named one of _dta
  mpg[two] : this is char named two of mpg
  mpg[one] : this is char named one of mpg

- `. char list _dta[]
  _dta[two] : this is char named two of _dta
  _dta[one] : this is char named one of _dta

- `. char list mpg[]
  mpg[two] : this is char named two of mpg
  mpg[one] : this is char named one of mpg

- `. char list mpg[one]
  mpg[one] : this is char named one of mpg

The order may surprise you—it is the way it is because of how Stata’s memory-management routines work—but it does not matter.

**char rename** moves all the characteristics associated with `oldvar` to `newvar`:

- `. char rename mpg weight
- `. char list
  _dta[two] : this is char named two of _dta
  _dta[one] : this is char named one of _dta
  weight[two] : this is char named two of mpg
  weight[one] : this is char named one of mpg

- `. char rename weight mpg // put it back`

The contents of specific characteristics may be obtained in the same way as local macros by referring to the characteristic name between left and right single quotes; see [U] 12.8 Characteristics.

- `. display "'mpg[one]'"
  this is char named one of mpg
- `. display "'_dta[]'"
  two one

Referring to a nonexisting characteristic returns a null string:

- `. display "the value is |'mpg[three]'|
  the value is ||
How to program with characteristics

Example 1

You are writing a program that requires the value of the variable recording “instance” (first time, second time, etc.). You want your command to have an option \texttt{ins(varname)}, but after the user has specified the variable once, you want your program to remember it in the future, even across sessions. An outline of your program is

\begin{verbatim}
program ... 
version 17.0 
syntax ... [... ins(varname) ... ] 
... 
if "" \text{ins}"=="" 
  local \text{ins} "\_dta[Instance]"
}
confirm variable \text{`ins'} 
char \_dta[Instance] : \text{`ins'}
...
end
\end{verbatim}

Example 2

You write a program, and among other things, it changes the contents of one of the variables in the user’s data. You worry about the user pressing \textit{Break} while the program is in the midst of the change, so you correctly decide to construct the replaced values in a temporary variable and, only at the conclusion, drop the user’s original variable and replace it with the new one. In this example, macro \texttt{`uservar'} contains the name of the user’s original variable. Macro \texttt{`newvar'} contains the name of the temporary variable that will ultimately replace it.

The following issues arise when you duplicate the original variable: you want the new variable to have the same variable label, the same value label, the same format, and the same characteristics.

\begin{verbatim}
program ... 
version 17.0 
... 
tempvar newvar 
... 
( code creating \text{`newvar'}) 
... 
local varlab : variable label \texttt{`uservar'} 
local vallab : value label \texttt{`uservar'} 
local format : format \texttt{`uservar'} 
label var \texttt{`newvar'} "\texttt{varlab}" 
label values \texttt{`newvar'} \texttt{`vallab'} 
format \texttt{`newvar'} \texttt{`format'} 
char rename \texttt{`uservar'} \texttt{`newvar'} 
drop \texttt{`uservar'} 
rename \texttt{`newvar'} \texttt{`uservar'}
end
\end{verbatim}

You are supposed to notice the \texttt{char rename} command included to move the characteristics originally attached to \texttt{`uservar'} to \texttt{`newvar'}. See \texttt{[P] macro}, \texttt{[D] label}, and \texttt{[D] format} for information on the commands preceding the \texttt{char rename} command.
This code is almost perfect, but if you are really concerned about the user pressing Break, there is a potential problem. What happens if the user presses Break between the char rename and the final rename? The last three lines would be better written as

```
nobreak {
    char rename 'uservar' 'newvar'
    drop 'uservar'
    rename 'newvar' 'uservar'
}
```

Now even if the user presses Break during these last three lines, it will be ignored; see [P] break.

Also see

- [P] macro — Macro definition and manipulation
- [D] notes — Place notes in data
- [U] 12.8 Characteristics
- [U] 18.3.6 Macro functions
- [U] 18.3.13 Referring to characteristics
Description

Stata’s two programming languages, ado and Mata, each support object-oriented programming. This manual entry explains object-oriented programming in ado. Most users interested in object-oriented programming will wish to do the programming in Mata. See [M-2] class to learn about object-oriented programming in Mata.

Ado classes are a programming feature of Stata that are especially useful for dealing with graphics and GUI problems, although their use need not be restricted to those topics. Ado class programming is an advanced programming topic and will not be useful to most programmers.

Remarks and examples

Remarks are presented under the following headings:

1. Introduction
2. Definitions
   2.1 Class definition
   2.2 Class instance
   2.3 Class context
3. Version control
4. Member variables
   4.1 Types
   4.2 Default initialization
   4.3 Specifying initialization
   4.4 Specifying initialization 2, .new
   4.5 Another way of declaring
   4.6 Scope
   4.7 Adding dynamically
   4.8 Advanced initialization, .oncopy
   4.9 Advanced cleanup, destructors
5. Inheritance
6. Member programs’ return values
7. Assignment
   7.1 Type matching
   7.2 Arrays and array elements
   7.3 lvalues and rvalues
   7.4 Assignment of reference
8. Built-ins
   8.1 Built-in functions
   8.2 Built-in modifiers
9. Prefix operators
10. Using object values
11. Object destruction
12. Advanced topics
   12.1 Keys
   12.2 Unames
   12.3 Arrays of member variables
Appendix A. Finding, loading, and clearing class definitions
Appendix B. Jargon
1. Introduction

A class is a collection of member variables and member programs. The member programs of a class manipulate or make calculations based on the member variables. Classes are defined in .class files. For instance, we might define the class coordinate in the file coordinate.class:

begin coordinate.class

version 17.0
class coordinate {
    double x
    double y
}
program .set
    args x y
    .x = ‘x’
    .y = ‘y’
end

end coordinate.class

The above file does not create anything. It merely defines the concept of a “coordinate”. Now that the file exists, however, you could create a “scalar” variable of type coordinate by typing

.coord = .coordinate.new

.coord is called an instance of coordinate; it contains .coord.x (a particular x coordinate) and .coord.y (a particular y coordinate). Because we did not specify otherwise, .coord.x and .coord.y contain missing values, but we could reset .coord to contain (1,2) by typing

    .coord.x = 1
    .coord.y = 2

Here we can do that more conveniently by typing

    .coord.set 1 2

because coordinate.class provides a member program called .set that allows us to set the member variables. There is nothing especially useful about .set; we wrote it mainly to emphasize that classes could, in fact, contain member programs. Our coordinate.class definition would be nearly as good if we deleted the .set program. Classes are not required to have member programs, but they may.

If we typed

    .coord2 = .coordinate.new
    .coord2.set 2 4

we would now have a second instance of a coordinate, this one named .coord2, which would contain (2,4).
Now consider another class, line.class:

```
version 17.0
class line {
    coordinate c0
    coordinate c1
}
program .set
    args x0 y0 x1 y1
    .c0.set 'x0' 'y0'
    .c1.set 'x1' 'y1'
end
program .length
    class exit sqrt(('.c0.y'-.c1.y')^2 + ('.c0.x'-.c1.x')^2)
end
program .midpoint
    local cx = ('.c0.x' + '.c1.x')/2
    local cy = ('.c0.y' + '.c1.y')/2
    tempname b
    .'b'.=coordinate.new
    .'b'.set 'cx' 'cy'
    class exit .'b'
end
```

Like coordinate.class, line.class has two member variables—named .c0 and .c1—but rather than being numbers, .c0 and .c1 are coordinates as we have previously defined the term. Thus the full list of the member variables for line.class is

```
    .c0    first coordinate
    .c0.x   x value (a double)
    .c0.y   y value (a double)
    .c1    second coordinate
    .c1.x   x value (a double)
    .c1.y   y value (a double)
```

If we typed

```
    .li = .line.new
```

we would have a line named .li in which

```
    .li.c0    first coordinate of line .li
    .li.c0.x   x value (a double)
    .li.c0.y   y value (a double)
    .li.c1    second coordinate of line .li
    .li.c1.x   x value (a double)
    .li.c1.y   y value (a double)
```

What are the values of these variables? Because we did not specify otherwise, .li.c0 and .li.c1 will receive default values for their type, coordinate. That default is (...) because we did not specify otherwise when we defined lines or coordinates. Therefore, the default values are (...) and (...), and we have a missing line.

As with coordinate, we included the member function .set to make setting the line easier. We can type

```
    .li.set 1 2 2 4
```

and we will have a line going from (1,2) to (2,4).
line.class contains the following member programs:

- .set program to set .c0 and .c1
- .c0.set program to set .c0
- .c1.set program to set .c1
- .length program to return length of line
- .midpoint program to return coordinate of midpoint of line

.set, .length, and .midpoint came from line.class. .c0.set and .c1.set came from coordinate.class.

Member program .length returns the length of the line.

```
.len = .li.length
```

would create .len containing the result of .li.length. The result of running the program .length on the object .li. .length returns a double, and therefore, .len will be a double.

Member program .midpoint returns the midpoint of a line.

```
.mid = .li.midpoint
```

would create .mid containing the result of .li.midpoint, the result of running the program .midpoint on the object .li. .midpoint returns a coordinate, and therefore, .mid will be a coordinate.

2. Definitions

2.1 Class definition

Class classname is defined in file classname.class. The definition does not create any instances of the class.

The classname.class file has three parts:

```
begin classname.class

version ...
class classname {
    ...
} // Part 1: version statement

program ...
    ...
} // Part 2: declaration of member variables

program ...
    ...
end

end

end
```

end classname.class

2.2 Class instance

To create a “variable” name of type classname, you type

```
.name = .classname.new
```
After that, \textit{name} is variously called an identifier, class variable, class instance, object, object instance, or sometimes just an instance. Call it what you will, the above creates new \textit{name}—or replaces existing \textit{name}—to contain the result of an application of the definition of \textit{classname}. And, just as with any variable, you can have many different variables with many different names all the same type.

\textit{name} is called a first-level or top-level identifier. \textit{name1}.\textit{name2} is called a second-level identifier, and so on. Assignment into top-level identifiers is allowed if the identifier does not already exist or if the identifier exists and is of type \textit{classname}. If the top-level identifier already exists and is of a different type, you must drop the identifier first and then re-create it; see \textbf{11. Object destruction}.

Consider the assignment

\begin{verbatim}
.name1.name2 = .classname.new
\end{verbatim}

The above statement is allowed if \textit{name1} already exists and if \textit{name2} is declared, in \textit{name1}'s class definition, to be of type \textit{classname}. In that case, \textit{name1}.\textit{name2} previously contained a \textit{classname} instance and now contains a \textit{classname} instance, the difference being that the old contents were discarded and replaced with the new ones. The same rule applies to third-level and higher identifiers.

Classes, and class instances, may also contain member programs. Member programs are identified in the same way as class variables. \textit{name1}.\textit{name2} might refer to a member variable or to a member program.

\section*{2.3 Class context}

When a class program executes, it executes in the context of the current instance. For example, consider the instance creation

\begin{verbatim}
.mycoord = .coordinate.new
\end{verbatim}

and recall that \texttt{coordinate.class} provides member program \texttt{.set}, which reads

\begin{verbatim}
program .set
  args x y
  .x = 'x'
  .y = 'y'
end
\end{verbatim}

Assume that we type \texttt{.".mycoord.set 2 4"}. When \texttt{.set} executes, it executes in the context of \texttt{.mycoord}. In the program, the references to \texttt{x} and \texttt{y} are assumed to be to \texttt{.mycoord.x} and \texttt{.mycoord.y}. If we typed \texttt{.".other.set"}, the references would be to \texttt{.other.x} and \texttt{.other.y}.

Look at the statement \texttt{.".x = 'x'"} in \texttt{.set}. Pretend that \texttt{'x'} is 2 so that, after macro substitution, the statement reads \texttt{.".x = 2"}. Is this a statement that the first-level identifier \texttt{.x} is to be set to 2? No, it is a statement that \texttt{.impliedcontext.x} is to be set to 2. The same would be true whether \texttt{x} appeared to the right of the equal sign or anywhere else in the program.

The rules for resolving things like \texttt{x} and \texttt{y} are actually more complicated. They are resolved to the implied context if they exist in the implied context, and otherwise they are interpreted to be in the global context. Hence, in the above examples, \texttt{x} and \texttt{y} were interpreted as being references to \texttt{.impliedcontext.x} and \texttt{.impliedcontext.y} because \texttt{x} and \texttt{y} existed in \texttt{.impliedcontext}. If, however, our program made a reference to \texttt{.c}, that would be assumed to be in the global context (that is, to be just \texttt{.c}), because there is no \texttt{.c} in the implied context. This is discussed at length in \textbf{9. Prefix operators}.

If a member program calls a regular program—a regular ado-file—that program will also run in the same class context; for example, if \texttt{.set} included the lines
move_to_right
    .x = r(x)
    .y = r(y)

and program move_to_right.ado had lines in it referring to .x and .y, they would be interpreted as .impliedcontext.x and .impliedcontext.y.

In all programs—member programs or ado-files—we can explicitly control whether we want identifiers in the implied context or globally with the .Local and .Global prefixes; see 9. Prefix operators.

3. Version control

The first thing that should appear in a .class file is a version statement; see [P] version. For example, coordinate.class reads

version 17.0
begin coordinate.class
    class coordinate {
        double x
        double y
    }
    [class statement defining member variables omitted]
    program .set
        args x y
        .x = 'x'
        .y = 'y'
    end
end coordinate.class

The version 17.0 at the top of the file specifies not only that, when the class definition is read, it be interpreted according to version 17.0 syntax, but also that when each of the member programs runs, it be interpreted according to version 17.0. Thus you do not need to include a version statement inside the definition of each member program, although you may if you want that one program to run according to the syntax of a different version of Stata.

Including the version statement at the top, however, is of vital importance. Stata is under continual development, and so is the class subsystem. Syntax and features can change. Including the version command ensures that your class will continue to work as you intended.

4. Member variables

4.1 Types

The second thing that appears in a .class file is the definition of the member variables. We have seen two examples:

version 17.0
begin coordinate.class
    class coordinate {
        double x
        double y
    }
    [member programs omitted]
end coordinate.class

and
In the first example, the member variables are \( .x \) and \( .y \), and in the second, \( .c0 \) and \( .c1 \). In the first example, the member variables are of type `double`, and in the second, of type `coordinate`, another class.

The member variables may be of type

- `double`: double-precision scalar numeric value, which includes missing values \( ., .a, ..., .z \)
- `string`: scalar string value, with minimum length 0 (""") and maximum length the same as for macros, in other words, long

The class `string` type is different from Stata's `str` and `strL` types. It can hold much longer string values than can the `str` type, but not as long of string values as the `strL` type. Additionally, unlike `strL` s, class `strings` cannot contain binary 0.

- `classname`: other classes, excluding the class being defined
- `array`: array containing any of the `types`, including other `arrays`

A class definition might read

```
begin todolist.class
version 17.0
class todolist {
  double n // number of elements in list
  string name // who the list is for
  array list // the list itself
  actions x // things that have been done
}
end todolist.class
```

In the above, `actions` is a class, not a primitive type. Somewhere else, we have written `actions.class`, which defines what we mean by `actions`.

Arrays are not typed when they are declared. An `array` is not an array of `doubles` or an array of `strings` or an array of `coordinates`; rather, each array element is separately typed at run time, so an array may turn out to be an array of `doubles` or an array of `strings` or an array of `coordinates`, or it may turn out that its first element is a `double`, its second element is a `string`, its third element is a `coordinate`, its fourth element is something else, and so on.

Similarly, arrays are not declared to be of a predetermined size. The size is automatically determined at run time according to how the array is used. Also arrays can be sparse. The first element of an array might be a `double`, its fourth element a `coordinate`, and its second and third elements left undefined. There is no inefficiency associated with this. Later, a value might be assigned to the fifth element of the array, thus extending it, or a value might be assigned to the second and third elements, thus filling in the gaps.
4.2 Default initialization

When an instance of a class is created, the member variables are filled in as follows:

- `double` attributed with a missing value,
- `string` attributed with a single double quote ("),
- `classname` as specified by class definition,
- `array` empty, an array with no elements yet defined.

4.3 Specifying initialization

You may specify the initial values for member variables. To do this, you type an equal sign after the identifier, and then you type the initial value. For example,

```plaintext
version 17.0
class todolist {
    double n = 0
    string name = "nobody"
    array list = {"show second syntax", "mark as done"}
    actions x = .actions.new arguments
}
```

The initialization rules are as follows:

- **double** `membervarname` = ...
  - After the equal sign, you may type any number or expression. To initialize the member variable with a missing value (., .a, .b, ..., .z), you must enclose the missing value in parentheses. Examples include:
    ```plaintext
double n = 0
double a = (.)
double b = (.b)
double z = (2+3)/sqrt(5)
```
  - Alternatively, after the equal sign, you may specify the identifier of a member variable to be copied or program to be run as long as the member variable is a `double` or the program returns a `double`. If a member program is specified that requires arguments, they must be specified following the identifier. Examples include:
    ```plaintext
double n = .clearcount
double a = .gammavalue 4 5 2
double b = .color.cvalue, color(green)
```
  - The identifiers are interpreted in terms of the global context, not the class context being defined. Thus .clearcount, .gammavalue, and .color.cvalue must exist in the global context.

- **string** `membervarname` = ...
  - After the equal sign, you type the initial value for the member variable enclosed in quotes, which may be either simple (" and ") or compound (‘“ and ”‘). Examples include:
    ```plaintext
    string name = "nobody"
    string s = "quotes "inside" strings"
    string a = ""
```
You may also specify a string expression, but you must enclose it in parentheses. For example,

```java
string name = ("no" + "body")
string b   = (char(11))
```

Or you may specify the identifier of a member variable to be copied or a member program to be run, as long as the member variable is a string or the program returns a string. If a member program is specified that requires arguments, they must be specified following the identifier. Examples include

```java
string n = .defaultname
string a = .recapitalize "john smith"
string b = .names.defaults, category(null)
```

The identifiers are interpreted in terms of the global context, not the class context being defined. Thus `.defaultname`, `.recapitalize`, and `.names.defaults` must exist in the global context.

```java
array membervarname = {...}
```

After the equal sign, you type the set of elements in braces ({ and }), with each element separated from the next by a comma.

If an element is enclosed in quotes (simple or compound), the corresponding array element is defined to be string with the contents specified.

If an element is a literal number excluding ., .a, ..., and .z, the corresponding array element is defined to be double and filled in with the number specified.

If an element is enclosed in parentheses, what appears inside the parentheses is evaluated as an expression. If the expression evaluates to a string, the corresponding array element is defined to be string and the result is filled in. If the expression evaluates to a number, the corresponding array element is defined to be double and the result is filled in. Missing values may be assigned to array elements by being enclosed in parentheses.

An element that begins with a period is interpreted as an object identifier in the global context. That object may be a member variable or a member program. The corresponding array element is defined to be of the same type as the specified member variable or of the same type as the member program returns. If a member program is specified that requires arguments, the arguments must be specified following the identifier, but the entire syntactical elements must be enclosed in square brackets ([ and ]).

If the element is nothing, the corresponding array element is left undefined.

Examples include

```java
array mixed = {1, 2, "three", 4}
array els   = {.box.new, , .table.new}
array rad   = {[.box.new 2 3], , .table.new}
```

Note the double commas in the last two initializations. The second element is left undefined. Some programmers would code

```java
array els   = {.box.new, /*nothing*/, .table.new}
array rad   = {[.box.new 2 3], /*nothing*/, .table.new}
```

to emphasize the null initialization.
After the equal sign, you specify the identifier of a member variable to be copied or a member program to be run, as long as the member variable is of type `classname` or the member program returns something of type `classname`. If a member program is specified that requires arguments, they must be specified following the identifier. In either case, the identifier will be interpreted in the global context. Examples include

```plaintext
box mybox1 = .box.new
box mybox2 = .box.new 2 4 7 8, tilted
```

All the types can be initialized by copying other member variables or by running other member programs. These other member variables and member programs must be defined in the global context and not the class context. In such cases, each initialization value or program is, in fact, copied or run only once—at the time the class definition is read—and the values are recorded for future use. This makes initialization fast. This also means, however, that

- If, in a class definition called, say, `border.class`, you defined a member variable that was initialized by `box.new`, and if `box.new` counted how many times it is run, then even if you were to create 1,000 instances of `border`, you would discover that `box.new` was run only once. If `box.new` changed what it returned over time (perhaps because of a change in some state of the system being implemented), the initial values would not change when a new border object was created.

- If, in `border.class`, you were to define a member variable that is initialized as `.system.curvals.no_of_widgets`, which we will assume is another member variable, then even if `.system.curvals.no_of_widgets` were changed, the new instances of `border.class` would always have the same value—the value of `.system.curvals.no_of_widgets` current at the time `border.class` was read.

In both of the above examples, the method just described—the prerecorded assignment method of specifying initial values—would be inadequate. The method just described is suitable for specifying constant initial values only.

### 4.4 Specifying initialization 2, `.new`

Another way to specify how member variables are to be initialized is to define a `.new` program within the class.

To create a new instance of a class, you type

```plaintext
.name = .classname .new
```

`.new` is, in fact, a member program of `classname`; it is just one that is built in, and you do not have to define it to use it. The built-in `.new` allocates the memory for the instance and fills in the default or specified initial values for the member variables. If you define a `.new`, your `.new` will be run after the built-in `.new` finishes its work.

For example, our example `coordinate.class` could be improved by adding a `.new` member program:
begin coordinate.class

class coordinate {
    double x
    double y
}

program .new
    if "'0'" != "" {
        .set '0'
    }
end

program .set
    args x y
    .x = 'x'
    .y = 'y'
end

end coordinate.class

With this addition, we could type

    .coord = .coordinate.new
    .coord.set 2 4

or we could type

    .coord = .coordinate.new 2 4

We have arranged .new to take arguments—optional ones here—that specify where the new point is to be located. We wrote the code so that .new calls .set, although we could just as well have written the code so that the lines in .set appeared in .new and then deleted the .set program. In fact, the two-part construction can be desirable because then we have a function that will reset the contents of an existing class as well.

In any case, by defining your own .new, you can arrange for any sort of complicated initialization of the class, and that initialization can be a function of arguments specified if that is necessary.

The .new program need not return anything; see 6. Member programs’ return values.

.new programs are not restricted just to filling in initial values. They are programs that you can code however you wish. .new is run every time a new instance of a class is created with one exception: when an instance is created as a member of another instance (in which case, the results are prerecorded).

4.5 Another way of declaring

In addition to the syntax

    type name [ = initialization ]

where type is one of double, string, classname, or array, there is an alternative syntax that reads

    name = initialization

That is, you may omit specifying type when you specify how the member variable is to be initialized because, then, the type of the member variable can be inferred from the initialization.
In the examples we have seen so far, the member variables are unique to the instance. For example, if we have

```plaintext
.coord1 = .coordinate.new
.coord2 = .coordinate.new
```
then the member variables of .coord1 have nothing to do with the member variables of .coord2. If we were to change .coord1.x, then .coord2.x would remain unchanged.

Classes can also have variables that are shared across all instances of the class. Consider

```plaintext
begin coordinate2.class

version 17.0
class coordinate2 {
    classwide:
        double x_origin = 0
        double y_origin = 0
    instancespecific:
        double x = 0
        double y = 0
}
end coordinate2.class
```

In this class definition, .x and .y are as they were in coordinate.class—they are unique to the instance. .x_origin and .y_origin, however, are shared across all instances of the class. That is, if we were to type

```plaintext
.ac = .coordinate2.new
.bc = .coordinate2.new
```
there would be only one copy of .x_origin and of .y_origin. If we changed .x_origin in .ac,

```
.ac.x_origin = 2
```
we would find that .bc.x_origin had similarly been changed. That is because .ac.x_origin and .bc.x_origin are, in fact, the same variable.

The effects of initialization are a little different for classwide variables. In coordinate2.class, we specified that .origin_x and .origin_y both be initialized as 0, and so they were when we typed

```
".ac = .coordinate2.new"
```
creating the first instance of the class. After that, however, .origin_x and .origin_y will never be reinitialized because they need not be re-created, being shared. (That is not exactly accurate because, once the last instance of a coordinate2 has been destroyed, the variables will need to be reinitialized the next time a new first instance of coordinate2 is created.)

Classwide variables, just as with instance-specific variables, can be of any type. We can define

```plaintext
begin supercoordinate.class

version 17.0
class supercoordinate {
    classwide:
        coordinate origin
    instancespecific:
        coordinate pt
}
end supercoordinate.class
```

The qualifiers classwide: and instancespecific: are used to designate the scope of the member variables that follow. When neither is specified, instancespecific: is assumed.
4.7 Adding dynamically

Once an instance of a class exists, you can add new (instance-specific) member variables to it. The syntax for doing this is

\[\text{name } .\text{Declare attribute\_declaration}\]

where \text{name} is the identifier of an instance and \text{attribute\_declaration} is any valid attribute declaration such as

- \text{double vasename}
- \text{string vasename}
- \text{array vasename}
- \text{classname vasename}

and, on top of that, we can include = and initializer information as defined in 4.3 Specifying initialization above.

For example, we might start with

\[.\text{coord} = .\text{coordinate.new}\]

and discover that there is some extra information that we would like to carry around with the particular instance \text{.coord}. Here we want to carry around some color information that we will use later, and we have at our fingertips \text{color.class}, which defines what we mean by color. We can type

\[.\text{coord}.\text{Declare color mycolor}\]

or even

\[.\text{coord}.\text{Declare color mycolor} = .\text{color.new}, \text{color(default)}\]

to cause the new class instance to be initialized the way we want. After that command, \text{.coord} now contains \text{.coord.color} and whatever third-level or higher identifiers \text{color} provides. We can still invoke the member programs of \text{coordinate} on \text{.coord}, and to them, \text{.coord} will look just like a \text{coordinate} because they will know nothing about the extra information (although if they were to make a copy of \text{.coord}, then the copy would include the extra information). We can use the extra information in our main program and even in subroutines that we write.

⚠️ Technical note

Just as with the declaration of member variables inside the class {} statement, you can omit specifying the \text{type} when you specify the initialization. In the above, the following would also be allowed:

\[.\text{coord}.\text{Declare mycolor} = .\text{color.new}, \text{color(default)}\]
4.8 Advanced initialization, .oncopy

Advanced initialization is an advanced concept, and we need concern ourselves with it only when our class is storing references to items outside the class system. In such cases, the class system knows nothing about these items other than their names. We must manage the contents of these items.

Assume that our coordinates class was storing not scalar coordinates but rather the names of Stata variables that contained coordinates. When we create a copy of such a class,

```
.oncopy

coord = .coordinate.new 2 4
 coordinatocopy = .coord
```

.coordinatocopy will contain copies of the names of the variables holding the coordinates, but the variables themselves will not be copied. To be consistent with how all other objects are treated, we may prefer that the contents of the variables be copied to new variables.

As with .new we can define an .oncopy member program that will be run after the default copy operation has been completed. We will probably need to refer to the source object of the copy with the built-in .oncopy_src, which returns a key to the source object.

Let’s write the beginnings of a coordinate class that uses Stata variables to store vectors of coordinates.

```bash
begin varcoordinate.class
version 17.0

class varcoordinate {
    classwide:
        n = 0
    instancespecific:
        string x
        string y
}

program .new

    .nextnames
    if "'0'" != "" {
        .set '0'
    }

end

program .set

    args x y
    replace '.x' = 'x'
    replace '.y' = 'y'

end

program .nextnames

    .n = '.n' + 1
    .x = "__varcorrd_vname_'.n'"
    .n = '.n' + 1
    .y = "__varcorrd_vname_'.n'"

    generate '.x' = .
    generate '.y' = .

end

program .oncopy

    .nextnames
    .set '.oncopy_src'.x ' '.oncopy_src'.y'

end
```

This class is more complicated than what we have seen before. We are going to use our own unique variable names to store the $x$- and $y$-coordinate variables. To ensure that we do not try to reuse the same name, we number these variables by using the classwide counting variable .n. Every
time a new instance is created, unique \( x \)- and \( y \)-coordinate variables are created and filled in with missing. This work is done by \texttt{.nextnames}.

The \texttt{.set} looks similar to the one from \texttt{.varcoordinates} except that now we are holding variable names in ‘.x’ and ‘.y’, and we use \texttt{replace} to store the values from the specified variables into our coordinate variables.

The \texttt{.oncopy} member function creates unique names to hold the variables, using \texttt{.nextnames}, and then copies the contents of the coordinate variables from the source object, using \texttt{.set}.

Now, when we type

\verbatim
 coordinated = .coord
\endverbatim

the \( x \)- and \( y \)-coordinate variables in \texttt{.coordinated} will be different variables from those in \texttt{.coord} with copies of their values.

The \texttt{varcoordinate} class does not yet do anything interesting, and other than the example in the following section, we will not develop it further.

4.9 Advanced cleanup, destructors

We rarely need to concern ourselves with objects being removed when they are deleted or replaced.

When we type

\verbatim
 .a = .classname.new 
 .b = .classname.new 
 .a = .b
\endverbatim

the last command causes the original object, \texttt{.a}, to be destroyed and replaces it with \texttt{.b}. The class system handles this task, which is usually all we want done. An exception is objects that are holding onto items outside the class system, such as the coordinate variables in our \texttt{destructor} class.

When we need to perform actions before the system deletes an object, we write a \texttt{.destructor} member program in the class file. The \texttt{.destructor} for our \texttt{varcoordinate} class is particularly simple; it drops the coordinate variables.

\verbatim
begin varcoordinate.class -- destructor

program .destructor
  capture drop `.x`
  capture drop `.y`

end

end varcoordinate.class -- destructor
\endverbatim

5. Inheritance

One class definition can inherit from other class definitions. This is done by including the \texttt{inherit(classnamelist)} option:

\verbatim
begin newclassname.class

version 17.0
class newclassname { 
  ...
}, inherit(classnamelist)
program ...
  ...
end
...
\endverbatim

end newclassname.class
newclassname inherits the member variables and member programs from classnamelist. In general, classnamelist contains one class name. When classnamelist contains more than one class name, that is called multiple inheritance.

To be precise, newclassname inherits all the member variables from the classes specified except those that are explicitly defined in newclassname, in which case the definition provided in newclassname.class takes precedence. It is considered bad style to name member variables that conflict.

For multiple inheritance, it is possible that, although a member variable is not defined in newclassname, it is defined in more than one of the “parents” (classnamelist). Then it will be the definition in the rightmost parent that is operative. This too is to be avoided, because it almost always results in programs’ breaking.

newclassname also inherits all the member programs from the classes specified. Here name conflicts are not considered bad style, and in fact, redefinition of member programs is one of the primary reasons to use inheritance.

newclassname inherits all the programs from classnamelist—even those with names in common—and a way is provided to specify which of the programs you wish to run. For single inheritance, if member program .zifl is defined in both classes, then .zifl is taken as the instruction to run .zifl as defined in newclassname, and .Super.zifl is taken as the instruction to run .zifl as defined in the parent.

For multiple inheritance, .zifl is taken as the instruction to run .zifl as defined in newclassname, and .Super(classname).zifl is taken as the instruction to run .zifl as defined in the parent classname.

A good reason to use inheritance is to “steal” a class and to modify it to suit your purposes. Pretend that you have alreadyexists.class and from that you want to make alternative.class, something that is much like alreadyexists.class—so much like it that it could be used wherever alreadyexists.class is used—but it does one thing a little differently. Perhaps you are writing a graphics system, and alreadyexists.class defines everything about the little circles used to mark points on a graph, and now you want to create alternate.class that does the same, but this time for solid circles. Hence, there is only one member program of alreadyexists.class that you want to change: how to draw the symbol.

In any case, we will assume that alternative.class is to be identical to alreadyexists.class, except that it has changed or improved member function .zifl. In such a circumstance, it would not be uncommon to create

```plaintext
begin alternative.class

version 17.0
class alternative {
}, inherit(alreadyexists)
program .zifl ...

end
end alternative.class
```

Moreover, in writing .zifl, you might well call .Super.zifl so that the old .zifl performed its tasks, and all you had to do was code what was extra (filling in the circles, say). In the example above, we added no member variables to the class.
Perhaps the new .zifl needs a new member variable—a double—and let’s call it .sizeofresult. Then we might code

```stata
version 17.0
class alternative {
    double sizeofresult
}, inherit(alreadyexists)
program .zifl
...
end
```

Now let’s consider initialization of the new variable, .sizeofresult. Perhaps having it initialized as missing is adequate. Then our code above is adequate. Suppose that we want to initialize it to 5. Then we could include an initializer statement. Perhaps we need something more complicated that must be handled in a .new. In this final case, we must call the inherited classes’ .new programs by using the .Super modifier:

```stata
version 17.0
class alternative {
    double sizeofresult
}, inherit(alreadyexists)
program .new
    ...
    .Super.new
    ...
end
program .zifl
...
end
```

### 6. Member programs’ return values

Member programs may optionally return “values”, and those can be doubles, strings, arrays, or class instances. These return values can be used in assignment, and thus you can code

```
.len   = .li.length
.coord3 = .li.midpoint
```

Just because a member program returns something, it does not mean it has to be consumed. The programs .li.length and .li.midpoint can still be executed directly,

```
.li.length
.li.midpoint
```

and then the return value is ignored. (.midpoint and .length are member programs that we included in line.class. .length returns a double, and .midpoint returns a coordinate.)

You cause member programs to return values by using the class exit command; see [P] class exit.

Do not confuse returned values with return codes, which all Stata programs set, even member programs. Member programs exit when they execute.
<table>
<thead>
<tr>
<th>Condition</th>
<th>Returned value</th>
<th>Return code</th>
</tr>
</thead>
<tbody>
<tr>
<td>class <code>exit</code> with arguments</td>
<td>as specified</td>
<td>0</td>
</tr>
<tr>
<td>class <code>exit</code> without arguments</td>
<td>nothing</td>
<td>0</td>
</tr>
<tr>
<td><code>exit</code> without arguments</td>
<td>nothing</td>
<td>0</td>
</tr>
<tr>
<td><code>exit</code> with arguments</td>
<td>nothing</td>
<td>as specified</td>
</tr>
<tr>
<td><code>error</code></td>
<td>nothing</td>
<td>as specified</td>
</tr>
<tr>
<td>command having error</td>
<td>nothing</td>
<td>as appropriate</td>
</tr>
</tbody>
</table>

Any of the preceding are valid ways of exiting a member program, although the last is perhaps best avoided. class `exit` without arguments has the same effect as `exit` without arguments; it does not matter which you code.

If a member program returns nothing, the result is as if it returned string containing "" (nothing).

Member programs may also return values in r(), e(), and s(), just like regular programs. Using class `exit` to return a class result does not prevent member programs from also being r-class, e-class, or s-class.

### 7. Assignment

Consider `.coord` defined

```plaintext
.coord = .coordinate.new
```

That is an example of assignment. A new instance of class `coordinate` is created and assigned to `.coord`. In the same way,

```plaintext
.coord2 = .coord
```

is another example of assignment. A copy of `.coord` is made and assigned to `.coord2`.

Assignment is not allowed just with top-level names. The following are also valid examples of assignment:

```plaintext
.coord.x = 2
.li.c0 = .coord
.li.c0.x = 2+2
.todo.name = "Jane Smith"
.todo.n = 2
.todo.list[1] = "Turn in report"
.todo.list[2] = .li.c0
```

In each case, what appears on the right is evaluated, and a copy is put into the specified place. Assignment based on the returned value of a program is also allowed, so the following are also valid:

```plaintext
.coord.x = .li.length
.li.c0 = .li.midpoint
```

`.length` and `.midpoint` are member programs of `line.class`, and `.li` is an instance of `line`. In the first example, `.li.length` returns a double, and that double is assigned to `.coord.x`. In the second example, `.li.midpoint` returns a `coordinate`, and that `coordinate` is assigned to `.li.c0`.

Also allowed would be

```plaintext
.todo.list[3] = .color.cvalue, color(green)
.todo.list = {"Turn in report", .li.c0, [.color.cvalue, color(green)]}
```
In both examples, the result of running `.color.cvalue, color(green)` is assigned to the third array element of `.todo.list`.

### 7.1 Type matching

All the examples above are valid because either a new identifier is being created or the identifier previously existed and was of the same type as the identifier being assigned.

For example, the following would be invalid:

```plaintext
.todothing = 2  // valid so far...
.todothing = "new"  // ... invalid
```

The first line is valid because `.todothing` did not previously exist. After the first assignment, however, `.todothing` did exist and was of type `double`. That caused the second assignment to be invalid, the error being “type mismatch”; r(109).

The following are also invalid:

```plaintext
.coord.x = .li.midpoint
.li.c0 = .li.length
```

They are invalid because `.li.midpoint` returns a coordinate, and `.coord.x` is a double, and because `.li.length` returns a double, and `.li.c0` is a coordinate.

### 7.2 Arrays and array elements

The statements

```plaintext
.todo.list[1] = "Turn in report"
.todo.list[2] = .li.c0
.todo.list[3] = .color.cvalue, color(green)
```

and

```plaintext
.todo.list = {"Turn in report", .li.c0, [.color.cvalue, color(green)]}
```

do not have the same effect. The first set of statements reassigns elements 1, 2, and 3 and leaves any other defined elements unchanged. The second statement replaces the entire array with an array that has only elements 1, 2, and 3 defined.

After an element has been assigned, it may be unassigned (cleared) using `.Arrdropel`. For example, to unassign `.todo.list[1]`, you would type

```plaintext
.todo.list[1].Arrdropel
```

Clearing an element does not affect the other elements of the array. In the above example, `.todo.list[2]` and `.todo.list[3]` continue to exist.

New and existing elements may be assigned and reassigned freely, except that if an array element already exists, it may be reassigned only to something of the same type.

```plaintext
```

would be allowed, but

```plaintext
.todo.list[2] = "Clear the coordinate"
```
would not be allowed because `.todo.list[2]` is a coordinate and "Clear the coordinate" is a string. If you wish to reassign an array element to a different type, you first drop the existing array element and then assign it.

```javascript
.todo.list[2].arrdelete
.todo.list[2] = "Clear the coordinate"
```

### 7.3 lvalues and rvalues

Notwithstanding everything that has been said, the syntax for assignment is

```javascript
lvalue = rvalue
```

*lvalue* stands for what may appear to the left of the equal sign, and *rvalue* stands for what may appear to the right.

The syntax for specifying an *lvalue* is

```javascript
.id[ .id[ ... ] ]
```

where *id* is either a *name* or *name[exp]*, the latter being the syntax for specifying an array element, and *exp* must evaluate to a number; if *exp* evaluates to a noninteger number, it is truncated.

Also an *lvalue* must be assignable, meaning that *lvalue* cannot refer to a member program; that is, an *id* element of *lvalue* cannot be a program name. (In an *rvalue*, if a program name is specified, it must be in the last *id*.)

The syntax for specifying an *rvalue* is any of the following:

- "*string*"
- ‘*string*’
- `#`
- `exp`
- `(exp)`
- `.id[ .id[ ... ] ] [ program_arguments ]`
- `{}`
- `{el[ ,el[ ,... ] ]}`

The last two syntaxes concern assignment to arrays, and *el* may be any of the following:

- `nothing`
- "*string*"
- ‘*string*’
- `#`
- `(exp)`
- `.id[ .id[ ... ] ]`
- `[ .id[ .id[ ... ] ] [ program_arguments ] ]`

Let’s consider each of the syntaxes for an *rvalue* in turn:

- "*string*" and ‘*string*’
  - If the *rvalue* begins with a double quote (simple or compound), a string containing *string* will be returned. *string* may be long—up to the length of a macro.
If the *rvalue* is a number excluding missing values ., .a, ..., and .z, a *double* equal to the number specified will be returned.

**exp and (exp)**

If the *rvalue* is an expression, the expression will be evaluated and the result returned. A *double* will be returned if the expression returns a numeric result and a *string* will be returned if expression returns a string. Expressions returning matrices are not allowed.

The expression need not be enclosed in parentheses if the expression does not begin with simple or compound double quotes and does not begin with a period followed by nothing or a letter. In the cases just mentioned, the expression must be enclosed in parentheses. All expressions may be enclosed in parentheses.

An implication of the above is that missing value literals must be enclosed in parentheses: `lvalue = (.)`.

`id[.id[...]] [program_arguments]`

If the *rvalue* begins with a period, it is interpreted as an object reference. The object is evaluated and returned. `id[.id[...]]` may refer to a member variable or a member program.

If `id[.id[...]]` refers to a member variable, the value of the variable will be returned.

If `id[.id[...]]` refers to a member program, the program will be executed and the result returned. If the member program returns nothing, a *string* containing "" (nothing) will be returned.

If `id[.id[...]]` refers to a member program, arguments may be specified following the program name.

`{}` and `{el[,el[,...]]}`

If the *rvalue* begins with an open brace, an *array* will be returned.

If the *rvalue* is `{}`, an empty array will be returned.

If the *rvalue* is `{el[,el[,...]]}`, an array containing the specified elements will be returned.

If an *el* is nothing, the corresponding array element will be left undefined.

If an *el* is "[string]" or "'[string]'", the corresponding array element will be defined as a *string* containing *string*.

If an *el* is # excluding missing values ., .a, ..., .z, the corresponding array element will be defined as a *double* containing the number specified.

If an *el* is (exp), the expression is evaluated, and the corresponding array element will be defined as a *double* if the expression returns a numeric result or as a *string* if the expression returns a string. Expressions returning matrices are not allowed.

If an *el* is `.id[.id[...]]` or `[.id[.id[...]] [program_arguments]]`, the object is evaluated, and the corresponding array element will be defined according to what was returned. If the object is a member program and arguments need to be specified, the *el* must be enclosed in square brackets.

Recursive array definitions are not allowed.

Finally, in 4.3 *Specifying initialization*—where we discussed member variable initialization—what actually appears to the right of the equal sign is an *rvalue*, and everything just said applies. The previous discussion was incomplete.
7.4 Assignment of reference

Consider two different identifiers, .a.b.c and .d.e, that are of the same type. For example, perhaps both are doubles or both are coordinates. When you type

```
.a.b.c = .d.e
```

the result is to copy the values of .d.e into .a.b.c. If you type

```
.a.b.c.ref = .d.e.ref
```

the result is to make .a.b.c and .d.e be the same object. That is, if you were later to change some element of .d.e, the corresponding element of .a.b.c would change, and vice versa.

To understand this, think of member values as each being written on an index card. Each instance of a class has its own collection of cards (assuming no classwide variables). When you type

```
.a.b.c.ref = .d.e.ref
```

the card for .a.b.c is removed and a note is substituted that says to use the card for .d.e. Thus both .a.b.c and .d.e become literally the same object.

More than one object can share references. If we were now to code

```
.i.ref = .a.b.c.ref
```

or

```
.i.ref = .d.e.ref
```

the result would be the same: .i would also share the already-shared object.

We now have .a.b.c, .d.e, and .i all being the same object. Say that we want to make .d.e into its own unique object again. We type

```
.d.e.ref = anything evaluating to the right type not ending in .ref
```

We could, for instance, type any of the following:

```
.d.e.ref = .classname.new
.d.e.ref = .j.k
.d.e.ref = .d.e
```

All the above will make .d.e unique because what is returned on the right is a copy. The last of the three examples is intriguing because it results in .d.e not changing its values but becoming once again unique.

8. Built-ins

.new and .ref are examples of built-in member programs that are included in every class. There are other built-ins as well.

Built-ins may be used on any object except programs and other built-ins. Let .B refer to a built-in. Then

- If .a.b.myprog refers to a program, .a.b.myprog.B is an error (and, in fact, .a.b.myprog.anything is also an error).
- .a.b.B.anything is an error.
Built-ins come in two forms: built-in functions and built-in modifiers. Built-in functions return information about the class or class instance on which they operate but do not modify the class or class instance. Built-in modifiers might return something—in general they do not—but they modify (change) the class or class instance.

Except for `.new` (and that was covered in 4.4 Specifying initialization 2, `.new`), built-ins may not be redefined.

### 8.1 Built-in functions

In the documentation below, *object* refers to the context of the built-in function. For example, if `.a.b.F` is how the built-in function `.F` was invoked, then `.a.b` is the object on which it operates.

The built-in functions are

- **.new** returns a new instance of *object*. `.new` may be used whether the *object* is a class name or an instance, although it is most usually used with a class name. For example, if `coordinate` is a class, `.coordinate.new` returns a new instance of `coordinate`.

  If `.new` is used with an instance, a new instance of the class of the object is returned; the current instance is not modified. For example, if `.a.b` is an instance of `coordinate`, then `.a.b.new` does exactly what `.coordinate.new` would do; `.a.b` is not modified in any way.

  If you define your own `.new` program, it is run after the built-in `.new` is run.

- **.copy** returns a new instance—a copy—of *object*, which must be an instance. `.copy` returns a new object that is a copy of the original.

- **.ref** returns a reference to the object. See 7.4 Assignment of reference.

- **.objtype** returns a string indicating the type of *object*. Returned is one of "double", "string", "array", or "classname".

- **.isa** returns a string indicating the category of *object*. Returned is one of "double", "string", "array", "class", or "classtype". "classtype" is returned when *object* is a class definition; "class" is returned when the object is an instance of a class (sic).

- **.classname** returns a string indicating the name of the class. Returned is "classname" or, if *object* is of type double, string, or array, returned is "."

- **.isofclass classname** returns a double. Returns 1 if *object* is of class type `classname` and 0 otherwise. To be of a class type, *object* must be an instance of `classname`, inherited from the class `classname`, or inherited from a class that inherits anywhere along its inheritance path from `classname`.

- **.objkey** returns a string that can be used to reference an object outside the implied context. See 12.1 Keys.

- **.uname** returns a string that can be used as a *name* throughout Stata that corresponds to the object. See 12.2 Unames.
.ref_n
returns a double. Returned is the total number of identifiers sharing object. Returned is 1 if the object is unshared. See 7.4 Assignment of reference.

.arrnels
returns a double. .arrnels is for use with arrays; it returns the largest index of the array that has been assigned data. If object is not an array, it returns an error.

.arrindexof "string"
returns a double. .arrindexof is for use with arrays; it searches the array for the first element equal to string and returns the index of that element. If string is not found, .arrindexof returns 0. If object is not an array, it returns an error.

classmv
returns an array containing the .refs of each classwide member variable in object. See 12.3 Arrays of member variables.

instancemv
returns an array containing the .refs of each instance-specific member variable in object. See 12.3 Arrays of member variables.

dynamicmv
returns an array containing the .refs of each dynamically allocated member variable in object. See 12.3 Arrays of member variables.

.superclass
returns an array containing the .refs of each of the classes from which the specified object inherited. See 12.3 Arrays of member variables.

8.2 Built-in modifiers

Modifiers are built-ins that change the object to which they are applied. All built-in modifiers have names beginning with a capital letter. The built-in modifiers are

Declare declarator
returns nothing. .Declare may be used only when object is a class instance. .Declare adds the specified new member variable to the class instance. See 4.7 Adding dynamically.

Arrdropel #
returns nothing. .Arrdropel may be used only with array elements. .Arrdropel drops the specified array element, making it as if it was never defined. .arrnels is, of course, updated. See 7.2 Arrays and array elements.

Arrdropall
returns nothing. .Arrdropall may be used only with arrays. .Arrdropall drops all elements of an array. .Arrdropall is the same as .arrayname = {}. If object is not an array, .Arrdropall returns an error.

Arrpop
returns nothing. .Arrpop may be used only with arrays. .Arrpop finds the top element of an array (largest index) and removes it from the array. To access the top element before popping, use .arrayname['.arrayname.arrnels']. If object is not an array, .Arrpop returns an error.

Arrpush "string"
returns nothing. .Arrpush may be used only with arrays. .Arrpush pushes string onto the end of the array, where end is defined as .arrnels+1. If object is not an array, .Arrpush returns an error.
9. Prefix operators

There are three prefix operators:

\[ \text{.Global} \]
\[ \text{.Local} \]
\[ \text{.Super} \]

Prefix operators determine how object names such as \[ .a, .a.b, .a.b.c, \ldots \] are resolved.

Consider a program invoked by typing \[ .alpha.myprog \]. In program \[ .myprog \], any lines such as
\[ .a = .b \]
are interpreted according to the implied context, if that is possible. \[ .a \] is interpreted to mean \[ .alpha.a \] if \[ .a \] exists in \[ .alpha \]; otherwise, it is taken to mean \[ .a \] in the global context, meaning that it is taken to mean just \[ .a \]. Similarly, \[ .b \] is taken to mean \[ .alpha.b \] if \[ .b \] exists in \[ .alpha \]; otherwise, it is taken to mean \[ .b \].

What if \[ .myprog \] wants \[ .a \] to be interpreted in the global context even if \[ .a \] exists in \[ .alpha \]? Then the code would read
\[ \text{.Global.a} = .b \]

If instead \[ .myprog \] wanted \[ .b \] to be interpreted in the global context (and \[ .a \] to be interpreted in the implied context), the code would read
\[ .a = \text{.Global.b} \]

Obviously, if the program wanted both to be interpreted in the global context, the code would read
\[ \text{.Global.a} = \text{.Global.b} \]

\[ \text{.Local} \] is the reverse of \[ \text{.Global} \]: it ensures that the object reference is interpreted in the implied context. \[ \text{.Local} \] is rarely specified because the local context is searched first, but if there is a circumstance where you wish to be certain that the object is not found in the global context, you may specify its reference preceded by \[ \text{.Local} \]. Understand, however, that if the object is not found, an error will result, so you would need to precede commands containing such references with \[ \text{capture} \]; see \[ \text{[P] capture} \].

In fact, if it is used at all, \[ \text{.Local} \] is nearly always used in a macro-substitution context—something discussed in the next section—where errors are suppressed and where nothing is substituted when errors occur. Thus in advanced code, if you were trying to determine whether member variable \[ .addedvar \] exists in the local context, you could code
\[
\begin{align*}
\text{if "Local.addedvar.objtype" == ""} \\
\quad \text{/* it does not exist */} \\
\text{else} \\
\quad \text{/* it does */}
\end{align*}
\]

The \[ \text{.Super} \] prefix is used only in front of program names and concerns inheritance when one program occults another. This was discussed in \[ 5. \text{Inheritance} \].
10. Using object values

We have discussed definition and assignment of objects, but we have not yet discussed how you might use class objects in a program. How do you refer to their values in a program? How do you find out what a value is, skip some code if the value is one thing, and loop if it is another?

The most common way to refer to objects (and the returned results of member programs) is through macro substitution; for example,

```plaintext
local x = '.li.c0.x'
local clr "'.color.cvalue, color(green)'"
scalar len = '.coord.length'
forvalues i=1(1)'todo.n' {
    Mysub "'todo.list[‘i’]’"
}
```

When a class object is quoted, its printable form is substituted. This is defined as

<table>
<thead>
<tr>
<th>Object type</th>
<th>Printable form</th>
</tr>
</thead>
<tbody>
<tr>
<td>string</td>
<td>contents of the string</td>
</tr>
<tr>
<td>double</td>
<td>number printed using %18.0g, spaces stripped</td>
</tr>
<tr>
<td>array</td>
<td>nothing</td>
</tr>
<tr>
<td>classname</td>
<td>nothing or, if member program .macroexpand is defined, then string or double returned</td>
</tr>
</tbody>
</table>

Any object may be quoted, including programs. If the program takes arguments, they are included inside the quotes:

```plaintext
scalar len = ‘.coord.length’
local clr "‘.color.cvalue, color(green)’"
```

If the quoted reference results in an error, the error message is suppressed, and nothing is substituted.

Similarly, if a class instance is quoted—or a program returning a class instance is quoted—nothing is substituted. That is, nothing is substituted, assuming that the member program .macroexpand has not been defined for the class, as is usually the case. If .macroexpand has been defined, however, it is executed, and what macroexpand returns—which may be a string or a double—is substituted.

For example, say that we wanted to make all objects of type coordinate substitute (#,#) when they were quoted. In the class definition for coordinate, we could define .macroexpand,
begin coordinate.class 

version 17.0
class coordinate {
    [ declaration of member variables omitted ]
}
[ definitions of class programs omitted ]
program .macroexpand
    local tosub : display "(" '.x' "," "," '.y' ")"
    class exit "tosub"
end
end coordinate.class 

and now coordinates will be substituted. Say that .mycoord is a coordinate currently set to (2,3). If we did not include .macroexpand in the coordinate.class file, typing ...

...`.mycoord'...

would not be an error but would merely result in ........

Having defined .macroexpand, it will result in ...

...(2,3)...

A .macroexpand member function is intended as a utility for returning the printable form of a class instance and nothing more. In fact, the class system prevents unintended corruption of class-member variables by making a copy, returning the printable form, and then destroying the copy. These steps ensure that implicitly calling .macroexpand has no side effects on the class instance.

11. Object destruction

To create an instance of a class, you type

```
.name = .classname.new [arguments]
```

To destroy the resulting object and thus release the memory associated with it, you type

```
classutil drop .name
```

(See [P] classutil for more information on the classutil command.) You can drop only top-level instances. Objects deeper than that are dropped when the higher-level object containing them is dropped, and classes are automatically dropped when the last instance of the class is dropped.

Also any top-level object named with a name obtained from tempname—see [P] macro—is automatically dropped when the program concludes. Even so, tempname objects may be returned by class exit. The following is valid:

```
program .tension 

    tempname a b
    '.'a' = .bubble.new
    '.'b' = .bubble.new
    ...
    class exit '.'a'
```

The program creates two new class instances of bubbles in the global context, both with temporary names. We can be assured that ‘a’ and ‘b’ are global because the names ‘a’ and ‘b’ were obtained from tempname and therefore cannot already exist in whatever context in which .tension runs. Therefore, when the program ends, ‘a’ and ‘b’ will be automatically dropped. Even so, .tension can return ‘a’. It can do that because, at the time class exit is executed, the program has not yet concluded and ‘a’ still exists. You can even code

    program .tension
    ...
    tempname a b
    ‘a’ = .bubble.new
    ‘b’ = .bubble.new
    ...
    class exit ‘a’.ref
    end

and that also will return .a and, in fact, will be faster because no extra copy will be made. This form is recommended when returning an object stored in a temporary name. Do not, however, add .refs on the end of “real” (nontemporary) objects being returned because then you would be returning not just the same values as in the real object but the object itself.

You can clear the entire class system by typing discard; see [P] discard. There is no classutil drop _all command: Stata’s graphics system also uses the class system, and dropping all the class definitions and instances would cause graph difficulty. discard also clears all open graphs, so the disappearance of class definitions and instances causes graph no difficulty.

During the development of class-based systems, you should type discard whenever you make a change to any part of the system, no matter how minor or how certain you are that no instances of the definition modified yet exist.

12. Advanced topics

12.1 Keys

The .objkey built-in function returns a string called a key that can be used to reference the object as an rvalue but not as an lvalue. This would typically be used in

    local k = ‘.a.b.objkey’

or

    .c.k = .a.b.objkey

where .c.k is a string. Thus the keys stored could be then used as follows:

    .d = ‘k’.x
    .d = ‘.c.k’.x
    local z = ‘.k’.x
    local z = ‘.c.k’.x

meaning to assign .a.b.x to .d

(same)

meaning to put value of .a.b.x in ‘z’

(same)

It does not matter if the key is stored in a macro or a string member variable—it can be used equally well—and you always use the key by macro quoting.

A key is a special string that stands for the object. Why not, you wonder, simply type .a.b rather than ‘.c.k’ or ‘k’? The answer has to do with implied context.
Pretend that `.myvar.bin.myprogram` runs `.myprogram`. Obviously, it runs `.myprogram` in the context `.myvar.bin`. Thus `.myprogram` can include lines such as

```
.x = 5
```

and that is understood to mean that `.myvar.bin.x` is to be set to 5. `.myprogram`, however, might also include a line that reads

```
.Global.utility.setup '.x.objkey'
```

Here `.myprogram` is calling a utility that runs in a different context (namely, `.utility`), but `.myprogram` needs to pass `.x`—of whatever type it might be—to the utility as an argument. Perhaps `.x` is a coordinate, and `.utility.setup` expects to receive the identifier of a coordinate as its argument. `.myprogram`, however, does not know that `.myvar.bin.x` is the full name of `.x`, which is what `.utility.setup` will need, so `.myprogram` passes `.x.objkey`. Program `.utility.setup` can use what it receives as its argument just as if it contained `.myvar.bin.x`, except that `.utility.setup` cannot use that received reference on the left-hand side of an assignment.

If `.myprogram` needed to pass to `.utility.setup` a reference to the entire implied context (.myvar.bin), the line would read

```
.Global.utility.setup '.objkey'
```

because `.objkey` by itself means to return the key of the implied context.

### 12.2 Unames

The built-in function `.uname` returns a name that can be used throughout Stata that uniquely corresponds to the object. The mapping is one way. Unames can be obtained for objects, but the original object’s name cannot be obtained from the uname.

Pretend that you have object `.a.b.c`, and you wish to obtain a name you can associate with that object because you want to create a variable in the current dataset, or a value label, or whatever else, to go along with the object. Later, you want to be able to reobtain that name from the object’s name. `.a.b.cuname` will provide that name. The name will be ugly, but it will be unique. The name is not temporary: you must drop whatever you create with the name later.

Unames are, in fact, based on the object’s `.ref`. That is, consider two objects, `.a.b.c` and `.d.e`, and pretend that they refer to the same data; that is, you have previously executed

```
.a.b.c.ref = .d.e.ref
```

or

```
.d.e.ref = .a.b.c.ref
```

Then `.a.b.c.uname` will equal `.d.e.uname`. The names returned are unique to the data being recorded, not the identifiers used to arrive to the data.

As an example of use, within Stata’s graphics system sersets are used to hold the data behind a graph; see `[P] serset`. An overall graph might consist of several graphs. In the object nesting for a graph, each individual graph has its own object holding a serset for its use. The individual objects, however, are shared when the same serset will work for two or more graphs, so that the same data are not recorded again and again. That is accomplished by simply setting their `.ref` equal. Much later in the graphics code, when that code is writing a graph out to disk for saving, it needs to figure out which sersets need to be saved, and it does not wish to write shared sersets out multiple times. Stata finds out what sersets are shared by looking at their unames and, in fact, uses the unames to help it keep track of which sersets go with which graph.
12.3 Arrays of member variables

Note: The following functions are of little use in class programming. They are of use to those writing utilities to describe the contents of the class system, such as the features documented in [P] classutil.

The built-in functions .classmv, .instancemv, and .dynamicmv each return an array containing the .refs of each classwide, instance-specific, and dynamically declared member variables. These array elements may be used as either lvalues or rvalues.

.superclass also returns an array containing .refs, these being references to the classes from which the current object inherited. These array elements may be used as rvalues but should not be used as lvalues because they refer to underlying class definitions themselves.

.classmv, .instancemv, .dynamicmv, and .superclass, although documented as built-in functions, are not really functions, but instead are built-in member variables. This means that, unlike built-in functions, their references may be followed by other built-in functions, and it is not an error to type, for instance,

... .li.instancemv.arrnels ...

and it would be odd (but allowed) to type

.myarray = .li.instancemv

It would be odd simply because there is no reason to copy them because you can use them in place.

Each of the above member functions are a little sloppy in that they return nothing (produce an error) if there are no classwide, instance-specific, and dynamically declared member variables, or no inherited classes. This sloppiness has to do with system efficiency, and the proper way to work around the sloppiness is to obtain the number of elements in each array as 0'.classmv.arrnels', 0'.instancemv.arrnels', 0'.dynamicmv.arrnels', and 0'.superclass.arrnels'. If an array does not exist, then nothing will be substituted, and you will still be left with the result 0.

For example, assume that .my.c is of type coordinate2, defined as

```
begin coordinate2.class

class coordinate2 {
    classwide:
        double x_origin = 0
        double y_origin = 0
    instancespecific:
        double x = 0
        double y = 0
}
end coordinate2.class
```

Then

<table>
<thead>
<tr>
<th>referring to ...</th>
<th>is equivalent to referring to ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>.my.c.classmv[1]</td>
<td>.my.c.c.x_origin</td>
</tr>
<tr>
<td>.my.c.classmv[2]</td>
<td>.my.c.c.y_origin</td>
</tr>
<tr>
<td>.my.cinstancemv[1]</td>
<td>.my.c.c.x</td>
</tr>
<tr>
<td>.my.cinstancemv[2]</td>
<td>.my.c.c.y</td>
</tr>
</tbody>
</table>
If any member variables were added dynamically using `Dynamic`, they could equally well be accessed via `.my.c.dynamicmv[]` or their names. Either of the above could be used on the left or right of an assignment.

If `coordinate2.class` inherited from another class (it does not), referring to `coordinate2.superclass[1]` would be equivalent to referring to the inherited class; `coordinate2.superclass[1].new`, for instance, would be allowed.

These “functions” are mainly of interest to those writing utilities to act on class instances as a general structure.

Appendix A. Finding, loading, and clearing class definitions

The definition for class `xyz` is located in file `xyz.class`.

Stata looks for `xyz.class` along the ado-path in the same way that it looks for ado-files; see [U] 17.5 Where does Stata look for ado-files? and see [P] `sysdir`.

Class definitions are loaded automatically, as they are needed, and are cleared from memory as they fall into disuse.

When you type `discard`, all class definitions and all existing instances of classes are dropped; see [P] `discard`.

Appendix B. Jargon

**built-in**: a member program that is automatically defined, such as `.new`. A **built-in function** is a member program that returns a result without changing the object on which it was run. A **built-in modifier** is a member program that changes the object on which it was run and might return a result as well.

**class**: a name for which there is a class definition. If we say that `coordinate` is a class, then `coordinate.class` is the name of the file that contains its definition.

**class instance**: a “variable”; a specific, named copy (instance) of a class with its member values filled in; an identifier that is defined to be of type `classname`.

**classwide variable**: a member variable that is shared by all instances of a class. Its alternative is an instance-specific variable.

**inheritance**: the ability to define a class in terms of one (single inheritance) or more (multiple inheritance) existing classes. The existing class is typically called the base or super class, and by default, the new class inherits all the member variables and member programs of the base class.

**identifier**: the name by which an object is identified, such as `.mybox` or `.mybox.x`.

**implied context**: the instance on which a member program is run. For example, in `.a.b.myprog`, `.a.b` is the implied context, and any references to, say, `.x` within the program, are first assumed to, in fact, be references to `.a.b.x`.

**instance**: a class instance.

**instance-specific variable**: a member variable that is unique to each instance of a class; each instance has its own copy of the member variable. Its alternative is a classwide variable.

**lvalue**: an identifier that may appear to the left of the `=` assignment operator.

**member program**: a program that is a member of a class or of an instance.

**member variable**: a variable that is a member of a class or of an instance.
object: a class or an instance; this is usually a synonym for an instance, but in formal syntax
definitions, if something is said to be allowed to be used with an object, that means it may be
used with a class or with an instance.

polymorphism: when a system allows the same program name to invoke different programs according
to the class of the object. For example, `.draw` might invoke one program when used on a star
object, `.mystar.draw`, and a different program when used on a box object, `.mybox.draw`.

reference: most often the word is used according to its English-language definition, but a `.ref`
reference can be used to obtain the data associated with an object. If two identifiers have the same
reference, then they are the same object.

return value: what an object returns, which might be of type `double`, `string`, `array`, or `classname`.
Generally, return value is used in discussions of member programs, but all objects have a return
value; they typically return a copy of themselves.

rvalue: an identifier that may appear to the right of the `=` assignment operator.

scope: how it is determined to what object an identifier references. `.a.b` might be interpreted in the
global context and literally mean `.a.b`, or it might be interpreted in an implied context to mean
`.impliedcontext.a.b`.

shared object: an object to which two or more different identifiers refer.

type: the type of a member variable or of a return value, which is `double`, `string`, `array`, or `classname`.

Appendix C. Syntax diagrams

Appendix C.1 Class declaration

```
class [newclassname] { 
  [classwide:]
  [type mvname [= rvalue]]
  [mvname = rvalue]
  [...
   [instancespecific:]
   [type mvname [= rvalue]]
   [mvname = rvalue]
   [...

} [, inherit(classnamelist)]
```

where

`mvname` stands for member variable name;

`rvalue` is defined in Appendix C.2 Assignment; and

`type` is `{classname | double | string | array}`.
The `.Declare` built-in may be used to add a member variable to an existing class instance,

```c
.id[.id[...]] .Declare type newmvname [ = rvalue ]
.id[.id[...]] .Declare newmvname = rvalue
```

where `id` is `{name | name[exp]}`, the latter being how you refer to an array element; `exp` must evaluate to a number. If `exp` evaluates to a noninteger number, it is truncated.

### Appendix C.2 Assignment

```c
lvalue = rvalue
lvalue.ref = lvalue.ref                         (sic)
lvalue.ref = rvalue
```

where

- `lvalue` is `.id[.id[...]]`
- `rvalue` is
  ```c
  "[string]"
  '"[string]"',
  #
  exp
  (exp)
  .id[.id[...]]
  [ .id[.id[...]]].pgmname [pgm_arguments]
  [ .id[.id[...]]].Super[ (classname) ].pgmname [pgm_arguments]
  {}
  {el [,el [,...]]}
  ```

When `exp` evaluates to a string, the result will contain at most 2045 characters and will be terminated early if it contains a binary 0.

The last two syntaxes concern assignment to arrays; `el` may be

- `nothing`
  ```c
  "[string]"
  '"[string]"',
  #
  (exp)
  .id[.id[...]]
  [ .id[.id[...]]].pgmname
  [ [ .id[.id[...]]].pgmname [pgm_arguments]]
  [ [ .id[.id[...]]].Super[ (classname) ].pgmname [pgm_arguments]]
  ```

`id` is `{name | name[exp]}`, the latter being how you refer to an array element; `exp` must evaluate to a number. If `exp` evaluates to a noninteger number, it is truncated.
Appendix C.3 Macro substitution

Values of member variables or values returned by member programs can be substituted in any Stata command line in any context using macro quoting. The syntax is

\[ \ldots \text{'} .id[ .id[ .id ] ] \text{'} \ldots \]

\[ \ldots \text{'} .id[ .id[ .id ] ] .pgmname \text{'} \ldots \]

\[ \ldots \text{'} .id[ .id[ .id ] ] .pgmname\text{ }pgm\_arguments \text{'} \ldots \]

\[ \ldots \text{'} .id[ .id[ .id ] ] .Super\{(classname)\}.pgmname \text{'} \ldots \]

\[ \ldots \text{'} .id[ .id[ .id ] ] .Super\{(classname)\}.pgmname\text{ }pgm\_arguments \text{'} \ldots \]

Nested substitutions are allowed. For example,

\[ \ldots \text{'} .tmpname .x \text{'} \ldots \]

\[ \ldots \text{'} .ref \text{'} \ldots \]

In the above, perhaps local tmpname was obtained from tempname (see [P] macro), and perhaps local ref contains ‘‘.myobj.cvalue’’.

When a class object is quoted, its printable form is substituted. This is defined as

<table>
<thead>
<tr>
<th>Object type</th>
<th>Printable form</th>
</tr>
</thead>
<tbody>
<tr>
<td>string</td>
<td>contents of the string</td>
</tr>
<tr>
<td>double</td>
<td>number printed using %18.0g, spaces stripped</td>
</tr>
<tr>
<td>array</td>
<td>nothing</td>
</tr>
<tr>
<td>classname</td>
<td>nothing or, if member program .macroexpand is defined, then string or double returned</td>
</tr>
</tbody>
</table>

If the quoted reference results in an error, the error message is suppressed and nothing is substituted.

Appendix C.4 Quick summary of built-ins

Built-ins come in two forms: 1) built-in functions—built-ins that return a result but do not change the object on which they are run, and 2) built-in modifiers—built-ins that might return a result but more importantly modify the object on which they are run.
Built-in functions (may be used as \textit{rvalues})

- \texttt{.object.id}
  - creates new instance of \texttt{.object}
- \texttt{.instance.copy}
  - makes a copy of \texttt{.instance}
- \texttt{.instance.ref}
  - for use in assignment by reference
- \texttt{.object.objtype}
  - returns “double”, “string”, “array”, or “classname”
- \texttt{.object.isa}
  - returns “double”, “string”, “array”, “class”, or “classtype”
- \texttt{.object.classname}
  - returns “classname” or “”
- \texttt{.object.isofclass classname}
  - returns 1 if \texttt{.object} is of class type \texttt{classname}
- \texttt{.object.objkey}
  - returns a string that can be used to refer to an object outside the implied context
- \texttt{.object.uname}
  - returns a string that can be used as \texttt{name} throughout Stata; \texttt{name} corresponds to \texttt{.object}’s \texttt{.ref}.
- \texttt{.object.ref_n}
  - returns number (double) of total number of identifiers sharing object
- \texttt{.array.arrnels}
  - returns number (double) corresponding to largest index of the array assigned
- \texttt{.array.arrindexof "string"}
  - searches array for first element equal to \texttt{string} and returns the index (double) of element or returns 0
- \texttt{.object.classmv}
  - returns array containing the \texttt{.refs} of each classwide member of \texttt{.object}
- \texttt{.object.instancemv}
  - returns array containing the \texttt{.refs} of each instance-specific member of \texttt{.object}
- \texttt{.object.dynamicmv}
  - returns array containing the \texttt{.refs} of each dynamically added member of \texttt{.object}
- \texttt{.object.superclass}
  - returns array containing the \texttt{.refs} of each of the classes from which \texttt{.object} inherited

Built-in modifiers

- \texttt{.instance.Declare declarator}
  - returns nothing; adds member variable to instance; see \textit{Appendix C.1 Class declaration}
- \texttt{.array[exp].Arrdropel #}
  - returns nothing; drops the specified array element
- \texttt{.array.Arrpop}
  - returns nothing; finds the top element and removes it
- \texttt{.array.Arrpush "string"}
  - returns nothing; adds string to end of array
Also see

[P] class exit — Exit class-member program and return result

[P] classutil — Class programming utility

[P] sysdir — Query and set system directories

[M-2] class — Object-oriented programming (classes)

[U] 17.5 Where does Stata look for ado-files?
class exit — Exit class-member program and return result

Description
class exit exits a class-member program and optionally returns the specified result.
class exit may be used only from class-member programs; see [P] class.

Syntax
class exit [ rvalue ]

where rvalue is

" [ string ] "
` " [ string ] "`
#
exp
(exp)
.id[ .id[ ... ] ] [ program_arguments ]
{
}{el[,el[,] ... ]}

See [P] class for more information on rvalues.

Remarks and examples
Do not confuse returned values with return codes, which all Stata programs set, including member programs. Member programs exit when they execute.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Returned value</th>
<th>Return code</th>
</tr>
</thead>
<tbody>
<tr>
<td>class exit with arguments</td>
<td>as specified</td>
<td>0</td>
</tr>
<tr>
<td>class exit without arguments</td>
<td>nothing</td>
<td>0</td>
</tr>
<tr>
<td>exit without arguments</td>
<td>nothing</td>
<td>0</td>
</tr>
<tr>
<td>exit with arguments</td>
<td>nothing</td>
<td>as specified</td>
</tr>
<tr>
<td>error</td>
<td>nothing</td>
<td>as specified</td>
</tr>
<tr>
<td>command having error</td>
<td>nothing</td>
<td>as appropriate</td>
</tr>
</tbody>
</table>

Any of the preceding are valid ways of exiting a member program, although the last is perhaps best avoided. class exit without arguments has the same effect as exit without arguments; it does not matter which you use.
Examples

```plaintext
class exit sqrt(('.c0.y1'-'c1.y0')^2 + ('.c0.y1'-'c1.y0')^2)
class exit "myresult"
class exit (.)
class exit "true"
class exit { 'one', 'two'}
class exit .coord
class exit .coord.x
tempname a
... 
class exit .'a'
```

Warning: Distinguish carefully between “class exit .a” and “class exit (.a)”. The first returns a copy of the instance .a. The second returns a double equal to the extended missing value .a.

Also see

[P] class — Class programming

[P] exit — Exit from a program or do-file

[M-2] class — Object-oriented programming (classes)
**Description**

If you have not yet read [P] `class`, please do so. `classutil` stands outside the class system and provides utilities for examining and manipulating what it contains.

- `classutil drop` drops the specified top-level class instances from memory. To drop all class objects, type `discard`; see [P] `discard`.
- `classutil describe` displays a description of an object.
- `classutil dir` displays a list of all defined objects.
- `classutil cdir` displays a directory of all classes available.
- `classutil which` lists which `.class` file corresponds to the class specified.

**Syntax**

*Drop class instances from memory*

```
classutil drop instance [instance [...]]
```

*Describe object*

```
classutil describe object [, recurse newok]
```

*List all defined objects*

```
classutil dir [pattern] [, all detail]
```

*Display directory of available classes*

```
classutil cdir [pattern]
```

*List .class file corresponding to classname*

```
classutil which classname [, all]
```

where

* `object`, `instance`, and `classname` may be specified with or without a leading period.

* `instance` and `object` are as defined in [P] `class`: `object` is an `instance` or a `classname`.

* `pattern` is as allowed with the `strmatch()` function: * means that 0 or more characters go here, and ? means that exactly one character goes here.

Command `cutil` is a synonym for `classutil`.

`collect` is allowed with `classutil describe`, `classutil dir`, and `classutil cdir`; see [U] 11.1.10 Prefix commands.
Options for classutil describe

recurse specifies that classutil describe be repeated on any class instances or definitions that occur within the specified object. Consider the case where you type classutil describe .myobj and .myobj contains .myobj.c0, which is a coordinate. Without the recurse option, you will be informed that .myobj.c0 is a coordinate, and classutil describe will stop right there. With the recurse option, you will be informed that .myobj.c0 is a coordinate, and then classutil describe will proceed to describe .myobj.c0, just as if you had typed “classutil describe .myobj.c0”. If .myobj.c0 itself includes classes or class instances, they too will be described.

newok is relevant only when describing a class, although it is allowed—and ignored—at other times. newok allows classes to be described even when no instances of the class exist.

When asked to describe a class, Stata needs to access information about that class, and Stata knows the details about a class only when one or more instances of the class exist. If there are no instances, Stata is stuck—it does not know anything other than a class of that name exists. newok specifies that, in such a circumstance, Stata may temporarily create an instance of the class by using .new. If Stata is not allowed to do this, then Stata cannot describe the class. The only reason you are being asked to specify newok is that in some complicated systems, running .new can have side effects, although in most complicated and well-written systems, that will not be the case.

Options for classutil dir

all specifies that class definitions (classes) be listed, as well as top-level instances.

detail specifies that a more detailed description of each of the top-level objects be provided. The default is simply to list the names of the objects in tabular form.

Option for classutil which

all specifies that classutil which list all files along the search path with the specified name, not just the first one (the one Stata will use).

Remarks and examples

Remarks are presented under the following headings:

classutil drop
classutil describe
classutil dir
classutil cdir
classutil which

classutil drop

classutil drop may be used only with top-level instances, meaning objects other than classes having names with no dots other than the leading dot. If .mycoord is of type coordinate (or of type double), it would be allowed to drop .mycoord but not coordinate (or double). Thus each of the following would be valid, assuming that each is not a class definition:
The following would be invalid, assuming that `coordinate` is a class:

```
.classutil drop coordinate
```

There is no need to drop classes because they are automatically dropped when the last instance of them is dropped.

The following would not be allowed because they are not top-level objects:

```
.classutil drop .this.that
.classutil drop .mycolor.color.rgb[1]
```

Second-, third-, and higher-level objects are dropped when the top-level objects containing them are dropped.

In all the examples above, we have shown objects identified with leading periods, as is typical. The period may, however, be omitted.

```
.classutil drop this mycolor
```

Technical note

Stata’s graphics are implemented using classes. If you have a graph displayed, be careful not to drop objects that are not yours. If you drop a system object, Stata will not crash, but `graph` may produce some strange error messages. If you are starting a development project, it is best to discard (see `p discard`) before starting—that will eliminate all objects and clear any graphs. This way, the only objects defined will be the objects you have created.

classutil describe

`classutil describe` presents a description of the object specified. The object may be a class or an instance and may be of any depth. The following are all valid:

```
.classutil describe coordinate
.classutil describe .this
.classutil describe .color.rgb
.classutil describe .color.rgb[1]
```

The object may be specified with or without a leading period; it makes no difference.

Also see above the descriptions of the `recurse` and `newok` options. The following would also be allowed:

```
.classutil describe coordinate, newok
.classutil describe line, recurse
.classutil describe line, recurse newok
```
classutil dir

_classutil dir_ lists all top-level instances currently defined. Note the emphasis on instances: class definitions (classes) are not listed. _classutil dir, all_ will list all objects, including the class definitions.

If the _detail_ option is specified, a more detailed description is presented, but it is still less detailed than that provided by _classutil describe_.

_pattern_, if specified, is as defined for Stata’s _strmatch()_ function: * means that 0 or more characters go here, and ? means that exactly one character goes here. If _pattern_ is specified, only top-level instances or objects matching the pattern will be listed. Examples include

```
. classutil dir
. classutil dir, detail
. classutil dir, detail all
. classutil dir c*
. classutil dir *_g, detail
```

classutil cdir

_classutil cdir_ lists the available classes. Without arguments, all classes are listed. If _pattern_ is specified, only classes matching the pattern are listed:

```
. classutil cdir
. classutil cdir c*
. classutil cdir coord*
. classutil cdir *_g
. classutil cdir color_{_?}_*
```

_pattern_ is as defined for Stata’s _strmatch()_ function: * means that 0 or more characters go here, and ? means that exactly one character goes here.

_classutil cdir_ obtains the list by searching for *.class files along the ado-path; see _[P sysdir]_.

classutil which

_classutil which_ identifies the .class file associated with class _classname_ and displays lines from the file that begin with *!_. For example,

```
. classutil which mycolortype
C:\ado\personal\mycolortype.class
*! version 1.0.1
```

_classutil which_ searches in the standard way for the .class files, that is, by looking for them along the ado-path; see _[P sysdir]_.


With the all option, `classutil which` lists all files along the search path with the specified name, not just the first one found (the one Stata would use):

```
. classutil which mycolortype, all
C:\ado\personal\mycolortype.class
*! version 1.0.1
C:\ado\plus\m\mycolortype.class
*! version 1.0.0
```

*! lines have to do with versioning. * is one of Stata’s comment markers, so *! lines are comment lines. *! is a convention that some programmers use to record version or author information. If there are no *! lines, then only the filename is listed.

### Stored results

- `classutil drop` returns nothing.
- `classutil describe` returns macro `r(type)` containing `double`, `string`, `classname`, or `array` and returns `r(bitype)` containing the same, except that if `r(type)=="classname"`, `r(bitype)` contains `class` or `instance`, depending on whether the object is the definition or an instance of the class.
- `classutil cdir` returns in macro `r(list)` the names of the available classes matching the pattern specified. The names will not be preceded by a period.
- `classutil dir` returns in macro `r(list)` the names of the top-level instances matching the pattern specified as currently defined in memory. The names will be preceded by a period if the corresponding object is an instance and will be unadorned if the corresponding object is a class definition.
- `classutil which` without the all option returns in `r(fn)` the name of the file found; the name is not enclosed in quotes. With the all option, `classutil which` returns in `r(fn)` the names of all the files found, listed one after the other and each enclosed in quotes.

### Also see

[P] class — Class programming
This entry provides a quick reference for how to specify comments in programs. See [U] 16.1.2 Comments and blank lines in do-files for more details.

## Remarks and examples

Comments may be added to programs in three ways:

- begin the line with `*;`
- begin the comment with `//`; or
- place the comment between `/*` and `*/` delimiters.

Here are examples of each:

```plaintext
* a sample analysis job
version 17.0
use census
 /* obtain the summary statistics */
tabulate region  // there are 4 regions in this dataset
summarize marriage

* a sample analysis job
version 17.0
use /* obtain the summary statistics */ census
tabulate region
 // there are 4 regions in this dataset
summarize marriage
```

The comment indicator `*` may be used only at the beginning of a line, but it does have the advantage that it can be used interactively. `*` indicates that the line is to be ignored. The `*` comment indicator may not be used within Mata.

The `//` comment indicator may be used at the beginning or at the end of a line. However, if the `//` indicator is at the end of a line, it must be preceded by one or more blanks. That is, you cannot type the following:

```plaintext
tabulate region// there are 4 regions in this dataset
```

`//` indicates that the rest of the line is to be ignored.

The `/*` and `*/` comment delimiter has the advantage that it may be used in the middle of a line, but it is more cumbersome to type than the other two comment indicators. What appears inside `/*` `*/` is ignored.
Technical note

There is a fourth comment indicator, ///, that instructs Stata to view from /// to the end of a line as a comment and to join the next line with the current line. For example,

```
args a /// input parameter for a
    b /// input parameter for b
    c /// input parameter for c
```

is equivalent to

```
args a b c
```

/// is one way to make long lines more readable:

```stata
replace final_result = ///
sqrt(first_side^2 + second_side^2) ///
    if type == "rectangle"
```

Another popular method is

```stata
replace final_result = /*
    */ sqrt(first_side^2 + second_side^2) /*
    */ if type == "rectangle"
```

Like the // comment indicator, the /// indicator must be preceded by one or more blanks.

Also see

[P] #delimit — Change delimiter

[U] 16.1.2 Comments and blank lines in do-files

[U] 18.11.2 Comments and long lines in ado-files
confirm — Argument verification

Description

confirm verifies that the arguments following confirm ... are of the claimed type and issues the appropriate error message and nonzero return code if they are not.

confirm is useful in do-files and programs when you do not want to bother issuing your own error message. confirm can also be combined with capture to detect and handle error conditions before they arise; see [P] capture.

Syntax

confirm existence string  
confirm [new] file filename  
confirm [numeric|string|date] format string  
confirm [new] frame name  
confirm names names  
confirm [integer] number string  
confirm matrix string  
confirm scalar string  
confirm [new|numeric|string|str#|type] variable varlist [ , exact ]

where type is {byte|int|long|float|double|str#|strL}

Option

exact specifies that a match be declared only if the names specified in varlist match. By default, names that are abbreviations of variables are considered to be a match.

Remarks and examples

Remarks are presented under the following headings:

confirm existence  
confirm file  
confirm format  
confirm frame  
confirm names  
confirm number  
confirm matrix  
confirm scalar  
confirm variable
confirm existence

confirm existence displays the message “’’ found where something expected” and produces a return code of 6 if string does not exist.

confirm file

confirm file verifies that filename exists and is readable and issues the appropriate error message and return code if not.

confirm new file verifies that filename does not exist and that filename could be opened for writing, and issues the appropriate error message and return code if not.

The possible error messages and return codes are

<table>
<thead>
<tr>
<th>Message</th>
<th>Return code</th>
</tr>
</thead>
<tbody>
<tr>
<td>___ found where filename expected</td>
<td>7</td>
</tr>
<tr>
<td>file ___ not found</td>
<td>601</td>
</tr>
<tr>
<td>file ___ already exists</td>
<td>602</td>
</tr>
<tr>
<td>file ___ could not be opened</td>
<td>603</td>
</tr>
</tbody>
</table>

Return codes of 7 and 603 are possible for both confirm file and confirm new file. For confirm new file, a return code of 603 indicates that the filename is invalid, the specified directory does not exist, or the directory permissions do not allow you to create a new file. For instance, even if filename does not exist, confirm new file newdir\newfile will generate an error if newdir does not exist and if you do not have permissions to create a file in newdir. confirm new file filename will fail if you do not have adequate permissions to create a new file in the current working directory.

confirm format

confirm format verifies that string is a valid variable display format. It produces the message

’string’ found where format expected

with a return code of 7 if the format is not valid. It produces the message

” found where format expected

with a return code of 7 if the format is empty.

confirm numeric format specifies that the argument must be a valid numeric format. Valid numeric formats are general, fixed, and exponential. If not, it produces a return code of 7 and the message

’string’ found where numeric format expected

or

” found where numeric format expected

if string is empty.
confirm string format specifies that the argument must be a valid string format. If not, it produces a return code of 7 and the message

```
'string' found where string format expected
```

or

```
'' found where string format expected
```

if string is empty.

confirm date format specifies that the argument must be a valid date format. If not, it produces a return code of 7 and the message

```
'string' found where date format expected
```

or

```
'' found where date format expected
```

if string is empty.

confirm frame

confirm frame verifies that name is a frame (see [D] frames). It produces the message

```
frame name not found
```

with a return code of 111 if a frame named name does not exist.

confirm new frame verifies that name is valid to be used as the name of a frame and that a frame with that name does not already exist. The possible messages and return codes are the following:

<table>
<thead>
<tr>
<th>Message</th>
<th>Return code</th>
</tr>
</thead>
<tbody>
<tr>
<td>___ found where frame name expected</td>
<td>7</td>
</tr>
<tr>
<td>frame ___ already defined</td>
<td>110</td>
</tr>
<tr>
<td>___ invalid name</td>
<td>198</td>
</tr>
</tbody>
</table>

confirm names

confirm names verifies that the argument or arguments are valid names according to Stata’s naming conventions. It produces the message

```
{name | nothing} invalid name
```

with a return code of 7 if the names are not valid.
confirm number

confirm number verifies that the argument can be interpreted as a number, such as 1, 5.2, −5.2, or 2.5e+10. It produces the message

\{string | nothing\} found where number expected

with a return code of 7 if not.

confirm integer number specifies that the argument must be an integer, such as 1 or 2.5e+10, but not 5.2 or −5.2. If not, it produces a return code of 7 and a slight variation on the message above:

\{string | nothing\} found where integer expected

confirm matrix

confirm matrix verifies that string is a matrix. It produces the message

matrix string not found

with a return code of 111 if string is not a matrix.

confirm scalar

confirm scalar verifies that string is a scalar. It produces the message

scalar string not found

with a return code of 111 if string is not a scalar.

confirm variable

confirm variable verifies that varlist can be interpreted as an existing varlist of any types of variables. If not, the appropriate error message and nonzero return code are returned:

<table>
<thead>
<tr>
<th>Message</th>
<th>Return code</th>
</tr>
</thead>
<tbody>
<tr>
<td>___ found where numeric variable expected</td>
<td>7</td>
</tr>
<tr>
<td>___ found where string variable expected</td>
<td>7</td>
</tr>
<tr>
<td>___ found where str# variable expected</td>
<td>7</td>
</tr>
<tr>
<td>___ found where strL variable expected</td>
<td>7</td>
</tr>
<tr>
<td>no variables defined</td>
<td>111</td>
</tr>
<tr>
<td>variable ___ not found</td>
<td>111</td>
</tr>
<tr>
<td>___ invalid name</td>
<td>198</td>
</tr>
</tbody>
</table>

confirm numeric variable specifies that all the variables are numeric. If the variable exists but is not numeric, Stata displays the message

'varname' found where numeric variable expected

or

'' found where numeric variable expected

with a return code of 7 if varlist is not specified.

confirm string variable specifies that all the variables are strings, meaning str# or strL. If the variable exists but is not a string variable, Stata displays the message

'varname' found where string variable expected

or

'' found where string variable expected

with a return code of 7 if varlist is not specified.
confirm str# variable specifies that all the variables are str#, such as str10 or str42, but are not strLs.

confirm type variable specifies that all variables are of the indicated storage type. For example, confirm int variable myvar, confirm float variable myvar thatvar, or confirm strL variable blobvar. As with confirm string variable, the appropriate message and return code of 7 are possible.

confirm new variable verifies that varlist can be interpreted as a new varlist. The possible messages and return codes are

<table>
<thead>
<tr>
<th>Message</th>
<th>Return code</th>
</tr>
</thead>
<tbody>
<tr>
<td>found where varname expected</td>
<td>7</td>
</tr>
<tr>
<td>already defined</td>
<td>110</td>
</tr>
<tr>
<td>invalid name</td>
<td>198</td>
</tr>
</tbody>
</table>

**Example 1**

confirm is a cheap way to include minimal syntax checking in your programs. For instance, you have written a program that is supposed to take a one-integer argument. Although you do not have to include any syntax checking at all—the program will probably fail with some error if the argument is incorrect—it is safer to add one line at the top of the program:

```plaintext
confirm integer number '1'
```

Now if the first argument is not an integer, you will get a reasonable error message, and the program will stop automatically.

**Example 2**

More sophisticated programs often combine the confirm and capture commands. For instance, ttest has a complex syntax: if the user types ttest var=5, it tests that the mean of var is 5 using one set of formulas, and if the user types ttest var=var2, it tests equality of means by using another set of formulas. Whether there is a number or a variable to the right of the equal sign determines which set of formulas ttest uses. This choice was done by

```plaintext
capture confirm number 'exp'
if _rc==0 {
    (code for test against a constant )
    exit
}
(code for test of two variables)
```

**Also see**

[P] capture — Capture return code
Title

continue — Break out of loops

Description

The continue command within a foreach, forvalues, or while loop breaks execution of the current loop iteration and skips the remaining commands within the loop. Execution resumes at the top of the loop unless the break option is specified, in which case execution resumes with the command following the looping command. See [P] foreach, [P] forvalues, and [P] while for a discussion of the looping commands.

Syntax

continue [, break]

Option

break indicates that the loop is to be exited. The default is to skip the remaining steps of the current iteration and to resume loop execution again at the top of the loop.

Remarks and examples

We illustrate continue with the forvalues command, but it can be used in the same way with the foreach and while commands.

Example 1

The following forvalues loop lists the odd and even numbers from one to four:

```
. forvalues x = 1(1)4 {
2.     if mod('x',2) {
3.         display "'x' is odd"
4.     }
5.     else {
6.         display "'x' is even"
7.     }
8. }
1 is odd
2 is even
3 is odd
4 is even
```
It could be coded using the `continue` command instead of `else`:

```
    . forvalues x = 1(1)4 {
        2.     if mod('x',2) {
            3.         display "'x' is odd"
            4.         continue
            5.     }
        6.     display "'x' is even"
        7.   }
```

1 is odd
2 is even
3 is odd
4 is even

When `continue` is executed, any remaining statements that exist in the loop are ignored. Execution continues at the top of the loop where, here, `forvalues` sets the next value of `x`, compares that with 4, and then perhaps begins the loop again.

Example 2

`continue, break` causes execution of the loop to stop; it prematurely exits the loop.

```
    . forvalues x = 6/1000 {
        2.     if mod('x',2)==0 & mod('x',3)==0 & mod('x',5)==0 {
            3.         display "The least common multiple of 2, 3, and 5 is 'x'"
            4.         continue, break
            5.     }
        6.   }
```

The least common multiple of 2, 3, and 5 is 30

Although the `forvalues` loop was scheduled to go over the values 6–1,000, the `continue, break` statement forced it to stop after 30.

Also see

[P] `foreach` — Loop over items
[P] `forvalues` — Loop over consecutive values
[P] `while` — Looping
[P] `exit` — Exit from a program or do-file
[P] `if` — if programming command
[U] 18 Programming Stata
creturn  —  Return c-class values

Description

Stata’s c-class, c(), contains the values of system parameters and settings, along with certain constants such as the value of pi. c() values may be referred to but may not be assigned.

Menu

Data > Other utilities > List constants and system parameters

Syntax

\texttt{creturn list}

Remarks and examples

The c-class values are presented under the following headings:

- System values
- Directories and paths
- System limits
- Numerical and string limits
- Current dataset
- Memory settings
- Output settings
- Interface settings
- Graphics settings
- Network settings
- Update settings
- Trace (program debugging) settings
- Mata settings
- Java settings
- LAPACK settings
- putdocx settings
- Python settings
- RNG settings
- sort settings
- Unicode settings
- Other settings
- Other

There may be other c-class values that have been added since the printing of this manual. Type \texttt{help creturn} for up-to-date information.
System values

\(\text{c(current\_date)}\) returns the current date as a string in the format "dd Mon yyyy", where dd is the day of the month (if day is less than 10, a space and one digit are used); Mon is one of Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, or Dec; and yyyy is the four-digit year.

Examples:
1 Jan 2003
26 Mar 2007
28 Jan 2013

\(\text{c(current\_time)}\) returns the current time as a string in the format "hh:mm:ss", where hh is the hour 00–23, mm is the minute 00–59, and ss is the second 00–59.

Examples:
09:42:55
13:02:01
21:15:59

\(\text{c(rmsg\_time)}\) returns a numeric scalar equal to the elapsed time last reported as a result of \text{set rmsg} on; see \text{[P] rmsg}.

\(\text{c(stata\_version)}\) returns a numeric scalar equal to the version of Stata that you are running. In Stata 17, this number is 17; in Stata 17.1, 17.1; and in Stata 18, 18. This is the version of Stata that you are running, not the version being mimicked by the \text{version} command.

\(\text{c(version)}\) returns a numeric scalar equal to the version currently set by the \text{version} command; see \text{[P] version}.

\(\text{c(userversion)}\) returns a numeric scalar equal to the user version currently set by the \text{version} command; see \text{[P] version}.

\(\text{c(dyndoc\_version)}\) returns a numeric scalar equal to the current version of \text{dynamic documents} Stata understands how to convert. Stata can convert any dynamic document with a version less than or equal to \(\text{c(dyndoc\_version)}\). The dynamic document version is set by the \text{\(<<dd\_version>>\)} tag within the document.

\(\text{c(born\_date)}\) returns a string in the same format as \(\text{c(current\_date)}\) containing the date of the Stata executable that you are running; see \text{[R] update}.

\(\text{c(edition)}\) returns a string containing "BE", according to the version of Stata that you are running.
\(\text{c(edition)} == "BE"\) for Stata/MP and Stata/SE, as well as for Stata/BE. Think of \(\text{c(edition)} == "BE"\) as meaning "BE or better", so Stata/BE and all higher editions of Stata are considered to be "BE".

\(\text{c(edition\_real)}\) returns a string containing "BE", "SE", or "MP", according to the version of Stata that you are running. \(\text{c(edition\_real)} == "BE"\) for Stata/BE. \(\text{c(edition\_real)} == "SE"\) for Stata/SE. \(\text{c(edition\_real)} == "MP"\) for Stata/MP.

\(\text{c(bit)}\) returns a numeric scalar equal to 64 if you are using a 64-bit version of Stata and 32 if you are using a 32-bit version of Stata. You would only see \(\text{c(bit)} == 32\) if you were using an older version of Stata; all modern Stata executables are 64-bit.

\(\text{c(SE)}\) returns a numeric scalar equal to 1 if you are running Stata/SE or Stata/MP and returns 0 otherwise. Think of \(\text{c(SE)} == 1\) as meaning "SE or better", so Stata/SE and Stata/MP both return 1.

\(\text{c(MP)}\) returns a numeric scalar equal to 1 if you are running Stata/MP and 0 otherwise.

\(\text{c(processors)}\) returns a numeric scalar equal to the number of processors/cores that Stata/MP is currently set to use. It returns 1 if you are not running Stata/MP.
c(processors_lic) returns a numeric scalar equal to the number of processors/cores that your Stata/MP license allows. It returns 1 if you are not running Stata/MP.

c(processors_mach) returns a numeric scalar equal to the number of processors/cores that your computer has if you are running Stata/MP. It returns missing value (.) if you are not running Stata/MP.

c(processors_max) returns a numeric scalar equal to the maximum number of processors/cores that Stata/MP could use, which is equal to the minimum of c(processors_lic) and c(processors_mach). It returns 1 if you are not running Stata/MP.

c(mode) returns a string containing "" or "batch", depending on whether Stata was invoked in interactive mode (the usual case) or batch mode (using, perhaps, the -b option of Stata for Unix).

c(console) returns a string containing "" or "console", depending on whether you are running a windowed version of Stata or Stata(console).

c(os) returns a string containing "MacOSX", "Unix", or "Windows", depending on the operating system that you are using. The list of alternatives, although complete as of the date of this writing, may not be complete.

c(osdtl) returns an additional string, depending on the operating system, that provides the release number or other details about the operating system. c(osdtl) is often "".

c(hostname) returns a string containing the name of the host machine.

c(machine_type) returns a string that describes the hardware platform, such as "PC", "PC (64-bit x86-64)", or "Macintosh (Intel 64-bit)".

c(byteorder) returns a string containing "lohi" or "hilo", depending on the byte order of the hardware. Consider a two-byte integer. On some computers, the most significant byte is written first, so x'0001' (meaning the byte 00 followed by 01) would mean the number 1. Such computers are designated "hilo". Other computers write the least-significant byte first, so x'0001' would be 256, and 1 would be x'0100'. Such computers are designated "lohi".

c(username) returns the user ID (provided by the operating system) of the user currently using Stata.

Directories and paths

Note: The directory paths returned below usually end in a directory separator, so if you wish to construct the full path name of file abc.def in directory c(...), you code

    ...'c(...)'abc.def...

and not

    ...'c(...)'/abc.def...

If c(...) returns a directory name that does not end in a directory separator, a special note of the fact is made.

c(sysdir_stata) returns a string containing the name of the directory in which Stata is installed. More technically, c(sysdir_stata) returns the STATA directory as defined by sysdir; see [P] sysdir.

Example: C:\Program Files\Stata17/

The above example contains no typographical errors. Under Windows, the directory name will end in forward slash. That is so you can code things such as ‘c(sysdir_stata)’‘filename’.

If c(sysdir_stata) ended in backslash, Stata’s macro expander would interpret the backslash as an escape character and so not expand ‘filename’.

c(sysdir_base) returns a string containing the name of the directory in which the original official ado-files that were shipped with Stata were installed.

Example: C:\Program Files\Stata17\ado\base/

c(sysdir_site) returns a string containing the name of the directory in which community-contributed additions may be installed for sitewide use. More technically, c(sysdir_site) returns the SITE directory as defined by sysdir; see [P] sysdir.

Example: C:\Program Files\Stata17\ado\site/

c(sysdir_plus) returns a string containing the name of the directory in which additions written by others may be installed for personal use. More technically, c(sysdir_plus) returns the PLUS directory, as defined by sysdir; see [P] sysdir.

Example: C:\ado\plus/

c(sysdir_personal) returns a string containing the name of the directory in which additions written by you may be installed. More technically, c(sysdir_personal) returns the PERSONAL directory, as defined by sysdir; see [P] sysdir.

Example: C:\ado\personal/

c(sysdir_oldplace) identifies another directory in which community-contributed ado-files might be installed. c(sysdir_oldplace) maintains compatibility with very ancient versions of Stata.

c(tmpdir) returns a string containing the name of the directory used by Stata for temporary files.

Example: /tmp

c(adopath) returns a string containing the directories that are to be searched when Stata is attempting to locate an ado-file. The path elements are separated by a semicolon (;), and the elements themselves may be directory names, "." to indicate the current directory, or sysdir references.

Example: BASE;SITE;.;PERSONAL;PLUS;OLDPLACE

c(pwd) returns a string containing the current (working) directory.

Example: C:\data

Notice that c(pwd) does not end in a directory separator, so in a program, to save the name of the file abc.def prefixed by the current directory (for example, because you were about to change directories and still wanted to refer to the file), you would code

   local file "c(pwd)'/abc.def"

or

   local file "c(pwd)"c(dirsep)"abc.def"

The second form is preferred if you want to construct “pretty” filenames, but the first form is acceptable because Stata understands a forward slash (/) as a directory separator.

c(dirsep) returns a string containing "/".

Example: /

For Windows operating systems, a forward slash (/) is returned rather than a backslash (\). Stata for Windows understands both, but in programs, use of the forward slash is recommended because the backslash can interfere with Stata’s interpretation of macro expansion characters. Do not be concerned if the result of your code is a mix of backslash and forward slash characters, such as \a\b/myfile.dta: Stata will understand it just as it would understand /a/b/myfile.dta or \a\b\myfile.dta.
System limits

\( c(\text{max\_N\_theory}) \) returns a numeric scalar reporting the maximum number of observations allowed. \( c(\text{max\_N\_theory}) \) reports the maximum number of observations that Stata can process if it has enough memory. This is usually 2,147,483,619 for Stata/SE and Stata/BE and is 1,099,511,627,775 for Stata/MP.

\( c(\text{max\_k\_theory}) \) returns a numeric scalar reporting the maximum number of variables allowed. If you have Stata/MP or Stata/SE, you can change this number with \texttt{set maxvar}; see \texttt{[D] memory}.

\( c(\text{max\_width\_theory}) \) returns the theoretical maximum width allowed. The width of a dataset is defined as the sum of the byte lengths of its individual variables. If you had a dataset with two \texttt{int} variables, three \texttt{floats}, one \texttt{double}, and a \texttt{str20} variable, the width of the dataset would be \( 2 \times 2 + 3 \times 4 + 8 + 20 = 44 \) bytes.

\( c(\text{max\_matdim}) \) returns the maximum row or column dimension for Stata matrices. This dimension is 65,534 for Stata/MP, 32,767 for Stata/SE, and 800 for Stata/BE.

\( c(\text{max\_it\_cvars}) \) returns a numeric scalar reporting the maximum number of continuous variables allowed in an interaction.

\( c(\text{max\_it\_fvars}) \) returns a numeric scalar reporting the maximum number of factor variables allowed in an interaction.

\( c(\text{max\_macrolen}) \) and \( c(\text{macrolen}) \) each return a numeric scalar reporting the maximum length of macros. \( c(\text{max\_macrolen}) \) and \( c(\text{macrolen}) \) may not be equal under Stata/MP or Stata/SE and will be equal otherwise. For Stata/MP or Stata/SE, \( \text{macrolen} \) is set according to \texttt{maxvar}: the length is long enough to hold a macro referring to every variable in the dataset.

\( c(\text{charlen}) \) returns a numeric scalar reporting the maximum length of a characteristic.

\( c(\text{max\_cmdlen}) \) and \( c(\text{cmdlen}) \) each return a numeric scalar reporting the maximum length of a Stata command. \( c(\text{max\_cmdlen}) \) and \( c(\text{cmdlen}) \) may not be equal under Stata/MP or Stata/SE and will be equal otherwise. For Stata/MP or Stata/SE, \( \text{cmdlen} \) is set according to \texttt{maxvar}: the length is long enough to hold a command referring to every variable in the dataset.

\( c(\text{nameLEN\_byte}) \) returns a numeric scalar equal to 128, which is the current maximum length in bytes of names in Stata.

\( c(\text{nameLEN\_char}) \) returns a numeric scalar equal to 32, which is the current maximum length in Unicode characters of names in Stata.

\( c(\text{eq\_len}) \) returns the maximum length that Stata allows for equation names.

Numerical and string limits

\( c(\text{mindouble}), c(\text{maxdouble}), \) and \( c(\text{eps\_double}) \) each return a numeric scalar. \( c(\text{mindouble}) \) is the largest negative number that can be stored in the 8-byte \texttt{double} storage type. \( c(\text{maxdouble}) \) is the largest positive number that can be stored in a \texttt{double}. \( c(\text{eps\_double}) \) is the smallest nonzero, positive number (epsilon) that, when added to 1 and stored as a \texttt{double}, does not equal 1.

\( c(\text{smallest\_double}) \) returns a numeric scalar containing the smallest full-precision \texttt{double} that is bigger than zero. There are smaller positive values that can be stored; these are denormalized numbers. Denormalized numbers do not have full precision.

\( c(\text{min\_float}), c(\text{max\_float}), \) and \( c(\text{eps\_float}) \) each return a numeric scalar that reports for the 4-byte \texttt{float} storage type what \( c(\text{mindouble}), c(\text{maxdouble}), \) and \( c(\text{eps\_double}) \) report for \texttt{double}. 
c(minlong) and c(maxlong) return scalars reporting the largest negative number and the largest positive number that can be stored in the 4-byte, integer long storage type. There is no c(epslong), but if there were, it would return 1.

c(minint) and c(maxint) return scalars reporting the largest negative number and the largest positive number that can be stored in the 2-byte, integer int storage type.

c(minbyte) and c(maxbyte) return scalars reporting the largest negative number and the largest positive number that can be stored in the 1-byte, integer byte storage type.

c(maxstrvarlen) returns the longest str# string storage type allowed, which is 2045. Do not confuse c(maxstrvarlen) with c(macrolen). c(maxstrvarlen) corresponds to string variables stored in the data.

c(maxstrlvarlen) returns the length of the longest string that can be stored in a strL, which is 2,000,000,000.

c(maxvlabellen) returns the maximum length for one value label string, which is 32,000.

Current dataset

c(frame) returns a string containing the name of the current frame; see [D] frames intro.

c(N) returns a numeric scalar equal to _N, the number of observations in the dataset in memory. In an expression, it makes no difference whether you refer to _N or c(N). However, when used in expressions with the by prefix, c(N) does not change with the by-group like _N.

The advantage of c(N) is in nonexpression contexts. Say that you are calling a subroutine, mysub, which takes as an argument the number of observations in the dataset. Then you could code

local nobls = _N
mysub 'nobs'

or

mysub 'c(N)'

The second requires less typing.

c(obs_t) returns a string equal to the optimal data type for storing _n. This allows you to code

generate 'c(obs_t)' index = _n

and know that index will go from 1 to _N without roundoff errors and without wasting any space.

c(k) returns a numeric scalar equal to the number of variables in the dataset in memory. c(k) is equal to r(k), which is returned by describe.

c(width) returns a numeric scalar equal to the width, in bytes, of the dataset in memory. If you had a dataset with two int variables, three floats, one double, and a str20 variable, the width of the dataset would be 2 * 2 + 3 * 4 + 8 + 20 = 44 bytes. c(width) is equal to r(width), which is returned by describe.

c(changed) returns a numeric scalar equal to 0 if the dataset in memory has not changed since it was last saved and 1 otherwise. c(changed) is equal to r(changed), which is returned by describe.

c(filename) returns a string containing the filename last specified with a use or save, such as "C:\Data\auto.dta". c(filename) is equal to $S_FN.

c(filedate) returns a string containing the date and time the file in c(filename) was last saved, such as "7 Jul 2020 13:51". c(filedate) is equal to $S_FNDATE.
Memory settings

c(memory) returns a numeric scalar reporting the amount of memory, in bytes, currently allocated by Stata.

c(maxvar) returns a numeric scalar reporting the maximum number of variables currently allowed in a dataset, as set by `set maxvar` if you are running Stata/MP or Stata/SE. Otherwise, c(maxvar) is a constant.

c(niceness) returns a numeric scalar recording how soon Stata gives back unused segments to the operating system.

c(min_memory) returns a numeric scalar recording the minimum value to which memory can be reduced when its memory is unused.

c(max_memory) returns a numeric scalar recording the maximum amount of memory that Stata may allocate.

c(segmentsize) returns a numeric scalar recording the size of the segments in which memory is allocated.

c(adosize) returns a numeric scalar equal to the current `set adosize` setting.

c(max_preservemem) returns a numeric scalar recording the maximum amount of memory that `preserve` may use to store datasets in memory before reverting to disk storage, as set by `set max_preservemem` if you are running Stata/MP. Otherwise, c(max_preservemem) returns system missing value.

Output settings

c(more) returns a string containing "on" or "off", according to the current `set more` setting.

c(rmsg) returns a string containing "on" or "off", according to the current `set rmsg` setting.

c(dp) returns a string containing "period" or "comma", according to the current `set dp` setting.

c(linesize) returns a numeric scalar equal to the current `set linesize` setting.

c(pagesize) returns a numeric scalar equal to the current `set pagesize` setting.

c(logtype) returns a string containing "smcl" or "text", according to the current `set logtype` setting.

c(noisily) returns a numeric scalar equal to 0 if output is being suppressed and 1 if output is being displayed; see [P] quietly.

c(notifyuser) (Mac only) returns a string containing "on" or "off", according to the current `set notifyuser` setting.

c(playsnd) (Mac only) returns a string containing "on" or "off", according to the current `set playsnd` setting.

c(include_bitmap) (Mac only) returns a string containing "on" or "off", according to the current `set include_bitmap` setting.

c(iterlog) returns a string containing "on" or "off", according to the current `set iterlog` setting.

c(level) returns a numeric scalar equal to the current `set level` setting.

c(clevel) returns a numeric scalar equal to the current `set clevel` setting.
c(showbaselevels) returns a string containing "", "on", "off", or "all", according to the current set showbaselevels setting. See [R] set showbaselevels.

c(showemptycells) returns a string containing "", "on", or "off", according to the current set showemptycells setting. See [R] set showbaselevels.

c(showomitted) returns a string containing "", "on", or "off", according to the current set showomitted setting. See [R] set showbaselevels.

c(fvlabel) returns a string containing "on" or "off", according to the current set fvlabel setting. See [R] set showbaselevels.

c(fvwrap) returns a numeric scalar equal to the current set fvwrap setting. See [R] set showbaselevels.

c(fvwrapon) returns a string containing "word" or "width", according to the current set fvwrapon setting. See [R] set showbaselevels.

c(lstretch) returns a string containing "", "on", or "off", according to the current set lstretch setting.

c(cformat) returns a string containing the current set cformat setting. See [R] set cformat.

c(sformat) returns a string containing the current set sformat setting. See [R] set cformat.

c(pformat) returns a string containing the current set pformat setting. See [R] set cformat.

c(coeftabresults) returns a string containing "on" or "off", according to the current set coeftabresults setting.

c(dots) returns a string containing "on" or "off", according to the current set dots setting.

c(collect_label) returns a string containing "default" or the filename with labels set to be used as default labels in tables. See [TABLES] set collect_label.

c(collect_style) returns a string containing "default" or the filename with styles set to be used as default styles in tables created by collect. See [TABLES] set collect_style.

c(table_style) returns a string containing "table" or the filename with styles set to be used as default styles in tables created by table. See [TABLES] set table_style.

c(etable_style) returns a string containing "etable" or the filename with styles set to be used as default styles in tables created by etable. See [TABLES] set etable_style.

c(collect_warn) returns a string containing "on" or "off", according to the current set collect_warn setting.

Interface settings

c(dockable) (Windows only) returns a string containing "on" or "off", according to the current set dockable setting.

c(locksplitters) (Windows only) returns a string containing "on" or "off", according to the current set locksplitters setting.

c(pinnable) (Windows only) returns a string containing "on" or "off", according to the current set pinnable setting.

c(doublebuffer) (Windows only) returns a string containing "on" or "off", according to the current set doublebuffer setting.

c(reventries) returns a numeric scalar containing the maximum number of commands stored by the History window.
c(fastscroll) (Unix and Windows only) returns a string containing "on" or "off", according to the current `set fastscroll` setting.

c(revkeyboard) (Mac only) returns a string containing "on" or "off", according to the current `set revkeyboard` setting.

c(varkeyboard) (Mac only) returns a string containing "on" or "off", according to the current `set varkeyboard` setting.

c(smoothfonts) (Mac only) returns a string containing "on" or "off", according to the current `set smoothfonts` setting.

c(linegap) returns a numeric scalar equal to the current `set linegap` setting. If `set linegap` is irrelevant under the version of Stata that you are running, `c(linegap)` returns a system missing value.

c(scrollbufsize) returns a numeric scalar equal to the current `set scrollbufsize` setting. If `set scrollbufsize` is irrelevant under the version of Stata that you are running, `c(scrollbufsize)` returns a system missing value.

c(maxdb) returns a numeric scalar containing the maximum number of dialog boxes whose contents are remembered from one invocation to the next during a session; see [R] `db`.

**Graphics settings**

c(graphics) returns a string containing "on" or "off", according to the current `set graphics` setting.

c(autotabgraphs) (Windows only) returns a string containing "on" or "off", according to the current `set autotabgraphs` setting.

c(scheme) returns the name of the current `set scheme` setting.

c(printcolor) returns "automatic", "asis", "gs1", "gs2", or "gs3", according to the current `set printcolor` setting.

c(copycolor) (Mac and Windows only) returns "automatic", "asis", "gs1", "gs2", or "gs3", according to the current `set copycolor` setting.

c(maxbezierpath) (Mac only) returns a numeric scalar containing the maximum number of lines that can be added to a Bézier path when rendering a Stata graph to a screen; see `set maxbezierpath`.

c(min_graphsize) returns a numeric scalar containing the minimum number of inches for a Stata graph.

c(max_graphsize) returns a numeric scalar containing the maximum number of inches for a Stata graph.

**Network settings**

c(httpproxy) returns a string containing "on" or "off", according to the current `set httpproxy` setting.

c(httpproxyhost) returns a string containing the name of the proxy host or "" if no proxy host is set. `c(httpproxyhost)` is relevant only if `c(httpproxy) = "on"`.

c(httpproxyport) returns a numeric scalar equal to the proxy port number. `c(httpproxyport)` is relevant only if `c(httpproxy) = "on"`.
c(httpproxyauth) returns a string containing "on" or "off", according to the current set httpproxyauth setting. c(httpproxyauth) is relevant only if c(httpproxy) = "on".

c(httpproxyuser) returns a string containing the name of the proxy user, if one is set, or "" otherwise. c(httpproxyuser) is relevant only if c(httpproxyauth) = "on" and c(httpproxy) = "on".

c(httpproxypw) returns a string containing "*" if a password is set or "" otherwise. c(httpproxypw) is relevant only if c(httpproxyauth) = "on" and c(httpproxy) = "on".

**Update settings**

c(update_query) (Mac and Windows only) returns a string containing "on" or "off", according to the current set update_query setting.

c(update_interval) (Mac and Windows only) returns a numeric scalar containing the current set update_interval setting.

c(update_prompt) (Mac and Windows only) returns a string containing "on" or "off", according to the current set update_prompt setting.

**Trace (program debugging) settings**

c(trace) returns a string containing "on" or "off", according to the current set trace setting.

c(tracedepth) returns a numeric scalar reporting the current set tracedepth setting.

c(tracesep) returns a string containing "on" or "off", according to the current set tracesep setting.

c(traceindent) returns a string containing "on" or "off", according to the current set traceindent setting.

c(traceexpand) returns a string containing "on" or "off", according to the current set traceexpand setting.

c(tracenumber) returns a string containing "on" or "off", according to the current set tracenumber setting.

c(tracehilite) returns a string containing "pattern", according to the current set tracehilite setting.

**Mata settings**

c(matastrict) returns a string containing "on" or "off", according to the current set matastrict setting.

c(matalnum) returns a string containing "on" or "off", according to the current set matalnum setting.

c(mataoptimize) returns a string containing "on" or "off", according to the current set mataoptimize setting.

c(matafavor) returns a string containing "space" or "speed", according to the current set matafavor setting.
c(matacache) returns a numeric scalar containing the maximum amount of memory, in kilobytes, that may be consumed before Mata starts looking to drop autoloaded functions that are not currently being used.

c(matalibs) returns a string containing the names in order of the .mlib libraries to be searched; see [M-1] How.

c(matamofirst) returns a string containing "on" or "off", according to the current set mata-mofirst setting.

c(matasolvetol) returns a numeric scalar containing \# or \#, according to the current set mata-solvetol setting.

Java settings

\texttt{c(java_heapmax)} returns a string containing the maximum amount of heap memory allocated for the Java Virtual Machine, according to the current \texttt{java set heapmax} setting.

\texttt{c(java_home)} returns a string containing the path to the Java Development Kit, according to the current \texttt{java set home} setting.

LAPACK settings

\texttt{c(lapack_mkl)} returns a string containing "on" or "off", according to the current \texttt{set lapack_mkl} setting.

\texttt{c(lapack_mkl_cnr)} returns a string containing the conditional numerical reproducibility mode for Intel MKL LAPACK routines, according to the current \texttt{set lapack_mkl_cnr} setting.

putdocx settings

\texttt{c(docx_hardbreak)} returns a string containing "on" or "off", according to the current \texttt{set docx_hardbreak} setting.

\texttt{c(docx_paramode)} returns a string containing "on" or "off", according to the current \texttt{set docx_paramode} setting.

Python settings

\texttt{c(python_exec)} returns a string containing the path to a Python executable, according to the current \texttt{python set exec} setting.

\texttt{c(python_userpath)} returns a string containing the list of paths to be searched for user's own Python modules, according to the current \texttt{python set userpath} setting.

RNG settings

\texttt{c(rng)} returns a string containing the current \texttt{set rng} setting. This controls which random-number generator Stata will use. Possible values are "mt64", which specifies to always use the 64-bit Mersenne Twister random-number generator; "mt64s", which specifies to always use the 64-bit Mersenne Twister stream random-number generator; "kiss32", which specifies to always use the 32-bit KISS (keep it simple stupid) random-number generator; or "default", which specifies to let Stata choose between these random-number generators based on version control. Stata’s default random-number generator in the absence of version control and with \texttt{set rng default} is the 64-bit Mersenne Twister. See [R] \texttt{set rng}. 

\texttt{c(return)} — Return c-class values
c(rng_current) returns a string containing the random-number generator currently in effect, that is, "mt64", "mt64s", or "kiss32", depending on the current set rng setting. If set rng is currently set to "default", then c(rng_current) depends on the current user version. See [P] version.

c(rngstate) returns a string containing the current state of the runiform() random-number generator. You can initialize the state of the random-number generator with set seed, and you can restore the state of the random-number generator to a saved state with set rngstate. See [R] set seed.

c(rngseed_mt64s) returns the seed last set for the stream random-number generator (mt64s). See [R] set rngstream.

c(rngstream) returns the current stream of the stream random-number generator (mt64s). See [R] set rngstream.

sort settings

c(sortmethod) returns a string containing the current set sortmethod setting. Possible values are "fsort", which specifies to always use the fast modified quicksort with a three-way partition and insertion sort when the problem size becomes small; "qsort", which specifies to always use the standard quicksort algorithm; and "default", which specifies to let Stata choose between these sort methods based on version control. Stata’s default sort method in the absence of version control and with set sortmethod default is the fast modified quicksort. If user version is set prior to 17 by specifying the version in a do-file or interactively, the standard quicksort algorithm will become the default.

c(sort_current) returns either "fsort" or "qsort" to designate which sort method is to be used based on both the setting of set sortmethod and the current setting of user version.

c(sortrngstate) returns a string containing the current state of sort’s prerandomizer (or jumbler) that preorders the observations prior to sorting to ensure high performance in the sorting. You can initialize the state of the jumbler or restore its state using set sortrngstate.

Unicode settings

c(locale_ui) returns a string containing the locale that specifies the localization package for the user interface. See [P] set locale_ui.

c(locale_functions) returns a string containing the default locale for string functions. See [P] set locale_functions.

c(locale_icudflt) returns a string containing the default ICU locale. See [U] 12.4.2.4 Locales in Unicode.

Other settings

c(type) returns a string containing "float" or "double", according to the current set type setting.

c(maxiter) returns a numeric scalar equal to the current set maxiter setting.

c(searchdefault) returns a string containing "local", "net", or "all", according to the current searchdefault setting.
c(varabbrev) returns a string containing "on" or "off", according to the current set varabbrev setting.

c(emptycells) returns a string containing "keep" or "drop", according to the current set emptycells setting.

c(fvtrack) returns a string containing "term" or "factor", according to the current set fvtrack setting.

c(fvbase) returns a string containing "on" or "off", according to the current set fvbase setting.

c(haferdir) (Windows only) returns a string containing the name of the directory that you specified to contain the Haver databases; see set haferdir in [D] import haver.

c(odbcmgr) (Mac and Unix only) returns a string containing "iodbc" or "unixodbc", according to the current set odbcmgr setting.

c(odbcdriver) returns a string containing "unicode" or "ansi", according to the current set odbcdriver setting.

c(fredkey) returns the current API key, according to the current set fredkey setting.

c(collect_double) returns a string containing "on" or "off", according to the current set collect_double setting.

Other

c(pi) returns a numerical scalar equal to _pi, the value of the ratio of the circumference to the diameter of a circle. In an expression context, it makes no difference whether you use c(pi) or _pi. c(pi), however, may be used (enclosed in single quotes) in other contexts.

c(alpha) returns a string containing "a b c d e f g h i ..".

c(ALPHA) returns a string containing "A B C D E F G H I ..".

c(Mons) returns a string containing "Jan Feb Mar Apr M ..".

c(Months) returns a string containing "January February ..".

c(Wdays) returns a string containing "Sun Mon Tue Wed T ..".

c(Weekdays) returns a string containing "Sunday Monday Tue ..".

c(rc) returns a numerical scalar equal to _rc, the value set by the capture command. In an expression context, it makes no difference whether you use c(rc) or _rc. c(rc), however, may be used (enclosed in single quotes) in other contexts. This is less important than it sounds because you could just as easily type ‘=_rc’.

Also see

[P] return — Return stored results

[R] query — Display system parameters

[R] set — Overview of system parameters
Title

\_datasignature — Determine whether data have changed

<table>
<thead>
<tr>
<th>Description</th>
<th>Syntax</th>
<th>Options</th>
<th>Remarks and examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stored results</td>
<td>Reference</td>
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<td></td>
</tr>
</tbody>
</table>

**Description**

\_datasignature calculates, displays, and stores in `r(_datasignature)` checksums of the data, forming a signature. A signature might be

162:11(12321):2725060400:4007406597

The signature can be stored and later used to determine whether the data have changed.

**Syntax**

\_datasignature [varlist] [if] [in] [, options]

**Options**

- **fast** specifies that the checksum calculation be made in a faster, less computationally intensive, and machine-dependent way. With this option, \_datasignature runs faster on all computers and can run in less than one-third of the time on some computers. The result can be compared with other fast computations made on the same computer, and computers of the same make, but not across computers of different makes. See Remarks and examples below.

- **esample** specifies that the checksum be calculated on the data for which `e(sample) = 1`. Coding

\_datasignature 'varlist', esample

or

\_datasignature 'varlist' if e(sample)

produces the same result. The former is a little quicker. If the esample option is specified, if exp may not be specified.

- **nonames** specifies that the variable-names checksum in the signature be omitted. Rather than the signature being 74:12(71728):2814604011:3381794779, it would be 74:12:2814604011:3381794779. This option is useful when you do not care about the names or you know that the names have changed, such as when using temporary variables.
nodefault specifies that when \texttt{varlist} is not specified, it be taken to mean no variables rather than all variables in the dataset. Thus you may code

\begin{verbatim}
    _datasignature 'modelvars', nodefault
\end{verbatim}

and obtain desired results even if ‘modelvars’ expands to nothing.

\section*{Remarks and examples}

For an introduction to data signatures, see \cite{D} \texttt{datasignature}. To briefly summarize:

\begin{itemize}
\item A signature is a short string that is calculated from a dataset, such as 74:12(71728):3831085005:1395876116. If a dataset has the same signature at two different times, then it is highly likely that the data have not changed. If a dataset has a different signature, then it is certain that the data have changed.
\item An example data signature is 74:12(71728):3831085005:1395876116. The components are
  \begin{enumerate}
  \item 74, the number of observations;
  \item 12, the number of variables;
  \item 71728, a checksum function of the variable names and the order in which they occur; and
  \item 3831085005 and 1395876116, checksum functions of the values of the variables, calculated two different ways.
  \end{enumerate}
\item Signatures are functions of
  \begin{enumerate}
  \item the number of observations and number of variables in the data;
  \item the values of the variables;
  \item the names of the variables;
  \item the order in which the variables occur in the dataset if \texttt{varlist} is not specified, or in \texttt{varlist} if it is; and
  \item the storage types of the variables.
  \end{enumerate}
\end{itemize}

If any of these change, the signature changes. The signature is not a function of the sort order of the data. The signature is not a function of variable labels, value labels, contents of characteristics, and the like.

Programs sometimes need to verify that they are running on the same data at two different times. This verification is especially common with estimation commands, where the estimation is performed by one command and postestimation analyses by another. To ensure that the data have not changed, one obtains the signature at the time of estimation and then compares that with the signature obtained when the postestimation command is run. See \cite{P} \texttt{signestimationsample} for an example.

If you are producing signatures for use within a Stata session—signatures that will not be written to disk and thus cannot possibly be transferred to different computers—specify \texttt{datasignature}'s \texttt{fast} option. On some computers, \texttt{datasignature} can run in less than one-third of the time if this option is specified.

\texttt{datasignature, fast} is faster for two reasons: 1) the option uses a less computationally intensive algorithm and 2) the computation is made in a machine-dependent way. The first affects the quality of the signature, and the second does not.
Remember that signatures have two checksums for the data. When `fast` is specified, a different, inferior algorithm is substituted for the second checksum. In the `fast` case, the second signature is not conditionally independent of the first and thus does not provide 48 bits of additional information; it probably provides around 24 bits. The default second checksum calculation was selected to catch problems that the first calculation does not catch. In the `fast` case, the second checksum does not have that property. These details make the `fast` signature sound markedly inferior. Nevertheless, the first checksum calculation, which is used both in the default and the `fast` cases, is good, and when `_datasignature` was written, we considered using only the first calculation in both cases. We believe that, for within-session testing, where one does not have to guard against changes produced by an intelligent enemy who may be trying to fool you, the first checksum alone is adequate. The inferior second checksum we include in the `fast` case provides more protection than we think necessary.

The second difference has nothing to do with quality. Modern computers come in two types: those that record least-significant bytes (LSBs) first and those that record most-significant bytes (MSBs) first. Intel-based computers, for instance, are usually LSB, whereas Sun computers are MSB.

By default, `_datasignature` makes the checksum calculation in an LSB way, even on MSB computers. MSB computers must therefore go to extra work to emulate the LSB calculation, and so `_datasignature` runs slower on them.

When you specify `fast`, `_datasignature` calculates the checksum the native way. The checksum is every bit as good, but the checksum produced will be different on MSB computers. If you merely store the signature in memory for use later in the session, however, that does not matter.

**Stored results**

 `_datasignature` stores the following in r():

Macros

   `r(datasignature)`  the signature

**Reference**


**Also see**

[D] `datasignature` — Determine whether data have changed

[P] `signestimationsample` — Determine whether the estimation sample has changed

[D] `compare` — Compare two variables

[D] `cf` — Compare two datasets
Description

The `#delimit` command resets the character that marks the end of a command. It can be used only in do-files or ado-files.

Syntax

```
#delimit { cr | ; }
```

Remarks and examples

`#delimit` (pronounced `pound-delimit`) is a Stata preprocessor command. `#commands` do not generate a return code, nor do they generate ordinary Stata errors. The only error message associated with `#commands` is “unrecognized #command”.

Commands given from the console are always executed when you press the `Enter`, or `Return`, key. `#delimit` cannot be used interactively, so you cannot change Stata’s interactive behavior.

Commands in a do-file, however, may be delimited with a carriage return or a semicolon. When a do-file begins, the delimiter is a carriage return. The command ‘`#delimit ;`’ changes the delimiter to a semicolon. To restore the carriage return delimiter inside a file, use `#delimit cr`.

When a do-file begins execution, the delimiter is automatically set to carriage return, even if it was called from another do-file that set the delimiter to semicolon. Also, the current do-file need not worry about restoring the delimiter to what it was because Stata will do that automatically.

Example 1

```*/
    When the do-file begins, the delimiter is carriage return:
    */
    use basedata, clear
    /*
        The last command loaded our data.
        Let’s now change the delimiter:
    */
    #delimit ;
    summarize sex
        salary ;
    /*
        Because the delimiter is semicolon, it does not matter that our
        command took two lines.
        We can change the delimiter back:
    */
```
#delimit cr

generate sex salary

/*
Now our lines once again end on return. The semicolon delimiter
is often used when loading programs:
*/
capture program drop fix
program fix
    confirm var `1'
    #delimit ;
    replace `1' = . if salary>=. | salary==0 |
        `1' = . if salary>=. | salary==0 |
        hours>=. | hours==0 ;
    #delimit cr
end
fix var1
fix var2

Technical note

Just because you have long lines does not mean that you must change the delimiter to semicolon. Stata does not care that the line is long. There are also other ways to indicate that more than one physical line is one logical line. One popular choice is ///:

    replace `1' = . if salary>=. | salary==0 | ///
        hours>=. | hours==0

See [P] comments.

Also see

[P] comments — Add comments to programs
[U] 16.1.3 Long lines in do-files
[U] 18.11.2 Comments and long lines in ado-files
Dialog programming — Dialog programming

Description

Dialog-box programs—also called dialog resource files—allow you to define the appearance of a dialog box, specify how its controls work when the user fills it in (such as hiding or disabling specific controls), and specify the ultimate action to be taken (such as running a Stata command) when the user clicks on **OK** or **Submit**.

Remarks and examples

Remarks are presented under the following headings:

1. Introduction
2. Concepts
   2.1 Organization of the .dlg file
   2.2 Positions, sizes, and the DEFINE command
   2.3 Default values
   2.4 Memory (recollection)
   2.5 i-actions and member functions
   2.6 U-actions and communication options
   2.7 The distinction between i-actions and u-actions
   2.8 Error and consistency checking
3. Commands
   3.1 VERSION
   3.2 INCLUDE
   3.3 DEFINE
   3.4 POSITION
   3.5 LIST
   3.6 DIALOG
      3.6.1 CHECKBOX on/off input control
      3.6.2 RADIO on/off input control
      3.6.3 SPINNER numeric input control
      3.6.4 EDIT string input control
      3.6.5 VARLIST and VARNAME string input controls
      3.6.6 FILE string input control
      3.6.7 LISTBOX list input control
      3.6.8 COMBOBOX list input control
      3.6.9 BUTTON special input control
      3.6.10 TEXT static control
      3.6.11 TEXTBOX static control
      3.6.12 GROUPBOX static control
      3.6.13 FRAME static control
      3.6.14 COLOR input control
      3.6.15 EXP expression input control
      3.6.16 HLINK hyperlink input control
      3.6.17 TREEVIEW tree input control
   3.7 OK, SUBMIT, CANCEL, and COPY u-action buttons
   3.8 HELP and RESET helper buttons
   3.9 Special dialog directives
4. SCRIPT
5. PROGRAM
   5.1 Concepts
      5.1.1 Vnames
At a programming level, the purpose of a dialog box is to produce a Stata command to be executed. Along the way, it hopefully provides the user with an intuitive and consistent experience—that is your job as a dialog-box programmer—but the ultimate output will be

```
list mpg weight
```

or whatever other Stata command is appropriate. Dialog boxes are limited to executing one Stata command, but that does not limit what you can do with them because that Stata command can be an ado-file. (Actually, there is another way around the one-command limit, which we will discuss in 5.1.3 rstrings: cmdstring and optstring.)

This ultimate result is called the dialog box’s u-action.

The u-action of the dialog box is determined by the code you write, called dialog code, which you store in a .dlg file. The name of the .dlg file is important because it determines the name of the dialog box. When a user types

```
.db regress
```
regress.dlg is executed. Stata finds the file the same way it finds ado-files—by looking along the ado-path; see [P] sysdir. regress.dlg runs regress commands because of the dialog code that appears inside the regress.dlg file. regress.dlg could just as well execute probit commands or even merge commands if the code were written differently.

.dlg files describe
1. how the dialogs look,
2. how the input controls of the dialogs interact with each other, and
3. how the u-action is constructed from the user’s input.

Items 1 and 2 determine how intuitive and consistent the user finds the dialog. Item 3 determines what the dialog box does. Item 2 determines whether some fields are disabled or hidden so that they cannot be mistakenly filled in until the user clicks on something, checks something, or fills in a certain result.

2. Concepts

A dialog box is composed of many elements called controls, including static text, edit fields, and checkboxes. Input controls are those that the user fills in, such as checkboxes and text-entry fields. Static controls are fixed text and lines that appear on the dialog box but that the user cannot change. See Appendix A below for definitions of the various types of controls as well as other related jargon.

In the jargon we use, a dialog box is composed of dialogs, and dialogs are composed of controls. When a dialog box contains multiple dialogs, only one dialog is shown at a time. Here access to the dialogs is made possible through small tabs. Clicking on the tab associated with a dialog makes that dialog active.

The dialog box may contain the helper buttons Help (shown as a small button with a question mark on it) and Reset (shown as a small button with an R on it). These buttons appear in the dialog box—not the individual dialogs—so in a multiple-dialog dialog box, they appear regardless of the dialog (tab) selected.

The Help helper button displays a help file associated with the dialog box.

The Reset helper button resets the dialog box to its initial state. Each time a user invokes a particular dialog box, it will remember the values last set for its controls. The reset button allows the user to restore the default values for all controls in the dialog box.

The dialog box may also include the u-action buttons OK, Submit, Copy, and Cancel. Like the helper buttons, u-action buttons appear in the dialog box—not the individual dialogs—so in a multiple-dialog dialog box, they appear regardless of the dialog (tab) selected.

The OK u-action button constructs the u-action, sends it to Stata for execution, and closes the dialog box.

The Submit u-action button constructs the u-action, sends it to Stata for execution, and leaves the dialog box open.

The Copy u-action button constructs the u-action, sends it to the clipboard, and leaves the dialog box open.

The Cancel u-action button closes the dialog box without constructing the u-action.

A dialog box does not have to include all of these u-action buttons, but it needs at least one.
Thus the nesting is

Dialog box, which contains
Dialog 1, which contains
  input controls and static controls
Dialog 2, which is optional and which, if defined, contains
  input controls and static controls
[. . .]
Helper buttons, which are optional and which, if defined, contain
  [Help button]
  [Reset button]
U-action buttons, which contain
  [OK button]
  [Submit button]
  [Copy button]
  [Cancel button]

Said differently,

1. a dialog box must have at least one dialog, must have one set of u-action buttons, and may have helper buttons;
2. a dialog must have at least one control and may have many controls; and
3. the u-action buttons may include any of OK, Submit, Copy, and Cancel and must include at least one of them.

Here is a simple .dlg file that will execute the kappa command, although it does not allow if exp and in range:

```
BEGIN mykappa.dlg

// ----------------- set version number and define size of box ---------
VERSION 17.0
POSITION . . 290 200

// ------------------------------------------- define a dialog ---------
DIALOG main, label("kappa - Interrater agreement")
BEGIN
  TEXT tx_var 10 10 270 ., label("frequency variables:")
  VARLIST vl_var @ +20 @ ., label("frequencies")
END

// -------------------- define the u-action and helper buttons ---------
OK ok1, label("OK")
CANCEL can1, label("Cancel")
SUBMIT sub1, label("Submit")
COPY copy1,
HELP hlp1, view("help kappa")
RESET res1

// --------------------------- define how to assemble u-action ---------
PROGRAM command
BEGIN
  put "kappa 
  varlist main.vl_var
END

END mykappa.dlg
```
### 2.1 Organization of the .dlg file

A .dlg file consists of seven parts, some of which are optional:

<table>
<thead>
<tr>
<th>Begin</th>
<th>dialogboxname.dlg</th>
</tr>
</thead>
<tbody>
<tr>
<td>VERSION 17.0</td>
<td>Part 1: version number</td>
</tr>
<tr>
<td>POSITION . . .</td>
<td>Part 2: set size of dialog box</td>
</tr>
<tr>
<td>DEFINE . . .</td>
<td>Part 3, optional: common definitions</td>
</tr>
<tr>
<td>LIST . . .</td>
<td></td>
</tr>
<tr>
<td>DIALOG . . .</td>
<td>Part 4: dialog definitions</td>
</tr>
<tr>
<td>\begin{verbatim}</td>
<td></td>
</tr>
<tr>
<td>\textbf{BEGIN}</td>
<td>\begin{verbatim}</td>
</tr>
<tr>
<td>FILE . . .</td>
<td>\ldots which contain input controls</td>
</tr>
<tr>
<td>BUTTON . . .</td>
<td></td>
</tr>
<tr>
<td>CHECKBOX . . .</td>
<td></td>
</tr>
<tr>
<td>COMBOBOX . . .</td>
<td></td>
</tr>
<tr>
<td>EDIT . . .</td>
<td></td>
</tr>
<tr>
<td>LISTBOX . . .</td>
<td></td>
</tr>
<tr>
<td>RADIO . . .</td>
<td></td>
</tr>
<tr>
<td>SPINNER . . .</td>
<td></td>
</tr>
<tr>
<td>VARLIST . . .</td>
<td></td>
</tr>
<tr>
<td>VARNAME . . .</td>
<td></td>
</tr>
<tr>
<td>FRAME . . .</td>
<td>\ldots and static controls</td>
</tr>
<tr>
<td>GROUPBOX . . .</td>
<td></td>
</tr>
<tr>
<td>TEXT . . .</td>
<td></td>
</tr>
<tr>
<td>\end{verbatim}</td>
<td></td>
</tr>
<tr>
<td>\end{verbatim}</td>
<td></td>
</tr>
<tr>
<td>\begin{verbatim}</td>
<td></td>
</tr>
<tr>
<td>\textbf{END}</td>
<td>\begin{verbatim}</td>
</tr>
<tr>
<td>\textbf{REPEAT DIALOG} . .</td>
<td>\begin{verbatim}</td>
</tr>
<tr>
<td>\textbf{BEGIN} . .</td>
<td>\begin{verbatim}</td>
</tr>
<tr>
<td>\textbf{END}</td>
<td>\end{verbatim}</td>
</tr>
<tr>
<td>\textbf{SCRIPT} . . .</td>
<td>Part 5, optional: i-action definitions</td>
</tr>
<tr>
<td>\begin{verbatim}</td>
<td>\ldots usually done as scripts</td>
</tr>
<tr>
<td>\textbf{BEGIN}</td>
<td></td>
</tr>
<tr>
<td>\end{verbatim}</td>
<td>\begin{verbatim}</td>
</tr>
<tr>
<td>\textbf{END}</td>
<td>\begin{verbatim}</td>
</tr>
<tr>
<td>\textbf{PROGRAM} . . .</td>
<td>\ldots but sometimes as programs</td>
</tr>
<tr>
<td>\begin{verbatim}</td>
<td></td>
</tr>
<tr>
<td>\textbf{BEGIN}</td>
<td></td>
</tr>
<tr>
<td>\end{verbatim}</td>
<td></td>
</tr>
<tr>
<td>\textbf{END}</td>
<td></td>
</tr>
<tr>
<td>OK . . .</td>
<td>Part 6: u-action and helper button definitions</td>
</tr>
<tr>
<td>CANCEL . . .</td>
<td></td>
</tr>
<tr>
<td>SUBMIT . . .</td>
<td></td>
</tr>
<tr>
<td>HELP . . .</td>
<td></td>
</tr>
<tr>
<td>RESET . . .</td>
<td></td>
</tr>
<tr>
<td>\textbf{PROGRAM command}</td>
<td>Part 7: u-action definition</td>
</tr>
<tr>
<td>\begin{verbatim}</td>
<td></td>
</tr>
<tr>
<td>\textbf{BEGIN}</td>
<td></td>
</tr>
<tr>
<td>\end{verbatim}</td>
<td></td>
</tr>
<tr>
<td>\begin{verbatim}</td>
<td></td>
</tr>
<tr>
<td>\textbf{END}</td>
<td>dialogueboxname.dlg</td>
</tr>
<tr>
<td>\end{verbatim}</td>
<td></td>
</tr>
</tbody>
</table>

The VERSION statement must appear at the top; the other parts may appear in any order.

**I-actions**, mentioned in Part 5, are intermediate actions, such as hiding or showing, disabling or enabling a control, or opening the Viewer to display something, etc., while leaving the dialog up and waiting for the user to fill in more or press a u-action button.

### 2.2 Positions, sizes, and the DEFINE command

Part of specifying how a dialog appears is defining where things go and how big they are.

Positions are indicated by a pair of numbers, \(x\) and \(y\). They are measured in pixels and are interpreted as being measured from the top-left corner: \(x\) is how far to the right, and \(y\) is how far down.
Sizes are similarly indicated by a pair of numbers, \( xsize \) and \( ysize \). They, too, are measured in pixels and indicate the size starting at the top-left corner of the object.

Any command that needs a position or a size always takes all four numbers—position and size—and you must specify all four. In addition to each element being allowed to be a number, some extra codes are allowed. A position or size element is defined as

- \( # \) any unsigned integer number, such as 0, 1, 10, 200, \ldots
- . (period) meaning the context-specific default value for this position or size element. . is allowed only with heights of controls (heights are measured from the top down) and for the initial position of a dialog box.
- \( @ \) means the previous value for this position or size element. If \( @ \) is used for an \( x \) or a \( y \), then the \( x \) or \( y \) from the preceding command will be used. If \( @ \) is used for an \( xsize \) or a \( ysize \), then the previous \( xsize \) or \( ysize \) will be used.
- \(+#\) means a positive offset from the last value (meaning to the right or down or bigger). If \(+10\) is used for \( x \), the result will be 10 pixels to the right of the previous position. If \(+10\) is used for a \( ysize \), it means 10 pixels taller.
- \(-#\) means a negative offset from the last value (meaning to the left or up or smaller). If \(-10\) is used for \( y \), the result will be 10 pixels above the previous position. If \(-10\) is used for a \( xsize \), it means 10 pixels narrower.

\( name \) means the value last recorded for \( name \) by the DEFINE command.

The DEFINE command has the syntax

\[
\text{DEFINE } name \{ . | # | +# | -# | @x | @y | @xsize | @ysize \}
\]

and may appear anywhere in your dialog code, even inside the BEGIN/END of DIALOG. Anywhere you need to specify a position or size element, you can use a \( name \) defined by DEFINE.

The first four possibilities for defining \( name \) have the obvious meaning: . means the default, \# means the number specified, \(+#\) means a positive offset, and \(-#\) means a negative offset. The other four possibilities—\( @x \), \( @y \), \( @xsize \), and \( @ysize \)—refer to the previous \( x \), \( y \), \( xsize \), and \( ysize \) values, with “previous” meaning previous to the time the DEFINE command was issued.

### 2.3 Default values

You can also load input controls with initial, or default, values. For instance, perhaps, as a default, you want one checkbox checked and another unchecked, and you want an edit field filled in with “Default title”.

The syntax of the CHECKBOX command, which creates checkboxes, is

\[
\text{CHECKBOX ... } [ , \ldots \text{ default(defnumval) } \ldots ]
\]

In checkboxes, the default() option specifies how the box is to be filled in initially, and 1 corresponds to checked and 0 to unchecked.

The syntax of EDIT, which creates edit fields, is

\[
\text{EDIT ... } [ , \ldots \text{ default(defstrval) } \ldots ]
\]

In edit fields, default() specifies what the box will contain initially.
Wherever `defnumval` appears in a syntax diagram, you may type

<table>
<thead>
<tr>
<th>defnumval</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>#</code></td>
<td>meaning the number specified</td>
</tr>
<tr>
<td><code>literal #</code></td>
<td>same as <code>#</code></td>
</tr>
<tr>
<td><code>c(name)</code></td>
<td>value of <code>c(name)</code>; see [P] <code>creturn</code></td>
</tr>
<tr>
<td><code>r(name)</code></td>
<td>value of <code>r(name)</code>; see [P] <code>return</code></td>
</tr>
<tr>
<td><code>e(name)</code></td>
<td>value of <code>e(name)</code>; see [P] <code>ereturn</code></td>
</tr>
<tr>
<td><code>s(name)</code></td>
<td>value of <code>s(name)</code>; see [P] <code>return</code></td>
</tr>
<tr>
<td><code>global name</code></td>
<td>value of global macro <code>$name</code></td>
</tr>
</tbody>
</table>

Wherever `defstrval` appears in a syntax diagram, you may type

<table>
<thead>
<tr>
<th>defstrval</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>string</code></td>
<td>meaning the string specified</td>
</tr>
<tr>
<td><code>literal string</code></td>
<td>same as <code>string</code></td>
</tr>
<tr>
<td><code>c(name)</code></td>
<td>contents of <code>c(name)</code>; see [P] <code>creturn</code></td>
</tr>
<tr>
<td><code>r(name)</code></td>
<td>contents of <code>r(name)</code>; see [P] <code>return</code></td>
</tr>
<tr>
<td><code>e(name)</code></td>
<td>contents of <code>e(name)</code>; see [P] <code>ereturn</code></td>
</tr>
<tr>
<td><code>s(name)</code></td>
<td>contents of <code>s(name)</code>; see [P] <code>return</code></td>
</tr>
<tr>
<td><code>char varname[charname]</code></td>
<td>contents of characteristic; see [P] <code>char</code></td>
</tr>
<tr>
<td><code>global name</code></td>
<td>contents of global macro <code>$name</code></td>
</tr>
</tbody>
</table>

Note: If `string` is enclosed in double quotes (simple or compound), the first set of quotes is stripped.

List and combo boxes present the user with a list of items from which to choose. In dialog-box jargon, rather than having initial or default values, the boxes are said to be populated. The syntax for creating a list-box input control is

```
LISTBOX ... [ , ... contents(conspec) ... ]
```

Wherever a `conspec` appears in a syntax diagram, you may type

- **list listname**
  populates the box with the specified list, which you create separately by using the LIST command.
  LIST has the following syntax:

  ```
  LIST
  BEGIN
  item to appear
  item to appear
  ... 
  END
  ```

- **matrix**
  populates the box with the names of all matrices currently defined in Stata.

- **vector**
  populates the box with the names of all $1 \times k$ and $k \times 1$ matrices currently defined in Stata.

- **row**
  populates the box with the names of all $1 \times k$ matrices currently defined in Stata.
column
populates the box with the names of all $k \times 1$ matrices currently defined in Stata.

square
populates the box with the names of all $k \times k$ matrices currently defined in Stata.

scalar
populates the box with the names of all scalars currently defined in Stata.

constraint
populates the box with the names of all constraints currently defined in Stata.

estimates
populates the box with the names of all saved estimates currently defined in Stata.

char varname[charname]
populates the box with the elements of the characteristic varname[charname], parsed on spaces.

e(name)
populates the box with the elements of e(name), parsed on spaces.

global
populates the box with the names of all global macros currently defined in Stata.

valuelabels
populates the box with the names of all values labels currently defined in Stata.

Predefined lists for use with Stata graphics:

<table>
<thead>
<tr>
<th>Predefined lists</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>symbols</td>
<td>list of marker symbols</td>
</tr>
<tr>
<td>symbolnamesizes</td>
<td>list of marker symbol sizes</td>
</tr>
<tr>
<td>colors</td>
<td>list of colors</td>
</tr>
<tr>
<td>intensity</td>
<td>list of fill intensities</td>
</tr>
<tr>
<td>clockpos</td>
<td>list of clock positions</td>
</tr>
<tr>
<td>linepatterns</td>
<td>list of line patterns</td>
</tr>
<tr>
<td>linewidths</td>
<td>list of line widths</td>
</tr>
<tr>
<td>connecttypes</td>
<td>list of line connecting types</td>
</tr>
<tr>
<td>textsizes</td>
<td>list of text sizes</td>
</tr>
<tr>
<td>justification</td>
<td>list of horizontal text justifications</td>
</tr>
<tr>
<td>alignment</td>
<td>list of vertical text alignments</td>
</tr>
<tr>
<td>margin</td>
<td>list of margins</td>
</tr>
<tr>
<td>tickpos</td>
<td>list of axis-tick positions</td>
</tr>
<tr>
<td>angles</td>
<td>list of angles; usually used for axis labels</td>
</tr>
<tr>
<td>compass</td>
<td>list of compass directions</td>
</tr>
<tr>
<td>yesno</td>
<td>list containing Default, Yes, and No; usually accompanied by a user-defined values list</td>
</tr>
</tbody>
</table>
2.4 Memory (recollection)

All input control commands have a `default()` or `contents()` option that specifies how the control is to be filled in, for example,

```
CHECKBOX ... [, ... default(defnumval) ... ]
```

In this command, if `defnumval` evaluates to 0, the checkbox is initially unchecked; otherwise, it is checked. If `default()` is not specified, the box is initially unchecked.

Dialogs remember how they were last filled in during a session, so the next time the user invokes the dialog box that contains this CHECKBOX command, the `default()` option will be ignored and the checkbox will be as the user last left it. That is, the setting will be remembered unless you specify the input control’s `nomemory` option.

```
CHECKBOX ... [, ... default(defnumval) nomemory ... ]
```

`nomemory` specifies that the dialog-box manager not remember between invocations how the control is filled in; it will always reset it to the default, whether that default is explicitly specified or implied.

Whether or not you specify `nomemory`, explicit or implicit defaults are also restored when the user presses the **Reset** helper button.

The contents of dialog boxes are only remembered during a session, not between them. Within a session, the **discard** command causes Stata to forget the contents of all dialog boxes.

The issues of initialization and memory are in fact more complicated than they first appear. Consider a list box. A list box might be populated with the currently saved estimates. If the dialog box containing this list box is closed and reopened, the available estimates may have changed. So list boxes are always repopulated according to the instructions given. Even so, list boxes remember the choice that was made. If that choice is still among the possibilities, that choice will be the one selected unless `nomemory` is specified; otherwise, the choice goes back to being the default—the first choice in the list of alternatives.

The same issues arise with combo boxes, and that is why some controls have the `default()` option and others have `contents()`. `default()` is used once, and after that, memory is substituted (unless `nomemory` is specified). `contents()` is always used—`nomemory` or not—but the choice made is remembered (unless `nomemory` is specified).

2.5 I-actions and member functions

I-actions—intermediate actions—refer to all actions taken in producing the u-action. An i-action might disable or hide controls when another control is checked or unchecked, although there are many other possibilities. I-actions are always optional.

I-actions are invoked by `on*()` options—those that begin with the letters “on”. For instance, the syntax for the CHECKBOX command—the command for defining a checkbox control—is

```
CHECKBOX controlname ... [, ... onclickon(iaction) onclickoff(iaction) ... ]
```

`onclickon()` is the i-action to be taken when the checkbox is checked, and `onclickoff()` is the i-action for when the checkbox is unchecked. You do not have to fill in the `onclickon()` and `onclickoff()` options—the checkbox will work fine taking no i-actions—but you may fill them in if you want, say, to disable or to enable other controls when this control is checked. For instance, you might code

```
CHECKBOX sw2 ..., onclickon(d2.sw3.show) onclickoff(d2.sw3.hide) ...
```
Dialog programming — Dialog programming

d2.sw3 refers to the control named sw3 in the dialog d2 (for instance, the control we just defined is named sw2). hide and show are called member functions. hide is the member function that hides a control, and show is its inverse. Controls have other member functions as well; what member functions are available is documented with the command that creates the specific control.

Many commands have on*() options that allow you to specify i-actions. When iaction appears in a syntax diagram, you can specify

- (period)
  Do nothing; take no action. This is the default if you do not specify the on*() option.

\[ \text{gaction } \text{dialogname}.\text{controlname}.\text{memberfunction } [\text{arguments}] \]

Execute the specified memberfunction on the specified control, where memberfunction may be

\{ hide|show|disable|enable|setposition|something_else [arguments] \}

All controls provide the memberfunctions hide, show, disable, enable, and setposition, and some controls make other, special memberfunctions available.

hide specifies that the control disappear from view (if it has not already done so). show specifies that it reappear (if it is not already visible).

disable specifies that the control be disabled (if it is not already). enable specifies that it be enabled (if it is not already).

setposition specifies the new position and size of a control. setposition requires arguments in the form of x y xsizes ysize. A dot can be used with any of the four arguments to mean the current value.

Sometimes arguments may require quotes. For instance, CHECKBOX provides a special memberfunction

\[ \text{setlabel string} \]

which sets the text shown next to the checkbox, so you might specify onclickon(’"gaction main.robust.setlabel "Robust VCE""'). Anytime a string is required, you must place quotes around it if that string contains a space. When you specify an iaction inside the parentheses of an option, it is easier to leave the quotes off unless they are required. If quotes are required, you must enclose the entire contents of the option in compound double quotes as in the example above.

\[ \text{dialogname}.\text{controlname}.\text{memberfunction } [\text{arguments}] \]

Same as gaction; the gaction is optional.

\[ \text{action memberfunction } [\text{arguments}] \]

Same as gaction currentdialog .currentcontrol .memberfunction; executes the specified memberfunction on the current control.

\[ \text{view topic} \]

Display topic in viewer; see [R] view.

\[ \text{script scriptname} \]

Execute the specified script. A script is a set of lines, each specifying an iaction. So if you wanted to disable three things, gaction would be insufficient. You would instead define a script containing the three gaction lines.

\[ \text{program programname} \]

Execute the specified dialog-box program. Programs can do more than scripts because they provide if-statement flow of control (among other things), but they are more difficult to write; typically, the extra capabilities are not needed when specifying i-actions.
create STRING | DOUBLE | BOOLEAN propertyname


create PSTRING | PDDOUBLE | PBOOLEAN propertyname


create CHILD dialogname [AS referencename] [, nomodal allowsubmit allowcopy]

Creates a new instance of a child dialog. By default, the reference name will be the name of the
dialog unless otherwise specified. See 7. Child dialogs for details.

2.6 U-actions and communication options

Remember that the ultimate goal of a dialog box is to construct a u-action—a Stata command to
be executed. What that command is depends on how the user fills in the dialog box.

You construct the command by writing a dialog-box program, also known as a PROGRAM. You
arrange that the program be invoked by specifying the uaction() option allowed with the OK,
SUBMIT, CANCEL, and COPY u-action buttons. For instance, the syntax of OK is

OK ... [, ... uaction(pgmname) target(target) ...]

pgmname is the name of the dialog program you write, and target() specifies how the command
constructed by pgmname is to be executed. Usually, you will simply want Stata to execute the
command, which could be coded target(stata), but because that is the default, most programmers
omit the target() option altogether.

The dialog-box program you write accesses the information the user has filled in and outputs the
Stata command to be executed. Without going into details, the program might say to construct the
command by outputting the word regress, followed by the varlist the user specified in the varlist
field of the first dialog, and followed by if exp, getting the expression from what the user filled in
an edit field of the second dialog.

Dialogs and input controls are named, and in your dialog-box program, when you want to refer
to what a user has filled in, you refer to dialogname.inputcontrolname. dialogname was determined
when you coded the DIALOG command to create the dialog

DIALOG dialogname ...

and inputcontrolname was determined when you coded the input-control command to create the input
control, for instance,

CHECKBOX inputcontrolname ...

The details are discussed in 5. PROGRAM, but do not get lost in the details. Think first about
coding how the dialogs look and second about how to translate what the user specifies into the
u-action.

On the various commands that specify how dialogs look, you can specify an option that will
make writing the u-action program easier: the communication option option(), which communicates
something about the control to the u-action program, is allowed with every control. For instance, on
the CHECKBOX command, you could code

CHECKBOX ..., ..., option(robust) ...

When you wrote your dialog-box PROGRAM, you would find it easier to associate the robust
option in the command you are constructing with this checkbox. Communication options never alter
how a control looks or works: they just make extra information available to the PROGRAM and make
writing the u-action routine easier.
Do not worry much about communication options when writing your dialog. Wait until you are writing the corresponding u-action program. Then it will be obvious what communication options you should have specified, and you can go back and specify them.

2.7 The distinction between i-actions and u-actions

In this documentation, we distinguish between i-actions and u-actions, but if you read carefully, you will realize that the distinction is more syntactical than real. One way we have distinguished i-actions from u-actions is to note that only u-actions can run Stata commands. In fact, i-actions can also run Stata commands; you just code them differently. In the vast majority of dialog boxes, you will not do this.

Nevertheless, if you were writing a dialog box to edit a Stata graph, you might construct your dialog box so that it contained no u-actions and only i-actions. Some of those i-actions might invoke Stata commands.

As you already know, i-actions can invoke PROGRAMs, and PROGRAMs serve two purposes: coding of i-actions and coding of u-actions. PROGRAMs themselves, however, have the ability to submit commands to Stata, and therein lies the key. I-actions can invoke PROGRAMs, and PROGRAMs can invoke Stata commands. How this is done is discussed in 5.1.3 rstrings: cmdstring and optstring and 5.5 Command-execution commands.

We recommend that you not program i-actions and u-actions that are virtually indistinguishable except in rare, special circumstances. Users expect to fill in a dialog box and to be given the opportunity to click on OK or Submit before anything too severe happens.

2.8 Error and consistency checking

In filling in the dialogs you construct, the user might make errors. One alternative is simply to ignore that possibility and let Stata complain when it executes the u-action command you construct. Even in well-written dialog boxes, most errors should be handled this way because discovering all the problems would require rewriting the entire logic of the Stata command.

Nevertheless, you will want to catch easy-to-detect errors while the dialog is still open and the user can easily fix them. Errors come in two forms: An outright error would be typing a number in an edit field that is supposed to contain a variable name. A consistency error would be checking two checkboxes that are, logically speaking, mutually exclusive.

You will want to handle most consistency errors at the dialog level, either by design (if two checkboxes are mutually exclusive, perhaps the information should be collected as radio buttons) or by i-actions (disabling or even hiding some fields depending on what has been filled in). The latter was discussed in 2.5 I-actions and member functions.

Outright errors can be detected and handled in dialog-box programs and are usually detected and handled in the u-action program. For instance, in your dialog-box program, you can assert that dialogname.inputcontrolname must be filled in and pop up a custom error message if it is not, or the program code can be written so that an automatically generated error message is presented. You will find that all input-control commands have an error() option; for example,

```
VARLIST ... [ , ... error(string) ... ]
```

The error() string provides the text to describe the control when the dialog-box manager presents an error. For instance, if we specified

```
VARLIST ... [ , ... error(dependent variable) ... ]
```
the dialog-box manager might use that information later to construct the error message “dependent variable must be specified”.

If you do not specify the error() option, the dialog-box manager will use what was specified in the label(); otherwise, "" is used. The label() option specifies the text that usually appears near the control describing it to the user, but label() will do double duty so that you only need to specify error() when the two strings need to differ.

3. Commands

3.1 VERSION

Syntax

VERSION #[:##] [valid_operating_systems]

Description

VERSION specifies how the commands that follow are to be interpreted.

Remarks

VERSION must appear first in the .dlg file (it may be preceded by comments). In the current version of Stata, it should read VERSION 17 or VERSION 17.0. It makes no difference; both mean the same thing.

Optionally, VERSION can specify one or more valid operating systems. Accepted values are WINDOWS, MACINTOSH, and UNIX. If none of these are specified, all are assumed.

Including VERSION at the top is of vital importance. Stata is under continual development, so syntax and features can change. Including VERSION is how you ensure that your dialog box will continue to work as you intended.

3.2 INCLUDE

Syntax

INCLUDE includefilename

where includefilename refers to includefilename.idlg and must be specified without the suffix and without a path.

Description

INCLUDE reads and processes the lines from includefilename.idlg just as if they were part of the current file being read. INCLUDE may appear in both .dlg and .idlg files.

Remarks

The name of the file is specified without a file suffix and without a path. .idlg files are searched for along the ado-path, as are .dlg files.

INCLUDE may appear anywhere in the dialog code and may appear in both .dlg and .idlg files; include files may INCLUDE other include files. Files may contain multiple INCLUDEs. The maximum nesting depth is 10.
3.3 DEFINE

Syntax

```
DEFINE name { . | # | +# | -# | @x | @y | @xsize | @ysize }
```

Description

DEFINE creates *name*, which may be used in other commands wherever a position or size element is required.

Remarks

The first four possibilities for defining *name*—., #, +#, and #-specify default, number specified, positive offset, and negative offset.

The other four possibilities—@x, @y, @xsize, and @ysize—refer to the previous *x*, *y*, *xsize*, and *ysize* values, with “previous” meaning previous to the time the DEFINE command is issued, not at the time *name* is used.

3.4 POSITION

Syntax

```
POSITION x y xsize ysize
```

Description

POSITION is used to set the location and size of the dialog box. *x* and *y* refer to the upper-left-hand corner of the dialog box. *xsize* and *ysize* refer to the width and height of the dialog box.

Remarks

The positions *x* and *y* may each be specified as ., and Stata will determine where the dialog box will be displayed; this is recommended.

*xsize* and *ysize* may not be specified as . because they specify the overall size of the dialog box. You can discover the size by experimentation. If you specify a size that is too small, some elements will flow off the dialog box. If you specify a size that is too large, there will be large amounts of white space on the right and bottom of the dialog box. Good initial values for *xsize* and *ysize* are 400 and 300.

POSITION may be specified anywhere in the dialog code outside BEGIN ... END blocks. It does not matter where it is specified because the entire .dlg file is processed before the dialog box is displayed.
3.5 LIST

Syntax

LIST newlistname
BEGIN
  item
  item
  ...
END

Description

LIST creates a named list for populating list and combo boxes.

Example

LIST choices
BEGIN
  Statistics
  Graphics
  Data management
END
...
DIALOG ...
BEGIN
  ...
LISTBOX ... , ... contents(choices) ...
  ...
END

3.6 DIALOG

Syntax

DIALOG newdialogname [, title("string") tabtitle("string") ]
BEGIN
  { control definition statements | INCLUDE | DEFINE }
  ...
END

Description

DIALOG defines a dialog. Every .dlg file should define at least one dialog. Only control definition statements, INCLUDE, and DEFINE are allowed between BEGIN and END.

Options

title("string") defines the text to be displayed in the dialog’s title bar.

tabtitle("string") defines the text to be displayed on the dialog’s tab. Dialogs are tabbed if more than one dialog is defined. When a user clicks on the tab, the dialog becomes visible and active.

If only one dialog is specified, the contents of tabtitle() are irrelevant.
Member functions

```plaintext
settabtitle string     sets tab title to string
settitle string        sets overall dialog box title to string
```

`settitle` may be called as a member function of any dialog tab, but it is more appropriate to call it as a member function of the dialog box. This is accomplished by calling it in the local scope of the dialog.

Example:

```plaintext
settitle "sort - Sort data"
```

### 3.6.1 CHECKBOX on/off input control

**Syntax**

```plaintext
CHECKBOX newcontrolname x y xsize ysize [, label("string") error("string")
   default(defnumval) nomemory groupbox onclickon(iaction) onclickoff(iaction)
   option(optionname) tooltip("string") ]
```

**Member functions**

```plaintext
setlabel string       sets text to string
setoff               unchecks checkbox
seton                checks checkbox
setoption optionname associates optionname with the value of the checkbox
setdefault value     sets the default value for the checkbox; this does not change the selected state
settooltip string    sets the tooltip text to string
```

The standard member functions `hide`, `show`, `disable`, `enable`, and `setposition` are also provided.

**Returned values for use in PROGRAM**

Returns numeric, 0 or 1, depending on whether the box is checked.

**Description**

`CHECKBOX` defines a checkbox control, which indicates an option that is either on or off.

**Options**

- `label("string")` specifies the text to be displayed next to the control. You should specify text that clearly implies two opposite states so that it is obvious what happens when the checkbox is checked or unchecked.

- `error("string")` specifies the text to be displayed describing this field to the user in automatically generated error boxes.

- `default(defnumval)` specifies whether the box is checked or unchecked initially; it will be unchecked if `defnumval` evaluates to 0, and it will be checked otherwise. If `default()` is not specified, `default(0)` is assumed.
nomemory specifies that the checkbox not remember how it was filled in between invocations.

groupbox makes this checkbox control also a group box into which other controls can be placed to emphasize that they are related. The group box is just an outline; it does not cause the controls “inside” to be disabled or hidden or in any other way act differently than they would if they were outside the group box. On some platforms, radio buttons have precedence over checkbox group boxes. You may place radio buttons within a checkbox group box, but do not place a checkbox group box within a group of radio buttons. If you do, you may not be able to click on the checkbox control on some platforms.

onclickon(iaction) and onclickoff(iaction) specify the i-actions to be invoked when the checkbox is clicked on or off. This could be used, for instance, to hide, show, disable, or enable other input controls. The default i-action is to do nothing. The onclickon() or onclickoff() i-action will be invoked the first time the checkbox is displayed.

option(optionname) is a communication option that associates optionname with the value of the checkbox.

tooltip("string") specifies the text to be displayed as a tip or hint when the user hovers over the control with the mouse.

Example

    CHECKBOX robust 10 10 100 ., label(Robust VCE)

3.6.2 RADIO on/off input control

Syntax

    RADIO newcontrolname x y xsize ysize [, [first|middle|last] label("string")
    error("string") default(defnumval) nomemory onclickon(iaction)
    onclickoff(iaction) option(optionname) tooltip("string") ]

Member functions

    setlabel string sets text to string
    seton checks the radio button and unchecks any other buttons in the group
    setoption optionname associates optionname with the value of the radio
    setdefault value sets the default value for the radio; this does not change the selected state
    setttooltip string sets the tooltip text to string

The standard member functions hide, show, disable, enable, and setposition are also provided.

Returned values for use in PROGRAM

    Returns numeric, 0 or 1, depending on whether the button is checked.
Description

RADIO defines a radio button control in a radio-button group. Radio buttons are used in groups of two or more to select mutually exclusive, but related, choices when the number of choices is small. Selecting one radio button automatically unselects the others in its group.

Options

first, middle, and last specify whether this radio button is the first, a middle, or the last member of a group. There must be one first and one last. There can be zero or more middle members. middle is the default if no option is specified.

label("string") specifies the text to be displayed next to the control.

error("string") specifies the text to be displayed describing this field to the user in automatically generated error boxes.

default(defnumval) specifies whether the radio button is to start as selected or unselected; it will be unselected if defnumval evaluates to 0 and will be selected otherwise. If default() is not specified, default(0) is assumed unless first is also specified, in which case default(1) is assumed. It is considered bad style to use anything other than the first button as the default, so this option is rarely specified.

nomemory specifies that the radio button not remember how it was filled in between invocations.

onclickon(iaction) and onclickoff(iaction) specify that i-action be invoked when the radio button is clicked on or clicked off. This could be used, for instance, to hide, show, disable, or enable other input controls. The default i-action is to do nothing. The onclickon() i-action will be invoked the first time the radio button is displayed if it is selected.

option(optionname) is a communication option that associates optionname with the value of the radio button.

tooltip("string") specifies the text to be displayed as a tip or hint when the user hovers over the control with the mouse.

Example

RADIO r1 10 10 100 ., first label("First choice")
RADIO r2 @ +20 @ ., middle label("Second choice")
RADIO r3 @ +20 @ ., middle label("Third choice")
RADIO r4 @ +20 @ ., last label("Last choice")

3.6.3 SPINNER numeric input control

Syntax

SPINNER newcontrolname x y xsize ysize [, label("string") error("string")
   default(defnumval) nomemory min(defnumval) max(defnumval) onchange(iaction)
   option(optionname) tooltip("string") ]
Member functions

- `setvalue value` sets the actual value of the spinner to `value`
- `setrange min# max#` sets the range of the spinner to `min# max#`
- `setoption optionname` associates `optionname` with the value of the spinner
- `setdefault #` sets the default of the spinner to `#`; this does not change the value shown in the spinner control.
- `settooltip string` sets the tooltip text to `string`

The standard member functions `hide`, `show`, `disable`, `enable`, and `setposition` are also provided.

Returned values for use in PROGRAM

Returns numeric, the value of the spinner.

Description

`SPINNER` defines a spinner, which displays an edit field that accepts an integer number, which the user may either increase or decrease by clicking on an up or down arrow.

Options

- `label("string")` specifies a description for the control, but it does not display the label next to the spinner. If you want to label the spinner, you must use a `TEXT` static control.
- `error("string")` specifies the text to be displayed in describing this field to the user in automatically generated error boxes.
- `default(defnumval)` specifies the initial integer value of the spinner. If not specified, `min()` is assumed, and if that is not specified, 0 is assumed.
- `nomemory` specifies that the spinner not remember how it was filled in between invocations.
- `min(defnumval)` and `max(defnumval)` set the minimum and maximum integer values of the spinner. `min(0)` and `max(100)` are the defaults.
- `onchange(iaction)` specifies the i-action to be invoked when the spinner is changed. The default i-action is to do nothing. The `onchange()` i-action will be invoked the first time the spinner is displayed.
- `option(optionname)` is a communication option that associates `optionname` with the value of the spinner.
- `tooltip("string")` specifies the text to be displayed as a tip or hint when the user hovers over the control with the mouse.

Example

```
 SPINNER level 10 10 60 ., label(Sig. level) min(5) max(100) ///
        default(c(level)) option(level)
```
3.6.4 EDIT string input control

Syntax

    EDIT newcontrolname x y xsize ysize [, label("string") error("string")
    default(defstrval) nomemory max(#) numonly password onchange(iaction)
    _option(optionname) tooltip("string") ]

Member functions

    setlabel string sets the label for the edit field
    setvalue strvalue sets the value shown in the edit field
    append string appends string to the value in the edit field
    prepend string prepends string to the value of the edit field
    insert string inserts string at the current cursor position of the edit field
    smartinsert string inserts string at the current cursor position in the edit field with
    leading and trailing spaces around it
    setfocus causes the control to obtain keyboard focus
    setoption optionname associates optionname with the contents of the edit field
    setdefault string sets the default value for the edit field; this does not change
    what is displayed
    settooltip string sets the tooltip text to string

The standard member functions hide, show, disable, enable, and setposition are also
provided.

Returned values for use in PROGRAM

    Returns string, the contents of the edit field.

Description

    EDIT defines an edit field. An edit field is a box into which the user may enter text or in which
the user may edit text; the width of the box does not limit how much text can be entered.

Options

    label("string") specifies a description for the control, but it does not display the label next to the
edit field. If you want to label the edit field, you must use a TEXT static control.
    error("string") specifies the text to be displayed describing this field to the user in automatically
generated error boxes.
    default(defstrval) specifies the default contents of the edit field. If not specified, default(""") is
assumed.
    nomemory specifies that the edit field is not to remember how it was filled in between invocations.
    max(#) specifies the maximum number of characters that may be entered into the edit field.
    numonly specifies that the edit field be able to contain only a period, numeric characters 0 through
9, and - (minus).
    password specifies that the characters entered into the edit field be shown on the screen as asterisks
or bullets, depending on the operating system.
onchange(\textit{i-action}) specifies the i-action to be invoked when the contents of the edit field are changed. The default i-action is to do nothing. Note that the onchange() i-action will be invoked the first time the edit field is displayed.

\textbf{option(\textit{optionname})} is a communication option that associates \textit{optionname} with the contents of the edit field. 

\textbf{tooltip(\"string\")} specifies the text to be displayed as a tip or hint when the user hovers over the control with the mouse.

\textbf{Example}

\begin{verbatim}
TEXT tlab 10 10 200 ., label("Title")
EDIT title @ +20 @ ., label("title")
\end{verbatim}

\section*{3.6.5 \textbf{VARLIST} and \textbf{VARNAME} string input controls}

\textbf{Syntax}

\begin{verbatim}
\{ \textbf{VARLIST} | \textbf{VARNAME} \} newcontrolname x y xsize ysize [ , label("string")
   error("string") default(defstrval) nomemory fv ts option(optionname)
   tooltip("string") ]
\end{verbatim}

\textbf{Member functions}

- \texttt{setlabel \textit{string}} sets the label for the varlist edit field
- \texttt{setvalue \textit{strvalue}} sets the value shown in the varlist edit field
- \texttt{append \textit{string}} appends \textit{string} to the value in the varlist edit field
- \texttt{prepend \textit{string}} prepends \textit{string} to the value of the varlist edit field
- \texttt{insert \textit{string}} inserts \textit{string} at the current cursor position of the varlist edit field
- \texttt{smartinsert \textit{string}} inserts \textit{string} at the current cursor position in the varlist edit field with leading and trailing spaces around it
- \texttt{setfocus} causes the control to obtain keyboard focus
- \texttt{setoption \textit{optionname}} associates \textit{optionname} with the contents of the edit field
- \texttt{setdefault \textit{string}} sets the default value for the edit field; this does not change what is displayed
- \texttt{settooltip \textit{string}} sets the tooltip text to \textit{string}

The standard member functions hide, show, disable, enable, and setposition are also provided.

\textbf{Returned values for use in PROGRAM}

Returns \textit{string}, the contents of the varlist edit field.

\textbf{Description}

\textbf{VARLIST} and \textbf{VARNAME} are special cases of an edit field. \textbf{VARLIST} provides an edit field into which one or more Stata variable names may be entered (along with standard Stata varlist abbreviations), and \textbf{VARNAME} provides an edit field into which one Stata variable name may be entered (with standard Stata varname abbreviations allowed).
Options

label("string") specifies a description for the control, but does not display the label next to the varlist edit field. If you want to label the control, you must use a TEXT static control.

effect("string") specifies the text to be displayed describing this field to the user in automatically generated error boxes.

default(defstrval) specifies the default contents of the edit field. If not specified, default("") is assumed.

nomemory specifies that the edit field not remember how it was filled in between invocations.

ef specifies that the control add a factor-variable dialog button.

ts specifies that the control add a time-series-operated variable dialog button.

option(optionname) is a communication option that associates optionname with the contents of the edit field.

tooltip("string") specifies the text to be displayed as a tip or hint when the user hovers over the control with the mouse.

Example

TEXT dvlab 10 10 200 ., label("Dependent variable")
VARNAME depvar @ +20 @ ., label("dep. var")
TEXT ivlab @ +30 @ ., label("Independent variables")
VARLIST idepvars @ +20 @ ., label("ind. vars.")

3.6.6 FILE string input control

Syntax

FILE newcontrolname x y xsize ysize [, label("string") error("string")

default(defstrval) nomemory buttonwidth(#) diagnostitle(string) save

multiselect directory filter(string) onchange(iaction) option(optionname)

tooltip("string")

Member functions

setLabel string sets the label shown on the edit button
setValue strvalue sets the value shown in the edit field
append string appends string to the value in the edit field
prepend string prepends string to the value of the edit field
insert string inserts string at the current cursor position of the edit field
smartinsert string inserts string at the current cursor position in the edit field with leading and trailing spaces around it
setoption optionname associates optionname with the contents of the edit field
setDefault string sets the default value for the edit field; this does not change what is displayed
setTooltip string sets the tooltip text to string

The standard member functions hide, show, disable, enable, and setPosition are also provided.
Returned values for use in PROGRAM

Returns `string`, the contents of the edit field (the file chosen).

Description

FILE is a special edit field with a button on the right for selecting a filename. When the user clicks on the button, a file dialog is displayed. If the user selects a filename and clicks on OK, that filename is put into the edit field. The user may alternatively type a filename into the edit field.

Options

- `label("string")` specifies the text to appear on the button. The default is ("Browse ...").
- `error("string")` specifies the text to be displayed describing this field to the user in automatically generated error boxes.
- `default(defstrval)` specifies the default contents of the edit field. If not specified, `default("")` is assumed.
- `nomemory` specifies that the edit field not remember how it was filled in between invocations.
- `buttonwidth(#)` specifies the width in pixels of the button. The default is `buttonwidth(80)`. The overall size specified in `xsize` includes the button.
- `dialogtitle(string)` is the title to show on the file dialog when you click on the file button.
- `save` specifies that the file dialog allow the user to choose a filename for saving rather than one for opening.
- `multiselect` specifies that the file dialog allow the user to select multiple filenames rather than only one filename.
- `directory` specifies that the file dialog select a directory rather than a filename. If specified, any nonrelevant options will be ignored.
- `filter(string)` consists of pairs of descriptions and wildcard file selection strings separated by “|”, such as
  ```
  filter("Stata Graphs|*.gph|All Files|*.*")
  ```
- `onchange(iaction)` specifies an i-action to be invoked when the user changes the chosen file. The default i-action is to do nothing. The `onchange()` i-action will be invoked the first time the file chooser is displayed.
- `option(optionname)` is a communication option that associates `optionname` with the contents of the edit field.
- `tooltip("string")` specifies the text to be displayed as a tip or hint when the user hovers over the control with the mouse.

Example

```
FILE fname 10 10 300 ., error("Filename to open") label("Browse ...")
```
3.6.7 LISTBOX list input control

Syntax

```
LISTBOX newcontrolname x y xsize ysize [, label("string") error("string")
nomemory contents(conspec) values(listname) default(defstrval)
ondblclick(iaction) [ onselchange(iaction) | onselchangelist(listname) ]
option(optionname) tooltip("string")]
```

Member functions

- `setlabel string` sets the label for the list box
- `setvalue strvalue` sets the currently selected item
- `setfocus` causes the control to obtain keyboard focus
- `setoption optionname` associates `optionname` with the element chosen from the list
- `setdefault string` sets the default value for the list box; this does not change what is displayed
- `repopulate` causes the associated contents list to rebuild itself and then updates the control with the new values from that list
- `forceselchange` forces an `onselchange` event to occur
- `settooltip string` sets the tooltip text to `string`

The standard member functions `hide`, `show`, `disable`, `enable`, and `setposition` are also provided.

Returned values for use in PROGRAM

Returns `string`, the text of the item chosen, or, if `values(listname)` is specified, the text from the corresponding element of `listname`.

Description

LISTBOX defines a list box control. Like radio buttons, a list box allows the user to make a selection from a number of mutually exclusive, but related, choices. A list box control is more appropriate when the number of choices is large.

Options

- `label("string")` specifies a description for the control but does not display the label next to the control. If you want to label the list box, you must use a `TEXT` static control.
- `error("string")` specifies the text to be displayed describing this field to the user in automatically generated error boxes.
- `nomemory` specifies that the list box not remember the item selected between invocations.
- `contents(conspec)` specifies the items to be shown in the list box. If `contents()` is not specified, the list box will be empty.
- `values(listname)` specifies the list (see 3.5 LIST) for which the values of `contents()` should match one to one. When the user chooses the `k`th element from `contents()`, the `k`th element of `listname` will be returned. If the lists do not match one to one, extra elements of `listname` are ignored, and extra elements of `contents()` return themselves.
default(defstrval) specifies the default selection. If not specified, or if defstrval does not exist, the first item is the default.

ondblclick(iaction) specifies the i-action to be invoked when an item in the list is double clicked. The double-clicked item is selected before the iaction is invoked.

onselchange(iaction) and onselchangelist(listname) are alternatives. They specify the i-action to be invoked when a selection in the list changes.

onselchange(iaction) performs the same i-action, regardless of which element of the list was chosen.

onselchangelist(listname) specifies a vector of iactions that should match one to one with contents(). If the user selects the \( k \)th element of contents(), the \( k \)th i-action from listname is invoked. See 3.5 LIST for information on creating listname. If the elements of listname do not match one to one with the elements of contents(), extra elements are ignored, and if there are too few elements, the last element will be invoked for the extra elements of contents().

option(optionname) is a communication option that associates optionname with the element chosen from the list.

tooltip("string") specifies the text to be displayed as a tip or hint when the user hovers over the control with the mouse.

Example

```
LIST ourlist
BEGIN
    Good
    Common or average
    Poor
END

DIALOG . . .
BEGIN
    TEXT ourlab 10 10 200 ., label("Pick a rating")
    LISTBOX rating @ +20 150 200, contents(ourlist)
    . . .
END
```

3.6.8 COMBOBOX list input control

Syntax

```
COMBOBOX newcontrolname x y xsize ysize [, label("string") error("string")
    [regular|dropdown|dropdownlist] default(defstrval) nomemory
    contents(conspec) values(listname) append
    [onselchange(iaction)|onselchangelist(listname)] option(optionname)
    tooltip("string")]
```
Member functions

- `setlabel string`: sets the label for the combo box
- `setvalue strvalue`: in the case of regular and drop-down combo boxes, sets the value of the edit field; in the case of a dropdownlist, sets the currently selected item
- `setfocus`: causes the control to obtain keyboard focus
- `setoption optionname`: associates `optionname` with the element chosen from the list
- `setdefault string`: sets the default value for the combo box; this does not change what is displayed or selected
- `repopulate`: causes the associated contents list to rebuild itself and then updates the control with the new values from that list
- `forceselchange`: forces an onselchange event to occur
- `settooltip string`: sets the tooltip text to `string`

Also, except for drop-down lists (option `dropdownlist` specified), the following member functions are also available:

- `append string`: appends `string` to the value in the edit field
- `prepend string`: prepends `string` to the value of the edit field
- `insert string`: inserts `string` at the current cursor position of the edit field
- `smartinsert string`: inserts `string` at the current cursor position in the edit field with leading and trailing spaces around it

The standard member functions `hide`, `show`, `disable`, `enable`, and `setposition` are also always provided.

Returned values for use in PROGRAM

Returns `string`, the contents of the edit field.

Description

`COMBOBOX` defines regular combo boxes, drop-down combo boxes, and drop-down-list combo boxes. By default, `COMBOBOX` creates a regular combo box; it creates a drop-down combo box if the `dropdown` option is specified, and it creates a drop-down-list combo box if the `dropdownlist` option is specified.

A regular combo box contains an edit field and a visible list box. The user may make a selection from the list box, which is entered into the edit field, or type in the edit field. Multiple selections are allowed using the `append` option. Regular combo boxes are useful for allowing multiple selections from the list as well as for allowing the user to type in an item not in the list.

A drop-down combo box contains an edit field and a list box that appears when the control is clicked on. The user may make a selection from the list box, which is entered into the edit field, or type in the edit field. The control has the same functionality and options as a regular combo box but requires less space. Multiple selections are allowed using the `append` option. Drop-down combo boxes may be cumbersome to use if the number of choices is large, so use them only when the number of choices is small or when space is limited.

A drop-down-list combo box contains a list box that displays only the current selection. Clicking on the control displays the entire list box, allowing the user to make a selection without typing in the edit field; the user chooses among the given alternatives. Drop-down-list combo boxes should be used only when the number of choices is small or when space is limited.
Options

**label("string")** specifies a description for the control but does not display the label next to the combo box. If you want to label a combo box, you must use a **TEXT static control**.

**error("string")** specifies the text to be displayed describing this field to the user in automatically generated error boxes.

**regular, dropdown, and dropdownlist** specify the type of combo box to be created.

  - If **regular** is specified, a regular combo box is created. **regular** is the default.
  - If **dropdown** is specified, a drop-down combo box is created.
  - If **dropdownlist** is specified, a drop-down-list combo box is created.

**default(defstrval)** specifies the default contents of the edit field. If not specified, **default("")** is assumed. If **dropdownlist** is specified, the first item is the default.

**nomemory** specifies that the combo box not remember the item selected between invocations. Even for drop-down lists—where there is no **default()**—combo boxes remember previous selections by default.

**contents(conspec)** specifies the items to be shown in the list box from which the user may choose. If **contents()** is not specified, the list box will be empty.

**values(listname)** specifies the list (see **3.5 LIST**) for which the values of **contents()** should match one to one. When the user chooses the kth element from **contents()**, the kth element of **listname** is copied into the edit field. If the lists do not match one to one, extra elements of **listname** are ignored, and extra elements of **contents()** return themselves.

**append** specifies that selections made from the combo box’s list box be appended to the contents of the combo box’s edit field. By default, selections replace the contents of the edit field. **append** is not allowed if **dropdownlist** is also specified.

**onselchange(iaction)** and **onselchangelist(listname)** are alternatives that specify the i-action to be invoked when a selection in the list changes.

  - **onselchange(iaction)** performs the same i-action, regardless of the element of the list that was chosen.
  - **onselchangelist(listname)** specifies a vector of i-actions that should match one to one with **contents()**. If the user selects the kth element of **contents()**, the kth i-action from **listname** is invoked. See **3.5 LIST** for information on creating **listname**. If the elements of **listname** do not match one to one with the elements of **contents()**, extra elements are ignored, and if there are too few elements, the last element will be invoked for the extra elements of **contents()**.

**option(optionname)** is a communication option that associates **optionname** with the element chosen from the list.

**tooltip("string")** specifies the text to be displayed as a tip or hint when the user hovers over the control with the mouse.
Example

    LIST namelist
    BEGIN
    John
    Sue
    Frank
    END

    DIALOG ...
    BEGIN
    ... 
    TEXT ourlab 10 10 200 ., label("Pick one or more names")
    COMBOBOX names @ +20 150 200, contents(namelist) append
    ...
    END

3.6.9 BUTTON special input control

Syntax

    BUTTON newcontrolname x y xsize ysize [, label("string") error("string")
                                           onpush(iaction) tooltip("string")]

Member functions

    setlabel string      sets the label for the button
    setfocus            causes the control to obtain keyboard focus
    settooltip string   sets the tooltip text to string

    The standard member functions hide, show, disable, enable, and setposition are also
    provided.

Returned values for use in PROGRAM

    None.

Description

    BUTTON creates a push button that performs instantaneous actions. Push buttons do not indicate a
    state, such as on or off, and do not return anything for use by the u-action PROGRAM. Buttons are
    used to invoke i-actions.

Options

    label("string") specifies the text to display on the button. You should specify text that contains
    verbs that describe the action to perform.

    error("string") specifies the text to be displayed describing this field to the user in automatically
    generated error boxes.

    onpush(iaction) specifies the i-action to be invoked when the button is clicked on. If onpush() is
    not specified, the button does nothing.
tooltip("string") specifies the text to be displayed as a tip or hint when the user hovers over the control with the mouse.

**Example**

```plaintext
BUTTON help 10 10 80 ., label("Help") onpush("view help example")
```

### 3.6.10 TEXT static control

**Syntax**

```plaintext
TEXT newcontrolname x y xsize ysize [, label("string") [left|center|right]]
```

**Member functions**

- `setlabel string` sets the text shown

The standard member functions `hide`, `show`, `disable`, `enable`, and `setposition` are also provided.

**Returned values for use in PROGRAM**

None.

**Description**

TEXT displays text.

**Options**

- `label("string")` specifies the text to be shown.
- `left`, `center`, and `right` are alternatives that specify the horizontal alignment of the text with respect to `x`. `left` is the default.

**Example**

```plaintext
TEXT dvlab 10 10 200 ., label("Dependent variable")
```

### 3.6.11 TEXTBOX static control

**Syntax**

```plaintext
TEXTBOX newcontrolname x y xsize ysize [, label("string") [left|center|right]]
```

**Member functions**

- `setlabel string` sets the text shown

The standard member functions `hide`, `show`, `disable`, `enable`, and `setposition` are also provided.
Returned values for use in PROGRAM

None.

Description

TEXTBOX displays multiline text.

Options

label("string") specifies the text to be shown.
left, center, and right are alternatives that specify the horizontal alignment of the text with respect to x. left is the default.

Example

TEXTBOX tx_note 10 10 200 45, label("Note ...")

3.6.12 GROUPBOX static control

Syntax

GROUPBOX newcontrolname x y xsize ysize [ , label("string")]

Member functions

setLabel string sets the text shown above the group box

The standard member functions hide, show, disable, enable, and setPosition are also provided.

Returned values for use in PROGRAM

None.

Description

GROUPBOX displays a frame (an outline) with text displayed above it. Group boxes are used for grouping related controls together. The grouped controls are sometimes said to be inside the group box, but there is no meaning to that other than the visual effect.

Options

label("string") specifies the text to be shown at the top of the group box.

Example

GROUPBOX weights 10 10 300 200, label("Weight type")
   RADIO w1 . . . , . . . label(fweight) first . . .
   RADIO w2 . . . , . . . label(aweight) . . .
   RADIO w3 . . . , . . . label(pweight) . . .
   RADIO w4 . . . , . . . label(iweight) last . . .
3.6.13 FRAME static control

Syntax

\[
\text{FRAME}\ newcontrolname\ x\ y\ xsize\ ysize\ [\ ,\ \text{label("string")}]\]

Member functions

There are no special member functions provided.

The standard member functions hide, show, disable, enable, and setPosition are also provided.

Returned values for use in PROGRAM

None.

Description

FRAME displays a frame (an outline).

Options

\text{label("string")} specifies the label for the frame, which is not used in any way, but some programmers use it to record comments documenting the purpose of the frame.

Remarks

The distinction between a frame and a group box with no label is that a frame draws its outline using the entire dimensions of the control. A group box draws its outline a few pixels offset from the top of the control, whether there is a label or not. A frame is useful for horizontal alignment with other controls.

Example

\[
\text{FRAME}\ box\ 10\ 10\ 300\ 200\ \\
\text{RADIO}\ w1\ .\ .\ .\ ,\ .\ .\ .\ \text{label(fweight)}\ \text{first}\ .\ .\ .\ \\
\text{RADIO}\ w2\ .\ .\ .\ ,\ .\ .\ .\ \text{label(aweight)}\ .\ .\ .\ \\
\text{RADIO}\ w3\ .\ .\ .\ ,\ .\ .\ .\ \text{label(pweight)}\ .\ .\ .\ \\
\text{RADIO}\ w4\ .\ .\ .\ ,\ .\ .\ .\ \text{label(iweight)}\ \text{last}\ .\ .\ .\ 
\]

3.6.14 COLOR input control

Syntax

\[
\text{COLOR}\ newcontrolname\ x\ y\ xsize\ ysize\ [\ ,\ \text{label("string")}\ \text{error("string")}\\
\text{default(rgbvalue)}\ \text{nomemory}\ \text{onchange(iaction)}\ \text{option(optionname)}\\
\text{tooltip("string")}]\]

**Member functions**

- `setvalue rgbvalue` sets the rgb value of the color selector
- `setoption optionname` associates `optionname` with the selected color
- `setdefault rgbvalue` sets the default rgb value of the color selector; this does not change the selected color
- `settooltip string` sets the tooltip text to `string`

The standard member functions `hide`, `show`, `disable`, `enable`, and `setposition` are also provided.

**Returned values for use in PROGRAM**

Returns `rgbvalue` of the selected color as a string.

**Description**

`COLOR` defines a button to access a color selector. The button shows the color that is currently selected.

**Options**

- `label("string")` specifies a description for the control, but it does not display the label next to the button. If you want to label the color control, you must use a `TEXT` static control.
- `error("string")` specifies the text to be displayed describing this field to the user in automatically generated error boxes.
- `default(rgbvalue)` specifies the default color of the color control. If not specified, `default(255 0 0)` is assumed.
- `nomemory` specifies that the color control not remember the set color between invocations.
- `onchange(iaction)` specifies the i-action to be invoked when the color is changed. The default i-action is to do nothing. Note that the `onchange()` i-action will be invoked the first time the color control is displayed.
- `option(optionname)` is a communication option that associates `optionname` with the selected color.
- `tooltip("string")` specifies the text to be displayed as a tip or hint when the user hovers over the control with the mouse.

**Example**

```
COLOR box_color 10 10 40 ., default(0 0 0)
```

### 3.6.15 EXP expression input control

**Syntax**

```
EXP newcontrolname x y xsize ysize [, label("string") error("string") default(defstrval) nomemory onchange(iaction) option(optionname) tooltip("string")]
```
Member functions

- **setlabel** *string* sets the label for the button
- **setvalue** *strvalue* sets the value shown in the edit field
- **append** *string* appends *string* to the value in the edit field
- **prepend** *string* prepends *string* to the value of the edit field
- **insert** *string* inserts *string* at the current cursor position of the edit field
- **smartinsert** *string* inserts *string* at the current cursor position in the edit field with leading and trailing spaces around it
- **setoption** *optionname* associates *optionname* with the contents of the edit field
- **setdefault** *string* sets the default value for the edit field; this does not change what is displayed
- **settooltip** *string* sets the tooltip text to *string*

The standard member functions hide, show, disable, enable, and setposition are also provided.

Returned values for use in PROGRAM

Returns *string*, the contents of the edit field.

Description

EXP defines an expression control that consists of an edit field and a button for launching the Expression Builder.

Options

- **label**("string") specifies the text for labeling the button.
- **error**("string") specifies the text to be displayed describing this field to the user in automatically generated error boxes.
- **default**(defstrval) specifies the default contents of the edit field. If not specified, default("") is assumed.
- nomemory specifies that the edit field not remember how it was filled in between invocations.
- **onchange**(iaction) specifies the i-action to be invoked when the contents of the edit field are changed.
  The default i-action is to do nothing. Note that the onchange() i-action will be invoked the first time the expression control is displayed.
- **option**(*optionname*) is a communication option that associates *optionname* with the contents of the edit field.
- **tooltip**("string") specifies the text to be displayed as a tip or hint when the user hovers over the control with the mouse.

Example

```
TEXT tlab 10 10 200 ., label("Expression:")
EXP exp @ +20 @ ., label("Expression")
```
3.6.16 HLINK hyperlink input control

Syntax

```plaintext
HLINK newcontrolname x y xsize ysize [, label("string") [left | center | right] onpush(iaction)]
```

Member functions

```plaintext
setlabel string sets the text shown
```

The standard member functions hide, show, disable, enable, and setposition are also provided.

Returned values for use in PROGRAM

None.

Description

HLINK creates a hyperlink that performs instantaneous actions. Hyperlinks do not indicate a state, such as on or off, and do not return anything for use by the i-action PROGRAM. Hyperlinks are used to invoke i-actions.

Options

```plaintext
label("string") specifies the text to be shown.
left, center, and right are alternatives that specify the horizontal alignment of the text with respect to x. left is the default.
onpush(iaction) specifies the i-action to be invoked when the hyperlink is clicked on. If onpush() is not specified, the hyperlink does nothing.
```

Example

```plaintext
HLINK help 10 10 80 , label("Help") onpush("view help example")
```

3.6.17 TREEVIEW tree input control

Syntax

```plaintext
TREEVIEW newcontrolname x y xsize ysize [, label("string") error("string")
nomemory contents conspec) values(listname) default(defstrval)
ondblclick(iaction) [onselectchange(iaction) | onselectchangelist(listname)
option(optionname) tooltip("string")]
```
Member functions

- **setlabel string**: sets the label for the tree
- **setvalue strvalue**: sets the currently selected item
- **setfocus**: causes the control to obtain keyboard focus
- **setoption optionname**: associates *optionname* with the element chosen from the tree
- **setdefault string**: sets the default value for the tree; this does not change what is displayed
- **forceselchange**: forces an *onselchange* event to occur
- **settooltip string**: sets the tooltip text to *string*

The standard member functions *hide*, *show*, *disable*, *enable*, and *setposition* are also provided.

Returned values for use in PROGRAM

Returns *string*, the text of the item chosen, or, if *values(listname)* is specified, the text from the corresponding element of *listname*.

Description

**TREEVIEW** defines a tree control, which is used to display a hierarchical view of labeled items. A tree view allows the user to select from several mutually exclusive but related choices. By clicking on an item, the user can expand or collapse the associated list of subitems.

Options

- **label("string")**: specifies a description for the control but does not display the label next to the control. If you want to label a tree view, you must use a TEXT static control.
- **error("string")**: specifies the text to be displayed describing this field to the user in automatically generated error boxes.
- **nomemory**: specifies that the control not remember the item selected between invocations.
- **contents(conspec)**: specifies the items to be shown in the control. If *contents()* is not specified, the tree view control will be empty.
- **values(listname)**: specifies the list (see 3.5 LIST) for which the values of *contents()* should match one to one. When the user chooses the *k*th element from *contents()* , the *k*th element of *listname* will be returned. If the lists do not match one to one, extra elements of *listname* are ignored, and extra elements of *contents()* return themselves.
- **default(defstrval)**: specifies the default selection. If not specified, or if *defstrval* does not exist, the first item is the default.
- **ondblclick(iaction)**: specifies the i-action to be invoked when an item in the control is double clicked. The double-clicked item is selected before the *iaction* is invoked.
- **onselchange(iaction)** and **onselchangelist(listname)** are alternatives. They specify the i-action to be invoked when a selection in the control changes.
- **onselchange(iaction)** performs the same i-action, regardless of which element of the control was chosen.
- **onselchangelist(listname)** specifies a vector of i-actions that should match one to one with *contents()* . If the user selects the *k*th element of *contents()* , the *k*th i-action from *listname* is invoked. See 3.5 LIST for information on creating *listname*. If the elements of *listname* do not match one to one with the elements of *contents()* , extra elements are ignored, and if there are too few elements, the last element will be invoked for the extra elements of *contents()*.
option(optionname) is a communication option that associates optionname with the element chosen from the tree view control.

tooltip("string") specifies the text to be displayed as a tip or hint when the user hovers over the control with the mouse.

**Organize data**

TREEVIEW represents a hierarchical view of information where each item may have a number of subitems. Items (nodes) in the tree view can be expanded or collapsed to show or hide subitems. For example,

```
Root 1
  SubItem A
    SubItem A1
    SubItem A2
  SubItem B
Root 2
  SubItem C
```

The parent–child relationship data are stored in a content list. Each item in the list represents a node of the tree. The string labeling each item contains two parts. The first part encloses a nonnegative integer in square brackets to denote the level or depth of each node. The second part following the square brackets is the content shown in the tree.

**Example**

```
LIST ourcontentlist
BEGIN
  [0]Root 1
  [1]SubItem A
    [2]SubItem A1
    [2]SubItem A2
  [1]SubItem B
  [0]Root 2
  [1]SubItem C
END

DIALOG ...
BEGIN
  TEXT ourlab 10 10 200 , label("Pick an item")
  TREEVIEW outtree @ +20 150 200, contents(ourcontentlist)
END
```

3.7 OK, SUBMIT, CANCEL, and COPY u-action buttons

**Syntax**

```
{ OK | SUBMIT | COPY } newbuttonname [ , label("string") uaction(programname) target(target) ]

CANCEL newbuttonname [ , label("string") ]
```
Description

OK, CANCEL, SUBMIT, and COPY define buttons that, when clicked on, invoke a u-action. At least one of the buttons should be defined (or the dialog will have no associated u-action); only one of each button may be defined; and usually, good style dictates defining all four.

OK executes `programname`, removes the dialog box from the screen, and submits the resulting command produced by `programname` to `target`. If no other buttons are defined, clicking on the close icon of the dialog box does the same thing.

SUBMIT executes `programname`, leaves the dialog box on the screen, and submits the resulting command produced by `programname` to `target`.

CANCEL removes the dialog from the screen and does nothing. If this button is defined, clicking on the close icon of the dialog box does the same thing.

COPY executes `programname`, leaves the dialog box on the screen, and copies the resulting command produced by `programname` to `target`. By default, the `target` is the `clipboard`.

You do not specify the location or size of these controls. They will be placed in the dialog box where the user would expect to see them.

Options

`label("string")` defines the text to appear on the button. The default `label()` is OK, Submit, and Cancel for each individual button.

`uaction(``programname``)``` specifies the PROGRAM to be executed. `uaction(command)` is the default.

`target(``target``)` defines what is to be done with the resulting string (command) produced by `programname`. The alternatives are

- `target(``stata``)`: The command is to be executed by Stata. This is the default.
- `target(``stata hidden``)`: The command is to be executed by Stata, but the command itself is not to appear in the Results window. The output from the command will appear normally. **This option may change in the future and should be avoided when possible.**
- `target(``cmdwin``)`: The command is to be placed in the Command window so that the user can edit it and then press `Enter` to submit it.
- `target(``clipboard``)`: The command is to be placed on the clipboard so that the user can paste it into the desired editor.

Example

```
OK ok1
CANCEL can1
SUBMIT sub1
COPY copy1
```

**3.8 HELP and RESET helper buttons**

Syntax

```
HELP newbuttonname [, view("viewertopic")]
RESET newbuttonname
```
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Description
HELP defines a button that, when clicked on, presents \textit{viewertopic} in the Viewer. \textit{viewertopic} is typically specified as "view helpfile".

RESET defines a button that, when clicked on, resets the values of the controls in the dialog box to their initial state, just as if the dialog box were invoked for the first time. Each time a user invokes a dialog box, its controls will be filled in with the values the user last entered. RESET restores the control values to their defaults.

You do not specify the location, size, or appearance of these controls. They will be placed in the lower-left corner of the dialog box. The HELP button will have a question mark on it, and the RESET button will have an R on it.

Option
view("viewertopic") specifies the topic to appear in the Viewer when the user clicks on the button.

The default is view("help contents").

Example
HELP hlp1, view("help mycommand")
RESET res1

3.9 Special dialog directives

Syntax
\{ MODAL \mid SYNCHRONOUS\_ONLY \}

Description
MODAL instructs the dialog to have modal behavior.
SYNCHRONOUS\_ONLY allows the dialog to invoke \texttt{stata hidden immediate} at special times during the initialization process. See \texttt{5.5.1 stata} for more information on this topic.

4. SCRIPT

Syntax
\begin{verbatim}
SCRIPT newscriptname
BEGIN
\textit{iaction} ...
END
\end{verbatim}

where \textit{iaction} is

\begin{verbatim}
\textit{action memberfunction}
\textit{gaction dialogname.controlname.memberfunction}
\end{verbatim}
dialogname.controlname.memberfunction

script scriptname
view topic
program programname

See 2.5 I-actions and member functions for more information on iactions.

Description

SCRIPT defines the newscriptname, which in turn defines a compound i-action. I-actions are invoked by the on *() options of the input controls. When a script is invoked, the lines are executed sequentially, and any errors are ignored.

Remarks

CHECKBOX provides onclickon(iaction) and onclickoff(iaction) options. Let’s focus on the onclickon(iaction) option. If you wanted to take just one action when the box was checked—say, disabling d1.s2—you could code

CHECKBOX . . . , . . . onclickon(d1.s2.disable) . . .

If you wanted to take two actions, say, disabling d1.s3 as well, you would have to use a SCRIPT. On the CHECKBOX command, you would code

CHECKBOX . . . , . . . onclickon(script buttonsoff) . . .

and then somewhere else in the .dlg file (it does not matter where), you would code

SCRIPT buttonsoff
BEGIN
  d1.s2.disable
  d1.s3.disable
END

5. PROGRAM

Syntax

PROGRAM programname
BEGIN
  [program_line | INCLUDE]
  [ . . . ]
END

Description

PROGRAM defines a dialog program. Dialog programs are used to describe complicated i-actions and to implement u-actions.
Remarks

Dialog programs are used to describe complicated i-actions when flow control (if/then) is necessary or when you wish to create heavyweight i-actions that are like u-actions because they invoke Stata commands; otherwise, you should use a SCRIPT. Used this way, programs are invoked when the specified iaction is program programname in an on*() option of an input control command; for instance, you could code

CHECKBOX . . . , . . . onclickon(program complicated) . . .

or use a SCRIPT:

CHECKBOX . . . , . . . onclickon(script multi) . . .

    SCRIPT multi
    BEGIN
    ।
    program complicated
    ।
    END

The primary use of dialog programs, however, is to implement u-actions. The program constructs and returns a string, which the dialog-box manager will then interpret as a Stata command. The program is invoked by the uaction() options of OK and SUBMIT; for instance,

OK . . . , . . . uaction(program command) . . .

The u-action program is nearly always named command because, if the uaction() option is not specified, command is assumed. The u-action program may, however, be named as you please.

Here is an example of a dialog program being used to implement an i-action with if/then flow control:

PROGRAM testprog
BEGIN
  if sample.cb1 & sample.cb2 {
    call sample.txt1.disable
  }
  if !(sample.cb1 & sample.cb2) {
    call sample.txt1.enable
  }
END

Here is an example of a dialog program being used to implement the u-action:

PROGRAM command
BEGIN
  put "mycmd "
  varlist main.vars // varlist [main.vars] would make optional
  ifexp main.if
  inrange main.obs1 main.obs2
  beginoptions
    option options.detail
    optionarg options.title
  endoptions
END

Using programs to implement heavyweight i-actions is much like implementing u-actions, except the program might not be a function of the input controls, and you must explicitly code the stata command to execute what is constructed. Here is an example of a dialog program being used to implement a heavyweight i-action:


5.1 Concepts

5.1.1 Vnames

A vname stands for value name and refers to the “value” of a control. Vnames are of the form `dialogname.controlname`; for example, `d2.s2` and `d2.list` would be vnames if input controls `s2` and `list` were defined in DIALOG `d2`:

```
DIALOG d2 . . .
BEGIN
  . . .
  CHECKBOX s2 . . .
  EDIT list . . .
  . . .
END
```

A vname can be numeric or string depending on the control to which it corresponds. For CHECKBOX, it was documented under “Returned value for use in PROGRAM” that CHECKBOX “returns numeric, 0 or 1, depending on whether box is checked”, so `d2.s2` is a numeric. For the EDIT input control, it was documented that EDIT returns a string representing the contents of the edit field, so `d2.list` is a string.

Different words are sometimes used to describe whether vname is numeric or string, including

- `vname` is numeric
- `vname` is string
- `vname` is a numeric control
- `vname` is a string control
- `vname` returns a numeric result
- `vname` returns a string result

In a program, you may not assign values to vnames; you may only examine their values and, for u-action (and heavyweight i-action) programs, output them. Thus dialog programs are pretty relaxed about types. You can ask whether `d2.s2` is true or `d2.list` is true, even though `d2.list` is a string. For a string, it is true if it is not "". Numeric vnames are true if the numeric result is not 0.

5.1.2 Enames

Enames are an extension of vnames. An ename is defined as

```
  vname
  or(vname vname . . . vname)
  radio(dialogname controlname . . . controlname)
```
or() returns the \textit{vname} of the first in the list that is true (filled in). For instance, the \texttt{varlist} \texttt{u-action} dialog-programming command “outputs” a \texttt{varlist} (see \textit{5.1.3 rstrings: cmdstring and optstring}). If you knew that the \texttt{varlist} was in either control \texttt{d1.field1} or \texttt{d1.field2} and knew that both could not be filled in, you might code

\begin{verbatim}
varlist or(d1.field1 d1.field2)
\end{verbatim}

which would have the same effect as

\begin{verbatim}
if d1.field1 {
    varlist d1.field1
} else if (!d1.field1) & d2.field2 {
    varlist d2.field2
}
\end{verbatim}

\texttt{radio()} is for dealing with radio buttons. Remember that each radio button is a separate control, and yet, in the set, we know that exactly one is clicked on. \texttt{radio} finds the clicked one. Typing

\begin{verbatim}
option radio(d1 b1 b2 b3 b4)
\end{verbatim}

would be equivalent to typing

\begin{verbatim}
option or(d1.b1 d1.b2 d1.b3 d1.b4)
\end{verbatim}

which would be equivalent to typing

\begin{verbatim}
option d1.b2
\end{verbatim}

assuming that the second radio button is selected. (The \texttt{option} command outputs the option corresponding to a control.)

\textit{5.1.3 rstrings: cmdstring and optstring}

\texttt{Rstrings, cmdstring} and \texttt{optstring}, are relevant only in \texttt{u-action} and heavyweight \texttt{i-action} programs.

The purpose of a \texttt{u-action} program is to build and return a string, which Stata will ultimately execute. To do that, dialog programs have an \texttt{rstring} to which the dialog-programming commands implicitly contribute. For example,

\begin{verbatim}
put "kappa"
\end{verbatim}

would add “kappa” (without the quotes) to the end of the \texttt{rstring} currently under construction, known as the current \texttt{rstring}. Usually, the current \texttt{rstring} is \texttt{cmdstring}, but within a \texttt{beginoptions/endoptions} block, the current \texttt{rstring} is switched to \texttt{optstring}:

\begin{verbatim}
beginoptions
    put "kappa"
endoptions
\end{verbatim}

The above would add “kappa” (without the quotes) to \texttt{optstring}.

When the program concludes, the \texttt{cmdstring} and the \texttt{optstring} are put together—separated by a comma—and that is the command Stata will execute. In any case, any command that can be used outside \texttt{beginoptions/endoptions} can be used inside them, and the only difference is the \texttt{rstring} to which the output is directed. Thus if our entire \texttt{u-action} program read
Dialog programming — Dialog programming

PROGRAM command
BEGIN
    put "kappa"
    beginoptions
    put "kappa"
    endoptions
END

the result would be to execute the command “kappa, kappa”.

The difference between a u-action program and a heavyweight i-action program is that you must, in your program, specify that the constructed command be executed. You do this with the stata command. The stata command can also be used in u-action programs if you wish to execute more than one Stata command:

PROGRAM command
BEGIN
    put, etc.  // construct first command
    stata    // execute first command
    clear    // clear cmdstring and optstring
    put, etc. // construct second command
    END

5.1.4 Adding to an rstring

When adding to an rstring, be aware of some rules in using spaces. Call A the rstring and B the string being added (say “kappa”). The following rules apply:

1. If A does not end in a space and B does not begin with a space, the two strings are joined to form “AB”. If A is “this” and B is “that”, the result is “thisthat”.

2. If A ends in one or more spaces and B does not begin with a space, the spaces at the end of A are removed, one space is added, and B is joined to form “rightstrip(A) B”. If A is “this ” and B is “that”, the result is “this that”.

3. If A does not end in a space and B begins with one or more spaces, the spaces at the beginning of B are ignored and treated as if there is one space, and the two strings are joined to form “A leftstrip(B)”. If A is “this” and B is “ that”, the result is “this that”.

4. If A ends in one or more spaces and B begins with one or more spaces, the spaces at the end of A are removed, the spaces at the beginning of B are ignored, and the two strings are joined with one space in between to form “rightstrip(A) leftstrip(B)”. If A is “this ” and B is “ that”, the result is “this that”.

These rules ensure that multiple spaces do not end up in the resulting string so that the string will look better and more like what a user might have typed.

When string literals are put, they are nearly always put with a trailing space

    put "kappa ">

to ensure that they do not join up with whatever is put next. If what is put next has a leading space, that space will be ignored.
5.2 Flow-control commands

5.2.1 if

Syntax

\begin{verbatim}
if ifexp {
    ...
}
\end{verbatim}

or

\begin{verbatim}
if ifexp {
    ...
} else {
    ...
}
\end{verbatim}

where \textit{ifexp} may be

\begin{tabular}{ll}
\textit{ifexp} & Meaning \\
\hline
(ifexp) & order of evaluation \\
\textit{!ifexp} & logical not \\
\textit{ifexp} | \textit{ifexp} & logical or \\
\textit{ifexp} & \textit{&} \textit{ifexp} & logical and \\
vname & true if \textit{vname} is not 0 and not "" \\
vname.booleanfunction & true if \textit{vname.booleanfunction} evaluates to true \\
\_rc & see 5.5 Command-execution commands \\
\_stbusy & true if Stata is busy \\
H(vname) & true if \textit{vname} is hidden or disabled \\
default(vname) & true if \textit{vname} is its default value \\
\end{tabular}

Note the recursive definition: An \textit{ifexp} may be substituted into itself to produce more complicated expressions, such as \((\textit{!d1.s1}) \& \textit{d1.s2}) | \textit{d1.s3}.isdefault()\).
Also note that the order of evaluation is left to right; use parentheses.

<table>
<thead>
<tr>
<th>boolean function</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>isdefault()</td>
<td>true if the value of vname is its default value</td>
</tr>
<tr>
<td>isenabled()</td>
<td>true if vname is enabled</td>
</tr>
<tr>
<td>isnumlist()</td>
<td>true if the value of vname is a numlist</td>
</tr>
<tr>
<td>isVisible()</td>
<td>true if vname is visible</td>
</tr>
<tr>
<td>isvalidname()</td>
<td>true if the value of vname is a valid Stata name</td>
</tr>
<tr>
<td>isvarname()</td>
<td>true if the value of vname is the name of a variable in the current dataset</td>
</tr>
<tr>
<td>iseq(argument)</td>
<td>true if the value of vname is equal to argument</td>
</tr>
<tr>
<td>isneq(argument)</td>
<td>true if the value of vname is not equal to argument</td>
</tr>
<tr>
<td>isgt(argument)</td>
<td>true if the value of vname is greater than argument</td>
</tr>
<tr>
<td>isge(argument)</td>
<td>true if the value of vname is greater than or equal to argument</td>
</tr>
<tr>
<td>islt(argument)</td>
<td>true if the value of vname is less than argument</td>
</tr>
<tr>
<td>isle(argument)</td>
<td>true if the value of vname is less than or equal to argument</td>
</tr>
<tr>
<td>isNumlistEQ(argument)</td>
<td>true if every value of vname is equal to argument, where vname may be a numlist</td>
</tr>
<tr>
<td>isNumlistLT(argument)</td>
<td>true if every value of vname is less than argument, where vname may be a numlist</td>
</tr>
<tr>
<td>isNumlistLE(argument)</td>
<td>true if every value of vname is less than or equal to argument, where vname may be a numlist</td>
</tr>
<tr>
<td>isNumlistGT(argument)</td>
<td>true if every value of vname is greater than argument, where vname may be a numlist</td>
</tr>
<tr>
<td>isNumlistGE(argument)</td>
<td>true if every value of vname is greater than or equal to argument, where vname may be a numlist</td>
</tr>
<tr>
<td>isNumlistInRange(arg1, arg2)</td>
<td>true if every value of vname is in between arg1 and arg2 inclusive, where vname may be a numlist</td>
</tr>
<tr>
<td>startswith(argument)</td>
<td>true if the value of vname starts with argument</td>
</tr>
<tr>
<td>endswith(argument)</td>
<td>true if the value of vname ends with argument</td>
</tr>
<tr>
<td>contains(argument)</td>
<td>true if the value of vname contains argument</td>
</tr>
<tr>
<td>iseqignorecase(argument)</td>
<td>true if the value of vname is equal to argument ignoring case</td>
</tr>
</tbody>
</table>

An argument can be a dialog control, a dialog property, or a literal. If the argument is a literal it can be either string or numeric, depending on the type of control the boolean function references. String controls require that literals be quoted, and numeric controls require that literals not be quoted.

**Description**

*if* executes the code inside the braces if *ifexp* evaluates to true and skips it otherwise. When an *else* has been specified, the code within its braces will be executed if *ifexp* evaluates to false. *if* commands may be nested.

**Example**

```plaintext
if d1.v1.isvisible() {
    put "thing=" d1.v1
} else {
    put "thing=" d1.v2
}
```
5.2.2 while

Syntax

```plaintext
while condition {
    ...
}
```

where `condition` may be

<table>
<thead>
<tr>
<th><code>condition</code></th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>(condition)</code></td>
<td>order of evaluation</td>
</tr>
<tr>
<td><code>!condition</code></td>
<td>logical not</td>
</tr>
<tr>
<td>`condition</td>
<td>condition`</td>
</tr>
<tr>
<td><code>condition &amp; condition</code></td>
<td>logical and</td>
</tr>
</tbody>
</table>

Description

A `while` loop is for circumstances where you want to do the same thing repeatedly. It is controlled by a counter. For a `while` loop to execute correctly, you must do the following:

1. Initialize a start value for the counter before the loop.
2. Specify a condition that tests the value of the counter against its expected final value such that the logical condition evaluates to false and the loop is forced to end at some point.
3. Specify a command that modifies the value of the counter inside the loop.

Example

```plaintext
PROGRAM testprog
    call create DOUBLE i
    call create ARRAY testlist
    while(i.islt(10)) {
        call i.withvalue testlist.Arrpush @
        call i.increment
    }
END
```
5.2.3 call

Syntax

call iaction

where iaction is

- action memberfunction
- gaction dialogname.controlname.memberfunction
dialogname.controlname.memberfunction
- script scriptname
- view topic
- program programname

iaction “action memberfunctionname” is invalid in u-action programs because there is no concept of a current control.

Description

call executes the specified iaction. If an iaction is not specified, gaction is assumed.

Example

PROGRAM testprog
BEGIN
  if sample.cb1 & sample.cb2 {
    call gaction sample.txt1.disable
  }
  if !(sample.cb1 & sample.cb2) {
    call gaction sample.txt1.enable
  }
END

5.2.4 exit

Syntax

exit [ # ]

where # ≥ 0. The following exit codes have special meaning:

<table>
<thead>
<tr>
<th>#</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>exit without error</td>
</tr>
<tr>
<td>&gt;0</td>
<td>exit with error</td>
</tr>
<tr>
<td>101</td>
<td>program exited because of a missing required object</td>
</tr>
</tbody>
</table>
Description

`exit` causes the program to exit and, optionally, to return `#`. `exit` without an argument is equivalent to “`exit 0`”. In u-action programs, the `cmdstring`, `optstring` will be sent to Stata for execution.

`exit #, # > 0`, indicates an error. In u-action programs, the `cmdstring`, `optstring` will not be executed. `exit 101` has special meaning. When a u-action program exits, Stata checks the exit code for that program and, if it is 101, presents an error box stating that the user forgot to fill in a required element of the dialog box.

Example

```plaintext
if !sample.var1 {
    exit 101
}
```

5.2.5 close

Syntax

```
close
```

Description

`close` causes the dialog box to close.

5.3 Error-checking and presentation commands

5.3.1 require

Syntax

```
require `ename` [ `ename` [ . . ] ]
```

where each `ename` must be `string`.

Description

`require` does nothing on each `ename` that is disabled or hidden.

For other `enames`, `require` requires that the controls specified not be empty (""`) and produces a stop-box error message such as “`dependent variable must be defined`” for any that are empty. The “dependent variable” part of the message will be obtained from the control’s `error()` option or, if that was not specified, from the control’s `label()` option; if that was not specified, a generic error message will be displayed.

Example

```plaintext
require main.grpvar
```
5.3.2 stopbox

Syntax

stopbox { stop | note | rasure } [ "line1" [ "line2" [ "line3" [ "line4" ] ] ] ]

Description

stopbox displays a message box containing up to four lines of text. Three types are available:

- **stop**: Displays a message box in which there is only one button, OK, which means that the user must accept that he or she made an error and correct it. The program will exit after stopbox stop.

- **note**: Displays a message box in which there is only one button, OK, which confirms that the user has read the message. The program will continue after stopbox note.

- **rusure**: Displays a message box in which there are two buttons, Yes and No. The program will continue if the user clicks on Yes or exit if the user clicks on No.

Also see [P] window stopbox for more information.

Example

stopbox stop "Nothing has been selected"

5.4 Command-construction commands

The command-construction commands are

```
by
bysort
put
varlist
ifexp
inrange
weight
beginoptions/option/optionarg/endoptions
allowxi/\xi
```

clear

Most correspond to the part of Stata syntax for which they are named:

```
by varlist: cmd varlist [ if ] [ in ] [ weight ] [ , options ]
```

put corresponds to cmd (although it is useful for other things as well), and allowxi/xi corresponds to putting xi: in front of the entire command; see [R] xi.

The command-construction commands (with the exception of xi) build cmdstring and optstring in the order the commands are executed (see 5.1.3 rstrings: cmdstring and optstring), so you should issue them in the same order they are used in Stata syntax.
Added to the syntax diagrams that follow is a new header:

Use of option() communication.

This refers to the option() option on the input control definition, such as CHECKBOX and EDIT; see 2.6 U-actions and communication options.

5.4.1 by

Syntax

by ename

where ename must contain a string and should refer to a VARNAME, VARLIST, or EDIT control.

Use of option() communication: None.

Description

by adds nothing to the current rstring if ename is hidden, disabled, or empty. Otherwise, by outputs “by varlist:”, followed by a blank, obtaining a varlist from ename.

Example

by d2.by

5.4.2 bysort

Syntax

bysort ename

where ename must contain a string and should probably refer to a VARNAME, VARLIST, or EDIT control.

Use of option() communication: None.

Description

bysort adds nothing to the current rstring if ename is hidden, disabled, or empty. Otherwise, bysort outputs “by varlist, sort :”, followed by a blank, obtaining a varlist from ename.

Example

bysort d2.by
5.4.3 put

Syntax

```
put [%fmt] putel [%fmt] putel [...]
```

where `putel` may be

```
""  
"string"

vname

/hidden vname

/on vname

/program programname
```

The word "output" means "add to the current result" in what follows. The `put` directives are defined as

```
"" and "string"

Outputs the fixed text specified.

vname

Outputs the value of the control.

/hidden vname

Outputs the value of the control, even if it is hidden or disabled.

/on vname

Outputs nothing if `vname`==0. `vname` must be numeric and should be the result of a `CHECKBOX` or `RADIO` control. `/on` outputs the text from the control’s `option()` option. Also see 5.4.8.1 `option` for an alternative using the `option` command.

/program programname

Outputs the `cmdstring`, `optstring` returned by `programname`.

If any `vname` is disabled or hidden and not preceded by `/hidden`, `put` outputs nothing.

If the directive is preceded by `%fmt`, the specified `%fmt` is always used to format the result. Otherwise, string results are displayed as is, and numeric results are displayed in `%10.0g` format and stripped of resulting leading and trailing blanks. See [D] `format`.

Use of `option()` communication: See `/on` above.

Description

`put` adds to the current rstring (outputs) what is specified.

Remarks

`put "string"` is often used to add the Stata command to the current rstring. When used in that way, the right way to code is

```
put "commandname 
```

Note the trailing blank on `commandname`; see 5.1.4 Adding to an rstring.

`put` displays nothing if any element specified is hidden or disabled. For instance,

```
put "thing=" d1.v1
```
will output nothing (not even "thing=") if d1.v1 is hidden or disabled. This saves you from having to code

```plaintext
if !H(d1.v1) {
    put "thing=" d1.v1
}
```

### 5.4.4 varlist

**Syntax**

```plaintext
varlist el [el [...]]
```

where an `el` is `ename` or `[ename]` (brackets significant).

Each `ename` must be string and should be the result from a `VARLIST`, `VARNAME`, or `EDIT` control.

If `ename` is not enclosed in brackets, it must not be hidden or disabled.

Use of option() communication: None.

**Description**

`varlist` considers it an error if any of the specified `enames` that are not enclosed in brackets are hidden or disabled or empty (contain "").

In these cases, `varlist` displays a stop-message box indicating that the varlist must be filled in and exits the program.

`varlist` adds nothing to the current rstring if any of the specified `enames` that are enclosed in brackets are hidden or disabled.

Otherwise, `varlist` outputs with leading and trailing blanks the contents of each `ename` that is not hidden, is not disabled, and does not contain "".

**Remarks**

`varlist` is most often used to output the varlist of a Stata command, such as

```plaintext
varlist main.depvar [main.indepvars]
```

`varlist` can also be used for other purposes. You might code

```plaintext
if d1.v1 {
    put " exog("
    varlist d2.v1
    put ") "
}
```

although coding

```plaintext
optionarg d2.v1
```

would be an easier way to achieve the same effect.
5.4.5 ifexp

**Syntax**

```
ifexp ename
```

where `ename` must be a string control.

Use of `option()` communication: None.

**Description**

`ifexp` adds nothing to the current `rstring` if `ename` is hidden, disabled, or empty. Otherwise, output is "if exp", with spaces added before and after.

**Example**

```
if d2.if
```

5.4.6 inrange

**Syntax**

```
inrange ename_1 ename_2
```

where `ename_1` and `ename_2` must be numeric controls.

Use of `option()` communication: None.

**Description**

If `ename_1` is hidden or disabled, results are as if `ename_1` were not hidden and contained 1. If `ename_2` is hidden or disabled, results are as if `ename_1` were not hidden and contained _N, the number of observations in the dataset.

If `ename_1==1` and `ename_2==_N`, nothing is output (added to the current `rstring`).

Otherwise, "in range" is output with spaces added before and after, with the range obtained from `ename_1` and `ename_2`.

**Example**

```
inrange d2.in1 d2.in2
```

5.4.7 weight

**Syntax**

```
weight ename_t ename_e
```

where `ename_t` may be a string or numeric control and must have had `option()` filled in with a weight type (one of `weight`, `fweight`, `aweight`, `pweight`, or `iweight`), and `ename_e` must be a string evaluating to the weight expression or variable name.

Use of `option()` communication: `ename_t` must have `option()` filled in the weight type.
Description

weight adds nothing to the current rstring if ename₁ or enameₑ are hidden, disabled, or empty. Otherwise, output is [weighttype=exp] with leading and trailing blanks.

Remarks

weight is typically used as

weight radio(d₁ w₁ w₂ . . . wk) d₁.wexp

where d₁.w₁, d₁.w₂, . . . , d₁.wk are radio buttons, which could be defined as

DIALOG d₁ . . .
BEGIN
  . . .
  RADIO w₁ . . . , . . . label(fweight) first . . .
  RADIO w₂ . . . , . . . label(aweight) . . .
  RADIO w₃ . . . , . . . label(pweight) . . .
  RADIO w₄ . . . , . . . label(iweight) last . . .
  . . .
END

Not all weight types need to be offered. If a command offers only one kind of weight, you do not need to use radio buttons. You could code

weight d₁.wt d₁.wexp

where d₁.wt was defined as

CHECKBOX wt . . . , . . . label(fweight) . . .

5.4.8 beginoptions and endoptions

Syntax

beginoptions
  any dialog-programming command except beginoptions
  . . .
endoptions

Use of option() communication: None.

Description

beginoptions/endoptions indicates that you wish what is enclosed to be treated as Stata options in constructing cmdstring, optstring.

The current rstring is, by default, cmdstring. beginoptions changes the current rstring to optstring. endoptions changes it back to cmdstring. So there are two strings being built. When the dialog program exits normally, if there is anything in optstring, trailing spaces are removed from cmdstring, a comma and a space are added, the contents of optstring are added, and all that is returned. Thus a dialog program can have many beginoptions/endoptions blocks, but all the options will appear at the end of the cmdstring.

The command-construction commands option and optionarg are documented below because they usually appear inside a beginoptions/endoptions block, but they can be used outside beginoptions/endoptions blocks, too. Also all the other command-construction commands can be used inside a beginoptions/endoptions block, and using put is particularly common.
5.4.8.1 option

Syntax

option ename [ename ...]

where ename must be a numeric control with 0 indicating that the option is not desired.

Use of option() communication: option() specifies the name of the option.

Description

option adds nothing to the current rstring if any of the enames specified are hidden or disabled. Otherwise, for each ename specified, if ename is not equal to 0, the contents of its option() are displayed.

Remarks

option is an easy way to output switch options such as noconstant and detail. You simply code

option d1.sw

where you have previously defined

CHECKBOX sw . . . , option(detail) . . .

Here detail will be output if the user checked the box.

5.4.8.2 optionarg

Syntax

optionarg [style] ename [[style] ename [ . . .]]

where each ename may be a numeric or string control and style is

<table>
<thead>
<tr>
<th>style</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>/asis</td>
<td>do not quote</td>
</tr>
<tr>
<td>/quoted</td>
<td>do quote</td>
</tr>
<tr>
<td>/oquoted</td>
<td>quote if necessary</td>
</tr>
<tr>
<td>%fmt</td>
<td>for use with numeric</td>
</tr>
</tbody>
</table>

Use of option() communication: option() specifies the name of the option.

Description

optionarg adds nothing to the current rstring if any of the enames specified are hidden or disabled. Otherwise, for each ename specified, if ename is not equal to "", the ename’s option() is output, followed by “(”, the ename’s contents, and “)” with blanks added before and after.
Remarks

optionarg is an easy way to output single-argument options such as title() or level(); for example,

```lisp
optionarg /quoted d1.ttl
if ! d1.level.isdefault() {
    optionarg d1.level
}
```

where you have previously defined

```lisp
EDIT   ttl . . . , . . . label(title) . . .
SPINNER level . . . , . . . label(level) . . .
```

5.5 Command-execution commands

Commands are executed automatically when a program is invoked by an input control’s uaction() option. Programs so invoked are called u-action programs. No command is executed when a program is invoked by an input control’s iaction() option. Programs so invoked are called i-action programs.

The stata and clear commands are for use if

1. you want to write a u-action program that executes more than one Stata command, or
2. you want to write an i-action program that executes one or more Stata commands (also known as heavyweight i-action programs).

5.5.1 stata

Syntax

```lisp
stata

stata hidden [immediate|queue]
```

Use of option() communication: None.

Description

stata executes the current cmdstring, optstring and displays the command in the Results window before execution, just as if the user had typed it.

stata hidden executes the current cmdstring, optstring but does not display the command in the Results window before execution. stata hidden may optionally be called with either of two modifiers: queue or immediate. If neither modifier is specified, immediate is implied.

immediate causes the command to execute at once, waits for the command to finish, and sets _rc to contain the return code. Because the command is to be executed immediately, the dialog engine will complain if Stata is not idle.

queue causes the command to be placed into the command buffer, allowing it to be executed as soon as Stata becomes idle. The behavior of stata and stata hidden queue are identical except that stata hidden queue does not echo the command.
Important notes about stata hidden immediate

A unique situation can occur when stata hidden immediate is used in an initialization script or program. Stata dialogs are considered asynchronous, meaning that Stata dialogs can be loaded through the menu and help systems even when Stata is busy processing an ado program. Because stata hidden immediate relies on ado processing and because ado processing is synchronous, dialogs that call stata hidden immediate during initialization can only be used synchronously. That means these types of dialogs cannot be loaded while Stata is busy processing other tasks. Because of this, the dialog must be notified that it is special in this regard. This is done by placing the dialog directive SYNCHRONOUS_ONLY in the dialog box program just after the VERSION statement.

SYNCHRONOUS_ONLY performs one other important function. Dialogs that are launched by using the db command cause Stata to become busy and remain busy until the dialog is completely loaded. After all, db is an ado program, and until the dialog loads and db subsequently exits execution, Stata is busy. The SYNCHRONOUS_ONLY directive lets the dialog engine know that executing stata hidden immediate during initialization routines is allowed even when the dialog is launched with an ado program.

5.5.2 clear

Syntax

    clear [curstring|cmdstring|optstring]

Use of option() communication: None.

Description

clear is seldom used and is typically specified without arguments. clear clears (resets to """) the specified return string or, if it is specified without arguments, clears cmdstring and optstring. If curstring is specified, clear clears the current return string, which is cmdstring by default or optstring within a beginoptions/endoptions block.

5.6 Special scripts and programs

Sometimes, it may be useful to have a script or program run automatically, either just before dialog-box controls are created or just after. The following scripts and programs are special, and when they are defined, they run automatically.

<table>
<thead>
<tr>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREINIT_SCRIPT</td>
<td>script that runs before any dialog box controls are created</td>
</tr>
<tr>
<td>PREINIT_PROGRAM</td>
<td>program that runs before any dialog box controls are created</td>
</tr>
<tr>
<td>POSTINIT_SCRIPT</td>
<td>script that runs after all dialog box controls are created</td>
</tr>
<tr>
<td>POSTINIT_PROGRAM</td>
<td>program that runs after all dialog box controls are created</td>
</tr>
<tr>
<td>PREINIT</td>
<td>shortcut for PREINIT_SCRIPT</td>
</tr>
<tr>
<td>POSTINIT</td>
<td>shortcut for POSTINIT_SCRIPT</td>
</tr>
<tr>
<td>ON_DOTPROMPT</td>
<td>program that runs when Stata returns from executing an interactive command; ON_DOTPROMPT program should never call the dialog system's stata command, because that would result in infinite recursion</td>
</tr>
</tbody>
</table>
Often it is desirable to encapsulate individual dialog tabs into .idlg files, particularly when a dialog tab is used in many different dialog boxes. In those circumstances, a dialog tab can use its own initialization script or program. The following naming conventions are used to define these scripts and programs.

<table>
<thead>
<tr>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>tabname_PREINIT_SCRIPT</code></td>
<td>script that runs before controls on dialog <code>tabname</code> are created</td>
</tr>
<tr>
<td><code>tabname_PREINIT_PROGRAM</code></td>
<td>program that runs before controls on dialog <code>tabname</code> are created</td>
</tr>
<tr>
<td><code>tabname_POSTINIT_SCRIPT</code></td>
<td>script that runs after controls on dialog <code>tabname</code> are created</td>
</tr>
<tr>
<td><code>tabname_POSTINIT_PROGRAM</code></td>
<td>program that runs after controls on dialog <code>tabname</code> are created</td>
</tr>
<tr>
<td><code>tabname_PREINIT</code></td>
<td>shortcut for <code>tabname_PREINIT_SCRIPT</code></td>
</tr>
<tr>
<td><code>tabname_POSTINIT</code></td>
<td>shortcut for <code>tabname_POSTINIT_SCRIPT</code></td>
</tr>
</tbody>
</table>

The order of execution for dialog initialization is as follows:

1. Execute PREINIT script or program for the dialog box.
2. Execute PREINIT scripts and programs for each dialog tab using the order in which the tabs are created.
3. Create all controls for the entire dialog box.
4. Execute POSTINIT scripts and programs for each dialog tab using the order in which the tabs are created.
5. Execute POSTINIT script or program for the dialog box.

6. Properties

Properties are used to store information that is useful for dialog box programming. Properties may be of type STRING, DOUBLE, or BOOLEAN and do not have a visual representation on the dialog box. Special variants of these basic types are available. These variants, PSTRING, PDOUBLE, and PBOOLEAN, are considered persistent and are identical to their counterparts. The contents of these persistent types do not get destroyed when a dialog is reset. Usually, the base types should be used. Application of the persistent types should be reserved for special circumstances. See `create` for information about creating new instances of a property.

**Member functions**

**STRING**

- `propertyname.setvalue strvalue`
- `propertyname.setstring strvalue`; synonym for `.setvalue`
- `propertyname.append strvalue`
- `propertyname.tokenize classArrayName`
- `propertyname.tokenizeOnStr classArrayName strvalue`
- `propertyname.tokenizeOnChars classArrayName strvalue`
- `propertyname.expandNumlist`
- `propertyname.storeDialogClassName`
- `propertyname.storeClsArrayToQuotedStr classArrayName`

**DOUBLE**

- `propertyname.setvalue value`
- `propertyname.increment`
propertyname.decrement
propertyname.add value
propertyname.subtract value
propertyname.multiply value
propertyname.divide value
propertyname.storeClsArraySize classArrayName

BOOLEAN

propertyname.settrue
propertyname.setfalse
propertyname.storeClsObjectExists objectName

Special definitions

<table>
<thead>
<tr>
<th>strvalue</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;string&quot;</td>
<td>quoted string literal</td>
</tr>
<tr>
<td>literal string</td>
<td>same as string</td>
</tr>
<tr>
<td>c(name)</td>
<td>contents of c(name); see [P] return</td>
</tr>
<tr>
<td>r(name)</td>
<td>contents of r(name); see [P] return</td>
</tr>
<tr>
<td>e(name)</td>
<td>contents of e(name); see [P] return</td>
</tr>
<tr>
<td>s(name)</td>
<td>contents of s(name); see [P] return</td>
</tr>
<tr>
<td>char varname[charname]</td>
<td>value of characteristic; see [P] char</td>
</tr>
<tr>
<td>class objectName</td>
<td>contents of a class system object; object name may be a fully qualified object name, or it may be given in the scope of the dialog box</td>
</tr>
</tbody>
</table>

value

<table>
<thead>
<tr>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>#</td>
</tr>
<tr>
<td>literal #</td>
</tr>
<tr>
<td>c(name)</td>
</tr>
<tr>
<td>r(name)</td>
</tr>
<tr>
<td>e(name)</td>
</tr>
<tr>
<td>s(name)</td>
</tr>
<tr>
<td>class objectName</td>
</tr>
<tr>
<td>global name</td>
</tr>
</tbody>
</table>

7. Child dialogs

Syntax

create CHILD dialogname [AS referenceName] [ , nomodal allowsubmit allowcopy message(string)]
Member functions

- **settitle string**
  sets the title text of the child dialog box.

- **setExitString string**
  informs the child where to save the command string when the OK or Submit button is clicked on.

- **setOkAction string**
  informs the child that it is to invoke a specific action in the parent when the OK button is clicked on and the child exits.

- **setSubmitAction string**
  informs the child that it is to invoke a specific action in the parent when the Submit button is clicked on.

- **setExitAction string**
  informs the child that it is to invoke a specific action in the parent when the OK or Submit button is clicked on; note that setExitAction has the same effect as calling both setOkAction and setSubmitAction with the same argument.

- **create property**
  allows the parent to create properties in the child; see 6. Properties

- **callthru gaction**
  allows the parent to call global actions in the context of the child.

Description

Child dialogs are dialogs that are spawned by another dialog. These dialogs form a relationship where the initial dialog is referred to as the parent and all dialogs spawned from that parent are referred to as its children. In most circumstances, the children collect information and return that information to the parent for later use. Unless AS referencename has been specified, children are referenced through the dialogname.

Options

- **nomodal**
  suppresses the default modal behavior of a child dialog unless the MODAL directive was specifically used inside the child dialog resource file.

- **allowsubmit**
  allows for the use of the Submit button on the dialog box. By default, the Submit button is removed if it has been declared in the child dialog resource file.

- **allowcopy**
  allows for the use of the Copy button on the dialog box. By default, the Copy button is removed if it has been declared in the child dialog resource file.

- **message(string)**
  specifies that string be passed to the child dialog box, where it can be referenced from STRING property named __MESSAGE.

7.1 Referencing the parent

While it is normally not necessary, it is sometimes useful for a child dialog box to give special instructions or information to its parent. All child dialog boxes contain a special object named PARENT, which can be used with a member program named callthru. PARENT.callthru can be used to call any intermediate action in the context of the parent dialog box.
8. Example

The following example will execute the `summarize` command. In addition to the copy below, a copy can be found among the Stata distribution materials. You can type

```
. which sumexample.dlg
```
to find out where it is.

```
sumexample.dlg

// sumexample
// version 1.0.0
VERSION 17.0
POSITION . . 320 200

DIALOG main, title("Example simple summarize dialog") tabtitle("Main")
BEGIN
  TEXT lab 10 10 300 ., label("Variables to summarize:"
  VARLIST vars @ +20 @ ., label("Variables to sum")
END

DIALOG options, tabtitle("Options")
BEGIN
  CHECKBOX detail 10 10 300 ., label("Show detailed statistics")
  onclickoff('"options.status.setlabel "(detail is off)""')
  onclickon('"gaction options.status.setlabel "(detail is on)""')
  TEXT status @ +20 @ ., label("This label won't be seen")
  BUTTON btnhide @ +30 200 ., label("Hide other controls") push("script hidethem")
  BUTTON btshow @ +30 @ ., label("Show other controls") push("script showthem")
  BUTTON btngrey @ +30 @ ., label("Disable other controls") push("script disablethem")
  BUTTON btnnorm @ +30 @ ., label("Enable other controls") push("script enablethem")
END

SCRIPT hidethem
BEGIN
  gaction main.lab.hide
  main.vars.hide
  options.detail.hide
  options.status.hide
END

SCRIPT showthem
BEGIN
  main.lab.show
  main.vars.show
  options.detail.show
  options.status.show
END

SCRIPT disablethem
BEGIN
  main.lab.disable
  main.vars.disable
  options.detail.disable
  options.status.disable
END
```
SCRIPT enablethem
BEGIN
  main.lab.enable
  main.vars.enable
  options.detail.enable
  options.status.enable
END

OK ok1, label("Ok")
CANCEL can1
SUBMIT sub1
HELP hlpl, view("help summarize")
RESET res1

PROGRAM command
BEGIN
  put "summarize"
  varlist main.vars /* varlist [main.vars] to make it optional */
  beginoptions
      option options.detail
  endoptions
END

sumexample.dlg

---

Appendix A: Jargon

**action:** See *i-action* and *u-action*.

**browser:** See *file chooser*.

**button:** A type of input control; a button causes an i-action to occur when it is clicked on. Also see *u-action buttons*, *helper buttons*, and *radio buttons*.

**checkbox:** A type of numeric input control; the user may either check or uncheck what is presented; suitable for obtaining yes/no responses. A checkbox has value 0 or 1, depending on whether the item is checked.

**combo box:** A type of string input control that has an edit field at the top and a list box underneath. Combo boxes come in three types:

A regular combo box has an edit field and a list below it. The user may choose from the list or type into the edit field.

A drop-down combo box also has an edit field and a list, but only the edit field shows. The user can click to expose the list. The user may choose from the list or type in the edit field.

A drop-down-list combo box is more like a list box. An edit field is displayed. The list is hidden, and the user can click to expose the list, but the user can only choose elements from the list; he or she cannot type in the edit field.

**control:** See *input control* and *static control*.

**control status:** Whether a control (input or static) is disabled or enabled, hidden or shown.

**dialog(s):** The main components of a dialog box in that the dialogs contain all the controls except for the u-action buttons.

**dialog box:** Something that pops up onto the screen that the user fills in; when the user clicks on an action button, the dialog box causes something to happen (namely, Stata to execute a command).

A dialog box is made up of one or more dialogs, u-action buttons, and a title bar.
If the dialog box contains more than one dialog, only one of the dialogs shows at a time, which one being determined by the tab selected.

**dialog program:** See *PROGRAM*.

**disabled and enabled:** A control that is disabled is visually grayed out; otherwise, it is enabled. The user cannot modify disabled input controls. Also see *hidden and exposed*.

**.dlg file:** The file containing the code defining a dialog box and its actions. If the file is named *xyz*.dlg, the dialog box is said to be named *xyz*.

**dlg-program:** The entire contents of a .dlg file; the code defining a dialog box and its actions.

**edit field:** A type of string input control; a box in which the user may type text.

**enabled and disabled:** See *disabled and enabled*.

**exposed and hidden:** See *hidden and exposed*.

**file browser:** See *file chooser*.

**file chooser:** A type of string input control; presents a list of files from which the user may choose one or type a filename.

**frame:** A type of static control; a rectangle drawn around a group of controls.

**group box:** A type of static control; a rectangle drawn around a group of controls with descriptive text at the top.

**helper buttons:** The buttons Help and Reset. When Help is clicked on, the help topic for the dialog box is displayed. When Reset is clicked on, the control values of the dialog box are reset to their defaults.

**hidden and exposed:** A control that is removed from the screen is said to be hidden; otherwise, it is exposed. Hidden input controls cannot be manipulated by the user. A control would also not be shown when it is contained in a dialog that does not have its tab selected in a multidialog dialog box; in this case, it may be invisible, but whether it is hidden or exposed is another matter. Also see *disabled and enabled*.

**i-action:** An intermediate action usually caused by the interaction of a user with an input control, such as hiding or showing and disabling or enabling other controls; opening the Viewer to display something; or executing a SCRIPT or a PROGRAM.

**input control:** A screen element that the user fills in or sets. Controls include checkboxes, buttons, radio buttons, edit fields, spinners, file choosers, etc. Input controls have (set) values, which can be string, numeric, or special. These values reflect how the user has “filled in” the control. Input controls are said to be string or numeric depending on the type of result they obtain (and how they store it).

Also see *static control*.

**label or title:** See *title or label*.

**list:** A programming concept; a vector of elements.

**list box:** A type of string input control; presents a list of items from which the user may choose. A list box has (sets) a string value.

**numeric input control:** An input control that returns a numeric value associated with it.

**position:** Where something is located, measured from the top left by how far to the right it is (x) and how far down it is (y).
PROGRAM: A programming concept dealing with the implementation of dialogs. PROGRAMs may be used to implement i-actions or u-actions. Also see SCRIPT.

radio buttons: A set of numeric input controls, each a button, of which only one may be selected at a time; suitable for obtaining categorical responses. Each radio button in the set has (sets) a numeric value, 0 or 1, depending on which button is selected. Only one in the set will be 1.

SCRIPT: A programming concept dealing with the implementation of dialogs. An array of i-actions to be executed one after the other; errors that occur do not stop subsequent actions from being attempted. Also see PROGRAM.

size: How large something is, measured from its top-left corner, as a width ($xsize$) and height ($ysize$). Height is measured from the top down.

spinner: A type of numeric input control; presents a numeric value that the user may increase or decrease over a range. A spinner has (sets) a numeric value.

static control: A screen element similar to an input control, except that the end user cannot interact with it. Static controls include static text and lines drawn around controls visually to group them together (group boxes and frames). Also see control and input control.

static text: A static control specifying text to be placed on a dialog.

string input control: An input control that returns a string value associated with it.

tabs: The small labels at the top of each dialog (when there is more than one dialog associated with the dialog box) and on which the user clicks to select the dialog to be filled in.

title or label: The fixed text that appears above or on objects such as dialog boxes and buttons. Controls are usually said to be labeled, whereas dialog boxes are said to be titled.

u-action: What a dialog box causes to happen after the user has filled it in and clicked on a u-action (ultimate action) button. The point of a dialog box is to result in a u-action.

u-action buttons: The buttons OK, Submit, Cancel, and Copy; clicking on one causes the ultimate action (u-action) associated with the button to occur and, perhaps, the dialog box to close.

varlist or varname control: A type of string input control; an edit field that also accepts input from the Variables window. This control also contains a combo-box-style list of the variables. A varlist or varname control has (sets) a string value.

Appendix B: Class definition of dialog boxes

Dialog boxes are implemented in terms of class programming; see [P] class.

The top-level class instance of a dialog box defined in dialogbox.dlg is .dialogbox_d1g. Dialogs and controls are nested within that, so .dialogbox_d1g.dialgname would refer to a dialog, and .dialogbox_d1g.dialgname.controlname would refer to a control in the dialog.

.dialbox_d1g.dialgname.controlname.value is the current value of the control, which will be either a string or a double. You must not change this value.

The member functions of the controls are implemented as member functions of .dialogbox_d1g.dialgname.controlname and may be called in the standard way.
Appendix C: Interface guidelines for dialog boxes

One of Stata’s strengths is its strong support for cross-platform use—datasets and programs are completely compatible across platforms. This includes dialogs written in the dialog-programming language. Although Mac, Windows, and X Windows share many common graphical user-interface elements and concepts, they all vary slightly in their appearance and implementation. This variation makes it difficult to design dialogs that look and behave the same across all platforms. Dialogs should look pleasant on screen to enhance their usability, and achieving this goal often means being platform specific when laying out controls. This often leads to undesirable results on other platforms.

The dialog-programming language was written with this in mind, and dialogs that appear and behave the same across multiple operating systems and appear pleasant can be created by following some simple guidelines.

Use default heights where applicable: Varying vertical-size requirements of controls across different operating systems can cause a dialog that appears properly on one platform to display controls that overlap one another on another platform. Using the default $y_{size}$ of . takes these variations into account and allows for much easier placement and alignment of controls. Some controls (list boxes, regular combo boxes, group boxes, and frames) still require their $y_{size}$ to be specified because their vertical size determines how much information they can reveal.

Use all horizontal space available: Different platforms use different types of fonts to display text labels and control values. These variations can cause some control labels to be truncated (or even word wrapped) if their $x_{size}$ is not large enough for a platform’s system font. To prevent this from happening, specify an $x_{size}$ that is as large as possible. For each column of controls, specify the entire column width for each control’s $x_{size}$, even for controls where it is obviously unnecessary. This reduces the chances of a control’s label being truncated on another platform and also allows you to make changes to the label without constantly having to adjust the $x_{size}$. If your control barely fits into the space allocated to it, consider making your dialog slightly larger.

Use the appropriate alignment for static text controls: The variations in system fonts also make it difficult to horizontally align static text controls with other controls. Placing a static text control next to an edit field may look good on one platform but show up with too much space between the controls on another or even show up truncated.

One solution is to place static text controls above controls that have an edit field and make the static text control as wide as possible. This gives more room for the static text control and makes it easier to left-justify it with other controls.

When placing a static text control to the left of a control is more appropriate (such as From: and To: edit fields), use right-alignment rather than the default left-alignment. The two controls will then be equally spaced apart on all platforms. Again be sure to make the static text control slightly wider than necessary—do not try to left-justify a right-aligned static text control with controls above and below it because it may not appear left-justified on other platforms or may even be truncated.

Do not crowd controls: Without making your dialog box unnecessarily large, use all the space that is available. Organize related controls close together, and put some distance between unrelated ones. Do not overload users with lots of controls in one dialog. If necessary, group controls in separate dialogs. Most importantly, be consistent in how you layout controls.

All vertical size and spacing of controls involves multiples of 10 pixels: The default $y_{size}$ for most controls is 20 pixels. Related controls are typically spaced 10 pixels apart, and unrelated ones are at least 20 pixels apart.

Use the appropriate control for the job: Checkboxes have two states: on or off. A radio-button group consisting of two radio buttons similarly has two states. A checkbox is appropriate when the
action taken is either on or off or easy to infer (for example, Use constant). A two-radio-button group is appropriate when the opposite state cannot be inferred (for example, Display graph and Display table).

Radio-button groups should contain at least two radio buttons and no more than about seven. If you need more choices, consider using a drop-down-list combo box or, if the number of choices is greater than about 12, a list box. If you require a control that allows multiple selections, consider a regular combo box or drop-down combo box. Drop-down combo boxes can be cumbersome to use if the number of choices is great, so use a regular combo box unless space is limited.

**Understand control precedence for mouse clicks:** Because of the limited size of dialogs, you may want to place several controls within the same area and hide and show them as necessary. It is also useful to place controls within other controls, such as group boxes and frames, for organizational and presentational purposes. However, the order of creation and placement and size of controls can affect which controls receive mouse clicks first or whether they receive them at all.

The control where this can be problematic is the radio button. On some platforms, the space occupied by a group of radio buttons is not the space occupied by the individual radio buttons. It is inclusive to the space occupied by the radio button that is closest to the top-left corner of the dialog, the widest radio button, and the bottommost radio button. To prevent a group of radio buttons from preventing mouse clicks being received by other controls, Stata gives precedence to all other controls except for group boxes and frames. The order of precedence for controls that can receive mouse clicks is the following: first, all controls other than radio buttons and checkbox group boxes, then radio buttons, then checkbox group boxes.

If you intend to place two or more groups of radio buttons in the same area and show and hide them as necessary, be sure that when you hide the radio buttons from a group, you hide all radio buttons from a group. The radio-button group with precedence over other groups will continue to have precedence as long as any of its radio buttons are visible. Mouse clicks in the space occupied by nonvisible radio buttons in a group with precedence will not pass through to any other groups occupying the same space.

It is always safe to place controls within frames, group boxes, and checkbox group boxes because all other controls take precedence over those controls.

In practice, you should never hide a radio button from a group without hiding the rest of the radio buttons from the group. Consider simply disabling the radio button or buttons instead. It is also not a good idea to hide or show radio buttons from different groups to make them appear that they are from the same group. That simply will not work on some platforms and is generally a bad idea, anyway.

Radio buttons have precedence over checkbox group boxes. You may place radio buttons within a checkbox group box, but do not place a checkbox group box within the space occupied by a group of radio buttons. If you do, you may not be able to click on the checkbox control on some platforms.

**Frequently asked questions**

See dialog programming FAQs on the Stata website.

**Also see**

[P] window programming — Programming menus and windows

[R] db — Launch dialog
**Description**

discard drops all automatically loaded programs (see [U] 17.2 What is an ado-file?); clears \$() stored results (see [P] return); eliminates information stored by the most recent estimation command and any other saved estimation results (see [P] ereturn); closes any open graphs and drops all sersets (see [P] serset); clears all class definitions and instances (see [P] classutil); clears all business calendars (see [D] Datetime business calendars); and closes all dialogs and clears their remembered contents (see [P] Dialog programming).

In short, discard causes Stata to forget everything current without forgetting anything important, such as the data in memory.

**Syntax**

discard

**Remarks and examples**

Use discard to debug ado-files. Making a change to an ado-file will not cause Stata to update its internal copy of the changed program. discard clears all automatically loaded programs from memory, forcing Stata to refresh its internal copies with the versions residing on disk.

Also all of Stata’s estimation commands can display their previous output when the command is typed without arguments. They achieve this by storing information on the problem in memory. predict (see [R] predict) calculates various statistics (predictions, residuals, influence statistics, etc.), estat vce (see [R] estat vce) shows the covariance matrix, lincom (see [R] lincom) calculates linear combinations of estimated coefficients, and test and testnl (see [R] test and [R] testnl) perform hypotheses tests, all using that stored information. discard eliminates that information, making it appear as if you never fit the model.

**Also see**

[D] clear — Clear memory

[P] class — Class programming

[P] classutil — Class programming utility

[P] Dialog programming — Dialog programming

[U] 17 Ado-files
# display — Display strings and values of scalar expressions

## Description

`display` displays strings and values of scalar expressions. `display` produces output from the programs that you write.

Interactively, `display` can be used as a substitute for a hand calculator; see [R] `display`. You can type things such as `display 2+2`.

## Syntax

```
display [display_directive [display_directive [...]]]
```

where `display_directive` is

- "double-quoted string"
- "compound double-quoted string"
- `\fmt` `= exp`
- `as {text|txt|result|error|input}`
- `in smcl`
- `_asis`
- `_skip(#)`
- `_column(#)`
- `_newline [(#) ]`
- `_continue`
- `_dup(#)`
- `_request(macname)`
- `_char(#)`
- `,`
- ``,

```
```
Remarks and examples

Remarks are presented under the following headings:

Introduction
Styles
display used with quietly and noisily
Columns
display and SMCL
Displaying variable names
Obtaining input from the terminal

Introduction

Interactively, display can be used as a substitute for a hand calculator; see [R] display. You can type things such as display 2+2.

display’s display_directives are used in do-files and programs to produce formatted output. The directives are

"double-quoted string" displays the string without the quotes
‘“compound double-quoted string”‘ displays the string without the outer quotes; allows embedded quotes
[%fmt] [=] exp allows results to be formatted;

as style sets the style (“color”) for the directives that follow;

in smcl switches from _asis mode to smcl mode
_asis switches from smcl mode to _asis mode
_skip(#) skips # columns
_column(#) skips to the #th column
_newline goes to a new line
_newline(#) skips # lines
_continue suppresses automatic newline at end of display command
_dup(#) repeats the next directive # times
_request(macname) accepts input from the console and places it into the macro macname

-char(#) displays the character for ASCII and extended ASCII code #,

, displays one blank between two directives
,, places no blanks between two directives
Example 1

Here is a nonsense program called silly that illustrates the directives:

```stata
. program list silly
silly:
  1.   set obs 10
  2.   gen myvar=runiform()
  3.   di as text _dup(59) "-
  4.   di "hello, world"
  5.   di %59s "This is centered"
  6.   di "myvar[1] = " as result myvar[1]
  9.   di "This" _newline _col(5) "That" _newline _col(10) "What"
 10.  di "'She said, "Hello"
 11.  di substr("abcI can do string expressionsXYZ",4,27)
 12.  di _char(65) _char(83) _char(67) _char(73) _char(73)
 13.  di _dup(59) "-" "(good-bye)"

Here is the result of running it:

. silly
Number of observations (N) was 0, now 10
-----------------------------------------------------------
hello, world
   This is centered
myvar[1] = .13698408
  myvar[2] = .64322066
myvar[1]/myvar[2] = 0.2130
This
   That
She said, "Hello"
I can do string expressions
ASCII
----------------------------------------------------------- (good-bye)
```

Styles

Stata has four styles: text (synonym txt), result, error, and input. Typically, these styles are rendered in terms of color,

- **text** = black
- **result** = black and bold
- **error** = red
- **input** = black and bold

or, at least, that is the default in the Results window when the window has a white background. On a black background, the defaults are

- **text** = green
- **result** = yellow
- **error** = red
- **input** = white
In any case, users can reset the styles by selecting Edit > Preferences > General Preferences in Windows or Unix(GUI) or by selecting Preferences > General Preferences in Mac.

The `display` directives as `text`, as `result`, as `error`, and as `input` allow you, the programmer, to specify in which rendition subsequent items in the `display` statement are to be displayed. So if a piece of your program reads

```plaintext
quietly summarize mpg
display as text "mean of mpg = " as result r(mean)
```

what might be displayed is

```
mean of mpg = 21.432432
```

where, above, our use of boldface for the 21.432432 is to emphasize that it would be displayed differently from the “mean of mpg =” part. In the Results window, if we had a black background, the “mean of mpg =” part would be in green and the 21.432432 would be in yellow.

You can switch back and forth among styles within a `display` statement and between `display` statements. Here is how we recommend using the styles:

- **as result** should be used to display things that depend on the data being used. For statistical output, think of what would happen if the names of the dataset remained the same but all the data changed. Clearly, calculated results would change. That is what should be displayed as `result`.

- **as text** should be used to display the text around the results. Again think of the experiment where you change the data but not the names. Anything that would not change should be displayed as `text`. This will include not just the names but also table lines and borders, variable labels, etc.

- **as error** should be reserved for displaying error messages. as `error` is special in that it not only displays the message as an error (probably meaning that the message is displayed in red) but also forces the message to display, even if output is being suppressed. (There are two commands for suppressing output: `quietly` and `capture`. `quietly` will not suppress as `error` messages but `capture` will, the idea being that `capture`, because it captures the return code, is anticipating errors and will take the appropriate action.)

- **as input** should never be used unless you are creating a special effect. as `input` (white on a black background) is reserved for what the user types, and the output your program is producing is by definition not being typed by the user. Stata uses as `input` when it displays what the user types.

**display used with quietly and noisily**

`display`’s output will be suppressed by `quietly` at the appropriate times. Consider the following:

```plaintext
. program list example1
example1:
    1. di "hello there"
example1
hello there
. quietly example1
.
```
The output was suppressed because the program was run quietly. Messages displayed as `error`, however, are considered error messages and are always displayed:

```
. program list example2
example2:
  1.    di as error "hello there"
. example2
hello there
. quietly example2
hello there
```

Even though the program was run quietly, the message as `error` was displayed. Error messages should always be displayed as `error` so that they will always be displayed at the terminal.

Programs often have parts of their code buried in `capture` or `quietly` blocks. Displays inside such blocks produce no output:

```
. program list example3
example3:
  1. quietly {
  2.     display "hello there"
  3.  }
. example3
```

If the `display` had included as `error`, the text would have been displayed, but only error output should be displayed that way. For regular output, the solution is to precede the `display` with `noisily`:

```
. program list example4
example4:
  1. quietly {
  2.     noisily display "hello there"
  3.  }
. example4
hello there
```

This method also allows Stata to correctly treat a `quietly` specified by the caller:

```
. quietly example4
```

Despite its name, `noisily` does not really guarantee that the output will be shown—it restores the output only if output would have been allowed at the instant the program was called.

For more information on `noisily` and `quietly`, see [P] quietly.

Columns

display can move only forward and downward. The directives that take a numeric argument allow only nonnegative integer arguments. It is not possible to back up to make an insertion in the output.
display — Display strings and values of scalar expressions

. program list cont
cont:
  1.  di "Stuff" _column(9) "More Stuff"
  2.  di "Stuff" _continue
  3.  di _column(9) "More Stuff"
. cont
Stuff  More Stuff
Stuff  More Stuff

display and SMCL

Stata Markup and Control Language (SMCL) is Stata's output formatter, and all Stata output passes through SMCL. See [P] smcl for a description. All the features of SMCL are available to display and so motivate you to turn to the SMCL section of this manual.

In our opening silly example, we included the line

```stata
    di as text _dup(59) "-"
```

That line would have better read

```stata
    di as text "{hline 59}"
```

The first display produces this:

```
-----------------------------------------------------------
```

and the second produces this:

```
-----------------------------------------------------------
```

It was not display that produced that solid line—display just displayed the characters {hline 59}. Output of Stata, however, passes through SMCL, and SMCL interprets what it hears. When SMCL heard {hline 59}, SMCL drew a horizontal line 59 characters wide.

SMCL has many other capabilities, including creating clickable links in your output that, when you click on them, can even execute other Stata commands.

If you carefully review the SMCL documentation, you will discover many overlap in the capabilities of SMCL and display that will lead you to wonder whether you should use display’s capabilities or SMCL’s. For instance, in the section above, we demonstrated the use of display’s _column() feature to skip forward to a column. If you read the SMCL documentation, you will discover that SMCL has a similar feature, {col}. You can type

```stata
    display "Stuff" _column(9) "More Stuff"
```

or you can type

```stata
    display "Stuff{col 9}More Stuff"
```

So, which should you type? The answer is that it makes no difference and that when you use display’s _column() directive, display just outputs the corresponding SMCL {col} directive for you. This rule generalizes beyond _column(). For instance,

```stata
    display as text "hello"
```

and

```stata
    display "{text}hello"
```

are equivalent. There is, however, one important place where display and SMCL are different:

```stata
    display as error "error message"
```
is not the same as

display "\{error\}error message"

Use `display as error`. The SMCL \{error\} directive sets the rendition to that of errors, but it does not tell Stata that the message is to be displayed, even if output is otherwise being suppressed. `display as error` both sets the rendition and tells Stata to override output suppression if that is relevant.

Technical note

All Stata output passes through SMCL, and one side effect of that is that open and close brace characters, { and }, are treated oddly by `display`. Try the following:

```stata
display as text "\{1, 2, 3\}"
{1, 2, 3}
```

The result is just as you expect. Now try

```stata
display as text \{result\}
```

The result will be to display nothing because \{result\} is a SMCL directive. The first displayed something, even though it contained braces, because \{1, 2, 3\} is not a SMCL directive.

You want to be careful when displaying something that might itself contain braces. You can do that by using `display`'s _asis directive. Once you specify _asis, whatever follows in the display will be displayed exactly as it is, without SMCL interpretation:

```stata
display as text _asis \{result\}
{result}
```

You can switch back to allowing SMCL interpretation within the line by using the in smcl directive:

```stata
display as text _asis \{result\} in smcl "is a \{bf:smcl\} directive"
{result} is a smcl directive
```

Every `display` command in your program starts off in SMCL mode.

Displaying variable names

Let's assume that a program we are writing is to produce a table that looks like this:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>mpg</td>
<td>74</td>
<td>21.2973</td>
<td>5.785503</td>
<td>12</td>
<td>41</td>
</tr>
<tr>
<td>weight</td>
<td>74</td>
<td>3019.459</td>
<td>777.1936</td>
<td>1760</td>
<td>4840</td>
</tr>
<tr>
<td>displacement</td>
<td>74</td>
<td>197.2973</td>
<td>91.83722</td>
<td>79</td>
<td>425</td>
</tr>
</tbody>
</table>

Putting out the header in our program is easy enough:

```stata
di as text " Variable \{c |\} Obs" /*
*/ _col(37) "Mean Std. dev. Min Max"
di as text "(hline 13){c +}{hline 53}"
```

We use the SMCL directive \{hline\} to draw the horizontal line, and we use the SMCL characters \{c |\} and \{c +\} to output the vertical bar and the “plus” sign where the lines cross.

Now let’s turn to putting out the rest of the table. Variable names can be of unequal length and can even be long. If we are not careful, we might end up putting out something that looks like this:
display — Display strings and values of scalar expressions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>miles_per_gallon</td>
<td>74</td>
<td>21.2973</td>
<td>5.785503</td>
<td>12</td>
<td>41</td>
</tr>
<tr>
<td>weight</td>
<td>74</td>
<td>3019.459</td>
<td>777.1936</td>
<td>1760</td>
<td>4840</td>
</tr>
<tr>
<td>displacement</td>
<td>74</td>
<td>197.2973</td>
<td>91.83722</td>
<td>79</td>
<td>425</td>
</tr>
</tbody>
</table>

If it were not for the too-long variable name, we could avoid the problem by displaying our lines with something like this:

```stata
display as text %12s "'vname'" " {c |}
*/
*/ as result /*
*/ %8.0g 'n' " " /*
*/ %9.0g 'mean' " " %9.0g 'sd' " " /*
*/ %9.0g 'min' " " %9.0g 'max'
```

What we are imagining here is that we write a subroutine to display a line of output and that the display line above appears in that subroutine:

```stata
program output_line
args vname n mean sd min max
display as text %12s "'vname'" " {c |}
*/ as result /*
*/ %8.0g 'n' " " /*
*/ %9.0g 'mean' " " %9.0g 'sd' " " /*
*/ %9.0g 'min' " " %9.0g 'max'
end
```

In our main routine, we would calculate results and then just call `output_line` with the variable name and results to be displayed. This subroutine would be sufficient to produce the following output:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>miles_per_gallon</td>
<td>74</td>
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<td>74</td>
<td>3019.459</td>
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<td>1760</td>
<td>4840</td>
</tr>
<tr>
<td>displacement</td>
<td>74</td>
<td>197.2973</td>
<td>91.83722</td>
<td>79</td>
<td>425</td>
</tr>
</tbody>
</table>

The short variable name `weight` would be spaced over because we specified the `%12s` format. The right way to handle the `miles_per_gallon` variable is to display its abbreviation with Stata's `abbrev()` function:

```stata
program output_line
args vname n mean sd min max
display as text %12s `abbrev("vname",12)" {c |}
*/ as result /*
*/ %8.0g 'n' " " /*
*/ %9.0g 'mean' " " %9.0g 'sd' " " /*
*/ %9.0g 'min' " " %9.0g 'max'
end
```

With this improved subroutine, we would get the following output:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>miles_per_~n</td>
<td>74</td>
<td>21.2973</td>
<td>5.785503</td>
<td>12</td>
<td>41</td>
</tr>
<tr>
<td>weight</td>
<td>74</td>
<td>3019.459</td>
<td>777.1936</td>
<td>1760</td>
<td>4840</td>
</tr>
<tr>
<td>displacement</td>
<td>74</td>
<td>197.2973</td>
<td>91.83722</td>
<td>79</td>
<td>425</td>
</tr>
</tbody>
</table>

The point of this is to persuade you to learn about and use Stata’s `abbrev()` function. `abbrev("vname",12)` returns `vname` abbreviated to 12 characters.
If we now wanted to modify our program to produce the following output,

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>miles_per_~n</td>
<td>74</td>
<td>21.2973</td>
<td>5.785503</td>
<td>12</td>
<td>41</td>
</tr>
<tr>
<td>weight</td>
<td>74</td>
<td>3019.459</td>
<td>777.1936</td>
<td>1760</td>
<td>4840</td>
</tr>
<tr>
<td>displacement</td>
<td>74</td>
<td>197.2973</td>
<td>91.83722</td>
<td>79</td>
<td>425</td>
</tr>
</tbody>
</table>

all we would need to do is add a display at the end of the main routine that reads

```
di as text "{hline 13}{c BT}{hline 53}" 
```

Note the use of `{c BT}`. The characters that we use to draw lines in and around tables are summarized in [P] smcl.

Technical note

Much of the output of Stata's official commands and of community-contributed commands is formatted to look good in a Results window that is 80 display columns wide. If you write a Stata program that you want to share with others, we recommend that you design it such that its output will fit in an 80-column-wide Results window. The `abbrev()` function described above is useful for abbreviating variable names such that output tables fit within 80 columns.

Your program can determine the current width of the Results window by checking the value of `c(linesize)`. Some Stata commands, such as official estimation commands that output a coefficient table, use the value of `c(linesize)` to determine by how much, if at all, they need to abbreviate variable names.

We can modify the `output_line` program above to respect `c(linesize)`. For every column the Results window is wider than 80, we can allow our variable name abbreviation to be one character longer. If the Results window is 100 or more columns wide, we may not need to abbreviate variable names at all, because the maximum length of a variable name is 32 characters, and we were already able to display 12 characters of the variable name at a line size of 80. Note that if your variable names contain Unicode characters, some of those characters may occupy two display columns. See [U] 12.4.2.2 Displaying Unicode characters.

```
program output_line
    args vname n mean sd min max
    if (c(linesize) >= 100)
        local abname = "'vname'"
    else if (c(linesize) > 80)
        local abname = abbrev("'vname'", 12+(c(linesize)-80))
    else
        local abname = abbrev("'vname'", 12)
    local abname = abbrev("'vname'",12)
    display as text %12s "'abname'" c | /*
        */ as result  /*
        */ %8.0g 'n' " " /*
        */ %9.0g 'mean' " " %9.0g 'sd' " " /*
        */ %9.0g 'min' " " %9.0g 'max'
end
```
Let’s now consider outputting the table in the form

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>miles_per_mile</td>
<td>74</td>
<td>21.2973</td>
<td>5.785503</td>
<td>12</td>
<td>41</td>
</tr>
<tr>
<td>weight</td>
<td>74</td>
<td>3019.459</td>
<td>777.1936</td>
<td>1760</td>
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<td>displacement</td>
<td>74</td>
<td>197.2973</td>
<td>91.83722</td>
<td>79</td>
<td>425</td>
</tr>
</tbody>
</table>

where the boldfaced entries are clickable and, if you click on them, the result is to execute `summarize` followed by the variable name. We assume that you have already read [P] smcl and so know that the relevant SMCL directive to create the link is `{stata}`, but continue reading even if you have not read [P] smcl.

The obvious fix to our subroutine would be simply to add the `{stata}` directive, although to do that we will have to store `abbrev("vname",12)` in a macro so that we can refer to it:

```stata
program output_line
    args vname n mean sd min max
    local abname = abbrev("vname",12)
    display as text %12s "{stata summarize 'vname':abname}" /*
        */ "{c |}" /*
        */ as result /*
        */ %8.0g 'n' " " /*
        */ %9.0g 'mean' " " %9.0g 'sd' " " /*
        */ %9.0g 'min' " " %9.0g 'max'
end
```

The SMCL directive `{stata summarize 'vname':abname}` says to display `abname` as clickable, and, if the user clicks on it, to execute `summarize vname`. We used the abbreviated name to display and the unabbreviated name in the command.

The one problem with this fix is that our table will not align correctly because `display` does not know that `{stata summarize 'vname':abname}` displays only `abname`. To display, the string looks long and is not going to fit into a `%12s` field. The solution to that problem is

```stata
program output_line
    args vname n mean sd min max
    local abname = abbrev("vname",12)
    display as text "{ralign 12:{stata summarize 'vname':abname}}" /*
        */ "{c |}" /*
        */ as result /*
        */ %8.0g 'n' " " /*
        */ %9.0g 'mean' " " %9.0g 'sd' " " /*
        */ %9.0g 'min' " " %9.0g 'max'
end
```

The SMCL `{ralign #:text}` macro right-aligns `text` in a field 12 wide and so is equivalent to `%12s`. The `text` that we are asking be aligned is `{stata summarize 'vname':abname}`, but SMCL understands that the only displayable part of the string is `abname` and so will align it correctly.

If we wanted to duplicate the effect of a `%12s` format by using SMCL, we would use `{lalign 12:text}`.
Obtaining input from the terminal

`display`s `_request(macname)` option accepts input from the console and places it into the macro `macname`. For example,

```stata
. display "What is Y? " _request(yval)
What is Y? i don't know
. display "$yval"
i don't know
```

If `yval` had to be a number, the code fragment to obtain it might be

```stata
global yval "junk"
capture confirm number $yval
while _rc!=0 {
    display "What is Y? " _request(yval)
    capture confirm number $yval
}
```

You will typically want to store such input into a local macro. Local macros have names that really begin with a `'`:

```stata
local yval "junk"
capture confirm number `yval'
while _rc!=0 {
    display "What is Y? " _request(_yval)
    capture confirm number `yval'
}
```

Also see

[P] `capture` — Capture return code
[P] `quietly` — Quietly and noisily perform Stata command
[P] `return` — Return stored results
[P] `smcl` — Stata Markup and Control Language
[D] `list` — List values of variables
[D] `outfile` — Export dataset in text format
[U] 12.5 Formats: Controlling how data are displayed
[U] 18 Programming Stata
**Title**

**ereturn — Post the estimation results**

<table>
<thead>
<tr>
<th>Description</th>
<th>Syntax</th>
<th>Options</th>
<th>Remarks and examples</th>
<th>Stored results</th>
<th>Also see</th>
</tr>
</thead>
</table>

**Description**

- `ereturn local`, `ereturn scalar`, and `ereturn matrix` set the `e()` macros, scalars, and matrices other than `b`, `V`, and `Cns` returned by estimation commands. See [P] `return` for more discussion on returning results.

- `ereturn clear` clears the `e()` stored results.

- `ereturn list` lists the names and values of the macros and scalars stored in `e()`, and the names and sizes of the matrices stored in `e()` by the last estimation command.

- `ereturn post` clears all existing `e-class` results and stores the coefficient vector (`b`), variance–covariance matrix (`V`), and constraint matrix (`Cns`) in Stata's system areas, making available all the postestimation features described in [U] 20 Estimation and postestimation commands. `b`, `V`, and `Cns` are optional for `ereturn post`; some commands (such as `factor`; see [MV] `factor`) do not have a `b`, `V`, or `Cns` but do set the estimation sample, `e(sample)`, and properties, `e(properties)`. You must use `ereturn post` before setting other `e()` macros, scalars, and matrices.

- `ereturn repost` changes the `b`, `V`, or `Cns` matrix (allowed only after estimation commands that posted their results with `ereturn post`) or changes the declared estimation sample or `e(properties)`. The specified matrices cease to exist after `post` or `repost`; they are moved into Stata’s system areas. The resulting `b`, `V`, and `Cns` matrices in Stata’s system areas can be retrieved by reference to `e(b)`, `e(V)`, and `e(Cns)`. `ereturn post` and `repost` deal with only the coefficient and variance–covariance matrices, whereas `ereturn matrix` is used to store other matrices associated with the estimation command.

- `ereturn display` displays or redisplays the coefficient table corresponding to results that have been previously posted using `ereturn post` or `repost`.

For a discussion of posting results with constraint matrices (`Cns` in the syntax diagram above), see [P] `makecns`, but only after reading this entry.
Syntax

Set macro returned by estimation command

```plaintext
ereturn  local name  . . .
```
(see [P] macro)

Set scalar returned by estimation command

```plaintext
ereturn  scalar name  = exp
```

Set matrix returned by estimation command

```plaintext
ereturn  matrix name [ = ] matname [ , copy ]
```

Clear e() stored results

```plaintext
ereturn  clear
```

List e() stored results

```plaintext
ereturn  list [ , all ]
```

Store coefficient vector and variance–covariance matrix into e()

```plaintext
ereturn  post  [ b  [ V  [ Cns ] ] ]  [ weight ] [ , depname(string) obs(#) dof(#) esample(varname) properties(string) buildfvinfo findomitted ]
```

Change coefficient vector and variance–covariance matrix

```plaintext
ereturn  repost  [ b = b ]  [ V = V ]  [ Cns = Cns ]  [ weight ] [ , esample(varname) properties(string) buildfvinfo findomitted rename resize ]
```

Display coefficient table

```plaintext
ereturn  display  [ , eform(string) first neq(#) plus level(#) display_options ]
```

where name is the name of the macro, scalar, or matrix that will be returned in e(name) by the estimation program; matname is the name of an existing matrix; b is a 1 × p coefficient vector (matrix); V is a p × p covariance matrix; and Cns is a c × (p + 1) constraint matrix. fweights, aweights, iweights, and pweights are allowed; see [U] 11.1.6 weight.
Options

copy specified with `ereturn matrix` indicates that the matrix is to be copied; that is, the original matrix should be left in place.

all specifies that hidden and historical stored results be listed along with the usual stored results. This option is seldom used. See `Using hidden and historical stored results` and `Programming hidden and historical stored results` under Remarks and examples of [P] return for more information. These sections are written in terms of `return list`, but everything said there applies equally to `ereturn list`.

defname(string) specified with `ereturn post` supplies a name that should be that of the dependent variable but can be anything; that name is stored and added to the appropriate place on the output whenever `ereturn display` is executed.

obs(#) specified with `ereturn post` supplies the number of observations on which the estimation was performed; that number is stored in `e(N)`.

dof(#) specified with `ereturn post` supplies the number of (denominator) degrees of freedom that is to be used with t and F statistics and is stored in `e(df_r)`. This number is used in calculating significance levels and confidence intervals by `ereturn display` and by subsequent test commands performed on the posted results. If the option is not specified, normal (Z) and \( \chi^2 \) statistics are used.

esample(varname) specified with `ereturn post` or `ereturn repost` gives the name of the 0/1 variable indicating the observations involved in the estimation. The variable is removed from the dataset but is available for use as `e(sample)`; see [U] 20.7 Specifying the estimation subsample. If the `esample()` option is not specified with `ereturn post`, it is set to all zeros (meaning no estimation sample). See [P] mark for details of the `marksample` command that can help create `varname`.

properties(string) specified with `ereturn post` or `ereturn repost` sets the `e(properties)` macro. By default, `e(properties)` is set to `b V` if `properties()` is not specified.

buildfvinfo specified with `ereturn post` or `ereturn repost` computes the H matrix that postestimation commands contrast, margins, and `pwcompare` use for determining estimable functions.

findomitted specified with `ereturn post` or `ereturn repost` adds the omit operator o. to variables in the column names corresponding to zero-valued diagonal elements of `e(V)`. This option is generally unnecessary but is useful when \_rmcoll is not used before estimation.

rename is allowed only with the `b = b` syntax of `ereturn repost` and tells Stata to use the names obtained from the specified `b` matrix as the labels for both the `b` and `V` estimation matrices. These labels are subsequently used in the output produced by `ereturn display`.

resize is allowed only with `ereturn repost` and tells Stata that the replacements `b`, `V`, and `Cns` have a different number of elements than the originals. This option implies `rename`.

`eform(string)` specified with `ereturn display` indicates that the exponentiated form of the coefficients is to be output and that reporting of the constant is to be suppressed. `string` is used to label the exponentiated coefficients; see [R] `eform_option`.

first requests that Stata display only the first equation and make it appear as if only one equation were estimated.

`neq(#)` requests that Stata display only the first # equations and make it appear as if only # equations were estimated.
plus changes the bottom separation line produced by `ereturn display` to have a + symbol at the position of the dividing line between variable names and results. This is useful if you plan on adding more output to the table.

`level(#)` is an option of `ereturn display`, specifies the confidence level, as a percentage, of confidence intervals for the estimated parameters; see [U] 20.8 Specifying the width of confidence intervals.

`display_options`: `noci`, `nopolvalues`, `noomitted`, `vsquish`, `noemptycells`, `baselevels`, `allbaselevels`, `nofvlabel`, `fwrap(#)`, `fwrapon(style)`, `cformat(%%fmt)`, `pformat(%%fmt)`, `sformat(%%fmt)`, and `nolstretch`; see [R] Estimation options.

Remarks and examples

Remarks are presented under the following headings:

- Estimation-class programs
- Setting individual estimation results
- Posting estimation coefficient and variance–covariance matrices
  - Single-equation models
  - Multiple-equation models
  - Single-equation models masquerading as multiple-equation models
- Setting the estimation sample
- Setting estimation-result properties
- Reposting results
- Minor details: The depname() and dof() options

For a summary of the `ereturn` command, see [P] return.

Estimation-class programs

After any estimation command, you can obtain individual coefficients and standard errors by using `_b[]` and `_se[]` (see [U] 13.5 Accessing coefficients and standard errors); list the coefficients by using `matrix list e(b)`, list the variance–covariance matrix of the estimators by using `matrix list e(V)` or in a table by using `estat vce` (see [R] estat vce); obtain the linear prediction and its standard error by using `predict` (see [R] predict); and test linear hypotheses about the coefficients by using `test` (see [R] test). Other important information from an estimation command can be obtained from the stored `e()` results. (For example, the estimation command name is stored in `e(cmd)`. The dependent variable name is stored in `e(depvar)`.) The `e()` results from an estimation command can be listed by using the `ereturn list` command. All of these features are summarized in [U] 20 Estimation and postestimation commands.

If you decide to write your own estimation command, your command can share all of these features as well. This is accomplished by posting the results you calculate to Stata. The basic outline of an estimation command is

```
program myest, eclass
    version 17.0
    if !replay() {
        syntax whatever [, whatever Level(cilevel)]
        marksample touse // see [P] mark
        perform any other parsing of the user's estimation request;
        local depn "dependent variable name"
        local nobs = number of observations in estimation
        tempname b V
        produce coefficient vector `b' and variance--covariance matrix `V'
        ereturn post `b' `V', obs(`nobs') depname(`depn') esample(`touse')
    }
```

For a summary of the `ereturn` command, see [P] return.
ereturn local depvar "'depn'"
store whatever else you want in e()
ereturn local cmd "myest"       // set e(cmd) last
}
else { // replay
    if "e(cmd)"!="myest" error 301
    syntax [, Level(cilevel)]
}
output any header above the coefficient table;
ereturn display, level('level')
end

We will not discuss here how the estimates are formed; see [P] matrix for an example of programming linear regression, and see [R] ml for examples of programming maximum likelihood estimators. However the estimates are formed, our interest is in posting those results to Stata.

When programming estimation commands, remember to declare them as estimation commands by including the eclass option of program; see [U] 18 Programming Stata. If you do not declare your program to be eclass, Stata will produce an error if you use ereturn local, ereturn scalar, or ereturn matrix in your program. For more information about storing program results, see [P] return.

The estimation program definition statement—program myest, eclass—should also have included a properties() option, but we omitted it because 1) it is not necessary and 2) you might confuse it with ereturn’s properties() option.

There are two sets of properties associated with estimation commands: program properties and estimation-result properties. The first are set by the properties() option of the program definition statement. The second are set by ereturn’s properties() option. The first tell Stata’s prefix commands, such as stepwise and svy, whether they should work with this new estimation command. The second tell Stata’s postestimation commands, such as predict and test, whether they should work after this new estimation command.

The first is discussed in [P] program properties. The second will be discussed below.

FAQ Technical note

Notice the use of the replay() function in our estimation program example. This function is not like other Stata functions; see [FN] Programming functions. replay() simply returns 1 if the command line is empty or begins with a comma, and 0 otherwise. More simply: replay() indicates whether the command is an initial call to the estimation program (replay() returns 0) or a call to redisplay past estimation results (replay() returns 1).

In fact,

    if !replay() {
        is equivalent to
    if trim(""O"") == "" | substr(trim(""O""),1,1) == "," {
        but is easier to read.

The ereturn local, ereturn scalar, ereturn matrix, ereturn clear, and ereturn list commands are discussed in Setting individual estimation results. The ereturn post, ereturn repost, and ereturn display commands are discussed in Posting estimation coefficient and variance–covariance matrices.
Setting individual estimation results

Stata’s estimation commands store the command name in the returned macro `e(cmd)` and store the name of the dependent variable in `e(depvar)`. Other macros and scalars are also stored. For example, the estimation sample size is stored in the returned scalar `e(N)`. The model and residual degrees of freedom are stored in `e(df_m)` and `e(df_r)`.

These `e()` macro and scalar results are stored using the `ereturn local` and `ereturn scalar` commands. Matrices may be stored using the `ereturn matrix` command. The coefficient vector `e(b)` and variance–covariance matrix `e(V)`, however, are handled differently and are stored using only the `ereturn post` and `ereturn repost` commands, which are discussed in the next section.

Example 1

Assume that we are programming an estimation command called `xyz` and that we have the dependent variable in `‘depname’`, the estimation sample size in `‘nobs’`, and other important information stored in other local macros and scalars. We also wish to store an auxiliary estimation matrix that our program has created called `lam` into the stored matrix `e(lambda)`. We would store these results by using commands such as the following in our estimation program:

```stata
... 
ereturn local depvar "‘depname’"
ereturn scalar N = ‘nobs’
ereturn matrix lambda lam 
...
ereturn local cmd "xyz"
```

The matrix given to the `ereturn matrix` command is removed, and the new `e()` matrix is then made available. For instance, in this example, we have the line

```stata
ereturn matrix lambda lam
```

After this line has executed, the matrix `lam` is no longer available for use, but you can instead refer to the newly created `e(lambda)` matrix.

The `e()` results from an estimation command can be viewed using the `ereturn list` command.

Example 2

We regress automobile weight on length and engine displacement by using the `auto` dataset.

```stata
.use https://www.stata-press.com/data/r17/auto
(1978 automobile data)
.regress weight length displ
```

```
<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of obs = 74</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>41063449.8</td>
<td>2</td>
<td>20531724.9</td>
<td>F(2, 71) = 480.99</td>
</tr>
<tr>
<td>Residual</td>
<td>3030728.55</td>
<td>71</td>
<td>42686.3176</td>
<td>Prob &gt; F = 0.0000</td>
</tr>
<tr>
<td>Total</td>
<td>44094178.4</td>
<td>73</td>
<td>604029.841</td>
<td>R-squared = 0.9293</td>
</tr>
</tbody>
</table>

| weight | Coefficient | Std. err. | t     | P>|t| | [95% conf. interval] |
|--------|-------------|-----------|-------|-----|----------------------|
| length | 22.91788    | 1.974431  | 11.61 | 0.000 | 18.98097 26.85478 |
| displac | 2.932772   | .4787094  | 6.13  | 0.000 | 1.978252 3.887291 |
| _cons  | -1866.181  | 297.7349  | -6.27 | 0.000 | -2459.847 -1272.514 |
```
. ereturn list

scalars:
   e(N) = 74
   e(df_m) = 2
   e(df_r) = 71
   e(F) = 480.9907735088096
   e(r2) = .9312669232040125
   e(rmse) = 206.6066736285298
   e(mss) = 41063449.82964133
   e(rss) = 3030728.548737053
   e(r2_a) = .9293307801956748
   e(ll) = -497.9506459758983
   e(ll_0) = -597.0190609278627
   e(rank) = 3

macros:
   e(cmdline) : "regress weight length displ"
   e(title) : "Linear regression"
   e(marginsok) : "XB default"
   e(vce) : "ols"
   e(depvar) : "weight"
   e(cmd) : "regress"
   e(properties) : "b V"
   e(predict) : "regres_p"
   e(model) : "ols"
   e(estat_cmd) : "regress_estat"

matrices:
   e(b) : 1 x 3
   e(V) : 3 x 3

functions:
   e(sample)

In addition to listing all the e() results after an estimation command, you can access individual e() results.

. display "The command is: 'e(cmd)'
The command is: regress
. display "The adjusted R-squared is: 'e(r2_a)'
The adjusted R-squared is: .9293307801956748
. display "The residual sums-of-squares is: 'e(rss)'
The residual sums-of-squares is: 3030728.548737053

. matrix list e(V)
symmetric e(V)[3,3]

   length   displacement   _cons
length 3.8983761
   displacement -0.78935643 0.22916272
   _cons -576.89342 103.13249 88646.064

. matrix list e(b)
e(b)[1,3]
   length   displacement   _cons
y1 22.917876 2.9327718 -1866.1807

For more information on referring to e() results, see [P] return.

The reference manuals’ entries for Stata’s estimation commands have a Stored results section describing the e() results that are returned by the command. If you are writing an estimation command, we recommend that you store the same kind of estimation results by using the same naming convention as Stata’s estimation commands. This is important if you want postestimation
commands to work after your estimation command. See [U] 20 Estimation and postestimation commands and [P] return for details.

When programming your estimation command, you will want to issue either an `ereturn clear` command or an `ereturn post` command before you store any estimation results. The `ereturn clear` command clears all `e()` results. The `ereturn post` command, which is discussed in the next section, first clears all previous `e()` results and then performs the post.

We recommend that you postpone clearing past estimation results and setting new `e()` results until late in your program. If an error occurs early in your program, the last successful estimation results will remain intact. The best place in your estimation program to set the `e()` results is after all other calculations have been completed and before estimation results are displayed.

We also recommend that you store the command name in `e(cmd)` as your last act of storing results. This ensures that if `e(cmd)` is present, then all the other estimation results were successfully stored. Postestimation commands assume that if `e(cmd)` is present, then the estimation command completed successfully and all expected results were stored. If you stored `e(cmd)` early in your estimation command and the user pressed Break before the remaining `e()` results were stored, postestimation commands operating on the partial results will probably produce an error.

### Posting estimation coefficient and variance–covariance matrices

The most important estimation results are the coefficient vector $b$ and the variance–covariance matrix $V$. Because these two matrices are at the heart of most estimation commands, for increased command execution speed, Stata handles these matrices in a special way. The `ereturn post`, `ereturn repost`, and `ereturn display` commands work on these matrices. The `ereturn matrix` command discussed in the last section cannot be used to store or to post the $b$ and $V$ matrices.

### Single-equation models

Before posting, the coefficient vector is stored as a $1 \times p$ matrix and the corresponding variance–covariance matrix as a $p \times p$ matrix. The names bordering the coefficient matrix and those bordering the variance–covariance matrix play an important role. First, they must be the same. Second, it is these names that tell Stata how the results link to Stata’s other features.

Estimation results come in two forms: those for single-equation models and those for multiple-equation models. The absence or presence of equation names in the names bordering the matrix (see [P] matrix rownames) tells Stata which form it is.

#### Example 3

For instance, consider

```
. use https://www.stata-press.com/data/r17/auto
(1978 automobile data)
. regress price weight mpg
(output omitted)
. matrix b = e(b)
. matrix V = e(V)
. matrix list b
  b[1,3] weight mpg _cons
     y1  1.7465592  -49.512221  1946.0687
```
If these were our estimation results, they would correspond to a single-equation model because the names bordering the matrices have no equation names. Here we post these results:

```
. ereturn post b V
. ereturn display
```

| Coefficient | Std. err. | z    | P>|z|    | [95% conf. interval] |
|-------------|-----------|------|--------|---------------------|
| weight      | 1.746559  | .6413538 | 2.72  | 0.006               | .4895288 3.003589 |
| mpg         | -49.51222 | 86.15644 | -0.57 | 0.566               | -218.375 119.3505 |
| _cons       | 1946.069  | 3597.05  | 0.54  | 0.588               | -5104.019 8996.156 |

Once the results have been posted, anytime the `ereturn display` command is executed, Stata will redisplay the coefficient table. Moreover, all of Stata’s other postestimation features work. For instance,

```
. test weight
   ( 1) weight = 0
        chi2( 1) = 7.42
        Prob > chi2 = 0.0065

. test weight=mpg/50
   ( 1) weight - .02*mpg = 0
        chi2( 1) = 4.69
        Prob > chi2 = 0.0303
```

If the user were to type `predict pred`, then `predict` would create a new variable based on

```
1.746559\times weight - 49.51222\times mpg + 1946.069
```

except that it would carry out the calculation by using the full, double-precision values of the coefficients. All determinations are made by Stata on the basis of the names bordering the posted matrices.

## Multiple-equation models

If the matrices posted using the `ereturn post` or `ereturn repost` commands have more than one equation name, the estimation command is treated as a multiple-equation model.

### Example 4

Consider the following two matrices before posting:

```
. matrix list b
b[1,6]
       price:     price:     price:  displacem-t:  displacem-t:  
          weight     mpg     _cons     weight     foreign
y1     1.7417059   -50.31993  1977.9249   .09341608   -35.124241
displacem-t:     
    _cons
y1     -74.326413
```

```
. matrix list V
symmetric V[6,6]

price:weight .38775906
price:mpg 41.645165 6930.8263
price:_cons -2057.7522 -273353.75 12116943

displacement:weight 0.00030351 -.01074361 -.68762197 .00005432
displacement:foreign -.18390487 -30.6065 1207.129 .05342871
displacement:_cons -.86175743 41.539129 1936.6875 -.1798972

. ereturn post b V
. ereturn display

|             | Coefficient | Std. err. | z    | P>|z|   | [95% conf. interval] |
|-------------|-------------|-----------|------|-------|---------------------|
| price       |             |           |      |       |                     |
| weight      | 1.741706    | .622703   | 2.80 | 0.005 | 0.5212304 2.962181  |
| mpg         | -50.31993   | 83.25158  | -0.60| 0.546 | -213.49 112.8502   |
| _cons       | 1977.925    | 3480.94   | 0.57 | 0.570 | -4844.592 8800.442 |
| displacement|             |           |      |       |                     |
| weight      | 0.0934161   | .0073701  | 12.67| 0.000 | 0.0789709 1.078612 |
| foreign     | -35.12424   | 12.33727  | -2.85| 0.004 | -59.30484 -10.94364|
| _cons       | -74.32641   | 25.01596  | -2.97| 0.003 | -123.3568 -25.29603|

. test [price]weight
( 1) [price]weight = 0
chi2( 1) =  7.82
Prob > chi2 =  0.0052

. test weight
( 1) [price]weight = 0
( 2) [displacement]weight = 0
chi2( 2) = 164.51
Prob > chi2 = 0.0000

Stata determined that this was a multiple-equation model because equation names were present. All of Stata’s equation-name features (such as those available with the test command) are then made available. The user could type predict pred to obtain linear predictions of the [price] equation (because predict defaults to the first equation) or type predict pred, equation(displ) to obtain predictions of the [displ] equation:

.0934161 weight − 35.12424 foreign − 74.32641
**Single-equation models masquerading as multiple-equation models**

### Example 5

Sometimes, it may be convenient to program a single-equation model as if it were a multiple-equation model. This occurs when there are ancillary parameters. Think of linear regression: in addition to the parameter estimates, there is \( s \), which is an estimate of \( \sigma \), the standard error of the residual. This can be calculated on the side in that you can calculate \( b = (X'X)^{-1}X'y \) independently of \( s \) and then calculate \( s \) given \( b \). Pretend that were not the case—think of a straightforward maximum likelihood calculation where \( s \) is just one more parameter (in most models, ancillary parameters and the coefficients must be solved for jointly). The right thing to do would be to give \( s \) its own equation:

```
. matrix list b
b[1,4]
     price: price: price: _anc: 
weight  mpg  _cons  sigma 
  y1  1.7465592 -49.512221  1946.0687  2514
.
. matrix list V
symmetric V[4,4]
     price: price: price: _anc: 
weight  mpg  _cons  sigma 
price:weight  .41133468
price:mpg     44.601659  7422.863
price:_cons  -2191.9032 -292759.82 12938766
_anc:sigma  0 0 0 810000
.
. ereturn post b V
. ereturn display
```

```
Coef.  Std. err.    z    P>|z|     [95% conf. interval]
------- -------- -------- -------- ------------------------
price
weight   1.746559   .6413538  2.72    0.006   .4895288   3.003589
mpg    -49.512221   86.15604  -0.57    0.566  -218.375    119.3505
_cons   1946.069    3597.05   0.54    0.588  -5104.019  8996.156

_anc
sigma    2514      900    2.79    0.005   750.0324   4277.968
```

Now consider the alternative, which would be simply to add \( s \) to the estimated parameters without equation names:

```
. matrix list b
b[1,4]
     weight  mpg  _cons  sigma 
  y1  1.7465592 -49.512221  1946.0687  2514
.
. matrix list V
symmetric V[4,4]
     weight  mpg  _cons  sigma 
weight  .41133468
mpg     44.601659  7422.863
=_cons -2191.9032 -292759.82 12938766
sigma  0 0 0 810000
.
. ereturn post b V
```
This second solution is inferior because, if the user typed `predict pred`, then `predict` would attempt to form the linear combination:

\[
1.746559 \text{ weight} - 49.51222 \text{ mpg} + 1946.069 + 2514 \text{ sigma}
\]

There are only two possibilities, and neither is good: either `sigma` does not exist in the dataset—which is to be hoped—and `predict` produces the error message “variable sigma not found”, or something called `sigma` does exist, and `predict` goes on to form this meaningless combination.

On the other hand, if the parameter estimates are separated from the ancillary parameter (which could be parameters) by the equation names, the user can type `predict pred, equation(price)` to obtain a meaningful result. Moreover, the user can omit `equation(price)` partly because `predict` (and Stata’s other postestimation commands) defaults to the first equation.

We recommend that ancillary parameters be collected together and given their own equation and that the equation be called `_anc`.

### Setting the estimation sample

In our previous examples, we did not indicate the estimation sample as specified with the `esample(varname)` option. In general, you provide this either with your initial `ereturn post` command or with a subsequent `ereturn repost` command. Some postestimation commands automatically restrict themselves to the estimation sample, and if you do not provide this information, they will complain that there are no observations; see [U] 20.7 Specifying the estimation subsample. Also, users of your estimation command expect to use `if e(sample)` successfully in commands that they execute after your estimation command.

#### Example 6

Returning to our first example:

```
. ereturn post b V
. ereturn display
(output omitted)
. summarize price if e(sample)
Variable |     Obs    Mean  Std. dev.     Min    Max
---------|--------|--------|--------|--------|--------
   price  |      0
```

does not produce what the user expects. Specifying the estimation sample with the `esample()` option of `ereturn post` produces the expected result:
. return post b V, esample(estsamp)
. return display
(output omitted)
. summarize price if e(sample)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>price</td>
<td>74</td>
<td>6165.257</td>
<td>2949.496</td>
<td>3291</td>
<td>15906</td>
</tr>
</tbody>
</table>

The `marksample` command (see [P] mark) is a useful programming command that aids in creating and setting up an estimation sample indicator variable, such as `estsamp`.

### Setting estimation-result properties

The `properties()` option of `return post` and `repost` allows you to set `e(properties)`. By default, `return post` sets `e(properties)` to `b V` when you supply a `b` and `V` argument. If you supply the `b`, but not the `V`, it defaults to `b`. If you do not supply the `b` and `V`, it defaults to being empty. Using the `properties()` option, you can augment or override the default setting. You are also free to use `return local` to set `e(properties)`.

`e(properties)` is used as a signal to postestimation commands. A `b` in `e(properties)` is a signal that the `e(b)` returned matrix can be interpreted as a coefficient vector. A `V` in `e(properties)` indicates that `e(V)` can be interpreted as a VCE matrix. An `e(properties)` containing `eigen` indicates that the estimation command has placed eigenvalues in `e(Ev)` and eigenvectors in `e(L)`. A command, such as `screeplot` (see [MV] screeplot), that plots the eigenvalues and can be used as a postestimation command looks to see if `eigen` is found in `e(properties)`. If so, it then looks for `e(Ev)` to contain the eigenvalues.

#### Example 7

We demonstrate by interactively posting a `b` vector without posting a `V` matrix. Even without a `V` matrix, the available information provided by `b` is used appropriately.

. use https://www.stata-press.com/data/r17/auto, clear
  (1978 automobile data)
. matrix b=(2,-1)
. matrix colnames b = turn trunk
. return post b
. return display

<table>
<thead>
<tr>
<th>Coefficient</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>turn</td>
<td>2</td>
</tr>
<tr>
<td>trunk</td>
<td>-1</td>
</tr>
</tbody>
</table>

. predict myxb, xb
. list trunk trunk myxb in 1/4

<table>
<thead>
<tr>
<th>turn</th>
<th>trunk</th>
<th>myxb</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>40</td>
<td>11</td>
</tr>
<tr>
<td>2.</td>
<td>40</td>
<td>11</td>
</tr>
<tr>
<td>3.</td>
<td>35</td>
<td>12</td>
</tr>
<tr>
<td>4.</td>
<td>40</td>
<td>16</td>
</tr>
</tbody>
</table>

The estimation table produced by ereturn display omits the standard errors, tests, and confidence intervals because they rely on having a VCE matrix. predict with the xb option produces the linear predictions. If you tried to use the stdp option of predict, you would get an error message indicating that the requested action was not valid.

The has_eprop() programmer’s function is useful for determining if e(properties) contains a particular property; see [FN] Programming functions.

Technical note

Do not confuse the properties set with the properties() option of ereturn post and ereturn repost, which are placed in e(properties) and used by postestimation commands, with the properties() option of the program command; see [P] program. The properties set by program indicate to other programs before the command is executed that certain features have been implemented, for example, the svyr property indicates to the svy prefix command that the requirements to use the vce(linearized) variance estimation method have been satisfied. On the other hand, the properties set by ereturn are for use after the program has run and may depend on the data and options of the program.

Reposting results

In certain programming situations, only a small part of a previous estimation result needs to be altered. ereturn repost allows us to change five parts of an estimation result that was previously posted with ereturn post. We can change the coefficient vector, the variance–covariance matrix, and the declared estimation sample by using the esample() option; we can change the declared properties by using the properties() option; and we can change the variable names for the coefficients by using the rename option. A programmer might, for instance, simply replace the variance–covariance matrix provided by a previous ereturn post with a robust covariance matrix to create a new estimation result.

Sometimes a programmer might preserve the data, make major alterations to the data (using drop, reshape, etc.) to perform needed computations, post the estimation results, and then finally restore the data. Here, when ereturn post is called, the correct estimation sample indicator variable is unavailable. ereturn repost with the esample() option allows us to set the estimation sample without changing the rest of our posted estimation results.
Example 8

For example, inside an estimation command program, we might have

```plaintext
... 
ereturn post b V 
... 
ereturn repost, esample(estsamp) 
... 
```

Technical note

`ereturn repost` may be called only from within a program that has been declared an estimation class program by using the `eclass` option of the `program` statement. The same is not true of `ereturn post`. We believe that the only legitimate uses of `ereturn repost` are in a programming context. `ereturn post`, on the other hand, may be important for some non–e-class programming situations.

Minor details: The `depname()` and `dof()` options

Single-equation models may have one dependent variable; in those that do, you should specify the identity of this one dependent variable in the `depname()` option with `ereturn post`. The result is simply to add a little more labeling to the output.

If you do not specify the `dof(#)` option at the time of posting or set `e(df_r)` equal to the degrees of freedom, normal (Z) statistics will be used to calculate significance levels and confidence intervals on subsequent `ereturn display` output. If you do specify `dof(#)` or set `e(df_r)` equal to #, $t$ statistics with # degrees of freedom will be used. Similarly, if you did not specify `dof(#)` or set `e(df_r)`, any subsequent `test` commands will present a $\chi^2$ statistic; if you specify `dof(#)` or set `e(df_r)`, subsequent `test` commands will use the $F$ statistic with # denominator degrees of freedom.

Example 9

Let’s add the dependent variable name and degrees of freedom to example 3.

```plaintext
. ereturn post b V, depname(price) dof(71) 
. ereturn display 
```

| price     | Coefficient | Std. err. | t     | P>|t| | [95% conf. interval] |
|-----------|-------------|-----------|-------|-----|----------------------|
| weight    | 1.746559    | .6413538  | 2.72  | 0.008 | .467736 3.025382    |
| mpg       | -49.51222   | 86.15604  | -0.57 | 0.567 | -221.3025 122.278   |
| _cons     | 1946.069    | 3597.05   | 0.54  | 0.590 | -5226.245 9118.382  |

Note the addition of the word `price` at the top of the table. This was produced because of the `depname(price)` option specification. Also $t$ statistics were used instead of normal (Z) statistics because the `dof(71)` option was specified.
 Stored results

**ereturn post** stores the following in e():

Scalars
- \( e(N) \) — number of observations
- \( e(df_r) \) — degrees of freedom, if specified

Macros
- \( e(wtype) \) — weight type
- \( e(wexp) \) — weight expression
- \( e(properties) \) — estimation properties; typically \( b V \)

Matrices
- \( e(b) \) — coefficient vector
- \( e(Cns) \) — constraints matrix
- \( e(V) \) — variance–covariance matrix of the estimators

Functions
- \( e(sample) \) — marks estimation sample

**ereturn repost** stores the following in e():

Macros
- \( e(wtype) \) — weight type
- \( e(wexp) \) — weight expression
- \( e(properties) \) — estimation properties; typically \( b V \)

Matrices
- \( e(b) \) — coefficient vector
- \( e(Cns) \) — constraints matrix
- \( e(V) \) — variance–covariance matrix of the estimators

Functions
- \( e(sample) \) — marks estimation sample

With **ereturn post**, all previously stored estimation results — e() items — are removed. **ereturn repost**, however, does not remove previously stored estimation results. **ereturn clear** removes the current e() results.

**ereturn display** stores the following in r():

Scalars
- \( r(level) \) — confidence level of confidence intervals

Macros
- \( r(label#) \) — label on the # coefficient, such as (base), (omitted), (empty), or (constrained)
- \( r(table) \) — information from the coefficient table (see below)

**r(table)** contains the following information for each coefficient:

- \( b \) — coefficient value
- \( se \) — standard error
- \( t/z \) — test statistic for coefficient
- \( pvalue \) — observed significance level for \( t/z \)
- \( ll \) — lower limit of confidence interval
- \( ul \) — upper limit of confidence interval
- \( df \) — degrees of freedom associated with coefficient
- \( crit \) — critical value associated with \( t/z \)
- \( eform \) — indicator for exponentiated coefficients
Also see

[P] _estimates — Manage estimation results
[P] return — Return stored results
[R] estimates — Save and manipulate estimation results
[U] 18 Programming Stata
[U] 18.9 Accessing results calculated by estimation commands
[U] 18.10.2 Storing results in e()
[U] 20 Estimation and postestimation commands
error — Display generic error message and exit

Description

error displays the most generic form of the error message associated with expression and sets the return code to the evaluation of the expression. If expression evaluates to 0, error does nothing. Otherwise, the nonzero return code will force an exit from the program or capture block in which it occurs. error sets the return code to 197 if there is an error in using error itself.

Syntax

```
error exp
```

Remarks and examples

Remarks are presented under the following headings:

- Introduction
- Summary
- Other messages

Introduction

error is used in two ways inside programs. In the first case, you want to display a standard error message so that users can look up your message by using search:

```
if ('nvals'>100) error 134
```

According to [R] search, return code 134 is associated with the message “too many values”. During program development, you can verify that by typing the error command interactively:

```
. error 134
too many values
r(134);
```

Below we list the individual return codes so that you can select the appropriate one for use with error in your programs.

error is also used when you have processed a block of code in a capture block, suppressing all output. If anything has gone wrong, you want to display the error message associated with whatever the problem was:

```
capture {
    code continues
}  
local rc=_rc  
preserve return code from capture
cleanup code
error 'rc'  
present error message and exit if necessary
code could continue
```

Usually, one hopes that the return code will be zero so that error does nothing.
You can interrogate the built-in variable `rc` to determine the type of error that occurred and then take the appropriate action. Also see [U] 16.1.4 Error handling in do-files.

The return codes are numerically grouped, which is a feature that you may find useful when you are writing programs. The groups are

<table>
<thead>
<tr>
<th>Return codes</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–99</td>
<td>sundry “minor” errors</td>
</tr>
<tr>
<td>100–199</td>
<td>syntax errors</td>
</tr>
<tr>
<td>300–399</td>
<td>failure to find previously stored result</td>
</tr>
<tr>
<td>400–499</td>
<td>statistical problems</td>
</tr>
<tr>
<td>500–599</td>
<td>matrix-manipulation errors</td>
</tr>
<tr>
<td>600–699</td>
<td>file errors</td>
</tr>
<tr>
<td>700–799</td>
<td>operating-system errors</td>
</tr>
<tr>
<td>900–999</td>
<td>insufficient-memory errors</td>
</tr>
<tr>
<td>1000–1999</td>
<td>system-limit-exceeded errors</td>
</tr>
<tr>
<td>2000–2999</td>
<td>nonerrors (continuation of 400–499)</td>
</tr>
<tr>
<td>3000–3999</td>
<td>Mata run-time errors; see [M-2] Errors for codes</td>
</tr>
<tr>
<td>4000–4999</td>
<td>class system errors</td>
</tr>
<tr>
<td>7100–7199</td>
<td>Python run-time errors; see Error codes in [P] PyStata integration</td>
</tr>
<tr>
<td>9000–9999</td>
<td>system-failure errors</td>
</tr>
</tbody>
</table>

Summary

1. You pressed Break. This is not considered an error.

3. **no dataset in use**
   You attempted to perform a command requiring data and have no data in memory.

4. **no; dataset in memory has changed since last saved**
   You attempted to perform a command that would substantively alter or destroy the data, and the data have not been saved, at least since the data were last changed. If you wish to continue anyway, add the `clear` option to the end of the command. Otherwise, `save` the data first.

5. **not sorted**
   **master data not sorted**
   **using data not sorted**
   The observations of the data are not in the order required. To solve the problem, use `sort` to sort the data then reissue the command; see [D] sort.

In the second and third cases, both the dataset in memory and the dataset on disk must be sorted by the variables specified in the varlist of `merge` before they can be merged. `merge` automatically sorts the datasets for you, unless you specify the `sorted` option. You specified `sorted`, but your dataset is not sorted on the variables in varlist. Do not specify `sorted`.

6. Return code from confirm existence when `string` does not exist.

7. `'________'` found where `________` expected
   You are using a program that is using the `confirm` command to verify that what you typed makes sense. The messages indicate what you typed and what the program expected to find instead of what you typed.

9. **assertion is false**
   **no action taken**
   Return code and message from `assert` when the assertion is false; see [D] assert.
   Or, you were using `mvencode` and requested that Stata change `.'` to `#` in the specified varlist, but `#` already existed in the varlist, so Stata refused; see [D] mvencode.

18. **you must start with an empty dataset**
   The command (for example, `infile`) requires that no data be in memory—you must `drop _all` first. You are probably using `infile` to append additional data to the data in memory. Instead, save the data in memory, `drop _all`, `infile` the new data, and then `append` the previously saved data; see [D] append.
100. varlist required
   = exp required
   using required
   by() option required
   Certain commands require a varlist or another element of the language. The message specifies the required item that was missing from the command you gave. See the command's syntax diagram. For example, merge requires using to be specified; perhaps you meant to type append. Or, ranksum requires a by() option; see [R] ranksum.

101. varlist not allowed
   weights not allowed
   in range not allowed
   if not allowed
   = exp not allowed
   using not allowed
   Certain commands do not allow an if qualifier or other elements of the language. The message specifies which item in the command is not allowed. See the command's syntax diagram. For example, append does not allow a varlist; perhaps you meant to type merge.

102. too few variables specified
   The command requires more variables than you specified. For instance, stack requires at least two variables. See the syntax diagram for the command.

103. too many variables specified
   The command does not allow as many variables as you specified. For example, tabulate takes only one or two variables. See the syntax diagram for the command.

104. nothing to input
   You gave the input command with no varlist. Stata will input onto the end of the dataset, but there is no existing dataset here. You must specify the variable names on the input command.

106. variable ______ is ______ in master but ______ in using data
   You have attempted to append two datasets, but there is a string or numeric mismatch for one of the variables. The first blank is filled in with a variable name, and the second and third blanks are filled in with a storage type (byte, int, long, float, double, str#, or strL). You could specify append's force option to ignore the mismatch. If the str# type is in the master data, the using variable would then be treated as if it contained "". If the str# type is in the using data, the using variable would then be treated as if it contained numeric missing value.
   key variable ______ is strL in using data
   You have attempted to merge two datasets, but one of the key variables is a strL. The blank is filled in with the variable name. The key variables—the variables on which observations are matched—can be str#, but they cannot be strLs.

107. not possible with numeric variable
   You have requested something that is logically impossible with a numeric variable, such as encoding it. Perhaps you meant another variable or typed encode when you meant decode.

108. not possible with string variable
   You have requested something that is logically impossible with a string variable, such as decoding it. Perhaps you meant another variable or typed decode when you meant encode.

109. type mismatch
   In an expression, you attempted to combine a string and numeric subexpression in a logically impossible way. For instance, you attempted to subtract a string from a number or you attempted to take the substring of a number.

110. ______ already defined
    A variable or a value label has already been defined, and you attempted to redefine it. This occurs most often with generate. If you really intend to replace the values, use replace. If you intend to replace a value label, specify the replace option with the label define command. If you are attempting to alter an existing label, specify the add or modify option with the label define command.
111. not found
no variables defined
The variable does not exist. You may have mistyped the variable’s name.

variables out of order
You specified a varlist containing varname1-varname2, yet varname1 occurs after varname2. Reverse the order of
the variables if you did not make some other typographical error. Remember, varname1-varname2 is taken by
Stata to mean varname1, varname2, and all the variables in dataset order in between. Type describe to see the
order of the variables in your dataset.

not found in using data
You specified a varlist with merge, but the variables on which you wish to merge are not found in the using
dataset, so the merge is not possible.

ambiguous abbreviation
You typed an ambiguous abbreviation for a variable in your data. The abbreviation could refer to more than one
variable. Use a nonambiguous abbreviation, or if you intend all the variables implied by the ambiguous abbreviation,
append a ‘*’ to the end of the abbreviation.

statement out of context
This is the generic form of this message; more likely, you will see messages such as “may not streset after ...”.
You have attempted to do something that, in this context, is not allowed or does not make sense.

invalid %fmt
You specified an invalid %fmt; see [U] 12.5 Formats: Controlling how data are displayed.

Return codes 121–127 are errors that might occur when you specify a numlist. For details about numlist, see
[U] 11.1.8 numlist.

121. invalid numlist
122. invalid numlist has too few elements
123. invalid numlist has too many elements
124. invalid numlist has elements out of order
125. invalid numlist has elements outside of allowed range
126. invalid numlist has noninteger elements
127. invalid numlist has missing values

expression too long
too many SUMs
In the first case, you specified an expression that is too long for Stata to process—the expression contains more
than 249 pairs of nested parentheses or more than 800 dyadic operators. Break the expression into smaller parts.
In the second case, the expression contains more than 5 sum() functions. This expression, too, will have to be
broken into smaller parts.

not possible with test
You requested a test of a hypothesis that is nonlinear in the variables. test tests only linear hypotheses. Use
testnl.

too many ’(’ or ’[
too many ’)’ or ’)’
You specified an expression with unbalanced parentheses or brackets.

unknown function ()
You specified a function that is unknown to Stata; see Stata Functions Reference Manual. Or you may have
meant to subscript a variable and accidentally used parentheses rather than square brackets; see [U] 13.7 Explicit
subscripting.

too many values
1) You attempted to encode a string variable that takes on more than 65,536 unique values. 2) You attempted
to tabulate a variable or pair of variables that take on too many values. If you specified two variables, try
interchanging them. 3) You issued a graph command using the by option. The by-variable takes on too many
different values to construct a readable chart.
190 error — Display generic error message and exit

135. not possible with weighted data
You attempted to predict something other than the prediction or residual, but the underlying model was weighted. Stata cannot calculate the statistic you requested using weighted data.

140. repeated categorical variable in term
At least one of the terms in your anova model or test statement has a repeated categorical variable, such as reg#div#reg. Either you forgot to specify that the variable is continuous or the second occurrence of the variable is unnecessary.

141. repeated term
In the list of terms in your anova model or test statement is a duplicate of another term, although perhaps ordered differently. For instance, X#A#X and A#X#X. Remove the repeated term.

145. term contains more than 8 variables
One of the terms in your anova model test statement contains more than eight variables. Stata cannot fit such models.

147. term not in model
Your test command refers to a term that was not contained in your anova model.

148. too few categories
You attempted to run a command that required specifying the number of groups, and the number specified was too small. For instance, you attempted to run the brier command and specified group(#), where # is less than 2.

149. too many categories
You attempted to fit an mprobit or slogit model with a dependent variable that takes on more than 30 categories.

151. non r-class program may not set r()
Perhaps you specified return local in your program but forgot to declare the program rclass in the program define statement.

152. non e-class program may not set e()
Perhaps you specified estimates local in your program but forgot to declare the program eclass in the program define statement.

153. non s-class program may not set s()
Perhaps you specified sreturn local in your program but forgot to declare the program sclass in the program define statement.

161. ado-file has commands outside of program define ...end
All commands in ado-files must be part of Stata programs. That is, all commands must be between a program define that begins a program definition and an end that concludes a program definition. The command you typed automatically loaded an ado-file that violates this rule.

162. ado-file does not define command
xyz.ado is supposed to define xyz and, perhaps, subroutines for use by xyz, in which case file xyz.ado did not define anything named xyz.

170. unable to chdir
(Unix and Mac.) cd was unable to change to the directory you typed because it does not exist, it is protected, or it is not a directory.

175. factor level out of range
You specified an invalid value for the level of a factor variable.

180. invalid attempt to modify label
You are attempting to modify the contents of an existing value label by using the label define command. If you mean to completely replace the existing label, specify the replace option with the label define command. If you wish to modify the existing label, be sure to specify either the add option or the modify option on the label define command. add lets you add new entries but not change existing ones, and modify lets you do both. You will get this error if you specify add and then attempt to modify an existing entry. Then edit the command and substitute modify for the add option.

181. may not label strings
You attempted to assign a value label to a string variable, which makes no sense.

182. not labeled
The indicated variable has no value label, yet your request requires a labeled variable. You may, for instance, be attempting to decode a numeric variable.
184. options ______ and ______ may not be combined
For instance, you issued the regress command and tried to specify both the beta and the vce(cluster clustvar) options.

190. request may not be combined with by
Certain commands may not be combined with by, and you constructed such a combination. See the syntax diagram for the command.

191. request may not be combined with by() option
Certain commands may not be combined with the by() option, and you constructed such a combination. See the syntax diagram for the command.

196. could not restore sort order because variables were dropped
You ran an ado-file program that has an error, and the program dropped the temporary marker variables that allow the sort order to be restored.

197. invalid syntax
This error is produced by syntax and other parsing commands when there is a syntax error in the use of the command itself rather than in what is being parsed.

198. invalid syntax
option ______ incorrectly specified
option ______ not allowed
range invalid
______ invalid obs no
invalid filename
______ invalid varname
______ invalid name
multiple by’s not allowed
______ found where number expected
on or off required
All items in this list indicate invalid syntax. These errors are often, but not always, due to typographical errors. Stata attempts to provide you with as much information as it can. Review the syntax diagram for the designated command.

In giving the message “invalid syntax”, Stata is not helpful. Errors in specifying expressions often result in this message.

199. unrecognized command
Stata failed to recognize the command, program, or ado-file name, probably because of a typographical or abbreviation error.

301. last estimates not found
You typed an estimation command, such as regress, without arguments or attempted to perform a test or typed predict, but there were no previous estimation results.

302. last test not found
You have requested the redisplay of a previous test, yet you have not run a test previously.

303. equation not found
You referred to a coefficient or stored result corresponding to an equation or outcome that cannot be found. For instance, you estimated an mlogit model and the outcome variable took on the values 1, 3, and 4. You referred to [2]_b[var] when perhaps you meant [#2]_b[var] or [3]_b[var].

304. ml model not found
You have used mleval, mlsum, or mlmatsum without having first used the other ml commands to define the model.

305. ml model not found
Same as 304.

310. not possible because object(s) in use
This can occur with mata describe and mata drop and indicates that the objects referred to cannot be described or eliminated because an earlier iteration of Mata is currently using them.
321. requested action not valid after most recent estimation command
   This message can be produced by `predict` or `test` and indicates that the requested action cannot be performed.

322. something that should be true of your estimation results is not
   This error is used by prefix commands and postestimation commands to indicate that the estimation command
   returned an unexpected result and that the prefix or postestimation command does not know how to proceed.

399. may not drop constant
   You issued a `logistic` or `logit` command and the constant was dropped. Your model may be underidentified; try removing one or more of the independent variables.

401. may not use noninteger frequency weights
   You specified an `fweight` frequency weight with noninteger weights, telling Stata that your weights are to be treated as replication counts. Stata encountered a weight that was not an integer, so your request made no sense. You probably meant to specify `aweight` analytic weights; see [U] 11.1.6 weight.

402. negative weights encountered
   negative weights not allowed
   You specified a variable that contains negative values as the weighting variable, so your request made no sense. Perhaps you meant to specify another variable.

404. not possible with `pweight` data
   You requested a statistic that Stata cannot calculate with `pweight` data, either because of a shortcoming in Stata or because the statistics of the problem have not been worked out. For example, perhaps you requested the standard error of the Kaplan–Meier survival curve, and you had previously specified `pweight` when you `stset` your data (a case where no one has worked out the statistics).

406. not possible with analytic weights
   You specified a command that does not allow analytic weights. See the syntax diagram for the command to see which types of weights are allowed.

407. weights must be the same for all observations in a group
   weights not constant for same observation across repeated variables
   For some commands, weights must be the same for all observations in a group for statistical or computational reasons. For the `anova` command with the `repeated()` option, weights must be constant for an observation across the repeated variables.

409. no variance
   You were using `lnskew0` or `bcskew0`, for instance, but the `exp` that you specified has no variance.

411. nonpositive values encountered
   time variable has negative values
   For instance, you have used `graph` with the `xlog` or `ylog` options, requesting log scales, and yet some of the data or the labeling you specified is negative or zero. Or perhaps you were using `ltable` and specified a time variable that has negative values.

412. redundant or inconsistent constraints
   For instance, you are estimating a constrained model with `mlogit`. Among the constraints specified is at least one that is redundant or inconsistent. A redundant constraint might constrain a coefficient to be zero that some other constraint also constrains to be zero. An inconsistent constraint might constrain a coefficient to be 1 that some other constraint constrains to be zero. List the constraints, find the offender, and then reissue the `mlogit` command omitting it.

416. missing values encountered
   You specified a variable with missing values in a place where Stata does not allow missing values.

420. ________ groups found, 2 required
   You used a command (such as `ttest`), and the grouping variable you specified does not take on two unique values.

421. could not determine between-subject error term; use `bse()` option
   You specified the `repeated()` option to `anova`, but Stata could not automatically determine certain terms that are needed in the calculation; see [R] `anova`.

422. could not determine between-subject basic unit; use `bseunit()` option
   You specified the `repeated()` option to `anova`, but Stata could not automatically determine certain terms that are needed in the calculation; see [R] `anova`.
430. convergence not achieved  
You have estimated a maximum likelihood model, and Stata’s maximization procedure failed to converge to a solution; see [R] Maximize. Check if the model is identified.

450. _______ is not a 0/1 variable  
invalid number of successes  
invalid success probability  
_______ takes on ________ values, not 2  
You have used a command, such as bitest, that requires the variable take on only the values 0, 1, or missing, but the variable you specified does not meet that restriction. (You can also get this message from, for example, bitestii, when you specify a number of successes greater than the number of observations or a probability not between 0 and 1.)

451. invalid values for time variable  
For instance, you specified mytime as a time variable, and mytime contains noninteger values.

452. invalid values for factor variable  
You specified a variable that does not meet the factor-variable restrictions. Factor variables are assumed to take on only nonnegative integer values.

459. something that should be true of your data is not data have changed since estimation  
This is the generic form of this message; more likely, you will see messages such as “y must be between 0 and 1” or “x not positive”. You have attempted to do something that, given your data, does not make sense.

460. fpc must be >= 0  
There is a problem with your fpc variable; see [SVY] svyset.

461. fpc for all observations within a stratum must be the same  
There is a problem with your fpc variable; see [SVY] svyset.

462. fpc must be <= 1 if a rate, or >= no. sampled PSUs per stratum if PSU totals  
There is a problem with your fpc variable; see [SVY] svyset.

463. sum of weights equals zero  
sum of weights for subpopulation equals zero  
When weights sum to zero, the requested statistic cannot be computed.

464. poststratum weights must be constant within poststrata  
You have svyset your data and specified the poststrata() and postweight() options. The variable containing poststratum population sizes must be constant within each poststratum to be valid.

465. poststratum weights must be >= 0  
You have svyset your data and specified the postweight() option. Poststratum population sizes cannot be negative.

466. standardization weights must be constant within standard strata  
You are using the mean, proportion, or ratio command, and you specified the stdweight() option. The weight variable for standardization must be constant within each standard stratum.

467. standardization weights must be >= 0  
You are using the mean, proportion, or ratio command, and you specified the stdweight() option. The standardization weights cannot be negative.

471. esample() invalid  
This concerns ereturn post. The varname variable specified by the esample(varname) option must contain exclusively 0 and 1 values (never, for instance, 2 or missing). varname contains invalid values.

480. starting values invalid or some RHS variables have missing values  
You were using nl and specified starting values that were infeasible, or you have missing values for some of your independent variables.

481. equation/system not identified  
cannot calculate derivatives  
You were using reg3, for instance, and the system that you have specified is not identified.

482. nonpositive value(s) among ________, cannot log transform  
You specified an lnlsq option in nl that attempts to take the log of a nonpositive value.
491. **could not find feasible values**
You are using `ml` and it could not find starting values for which the likelihood function could be evaluated. You could try using `ml search` with the `repeat()` option to randomly try more values, or you could use `ml init` to specify valid starting values.

498. **various messages**
The statistical problem described in the message has occurred. The code 498 is not helpful, but the message is supposed to be. Return code 498 is reserved for messages that are unique to a particular situation.

499. **various messages**
The statistical problem described in the message has occurred. The code 499 is not helpful, but the message is supposed to be. Return code 499 is reserved for messages that are unique to a particular situation.

501. **matrix operation not found**
You have issued an unknown `matrix` subcommand or used `matrix define` with a function or operator that is unknown to Stata.

503. **conformability error**
You have issued a `matrix` command attempting to combine two matrices that are not conformable, for example, multiplying a $3 \times 2$ matrix by a $3 \times 3$ matrix. You will also get this message if you attempt an operation that requires a square matrix and the matrix is not square.

504. **matrix has missing values**
This return code is now infrequently used because, beginning with version 8, Stata now permits missing values in matrices.

505. **matrix not symmetric**
You have issued a `matrix` command that can be performed only on a symmetric matrix, and your matrix is not symmetric. While fixing their code, programmers are requested to admire our choice of the “symmetric” number 505—it is symmetric about the zero—for this error.

506. **matrix not positive definite**
You have issued a `matrix` command that can be performed only on a positive-definite matrix, and your matrix is not positive definite.

507. **name conflict**
You have issued a `matrix post` command, and the variance–covariance matrix of the estimators does not have the same row and column names, or if it does, those names are not the same as for the coefficient vector.

508. **matrix has zero values**
- `matrix has zero values on diagonal`
- `matrix has zero or negative values`
- `matrix has zero or negative values on diagonal`
A matrix is being used or produced that has zero or negative values where it should not. For instance, you used the `matrix sweep()` function, but the matrix had zero values on the diagonal.

509. **matrix operators that return matrices not allowed in this context**
Expressions returning nonmatrices, such as those in `generate` and `replace`, may use matrix functions returning scalars, such as `trace(A)`, but may not include subexpressions evaluating to matrices, such as `trace(A+B)`, which requires evaluating the matrix expression $A + B$. (Such subexpressions are allowed in the context of expressions returning matrices, such as those in `matrix`.)

601. **file ______ not found**
The filename you specified cannot be found. Perhaps you mistyped the name, or it may be on another CD or directory. If you are a Mac user, perhaps you had an unintentional blank at the beginning or ending of your filename when it was created. In Finder, click on the file to blacken the name. If you see anything other than a thin, even space on each side of the name, rename the file to eliminate the leading and trailing space characters.

602. **file ______ already exists**
You attempted to write over a file that already exists. Stata will never let you do this accidentally. If you really intend to overwrite the previous file, reissue the last command, specifying the `replace` option.

603. **file ______ could not be opened**
The file, although found, could not be opened. Check to see if it is currently open in another application or, if it is a file on your network, it is being used by another person. If it is not in use, check to see if the file is in a directory where you are allowed to create files.
604. log file already open
You attempted to open a log file when one is already open. Perhaps you forgot that you have the file open or forgot to close it.

606. no log file open
You have attempted to close, turn on, or turn off logging when no log file was open. Perhaps you forgot to open the log file.

607. no cmdlog file open
You have attempted to close, turn on, or turn off logging when no cmdlog file was open. Perhaps you forgot to open the cmdlog file.

608. file is read-only; cannot be modified or erased
The operating system has the file marked as read-only, meaning that changes cannot be made.

609. file xp format
The designated file is stored in an unsupported cross-product format.

610. file _______ not Stata format
The designated file is not a Stata-format file. This occurs most often with use, append, and merge. You probably typed the wrong filename.

611. record too long
You have attempted to process a record that exceeds 524,275 characters by using formatted infile (that is, infile with a dictionary). When reading formatted data, records may not exceed this maximum. If the records are not formatted, you can read these data by using the standard infile command (that is, without a dictionary). There is no maximum record length for unformatted data.

612. unexpected end of file
You used infile with a dictionary, and the file containing the dictionary ended before the ‘}’ character. Perhaps you forgot to type the closing brace, or perhaps you are missing a hard return at the end of your file. You may also get this message if you issued the command #delimit ; in a do-file and then subsequently forgot to use ‘;’ before the ‘end’ statement.

613. file does not contain dictionary
You used infile with a dictionary, yet the file you specified does not begin with the word ‘dictionary’. Perhaps you are attempting to infile data without using a dictionary and forgot to specify the varlist on the infile command. Or you forgot to include the word dictionary at the top of the dictionary file or typed DICTIONARY in uppercase.

614. dictionary invalid
You used infile with a dictionary, and the file appears to contain a dictionary. Nevertheless, you have made some error in specifying the dictionary, and Stata does not understand your intentions. The contents of the dictionary are listed on the screen, and the last line is the line that gave rise to the problem.

616. wrong number of values in checksum file
The checksum file being used to verify integrity of another file does not contain values in the expected checksum format.

621. already preserved
You specified preserve, but you have already preserved the data.

622. nothing to restore
You issued the restore command, but you have not previously specified preserve.

Return codes 630–696 are all messages that you might receive when executing any command with a file over the network.

631. host not found
632. web filename not supported in this context
633. may not write files over Internet
639. file transmission error (checkums do not match)
640. package file too long
641. package file invalid
196  error — Display generic error message and exit

651. may not seek past end of file
    may not seek in write-append file
    You may not seek past the end of a file; if your desire is to increase the file’s length, you must seek to the end and then write.

660. proxy host not found
    The host name specified as a proxy server cannot be mapped to an IP address. Type query to determine the host you have set.

662. proxy server refused request to send
    Stata was able to contact the proxy server, but the proxy server refused to send data back to Stata. The proxy host or port specified may be incorrect. Type query to determine your settings.

665. could not set socket nonblocking

667. wrong version winsock.dll

668. could not find a valid winsock.dll

669. invalid URL

670. invalid network port number

671. unknown network protocol

672. server refused to send file
    If your computer is on a network, then more than likely your computer is behind a firewall. To get Internet access from within Stata, you will have to contact your network administrator and get the network proxy address and port. Once you have the proxy information, open Stata, and in your Stata menu bar click on Prefs and then General Preferences. Under the Internet Prefs tab, check the box labeled Use HTTP Proxy and fill in the appropriate IP and port settings. If you have to enter a username and password to get Internet access, check the box labeled Use HTTP Proxy Authorization and fill in your username and password.

    If your proxy information is entered into Stata correctly and you are still having troubles updating Stata, make sure that your firewall is caching the Stata website correctly. Sometimes at large corporate sites, there are firewalls and caching proxy servers that can interfere with some of the download operations of Stata. The error 672 in Stata is “server refused to send file”, which can come if the proxy server is caching information locally and not directly forwarding the packets on to our web server. Ask your network administrators if they can trace whether your update requests from Stata are making it to our web server or if they are stopping at your firewall.

673. authorization required by server

674. unexpected response from server

675. server reported server error

676. server refused request to send

678. could not open local network socket

681. too many open files

682. could not connect to odbc dsn
    This typically occurs because of incorrect permissions, such as a bad User Name or Password. Use set debug on to display the actual error message generated by the ODBC driver.

683. could not fetch variable in odbc table
    This error usually occurs when a requested variable is not found in the current ODBC data table. Other scenarios can generate this error, however, so use set debug on to display the error message generated by the ODBC driver.

688. file is corrupt

691. I/O error
    A filesystem error occurred during input or output. This typically indicates a hardware or operating system failure, although it is possible that the disk was merely full and this state was misinterpreted as an I/O error.

692. file I/O error on read

693. file I/O error on write

694. could not rename file
    The file is in a directory that is marked by the operating system as read-only, and therefore files in that directory cannot be modified.
695. could not copy file
   You tried to perform an update swap but Stata could not make a backup copy of the Stata executable, so the
   update was not performed.

696. _____ is temporarily unavailable

699. insufficient disk space
   You ran out of disk space while writing a file to disk. The file is now closed and is probably erased. Review your
   operating system documentation to determine how to proceed.

702. op. sys. refused to start new process

703. op. sys. refused to open pipe

791. system administrator will not allow you to change this setting

900. no room to add more variables
   Stata just attempted to exceed the maximum number of variables allowed. If you are using Stata/SE or Stata/MP,
   you can reset this maximum number; see [D] memory. For Stata/BE, the maximum number is fixed at 2,048.

901. no room to add more observations
   Stata just attempted to exceed the maximum number of observations allowed. This maximum number is
   1,099,511,627,775 for Stata/MP and 2,147,483,619 for Stata/SE and Stata/BE.

902. no room to add more variables because of width
   Width refers to the number of bytes required to store a single observation; it is the sum of the widths of the
   individual variables. You just attempted to exceed the maximum width. Try typing compress; see [D] compress.

903. no room to promote variable (e.g., change int to float) because of width
   Width refers to the number of bytes required to store a single observation; it is the sum of the widths of the
   individual variables. You just attempted to exceed the maximum width. Try typing compress; see [D] compress.

907. maxvar too small
   You have attempted to use an interaction with too many levels or attempted to fit a model with too many variables.
   You need to increase maxvar. Use set maxvar; see [D] memory.

   If you are using factor variables and included an interaction that has numerous missing cells, either increase maxvar
   or set emptycells drop to reduce the required matrix size; see [R] set emptycells.

   If you are using factor variables, you might have accidentally treated a continuous variable as a categorical, resulting
   in lots of categories. Use the c. operator on such variables.

909. op. sys. refuses to provide memory
   The message above can vary.
   Stata was unable to allocate more memory, either because the operating system refused or because of Stata’s
   max_memory setting (see [D] memory). The message will provide the details.

910. value too small
   You attempted to change the size of memory but specified values for memory, maximum observations, maximum
   width, or maximum variables that are too small. Stata wants to allocate a minimum of 300 K.

912. value too large
   You attempted to change the size of memory but specified values for memory, maximum observations, maximum
   width, or maximum variables that are too large.

913. op. sys. refuses to provide sufficient memory
   The message above can vary.
   You attempted to set segmentsize, and the operating system was unable to provide sufficient memory. The
   message will provide the details.

914. op. sys. refused to allow Stata to open a temporary file
   To honor your request for memory, Stata needed to open a temporary disk file, and the operating system said that
   it could not do so. This most often occurs under Unix, and then the text of the error message provided more
   information on how to repair the problem.

915. unable to allocate matrix
   You have attempted to create a matrix with too many rows or columns or attempted to fit a model with too many
   variables.

   You are using Stata/BE which supports matrices with up to 800 rows or columns. See limits for how many more
   rows and columns Stata/SE and Stata/MP can support.
If you are using factor variables and included an interaction that has lots of missing cells, try set emptycells drop to reduce the required matrix size; see help set emptycells.

If you are using factor variables, you might have accidentally treated a continuous variable as a categorical, resulting in lots of categories. Use the c. operator on such variables.

916. unable to allocate matrix
You have attempted to create a matrix with too many rows or columns or attempted to fit a model with too many variables.

Assuming that you are not playing with set max_memory, your system administrator froze the max_memory setting at its current value. Contact your system administrator if you need to change this setting.

If you are using factor variables and included an interaction that has lots of missing cells, try set emptycells drop to reduce the required matrix size; see help set emptycells.

If you are using factor variables, you might have accidentally treated a continuous variable as a categorical, resulting in lots of categories. Use the c. operator on such variables.

920. too many macros
You specified a line containing recursive macro substitutions. An example of single-level recursion is referring to "$this" when $this contains "$that" and $that contains "result". The result of evaluating "$this" is to produce "result". Double-level recursion would be when $this contains "$that" and $that contains "$what" and $what contains "result". Error 920 arises when the recursion level is greater than 20.

Error 920 also arises if macro substitution would result in text longer than the maximum number of characters allowed in a macro. See [R] Limits.

950. insufficient memory
There is insufficient memory to fulfill the request. Type discard, press Return, and try the command again. If that fails, consider dropping value labels, variable labels, or macros.

1000. system limit exceeded - see manual
See [R] Limits.

1001. too many values
You have attempted to create a table that has too many rows or columns. For a one-way table, the maximum number of rows is 12,000 for Stata/MP and Stata/SE and 3,000 for Stata/BE. For a two-way table, the maximum number of rows and columns is 1,200 by 80 for Stata/MP and Stata/SE and 300 by 20 for Stata/BE. Thus tabulate y x may not result in too many values even if tabulate x y does.

1002. too many by variables
The number of by variables exceeded 32,766 for Stata/MP or Stata/SE, or 2,048 for Stata/BE. You cannot exceed these maximums.

1003. too many options
The number of options specified exceeded 256. You cannot exceed this maximum.

1004. command too long
You attempted to issue a Stata command in a do-file, ado-file, or program, and the command exceeded 264,408 characters for Stata/BE. For Stata/MP and Stata/SE, the limit is $3*\text{max}_k\text{theory} + 216$, which for the default setting of 5,000 is 165,216.

1400. numerical overflow
You have attempted something that, in the midst of the necessary calculations, has resulted in something too large for Stata to deal with accurately. Most commonly, this is an attempt to estimate a model (say, with regress) with too many effective observations. This effective number could be reached with far fewer observations if you were running a frequency-weighted model.

2000. no observations
You have requested some statistical calculation and there are no observations on which to perform it. Perhaps you specified if or in and inadvertently filtered all the data.

2001. insufficient observations
You have requested some statistical calculation, and although there are some observations, the number is not sufficient to carry out your request.


4000–4999. Class system errors; see [P] class for information on the class system.

7100–7199. Python run-time errors; see Error codes in [P] PyStata integration.
9xxx. Various messages, all indicating an unexpected system failure. You should never see such a message. If one occurs, save your data, and exit Stata immediately. Please email tech-support@stata.com to report the problem.

Other messages

no observations
insufficient observations
You have requested something when there are either no observations or insufficient observations in memory to carry forth your request.

(_______ not found)
You referred to the indicated value name in an expression, and no such value label existed. A missing value was substituted.

(eof before end of obs)
infile was reading your data and encountered the end-of-file marker before it had completed reading the current observation. Missing values are filled in for the remaining variables. This message indicates that the dataset may contain more or fewer variables than you expected.

(_______ missing values generated)
The command created the indicated number of missing values. Missing values occur when a mathematical operation is performed on a missing value or when a mathematical operation is infeasible.

(file ______ not found)
You specified the replace option on a command, yet no such file was found. The file was saved anyway.

(variable ____ was ____., now ____ to accommodate using data’s values)
Occurs during append or merge when there is a type mismatch between the data in memory and the data on disk. The first blank is filled in with a variable name, and the second and third blanks with a storage type (byte, int, long, float, double, or str#, or strL). For instance, you might receive the message “variable myvar was str5, now strL to accommodate using data’s values”. This means that myvar is of type str5 in the master dataset and of type strL in the using dataset.

(label ______ already defined)
Occurs during append or merge. The using dataset has a label definition for one of its variables. A label with the same name exists in the master dataset. Thus you are warned that the label already exists, and the previous definition (the one from the master dataset) is retained.

(note: hascons false)
You specified the hascons option on regress, yet an examination of the data revealed that there is no effective constant in your varlist. Stata added a constant to your regression.

____ real changes made
You used replace. This is the actual number of changes made to your data, not counting observations that already contained the replaced value.

____ was ____ now ____
Occurs during replace, append, or merge. The first blank is filled in with a variable name, and the second and third blanks are filled in with a numeric storage type (byte, int, long, float, or double). For instance, you might receive the message “myvar was byte now float”. Stata automatically promoted myvar to a float to prevent truncation.

Also see

[P] break — Suppress Break key
[P] capture — Capture return code
[P] exit — Exit from a program or do-file
[R] search — Search Stata documentation and other resources
[U] 16.1.4 Error handling in do-files
Programmers of estimation commands can customize how \texttt{estat} works after their commands. If you want to use only the standard \texttt{estat} subcommands, \texttt{ic}, \texttt{summarize}, and \texttt{vce}, you do not need to do anything; see \texttt{[R] estat}. Stata will automatically handle those cases.

\textbf{Remarks and examples}\n
Remarks are presented under the following headings:

\begin{itemize}
\item \textit{Standard subcommands}
\item \textit{Adding subcommands to estat}
\item \textit{Overriding standard behavior of a subcommand}
\end{itemize}

\textbf{Standard subcommands}\n
For \texttt{estat} to work, your estimation command must be implemented as an e-class program, and it must store its name in \texttt{e(cmd)}.

\texttt{estat vce} requires that the covariance matrix be stored in \texttt{e(V)}, and \texttt{estat summarize} requires that the estimation sample be marked by the function \texttt{e(sample)}. Both requirements can be met by using \texttt{ereturn post} with the \texttt{esample()} option in your program; see \texttt{[P] ereturn}.

Finally, \texttt{estat ic} requires that your program store the final log likelihood in \texttt{e(ll)} and the sample size in \texttt{e(N)}. If your program also stores the log likelihood of the null (constant only) model in \texttt{e(ll_0)}, it will appear in the output of \texttt{estat ic}, as well.

\textbf{Adding subcommands to estat}\n
To add new features (subcommands) to \texttt{estat} for use after a particular estimation command, you write a handler, which is nothing more than an ado-file command. The standard is to name the new command \texttt{cmd_estat}, where \texttt{cmd} is the name of the corresponding estimation command. For instance, the handler that provides the special \texttt{estat} features after \texttt{regress} is named \texttt{regress_estat}, and the handler that provides the special features after \texttt{pca} is named \texttt{pca_estat}.

Next you must let \texttt{estat} know about your new handler, which you do by filling in \texttt{e(estat_cmd)} in the corresponding estimation command. For example, in the code that implements \texttt{pca} is the line

\begin{verbatim}
ereturn local estat_cmd "pca_estat"
\end{verbatim}

Finally, you must write \texttt{cmd_estat}. The syntax of \texttt{estat} is

\begin{verbatim}
estat subcmd ...
\end{verbatim}

When the \texttt{estat} command is invoked, the first and only thing it does is call \texttt{e(estat_cmd)} if \texttt{e(estat_cmd)} exists. This way, your handler can even do something special in the standard cases, if that is necessary. We will get to that, but in the meantime, understand that the handler receives just what \texttt{estat} received, which is exactly what the user typed. The outline for a handler is
The ideas underlying the above outline are simple:

1. You check that e(cmd) matches cmd.
2. You isolate the subcmd that the user typed and then see if it is one of the special cases that you wish to handle.
3. If subcmd is a special case, you call the code you wrote to handle it.
4. If subcmd is not a special case, you let Stata's estat_default handle it.

When you check for the special cases, those special cases can be new subcmds that you wish to add, or they can be standard subcmds whose default behavior you wish to override.

Example 1

Suppose that we have written the estimation command myreg and want the estat subcommands fit and sens to work after it, in addition to the standard subcommands. Moreover, we want to be able to abbreviate sens as se or sen. The following code fragment illustrates the structure of our myreg_estat handler program:
Say that we issue the command

\texttt{estat sen, myoption("Circus peanuts")}

The only way that the above differs from the standard outline is the complication we added to handle the abbreviation of \textit{subcmd} \textit{sens}. Rather than asking if \textquoteleft\textquoteleft \textit{subcmd}\textquoteleft\textquoteleft==\textquoteleft\textquoteleft\textit{sens}\textquoteleft\textquoteleft\textquoteleft, we asked if \textquoteleft\textquoteleft\textit{subcmd}\textquoteleft\textquoteleft==\texttt{substr("sens",1,max(2,\textit{lsubcmd}))}, where \textit{lsubcmd} was previously filled in with \texttt{length("\textit{subcmd}\textquoteleft\textquoteleft").}

\subsection*{Overriding standard behavior of a subcommand}

Occasionally, you may want to override the behavior of a subcommand normally handled by \texttt{estat default}. This is accomplished by providing a local handler. Consider, for example, \texttt{summarize} after \texttt{pca}. The standard way of invoking \texttt{estat summarize} is not appropriate here—\texttt{estat summarize} extracts the list of variables to be summarized from \texttt{e(b)}. This does not work after \texttt{pca}. Here the varlist has to be extracted from the column names of the correlation or covariance matrix \texttt{e(C)}. This varlist is transferred to \texttt{estat summarize} (or more directly to \texttt{estat summ}) as the argument of the standard \texttt{estat summ} program.

\begin{verbatim}
program Summarize
    syntax [, *]
    tempname C
    matrix `C' = e(C)
estat_summ ':colnames `C'', `options'
end
\end{verbatim}
You add the local handler by inserting an additional switch in `cmd_estat` to ensure that the `summarize` subcommand is not handled by the default handler `estat_default`. As a detail, we have to make sure that the minimal abbreviation is `summarize`.

```
program pca_estat, rclass
    version 17.0
    gettoken subcmd rest : 0, parse("", ")
    local lsubcmd = length("'subcmd'")
    if "'subcmd'" == substr("summarize", 1, max(2, 'lsubcmd')) {
        Summarize 'rest'
    }
    else {
        estat_default '0'
    }
    return add
end
program Summarize
    syntax ...
    ...
end
```

Also see

[R] estat — Postestimation statistics
Description

_estimates hold, _estimates unhold, _estimates dir, _estimates clear, and _estimates drop provide a low-level mechanism for setting aside and later restoring up to 300 estimation results.

_estimates hold moves, or copies if the copy option is specified, all information associated with the last estimation command into holdname. If holdname is a temporary name, it will automatically be deleted when you exit from the current program.

_estimates unhold restores the information from the estimation command previously moved into holdname and eliminates holdname.

_estimates dir lists the holdnames under which estimation results are currently held.

_estimates clear eliminates all set aside results. Also, if the restore option is specified when the estimates are held, those estimates will be automatically restored when the program concludes. It is not necessary to perform an _estimates unhold in that case.

_estimates drop eliminates the estimation results stored under the specified holdnames.

_estimates is a programmer’s command designed to be used within programs. estimates is a user’s command to manage multiple estimation results. estimates uses _estimates to hold and unhold results, and it adds features such as model-selection indices and looping over results. Postestimation commands, such as suest and lrtest, assume that estimation results are stored using estimates rather than _estimates.

Syntax

Move estimation results into holdname

_estimates hold holdname [, copy restore nullok varname(newvar)]

Restore estimation results

_estimates unhold holdname [, not]

List names holding estimation results

_estimates dir

Eliminate estimation results

_estimates clear

Eliminate specified estimation results

_estimates drop { holdnames | _all }

where holdname is the name under which estimation results will be held.
Options

copy requests that all information associated with the last estimation command be copied into `holdname`. By default, it is moved, meaning that the estimation results temporarily disappear. The default action is faster and uses less memory.

restore requests that the information in `holdname` be automatically restored when the program ends, regardless of whether that occurred because the program exited normally, the user pressed Break, or there was an error.

`nullok` specifies that it is valid to store null results. After restoring a null result, no estimation results are active.

`varname(newvar)` specifies the variable name under which `esample()` will be held. If `varname()` is not specified, `holdname` is used. If the variable already exists in the data, an error message is shown. This variable is visible to users. If it is dropped, `_estimates unhold` will not be able to restore the estimation sample `e(sample)` and sets `e(sample)` to 1.

`not` specifies that the previous `_estimates hold`, `restore` request for automatic restoration be canceled. The previously held estimation results are discarded from memory without restoration, now or later.

Remarks and examples

`_estimates hold` and `_estimates unhold` are typically used in programs and ado-files, although they can be used interactively. After fitting, say, a regression by using `regress`, you can replay the regression by typing `regress` without arguments, and you can obtain predicted values with `predict`, and the like; see [U] 20 Estimation and postestimation commands. This is because Stata stored information associated with the regression in what we will call the “last estimation results”. The last estimation results include the coefficient vector and the variance–covariance matrix, as well as the other `e()` stored results.

When you type `_estimates hold myreg`, Stata moves the last estimation results to a holding area named `myreg`. After issuing this command, you can no longer replay the regression, calculate predicted values, etc. From Stata’s point of view, the estimates are gone. When you type `_estimates unhold myreg`, however, Stata moves the estimates back. You can once again type `regress` without arguments, calculate predicted values, and everything else just as if the last estimation results were never disturbed.

If you instead type `_estimates hold myreg, copy`, Stata copies, rather than moves, the results, meaning that you can still redisplay results. Obviously, you hold estimates because you want to fit some other model and then get these estimates back, so generally, holding by moving works as well as holding by copying. Sometimes, however, you may want to hold by copy so that you can modify the estimates in memory and still retrieve the original.
Example 1

You could run a regression, hold the results, run another regression, and then unhold the original results. One method you could use is

```stata
regress y x1 x2 x3               \textit{(fit first model)}  
_estimates hold model1           \textit{(and hold on to it)}   
regress y x1 x2 x3 x4            \textit{(fit the second model)}  
_estimates hold model2           \textit{(and hold on to it, too)} 
use newdata                      \textit{(use another dataset)}    
_estimates unhold model1         \textit{(get the first model)}    
predict yhat1                    \textit{(predict using first regression)}  
_estimates unhold model2         \textit{(get the second model)}    
predict yhat2                    \textit{(predict using second regression)}
```

You are not limited to doing this with regression; you can do this with any estimation command.

Technical note

Warning: Holding estimation results can tie up considerable amounts of memory, depending on the kind of model and the number of variables in it. This is why there is a limit of 300 held estimation results.

```stata
_estimates dir, _estimates drop, and _estimates clear are utilities associated with _estimates hold and _estimates unhold. _estimates dir lists the names of held estimation results. _estimates drop drops held estimation results. _estimates clear is equivalent to _estimates drop _all.
```

Technical note

Despite our interactive example, _estimates hold and _estimates unhold are typically used inside programs. For instance, linktest fits a model of the dependent variable, the prediction, and the prediction squared and shows the result. Yet when it is over, the user's original model remains as the last estimation result just as if no intervening model had been estimated. linktest does this by holding the original model, performing its task, and then restoring the original model.

In addition to moving Stata's last estimation result matrices, e(b) and e(V), _estimates hold and _estimates unhold also move the other e() results. When you hold the current estimates, e(b), e(V), e(cmd), e(depvar), and the other e() results disappear. When you unhold them, they are restored.

To avoid naming conflicts, we recommend that estimates be held under a name created by tempvar or tempname; see [P] macro. Thus the code fragment is

```stata
tempvar est            \textit{(code including new estimation)} 
_estimates hold ‘est’  \textit{(code including new estimation)} 
_estimates unhold ‘est’
```
Estimates held under a temporary name will automatically be discarded when the program ends. You can also specify `_estimates hold's restore option when you hold the estimates, and then the held estimates will be restored when the program ends, too.

Stored results

`_estimates hold` removes the estimation results—`e()` items.

`_estimates unhold` restores the previously held `e()` results.

`_estimates clear` permanently removes all held `e()` results.

`_estimates dir` returns the names of the held estimation results in the local `r(names)`, separated by single spaces.

`_estimates dir` also returns `r(varnames)`, which has the corresponding variable names for `esample()`.

Also see

[P] `makecns` — Constrained estimation

[P] `mark` — Mark observations for inclusion

[P] `matrix` — Introduction to matrix commands

[P] `matrix rownames` — Name rows and columns

[P] `return` — Return stored results

[R] `estimates` — Save and manipulate estimation results

[R] `ml` — Maximum likelihood estimation

[R] `Stored results` — Stored results

[U] 13.5 Accessing coefficients and standard errors

[U] 18 Programming Stata

[U] 20 Estimation and postestimation commands
Description

Information on programming estimation commands is given in *The Stata Blog*. Below, we reproduce the blog Programming an estimation command in Stata: A map to posted entries (updated 23 February 2018) (Drukker 2016a).

Remarks and examples

I have posted a series of entries about programming an estimation command in Stata. They are best read in order. The comprehensive list below allows you to read them from first to last at your own pace.

1. Programming estimators in Stata: Why you should
   To help you write Stata commands that people want to use, I illustrate how Stata syntax is predictable and give an overview of the estimation–postestimation structure that you will want to emulate in your programs.

2. Programming an estimation command in Stata: Where to store your stuff
   I discuss the difference between scripts and commands, and I introduce some essential programming concepts and constructions that I use to write the scripts and commands.

3. Programming an estimation command in Stata: Global macros versus local macros
   I discuss a pair of examples that illustrate the differences between global macros and local macros.

4. Programming an estimation command in Stata: A first ado-command
   I discuss the code for a simple estimation command to focus on the details of how to implement an estimation command. The command that I discuss estimates the mean by the sample average. I begin by reviewing the formulas and a do-file that implements them. I subsequently introduce ado-file programming and discuss two versions of the command. Along the way, I illustrate some of the postestimation features that work after the command.

5. Programming an estimation command in Stata: Using Stata matrix commands and functions to compute OLS objects
   I present the formulas for computing the ordinary least-squares (OLS) estimator, and I discuss some do-file implementations of them. I discuss the formulas and the computation of independence-based standard errors, robust standard errors, and cluster–robust standard errors. I introduce the Stata matrix commands and matrix functions that I use in ado-commands that I discuss in upcoming posts.

6. Programming an estimation command in Stata: A first command for OLS
   I show how to write a Stata estimation command that implements the OLS estimator by explaining the code.
7. Programming an estimation command in Stata: A better OLS command

I use the `syntax` command to improve the command that implements the OLS estimator that I discussed in Programming an estimation command in Stata: A first command for OLS. I show how to require that all variables be numeric variables and how to make the command accept time-series–operated variables.

8. Programming an estimation command in Stata: Allowing for sample restrictions and factor variables

I modify the OLS command discussed in Programming an estimation command in Stata: A better OLS command to allow for sample restrictions, to handle missing values, to allow for factor variables, and to deal with perfectly collinear variables.

9. Programming an estimation command in Stata: Allowing for options

I make three improvements to the command that implements the OLS estimator that I discussed in Programming an estimation command in Stata: Allowing for sample restrictions and factor variables. First, I allow the user to request a robust estimator of the variance–covariance of the estimator. Second, I allow the user to suppress the constant term. Third, I store the residual degrees of freedom in `e(df_r)` so that test will use the $t$ or $F$ distribution instead of the normal or $\chi^2$ distribution to compute the $p$-value of Wald tests.

10. Programming an estimation command in Stata: Using a subroutine to parse a complex option

I make two improvements to the command that implements the OLS estimator that I discussed in Programming an estimation command in Stata: Allowing for options. First, I add an option for a cluster–robust estimator of the variance–covariance of the estimator (VCE). Second, I make the command accept the modern syntax for either a robust or a cluster–robust estimator of the VCE. In the process, I use subroutines in my ado-program to facilitate the parsing, and I discuss some advanced parsing tricks.

11. Programming an estimation command in Stata: Mata 101

I introduce Mata, the matrix programming language that is part of Stata.

12. Programming an estimation command in Stata: Mata functions

I show how to write a function in Mata, the matrix programming language that is part of Stata.

13. Programming an estimation command in Stata: A first ado-command using Mata

I discuss a sequence of ado-commands that use Mata to estimate the mean of a variable. The commands illustrate a general structure for Stata–Mata programs.

14. Programming an estimation command in Stata: Computing OLS objects in Mata

I present the formulas for computing the OLS estimator and show how to compute them in Mata. This post is a Mata version of Programming an estimation command in Stata: Using Stata matrix commands and functions to compute OLS objects. I discuss the formulas and the computation of independence-based standard errors, robust standard errors, and cluster–robust standard errors.

15. Programming an estimation command in Stata: An OLS command using Mata

I discuss a command that computes OLS results in Mata, paying special attention to the structure of Stata programs that use Mata work functions.
16. Programming an estimation command in Stata: Adding robust and cluster–robust VCEs to our Mata-based OLS command

I show how to use the undocumented command _vce_parse to parse the options for robust or cluster–robust estimators of the VCE. I then discuss myregress12.ado, which performs its computations in Mata and computes an independent and identically distributed based, a robust, or a cluster–robust estimator of the VCE.

17. Programming an estimation command in Stata: A review of nonlinear optimization using Mata

I review the theory behind nonlinear optimization and get some practice in Mata programming by implementing an optimizer in Mata. This post is designed to help you develop your Mata programming skills and to improve your understanding of how the Mata optimization suites optimize() and moptimize() work.

18. Programming an estimation command in Stata: Using optimize() to estimate Poisson parameters

I show how to use optimize() in Mata to maximize a Poisson log-likelihood function and to obtain estimators of the VCE based on independent and identically dependent observations or on robust methods.

19. Programming an estimation command in Stata: A poisson command using Mata

I discuss mypoisson1, which computes Poisson-regression results in Mata. The code in mypoisson1.ado is remarkably similar to the code in myregress11.ado, which computes OLS results in Mata, as I discussed in Programming an estimation command in Stata: An OLS command using Mata.

20. Programming an estimation command in Stata: Handling factor variables in optimize()

I discuss a method for handling factor variables when performing nonlinear optimization using optimize(). After illustrating the issue caused by factor variables, I present a method and apply it to an example using optimize().

21. Programming an estimation command in Stata: Handling factor variables in a poisson command using Mata

mypoison2.ado handles factor variables and computes its Poisson-regression results in Mata. I discuss the code for mypoison2.ado, which I obtained by adding the method for handling factor variables discussed in Programming an estimation command in Stata: Handling factor variables in optimize() to mypoisson1.ado, discussed in Programming an estimation command in Stata: A poisson command using Mata.

22. Programming an estimation command in Stata: Allowing for robust or cluster–robust standard errors in a poisson command using Mata

mypoison3.ado adds options for a robust or a cluster–robust estimator of the VCE to mypoison2.ado, which I discussed in Programming an estimation command in Stata: Handling factor variables in a poisson command using Mata. mypoison3.ado parses the vce() option using the techniques I discussed in Programming an estimation command in Stata: Adding robust and cluster–robust VCEs to our Mata-based OLS command. I show how to use optimize() to compute the robust or cluster–robust VCE.

23. Programming an estimation command in Stata: Adding analytical derivatives to a poisson command using Mata

Using analytically computed derivatives can greatly reduce the time required to solve a nonlinear estimation problem. I show how to use analytically computed derivatives with optimize(), and I discuss mypoisson4.ado, which uses these analytically computed derivatives. Only a few lines of mypoisson4.ado differ from the code for mypoisson3.ado, which I discussed in
Programming an estimation command in Stata: Allowing for robust or cluster–robust standard errors in a poisson command using Mata.

24. Programming an estimation command in Stata: Making predict work

I make predict work after mypoisson5 by writing an ado-command that computes the predictions and by having mypoisson5 store the name of this new ado-command in e(predict).

25. Programming an estimation command in Stata: Certifying your command

Before you use or distribute your estimation command, you should verify that it produces correct results and write a do-file that certifies that it does so. I discuss the processes of verifying and certifying an estimation command, and I present some techniques for writing a do-file that certifies mypoisson5, which I discussed in previous posts.

26. Programming an estimation command in Stata: Nonlinear least-squares estimators

I want to write ado-commands to estimate the parameters of an exponential conditional mean model and probit conditional mean model by nonlinear least squares. Before I can write these commands, I need to show how to trick optimize() into performing the Gauss–Newton algorithm and apply this trick to these two problems.

27. Programming an estimation command in Stata: Consolidating your code

I write ado-commands that estimate the parameters of an exponential conditional mean model and a probit conditional mean model by nonlinear least squares, using the methods that I discussed in Programming an estimation command in Stata: Nonlinear least-squares estimators. These commands will either share lots of code or repeat lots of code, because they are so similar. It is almost always better to share code than to repeat code. Shared code only needs to be changed in one place to add a feature or to fix a problem; repeated code must be changed everywhere. I introduce Mata libraries to share Mata functions across ado-commands, and I introduce wrapper commands to share ado-code.

28. Programming an estimation command in Stata: Writing an estat postestimation command

estat commands display statistics after estimation. Many of these statistics are diagnostics or tests used to evaluate model specification. Some statistics are available after all estimation commands; others are command specific. I illustrate how estat commands work and then show how to write a command-specific estat command for the mypoisson command that I have been developing.

29. Programming an estimation command in Stata: Preparing to write a plugin

Writing a function in another language (like C, C++, or Java) that Stata calls is known as writing a plugin for Stata or as writing a dynamic-link library (DLL) for Stata. I discuss the tradeoffs of writing a plugin or DLL, and I discuss a simple program whose calculations I will replace with plugins in posts 30–32.

30. Programming an estimation command in Stata: Writing a C plugin

I write a plugin in C that implements the calculations performed by mymean_work() in mymean11.ado, discussed in Programming an estimation command in Stata: Preparing to write a plugin. I discuss the plugin code and how to compile it on a Mac, Windows, and Linux.

31. Programming an estimation command in Stata: Writing a C++ plugin

I write a plugin in C++ that implements the calculations performed by mymean_work() in mymean11.ado, discussed in Programming an estimation command in Stata: Preparing to write a plugin. I discuss the plugin code and how to compile it on a Mac, Windows, and Linux.
32. Programming an estimation command in Stata: Writing a Java plugin

I write a plugin in Java that implements the calculations performed by mymean_work() in mymean11.ado, discussed in Programming an estimation command in Stata: Preparing to write a plugin. I discuss the plugin code and how to compile it using command-line tools that are compatible across platforms.

References


Also see

[U] 18 Programming Stata

[U] 20 Estimation and postestimation commands
exit — Exit from a program or do-file

Description

exit, when typed from the keyboard, causes Stata to terminate processing and returns control to the operating system. If the dataset in memory has changed since the last save command, you must specify the clear option before Stata will let you leave. Use of the command in this way is discussed in [R] exit.

More generally, exit causes Stata to terminate the current process and returns control to the calling process. The return code is set to the value of the expression or to zero if no expression is specified. Thus exit can be used to exit a program or do-file and return control to Stata. With an option, exit can even be used to exit Stata from a program or do-file. Such use of exit is the subject of this entry.

Syntax

exit [ [[=] exp] [, clear STATA]]

Options

clear permits you to exit, even if the current dataset has not been saved.

STATA exits Stata and returns control to the operating system, even when given from a do-file or program. The STATA option is implied when exit is issued from the keyboard.

Remarks and examples

exit can be used at the terminal, from do-files, or from programs. From the terminal, it allows you to leave Stata. Given from a do-file or program without the STATA option, it causes the do-file or program to terminate and return control to the calling process, which might be the keyboard or another do-file or program.

Caution should be used if exit is included to break execution within a loop. A more suitable command is continue or continue, break; see [P] continue. continue is used to explicitly break execution of the current loop iteration with execution resuming at the top of the loop unless the break option is specified, in which case execution resumes with the command following the looping command.

When using exit to force termination of a program or do-file, you may specify an expression following the exit, and the resulting value of that expression will be used to set the return code. Not specifying an expression is equivalent to specifying exit 0.
Example 1

Here is a useless program that will tell you whether a variable exists:

```stata
. program check
  1. capture confirm variable '1'
  2. if _rc!=0 {
      3. display '"1' not found"
      4. exit
      5. }
  6. display "The variable '1' exists."
  7. end

. check median_age
The variable median_age exists.
. check age
age not found
```

`exit` did not close Stata and cause a return to the operating system; it instead terminated the program.

Example 2

You type `exit` from the keyboard to leave Stata and return to the operating system. If the dataset in memory has changed since the last time it was saved, however, Stata will refuse. At that point, you can either `save` the data and then `exit` or type `exit, clear`:

```stata
. exit
  no; dataset in memory has changed since last saved
  r(4);
. exit, clear
  (Operating system prompts you for next command)
```

Technical note

You can also exit Stata and return to the operating system from a do-file or program by including the line `exit, STATA` in your do-file or program. To return to the operating system regardless of whether the dataset in memory has changed, you include the line `exit, STATA clear`.

Also see

- `capture` — Capture return code
- `class exit` — Exit class-member program and return result
- `continue` — Break out of loops
- `error` — Display generic error message and exit
- `Error messages` — Error messages and return codes
- `exit` — Exit Stata
file is a programmer’s command and should not be confused with import delimited (see \[D\] import delimited), infile (see \[D\] infile (free format) or \[D\] infile (fixed format)), and infix (see \[D\] infix (fixed format)), which are the usual ways that data are brought into Stata. file allows programmers to read and write both text and binary files, so file could be used to write a program to input data in some complicated situation, but that would be an arduous undertaking.

Files are referred to by a file handle. When you open a file, you specify the file handle that you want to use; for example, in

\[
\text{. file open myfile using example.txt, write}
\]

myfile is the file handle for the file named example.txt. From that point on, you refer to the file by its handle. Thus

\[
\text{. file write myfile "this is a test" _n}
\]

would write the line “this is a test” (without the quotes) followed by a new line into the file, and

\[
\text{. file close myfile}
\]

would then close the file. You may have multiple files open at the same time, and you may access them in any order.
Syntax

Open file

```pl
file open handle using filename, {read|write|read write}
```

```pl
[[text|binary] [replace|append] all]
```

Read file

```pl
file read handle [specs]
```

Write to file

```pl
file write handle [specs]
```

Change current location in file

```pl
file seek handle {query|tof|eof|#}
```

Set byte order of binary file

```pl
file set handle byteorder {hilo|lohi|1|2}
```

Close file

```pl
file close {handle | _all}
```

List file type, status, and name of handle

```pl
file _query
```

where `specs` for text output is

```
"string" or ‘"string"
(exp) (parentheses are required)
%fmt(exp) (see [D] format about %fmt)
_skip(#) `_column(#)
_newline[(#)]
_char(#) (0 ≤ # ≤ 255)
_tab[(#)]
_page[(#)]
_dup(#)
```
specs for text input is \textit{localmacroname},

specs for binary output is

\begin{verbatim}
\%{8|4}z (exp)
\%{4|2|1}b[s|u] (exp)
\%#s "text" (1 \leq \# \leq \text{max\_macrolen})
\%#s "text",
\%#s (exp)
\end{verbatim}

and specs for binary input is

\begin{verbatim}
\%{8|4}z scalarname
\%{4|2|1}b[s|u] scalarname
\%#s localmacroname (1 \leq \# \leq \text{max\_macrolen})
\end{verbatim}

collect is allowed with \texttt{file query}, \texttt{file read}, and \texttt{file seek}; see \cite{U} 11.1.10 Prefix commands.

**Options**

\texttt{read}, \texttt{write}, or \texttt{read write} is required; they specify how the file is to be opened. If the file is opened \texttt{read}, you can later use \texttt{file read} but not \texttt{file write}; if the file is opened \texttt{write}, you can later use \texttt{file write} but not \texttt{file read}. If the file is opened \texttt{read write}, you can then use both.

\texttt{read write} is more flexible, but most programmers open files purely \texttt{read} or purely \texttt{write} because that is all that is necessary; it is safer and it is faster.

When a file is opened \texttt{read}, the file must already exist, or an error message will be issued. The file is positioned at the top (tof), so the first \texttt{file read} reads at the beginning of the file. Both local files and files over the net may be opened for \texttt{read}.

When a file is opened \texttt{write} and the \texttt{replace} or \texttt{append} option is not specified, the file must not exist, or an error message will be issued. The file is positioned at the top (tof), so the first \texttt{file write} writes at the beginning of the file. Net files may not be opened for \texttt{write}.

When a file is opened \texttt{write} and the \texttt{replace} option is also specified, it does not matter whether the file already exists; the existing file, if any, is erased beforehand.

When a file is opened \texttt{write} and the \texttt{append} option is also specified, it also does not matter whether the file already exists; the file will be reopened or created if necessary. The file will be positioned at the append point, meaning that if the file existed, the first \texttt{file write} will write at the first byte past the end of the previous file; if there was no previous file, \texttt{file write} begins writing at the first byte in the file. \texttt{file seek} may not be used with \texttt{write append} files.

When a file is opened \texttt{read write}, it also does not matter whether the file exists. If the file exists, it is reopened. If the file does not exist, a new file is created. Regardless, the file will be positioned at the top of the file. You can use \texttt{file seek} to seek to the end of the file or wherever else you desire. Net files may not be opened for \texttt{read write}.

Before opening a file, you can determine whether it exists by using \texttt{confirm file}; see \cite{P} \texttt{confirm}. 

text and binary determine how the file is to be treated once it is opened. text is the default. With text, files are assumed to be composed of lines of characters, with each line ending in a line-end character. The character varies across operating systems, being line feed under Unix, carriage return under Mac, and carriage return/line feed under Windows. file understands all the ways that lines might end when reading and assumes that lines are to end in the usual way for the computer being used when writing.

The alternative to text is binary, meaning that the file is to be viewed merely as a stream of bytes. With binary, there is an issue of byte order; consider the number 1 written as a 2-byte integer. On some computers (called hilo), it is written as “00 01”, and on other computers (called lohi), it is written as “01 00” (with the least significant byte written first). There are similar issues for 4-byte integers, 4-byte floats, and 8-byte floats.

file assumes that the bytes are ordered in the way natural to the computer being used. file set can be used to vary this assumption. file set can be issued immediately after file open, or later, or repeatedly.

replace and append are allowed only when the file is opened for write (which does not include read write). They determine what is to be done if the file already exists. The default is to issue an error message and not open the file. See the description of the options read, write, and read write above for more details.

all is allowed when the file is opened for write or for read write. It specifies that, if the file needs to be created, the permissions on the file are to be set so that it is readable by everybody.

Text output specifications

"string" and ‘"string"’ write string into the file, without the surrounding quotes.

(exp) evaluates the expression exp and writes the result into the file. If the result is numeric, it is written with a %10.0g format, but with leading and trailing spaces removed. If exp evaluates to a string, the resulting string is written, with no extra leading or trailing blanks.

%fmt (exp) evaluates expression exp and writes the result with the specified %fmt. If exp evaluates to a string, %fmt must be a string format, and, correspondingly, if exp evaluates to a real, a numeric format must be specified. Do not confuse Stata’s standard display formats with the binary formats %b and %z described elsewhere in this entry. file write here allows Stata’s display formats described in [D] format and allows the centering extensions (for example, %-20s) described in [P] display.

_skip(#) inserts # blanks into the file. If # ≤ 0, nothing is written; # ≤ 0 is not considered an error.

_column(#) writes enough blanks to skip forward to column # of the line; if # refers to a prior column, nothing is displayed. The first column of a line is numbered 1. Referring to a column less than 1 is not considered an error; nothing is displayed then.

_newline(#), which may be abbreviated _n(#), outputs one end-of-line character if # is not specified or outputs the specified number of end-of-line characters. The end-of-line character varies according to your operating system, being line feed under Unix, carriage return under Mac, and the two characters carriage return/line feed under Windows. If # ≤ 0, no end-of-line character is output.

_char(#) outputs one ASCII character, being the one given by the ASCII code # specified. # must be between 0 and 255, inclusive.

_tab(#) outputs one tab character if # is not specified or outputs the specified number of tab characters. Coding _tab is equivalent to coding _char(9).
_page[(#)] outputs one page feed character if # is not specified or outputs the specified number of page feed characters. Coding _page is equivalent to coding _char(12). The page feed character is often called Control-L.

_dup(#) specified that the next directive is to be executed (duplicated) # times. # must be greater than or equal to 0. If # is equal to zero, the next element is not displayed.

Remarks and examples

Remarks are presented under the following headings:

Use of file
Use of file with tempfiles
Writing text files
Reading text files
Use of seek when writing or reading text files
Writing and reading binary files
Writing binary files
Reading binary files
Use of seek when writing or reading binary files
Appendix A.1 Useful commands and functions for use with file
Appendix A.2 Actions of binary output formats with out-of-range values

Use of file

_file provides low-level access to file I/O. You open the file, use _file read or _file write repeatedly to read or write the file, and then close the file with _file close:

```
_file open ...
...
_file read or _file write ...
...
_file read or _file write ...
...
_file close ...
```

Do not forget to close the file. Open files tie up system resources. Also, for files opened for writing, the contents of the file probably will not be fully written until you close the file.

Typing _file close _all will close all open files, and the _clear all command (see [D] clear) closes all files as well. These commands, however, should not be included in programs that you write; they are included to allow the user to reset Stata when programmers have been sloppy.

If you use file handles obtained from _tempname (see [P] macro), the file will be automatically closed when the ado-file terminates:

```
tempname myfile
_file open ‘myfile’ using ...
```

This is the only case when not closing the file is appropriate. Use of temporary names for file handles offers considerable advantages because programs can be stopped because of errors or because the user presses Break.
Use of file with tempfiles

In the rare event that you file open a tempfile, you must obtain the handle from tempname; see [P] macro. Temporary files are automatically deleted when the ado- or do-file ends. If the file is erased before it is closed, significant problems are possible. Using a tempname will guarantee that the file is properly closed beforehand:

```
tempname myfile
tempfile tfile
file open `myfile' using "'tfile'" ...
```

Writing text files

This is easy to do:

```
file open handle using filename, write text
file write handle ...

file close handle
```

The syntax of file write is similar to that of display; see [P] display. The significant difference is that expressions must be bound in parentheses. In display, you can code

```
display 2+2
```

but using file write, you must code

```
file write handle (2+2)
```

The other important difference between file write and display is that display assumes you want the end-of-line character output at the end of each display (and display provides _continue for use when you do not want this), but file write assumes you want an end-of-line character only when you specify it. Thus rather than coding “file write handle (2+2)”, you probably want to code

```
file write handle (2+2) _n
```

Because Stata outputs end-of-line characters only where you specify, coding

```
file write handle "first part is " (2+2) _n
```

has the same effect as coding

```
file write handle "first part is "
file write handle (2+2) _n
```
or even

```
file write handle "first part is "
file write handle (2+2)
file write handle _n
```

There is no limit to the line length that `file write` can write because, as far as `file write` is concerned, `_n` is just another character. The `_col(#)` directive, however, will lose count if you write lines of more than 2,147,483,646 characters (`_col(#)` skips forward to the specified column). In general, we recommend that you do not write lines longer than 165,199 characters because reading lines longer than that is more difficult using `file read`.

We say that `_n` is just another character, but we should say character or characters. `_n` outputs the appropriate end-of-line character for your operating system, meaning the two-character carriage return followed by line feed under Windows, the one-character carriage return under Mac, and the one-character line feed under Unix.

### Reading text files

The commands for reading text files are similar to those for writing them:

```
file open handle using filename, read text
file read handle localmacroname ...
file close handle
```

The `file read` command has one syntax:

```
file read handle localmacroname
```

One line is read from the file, and it is put in `localmacroname`. For instance, to read a line from the file `myfile` and put it in the local macro `line`, you code

```
file read myfile line
```

Thereafter in your code, you can refer to `line` to obtain the contents of the line just read. The following program will do a reasonable job of displaying the contents of the file, putting line numbers in front of the lines:

```plaintext
program ltype
    version 17.0
    local 0 "using '0',"
syntax using/
tempname fh
local linenum = 0
file open 'fh' using "'using'", read
file read 'fh' line
while r(eof)==0 {
    local linenum = 'linenum' + 1
    display %4.0f 'linenum' _asis '" 'macval(line)"'
    file read 'fh' line
}
file close 'fh'
end
```
In the program above, we used `tempname` to obtain a temporary name for the file handle. Doing that, we ensure that the file will be closed, even if the user presses `Break` while our program is displaying lines, and so never executes `file close 'fh'`. In fact, our `file close 'fh'` line is unnecessary.

We also used `r(eof)` to determine when the file ends. `file read` sets `r(eof)` to contain 0 before end of file and 1 once end of file is encountered; see `Stored results` below.

We included `_asis` in the `display` in case the file contained braces or SMCL commands. These would be interpreted, and we wanted to suppress that interpretation so that `ltype` would display lines exactly as written in the file; see `[P] smcl`. We also used the `macval()` macro function to obtain what was in `‘line’` without recursively expanding the contents of line.

### Use of `seek` when writing or reading text files

You may use `file seek` when reading or writing text files, although, in fact, it is seldom used, except with `read write` files, and even then, it is seldom used with text files.

See `Use of seek when writing or reading binary files` below for a description of `file seek`—`seek` works the same way with both text and binary files—and then bear the following in mind:

- The `#` in “`file seek handle #`” refers to byte position, not line number. “`file seek handle 5`” means to seek to the fifth byte of the file, not the fifth line.

- When calculating byte offsets by hand, remember that the end-of-line character is 1 byte under Mac and Unix but is 2 bytes under Windows.

- Rewriting a line of an text file works as expected only if the new and old lines are of the same length.

### Writing and reading binary files

Consider whether you wish to read this section. There are many potential pitfalls associated with binary files, and, at least in theory, a poorly written binary-I/O program can cause Stata to crash.

Binary files are made up of binary elements, of which Stata can understand the following:

<table>
<thead>
<tr>
<th>Element</th>
<th>Corresponding format</th>
</tr>
</thead>
<tbody>
<tr>
<td>single- and multiple-character strings</td>
<td><code>%1s</code> and <code>%#s</code></td>
</tr>
<tr>
<td>signed and unsigned 1-byte binary integers</td>
<td><code>%1b</code>, <code>%1bs</code>, and <code>%1bu</code></td>
</tr>
<tr>
<td>signed and unsigned 2-byte binary integers</td>
<td><code>%2b</code>, <code>%2bs</code>, and <code>%2bu</code></td>
</tr>
<tr>
<td>signed and unsigned 4-byte binary integers</td>
<td><code>%4b</code>, <code>%4bs</code>, and <code>%4bu</code></td>
</tr>
<tr>
<td>4-byte IEEE floating-point numbers</td>
<td><code>%4z</code></td>
</tr>
<tr>
<td>8-byte IEEE floating-point numbers</td>
<td><code>%8z</code></td>
</tr>
</tbody>
</table>

The differences between all of these types are only of interpretation. For instance, the decimal number 72, stored as a 1-byte binary integer, also represents the character H. If a file contained the 1-byte integer 72 and you were to read the byte by using the format `%1s`, you would get back the character “H”, and if a file contained the character “H” and you were to read the byte by using the format `%1bu`, you would get back the number 72; 72 and H are indistinguishable in that they represent the same bit pattern. Whether that bit pattern represents 72 or H depends on the format you use, meaning the interpretation you give to the field.
Similar equivalence relations hold between the other elements. A binary file is nothing more than a sequence of unsigned 1-byte integers, where those integers are sometimes given different interpretations or are grouped and given an interpretation. In fact, all you need is the format \%1bu to read or write anything. The other formats, however, make programming more convenient.

<table>
<thead>
<tr>
<th>Format</th>
<th>Length</th>
<th>Type</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Missing values?</th>
</tr>
</thead>
<tbody>
<tr>
<td>%1bu</td>
<td>1</td>
<td>unsigned byte</td>
<td>0</td>
<td>255</td>
<td>no</td>
</tr>
<tr>
<td>%1bs</td>
<td>1</td>
<td>signed byte</td>
<td>−127</td>
<td>127</td>
<td>no</td>
</tr>
<tr>
<td>%1b</td>
<td>1</td>
<td>Stata byte</td>
<td>−127</td>
<td>100</td>
<td>yes</td>
</tr>
<tr>
<td>%2bu</td>
<td>2</td>
<td>unsigned short int</td>
<td>0</td>
<td>65,535</td>
<td>no</td>
</tr>
<tr>
<td>%2bs</td>
<td>2</td>
<td>signed short int</td>
<td>−32,767</td>
<td>32,767</td>
<td>no</td>
</tr>
<tr>
<td>%2b</td>
<td>2</td>
<td>Stata int</td>
<td>−32,767</td>
<td>32,740</td>
<td>yes</td>
</tr>
<tr>
<td>%4bu</td>
<td>4</td>
<td>unsigned int</td>
<td>0</td>
<td>4,294,967,295</td>
<td>no</td>
</tr>
<tr>
<td>%4bs</td>
<td>4</td>
<td>signed int</td>
<td>−2,147,483,647</td>
<td>2,147,483,647</td>
<td>no</td>
</tr>
<tr>
<td>%4b</td>
<td>4</td>
<td>Stata long</td>
<td>−2,147,483,647</td>
<td>2,147,483,620</td>
<td>yes</td>
</tr>
<tr>
<td>%4z</td>
<td>4</td>
<td>float</td>
<td>−10^{38}</td>
<td>10^{38}</td>
<td>yes</td>
</tr>
<tr>
<td>%8z</td>
<td>8</td>
<td>double</td>
<td>−10^{307}</td>
<td>10^{307}</td>
<td>yes</td>
</tr>
</tbody>
</table>

When you write a binary file, you must decide on the format that you will use for every element that you will write. When you read a binary file, you must know ahead of time the format that was used for each element.

**Writing binary files**

As with text files, you open the file, write repeatedly, and then close the file:

```plaintext
    file open handle using filename, write binary
    file write handle ... 
    file close handle 
```

The `file write` command may include the following elements:

```plaintext
    \%{8|4}z (exp) 
    \%{4|2|1}b[s|u] (exp) 
    \%#s "text" (1 \leq # \leq \text{max\_macro\_len}) 
    \%#s "text", 
    \%#s (exp) 
```

For instance, to write “test file” followed by 2, 2 + 2, and 3 × 2 represented in its various forms, you could code

```plaintext
    . file write handle \%9s "test file" \%8z (2) \%4b (2+2) \%1bu (3*2)
```

or

```plaintext
    . file write handle \%9s "test file"
    . file write handle \%8z (2) \%4b (2+2) \%1bu (3*2)
```
or even

```
.file write handle %9s "test file"
.file write handle %8z (2)
.file write handle %4b (2+2) %1bu (3*2)
```

e etc.

You write strings with the %#s format and numbers with the %b or %z formats. Concerning strings, the # in %#s should be greater than or equal to the length of the string to be written in bytes. If # is too small, only that many characters of the string will be written. Thus

```
.file write handle %4s "test file"
```

would write “test” into the file and leave the file positioned at the fifth byte. There is nothing wrong with coding that (the “test” can be read back easily enough), but this is probably not what you intended to write.

Also concerning strings, you can output string literals—just enclose the string in quotes—or you can output the results of string expressions. Expressions, as for using `file write` to output text files, must be enclosed in parentheses:

```
.file write handle %4s (substr(a,2,6))
```

The following program will output a user-specified matrix to a user-specified file; the syntax of the command being implemented is

```
mymatout1 matname using filename [, replace]
```

and the code is

```
program mymatout1
    version 17.0
    gettoken mname 0 : 0
    syntax using/ [, replace]
    local r = rowsof('mname')
    local c = colsof('mname')
    tempname hdl
    file open 'hdl' using "using", 'replace' write binary
    file write 'hdl' %2b ('r') %2b ('c')
    forvalues i=1(1)'r' {
        forvalues j=1(1)'c' {
            file write 'hdl' %8z ('mname'['i','j'])
        }
    }
    file close 'hdl'
end
```

A significant problem with `mymatout1` is that, if we wrote a matrix on our Unix computer (an Intel-based computer) and copied the file to a SPARC-based computer, we would discover that we could not read the file. Intel computers write multiple-byte numbers with the least-significant byte first; SPARC-based computers write the most-significant byte first. Who knows what your computer does? Thus even though there is general agreement across computers on how numbers and characters are written, this byte-ordering difference is enough to stop binary files.

`file` can handle this problem for you, but you have to insert a little code. The recommended procedure is this: before writing any numbers in the file, write a field saying which byte order this computer uses (see `byteorder()` in [FN] Programming functions). Later, when we write the command to read the file, it will read the ordering that we recorded. We will then tell `file` which
byte ordering the file is using, and file itself will reorder the bytes if that is necessary. There are other ways that we could handle this—such as always writing in a known byte order—but the recommended procedure is better because it is, on average, faster. Most files are read on the same computer that wrote them, and thus the computer wastes no time rearranging bytes then.

The improved version of mymatout1 is

```stata
program mymatout2
    version 17.0
    gettoken mname 0 : 0
    syntax using/ [, replace]
    local r = rowsof('mname')
    local c = colsof('mname')
    tempname hdl
    file open 'hdl' using "using", 'replace' write binary
    /* new */
    file write 'hdl' %1b (byteorder())
    file write 'hdl' %2b ('r') %2b ('c')
    forvalues i=1(1)'r' {
        forvalues j=1(1)'c' {
            file write 'hdl' %8z ('mname'['i','j'])
        }
    }
    file close 'hdl'
end
```

byteorder() returns 1 if the machine is hilo and 2 if lohi, but all that matters is that it is small enough to fit in a byte. The important thing is that we write this number using %1b, about which there is no byte-ordering disagreement. What we do with this number we will deal with later.

The second significant problem with our program is that it does not write a signature. Binary files are difficult to tell apart: they all look like binary junk. It is important that we include some sort of marker at the top saying who wrote this file and in what format it was written. That is called a signature. The signature that we will use is

```stata
mymatout 1.0.0
```

We will write that 14-byte-long string first thing in the file so that later, when we write mymatin, we can read the string and verify that it contains what we expect. Signature lines should always contain a generic identity (mymatout here) along with a version number, which we can change if we modify the output program to change the output format. This way, the wrong input program cannot be used with a more up-to-date file format.
Our improved program is

```stata
program mymatout3
    version 17.0
    gettoken mname 0 : 0
    syntax using/ [, replace]
    local r = rowsof('mname')
    local c = colsof('mname')
    tempname hdl
    file open 'hdl' using ""using"", 'replace' write binary
    /* new */
    file write 'hdl' %14s "mymatout 1.0.0"
    file write 'hdl' %1b (byteorder())
    file write 'hdl' %2b ('r') %2b ('c')
    forvalues i=1(1)'r' {
        forvalues j=1(1)'c' {
            file write 'hdl' %8z ('mname'['i','j'])
        }
    }
    file close 'hdl'
end
```

This program works well. After we wrote the corresponding input routine (see Reading binary files below), however, we noticed that our restored matrices lacked their original row and column names, which led to a final round of changes:

```stata
program mymatout4
    version 17.0
    gettoken mname 0 : 0
    syntax using/ [, replace]
    local r = rowsof('mname')
    local c = colsof('mname')
    tempname hdl
    file open 'hdl' using ""using"", 'replace' write binary
    /* changed */
    file write 'hdl' %14s "mymatout 1.0.1"
    file write 'hdl' %1b (byteorder())
    file write 'hdl' %2b ('r') %2b ('c')
    /* new */
    local names : rownames 'mname'
    /* new */
    local len : length local names
    /* new */
    file write 'hdl' %4b ('len') %'len's ""names""
    /* new */
    local names : colnames 'mname'
    /* new */
    local len : length local names
    /* new */
    file write 'hdl' %4b ('len') %'len's ""names""
    forvalues i=1(1)'r' {
        forvalues j=1(1)'c' {
            file write 'hdl' %8z ('mname'['i','j'])
        }
    }
    file close 'hdl'
end
```

In this version, we added the lines necessary to write the row and column names into the file. We write the row names by coding

```
local names : rownames 'mname'
local len : length local names
file write 'hdl' %4b ('len') %'len's ""names""
```

and we similarly write the column names. The interesting thing here is that we need to write a string into our binary file for which the length of the string varies. One solution would be

```
file write 'hdl' %165199s ""mname""
```
but that would be inefficient because, in general, the names are much shorter than 165,199 bytes. The solution is to obtain the length of the string to be written and then write the length into the file. In the above code, macro ‘len’ contains the length, we write ‘len’ as a 4-byte integer, and then we write the string using a %‘len’s format. Consider what happens when ‘len’ is, say, 50. We write 50 into the file, and then we write the string using a %50s format. Later, when we read back the file, we can reverse this process, reading the length and then using the appropriate format.

We also changed the signature from “mymatout 1.0.0” to “mymatout 1.0.1” because the file format changed. Making that change ensures that an old read program does not attempt to read a more modern format (and so produce incorrect results).

Technical note

You may write strings using %#s formats that are narrower than, equal to, or wider than the length of the string being written. When the format is too narrow, only that many characters of the string are written. When the format and string are of the same width, the entire string is written. When the format is wider than the string, the entire string is written, and then the excess positions in the file are filled with binary zeros.

Binary zeros are special in strings because binary denotes the end of the string. Thus when you read back the string, even if it was written in a field that was too wide, it will appear exactly as it appeared originally.

Reading binary files

You read binary files just as you wrote them,

```c
file open handle using filename, read binary
file read handle ...
...
file close handle
```

When reading them, you must be careful to specify the same formats as you did when you wrote the file.

The program that will read the matrices written by mymatout1, presented below, has the syntax

```c
mymatin1 matname filename
```
and the code is

```stata
program mymatin1
    version 17.0
    gettoken mname 0 : 0
    syntax using/
    tempname hdl
    file open 'hdl' using ""using"", read binary
    tempname val
    file read 'hdl' %2b 'val'
    local r = 'val'
    file read 'hdl' %2b 'val'
    local c = 'val'
    matrix 'mname' = J('r', 'c', 0)
    forvalues i=1(1)'r' {
        forvalues j=1(1)'c' {
            file read 'hdl' %8z 'val'
            matrix 'mname'['i','j'] = 'val'
        }
    }
    file close 'hdl'
end
```

When `file read` reads numeric values, they are always stored into scalars (see `[P] scalar`), and you specify the name of the scalar directly after the binary numeric format. Here we are using the scalar named `val`, where `val` is a name that we obtained from `tempname`. We could just as well have used a fixed name, say, `myscalar`, so the first `file read` would read

```stata
file read 'hdl' %2b myscalar
```

and we would similarly substitute `myscalar` everywhere `val` appears, but that would make our program less elegant. If the user had previously stored a value under the name `myscalar`, our values would replace it.

In the second version of `mymatout`, we included the byte order. The correspondingly improved version of `mymatin` is

```stata
program mymatin2
    version 17.0
    gettoken mname 0 : 0
    syntax using/
    tempname hdl
    file open 'hdl' using ""using"", read binary
    tempname val
    /* new */ file read 'hdl' %1b 'val'
    /* new */ local border = 'val'
    /* new */ file set 'hdl' byteorder 'border'
    file read 'hdl' %2b 'val'
    local r = 'val'
    file read 'hdl' %2b 'val'
    local c = 'val'
    matrix 'mname' = J('r', 'c', 0)
    forvalues i=1(1)'r' {
        forvalues j=1(1)'c' {
            file read 'hdl' %8z 'val'
            matrix 'mname'['i','j'] = 'val'
        }
    }
    file close 'hdl'
end
```
We simply read back the value we recorded and then file set it. We cannot directly file set
handle byteorder ‘val’ because ‘val’ is a scalar, and the syntax for file set byteorder is

```
file set handle byteorder {hilo|lohi|1|2}
```

That is, file set is willing to see a number (1 and hilo mean the same thing, as do 2 and lohi),
but that number must be a literal (the character 1 or 2), so we had to copy ‘val’ into a macro before
we could use it. Once we set the byte order, however, we could from then on depend on file to
reorder the bytes for us should that be necessary.

In the third version of mymatout, we added a signature. In the modification below, we read the
signature by using a %14s format. Strings are copied into local macros, and we must specify the
name of the local macro following the format:

```
program mymatin3
  version 17.0
  gettoken mname 0 : 0
  syntax using/
  tempname hdl
  file open 'hdl' using "'using'"", read binary
/* new */ file read 'hdl' %14s signature
/* new */ if "'signature'" != "mymatout 1.0.0" {
/* new */     disp as err "file not mymatout 1.0.0"
/* new */     exit 610
/* new */ }
/* new */
  tempname val
  file read 'hdl' %1b 'val'
  local border = 'val'
  file set 'hdl' byteorder 'border'
  file read 'hdl' %2b 'val'
  local r = 'val'
  file read 'hdl' %2b 'val'
  local c = 'val'
  matrix 'mname' = J('r', 'c', 0)
  forvalues i=1(1)'r' {
    forvalues j=1(1)'c' {
      file read 'hdl' %8z 'val'
      matrix 'mname'['i','j'] = 'val'
    }
  }
file close 'hdl'
end
```

In the fourth and final version, we wrote the row and column names. We wrote the names by first
preceding them with a 4-byte integer recording their width:
Use of seek when writing or reading binary files

Nearly all I/O programs are written without using file seek. file seek changes your location in the file. Ordinarily, you start at the beginning of the file and proceed sequentially through the bytes. file seek lets you back up or skip ahead.

file seek handle query actually does not change your location in the file; it merely returns in scalar r(loc) the current position, with the first byte in the file being numbered 0, the second 1, and so on. In fact, all the file seek commands return r(loc), but file seek query is unique because that is all it does.

file seek handle tof moves to the beginning (top) of the file. This is useful with read files when you want to read the file again, but you can seek to tof even with write files and, of course, with read write files. (Concerning read files: you can seek to top, or any point, before or after the end-of-file condition is raised.)

file seek handle eof moves to the end of the file. This is useful only with write files (or read write files) but may be used with read files, too.
file seek handle # moves to the specified position. # is measured in bytes from the beginning of the file and is in the same units as reported in r(loc). `file seek handle 0` is equivalent to `file seek handle tof`.

Technical note

When a file is opened write append, you may not use file seek. If you need to seek in the file, open the file read write instead.

Appendix A.1 Useful commands and functions for use with file

- When opening a file read write or write append, file's actions differ depending upon whether the file already exists. confirm file (see [P] confirm) can tell you whether a file exists; use it before opening the file.
- To obtain the length of strings when writing binary files, use the macro function length:

  ```stata
  local length : length local mystr
  file write handle %1b (length's "mystr")
  ```

  See Macro functions for parsing in [P] macro for details.
- To write portable binary files, we recommend writing in natural byte order and recording the byte order in the file. Then the file can be read by reading the byte order and setting it:

  Writing:

  ```stata
  file write handle %1b (byteorder())
  ```

  Reading:

  ```stata
  tempname mysca
  file read handle %1b 'mysca'
  local b_order = 'mysca'
  file set handle byteorder 'b_order'
  ```

  The byteorder() function returns 1 or 2, depending on whether the computer being used records data in hilo or lohi format. See [FN] Programming functions.

Appendix A.2 Actions of binary output formats with out-of-range values

Say that you write the number 2,137 with a %1b format. What value will you later get back when you read the field with a %1b format? Here the answer is . , Stata’s missing value, because the %1b format is a variation of %1bs that supports Stata’s missing value. If you wrote 2,137 with %1bs, it would read back as 127; if you wrote it with %1bu, it would read back as 255.

In general, in the Stata variation, missing values are supported, and numbers outside the range are written as missing. In the remaining formats, the minimum or maximum is written as
<table>
<thead>
<tr>
<th>Format</th>
<th>Min value</th>
<th>Max value</th>
<th>Value written when value is . . .</th>
</tr>
</thead>
<tbody>
<tr>
<td>%1bu</td>
<td>0</td>
<td>255</td>
<td>Too small: 0, Too large: 255</td>
</tr>
<tr>
<td>%1bs</td>
<td>−127</td>
<td>127</td>
<td>Too small: −127, Too large: 127</td>
</tr>
<tr>
<td>%1b</td>
<td>−127</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>%2bu</td>
<td>0</td>
<td>65,535</td>
<td>Too small: 0, Too large: 65,535</td>
</tr>
<tr>
<td>%2bs</td>
<td>−32,767</td>
<td>32,767</td>
<td>Too small: −32,767, Too large: 32,767</td>
</tr>
<tr>
<td>%2b</td>
<td>−32,767</td>
<td>32,740</td>
<td></td>
</tr>
<tr>
<td>%4bu</td>
<td>0</td>
<td>4,294,967,295</td>
<td>Too small: 0, Too large: 4,294,967,295</td>
</tr>
<tr>
<td>%4bs</td>
<td>−2,147,483,647</td>
<td>2,147,483,647</td>
<td>Too small: −2,147,483,647, Too large: 2,147,483,647</td>
</tr>
<tr>
<td>%4b</td>
<td>−2,147,483,647</td>
<td>2,147,483,620</td>
<td></td>
</tr>
<tr>
<td>%4z</td>
<td>$10^{38}$</td>
<td>$10^{38}$</td>
<td></td>
</tr>
<tr>
<td>%8z</td>
<td>$10^{307}$</td>
<td>$10^{307}$</td>
<td></td>
</tr>
</tbody>
</table>

In the above table, if you write a missing value, take that as writing a value larger than the maximum allowed for the type.

If you write a noninteger value with an integer format, the result will be truncated to an integer. For example, writing 124.75 with a %2b format is the same as writing 124.

### Stored results

`file read` stores the following in `r()`:

**Scalars**

- `r(eof)`
  - 1 on end of file, 0 otherwise

**Macros**

- `r(status)` (if `text file`)
  - `win`: line read; line ended in cr-lf
  - `mac`: line read; line ended in cr
  - `unix`: line read; line ended in lf
  - `split`: line read; line was too long and so split
  - `none`: line read; line was not terminated
  - `eof`: line not read because of end of file

- `r(status) = split` indicates that `c(macrolen)−1(33maxvar+199)` for Stata/MP and Stata/SE, 165,199 for Stata/BE) characters of the line were returned and that the next `file read` will pick up where the last read left off.

- `r(status) = none` indicates that the entire line was returned, that no line-end character was found, and that the next `file read` will return `r(status) = eof`.

If `r(status) = eof (r(eof) = 1)`, then the local macro into which the line was read contains "". The local macro containing "", however, does not imply end of file because the line might simply have been empty.
file seek stores the following in $r()$:

Scalars

$r(loc)$  current position of the file

file query stores the following in $r()$:

 Scalars

$r(N)$  number of open files

Reference


Also see

[P] display — Display strings and values of scalar expressions

[D] filefilter — Convert ASCII or binary patterns in a file

[D] hexdump — Display hexadecimal report on file

[D] import — Overview of importing data into Stata

[D] import delimited — Import and export delimited text data

[D] infix (fixed format) — Import text data in fixed format

[M-4] IO — I/O functions
Description

Stata’s .dta datasets record data in a way generalized to work across computers that do not agree on how data are recorded. Thus the same dataset may be used, without translation, on different computers (Windows, Unix, and Mac computers). Given a computer, datasets are divided into two categories: native-format and foreign-format datasets. Stata uses the following two rules:

R1. On any computer, Stata knows how to write only native-format datasets.

R2. On all computers, Stata can read foreign-format as well as native-format datasets.

Rules R1 and R2 ensure that Stata users need not be concerned with dataset formats.

Stata is also continually being updated, and these updates sometimes require that changes be made to how Stata records .dta datasets. Stata can read older formats, but whenever it writes a dataset, it writes in the modern format. For up-to-date documentation on the Stata .dta file format, type help dta. The system help file contains all the details a programmer will need.

Also see

[D] save — Save Stata dataset
[D] use — Load Stata dataset
[D] sysuse — Use shipped dataset
[D] webuse — Use dataset from Stata website
[U] 1.2.2 Example datasets
findfile — Find file in path

Description

findfile looks for a file along a specified path and, if the file is found, displays the fully qualified name and returns the name in \texttt{r(fn)}. If the file is not found, the file-not-found error, \texttt{r(601)}, is issued.

Unless told otherwise, \texttt{findfile} looks along the ado-path, the same path that Stata uses for searching for ado-files, help files, etc.

In programming contexts, \texttt{findfile} is usually preceded by \texttt{quietly}; see \cite{Pquietly}.

Syntax

\begin{verbatim}
findfile filename [, path(path) nodescend all]
\end{verbatim}

where \textit{filename} and \textit{path} may optionally be enclosed in quotes, and the default is to look over the ado-path if option \texttt{path()} is not specified.

\texttt{collect} is allowed; see \cite{Uprefix}.

Options

\texttt{path(path)} specifies the path over which \texttt{findfile} is to search. Not specifying this option is equivalent to specifying \texttt{path("'"c(adopath)"'")}.

If specified, \textit{path} should be a list of directory (folder) names separated by semicolons; for example,

\begin{verbatim}
path('.;~/bin;~/data/my data;~')
path('.;\bin;\data\my data;~')
\end{verbatim}

The individual directory names may be enclosed in quotes, but if any are, remember to enclose the entire path argument in compound quotes.

Also any of the directory names may be specified as \texttt{BASE}, \texttt{SITE}, \texttt{PLUS}, \texttt{PERSONAL}, or \texttt{OLDPLACE}, which are indirect references to directories recorded by \texttt{sysdir} (see \cite{Psysdir}):

\begin{verbatim}
path(BASE;SITE;.;PERSONAL;PLUS)
path(\bin;SITE;.;PERSONAL;PLUS)
path("\bin.;"\data\my data";PERSONAL;PLUS")
path(".;"'c(adopath)"'")
\end{verbatim}

\texttt{nodescend} specifies that \texttt{findfile} not follow Stata’s normal practice of searching in letter subdirectories of directories in the path, as well as in the directories themselves. \texttt{nodescend} is rarely specified, and, if it is specified, \texttt{path()} would usually be specified, too.
all specifies that all files along the path with the specified name are to be found and then listed and stored in \texttt{r(fn)}. When \texttt{all} is not specified, the default is to stop the search when the first instance of the specified name is found.

When \texttt{all} is specified, the fully qualified names of the files found are returned in \texttt{r(fn)}, listed one after the other, and each enclosed in quotes. Thus when \texttt{all} is specified, if you later need to quote the returned list, you must use compound double quotes. Also remember that \texttt{findfile} issues a file-not-found error if no files are found. If you wish to suppress that and want \texttt{r(fn)} returned containing nothing, precede \texttt{findfile} with \texttt{capture}; see \cite{capture}. Thus the typical usage of \texttt{findfile}, \texttt{all} is

\begin{verbatim}
. capture findfile filename, all
. local filelist ":"r(fn)"
\end{verbatim}

Remarks and examples

\texttt{findfile} is not a utility to search everywhere for a file that you have lost. \texttt{findfile} is for use in those rare ado-files that use prerecorded datasets and for which you wish to place the datasets along the ado-path, along with the ado-file itself.

For instance, Stata’s \texttt{icd9} command performs a mapping, and that mapping is in fact stored in a dataset containing original values and mapped values. Thus along with \texttt{icd9.ado} is dataset \texttt{icd9\_cod.dta}, and that dataset is stored along the ado-path, too. Users of \texttt{icd9} know nothing about the dataset. In \texttt{icd9.ado}, the \texttt{icd9\_cod.dta} is merged with the data in memory. The code fragment that does that reads

\begin{verbatim}
. quietly findfile icd9\_cod.dta
. merge ... using ":"r(fn)"
\end{verbatim}

It would not have been possible to code

\begin{verbatim}
. merge ... using icd9\_cod.dta
\end{verbatim}

because \texttt{icd9\_cod.dta} is not in the current directory.

Stored results

\texttt{findfile} stores the following in \texttt{r(}):

Macros

\begin{verbatim}
r(fn) (all not specified) name of the file found; name not enclosed in quotes
  (all specified) names of the files found, listed one after the other, each enclosed in quotes
\end{verbatim}

Also see

\cite{sysdir} — Query and set system directories
\cite{unabcmd} — Unabbreviate command name
\cite{sysuse} — Use shipped dataset
\cite{which} — Display location of an ado-file
foreach repeatedly sets local macro `lname` to each element of the list and executes the commands enclosed in braces. The loop is executed zero or more times; it is executed zero times if the list is null or empty. Also see [P] forvalues, which is the fastest way to loop over consecutive values, such as looping over numbers from 1 to \( k \).

forecah `lname` in `list {...}` allows a general list. Elements are separated from each other by one or more blanks.

forecah `lname` of local `list {...}` and foreach `lname` of global `list {...}` obtain the list from the indicated place. This method of using foreach produces the fastest executing code.

forecah `lname` of varlist `list {...}`, foreach `lname` of newlist `list {...}`, and foreach `lname` of numlist `list {...}` are much like foreach `lname` in `list {...}`, except that the `list` is given the appropriate interpretation. For instance,

```stata
foreach x in mpg weight-turn {
    ...
}
```

has two elements, `mpg` and `weight-turn`, so the loop will be executed twice.

```stata
foreach x of varlist mpg weight-turn {
    ...
}
```

has four elements, `mpg`, `weight`, `length`, and `turn`, because `list` was given the interpretation of a varlist.

forecah `lname` of varlist `list {...}` gives `list` the interpretation of a varlist. The `list` is expanded according to standard variable abbreviation rules, and the existence of the variables is confirmed.

forecah `lname` of newlist `list {...}` indicates that the `list` is to be interpreted as new variable names; see [U] 11.4.2 Lists of new variables. A check is performed to see that the named variables could be created, but they are not automatically created.

forecah `lname` of numlist `list {...}` indicates a number list and allows standard number-list notation; see [U] 11.1.8 numlist.
Syntax

```plaintext
foreach \texttt{lname} \{ \texttt{in} | \texttt{of listtype} \} \texttt{list} \{ 
  \texttt{commands referring to \`lname'}
\}
```

Allowed are

```plaintext
foreach \texttt{lname} \texttt{in any list} \{

foreach \texttt{lname} \texttt{of local lmacname} \{

foreach \texttt{lname} \texttt{of global gmacname} \{

foreach \texttt{lname} \texttt{of varlist varlist} \{

foreach \texttt{lname} \texttt{of newlist newvarlist} \{

foreach \texttt{lname} \texttt{of numlist numlist} \{
```

Braces must be specified with `foreach`, and

1. the open brace must appear on the same line as `foreach`;
2. nothing may follow the open brace except, of course, comments; the first command to be executed must appear on a new line;
3. the close brace must appear on a line by itself.

Remarks and examples

Remarks are presented under the following headings:

- Introduction
- foreach ... of local and foreach ... of global
- foreach ... of varlist
- foreach ... of newlist
- foreach ... of numlist
- Use of foreach with continue
- The unprocessed list elements

Introduction

`foreach` has many forms, but it is just one command, and what it means is

```plaintext
foreach \texttt{value of a list of things, set \texttt{x} equal to each and \{ 
  execute these instructions once per value 
  and in the loop we can refer to \`x' to refer to the value
```
```
and this is coded

```
foreach x ... {
  ... 'x' ...
}
```

We use the name x for illustration; you may use whatever name you like. The list itself can come from a variety of places and can be given a variety of interpretations, but `foreach x in` is easiest to understand:

```
foreach x in a b mpg 2 3 2.2 {
  ... 'x' ...
}
```

The list is a, b, mpg, 2, 3, and 2.2, and appears right in the command. In some programming instances, you might know the list ahead of time, but often what you know is that you want to do the loop for each value of the list contained in a macro, for instance, `varlist`. Then you could code

```
foreach x in 'varlist' {
  ... 'x' ...
}
```

but your code will execute more quickly if you code

```
foreach x of local varlist {
  ... 'x' ...
}
```

Both work, but the second is quicker to execute. In the first, Stata has to expand the macro and substitute it into the command line, whereupon `foreach` must then pull back the elements one at a time and store them. In the second, all of that is already done, and `foreach` can just grab the local macro `varlist`.

The two forms we have just shown,

```
foreach x in ... {
  ... 'x' ...
}
```

and

```
foreach x of local ... {
  ... 'x' ...
}
```

are the two ways `foreach` is most commonly used. The other forms are for special occasions.

In the event that you have something that you want to be given the interpretation of a varlist, newvarlist, or numlist before it is interpreted as a list, you can code

```
foreach x of varlist mpg weight-turn g* {
  ... 'x' ...
}
```

or

```
foreach x of newlist id values1-values9 {
  ... 'x' ...
}
```
foreach — Loop over items

foreach x of numlist 1/3 5 6/10 {
    ... 'x' ...
}

Just as with foreach x in ..., you put the list right on the command line, and, if you have the list
in a macro, you can put `macroname` on the command line.

If you have the list in a macro, you have no alternative but to code `macroname`; there is no
special foreach x of local `macroname` variant for varlist, newvarlist, and numlist because, in those
cases, foreach x of local `macroname` itself is probably sufficient. If you have the list in a macro,
then how did it get there? Well, it probably was something that the user typed and that your program
has already parsed. Then the list has already been expanded, and treating the list as a general list is
adequate; it need not be given the special interpretation again, at least as far as foreach is concerned.

Example 1: Using foreach, interactively

foreach is generally used in programs, but it may be used interactively, and for illustration we
will use it that way. Three files are appended to the dataset in memory. The dataset currently in
memory and each of the three files has only one string observation.

```
.list
1. data in memory

.foreach file in this.dta that.dta theother.dta {
2. append using "'file'"
3. }

.list
1. data in memory
2. data from this.dta
3. data from that.dta
4. data from theother.dta
```

Quotes may be used to allow elements with blanks.

```
.foreach name in "Annette Fett" "Ashley Poole" "Marsha Martinez" {
2. display length("'name'") " characters long -- 'name'"
3. }
12 characters long -- Annette Fett
12 characters long -- Ashley Poole
15 characters long -- Marsha Martinez
```

foreach ... of local and foreach ... of global

foreach lname of local lmacname obtains the blank-separated list (which may contain quotes)
from local macro lmacname. For example,

```
.foreach file of local flist {
    ...
}
```
produces the same results as typing

```
foreach file in 'flist' {
    ...
}
```

except that `foreach file of local flist` is faster, uses less memory, and allows the list to be modified in the body of the loop.

If the contents of `flist` are modified in the body of `foreach file in 'flist'`, `foreach` will not notice, and the original list will be used. The contents of `flist` may, however, be modified in `foreach file of local flist`, but only to add new elements onto the end.

`foreach lname of global gmacname` is the same as `foreach lname in $gmacname`, with the same three caveats as to speed, memory use, and modification in the loop body.

### Example 2: Looping over the elements of local and global macros

```stata
local grains "rice wheat flax"
. foreach x of local grains {
    2. display "'x'"
    3. }
rice
wheat
flax

. global money "Dollar Lira Pound"
. foreach y of global money {
    2. display "'y'"
    3. }
Dollar
Lira
Pound
```

`foreach ... of varlist`

`foreach lname of varlist varlist` allows specifying an existing variable list.
Example 3: Looping over existing variables

```stata
foreach var of varlist pri-rep t* {
  2.   quietly summarize 'var'
  3.   summarize 'var' if 'var' > r(mean)
  4. }
```

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>price</td>
<td>22</td>
<td>9814.364</td>
<td>3022.929</td>
<td>6229</td>
<td>15906</td>
</tr>
<tr>
<td>mpg</td>
<td>31</td>
<td>26.67742</td>
<td>4.628802</td>
<td>22</td>
<td>41</td>
</tr>
<tr>
<td>rep78</td>
<td>29</td>
<td>4.37931</td>
<td>.493804</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>trunk</td>
<td>40</td>
<td>17.1</td>
<td>2.351214</td>
<td>14</td>
<td>23</td>
</tr>
<tr>
<td>turn</td>
<td>41</td>
<td>43.07317</td>
<td>2.412367</td>
<td>40</td>
<td>51</td>
</tr>
</tbody>
</table>

foreach lname of varlist varlist can be useful interactively but is rarely used in programming contexts. You can code

```stata
syntax [varlist] ...  
foreach var of varlist 'varlist' {
  ...  
}
```

but that is not as efficient as coding

```stata
syntax [varlist] ...  
foreach var of local varlist {
  ...  
}
```

because ‘varlist’ has already been expanded by the syntax command according to the macro rules.

Technical note

```stata
syntax [varlist] ...  
foreach var of local varlist {
  ...  
}
```

is also preferable to

```stata
syntax [varlist] ...  
tokenize 'varlist'  
while ""1"" != "" {
  ...  
  macro shift
}
```
foreach — Loop over items

or

```
syntax [varlist] ...
tokenize 'varlist'
local i = 1
while """"i"""" != ""

   ...
   local i = 'i' + 1
}
```
because it is not only more readable but also faster.

foreach ... of newlist

newlist signifies to foreach that the list is composed of new variables. foreach verifies that the list contains valid new variable names, but it does not create the variables. For instance,

```
foreach var of newlist z1-z4 {
    generate 'var' = runiform()
}
```

would create variables z1, z2, z3, and z4.

foreach ... of numlist

foreach lname of numlist numlist provides a method of looping through a list of numbers. Standard number-list notation is allowed; see [U] 11.1.8 numlist. For instance,

```
foreach num of numlist 1/4 8 103 {
    display 'num'
}
```

If you wish to loop over many equally spaced values, do not code, for instance,

```
foreach x in 1/1000 {
    ...
}
```

Instead, code

```
forvalues x = 1/1000 {
    ...
}
```

foreach must store the list of elements, whereas forvalues obtains the elements one at a time by calculation; see [P] forvalues.
Use of foreach with continue

The \texttt{lname} in \texttt{foreach} is defined only in the loop body. If you code

\begin{verbatim}
foreach x ... {
    // loop body, 'x' is defined
}
// 'x' is now undefined, meaning it contains ""
\end{verbatim}

'x' is defined only within the loop body, which is the case even if you use \texttt{continue}, \texttt{break} (see \texttt{[P] continue}) to exit the loop early:

\begin{verbatim}
foreach x ... {
    ...
    if ... {
        continue, break
    }
}
// 'x' is still undefined, even if continue, break is executed
\end{verbatim}

If you later need the value of 'x', code

\begin{verbatim}
foreach x ... {
    ...
    if ... {
        local lastx '"x"',
        continue, break
    }
}
// 'lastx' defined
\end{verbatim}

The unprocessed list elements

The macro \texttt{ferest()} may be used in the body of the \texttt{foreach} loop to obtain the unprocessed list elements.

\textbf{Example 4}

\begin{verbatim}
 foreach x in alpha "one two" three four {
2. display
3. display '" x is |x|"',
4. display '"ferest() is |ferest()|"',
5. }

 x is |alpha|
ferest() is |"one two" three four|

 x is |one two|
ferest() is |three four|

 x is |three|
ferest() is |four|

 x is |four|
ferest() is ||
\end{verbatim}
foreach — Loop over items

`iferest()` is available only within the body of the loop; outside that, `iferest()` evaluates to "". Thus you might code

```stata
foreach x ... {
    ...;
    if ... {
        local lastx "'x',"
        local rest "'iferest()'"
        continue, break
    }
}
// 'lastx' and 'rest' are defined
```

References


Also see

[P] continue — Break out of loops
[P] forvalues — Loop over consecutive values
[P] if — if programming command
[P] levelsof — Distinct levels of a variable
[P] while — Looping
[U] 18 Programming Stata
[U] 18.3 Macros
forvalues — Loop over consecutive values

Description

forvalues repeatedly sets local macro lname to each element of range and executes the commands enclosed in braces. The loop is executed zero or more times.

Syntax

```
forvalues lname = range {
    Stata commands referring to `lname'
}
```

where range is

- `#1(#d)#2` meaning #1 to #2 in steps of #d
- `#1/#2` meaning #1 to #2 in steps of 1
- `#1 #t to #2` meaning #1 to #2 in steps of #t − #1
- `#1 #t : #2` meaning #1 to #2 in steps of #t − #1

The loop is executed as long as calculated values of `lname` are ≤ #2, assuming that #d > 0.

Braces must be specified with forvalues, and

1. the open brace must appear on the same line as forvalues;
2. nothing may follow the open brace except, of course, comments; the first command to be executed must appear on a new line;
3. the close brace must appear on a line by itself.

Remarks and examples

forvalues is the fastest way to execute a block of code for different numeric values of lname.

Example 1

With forvalues lname = #1(#d)#2, the loop is executed zero or more times, once for lname = #1, once for lname = #1 + #d, once for lname = #1 + #d + #d, and so on, as long as lname ≤ #2 (assuming #d is positive) or as long as lname ≥ #2 (assuming #d is negative). Specifying #d as 0 is an error.

```
. forvalues i = 1(1)5 {
    2. display `i'
    3. }
```

1
2
3
4
5

247
lists the numbers 1–5, stepping by 1, whereas

```
  . forvalues i = 10(-2)1 {
     2. display 'i'
     3. }
  10
  8
  6
  4
  2
```

lists the numbers starting from 10, stepping down by 2 until it reaches 2. It stops at 2 instead of at 1 or 0.

```
  . forvalues i = 1(1)1 {
     2. display 'i'
     3. }
  1
```
displays 1, whereas

```
  . forvalues i = 1(1)0 {
     2. display 'i'
     3. }
```
displays nothing.

\[\text{forvalues lname} = \#_1/\#_2\] is the same as using \text{forvalues lname} = \#_1(1)\#_2. Using / does not allow counting backward.

\[\text{Example 2}\]

```
  . forvalues i = 1/3 {
     2. display 'i'
     3. }
  1
  2
  3
```
lists the three values from 1 to 3, but

```
  . forvalues i = 3/1 {
     2. display 'i'
     3. }
```
lists nothing because using this form of the \text{forvalues} command allows incrementing only by 1.

The \text{forvalues lname} = \#_1 \#_i to \#_2 and \text{forvalues lname} = \#_1 \#_i : \#_2 forms of the \text{forvalues} command are equivalent to computing \#_d = \#_i - \#_1 and then using the \text{forvalues lname} = \#_1(\#_d)\#_2 form of the command.
Example 3

```stata
. forvalues i = 5 10 : 25 {
    2.    display 'i'
    3. }
5
10
15
20
25
. forvalues i = 25 20 to 5 {
    2.    display 'i'
    3. }
25
20
15
10
5
```

Technical note

It is not legal syntax to type

```stata
. scalar x = 3
. forvalues i = 1(1)'x' {
    2.    local x = 'x' + 1
    3.    display 'i'
    4. }
```

`forvalues` requires literal numbers. Using macros, as shown in the following technical note, is allowed.

Technical note

The values of the loop bounds are determined once and for all the first time the loop is executed. Changing the loop bounds will have no effect. For instance,

```stata
. local n 3
. forvalues i = 1(1)'n' {
    2.    local n = 'n' + 1
    3.    display 'i'
    4. }
1
2
3
```

will not create an infinite loop. With `n` originally equal to 3, the loop will be performed three times.
Similarly, modifying the loop counter will not affect `forvalues`’ subsequent behavior. For instance,

```
. forvalues i = 1(1)3 {
    2.   display "Top of loop i = `i'"
    3.   local i = `i' * 4
    4.   display "After change i = `i'"
    5. }
Top of loop i = 1
After change i = 4
Top of loop i = 2
After change i = 8
Top of loop i = 3
After change i = 12
```

will still execute three times, setting `i` to 1, 2, and 3 at the beginning of each iteration.

References


Also see

[P] `continue` — Break out of loops

[P] `foreach` — Loop over items

[P] `if` — if programming command

[P] `while` — Looping

[U] 18 Programming Stata

[U] 18.3 Macros
**Title**

(frame post — Post results to dataset in another frame)

**Description**

These commands are utilities to assist Stata programmers in performing Monte Carlo-type experiments. They are similar to Stata’s postfile facilities (see [P] postfile) but operate on a dataset in a frame in memory rather than on disk.

frame create declares the variable names and frame name of a new Stata frame where results will be stored.

frame post adds a new observation to the dataset in the declared frame.

After you have posted all the observations you wish to the declared frame, you should save the data in it to disk; see [D] save.

These commands manipulate the data in the new frame without disturbing the data in memory in the current frame.

**Syntax**

Create new frame with specified variables for use with frame post

    frame create newframenam newvarlist

Add new observation to declared frame

    frame post framerate (exp) (exp) ... (exp)

**Remarks and examples**

The typical use of the frame post command is

    tempname memhold
    ...
    frame create 'memhold' ...
    ...
    while ... {
    ...
    frame post 'memhold' ...
    ...
    }
    save ...
    ...

In our example, we obtain the new frame name from Stata’s temporary name facility (see [P] macro). We recommend that newframenam usually be obtained from tempname. This ensures that your program can be nested within any other program and ensures that the memory used by frame post is freed if anything goes wrong. You can of course substitute a hard-coded newframenam for some programming situations.
Because `frame create` accepts a `newvarlist`, storage types may be interspersed, so you could have

```
frame create 'memhold' a b str20 c double(d e f)
```

Note that `frame create` allows `strL` as a variable storage type, unlike `[P] postfile`.

### Example 1

We wish to write a program to collect means and variances from 10,000 randomly constructed 100-observation samples of lognormal data and save the results in `results.dta`. Suppose that we are evaluating the coverage of the 95%, $t$-based confidence interval when applied to lognormal data. As background, we can obtain a 100-observation lognormal sample by typing

```
drop _all
set obs 100
generate z = exp(rnormal())
```

We can obtain the mean and standard deviation by typing

```
summarize z
```

Moreover, `summarize` stores the sample mean in `r(mean)` and variance in `r(Var)`. It is those two values we wish to collect. Our program is

```
program lnsim
    version 17.0
    tempname sim
    frame create 'sim' mean var
    quietly {
        forvalues i = 1/10000 {
            drop _all
            set obs 100
            generate z = exp(rnormal())
            summarize z
            frame post 'sim' (r(mean)) (r(Var))
        }
    }
    frame 'sim': save results.dta
end
```

The `frame create` command creates a new frame with a temporary name (`'sim'`); `mean` and `var` are the names to be given to the two variables that will contain the information we collect. Because two variable names were specified on the frame create line, two expressions must be specified following `frame post`. Here the expressions are simply `r(mean)` and `r(Var)`. If we had wanted, however, to store the mean divided by the standard deviation and the standard deviation, we could have typed

```
frame post 'sim' (r(mean)/r(sd)) (r(sd))
```

There is no need for a command to conclude the simulation. When the dataset in frame `sim` has everything in it we wish to have in it, we can either switch to frame `sim` to do what we wish with the data or save it to disk to examine later. Here we saved the new data in frame `sim` to a file named `results.dta`. 
We set the random-number seed to an arbitrary value, 12345, so that this example would be reproducible.

Also see

[P] postfile — Post results in Stata dataset
[D] frames intro — Introduction to frames
[D] frames — Data frames
[D] frame create — Create a new frame
[R] simulate — Monte Carlo simulations
Title

fvexpand — Expand factor varlists

Description

fvexpand expands a factor varlist to the corresponding expanded, specific varlist. *varlist* may be general or specific and even may already be expanded.

Syntax

```
fvexpand [ varlist ] [ if ] [ in ]
```

*varlist* may contain factor variables and time-series operators; see [U] 11.4.3 Factor variables and [U] 11.4.4 Time-series varlists.

collect is allowed; see [U] 11.1.10 Prefix commands.

Remarks and examples

An example of a general factor varlist is *mpg i.foreign*. The corresponding specific factor varlist would be *mpg i(0 1)b0.foreign* if *foreign* took on the values 0 and 1 in the data.

A specific factor varlist is specific with respect to a given problem, which is to say, a given dataset and subsample. The specific varlist identifies the values taken on by factor variables and the base.

Factor varlist *mpg i(0 1)b0.foreign* is specific. The same varlist could be written as *mpg i0b.foreign i1.foreign*, so that is specific, too. The first is unexpanded and specific. The second is expanded and specific.

fvexpand takes a general or specific (expanded or unexpanded) factor varlist, along with an optional *if* or *in*, and returns a fully expanded, specific varlist.

Stored results

fvexpand stores the following in *r()*:

Macros

<table>
<thead>
<tr>
<th>Syntax</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>r(varlist)</em></td>
<td>the expanded, specific varlist</td>
</tr>
<tr>
<td><em>r(fvops)</em></td>
<td>true if <em>varlist</em> contains factor variables</td>
</tr>
<tr>
<td><em>r(tsops)</em></td>
<td>true if <em>varlist</em> contains time-series operators</td>
</tr>
</tbody>
</table>

Also see

[R] fvrevar — Factor-variables operator programming command

[U] 11.4.3 Factor variables
gettoken is a low-level parsing command designed for programmers who wish to parse input for themselves. The `syntax` command (see [P] syntax) is an easier-to-use, high-level parsing command.

gettoken obtains the next token from the macro `emname3` and stores it in the macro `emname1`. If macro `emname2` is specified, the rest of the string from `emname3` is stored in the `emname2` macro. `emname1` and `emname3`, or `emname2` and `emname3`, may be the same name. The first token is determined based on the parsing characters `pchars`, which default to a space if not specified.

**Syntax**

```
gettoken emname1 [emname2] : emname3 [, parse("pchars") quotes
qed(lmacname) match(lmacname) bind]
```

where `pchars` are the parsing characters, `lmacname` is a local macro name, and `emname` is described in the following table:

<table>
<thead>
<tr>
<th><code>emname</code> is ...</th>
<th>Refers to a ...</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>macroname</code></td>
<td>local macro</td>
</tr>
<tr>
<td>(local) <code>macroname</code></td>
<td>local macro</td>
</tr>
<tr>
<td>(global) <code>macroname</code></td>
<td>global macro</td>
</tr>
</tbody>
</table>

**Options**

`parse("pchars")` specifies the parsing characters. If `parse()` is not specified, `parse(" ")` is assumed, meaning tokens are identified by blanks.

`quotes` specifies that the outside quotes are not to be stripped in what is stored in `emname1`. This option has no effect on what is stored in `emname2` because it always retains outside quotes. `quotes` is a rarely specified option; usually you want the quotes stripped. You would not want the quotes stripped if you wanted to make a perfect copy of the contents of the original macro for parsing at a later time.

`qed(lmacname)` specifies a local macroname that is to be filled in with 1 or 0 according to whether the returned token was enclosed in quotes in the original string. `qed()` does not change how parsing is done; it merely returns more information.

`match(lmacname)` specifies that parentheses be matched in determining the token. The outer level of parentheses, if any, are removed before the token is stored in `emname1`. The local macro `lmacname` is set to “(" if parentheses were found; otherwise, it is set to an empty string.
bind specifies that expressions within parentheses and those within brackets are to be bound together, even when not parsing on () and [].

**Remarks and examples**

Often we apply `gettoken` to the macro ‘0’ (see [U] 18.4.6 Parsing nonstandard syntax), as in

```
gettoken first : 0
```

which obtains the first token (with spaces as token delimiters) from ‘0’ and leaves ‘0’ unchanged. Or, alternatively,

```
gettoken first 0 : 0
```

which obtains the first token from ‘0’ and saves the rest back in ‘0’.

> **Example 1**

Even though `gettoken` is typically used as a programming command, we demonstrate its use interactively:

```
. local str "cat+dog mouse++horse"
. gettoken left : str
. display "left"
  cat+dog
. display "str"
  cat+dog mouse++horse
. gettoken left str : str, parse(" +")
. display "left"
  cat
. display "str"
  +dog mouse++horse
. gettoken next str : str, parse(" +")
. display "next"
  +
. display "str"
  dog mouse++horse
```

Both global and local variables may be used with `gettoken`. Strings with nested quotes are also allowed, and the `quotes` option may be specified if desired. For more information on compound double quotes, see [U] 18.3.5 Double quotes.

```
. global weird """"some" strings"""" are "within "strings""
. gettoken (local)left (global)right : (global)weird
. display "left"
  "some" strings
. display "$right"
  are "within "strings"
. gettoken left (global)right : (global)weird , quotes
. display "left"
  ""some" strings"
. display "$right"
  are "within "strings"
```

The `match()` option is illustrated below.
. local pstr "(a (b c)) ((d e f) g h)"
. gettoken left right : pstr
. display '\textasciitilde{}left'"
(a
. display '\textasciitilde{}right'"
(b c)) ((d e f) g h)
. gettoken left right : pstr, match(parns)
. display '\textasciitilde{}left'"
a (b c)
. display '\textasciitilde{}right'"
((d e f) g h)
. display '\textasciitilde{}parns'"
 \
\>

\section*{Example 2}

One use of \texttt{gettoken} is to process two-word commands. For example, \texttt{mycmd list} does one thing and \texttt{mycmd generate} does another. We wish to obtain the word following \texttt{mycmd}, examine it, and call the appropriate subroutine with a perfect copy of what followed.

\begin{verbatim}
program mycmd
    version 17.0
    gettoken subcmd 0 : 0
    if "'subcmd'" == "list" {
        mycmd_l '0'
    }
    else if "'subcmd'" == "generate" {
        mycmd_g '0'
    }
    else    error 199
end

program mycmd_l
    ...
end

program mycmd_g
    ...
end
\end{verbatim}

\section*{Example 3}

Suppose that we wish to create a general prefix command with the syntax

\begin{verbatim}
newcmd ... : stata_command
\end{verbatim}

where \ldots{} represents some possibly complicated syntax. We want to split this entire command line at the colon, making a perfect copy of what precedes the colon, which will be parsed by our program, and what follows the colon, which will be passed along to \texttt{stata_command}.\end{verbatim}
Technical note

We strongly encourage you to specify space as one of your parsing characters. For instance, with the last example, you may have been tempted to use `gettoken` but to parse only on colon instead of on colon and space, as in

```stata
gettoken left 0 : 0, parse(":") quotes
gettoken colon 0 : 0, parse(":")
```

and thereby avoid the `while` loop. This is not guaranteed to work for two reasons. First, if the length of the string up to the colon is large, then you run the risk of having it truncated. Second, if `left` begins with a quotation mark, then the result will not be what you expect.

Our recommendation is always to specify a space as one of your parsing characters and to grow your desired macro as demonstrated in our last example.

Technical note

If one of the parsing characters specified is the equal sign, for example, `parse("= ")`, then not only the equal sign is treated as one token but also Stata’s equality operator, `==`. For instance, parsing “y=x if z==3” results in the tokens “y”, “=”, “x”, “if”, “z”, “==”, and “3”.

Reference

Also see

[P] syntax — Parse Stata syntax

[P] tokenize — Divide strings into tokens

[P] while — Looping

[M-5] invtokens() — Concatenate string rowvector into string scalar

[M-5] tokenget() — Advanced parsing

[M-5] tokens() — Obtain tokens from string

[U] 18 Programming Stata
H2O is a scalable and distributed machine learning and predictive analytics platform. You can read more about H2O at http://docs.h2o.ai/.

We have been experimenting with connecting to H2O from official Stata. Typically, we keep such experiments in-house until either we fully flesh them out into something we release to users or we shelve them because they do not work out the way we wanted or our priorities have changed.

We think H2O is an interesting platform, and we want both our users and ourselves to be able to explore connecting to it from Stata. So, we are giving our users early access to our work, and we welcome any feedback. In addition to the connection we have enabled from official Stata, we expect to release some community-contributed packages, and we hope users will do the same.

The documentation for this experimental connection is available at https://www.stata.com/h2o/

The main command used to interact with H2O is `h2oframe`. Notice the underscore; this signifies that the command is intended more for programmatic use. For the most part, it does not return output or helpful error messages, and its syntax is intended more for programmers than end users. It can be used as an engine for wrappers that provide user-friendly output, error messages, and the like. What `h2oframe` does provide is access to H2O along with stored results based on the actions that it performs.

Syntax and features are subject to change. Keep in mind that when `h2oframe` provides access to a given feature of H2O, that feature is an H2O feature. Though it is accessed by a Stata command, what it does is up to H2O and is outside of Stata.
if — if programming command

Description

The if command (not to be confused with the if qualifier; see [U] 11.1.3 if exp) evaluates exp. If the result is true (nonzero), the commands inside the braces are executed. If the result is false (zero), those statements are ignored, and the statement (or statements if enclosed in braces) following the else is executed.

Syntax

if exp { or if exp single_command
    multiple_commands
} which, in either case, may be followed by

else { or else single_command
    multiple_commands
}

If you put braces following the if or else,

1. the open brace must appear on the same line as the if or else;
2. nothing may follow the open brace except, of course, comments; the first command to be executed must appear on a new line;
3. the close brace must appear on a line by itself.

Remarks and examples

Remarks are presented under the following headings:

Introduction
Avoid single-line if and else with ++ and -- macro expansion

Introduction

The if command is intended for use inside programs and do-files; see [U] 18.3.4 Macros and expressions for examples of its use.
Example 1

Do not confuse the if command with the if qualifier. Typing if (age>21) summarize age will summarize all the observations on age if the first observation on age is greater than 21. Otherwise, it will do nothing. Typing summarize age if age>21, on the other hand, summarizes all the observations on age that are greater than 21.

Example 2

if is typically used in do-files and programs. For instance, let’s write a program to calculate the Tukey (1977, 90–91) “power” function of a variable, x:

```stata
. program power
  if ’2’>0 {
    generate z=’1’^’2’
    label variable z ”’1’^’2’”
  }
  else if ’2’==0 {
    generate z=log(’1’)
    label variable z ”log(’1’)”
  }
  else {
    generate z=-(’1’^’2’)
    label variable z ”-(’1’^’2’)”
  }
end
```

This program takes two arguments. The first argument is the name of an existing variable, x. The second argument is a number, which we will call n. The program creates the new variable z. If n > 0, z is x^n; if n = 0, z is log x; and if n < 0, z is x^{-n}. No matter which path the program follows through the code, it labels the variable appropriately:

```stata
. power age 2
. describe z
```

<table>
<thead>
<tr>
<th>Variable name</th>
<th>Storage type</th>
<th>Display format</th>
<th>Value label</th>
</tr>
</thead>
<tbody>
<tr>
<td>z</td>
<td>float</td>
<td>%9.0g</td>
<td>age^2</td>
</tr>
</tbody>
</table>

Technical note

If the expression refers to any variables, their values in the first observation are used unless explicit subscripts are specified.

Avoid single-line if and else with ++ and -- macro expansion

Do not use the single-line forms of if and else—do not omit the braces—when the action includes the ‘++’ or ‘--’ macro-expansion operators. For instance, do not code

```stata
if (...) somecommand ‘++i’
```
Code instead,

```stata
if (...) {
    somecommand ‘++i’
}
```

In the first example, \( i \) will be incremented regardless of whether the condition is true or false because macro expansion occurs before the line is interpreted. In the second example, if the condition is false, the line inside the braces will not be macro expanded and so \( i \) will not be incremented.

The same applies to the `else` statement; do not code

```stata
else somecommand ‘++i’
```

Code instead,

```stata
else {
    somecommand ‘++i’
}
```

⚠️ Technical note

What was just said also applies to macro-induced execution of class programs that have side effects. Consider

```stata
if (...) somecommand ‘.clspgm.getnext’
```

Class-member program `.getnext` would execute regardless of whether the condition were true or false. Here code

```stata
if (...) {
    somecommand ‘.clspgm.getnext’
}
```

Understand that the problem arises only when macro substitution causes the invocation of the class program. There would be nothing wrong with coding

```stata
if (...) ‘.clspgm.getnext’
```

Reference


Also see

[P] `continue` — Break out of loops
[P] `foreach` — Loop over items
[P] `forvalues` — Loop over consecutive values
[P] `while` — Looping
[U] 18 Programming Stata
Description

`include` is a variation on `do` and `run` that causes Stata to execute the commands stored in the specified file as if they were entered from the keyboard. `include` is for advanced programming to share common definitions among several do-files. `include` may also be used in Mata to create a library of routines with shared concepts.

Syntax

```
include filename [, adopath]
```

If `filename` is specified without an extension, `.do` is assumed.

Option

`adopath` indicates to search Stata’s system directories for `filename` if it is not found in the default location.

Remarks and examples

Remarks are presented under the following headings:

- Use with do-files
- Use with Mata
- Warning

Use with do-files

`include` can be used in advanced programming situations where you have several do-files among which you wish to share common definitions. `include` differs from `do` and `run` in that any local macros (changed settings, etc.) created by executing the file are not dropped or reset when execution of the file concludes. Rather, results are as if the commands in `filename` appeared in the session or file that included `filename`.

Say that you have do-files `step1.do`, `step2.do`, and `step3.do` that perform a data management task. You want the do-files to include a common definition of the local macros ‘`inname`’ and ‘`outname`’, which are, respectively, the names of the files to be read and created. One way to do this is
Presumably, files step1.do, step2.do, and step3.do include lines such as

```
.use 'inname', clear
```

and

```
.save 'outname', replace
```

Our use of the .doh suffix in naming file common.doh is not a typo. We called the file .doh to emphasize that it is a header for do-files, but you can name the file as you wish, including common.do.

You could call the file common.do, but you could not use the do command to run it because the local macros that the file defines would automatically be dropped when the file finished executing; thus in step1.do, step2.do, and step3.do, the macros would be undefined.

**Use with Mata**

include is sometimes used in advanced Mata situations where you are creating a library of routines with shared concepts:

```
version 17.0
include limits.matah
mata:
real matrix inpivot(real matrix X)
{
    real matrix y1, yz
    real scalar n
    if (rows(X)>'MAXDIM' | cols(X)>'MAXDIM') {
        errprintf("inpivot: matrix too large\n")
        exit(1000)
    }
    ...
}
end
```
include — Include commands from file

 Presumably, many .mata files include limits.mata.

Warning

 Do not use command include in the body of a Stata program:

 program ...
    ...
    include ...
    ...
 end

 include will not be executed, as you might have hoped, when the program is compiled. Instead, include will be stored in your program and executed every time your program runs. The result will be the same as if the lines had been included at compile time, but the execution will be slower.

Also see

 [R] do — Execute commands from a file
 [R] doedit — Edit do-files and other text files
Access to the Java platform in Stata comes in two forms, Java integration and Java plugins.

Java integration is a drop-in environment similar to JShell, where Java code can be executed directly in Stata. This allows Java code to be invoked and executed interactively, in do-files, and in ado-files. Note that JShell is a console application available in Java Development Kit version 9 and later that allows for interactive Java programming and prototyping. While Stata’s implementation is similar to JShell, it is by design not the same.

Java plugins are Java programs that must be compiled and bundled into a Java Archive file. These files are invoked using the `javacall` command, which requires that a special method be defined that serves as an entry point for the plugin. For details about the signature of this method, see [P] javacall.

Whether you use Java integration or Java plugins, Stata provides Java packages to facilitate communication between the Java platform and Stata; refer to Java-Stata API Specification for details.

Also see [P] Java utilities for system information for your Java environment.

Also see

[P] Java integration — Java integration for Stata
[P] Java plugin — Introduction to Java plugins
[P] Java utilities — Java utilities
[P] javacall — Call a Java plugin
Title

**Java integration — Java integration for Stata**

<table>
<thead>
<tr>
<th>Description</th>
<th>Syntax</th>
<th>Option</th>
<th>Remarks and examples</th>
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</table>

**Description**

Java creates an instance of a Java environment for executing Java code within Stata. In this environment, Java code does not need to be compiled or bundled into a Java Archive (JAR) file. This allows Java code to be executed interactively, in do-files, and in ado-files. Stata’s datasets, matrices, macros, scalars, and more can be accessed using the Java-Stata API Specification.

Java[]: creates a Java environment in which Java code can be executed in a Read-Evaluate-Print-Loop environment, similar to JShell in Java 9 and later versions.

Java: istmt executes one Java simple statement or several simple statements separated by semicolons.

Java clear clears all instances of the Java environment. This means that the global environment and all environments associated with ado-files will be destroyed.

**Syntax**

Syntax is presented under the following headings:

*Calling Java from Stata*

*Instance commands*

**Calling Java from Stata**

**Enter Java environment**

\[
\text{java [varlist] [if] [in] [, shared(keyname)] [:]}
\]

**Execute Java simple statements**

\[
\text{java [varlist] [if] [in] [, shared(keyname)]: istmt}
\]

**Clear all instances of the Java environment**

\[
\text{java clear}
\]

A colon (:) tells the Java instances to exit the interactive mode if an error is encountered.

*istmt* is either one Java simple statement or several simple statements separated by semicolons.
Instance commands

The following commands can be issued inside the Java environment:

Exit the Java session

```
end
```

Show help information about the rest of the Java instance commands

```
/help
```

Set or display the class-path for the environment. When called without an argument, the current class-path will be displayed. The class-path must be set before calling anything depending on it; otherwise, you must call `/reset`.

```
/cp [jar_file | path]
```

Read a Java file, and execute the source in Stata’s Java environment

```
/open file | path
```

Show all imported packages

```
/imports
```

Reset the instance as if it were completely new

```
/reset
```

Show all active and inactive variables

```
/vars
```

Show all method declarations and unresolved references if they exist

```
/methods
```

Show all type declarations and unresolved references if they exist

```
/types
```

Show all source snippets given in the current Java environment

```
/list
```

Option

`shared(keyname)` specifies that a shareable instance of Java, named `keyname`, be invoked. This allows you to share an instance across ado-files. `keyname` must be a valid Stata name.
Remarks and examples

Remarks are presented under the following headings:
- How the environment works
- Invoking Java interactively
- Executing Java in a do-file
- Executing Java in an ado-file
- Executing Java files
- Stata Function Interface examples
- Using JAR dependencies

How the environment works

`java` provides utilities for integrating Java with Stata. `java` creates an instance of the Java environment that allows you to execute Java code interactively or in do-files and ado-files.

The `java` environment has different behavior based on how it is used. When used interactively or in do-files, class definitions and instance variables share a global instance of the environment. So a class defined in a do-file can also be referenced interactively or from another do-file. On the other hand, class definitions and instance variables that are defined in ado-files get their own unique instance of the environment by default. The `shared()` option can be used to override that default behavior. By limiting the scope of the environment associated with ado-files, you can make each ado-file behave autonomously without worry of class definitions and instance variables colliding in other ado-files.

Each `java` environment automatically imports `java.util.*`, `java.io.*`, `com.stata.sfi.*`, and `com.stata.sfi.util*` when initialized. Other packages can be imported in the usual way by using `import` statements in your code.

For information on Java versions supported by this integration, see [P] Java utilities.

Invoking Java interactively

To invoke Java interactively, you must type either `java` or `java:`. Including a colon tells the Java instances to exit the interactive mode if an error is encountered.

When you execute single statements, a semicolon at the end of the statement is optional. When you execute multiple or complex statements, semicolons are required to delimit the statements.

Below, we demonstrate the two syntaxes:

```
. java
              java (type end to exit and /help for help) ----
java> int x = 1
   x ==> 1
java> int y = 2; x + y;
   y ==> 2
   $1 ==> 3
java> end
```

You may have noticed `$1 ==> 3` in the output. When you execute a statement that returns some value without assigning it to a result, it will store the value in a temporary variable for you. You can access those variables by their names, for example, `int z = $1 + 2`.

To exit your interactive session, type `end`. This will exit your session; however, it will not get rid of your work. If you go back into `java`, you will be able to access your work. Let's try going back into our environment and looking at the variables we have set.
Java integration — Java integration for Stata 271

java> /vars
int x = 1
int y = 2
int $1 = 3
java> end

You can also enter interactive mode for a single statement with the syntax java: istmt, for example, java: /vars.

If you wish to reset your environment, you can type java: /reset to reset that instance. Alternatively, you can type java clear to clear all Java instances you have, including the ones in ado-files you may have loaded.

Executing Java in a do-file

Java code and Stata code can be executed in the same do-file. To do this, wrap your Java code in java[ : ] and end, similar to Python and Mata.

For example, we have the following do-file that calculates the mean of two Stata macros:

```
begin java_ex1.do
local x = 10
local y = 2
java:
double mean = ('x' + 'y') / 2;
Macro.setLocal("mean", String.valueOf(mean));
end
di 'mean'
end java_ex1.do
```

First, we define two local macros in Stata, x and y. Inside the Java block, we do basic arithmetic to compute the mean of the two local macros. Then, we use the Stata Function Interface package to set the value of the new mean macro in Stata. Macro substitution is a convenient way to pass values from Stata to Java.

Below, we run this do-file:

```
. do java_ex1
. local x = 10
. local y = 2
. java:
________________________________________________________ java (type end to exit and /help for help) __________
java> double mean = ('x' + 'y')/2;
mean ==> 6.0
java> Macro.setLocal("mean", String.valueOf(mean));
$2 ==> 0
java> end

. di 'mean'
6

end of do-file
```
Executing Java in do-files uses the same Java instance as the Command window. We call this the global instance. That means anything you do in this do-file will carry over to the Command window and other do-files.

Executing Java in an ado-file

Unlike do-files, ado-files will get their own instance of Java. This means that anything you do with Java in an ado-file is bound to it by default. However, if you use the `shared()` option, you will be able to access the same instance across multiple ado-files.

Java blocks may be placed in an ado-file but must be placed outside the ado program itself. Functions defined in the `java` block may be called from the ado-file using the `java: istmt` syntax.

For example, we have the following ado-file that prints the value of x:

```java
begin java_program.ado
  program java_program
    version 17
    java: printX();
  end

  java: int x = 123;
  void printX() {
    System.out.println("x: " + x);
  }
end java_program.ado
```

To run this program in Stata, we simply type

```
. java_program
x: 123
```

After running `java_program.ado`, if we type `java: x` in the Command window, we will not see a value of 123. This is because `x` is defined only in the context of the ado-file it was defined in. If you ran the example shown in *Invoking Java interactively*, then `x` would be 1; otherwise, it will not be defined.

Executing Java files

Executing Java files in Stata is a little bit different from the traditional way, in which you would normally include dependencies and have a single entry point. With the Java integration, we allow you to run any Java file as if it were passed in line by line into the environment; Stata will search along the ado-path for the specified file. This could mean you simply define classes to use, or you could even set up a dependency in your class-path and do real work in your Java file.

Let’s take this example that defines a class called `Addition`, which takes two arguments in its constructor and can return the sum of the two.
Below, we will open and use our new class:

```
.java: java (type end to exit and /help for help) ———
java> /open Addition.java
java> Addition addition = new Addition(4, 6);
addition ==> Addition{x=4, y=6}
java> int sum = addition.result();
sum ==> 10
java> end
```

Notice that the Addition class was declared in the file, but by running this file with /open, we declare it in whatever scope calls it. In our case, running /open in the Command window results in the Addition class being defined in the global instance.

**Stata Function Interface examples**

Integrating Java code with Stata requires use of the *Java-Stata API Specification*. This package provides tools to interact with Stata’s datasets, matrices, macros, scalars, and more.
For example, if we want to print a list of all the variables in Stata in `auto.dta`, we can type

```
   . sysuse auto, clear
   (1978 Automobile Data)
   . java:
   java (type end to exit and /help for help) ——
   java> int parsedVariables = Data.getParsedVarCount();
   parsedVariables ==> 12
   java> for (int v = 1; v <= parsedVariables; v++) {
   ...> /* Get the real index of parsed vars for varlist support */
   ...> int varIndex = Data.mapParsedVarIndex(v);
   ...> System.out.println(Data.getVarName(varIndex));
   ...> }
   make
   price
   mpg
   rep78
   headroom
   trunk
   weight
   length
   turn
   displacement
   gear_ratio
   foreign
   java> end
```

To interpret `varlist`, if, and in qualifiers, we can make use of a few notable functions in the `com.stata.sfi.Data` class.

To interpret `varlist`, we must first get a count of the variables set to be used in the environment. For this, we use `Data.getParsedVarCount()` . From there, we create an association between variables 1 through \( N \) in the environment and their location in the dataset as a whole. We can use `Data.mapParsedVarIndex(v)`, with \( v \) being the 1-based index starting with the first variable you passed into the environment with `varlist`. For example, if you call `java mpg price:`, `Data.mapParsedVarIndex(1)` will return the index in the dataset where the `mpg` variable is located, which would be 3. Alternatively, `Data.mapParsedVarIndex(2)` will return the index in the dataset where the `price` variable is located, which would be 2. We need this function because any of the functions in `com.stata.sfi.Data` that take an index as an argument refer to the entire dataset. For example:

```
   . java mpg price:
   java (type end to exit and /help for help) ——
   java> int parsedVariables = Data.getParsedVarCount();
   parsedVariables ==> 2
   java> for (int v = 1; v <= parsedVariables; v++) {
   ...> int varIndex = Data.mapParsedVarIndex(v);
   ...> SFIToolkit.displayln(Data.getVarName(varIndex));
   ...> }
   mpg
   price
   java> end
```
To interpret if, use the `Data.isParsedIfTrue(int obs)` method. If it returns false, you should not process the observation.

To interpret in, use the `Data.getObsParsedIn1()` and `Data.getObsParsedIn2()` methods. For example, if you type `java in 10/50:`; then the return values of `Data.getObsParsedIn1()` and `Data.getObsParsedIn2()` will be 10 and 50, respectively. From there, you can set up a loop to iterate over only those observations, like so:

```
. sysuse auto, clear
.ja in 1/50:
.java> long obsStart = Data.getObsParsedIn1();
.java> long obsEnd = Data.getObsParsedIn2();
.java> for (long i = obsStart; i <= obsEnd; i++)
...>
...>
.java> end
```

### Using JAR dependencies

To set up dependencies in the environment’s class-path, you will use the `/cp` instance command. Say you have a JAR file named `myjar.jar` in your ado-path. You can run the instance command `/cp myjar.jar` to include it in the class-path. After you include it, you may run code that uses that dependency. There is one caveat. If you try to run code that uses the dependency before adding it to the class-path, the class loader will try to load your nonexistent dependency and will require a `/reset` to reload it. Alternatively, you may provide an absolute path or a path relative to your current Stata working directory to search for dependencies.

#### Technical note

Note that the Stata `version` statement affects only the Stata command interpreter and does not affect the execution or behavior of the Java Virtual Machine.

### Also see

- [Java intro](#) — Introduction to Java in Stata
- [Java plugin](#) — Introduction to Java plugins
- [Java utilities](#) — Java utilities
- [javacall](#) — Call a Java plugin
Java plugin — Introduction to Java plugins

Description

Java plugins are Java programs that you can call from Stata. When called from Stata, a Java plugin can interact with Stata’s datasets, matrices, macros, scalars, and more. Programmers familiar with Java can use Java’s extensive language features. There are also many third-party libraries available. If you are not an experienced Java programmer and you intend to implement a Java plugin, you should start by learning Java. Once you become a proficient Java programmer, writing a Java plugin for Stata should be relatively easy.

If you are interested in writing plugins for Stata in another language such as C or C++, see [P] plugin.

Also see [P] Java utilities for system information for your Java environment.

Remarks and examples

A Java plugin is called or executed using Stata’s javacall command. For a Java plugin to be useful, it needs to have access to a set of Stata’s core features. Stata provides Java packages that allow plugins to interact with Stata; refer to Java-Stata API Specification for details. When compiling your Java plugin to use these features, the sfi-api.jar file needs to be added to the class path of your Java compiler. This file is located in utilities/jar/, which can be found in the directory where Stata was installed.

Once Java source code has been compiled, a Java plugin can be executed from Stata by bundling your plugin in a JAR file and then placing the JAR file in Stata’s ado-path. See [P] javacall for examples and additional details about loading plugins.

Java plugins can be redistributed just like any other Stata program. To redistribute your Java plugin through Stata’s net command, you must bundle your compiled program into a JAR file because net copies .class files as text instead of binary. Additionally, you should always write a Stata ado-program as a wrapper to javacall to parse your syntax.

A typical Java standalone program has an entry point through a main() method, which looks like this:

    static void main(String[] args)

To call a Java plugin from Stata, you must define a similar entry point. However, there are two important distinctions. First, you may name your method whatever you like, as long as it conforms to standard Java naming requirements. Second, your method must have a return type of int instead of void. Here is an example of a valid method signature that Stata can call:

    static int mymethod(String[] args)

Let’s assume that mymethod() exists and that the compiled Java files have been placed in an appropriate location. To call mymethod(), we use Stata’s javacall command. javacall allows you to invoke any static method in the class path if that method follows the correct signature as described above. For details on class-path behavior, see [P] javacall.
References


Also see

[P] Java intro — Introduction to Java in Stata

[P] Java integration — Java integration for Stata

[P] Java utilities — Java utilities

[P] javacall — Call a Java plugin
Description

java query shows settings and system information for the Java environment. Some system information is only available after the Java Virtual Machine (JVM) has been initialized.

java set home sets the path to the JVM—a Java Development Kit (JDK) is required for Java integration.

java set heapmax sets the maximum amount of heap memory allocated for the JVM.

java initialize manually initializes the JVM. Manual initialization is not typically used because the JVM initializes automatically when it is required. Once the JVM has been initialized, it cannot be uninitialized within a Stata session.

For details about creating Java plugins in Stata, see [P] Java plugin.

Syntax

List Java environment settings and system information

java_query

Initialize the Java Virtual Machine

java_initialize

Set the path to the Java Development Kit

java_set_home default | "path_to_java_home_dir"

set java_home is a synonym for java set home.

Set the amount of heap memory for the Java Virtual Machine

java_set_heapmax default | size

set java_heapmax is a synonym for java set heapmax.

size is # [m | g], and the default unit is m.

Remarks and examples

Stata requires a JDK for some functionality. The JDK redistributed with Stata is based on source code from the OpenJDK and is licensed under the terms of the GPL v2 with Classpath Exception. This version of Stata contains build 11.0.13-LTS acquired from Azul Systems.
Sometimes, it may be necessary to use and maintain your own version of the JDK. For example, some institutions require that frequent security patches be applied to the JDK to maintain security compliance. For these situations, using `java set home` will tell Stata to use your JDK instead of the JDK that is distributed with Stata. When replacing the default JDK, we recommend that only long-term support (LTS) versions be used. The minimum Java version supported by this version of Stata is release 11. For developers who wish to redistribute a Java plugin, we recommend that they compile their code to target release 11.

Also see

- [P] **Java intro** — Introduction to Java in Stata
- [P] **Java integration** — Java integration for Stata
- [P] **Java plugin** — Introduction to Java plugins
- [P] **javacall** — Call a Java plugin
javacall — Call a Java plugin

Description

javacall calls a Java plugin by invoking a static method. The method to be called must be implemented with a specific Java signature in the following form:

\[
\text{static int } \text{java\_method\_name(String[]} \text{args})
\]

javacall requires class to be a fully qualified name that includes the class’s package specification. For example, to call a method named method1 from class Class1, which was part of package com.mydomain and packaged in myjarfile.jar, the following command would be used:

\[
\text{. javacall com.mydomain.Class1 method1, jars(myjarfile.jar)}
\]

javacall can parse a varlist, along with if and in qualifiers. The Data class in the Java-Stata API Specification has methods for interpreting those parsed values.

Syntax

javacall class method [varlist] [if] [in], {jars(jar_files) | classpath(classpath)} [args(arg_list)]

Options

jars(jar_files) specifies the JAR files to be added to the class path. jar_files may be one JAR file or a list of JAR files separated either by spaces or by semicolons. Stata will search along the ado-path for the specified JAR files and add them to the Java class path for the plugin. Either jars() or classpath() must be specified.

classpath(classpath) specifies the class path to use. classpath may be a single class path or multiple paths specified using a platform-specific Java class path. On Windows, multiple paths are separated by semicolons. On Mac and Unix, multiple paths are separated by colons. Either jars() or classpath() must be specified.

This option is provided as a convenience for use during the development process. For example, a developer might use this option to set the class path to the directory where their compiler is generating .class files, allowing newly compiled code to be tested quickly without the need to build a JAR file. After the development process is complete, a JAR file should be created, and the jars() option should be used instead.

args(args_list) specifies the args_list that will be passed to the Java method as a string array. If args() is not specified, the array will be empty.
Remarks and examples

Each Java plugin uses its own instance of the class loader, allowing the currently loaded plugin to be discarded and a new version of the plugin to be loaded. Because each plugin uses a separate instance of the class loader, dependencies are not shared globally. A plugin developer can bundle their plugin with any third-party dependencies using a single JAR file, or dependencies may be distributed in multiple JAR files. Plugin isolation occurs because the jars() option allows each plugin to use a unique set of JAR files.

Example 1

Consider two variables needing to store integers too large to be held accurately in a double or a long, so instead they are stored as strings. If we needed to subtract the values in one variable from another, we could write a plugin using Java’s BigInteger class. The following code shows how we could perform the task:

```java
/* Java class begins here */
import java.math.BigInteger;
import com.stata.sfi.*;
public class MyClass {
    /* Define the static method with the correct signature */
    public static int sub_string_vals(String[] args) {
        long nobs1 = Data.getObsParsedIn1() ;
        long nobs2 = Data.getObsParsedIn2() ;
        BigInteger b1, b2 ;
        if (Data.getParsedVarCount() != 2) {
            SFIToolkit.error("Exactly two variables must be specified\n") ;
            return(198) ;
        }
        if (args.length != 1) {
            SFIToolkit.error("New variable name not specified\n") ;
            return(198) ;
        }
        if (Data.addVarStr(args[0], 10)!=0) {
            SFIToolkit.errorln("Unable to create new variable " + args[0]) ;
            return(198) ;
        }
        // get the real indexes of the varlist
        int mapv1 = Data.mapParsedVarIndex(1) ;
        int mapv2 = Data.mapParsedVarIndex(2) ;
        int resv = Data.getVarIndex(args[0]) ;
        if (!Data.isVarTypeStr(mapv1) || !Data.isVarTypeStr(mapv2)) {
            SFIToolkit.error("Both variables must be strings\n") ;
            return(198) ;
        }
        for(long obs=nobs1; obs<=nobs2; obs++) {
            // Loop over the observations
            if (!Data.isParsedIfTrue(obs)) continue ;
            // skip any observations omitted from an [if] condition
            try {
                b1 = new BigInteger(Data.getStr(mapv1, obs)) ;
                b2 = new BigInteger(Data.getStr(mapv2, obs)) ;
                Data.storeStr(resv, obs, b1.subtract(b2).toString()) ;
            } catch (NumberFormatException e) { }
        }
        return(0) ;
    }
    /* Java class ends here */
```
Consider the following data, containing two string variables with four observations:

```
. input str20 big1 str20 big2
  29811231010193176  29811231010193168
  42981123101023696  42981123101023669
  -98121437010116560  -98121437010116589
  1000 999
end

. list
```

Next we call the Java method using `javacall`. The two variables to subtract are passed in as a `varlist`, and the name of the new variable is passed in as a single argument using the `args()` option.

```
. javacall MyClass sub_string_vals big1 big2, args(result1) jars(test.jar)

. list
```

Normally, a program should be used as a wrapper for `javacall`; see `[U] 18 Programming Stata`. For example,

```
program subtract_str
  version 17.0
  syntax varlist [if] [in], result(string)
  confirm new variable 'result'
  javacall MyClass sub_string_vals 'varlist' 'if' 'in', ///
    args('result') jars(test.jar)
end

. subtract_str big1 big2, result(bigres)

. list
```
Also see

- [P] Java intro — Introduction to Java in Stata
- [P] Java integration — Java integration for Stata
- [P] Java plugin — Introduction to Java plugins
- [P] Java utilities — Java utilities
levelsof — Distinct levels of a variable

Description

levelsof displays a sorted list of the distinct values of `varname`.

Syntax

```
levelsof varname [ if ] [ in ] [ , options ]
```

Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>clean</code></td>
<td>display string values without compound double quotes</td>
</tr>
<tr>
<td><code>local(macname)</code></td>
<td>insert the list of values in the local macro <code>macname</code></td>
</tr>
<tr>
<td>missing</td>
<td>include missing values of <code>varname</code> in calculation</td>
</tr>
<tr>
<td>separate(separator)</td>
<td>separator to serve as punctuation for the values of returned list;</td>
</tr>
<tr>
<td></td>
<td>default is a space</td>
</tr>
<tr>
<td>matcell(matname)</td>
<td>save frequencies of distinct values in <code>matname</code></td>
</tr>
<tr>
<td>matrow(matname)</td>
<td>save distinct values of <code>varname</code> in <code>matname</code></td>
</tr>
<tr>
<td>hexadecimal</td>
<td>use hexadecimal format for numerical values</td>
</tr>
</tbody>
</table>

Hexadecimal is allowed; see [U] 11.1.10 Prefix commands.

Options

- `clean` displays string values without compound double quotes. By default, each distinct string value is displayed within compound double quotes, as these are the most general delimiters. If you know that the string values in `varname` do not include embedded spaces or embedded quotes, this is an appropriate option. `clean` does not affect the display of values from numeric variables.

- `local(macname)` inserts the list of values in local macro `macname` within the calling program’s space. Hence, that macro will be accessible after `levelsof` has finished. This is helpful for subsequent use, especially with `foreach`; see [P] `foreach`.

- `missing` specifies that missing values of `varname` be included in the tabulation. The default is to exclude them.

- `separate(separator)` specifies a separator to serve as punctuation for the values of the returned list. The default is a space. A useful alternative is a comma.

- `matcell(matname)` saves the frequencies of the distinct values in `matname`.

- `matrow(matname)` saves the distinct values of `varname` in `matname`. `matrow()` may not be specified if `varname` is a string.
hexadecimal specifies that hexadecimal format \%21x be used when varname is numeric. See [D] format. This option guarantees that the values in the macro that levelsof creates are exactly numerically equal to their values in varname. For integer data, except for extremely large integers (absolute value \(\geq 10^{19}\)), levelsof always produces values that give equality without this option. For noninteger data or extremely large integers, exact numerical equality may not be true in all cases by default. Specifying hexadecimal guarantees equality in all cases.

**Remarks and examples**

levelsof serves two different functions. First, it provides a compact list of the distinct values of varname. More commonly, it is useful when you desire to cycle through the distinct values of varname with (say) foreach; see [P] foreach. levelsof leaves behind a list in r(levels) that may be used in a subsequent command. When wanting to get the levels of noninteger data, one may use matrow(matname) to obtain the levels in full precision.

levelsof may hit the limits imposed by your Stata. However, it is typically used when the number of distinct values of varname is not extremely large.

The terminology of levels of a factor has long been standard in experimental design. See Cochran and Cox (1957, 148), Fisher (1942), or Yates (1937, 5).

**Example 1**

```stata
. use https://www.stata-press.com/data/r17/auto
   (1978 automobile data)
. levelsof rep78
   1 2 3 4 5
. display "r(levels)"
   1 2 3 4 5
. levelsof rep78, miss local(mylevs)
   1 2 3 4 5
. display "mylevs"
   1 2 3 4 5
. levelsof rep78, sep(,)  
   1,2,3,4,5
. display "r(levels)"
   1,2,3,4,5

Showing value labels when defined:
. levelsof factor, local(levels)
. foreach l of local levels {
   . di "-> factor = ': label (factor) 'l'"
   . whatever if factor == 'l'
. }
```

**Example 2**

By default, levelsof gives exact numerical equality for all integers except extremely large ones (absolute value \(\geq 10^{19}\)). If you are working with integers that are not of this extreme size, levelsof will do what you want in all cases. You can test the equality of the macro values with the variable values using ==. When working with nonintegers or extremely large integers, however, using == may not always be true when it “should” be true.
levelsof fills a macro with numbers formatted in base 10, but the values of a variable are stored in base 2. The conversion of values from base 2 to base 10 may yield an approximation where an expression using == does not evaluate to true.

Here’s a simple example:

```
. clear
. set obs 5
Number of observations (_N) was 0, now 5.
. generate double x = ln(_n + 1)
. levelsof x
.6931471805599453 1.098612288666811 1.386294361119891 1.6094379124341
> 1.791759469228055
. foreach level in `r(levels)' {
2. count if x == `level'
3. }
1
0
0
0
1
In 3 cases out of 5, equality was not true. Using the option hexadecimal solves this problem. The macro values are formatted in base 16 using Stata’s hexadecimal format %21x. See [D] format.

```
. levelsof x, hexadecimal
+1.62e42fefa39efX-001 +1.193ea7aad030bX+000 +1.62e42fefa39efX+000
> +1.9c041f7ed8d33X+000 +1.cab0bfa2a2002X+000
. foreach level in `r(levels)' {
2. display "x =" %10.0g `level'
3. count if x == `level'
4. }
x = .69314718
1
x = 1.0986123
1
x = 1.3862944
1
x = 1.6094379
1
x = 1.7917595
1
```

The only downside of using hexadecimal is that the values of the levels may be hard to read if we do not reformat them. Or we can just learn to read base 16.

```
```

Stored results

levelsof stores the following in r():

Scalars

- r(N) number of observations
- r(r) number of distinct values

Macros

- r(levels) list of distinct values
Acknowledgments

The original version of levelsof was written by Nicholas J. Cox of the Department of Geography at Durham University, UK, who is coeditor of the Stata Journal and author of Speaking Stata Graphics. He in turn thanks Christopher F. Baum of the Department of Economics at Boston College and author of the Stata Press books An Introduction to Modern Econometrics Using Stata and An Introduction to Stata Programming and Nicholas Winter of the Department of Politics at the University of Virginia, for their input.

References


Also see

[P] foreach — Loop over items
[D] codebook — Describe data contents
[D] format — Set variables’ output format
[D] inspect — Display simple summary of data’s attributes
[R] tabulate oneway — One-way table of frequencies
**Description**

**global** assigns strings to specified global macro names (*mnames*). **local** assigns strings to local macro names (*lclnames*). Both double quotes (" and ") and compound double quotes (‘‘ and ‘’) are allowed; see [U] 18.3.5 Double quotes. If the string has embedded quotes, compound double quotes are needed.

**tempvar** assigns names to the specified local macro names that may be used as temporary variable names in a dataset. When the program or do-file concludes, any variables with these assigned names are dropped.

**tempname** assigns names to the specified local macro names that may be used as temporary local macro, scalar, matrix, or frame names. When the program or do-file concludes, any local macros, scalars, matrices, or frames with these assigned names are dropped.

**tempfile** assigns names to the specified local macro names that may be used as names for temporary files. When the program or do-file concludes, any datasets created with these assigned names are erased.

**macro** manipulates global and local macros.

See [U] 18.3 Macros for information on macro substitution.

**Syntax**

```
[global]  mname  [ =exp  |  :macro_fcn  |  "[ string ]"  |  ‘“[ string ]”’ ]
[local]  lclname  [ =exp  |  :macro_fcn  |  "[ string ]"  |  ‘“[ string ]”’ ]
[tempvar]  lclname  [ lclname  [...] ]
[tempname]  lclname  [ lclname  [...] ]
[tempfile]  lclname  [ lclname  [...] ]
[local]  {  ++lclname  |  --lclname  }
[macro]  dir
[macro]  drop  {  mname  [ mname  [...] ]  |  mname*  |  _all  }
[macro]  list  [ mname  [ mname  [...] ]  |  _all  ]
[macro]  shift  [#]
[   [...]  ‘expansion_optr’h[   [...]  ]
```
where \( \text{exp} \text{_op} \text{tr} \) is

\[
\text{lcname} | \text{lcname} \text{+} | \text{lcname} \text{++} | \text{lcname} \text{--} | \text{lcname} \text{--} | \text{exp} | \\
\text{mac} | \text{class} \text{_directive} | \text{mac} | \text{val} (\text{lcname})
\]

and where \( \text{mac} \text{_fcn} \) is any of the following:

**Macro function for extracting program properties**

\[
\text{properties} \text{ command}
\]

**Macro function for extracting program results class**

\[
\text{results} \text{ command}
\]

**Macro functions for extracting data attributes**

\[
\{ \text{type} | \text{format} | \text{value} \text{ label} | \text{variable} \text{ label} \} \text{ varname}
\]

\[
\text{data label}
\]

\[
\text{sortedby}
\]

\[
\text{label} \{ \text{vlabel} \text{ name} | (\text{vname}) \} \{ \text{max} \text{ length} | \# [ \#_2 ] \} [ , \text{ strict}]
\]

\[
\text{constraint} \{ \# | \text{dir} \}
\]

\[
\text{char} \{ \text{vname} | \text{vname} \text{ [charname]} \} \text{ or char} \{ \_\text{dta}[] | \_\text{dta} [\text{charname}] \}
\]

**Macro function for naming variables**

\[
\text{permname suggested name} [ , \text{ length}(\#) ]
\]

**Macro functions for filenames and file paths**

\[
\text{adosubdir} ["\text{filename}"]
\]

\[
\text{dir} ["\text{name}"] \{ \text{files} | \text{dirs} | \text{other} \}["\text{pattern}"]. [ , \text{nofail respectcase}]
\]

\[
\text{sysdir} \{ \text{STATA} | \text{BASE} | \text{SITE} | \text{PLUS} | \text{PERSONAL} | \text{name} \}
\]

**Macro function for accessing operating-system parameters**

\[
\text{environment name}
\]
Macro functions for names of stored results

- `e(scalars | macros | matrices | functions)`
- `r(scalars | macros | matrices | functions)`
- `s(macros)`

`all {globals | scalars | matrices} ["pattern"]`
`all {numeric | string} scalars ["pattern"]`

Macro function for formatting results

```
display display_directive
```

Macro function for manipulating lists

```
list macro_list_directive
```

Macro functions related to matrices

{ `rownames | colnames | rowfullnames | colfullnames` matname [ , quoted ] }
{ `roweq | coleq` matname [ , quoted ] }
{ `rownumb | colnumb | roweqnumb | coleqnumb` matname string }
{ `rownfreeparms | colnfreeparms | rownlfs | colnlfs` matname }
{ `rowsof | colsof | rowvarlist | colvarlist` matname }
{ `rowlnames | collfnames` matname [ , quoted ] }

Macro function related to time-series operators

```
tsnorm string [ , varname ]
```

Macro function for copying a macro

```
copy { local | global } mname
```

Macro functions for parsing

```
word { count | # of } string
```
```
piece #piece_number #length_of_pieces of [’]"string"[’] [ , nobreak ]
```
```
strlen{ local | global } mname
```
```
ustrlen{ local | global } mname
```
```
udstrlen{ local | global } mname
```
```
subinstr { global mname2 | local lclname2 }
```
```
{ "from" | ’from’ ; } { "to" | ’to’ ; }
```
```
[ , all count(global mname3 | local lclname3) word ]
```
Remarks and examples

Remarks are presented under the following headings:

- Formal definition of a macro
- Global and local macro names
- Macro assignment
- Macro functions
- Macro function for extracting program properties
- Macro function for extracting program results class
- Macro functions for extracting data attributes
- Macro function for naming variables
- Macro functions for filenames and file paths
- Macro function for accessing operating-system parameters
- Macro functions for names of stored results
- Macro function for formatting results
- Macro functions for manipulating lists
- Macro functions related to matrices
- Macro function related to time-series operators
- Macro function for copying a macro
- Macro functions for parsing
- Macro expansion operators and function
- The tempvar, tempname, and tempfile commands
  - Temporary variables
  - Temporary scalars and matrices
  - Temporary files
- Manipulation of macros
- Macros as arguments

Macros are a tool used in programming Stata, and this entry assumes that you have read [U] 18 Programming Stata and especially [U] 18.3 Macros. This entry concerns advanced issues not previously covered.

Formal definition of a macro

A macro has a macro name and macro contents. Everywhere a punctuated macro name appears in a command—punctuation is defined below—the macro contents are substituted for the macro name.

Macros come in two types, global and local. Macro names are up to 32 characters long for global macros and up to 31 characters long for local macros. The contents of global macros are defined with the global command and those of local macros with the local command. Global macros, once defined, are available anywhere in Stata. Local macros exist solely within the program or do-file in which they are defined. If that program or do-file calls another program or do-file, the local macros previously defined temporarily cease to exist, and their existence is reestablished when the calling program regains control. When a program or do-file ends, its local macros are permanently deleted.

To substitute the macro contents of a global macro name, the macro name is typed (punctuated) with a dollar sign ($) in front. To substitute the macro contents of a local macro name, the macro name is typed (punctuated) with surrounding left and right single quotes (‘’). In either case, braces ({} ) can be used to clarify meaning and to form nested constructions. When the contents of an undefined macro are substituted, the macro name and punctuation are removed, and nothing is substituted in its place.
For example,

The input

\[
\text{global a "myvar"}
\]

\[
generate \$a = \text{oldvar}
\]

\[
generate \text{a = oldvar}
\]

\[
local \text{a "myvar"}
\]

\[
generate \text{a' = oldvar}
\]

\[
generate \text{a = oldvar}
\]

\[
\text{global a "newvar"}
\]

\[
global \text{i = 2}
\]

\[
generate \$a$i = \text{oldvar}
\]

\[
local \text{a "newvar"}
\]

\[
llocal \text{i = 2}
\]

\[
generate \text{a' = oldvar}
\]

\[
generate \text{a = oldvar}
\]

\[
\text{global a "newvar"}
\]

\[
global \text{i = 1}
\]

\[
generate \${b$i} = \text{oldvar}
\]

\[
local \text{b1 "newvar"}
\]

\[
llocal \text{i = 1}
\]

\[
generate \text{b' = oldvar}
\]

\[
generate \text{b = oldvar}
\]

\[
\text{global b1 "newvar"}
\]

\[
\text{global a "b"}
\]

\[
global \text{i = 1}
\]

\[
generate \${$a$i} = \text{oldvar}
\]

\[
local \text{b1 "newvar"}
\]

\[
llocal \text{a "b"}
\]

\[
llocal \text{i = 1}
\]

\[
generate \text{a' = oldvar}
\]

\[
generate \text{a = oldvar}
\]

Global and local macro names

What we say next is an exceedingly fine point: global macro names that begin with an underscore are really local macros; this is why local macro names can have only 31 characters. The local command is formally defined as equivalent to global _. Thus the following are equivalent:

\[
\text{local x}
\]

\[
\text{global _x}
\]

\[
\text{local i=1}
\]

\[
\text{global _i=1}
\]

\[
\text{local name "Bill"}
\]

\[
\text{global _name "Bill"}
\]

\[
\text{local fmt : format myvar}
\]

\[
\text{global _fmt : format myvar}
\]

\[
\text{local 3 '2'}
\]

\[
\text{global _3 $2}
\]

\[
\text{tempvar}
\]

\[
\text{is formally defined as equivalent to local name : tempvar for each name specified after tempvar. Thus}
\]

\[
\text{tempvar a b c}
\]

\[
\text{is equivalent to}
\]

\[
\text{local a : tempvar}
\]

\[
\text{local b : tempvar}
\]

\[
\text{local c : tempvar}
\]

\[
\text{which in turn is equivalent to}
\]

\[
\text{global _a : tempvar}
\]

\[
\text{global _b : tempvar}
\]

\[
\text{global _c : tempvar}
\]

\[
\text{tempfile is defined similarly.}
\]
Macro assignment

When you type

. local name "something"

or

. local name "something"

"something" becomes the contents of the macro. The compound double quotes (" and ") are needed when "something" itself contains quotation marks. In fact, if the string is anything more complex than a single word, it is safest to enclose the string in compound quotes (" "). The outermost compound quotes will be stripped, and all that remains will be assigned to name. Note that any embedded macro references in "something" are expanded before assignment to name whether or not compound quotes are used.

When you type

. local name = something

"something" is evaluated as an expression, and the result becomes the contents of the macro. Note the presence and lack of the equal sign. That is, if you type

. local problem "2+2"
. local result = 2+2

then problem contains 2+2, whereas result contains 4.

Finally, when you type

. local name : something

"something" is interpreted as a macro function. (Note the colon rather than nothing or the equal sign.) Of course, all of this applies to global as well as to local.

local ++lclname, or local --lclname, is used to increment, or decrement, lclname. For instance, typing

. local ++x

is equivalent to typing

. local x = 'x' + 1

Macro functions

Macro functions are of the form

. local mname : ...

For instance,

. local x : type mpg
. local y : sortedby
. local z : display %9.4f sqrt(2)

We document the macro functions below. Macro functions are typically used in programs, but you can experiment with them interactively. For instance, if you are unsure what 'local x : type mpg' does, you could type

. local x : type mpg
. display "'x'"
int
Macro function for extracting program properties

properties command
returns the properties declared for command; see [P] program properties.

Macro function for extracting program results class

results command
returns the results class—nclass, eclass, rclass, or sclass—declared for command; see [P] program.

Macro functions for extracting data attributes

type varname
returns the storage type of varname, which might be int, long, float, double, str1, str2, etc.

format varname
returns the display format associated with varname, for instance, %9.0g or %12s.

value label varname
returns the name of the value label associated with varname, which might be “” (meaning no label), or, for example, make, meaning that the value label’s name is make.

variable label varname
returns the variable label associated with varname, which might be “” (meaning no label), or, for example, Repair Record 1978.

data label
returns the dataset label associated with the dataset currently in memory, which might be “” (meaning no label), or, for example, 1978 automobile data. See [D] label.

sortedby
returns the names of the variables by which the data in memory are currently sorted, which might be “” (meaning not sorted), or, for example, foreign mpg, meaning that the data are in the order of the variable foreign, and, within that, in the order of mpg (the order that would be obtained from the Stata command sort foreign mpg). See [D] sort.

label valuelabelname {maxlength | # [#2]} [, strict]
returns the label value of # in valuelabelname. For instance, label forlab 1 might return Foreign cars if forlab were the name of a value label and 1 mapped to “Foreign cars”. If 1 did not correspond to any mapping within the value label, or if the value label forlab were not defined, 1 (the # itself) would be returned.

#2 optionally specifies the maximum length of the label to be returned. If label forlab 1 would return Foreign cars, then label forlab 1 6 would return Foreig.

maxlength specifies that, rather than looking up a number in a value label, label return the maximum length of the labelings. For instance, if value label yesno mapped 0 to no and 1 to yes, then its maxlength would be 3 because yes is the longest label and it has three characters.

strict specifies that nothing is to be returned if there is no value label for #.

label (varname) {maxlength | # [#2]} [, strict]
works exactly as the above, except that rather than specifying the valuelabelname directly, you indirectly specify it. The value label name associated with varname is used, if there is one. If not, it is treated just as if valuelabelname were undefined, and the number itself is returned.
constraint \{ # \mid \text{dir}\}
  
gives information on constraints.

constraint # puts constraint # in mname or returns "" if constraint # is not defined. constraint # for # < 0 is an error.

constraint dir returns an unsorted numerical list of those constraints that are currently defined. For example,

\begin{verbatim}
. constraint 1 price = weight
. constraint 2 mpg > 20
. local myname : constraint 2
. macro list _myname
   _myname: mpg > 20
. local aname : constraint dir
. macro list _aname
   _aname: 2 1
\end{verbatim}

char \{ varname[] \mid varname[charname] \} or char \{ _dta[] \mid _dta[charname] \} returns information on the characteristics of a dataset; see \cite{char}. For instance,

\begin{verbatim}
. sysuse auto
(1978 automobile data)
. char mpg[one] "this"
. char mpg[two] "that"
. local x : char mpg[one]
. di "'x'"
this
. local x : char mpg[nosuch]
. di "'x'"
. local x : char mpg[]
. di "'x'"
two one
\end{verbatim}

**Macro function for naming variables**

\texttt{permname suggested\_name[, length(#)]}

returns a valid new variable name based on \texttt{suggested\_name} in \texttt{mname}, where \texttt{suggested\_name} must follow naming conventions but may be too long or correspond to an already existing variable. \texttt{length(#)} specifies the maximum length of the returned variable name, which must be between 8 and 32. \texttt{length(32)} is the default. For instance,

\begin{verbatim}
. local myname : permname foreign
. macro list _myname
   _myname: foreign1
. local aname : permname displacement, length(8)
. macro list _aname
   _aname: displace
\end{verbatim}
Macro functions for filenames and file paths

adosubdir \["filename"\]

puts in mname the subdirectory in which Stata would search for this file along the ado-path. Typically, the directory name would be the first letter of filename. However, certain files may result in a different name depending on their extension.

dir \["dirname"\] \{files | dirs | other\} \["pattern"\] [ , nofail respectcase]

puts in mname the specified files, directories, or entries that are neither files nor directories, from directory dirname and matching pattern pattern, where the pattern matching is defined by Stata’s \texttt{strmatch(s1,s2)} function; see \texttt{[FN] String functions}. The quotes in the command are optional but recommended, and they are nearly always required surrounding pattern. The returned string will contain each of the names, separated one from the other by spaces and each enclosed in double quotes. If mname is subsequently used in a quoted context, it must be enclosed in compound double quotes: ‘"mname"’.

The nofail option specifies that if the directory contains too many filenames to fit into a macro, rather than issuing an error message, the filenames that fit into mname should be returned. nofail should rarely, if ever, be specified.

In Windows only, the respectcase option specifies that dir respect the case of filenames when performing matches. Unlike other operating systems, Windows has, by default, case-insensitive filenames. respectcase is ignored in operating systems other than Windows.

For example,

\begin{verbatim}
local list : dir . files "*" makes a list of all regular files in the current directory. In list might be returned "subjects.dta" "step1.do" "step2.do" "reest.ado".
local list : dir . files "s*", respectcase in Windows makes a list of all regular files in the current directory that begin with a lowercase “s”. The case of characters in the filenames is preserved. In Windows, without the respectcase option, all filenames would be converted to lowercase before being compared with pattern and possibly returned.
local list : dir . dirs "*" makes a list of all subdirectories of the current directory. In list might be returned "notes" "subpanel".
local list : dir . other "*" makes a list of all things that are neither regular files nor directories. These files rarely occur and might be, for instance, Unix device drivers.
local list : dir "\mydir\data" files "*" makes a list of all regular files that are to be found in \mydir\data. Returned might be "example.dta" "make.do" "analyze.do".
It is the names of the files that are returned, not their full path names.
local list : dir "subdir" files "*" makes a list of all regular files that are to be found in subdir of the current directory.
\end{verbatim}

\begin{verbatim}
\texttt{sysdir} \{\texttt{STATA} | \texttt{BASE} | \texttt{SITE} | \texttt{PLUS} | \texttt{PERSONAL}\}
returns the various Stata system directory paths; see \texttt{[P] sysdir}. The path is returned with a trailing separator; for example, \texttt{sysdir STATA} might return \texttt{D:\PROGRAMS\STATA\}.
\texttt{sysdir dirname}
returns dirname. This function is used to code local x : \texttt{sysdir \{dir\}}, where \texttt{dir} might contain the name of a directory specified by a user or a keyword, such as \texttt{STATA} or \texttt{BASE}. The appropriate directory name will be returned. The path is returned with a trailing separator.
\end{verbatim}
Macro function for accessing operating-system parameters

environment name
returns the contents of the operating system’s environment variable named name, or “” if name is undefined.

Macro functions for names of stored results

e(scalars | macros | matrices | functions)
returns the names of all the stored results in e() of the specified type, with the names listed one after the other and separated by one space. For instance, e(scalars) might return N 11_0 11 df_m chi2 r2_p, meaning that scalar stored results e(N), e(11_0), ... exist.

r(scalars | macros | matrices | functions)
returns the names of all the stored results in r() of the specified type.

s(macros)
returns the names of all the stored results in s() of type macro, which is the only type that exists within s().

all \{ globals | scalars | matrices \} [ "pattern" ]
puts in mname the specified globals, scalars, or matrices that match the pattern, where the pattern matching is defined by Stata’s strmatch(s1, s2) function; see [FN] String functions.

all \{ numeric | string \} scalars [ "pattern" ]
puts in mname the specified numeric or string scalars that match the pattern, where the pattern matching is defined by Stata’s strmatch(s1, s2) function; see [FN] String functions.

Macro function for formatting results

display displayDirective
returns the results from the display command. The display function is the display command, except that the output is rerouted to a macro rather than to the screen.

You can use all the features of display that make sense. That is, you may not set styles with as style because macros do not have colors, you may not use _continue to suppress going to a new line on the real display (it is not being displayed), you may not use _newline (for the same reason), and you may not use _request to obtain input from the console (because input and output have nothing to do with macro definition). Everything else works. See [P] display.

Example:
local x : display %9.4f sqrt(2)

Macro function for manipulating lists

list macrolistDirective
fills in mname with the macrolistDirective, which specifies one of many available commands or operators for working with macros that contain lists; see [P] macro lists.
Macro functions related to matrices

In understanding the functions below, remember that the full name of a matrix row or column is defined as eqname:name. For instance, full name might be outcome:weight, and then the eqname is outcome and the name is weight. Or the full name might be gnp:L.cpi, and then the eqname is gnp and the name is L.cpi. Or the full name might be mpg, in which case the eqname is “” and the name is mpg. Or the full name might be gnp:1.south#1.smsa, and then the eqname is gnp and the name is 1.south#1.smsa. For more information, see [P] matrix define.

rownames matname [, quoted]
returns the names of the rows of matname, listed one after another and separated by one space. As many names are listed as there are rows of matname. quoted specifies that row names be enclosed in double quotes.

colnames matname [, quoted]
is like rownames but returns the names of the columns.

rowfullnames matname [, quoted]
returns the full names of the rows of matname, listed one after another and separated by one space. As many full names are listed as there are rows of matname. quoted specifies that full names be enclosed in double quotes.

colfullnames matname [, quoted]
is like rowfullnames but returns the full names of the columns.

roweq matname [, quoted]
returns the equation names of the columns of matname, listed one after another and separated by one space. As many names are listed as there are columns of matname. If the eqname of a column is blank, _ (underscore) is substituted. Thus roweq might return “Poor Poor Poor Average Average” for one matrix and “_ _ _ _ _” for another. quoted specifies that equation names be enclosed in double quotes.

coleq matname [, quoted]
is like roweq but returns the equation names of the columns.

rownumb matname string
returns the row number of matname that matches string.

colnumb matname string
is like rownumb but returns the column number of matname.

roweqnumb matname string
returns the row equation number of matname that matches string.

coleqnumb matname string
is like roweqnumb but returns the column equation number of matname.

rowfreeparms matname
returns the number of free parameters in rows of matname.

colfreeparms matname
returns the number of free parameters in columns of matname.

rownlfs matname
returns the number of linear forms among the rows of matname.

colnlfs matname
returns the number of linear forms among the columns of matname.

rowsof matname
returns the number of rows of matname.
colsof \textit{matname}
  returns the number of columns of \textit{matname}.

\texttt{rowvarlist matname}
  returns the variable list corresponding to the rows of \textit{matname}.

\texttt{colvarlist matname}
  returns the variable list corresponding to the columns of \textit{matname}.

\texttt{rowlfnames matname [ , quoted ]}
  returns the list of names corresponding to the linear forms in the rows of \textit{matname}.

\texttt{collfnames matname [ , quoted ]}
  returns the list of names corresponding to the linear forms in the columns of \textit{matname}.

In all cases, \textit{matname} may be either a Stata matrix name or a matrix stored in \texttt{e()} or \texttt{r()}, such as \texttt{e(b)} or \texttt{e(V)}.

**Macro function related to time-series operators**

\texttt{tsnorm string}
  returns the canonical form of \textit{string} when \textit{string} is interpreted as a time-series operator. For instance, if \textit{string} is \texttt{1dl}, then \texttt{L2D} is returned, or if \textit{string} is \texttt{1.1dl}, then \texttt{L3D} is returned. If \textit{string} is nothing, “” is returned.

\texttt{tsnorm string , varname}
  returns the canonical form of \textit{string} when \textit{string} is interpreted as a time-series–operated variable. For instance, if \textit{string} is \texttt{1dl.gnp}, then \texttt{L2D.gnp} is returned, or if \textit{string} is \texttt{1.1dl.gnp}, then \texttt{L3D.gnp} is returned. If \textit{string} is just a variable name, then the variable name is returned.

**Macro function for copying a macro**

\texttt{copy \{local|global\} mname}
  returns a copy of the contents of \textit{mname}, or an empty string if \textit{mname} is undefined.

**Macro functions for parsing**

\texttt{word count string}
  returns the number of tokens in \textit{string}. A token is a word (characters separated by spaces) or set of words enclosed in quotes. Do not enclose \textit{string} in double quotes because \texttt{word count} will return 1.

\texttt{word # of string}
  returns the \#th token of \textit{string}. Do not enclose \textit{string} in double quotes.

\texttt{piece \#1 \#2 of "string" [ , nobreak ]}
  returns a piece of \textit{string}. This macro function provides a smart method of breaking a string into pieces of roughly the specified display columns. \#1 specifies which piece to obtain. \#2 specifies the maximum number of display columns of each piece. Each piece is built trying to fill to the maximum number of display columns without breaking in the middle of a word. However, when a word takes more display columns than \#2, the word will be split unless \texttt{nobreak} is specified. \texttt{nobreak} specifies that words not be broken, even if that would result in a string being displayed in more than \#2 columns.

Compound double quotes may be used around \textit{string} and must be used when \textit{string} itself might contain double quotes.
strlen \{ local | global \} mname
returns the length of the contents of mname in bytes. If mname is undefined, then 0 is returned.
For instance,

```
. constraint 1 price = weight
. local myname : constraint 1
. macro list _myname
   _myname price = weight
. local lmyname : strlen local myname
. macro list _lmyname
   _lmyname: 14
```

ustrlen \{ local | global \} mname
returns the length of the contents of mname in Unicode characters. If mname is undefined, then 0 is returned.

udstrlen \{ local | global \} mname
returns the length of the contents of mname in display columns. If mname is undefined, then 0 is returned.

subinstr local mname "from" "to"
returns the contents of mname, with the first occurrence of “from” changed to “to”.

subinstr local mname "from" "to", all
does the same thing but changes all occurrences of “from” to “to”.

subinstr local mname "from" "to", word
returns the contents of mname, with the first occurrence of the word “from” changed to “to”. A word is defined as a space-separated token or a token at the beginning or end of the string.

subinstr local mname "from" "to", all word
does the same thing but changes all occurrences of the word “from” to “to”.

subinstr global mname ...
is the same as the above but obtains the original string from the global macro $mname rather than from the local macro mname.

subinstr ... global mname ... ... count({global | local} mname2)
in addition to the usual, places a count of the number of substitutions in the specified global or in local macro mname2.

Example 1

```
. local string "a or b or c or d"
. global newstr : subinstr local string "c" "sand"
. display "$newstr"
a or b or sand or d
. local string2 : subinstr global newstr "or" "and", all count(local n)
. display "'string2'"
a and b and sand and d
```
display "'n'"
. local string3: subinstr local string2 "and" "x", all word
. display "'string3'"

The “and” in “sand” was not replaced by “x” because the word option was specified.

Macro expansion operators and function

There are five macro expansion operators that may be used within references to local (not global) macros.

‘lclname++’ and ‘++lclname’ provide inline incrementation of local macro lclname. For example,

. local x 5
. display "'x++'"
5
. display "'x'"
6

++ can be place before lclname, in which case lclname is incremented before ‘lclname’ is evaluated.

. local x 5
. display "'++x'"
6
. display "'x'"
6

‘lclname--’ and ‘--lclname’ provide inline decrementation of local macro lclname.

‘=exp’ provides inline access to Stata’s expression evaluator. The Stata expression exp is evaluated and the result substituted. For example,

. local alpha = 0.05
. regress mpg weight, level('=100*(1-'alpha')')

‘:macro_fcn’ provides inline access to Stata’s macro functions. ‘:macro_fcn’ evaluates to the results of the macro function macro_fcn. For example,

. format ':format gear_ratio' headroom

will set the display format of headroom to that of gear_ratio, which was obtained via the macro function format.

‘.class_directive’ provides inline access to class-object values. See [P] class for details.

The macro expansion function ‘macval(name)’ expands local macro name but not any macros contained within name. For instance, if name contained “example ‘of’ macval”, ‘name’ would expand to “example macval” (assuming that ‘of’ is not defined), whereas ‘macval(name)’ would expand to “example ‘of’ macval”. The ‘of’ would be left just as it is.

Technical note

To store an unexpanded macro within another macro, use “\” to prevent macro expansion. This is useful when defining a formula with elements that will be substituted later in the program. To save the formula sqrt(‘A’ + 1), where ‘A’ is a macro you would like to fill in later, you would use the command

. local formula sqrt(\‘A’ + 1)
which would produce

```
.macro list _formula
_formula: sqrt('A' + 1)
```

Because the statement `\`A`' was used, it prevented Stata from expanding the macro `\`A`' when it stored it in the macro `\`formula`'.

Now you can fill in the macro `\`A`' with different statements and have this be reflected when you call `\`formula`'.

```
.local A 2^3
.display "formula 'formula': " 'formula'
formula sqrt(2^3 + 1): 3
.local A log10((\`A` + 2)^3)
.display "formula 'formula': " 'formula'
formula sqrt(log10((2^3 + 2)^3) + 1): 2
```

### The tempvar, tempname, and tempfile commands

The **tempvar**, **tempname**, and **tempfile** commands create names that may be used for temporary variables, temporary scalars and matrices, and temporary files. A temporary element exists while the program or do-file is running but, once it concludes, automatically ceases to exist.

#### Temporary variables

You are writing a program, and in the middle of it you need to calculate a new variable equal to \[\text{var1}^2 + \text{var2}^2\] for use in the calculation. You might be tempted to write

```
(code omitted)
generate sumsq = var1^2 + var2^2
(code continues)
(code uses sumsq in subsequent calculations)
drop sumsq
```

This would be a poor idea. First, users of your program might already have a variable called `sumsq`, and if they did, your program would break at the `generate` statement with the error “sumsq already defined”. Second, your program in the subsequent code might call some other program, and perhaps that program also attempts (poorly) to create the variable `sumsq`. Third, even if nothing goes wrong, if users press **Break** after your code executes `generate` but before `drop`, you would confuse them by leaving behind the `sumsq` variable.

The way around these problems is to use temporary variables. Your code should read

```
(code omitted)
tempvar sumsq
generate `sumsq' = var1^2 + var2^2
(code continues)
(code uses `sumsq' in subsequent calculations)
(you do not bother to drop `sumsq')
```

The **tempvar** `sumsq` command creates a local macro called `sumsq` and stores it a name that is different from any name currently in the data. Subsequently, you then use `\`sumsq`' with single quotes around it rather than `sumsq` in your calculation, so that rather than naming your temporary variable `sumsq`, you are naming it whatever Stata wants you to name it. With that small change, your program works just as before.
Another advantage of temporary variables is that you do not have to drop them—Stata will do that for you when your program terminates, regardless of the reason for the termination. If a user presses *Break* after the *generate*, your program is stopped, the temporary variables are dropped, and things really are just as if the user had never run your program.

**Technical note**

What do these temporary variable names assigned by Stata look like? It should not matter to you; however they look, they are guaranteed to be unique (*tempvar* will not hand out the same name to more than one concurrently executing program). Nevertheless, to satisfy your curiosity,

```
. tempvar var1 var2
. display "'var1' 'var2'"
__000009 __00000A
```

Although we reveal the style of the names created by *tempvar*, you should not depend on this style. All that is important is that

- The names are unique; they differ from one call to the next.
- You should not prefix or suffix them with additional characters.
- Stata keeps track of any names created by *tempvar* and, when the program or do-file ends, searches the data for those names. Any variables found with those names are automatically dropped. This happens regardless of whether your program ends with an error.

**Temporary scalars and matrices**

*tempname* is the equivalent of *tempvar* for obtaining names for scalars and matrices. This use is explained, with examples, in [*P* *scalar*].

**Technical note**

The temporary names created by *tempname* look just like those created by *tempvar*. The same cautions and features apply to *tempname* as *tempvar*:

- The names are unique; they differ from one call to the next.
- You should not prefix or suffix them with additional characters.
- Stata keeps track of any names created by *tempname* and, when the program or do-file ends, searches for scalars or matrices with those names. Any scalars or matrices so found are automatically dropped; see [*P* *scalar*]. This happens regardless of whether your program ends with an error.

**Temporary files**

*tempfile* is the equivalent of *tempvar* for obtaining names for disk files. Before getting into that, let's discuss how you should not use *tempfile*. Sometimes, in the midst of your program, you will find it necessary to destroy the user's data to obtain your desired result. You do not want to change the data, but it cannot be helped, and therefore you would like to arrange things so that the user's original data are restored at the conclusion of your program.
You might then be tempted to save the user’s data in a (temporary) file, do your damage, and then restore the data. You can do this, but it is complicated, because you then have to worry about the user pressing *Break* after you have stored the data and done the damage but have not yet restored the data. Working with *capture* (see [P] *capture*), you can program all of this, but you do not have to. Stata’s *preserve* command (see [P] *preserve*) will handle saving and restoring the user’s data, regardless of how your program ends.

Still, there may be times when you need temporary files. For example,

```
preserve // preserve user’s data
keep var1 var2 xvar
save master, replace
drop var2
save part1, replace
use master, clear
drop var1
rename var2 var1
append using part1
erase master.dta
erase part1.dta
```

This is poor code, even though it does use *preserve* so that, regardless of how this code concludes, the user’s original data will be restored. It is poor because datasets called *master.dta* and *part1.dta* might already exist, and, if they do, this program will replace the user’s (presumably valuable) data. It is also poor because, if the user presses *Break* before both (temporary) datasets are erased, they will be left behind to consume (presumably valuable) disk space.

Here is how the code should read:

```
preserve // preserve user’s data
keep var1 var2 xvar
tempfile master part1 // declare temporary files
save "'master'", replace
drop var2
save "'part1'", replace
use "'master'", clear
drop var1
rename var2 var1
append using "'part1'", replace
```

In this version, Stata was asked to provide the names of temporary files in local macros named *master* and *part1*. We then put single quotes around *master* and *part1* wherever we referred to them so that, rather than using the names *master* and *part1*, we used the names Stata handed us. At the end of our program, we no longer bother to erase the temporary files. Because Stata gave us the temporary filenames, it knows that they are temporary and erases them for us if our program completes, has an error, or the user presses *Break*.

**Technical note**

What do the temporary filenames look like? Again it should not matter to you, but for the curious,

```
.tempfile file1 file2
.display "'file1' 'file2'	''
/tmp/St13310.0001 /tmp/St13310.0002
```
We were using the Unix version of Stata; had we been using the Windows version, the last line might read

```
  . display "'file1' 'file2'"
  C:\WIN\TEMP\ST_0a00000c.tmp C:\WIN\TEMP\ST_00000d.tmp
```

Under Windows, Stata uses the environment variable TEMP to determine where temporary files are to be located. This variable is typically set in your \texttt{autoexec.bat} file. Ours is set to C:\WIN\TEMP. If the variable is not defined, Stata places temporary files in your current directory.

Under Unix, Stata uses the environment variable TMPDIR to determine where temporary files are to be located. If the variable is not defined, Stata locates temporary files in /tmp.

Although we reveal the style of the names created by \texttt{tempfile}, just as with \texttt{tempvar}, you should not depend on it. \texttt{tempfile} produces names the operating system finds pleasing, and all that is important is that

- The names are unique; they differ from one call to the next.
- You should assume that they are so long that you cannot prefix or suffix them with additional characters and make use of them.
- Stata keeps track of any names created by \texttt{tempfile}, and, when your program or do-file ends, looks for files with those names. Any files found are automatically erased. This happens regardless of whether your program ends with an error.

\section*{Manipulation of macros}

\texttt{macro dir} and \texttt{macro list} list the names and contents of all defined macros; both do the same thing:

```
  . macro list
  S_FNDATE: 13 Apr 2020 17:45
  S_FN: C:\Program Files\Stata17\ado\base\a\auto.dta
tofname: str18
  S_level: 95
  F1: help advice;
  F2: describe;
  F7: save
  F8: use
  S_MACH: PC (64-bit x86-64)
  S_OS: Windows
  S_OSDTL: 64-bit
  S_StataSE: SE
  S_StataMP: MP
  S_ADO: BASE;SITE;.PERSONAL;PLUS;OLDPLACE
  _file2: C:\WIN\Temp\ST_0a00000d.tmp
  _file1: C:\WIN\Temp\ST_0a00000c.tmp
  _var2: __00000A
  _var1: __000009
  _str3: a x b x sand x d
  _dl: Employee Data
  _lbl: Employee name
  _vl: sexlbl
  _fmt: %9.0g
```

\texttt{macro drop} eliminates macros from memory, although it is rarely used because most macros are local and automatically disappear when the program ends. Macros can also be eliminated by defining their contents to be nothing using \texttt{global} or \texttt{local}, but \texttt{macro drop} is more convenient.
Typing `macro drop base*` drops all global macros whose names begin with `base`.

Typing `macro drop _all` eliminates all macros except system macros—those with names that begin with “S_”.

Typing `macro drop S_*` does not drop all system macros that begin with “S_”. It leaves certain macros in place that should not be casually deleted.

**Example 2**

```stata
.macro drop _var* _lbl tofname _fmt
.macro list
S_FNDATE: 13 Apr 2020 17:45
S_FN: C:\Program Files\Stata17\ado\base\a\auto.dta
S_level: 95
F1: help advice;
F2: describe;
F7: save
F8: use
S_MACH: PC (64-bit x86-64)
S_OS: Windows
S_OSDTL: 64-bit
S_StataSE: SE
S_StataMP: MP
S_ADO: BASE;SITE;.;PERSONAL;PLUS;OLDPLACE
_file2: C:\WIN\Temp\ST_0a00000d.tmp
_file1: C:\WIN\Temp\ST_0a00000c.tmp
_str3: a x b x sand x d
_dl: Employee Data
_vl: sexlbl
.macro drop _all
.macro list
S_FNDATE: 13 Apr 2020 17:45
S_FN: C:\Program Files\Stata17\ado\base\a\auto.dta
S_level: 95
S_MACH: PC (64-bit x86-64)
S_OS: Windows
S_OSDTL: 64-bit
S_StataSE: SE
S_StataMP: MP
S_ADO: BASE;SITE;.;PERSONAL;PLUS;OLDPLACE
.macro drop S_*
.macro list
S_level: 95
S_MACH: PC (64-bit x86-64)
S_OS: Windows
S_OSDTL: 64-bit
S_StataSE: SE
S_StataMP: MP
S_ADO: BASE;SITE;.;PERSONAL;PLUS;OLDPLACE
```

**Technical note**

Stata usually requires that you explicitly drop something before redefining it. For instance, before redefining a value label with the `label define` command or redefining a program with the `program define` command, you must type `label drop` or `program drop`. This way, you are protected from accidentally replacing something that might require considerable effort to reproduce.
Macros, however, may be redefined freely. It is not necessary to drop a macro before redefining it. Macros typically consist of short strings that could be easily reproduced if necessary. The inconvenience of the protection is not justified by the small benefit.

Macros as arguments

Sometimes programs have in a macro a list of things—numbers, variable names, etc.—that you wish to access one at a time. For instance, after parsing (see [U] 18.4 Program arguments), you might have in the local macro `varlist` a list of variable names. The `tokenize` command (see [P] tokenize) will take any macro containing a list and assign the elements to local macros named `1`, `2`, and so on. That is, if `varlist` contained “mpg weight displ”, then coding

```
tokenize `varlist'
```

will make `1` contain “mpg”, `2` contain “weight”, `3` contain “displ”, and `4` contain “” (nothing). The empty fourth macro marks the end of the list.

`macro shift` can be used to work through these elements one at a time in constructs like

```
while "'1'" != "" {
    do something based on '1'
    macro shift
}
```

`macro shift` discards `1`, shifts `2` to `1`, `3` to `2`, and so on. For instance, in our example, after the first `macro shift`, `1` will contain “weight”, `2` will contain “displ”, and `3` will contain “” (nothing).

It is better to avoid `macro shift` and instead code

```
local i = 1
while "'i'" != "" {
    do something based on 'i'
    local i = 'i' + 1
}
```

This second approach has the advantage that it is faster. Also what is in `1`, `2`, ... remains unchanged so that you can pass through the list multiple times without resetting it (coding “`tokenize `varlist'`” again).

It is even better to avoid `tokenize` and the numbered macros altogether and to instead loop over the variables in `varlist` directly:

```
foreach var of local varlist {
    do something based on 'var'
}
```

This is easier to understand and executes even more quickly; see [P] foreach.

`macro shift #` performs multiple macro shifts, or if `#` is 0, none at all. That is, `macro shift 2` is equivalent to two `macro shift` commands. `macro shift 0` does nothing.

Also see [P] macro lists for other list-processing commands.

References


Also see

[P] char — Characteristics

[P] creturn — Return c-class values

[P] display — Display strings and values of scalar expressions

[P] gettoken — Low-level parsing

[P] macro lists — Manipulate lists

[P] matrix — Introduction to matrix commands

[P] numlist — Parse numeric lists

[P] preserve — Preserve and restore data

[P] program — Define and manipulate programs

[P] return — Return stored results

[P] scalar — Scalar variables

[P] syntax — Parse Stata syntax

[P] tokenize — Divide strings into tokens

[M-5] st_global( ) — Obtain strings from and put strings into global macros

[M-5] st_local( ) — Obtain strings from and put strings into Stata macros

[U] 12.8 Characteristics

[U] 18 Programming Stata

[U] 18.3 Macros

*Stata Functions Reference Manual*
**Description**

The macro function `list` manipulates lists. See [P] `macro` for other macro functions.

uniq $A$ returns $A$ with duplicate elements removed. The resulting list has the same ordering of its elements as $A$; duplicate elements are removed from their rightmost position. If $A = “a b a c a”$, uniq returns “$a b c$”.

dups $A$ returns the duplicate elements of $A$. If $A = “a b a c a”$, dups returns “$a a$”.

sort $A$ returns $A$ with its elements placed in alphabetical (ascending ASCII or code-point) order.

retokenize $A$ returns $A$ with single spaces between elements. Logically speaking, it makes no difference how many spaces a list has between elements, and thus retokenize leaves the list logically unchanged.

clean $A$ returns $A$ retokenized and with each element adorned minimally. An element is said to be unadorned if it is not enclosed in quotes (for example, $a$). An element may also be adorned in simple or compound quotes (for example, "$a$" or ‘"$a"’). Logically speaking, it makes no difference how elements are adorned, assuming that they are adorned adequately. The list

```
"a", "b c", ‘"b"c"’ d
```

is equal to

```
a "b c" ‘"b"c"’ d
```

clean, in addition to performing the actions of retokenize, adorns each element minimally: not at all if the element contains no spaces or quotes, in simple quotes (" and ") if it contains spaces but not quotes, and in compound quotes (‘" and “”) otherwise.

$A | B$ returns the union of $A$ and $B$, the result being equal to $A$ with elements of $B$ not found in $A$ added to the tail. For instance, if $A = “a b c”$ and $B = “b d e”$, $A | B$ is “$a b c d e$”. If you instead want list concatenation, you code,

```
local newlist ‘‘A’ ‘‘B’’
```

In the example above, this would return “$a b c b d e$”.

$A & B$ returns the intersection of $A$ and $B$. If $A = “a b c d”$ and $B = “b c f g”$, then $A & B = “b c”$.

$A - B$ returns a list containing elements of $A$ with the elements of $B$ removed, with the resulting elements in the same order as $A$. For instance, if $A = “a b c d”$ and $B = “b e”$, the result is “$a c d$”.

$A == B$ returns 0 or 1; it returns 1 if $A$ is equal to $B$, that is, if $A$ has the same elements as $B$ and in the same order. Otherwise, 0 is returned.

$A === B$ returns 0 or 1; it returns 1 if $A$ is equivalent to $B$, that is, if $A$ has the same elements as $B$ regardless of the order in which the elements appear. Otherwise, 0 is returned.
$A$ in $B$ returns 0 or 1; it returns 1 if all elements of $A$ are found in $B$. If $A$ is empty, in returns 1. Otherwise, 0 is returned.

`sizeof A` returns the number of elements of $A$. If $A = \text{"a b c"}$, `sizeof A` is 3. (sizeof returns the same result as the macro function `word count`; see Macro functions for parsing under Syntax in [P] macro.)

`posof "element" in A` returns the location of `macname` in $A$ or returns 0 if not found. For instance, if $A$ contains `"a b c d"`, then `posof "b" in A` returns 2. (word # of may be used to extract positional elements from lists, as can tokenize and gettoken; see Macro functions for parsing under Syntax in [P] macro and also see [P] tokenize and [P] gettoken.)

It is the element itself and not a macroname that you type as the first argument. In a program where macro `tofind` contained an element to be found in list (macro) variables, you might code

```
local i : list posof 'tomfind' in variables
```

`element` must be enclosed in simple or compound quotes.

**Syntax**

```plaintext
{local | global} macname : list uniq macname
{local | global} macname : list dups macname
{local | global} macname : list sort macname
{local | global} macname : list retokenize macname
{local | global} macname : list clean macname
{local | global} macname : list macname | macname
{local | global} macname : list macname & macname
{local | global} macname : list macname - macname
{local | global} macname : list macname == macname
{local | global} macname : list macname === macname
{local | global} macname : list macname in macname
{local | global} macname : list sizeof macname
{local | global} macname : list posof "element" in macname
```

Note: Where `macname` appears above, it is the name of a macro and not its contents that you are to type. For example, you are to type

```
local result : list list1 | list2
```
and not

\[ \text{local result: list } \texttt{"list1"} \mid \texttt{"list2"} \]

\textbf{macnames} that appear to the right of the colon are assumed to be the names of local macros. You may type \texttt{local(macname)} to emphasize that fact. Type \texttt{global(macname)} if you wish to refer to a global macro.

\section*{Remarks and examples}

Remarks are presented under the following headings:

\textit{Treatment of adornment}
\textit{Treatment of duplicate elements in lists}

A \textit{list} is a space-separated set of elements listed one after the other. The individual elements may be enclosed in quotes, and elements containing spaces obviously must be enclosed in quotes. The following are examples of lists:

\begin{verbatim}
this that what
"first element" second "third element" 4
this that what this that
\end{verbatim}

Also a list could be empty.

Do not confuse varlist with list. Varlists are a special notation, such as \texttt{"id m* pop*"}, which is a shorthand way of specifying a list of variables; see [U] 11.4 varname and varlists. Once expanded, however, a varlist is a list.

\section*{Treatment of adornment}

An element of a list is said to be adorned if it is enclosed in quotes. Adornment, however, plays no role in the substantive interpretation of lists. The list

\begin{verbatim}
a "b" c
\end{verbatim}

is identical to the list

\begin{verbatim}
a b c
\end{verbatim}

\section*{Treatment of duplicate elements in lists}

With the exception of \texttt{uniq} and \texttt{dups}, all list functions treat duplicates as being distinct. For instance, consider the list \texttt{A},

\begin{verbatim}
a b c b
\end{verbatim}

Notice that \texttt{b} appears twice in this list. You want to think of the list as containing \texttt{a}, the first occurrence of \texttt{b}, \texttt{c}, and the second occurrence of \texttt{b}:

\begin{verbatim}
a b1 c b2
\end{verbatim}

Do the same thing with the duplicate elements of all lists, carry out the operation on the now unique elements, and then erase the subscripts from the result.
If you were to ask whether $B = “b\ b”$ is in $A$, the answer would be yes, because $A$ contains two occurrences of $b$. If $B$ contained “$b\ b\ b$", however, the answer would be no because $A$ does not contain three occurrences of $b$.

Similarly, if $B = “b\ b”$, then $A \ | \ B = “a\ b\ c\ b”$, but if $B = “b\ b\ b”$, then $A \ | \ B = “a\ b\ c\ b\ b”$.

Also see

[P] macro — Macro definition and manipulation
makecns — Constrained estimation

Description

makecns is a programmer’s command that facilitates adding constraints to estimation commands. makecns will create a constraint matrix and displays a note for each constraint that is dropped because of an error. When called without arguments, makecns will add missing factor-variable constraints implied by base levels, empty levels, and omitted coefficients. The constraint matrix is stored in e(Cns).

matcproc returns matrices helpful for performing constrained estimation, including the constraint matrix.

If your interest is simply in using constraints in a command that supports constrained estimation, see [R] constraint.

Syntax

Build constraints

makecns [numlist | matname] [, options]

Create constraint matrix

matcproc T a C

numlist is a list of constraint numbers, separated by blanks or dashes; matname is an existing matrix representing the constraints and must have one more column than the e(b) and e(V) matrices.

T, a, and C are names of new or existing matrices.

<table>
<thead>
<tr>
<th>options</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nocnsnotes</td>
<td>do not display notes when constraints are dropped</td>
</tr>
<tr>
<td>displaycns</td>
<td>display the system-stored constraint matrix</td>
</tr>
<tr>
<td>r</td>
<td>return the accepted constraints in r(); this option overrides displaycns</td>
</tr>
</tbody>
</table>

collect is allowed; see [U] 11.1.10 Prefix commands.

Options

nocnsnotes prevents notes from being displayed when constraints are dropped.
displaycns displays the system-stored constraint matrix in readable form.
r returns the accepted constraints in r(). This option overrides displaycns.
Remarks and examples

Remarks are presented under the following headings:

- Introduction
- Overview
- Mathematics
- Linkage of the mathematics to Stata

Introduction

Users of estimation commands that allow constrained estimation define constraints with the `constraint` command; they indicate which constraints they want to use by specifying the `constraint(numlist)` option to the estimation command. This entry concerns programming such sophisticated estimators. If you are programming using `ml`, you can ignore this entry. Constraints are handled automatically (and if you were to look inside the `ml` code, you would find that it uses `makecns`).

Before reading this entry, you should be familiar with constraints from a user’s perspective; see [R] constraint. You should also be familiar with programming estimation commands that do not include constraints; see [P] `ereturn`.

Overview

You have an estimation command and wish to allow a set of linear constraints to be specified for the parameters by the user and then to produce estimates subject to those constraints. Stata will do most of the work for you. First, it will collect the constraints—all you have to do is add an option to your estimation command to allow the user to specify which constraints to use. Second, it will process those constraints, converting them from algebraic form (such as `group1=group2`) to a constraint matrix. Third, it will convert the constraint matrix into two matrices that will, for maximum likelihood estimation, allow you to write your routine almost as if there were no constraints.

There will be a “reduced-form” parameter vector, $b_c$, which your likelihood-calculation routine will receive. That vector, multiplied by one of the almost magical matrices and then added to the other, can be converted into a regular parameter vector with the constraints applied, so other than the few extra matrix calculations, you can calculate the likelihood function as if there were no constraints. You can do the same thing with respect to the first and second derivatives (if you are calculating them), except that, after getting them, you will need to perform another matrix multiplication or two to convert them into the reduced form.

Once the optimum is found, you will have reduced-form parameter vector $b_c$ and variance–covariance matrix $V_c$. Both can be easily converted into full-form-but-constrained $b$ and $V$.

Finally, you will `ereturn post` the results along with the constraint matrix Stata made up for you in the first place. You can, with a few lines of program code, arrange it so that, every time results are replayed, the constraints under which they were produced areredisplayed in standard algebraic format.
Mathematics

Let \( Rb' = r \) be the constraint for \( R \), a \( c \times p \) constraint matrix imposing \( c \) constraints on \( p \) parameters; \( b \), a \( 1 \times p \) parameter vector; and \( r \), a \( c \times 1 \) vector of constraint values.

We wish to construct a \( p \times k \) matrix, \( T \), that takes \( b \) into a reduced-rank form, where \( k = p - c \). There are obviously many \( T \) matrices that will do this; we choose one with the properties

\[
\begin{align*}
  b_c &= b_0 T \\
  b &= b_c T' + a
\end{align*}
\]

where \( b_c \) is a reduced-form projection of any solution \( b_0 \); that is, \( b_c \) is a vector of lesser dimension (\( 1 \times k \) rather than \( 1 \times p \)) that can be treated as if it were unconstrained. The second equation says that \( b_c \) can be mapped back into a higher-dimensioned, properly constrained \( b \); \( 1 \times p \) vector \( a \) is a constant that depends only on \( R \) and \( r \).

With such a \( T \) matrix and \( a \) vector, you can engage in unconstrained optimization of \( b_c \). If the estimate \( b_c \) with variance–covariance matrix \( V_c \) is produced, it can be mapped back into

\[
(\mathbf{b}_c, r') = \mathbf{b}(T, R')
\]

because

\[
(\mathbf{b}_c, r') = \mathbf{b}(\mathbf{T}, \mathbf{R}')
\]

If \( R \) consists of a set of consistent constraints, then it is guaranteed to have rank \( c \). Thus \( RR' \) is a \( c \times c \) invertible matrix.

We will now show that \( RT = 0 \) and \( R(LL') = R \).

Because \( R \): \( c \times p \) is assumed to be of rank \( c \), the first \( k \) eigenvalues of \( P = I - R'(RR')^{-1}R \) are positive and the last \( c \) are zero. Break \( R \) into a basis spanned by these components. If \( R \) had any components in the first \( k \), they could not be annihilated by \( P \), contradicting

\[
RP = R - RR'(RR')^{-1}R = 0
\]

Therefore, \( T \) and \( R \) are orthogonal to each other. Because \( (\mathbf{T}, L) \) is an orthonormal basis, \( (\mathbf{T}, L)' \) is its inverse, so \( (\mathbf{T}, L)(\mathbf{T}, L)' = I \). Thus

\[
\begin{align*}
  TT' + LL' &= I \\
  (TT' + LL')R' &= R' \\
  (LL')R' &= R'
\end{align*}
\]

So we conclude that \( r = bR(LL') \). \( RL \) is an invertible \( c \times c \) matrix, so

\[
\begin{align*}
  \{b_c, r'(L'R')^{-1}\} &= \mathbf{b}(\mathbf{T}, \mathbf{L})
\end{align*}
\]

Technical note

So how did we get so lucky? This happy solution arises if

\[
\begin{align*}
  T &= \text{first } k \text{ eigenvectors of } I - R'(RR')^{-1}R \quad (p \times k) \\
  L &= \text{last } c \text{ eigenvectors of } I - R'(RR')^{-1}R \quad (p \times c) \\
  a &= r'(L'R')^{-1}L'
\end{align*}
\]

because

\[
(\mathbf{b}_c, r') = \mathbf{b}(\mathbf{T}, \mathbf{R}')
\]

If \( R \) consists of a set of consistent constraints, then it is guaranteed to have rank \( c \). Thus \( RR' \) is a \( c \times c \) invertible matrix.

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Therefore, \( T \) and \( R \) are orthogonal to each other. Because \( (\mathbf{T}, L) \) is an orthonormal basis, \( (\mathbf{T}, L)' \) is its inverse, so \( (\mathbf{T}, L)(\mathbf{T}, L)' = I \). Thus

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\]

So we conclude that \( r = bR(LL') \). \( RL \) is an invertible \( c \times c \) matrix, so

\[
\begin{align*}
  \{b_c, r'(L'R')^{-1}\} &= \mathbf{b}(\mathbf{T}, \mathbf{L})
\end{align*}
\]
Remember, $\mathbf{(T, L)}$ is a set of eigenvectors, meaning $(\mathbf{T, L})^{-1} = (\mathbf{T', L'})$, so $\mathbf{b} = \mathbf{b_c T' + r'(L'R')}^{-1}\mathbf{L'}$.

If a solution is found by likelihood methods, the reduced-form parameter vector is passed to the maximizer and from there to the program that computes a likelihood value from it. To find the likelihood value, the inner routines can compute $\mathbf{b} = \mathbf{b_c T' + a}$. The routine may then go on to produce a set of $1 \times p$ first derivatives, $\mathbf{d}$, and $p \times p$ second derivatives, $\mathbf{H}$, even though the problem is of lesser dimension. These matrices can be reduced to the $k$-dimensional space via

$$
\begin{align*}
\mathbf{d_c} &= \mathbf{dT} \\
\mathbf{H_c} &= \mathbf{T'HT}
\end{align*}
$$

**Technical note**

Alternatively, if a solution were to be found by direct matrix methods, the programmer must derive a new solution based on $\mathbf{b} = \mathbf{b_c T' + a}$. For example, the least-squares normal equations come from differentiating $(\mathbf{y - Xb})^2$. Setting the derivative with respect to $\mathbf{b}$ to zero results in

$$
\mathbf{T'X'}\left\{\mathbf{y - X(Tb_c' + a')}\right\} = 0
$$

yielding

$$
\begin{align*}
\mathbf{b_c'} &= (\mathbf{T'X'}\mathbf{XT})^{-1}(\mathbf{T'X'}\mathbf{y} - \mathbf{T'X'}\mathbf{Xa'}) \\
\mathbf{b'} &= \mathbf{T}\left\{(\mathbf{T'X'}\mathbf{XT})^{-1}(\mathbf{T'X'}\mathbf{y} - \mathbf{T'X'}\mathbf{Xa'})\right\} + \mathbf{a'}
\end{align*}
$$

Using the matrices $\mathbf{T}$ and $\mathbf{a}$, the solution is not merely to constrain the $\mathbf{b'}$ obtained from an unconstrained solution $(\mathbf{X'X})^{-1}\mathbf{X'y}$, even though you might know that, here, with further substitutions this could be reduced to

$$
\mathbf{b'} = (\mathbf{X'X})^{-1}\mathbf{X'y} + (\mathbf{X'X})^{-1}\mathbf{R'}\{\mathbf{R(X'X)^{-1}R'}\}^{-1}\{\mathbf{r - R(X'X)^{-1}X'y}\}
$$

**Linkage of the mathematics to Stata**

Users define constraints using the `constraint` command; see \[R\] `constraint`. The constraints are numbered, and Stata stores them in algebraic format—the same format in which the user typed them. Stata does this because, until the estimation problem is defined, it cannot know how to interpret the constraint. Think of the constraint $\_b[\text{group1}]=\_b[\text{group2}]$, meaning that two coefficients are to be constrained to equality, along with the constraint $\_b[\text{group3}]=2$. The constraint matrices $\mathbf{R}$ and $\mathbf{r}$ are defined so that $\mathbf{Rb'} = \mathbf{r}$ imposes the constraint. The matrices might be

$$
\begin{pmatrix}
0 & 0 & 1 & -1 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & 0
\end{pmatrix}
\begin{pmatrix}
b_1 \\
b_2 \\
b_3 \\
b_4 \\
b_5 \\
b_6
\end{pmatrix}
= 
\begin{pmatrix}
0 \\
2
\end{pmatrix}
$$
if it just so happened that the third and fourth coefficients corresponded to `group1` and `group2`, and the fifth corresponded to `group3`. Then again, it might look different if the coefficients were organized differently.

Therefore, Stata must wait until estimation begins to define the $R$ and $r$ matrices. Stata learns about the organization of a problem from the names bordering the coefficient vector and variance–covariance matrix. Therefore, Stata requires you to `ereturn post` a dummy estimation result that has the correct names. From that, it can now determine the organization of the constraint matrix and make it for you. Once an (dummy) estimation result has been posted, `makecns` can make the constraint matrices, and, once they are built, you can obtain copies of them from `e(Cns)`. Stata stores the constraint matrices $R$ and $r$ as a $c \times (p + 1)$ matrix $C = (R, r)$. Putting them together makes it easier to pass them to subroutines.

The second step in the process is to convert the constrained problem to a reduced-form problem. We outlined the mathematics above; the `matcproc` command will produce the $T$ and $a$ matrices. If you are performing maximum likelihood, your likelihood, gradient, and Hessian calculation subroutines can still work in the full metric by using the same $T$ and $a$ matrices to translate the reduced-format parameter vector back to the original metric. If you do this, and if you are calculating gradients or Hessians, you must remember to compress them to reduced form using the $T$ and $a$ matrices.

When you have a reduced-form solution, you translate this back to a constrained solution using $T$ and $a$. You then `ereturn post` the constrained solutions, along with the original `Cns` matrix, and use `ereturn display` to display the results.

Thus the outline of a program to perform constrained estimation is

```stata
program myest, eclass properties(...) 
version 17.0 
if replay() { // replay the results 
    if ("e(cmd)" != "myest") error 301 
syntax [, Level(cilevel) ] 
makecns , displaycns 
} 
else { // fit the model 
syntax whatever [, Level(cilevel) ] 
} 
// any other parsing of the user's estimate request 
tempname b V C T a bc Vc 
local p=number of parameters 
// define the model (set the row and column names) in 'b' 
if "'constraints'" != "" { 
    matrix 'V' = 'b'\n'b'
    ereturn post 'b' 'V', // a dummy solution 
    makecns 'constraints', display 
    matcproc 'T' 'a' 'C', // obtain solution in 'bc' and 'Vc' 
    matrix 'b' = 'bc'\n'T'
    + 'a' // note prime 
    matrix 'V' = 'T'\n'Vc'
    * 'T'
    // note prime 
    ereturn post 'b' 'V' 'C', options 
} 
else { // obtain standard solution in 'b' and 'V' 
    ereturn post 'b' 'V', options 
} 
// store whatever else you want in e() 
```

The second step in the process is to convert the constrained problem to a reduced-form problem. We outlined the mathematics above; the `matcproc` command will produce the $T$ and $a$ matrices. If you are performing maximum likelihood, your likelihood, gradient, and Hessian calculation subroutines can still work in the full metric by using the same $T$ and $a$ matrices to translate the reduced-format parameter vector back to the original metric. If you do this, and if you are calculating gradients or Hessians, you must remember to compress them to reduced form using the $T$ and $a$ matrices.

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if "'constraints'" != "" { 
    matrix 'V' = 'b'\n'b'
    ereturn post 'b' 'V', // a dummy solution 
    makecns 'constraints', display 
    matcproc 'T' 'a' 'C', // obtain solution in 'bc' and 'Vc' 
    matrix 'b' = 'bc'\n'T'
    + 'a' // note prime 
    matrix 'V' = 'T'\n'Vc'
    * 'T'
    // note prime 
    ereturn post 'b' 'V' 'C', options 
} 
else { // obtain standard solution in 'b' and 'V' 
    ereturn post 'b' 'V', options 
} 
// store whatever else you want in e() 
```
There is one point that might escape your attention: Immediately after obtaining the constraint, we display the constraints even before we undertake the estimation. This way, a user who has made a mistake may press Break rather than waiting until the estimation is complete to discover the error. Our code displays the constraints every time the results are reported, even when typing `myest` without arguments.

### Stored results

`makecns` stores the following in `r()`:

** Scalars  
`r(k_autoCns)` number of base, empty, and omitted constraints  

** Macros  
`r(clist)` constraints used (numlist or matrix name)

### Also see

-[R] `constraint` — Define and list constraints  
-[P] `ereturn` — Post the estimation results  
-[P] `macro` — Macro definition and manipulation  
-[P] `matrix` — Introduction to matrix commands  
-[P] `matrix get` — Access system matrices  
-[R] `cnsreg` — Constrained linear regression  
-[R] `ml` — Maximum likelihood estimation
Description

marksample, mark, and markout are for use in Stata programs. marksample and mark are alternatives; marksample links to information left behind by syntax, and mark is seldom used. Both create a 0/1 to-use variable that records which observations are to be used in subsequent code. markout sets the to-use variable to 0 if any variables in varlist contain missing and is used to further restrict observations.

markin is for use after marksample, mark, and markout and, sometimes, provides a more efficient encoding of the observations to be used in subsequent code. markin is rarely used.

svymarkout sets the to-use variable to 0 wherever any of the survey-characteristic variables contain missing values; it is discussed in [SVY] svymarkout and is not further discussed here.

Syntax

Create marker variable after syntax

```
marksample lname [ , novarlist strok zeroweight noby ]
```

Create marker variable

```
mark newmarkvar [ if ] [ in ] [ weight ] [ , zeroweight noby ]
```

Modify marker variable

```
markout markvar [ varlist ] [ , strok sysmissok ]
```

Find range containing selected observations

```
markin [ if ] [ in ] [ , name(lclname) noby ]
```

Modify marker variable based on survey-characteristic variables

```
svymarkout markvar
```

aweights, fweights, iweights, and pweights are allowed; see [U] 11.1.6 weight.

varlist may contain time-series operators; see [U] 11.4.4 Time-series varlists.
Options

`novarlist` is for use with `marksample`. It specifies that missing values among variables in `varlist` not cause the marker variable to be set to 0. Specify `novarlist` if you previously specified:

```
syntax newvarlist ...
```
or
```
syntax newvarname ...
```
You should also specify `novarlist` when missing values are not to cause observations to be excluded (perhaps you are analyzing the pattern of missing values).

`strok` is used with `marksample` or `markout`. Specify this option if string variables in `varlist` are to be allowed. `strok` changes rule 6 in Remarks and examples below to read

“The marker variable is set to 0 in observations for which any of the string variables in `varlist` contain "".”

`zeroweight` is for use with `marksample` or `mark`. It deletes rule 1 in Remarks and examples below, meaning that observations will not be excluded because the weight is zero.

`noby` is used rarely and only in `byable(recall)` programs. It specifies that, in identifying the sample, the restriction to the by-group be ignored. `mark` and `marksample` are to create the marker variable as they would had the user not specified the by prefix. If the user did not specify the by prefix, specifying `noby` has no effect. `noby` provides a way for `byable(recall)` programs to identify the overall sample. For instance, if the program needed to calculate the percentage of observations in the by-group, the program would need to know both the sample to be used on this call and the overall sample. The program might be coded as

```
program ..., byable(recall)
...
marksample touse
marksample alluse, noby
...
quietly count if ‘touse’
local curN = r(N)
quietly count if ‘alluse’
local totN = r(N)
local frac = ‘curN’/’totN’
...
end
```

See [P] byable.

`sysmissok` is used with `markout`. Specify this option if numeric variables in `varlist` equal to system missing (.) are to be allowed and only numeric variables equal to extended missing (.a, .b, ...) are to be excluded. The default is that all missing values (., .a, .b, ...) are excluded.

`name(lcname)` is for use with `markin`. It specifies the name of the macro to be created. If `name()` is not specified, the name `in` is used.

Remarks and examples

`marksample`, `mark`, and `markout` are for use in Stata programs. They create a 0/1 variable recording which observations are to be used in subsequent code. The idea is to determine the relevant sample early in the code:
marksample, mark, and markout assist in this.

```
program ...
    (parse the arguments)
    (use mark* to create temporary variable ‘touse’ containing 0 or 1)
    rest of code ... if ‘touse’
end
```

marksample is for use in programs where the arguments are parsed using the syntax command; see [P] syntax. marksample creates a temporary byte variable, stores the name of the temporary variable in lmacname, and fills in the temporary variable with 0s and 1s according to whether the observation should be used. This determination is made by accessing information stored by syntax concerning the varlist, if exp, etc., allowed by the program. Its typical use is

```
program ...
    syntax ...
    marksample touse
    rest of code ... if ‘touse’
end
```

mark starts with an already created temporary variable name. It fills in newmarkvar with 0s and 1s according to whether the observation should be used according to the weight, if exp, and in range specified. markout modifies the variable created by mark by resetting it to contain 0 in observations that have missing values recorded for any of the variables in varlist. These commands are typically used as

```
program ...
    (parse the arguments)
    tempvar touse
    mark ‘touse’ ...
    markout ‘touse’ ...
    rest of code ... if ‘touse’
end
```

marksample is better than mark because there is less chance that you will forget to include some part of the sample restriction. markout can be used after mark or marksample when there are variables other than the varlist and when observations that contain missing values of those variables are also to be excluded. For instance, the following code is common:

```
program ...
    syntax ... [, Denom(varname) ... ]
    marksample touse
    markout ‘touse’ ‘denom’
    rest of code ... if ‘touse’
end
```

Regardless of whether you use mark or marksample, followed or not by markout, the following rules apply:

1. The marker variable is set to 0 in observations for which weight is 0 (but see the zeroweight option).
2. The appropriate error message is issued, and everything stops if weight is invalid (such as being less than 0 in some observation or being a noninteger for frequency weights).
3. The marker variable is set to 0 in observations for which \texttt{if exp} is not satisfied.

4. The marker variable is set to 0 in observations outside \texttt{in range}.

5. The marker variable is set to 0 in observations for which any of the numeric variables in \texttt{varlist} contain a numeric missing value.

6. The marker variable is set to 0 in all observations if any of the variables in \texttt{varlist} are strings; see the \texttt{strok} option for an exception.

7. The marker variable is set to 1 in the remaining observations.

Using the name \texttt{touse} is a convention, not a rule, but it is recommended for consistency between programs.

\textbf{Technical note}

\texttt{markin} is for use after \texttt{marksample, mark, and markout} and should be used only with extreme caution. Its use is never necessary, but when it is known that the specified \texttt{if exp} will select a small subset of the observations (small being, for example, 6 of 750,000), using \texttt{markin} can result in code that executes more quickly. \texttt{markin} creates local macro ‘\texttt{lclname}’ (or ‘\texttt{in}’ if \texttt{name()} is not specified) containing the smallest \texttt{in range} that contains the \texttt{if exp}.

By far the most common programming error—made by us at StataCorp and others—is to use different samples in different parts of a Stata program. We strongly recommend that programmers identify the sample at the outset. This is easy with \texttt{marksample} (or alternatively, \texttt{mark} and \texttt{markout}). Consider a Stata program that begins

\begin{verbatim}
program myprog
    version 17.0
    syntax varlist [if] [in]
    ...
end
\end{verbatim}

Pretend that this program makes a statistical calculation based on the observations specified in \texttt{varlist} that do not contain missing values (such as a linear regression). The program must identify the observations that it will use. Moreover, because the user can specify \texttt{if exp} or \texttt{in range}, these restrictions must also be taken into account. \texttt{marksample} makes this easy:

\begin{verbatim}
version 17.0
syntax varlist [if] [in]
marksample touse
...
end
\end{verbatim}

To produce the same result, we could create the temporary variable \texttt{touse} and then use \texttt{mark} and \texttt{markout} as follows:

\begin{verbatim}
program myprog
    version 17.0
    syntax varlist [if] [in]
tempvar touse
    mark ‘touse’ ‘if’ ‘in’
    markout ‘touse’ ‘varlist’
    ...
end
\end{verbatim}

The result will be the same.
The `mark` command creates temporary variable `touse` (temporary because of the preceding `tempvar`; see [P] macro) based on the `if exp` and `in range`. If there is no `if exp` or `in range`, `touse` will contain 1 for every observation in the data. If `if price>1000` was specified by the user, only observations for which `price` is greater than 1,000 will have `touse` set to 1; the remaining observations will have `touse` set to 0.

The `markout` command updates the `touse` marker created by `mark`. For observations where `touse` is 1—observations that might potentially be used—the variables in `varlist` are checked for missing values. If such an observation has any variables equal to missing, the observation’s `touse` value is reset to 0.

Thus observations to be used all have `touse` set to 1. Including `if `touse``` at the end of statistical or data management commands will restrict the command to operate on the appropriate sample.

**Example 1**

Let’s write a program to do the same thing as `summarize`, except that our program will also engage in casewise deletion—if an observation has a missing value in any of the variables, it is to be excluded from all the calculations.

```plaintext
program cwsumm
version 17.0
syntax [varlist(fv ts)] [if] [in] [aweight fweight] [, Detail noFormat]
marksample touse
summarize `varlist' [weight`exp`] if `touse', `detail' `format'
end
```

**Technical note**

Let’s now turn to `markin`, which is for use in those rare instances where you, as a programmer, know that only a few of the observations are going to be selected, that those small number of observations probably occur close together in terms of observation number, and that speed is important. That is, the use of `markin` is never required, and a certain caution is required in its use, so it is usually best to avoid it. On the other hand, when the requirements are met, `markin` can speed programs considerably.

The safe way to use `markin` is to first write the program without it and then splice in its use. Form a `touse` variable in the usual way by using `marksample`, `mark`, and `markout`. Once you have identified the `touse` sample, use `markin` to construct an `in range` from it. Then add `in` on every command in which `if `touse``` appears, without removing the `if `touse```.

That is, pretend that our original code reads like the following:

```plaintext
program ...
    syntax ...
    marksample touse
    markout `touse' ...
    // touse now fully set
    generate ... if `touse'
    replace ... if `touse'
    summarize ... if `touse'
    replace ... if `touse'
    ...
end
```
We now change our code to read as follows:

```stata
program ...
syntax ...
marksample touse
markout 'touse' ...   // touse now fully set
markin if 'touse'   // <- new
    // we add 'in':
gen ... if 'touse' 'in'
replace ... if 'touse' 'in'
summarize ... if 'touse' 'in'
replace ... if 'touse' 'in'
...
end
```

This new version will, under certain conditions, run faster. Why? Consider the case when the program is called and there are 750,000 observations in memory. Let’s imagine that the 750,000 observations are a panel dataset containing 20 observations each on 37,500 individuals. Let’s further imagine that the dataset is sorted by `subjectid`, the individual identifier, and that the user calls our program and includes the restriction `if subject_id==4225`.

Thus our program must select 20 observations from the 750,000. That’s fine, but think about the work that `generate`, `replace`, `summarize`, and `replace` must each go to in our original program. Each must thumb through 750,000 observations, asking themselves whether `touse` is true, and 749,980 times, the answer is no. That will happen four times.

`markin` will save Stata work here. It creates a macro named `in` of the form “`in j1/j2`”, where `j1` to `j2` is the narrowest range that contains all the `touse` ≠ 0 values. Under the assumptions we made, that range will be exactly 20 long; perhaps it will be `in 84500/84520`. Now the `generate`, `replace`, `summarize`, and `replace` commands will each restrict themselves to those 20 observations. This will save them much work and the user much time.

Because there is a speed advantage, why not always use `markin` in our programs? Assume that between the `summarize` and the `replace` there was a `sort` command in our program. The `in` range constructed by `markin` would be inappropriate for our last `replace`; we would break our program. If we use `markin`, we must make sure that the `in` range constructed continues to be valid throughout our program (our construct a new one when it changes). So that is the first answer: you cannot add `markin` without thinking. The second answer is that `markin` takes time to execute, albeit just a little, and that time is usually wasted because `in` range will not improve performance because the data are not ordered as required. Taking the two reasons together, adding `markin` to most programs is simply not worth the effort.

When it is worth the effort, you may wonder why, when we added `in` to the subsequent commands, we did not simultaneously remove `if `touse`. The answer is that `in` is not a guaranteed substitute for `if`. In our example, under the assumptions made, the `in` happens to substitute perfectly, but that was just an assumption, and we have no guarantees that the user happens to have his or her data sorted in the desired way. If, in our program, we sorted the data, and then we used `markin` to produce the range, we could omit `if `touse`, but even then, we do not recommend it. We always recommend programming defensively, and the cost of evaluating `if `touse`, when `in` really does restrict the sample to the relevant observations, is barely measurable.
Reference

Also see
[P] byable — Make programs byable
[P] syntax — Parse Stata syntax
[SVY] svymarkout — Mark observations for exclusion on the basis of survey characteristics
[U] 18 Programming Stata
### matlist — Display a matrix and control its format

**Description**

`matlist` displays a matrix, allowing you to control the display format. Row and column names are used as the row and column headers. Equation names are displayed in a manner similar to estimation results.

Columns may have different formats, and lines may be shown between each column. You cannot format rows of the matrix differently.

`matlist` is an extension of the `matrix list` command (see `[P] matrix utility`).

### Syntax

**One common display format for every column**

```
matlist matrix_exp [, style_options general_options ]
```

**Each column with its own display format**

```
matlist matrix_exp, cspec(cspec) rspec(rspec) [ general_options ]
```

### Style options

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>lines(lstyle)</code></td>
<td>lines style; default between headers/labels and data</td>
</tr>
<tr>
<td><code>border(bspec)</code></td>
<td>border style; default is none</td>
</tr>
<tr>
<td><code>border</code></td>
<td>same as <code>border(all)</code></td>
</tr>
<tr>
<td><code>format(%fmt)</code></td>
<td>display format; default is <code>format(%9.0g)</code></td>
</tr>
<tr>
<td><code>twidth(#)</code></td>
<td>row-label width; default is <code>twidth(12)</code></td>
</tr>
<tr>
<td><code>left(#)</code></td>
<td>left indent for tables; default is <code>left(0)</code></td>
</tr>
<tr>
<td><code>right(#)</code></td>
<td>right indent for tables; default is <code>right(0)</code></td>
</tr>
</tbody>
</table>

### lstyle

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>oneline</code></td>
<td>between headers/labels and data; default with no equations</td>
</tr>
<tr>
<td><code>eq</code></td>
<td>between equations; default when equations are present</td>
</tr>
<tr>
<td><code>rowtotal</code></td>
<td>same as <code>oneline</code> plus line before last row</td>
</tr>
<tr>
<td><code>coltotal</code></td>
<td>same as <code>oneline</code> plus line before last column</td>
</tr>
<tr>
<td><code>rctotal</code></td>
<td>same as <code>oneline</code> plus line before last row and column</td>
</tr>
<tr>
<td><code>rows</code></td>
<td>between all rows; between row labels and data</td>
</tr>
<tr>
<td><code>columns</code></td>
<td>between all columns; between column header and data</td>
</tr>
<tr>
<td><code>cells</code></td>
<td>between all rows and columns</td>
</tr>
<tr>
<td><code>none</code></td>
<td>suppress all lines</td>
</tr>
</tbody>
</table>
**bspec**  
Border lines are drawn . . .

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>none</td>
<td>no border lines are drawn; the default</td>
</tr>
<tr>
<td>all</td>
<td>around all four sides</td>
</tr>
<tr>
<td>rows</td>
<td>at the top and bottom</td>
</tr>
<tr>
<td>columns</td>
<td>at the left and right</td>
</tr>
<tr>
<td>left</td>
<td>at the left</td>
</tr>
<tr>
<td>right</td>
<td>at the right</td>
</tr>
<tr>
<td>top</td>
<td>at the top</td>
</tr>
<tr>
<td>bottom</td>
<td>at the bottom</td>
</tr>
</tbody>
</table>

**general_options**  
Description

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>title(string)</td>
<td>title displayed above table</td>
</tr>
<tr>
<td>tindent(#</td>
<td>)</td>
</tr>
<tr>
<td>rowtitle(string)</td>
<td>title to display above row names</td>
</tr>
<tr>
<td>names(rows)</td>
<td>display row names</td>
</tr>
<tr>
<td>names(columns)</td>
<td>display column names</td>
</tr>
<tr>
<td>names(all)</td>
<td>display row and column names; the default</td>
</tr>
<tr>
<td>names(none)</td>
<td>suppress row and column names</td>
</tr>
<tr>
<td>nonames</td>
<td>same as names(none)</td>
</tr>
<tr>
<td>showcoleq(ceq)</td>
<td>specify how column equation names are displayed</td>
</tr>
<tr>
<td>roweqonly</td>
<td>display only row equation names</td>
</tr>
<tr>
<td>coleqonly</td>
<td>display only column equation names</td>
</tr>
<tr>
<td>colorcoleq(txt</td>
<td>res)</td>
</tr>
<tr>
<td>keepcoleq</td>
<td>keep columns of the same equation together</td>
</tr>
<tr>
<td>aligncolnames(ralign)</td>
<td>right-align column names</td>
</tr>
<tr>
<td>aligncolnames(lalign)</td>
<td>left-align column names</td>
</tr>
<tr>
<td>aligncolnames(center)</td>
<td>center column names</td>
</tr>
<tr>
<td>noblank</td>
<td>suppress blank line before tables</td>
</tr>
<tr>
<td>nohalf</td>
<td>display full matrix even if symmetric</td>
</tr>
<tr>
<td>nodotz</td>
<td>display missing value .z as blank</td>
</tr>
<tr>
<td>underscore</td>
<td>display underscores as blanks in row and column names</td>
</tr>
<tr>
<td>linesize(#)</td>
<td>overrule linesize setting</td>
</tr>
</tbody>
</table>

**ceq**  
Equation names are displayed

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>first</td>
<td>over the first column only; the default</td>
</tr>
<tr>
<td>each</td>
<td>over each column</td>
</tr>
<tr>
<td>combined</td>
<td>centered over all associated columns</td>
</tr>
<tr>
<td>lcombined</td>
<td>left-aligned over all associated columns</td>
</tr>
<tr>
<td>rcombined</td>
<td>right-aligned over all associated columns</td>
</tr>
</tbody>
</table>
Style options

lines\((lstyle)\) specifies where lines are drawn in the display of \textit{matrix\_exp}. The following values of \textit{lstyle} are allowed:

- \texttt{oneline} draws lines separating the row and column headers from the numerical entries. This is the default if the \textit{matrix\_exp} has no equation names.
- \texttt{eq} draws horizontal and vertical lines between equations. This is the default if the \textit{matrix\_exp} has row or column equation names.
- \texttt{rowtotal} is the same as \texttt{oneline} and has a line separating the last row (the totals) from the rest.
- \texttt{coltotal} is the same as \texttt{oneline} and has a line separating the last column (the totals) from the rest.
- \texttt{rctotal} is the same as \texttt{oneline} and has lines separating the last row and column (the totals) from the rest.
- \texttt{rows} draws horizontal lines between all rows and one vertical line between the row-label column and the first column with numerical entries.
- \texttt{columns} draws vertical lines between all columns and one horizontal line between the headers and the first numeric row.
- \texttt{cells} draws horizontal and vertical lines between all rows and columns.
- \texttt{none} suppresses all horizontal and vertical lines.

\texttt{border\[(bspec)\]} specifies the type of border drawn around the table. \textit{bspec} is any combination of the following values:

- \texttt{none} draws no outside border lines and is the default.
- \texttt{all} draws all four outside border lines.
- \texttt{rows} draws horizontal lines in the top and bottom margins.
- \texttt{columns} draws vertical lines in the left and right margins.
- \texttt{left} draws a line in the left margin.
- \texttt{right} draws a line in the right margin.
- \texttt{top} draws a line in the top margin.
- \texttt{bottom} draws a line in the bottom margin.

\texttt{border} without an argument is equivalent to \texttt{border(all)}, or, equivalently, \texttt{border(left right top bottom)}.

\texttt{format\[(\%fmt)\]} specifies the format for displaying the individual elements of the matrix. The default is \texttt{format\[(\%9.0g)\]}. See [U] 12.5 Formats: Controlling how data are displayed.

\texttt{twidth(\#)} specifies the width of the row-label column (first column). The default is \texttt{twidth(12)}.

\texttt{left(\#)} specifies that the table be indented \# spaces; the default is \texttt{left(0)}. To indent the title, see the \texttt{tindent()} option.

\texttt{right(\#)} specifies that the right margin of the table be \# spaces in from the page margin. The default is \texttt{right(0)}. The right margin affects the number of columns that are displayed before wrapping.
General options

title(string) adds string as the title displayed before the matrix. matlist has no default title or header.

tindent(#) specifies the indentation for the title; the default is tindent(0).

rowtitle(string) specifies that string be used as a column header for the row labels. This option is allowed only when both row and column labels are displayed.

names(rows | columns | all | none) specifies whether the row and column names are displayed; the default is names(all), which displays both.

nonames suppresses row and column names and is a synonym for names(none).

showcoleq(ceq) specifies how column equation names are displayed. The following ceq are allowed:
  first displays an equation name over the first column associated with that name; this is the default.
  each displays an equation name over each column.
  combined displays an equation name centered over all columns associated with that name.
  lcombined displays an equation name left-aligned over all columns associated with that name.
  rcombined displays an equation name right-aligned over all columns associated with that name.

If necessary, equation names are truncated to the width of the field in which the names are displayed. With combined, lcombined, and rcombined, the field comprises all columns and the associated separators for the equation.

roweqonly specifies that only row equation names be displayed in the output. This option may not be combined with names(columns), names(none), or nonames.

coleqonly specifies that only column equation names be displayed in the output. This option may not be combined with names(rows), names(none), or nonames.

colorcoleq(txt | res) specifies the mode (color) used for the column equation names that appear in the first displayed row. Specifying txt (the default) displays the equation name in the same color used to display text. Specifying res displays the name in the same color used to display results.

keepcoleq specifies that columns of the same equation be kept together if possible.

aligncolnames(ralign | lalign | center) specifies the alignment for the column names. ralign indicates alignment to the right, lalign indicates alignment to the left, and center indicates centering. aligncolnames(ralign) is the default.

noblank suppresses printing a blank line before the matrix. This is useful in programs.

nohalf specifies that, even if the matrix is symmetric, the full matrix be printed. The default is to print only the lower triangle in such cases.

nodotz specifies that .z missing values be listed as a field of blanks rather than as .z; see [U] 12.2.1 Missing values.

underscore converts underscores to blanks in row and column names.

linesize(#) specifies the width of the page for formatting the table. Specifying a value of linesize() wider than your screen width can produce truly ugly output on the screen, but that output can nevertheless be useful if you are logging output and later plan to print the log on a wide printer.
matlist — Display a matrix and control its format

Required options for the second syntax

cspec(cspec) specifies the formatting of the columns and the separators of the columns,
where cspec is \[ sep \ [ qual \] \%#s \] sep nspec \[ nspec \ [ \ldots \] \]
and where sep is \[ o# \] \&|l \[ o# \]

\textit{qual} is

<table>
<thead>
<tr>
<th>qual</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>s</td>
<td>standard font</td>
</tr>
<tr>
<td>b</td>
<td>boldface font</td>
</tr>
<tr>
<td>i</td>
<td>italic font</td>
</tr>
<tr>
<td>t</td>
<td>text mode</td>
</tr>
<tr>
<td>e</td>
<td>error mode</td>
</tr>
<tr>
<td>c</td>
<td>command mode</td>
</tr>
<tr>
<td>L</td>
<td>left-aligned</td>
</tr>
<tr>
<td>R</td>
<td>right-aligned</td>
</tr>
<tr>
<td>C</td>
<td>centered</td>
</tr>
<tr>
<td>w#</td>
<td>field width #</td>
</tr>
</tbody>
</table>

nspec is \[ qual \] nfmt sep

\textit{nfmt} is \%#.##\{f|g\}

The first (optional) part, \[ sep \ [ qual \] \%#s \], of cspec specifies the formatting for the column containing row names. It is required if the row names are part of the display; see the names() option. The number of nspecs should equal the number of columns of matname.

In a separator specification, sep, | specifies that a vertical line be drawn. & specifies that no line be drawn. The number of spaces before and after the separator may be specified with o#; these default to one space, except that by default no spaces are included before the first column and after the last column.

Here are examples for a matrix with two columns (three columns when you count the column containing the row labels):

\texttt{cspec(& %16s & %9.2f & %7.4f &)}

specifies that the first column, containing row labels, be displayed using 16 characters; the second column, with format \%9.2f; and the third column, with format \%7.4f. No vertical lines are drawn. The number of spaces before and after the table is 0. Columns are separated with two spaces.

\texttt{cspec(&o2 %16s o2&o2 %9.2f o2&o2 %7.4f o2&)}

specifies more white space around the columns (two spaces everywhere, for a total of four spaces between columns).

\texttt{cspec(| %16s | %9.2f & %7.4f |)}

displays the columns in the same way as the first example but draws vertical lines before and after each column.

\texttt{cspec(| b %16s | %9.2f & %7.4f |)}

specifies that vertical lines be drawn before and after all columns, except between the two columns with numeric entries. The first column is displayed in the boldface font.
**rspec**($rspec$) specifies where horizontal lines be drawn. $rspec$ consists of a sequence of characters, optionally separated by white space. `-` (or synonym `|`) specifies that a line be drawn. `&` indicates that no line be drawn. When $matname$ has $r$ rows, $r + 2$ characters are required if column headers are displayed, and $r + 1$ characters are required otherwise. The first character specifies whether a line is to be drawn before the first row of the table; the second, whether a line is to be drawn between the first and second row, etc.; and the last character, whether a line is to be drawn after the last row of the table.

You cannot add blank lines before or after the horizontal lines.

For example, in a table with column headers and three numeric rows,

\[
rspec(||&|) \quad \text{or equivalently} \quad rspec(--&--) \]

specifies that horizontal lines be drawn before the first and second rows and after the last row, but not elsewhere.

**Remarks and examples**

Remarks are presented under the following headings:

- *All columns with the same format*
- *Different formats for each column*
- *Other output options*

**All columns with the same format**

The **matrix list** command displays Stata matrices but gives you little control over formatting; see [P] **matrix utility**.

The **matlist** command, on the other hand, offers a wide array of options to give you more detailed control over the formatting of the output.

The output produced by **matlist** is a rectangular table of numbers with an optional row and column on top and to the left of the table. We distinguish two cases. In the first style, all numeric columns are to be displayed in the same format. In the second style, each column and each intercolumn divider is formatted individually.
We demonstrate with a simple $3 \times 2$ matrix, $A$.

```plaintext
.matrix A = ( 1,2 \ 3,4 \ 5,6 )
.matrix list A
A[3,2]
c1 c2
r1 1 2
r2 3 4
r3 5 6
```

Like `matrix list`, the `matlist` command displays one matrix but adopts a tabular display style.

```plaintext
.matlist A
c1 c2
r1 1 2
r2 3 4
r3 5 6
```

Other border lines at the left, top, right, and bottom of the table may be specified with the `border()` option. For instance, `border(rows)` specifies a horizontal line at the top and bottom margins. `rowtitle()` specifies a row title. To make it easier to organize output with multiple matrices, you can use the `left()` option to left-indent the output.

```plaintext
.matlist A, border(rows) rowtitle(rows) left(4)
c1 c2
r1 1 2
r2 3 4
r3 5 6
```

The `lines()` option specifies where internal lines are to be drawn. `lines(none)` suppresses all internal horizontal and vertical lines. `lines(cell)` displays lines between all rows and columns. `twidth()` specifies the width of the first column—the column containing the row names. By default, `matlist` shows row and column names obtained from the matrix resulting from `matrix_exp`. `names(rows)` specifies that the row names be shown, and the column names be suppressed. `names(none)` would suppress all row and column names. You may also display a title for the table, displayed in SMCL paragraph mode; see [P] smcl. If the table is indented, the title will be shown with a hanging indent. The `tindent()` option allows you to indent the title as well. Finally, `matlist` allows a matrix expression—convenient for interactive use. Enclose the matrix expression in parentheses if the expression itself contains commas.

```plaintext
.matlist 2*A, border(all) lines(none) format(%6.1f) names(rows) twidth(8) > left(4) title(Guess what, a title)
```

```
rows | c1 | c2
-----|----|----
r1   | 1  | 2  
r2   | 3  | 4  
r3   | 5  | 6  
```

```
Guess what, a title
r1  2.0  4.0
r2  6.0  8.0
r3 10.0 12.0
```
matlist supports equations.

Example 2

By default, matlist draws vertical and horizontal lines between equations.

```
. matrix E = ( 1, 2, 3, 4, 5, 6, 7 
>     8, 9, 10, 11, 12, 13, 14 
>    15, 16, 17, 18, 19, 20, 21 
>    22, 23, 24, 25, 26, 27, 28 
>    29, 30, 31, 32, 33, 34, 35 
>    36, 37, 38, 39, 40, 41, 42 )
. matrix colnames E = A:a1 A:a2 B:b1 B:b2 C:c1 C:c2 C:c3
. matrix rownames E = D:d1 D:d2 E:e1 E:e2 F:f1 F:f2
. matlist E

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a1</td>
<td>a2</td>
<td>b1</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>d1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>d2</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>e1</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>e2</td>
<td>22</td>
<td>23</td>
</tr>
<tr>
<td>F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>f1</td>
<td>29</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>f2</td>
<td>36</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

matlist wraps the columns, if necessary. The keepcoleq option keeps all columns of an equation together. By default, matlist shows the equation name left-aligned over the first column associated with the equation. Equation names are truncated, if necessary. We may also display equation names in the field created by combining the columns associated with the equation. In this wider field, truncation of equation names will be rare. The showcoleq(combined) option displays the equation names centered in this combined field. See the description of the showcoleq() option for other ways to format the column equation names. border(right) displays a vertical line to the right of the table. If the table is wrapped, a border line is shown to the right of each panel.
. matlist hadamard(E,E)', showcoleq(c) keepcoleq border(right) left(4)

<table>
<thead>
<tr>
<th></th>
<th>D</th>
<th></th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a1</td>
<td>1</td>
<td>64</td>
<td>225</td>
</tr>
<tr>
<td>a2</td>
<td>4</td>
<td>81</td>
<td>256</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b1</td>
<td>9</td>
<td>100</td>
<td>289</td>
</tr>
<tr>
<td>b2</td>
<td>16</td>
<td>121</td>
<td>324</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c1</td>
<td>25</td>
<td>144</td>
<td>361</td>
</tr>
<tr>
<td>c2</td>
<td>36</td>
<td>169</td>
<td>400</td>
</tr>
<tr>
<td>c3</td>
<td>49</td>
<td>196</td>
<td>441</td>
</tr>
</tbody>
</table>

| F        |       |
| f1       |        |
| f2       |        |

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a1</td>
<td>841</td>
<td>1296</td>
<td></td>
</tr>
<tr>
<td>a2</td>
<td>900</td>
<td>1369</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b1</td>
<td>961</td>
<td>1444</td>
<td></td>
</tr>
<tr>
<td>b2</td>
<td>1024</td>
<td>1521</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c1</td>
<td>1089</td>
<td>1600</td>
<td></td>
</tr>
<tr>
<td>c2</td>
<td>1156</td>
<td>1681</td>
<td></td>
</tr>
<tr>
<td>c3</td>
<td>1225</td>
<td>1764</td>
<td></td>
</tr>
</tbody>
</table>

Different formats for each column

`matlist` allows you to format each column’s display format (for example, `%8.2f` for the data columns), type style (for example, boldface font), and alignment. You may also specify whether a vertical line is to be drawn between the columns and the number of spaces before and after the line.

> Example 3

We illustrate the different formatting options with the example of a matrix of test results, one row per test, with the last row representing an overall test.

```
. matrix Htest = (  12.30,   2,   .00044642 \
                   >    2.17,   1,   .35332874 \
                   >    8.81,   3,   .04022625 \
                   >   20.05,   6,   .00106763 )
. matrix rownames Htest = trunk length weight overall
. matrix colnames Htest = chi2 df p
```
Again we can display the matrix \texttt{Htest} with \texttt{matrix list},

\begin{verbatim}
.matrix list Htest
Htest[4,3]
  chi2    df    p
  trunk   12.3   2  .00044642
  length  2.17   1  .35332874
  weight  8.81   3  .04022625
  overall 20.05  6  .00106763
\end{verbatim}

or with \texttt{matlist},

\begin{verbatim}
.matlist Htest
  chi2    df    p
  trunk   12.3   2  .0004464
  length  2.17   1  .3533287
  weight  8.81   3  .0402262
  overall 20.05  6  .0010676
\end{verbatim}

Neither of these displays of \texttt{Htest} is attractive because all columns are the same width and the numbers are formatted with the same display format. \texttt{matlist} can provide a better display of the matrix \texttt{Htest}.

\begin{verbatim}
.matlist Htest, rowtitle(Variables) title(Test results)
> cspec(o4& %12s | %8.0g & %5.0f & %8.4f o2&) rspec(&-&&--)
\end{verbatim}

Test results

<table>
<thead>
<tr>
<th>Variables</th>
<th>chi2</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>trunk</td>
<td>12.3</td>
<td>2</td>
<td>.0004</td>
</tr>
<tr>
<td>length</td>
<td>2.17</td>
<td>1</td>
<td>.3533</td>
</tr>
<tr>
<td>weight</td>
<td>8.81</td>
<td>3</td>
<td>.0402</td>
</tr>
<tr>
<td>overall</td>
<td>20.05</td>
<td>6</td>
<td>.0011</td>
</tr>
</tbody>
</table>

The \texttt{cspec()} and \texttt{rspec()} options may look somewhat intimidating at first, but they become clear if we examine their parts. The table for matrix \texttt{Htest} has four columns: one string column with the row names and three numeric columns with \texttt{chi2} statistics, degrees of freedom, and \texttt{p}-values. There are also five separators: one before the first column, three between the columns, and one after the last column. Thus the \texttt{cspec()} specification is made up of \(4 + 5 = 9\) elements that are explained in the next table.

<table>
<thead>
<tr>
<th>Element</th>
<th>Purpose</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>o4&amp;</td>
<td>before column 1</td>
<td>4 spaces/no vertical line</td>
</tr>
<tr>
<td>%12s</td>
<td>display format column 1</td>
<td>string display format %12s</td>
</tr>
<tr>
<td></td>
<td>between columns 1 and 2</td>
<td>1 space/vertical line/1 space</td>
</tr>
<tr>
<td>%8.0g</td>
<td>display format column 2</td>
<td>numeric display format %8.0g</td>
</tr>
<tr>
<td>&amp;</td>
<td>between columns 2 and 3</td>
<td>1 space/no vertical line/1 space</td>
</tr>
<tr>
<td>%5.0f</td>
<td>display format column 3</td>
<td>numeric display format %5.0f</td>
</tr>
<tr>
<td>&amp;</td>
<td>between columns 3 and 4</td>
<td>1 space/no vertical line/1 space</td>
</tr>
<tr>
<td>%8.4f</td>
<td>display format column 4</td>
<td>numeric display format %8.4f</td>
</tr>
<tr>
<td>o2&amp;</td>
<td>after column 4</td>
<td>2 spaces/no vertical line</td>
</tr>
</tbody>
</table>

Vertical lines are drawn if the separator consists of a \texttt{|} character, whereas no vertical line is drawn with an \texttt{&} specification. By default, one space is displayed before and after the vertical line;
the exception is that, by default, no space is displayed before the first separator and after the last separator. More white space may be added by adding \textit{o} specifications. For instance, \textit{o3 | o2}, or more compactly \textit{o3|o2}, specifies that three spaces be included before the vertical line and two spaces after the line.

The \texttt{rspec()} row formatting specification for a table with \textit{r} rows (including the column headers) comprises a series of \textit{r} + 1 \textit{−} and \textit{&} characters, where

− denotes that a horizontal line is to be drawn and

& denotes that no horizontal line is to be drawn.

The table for matrix \texttt{Htest} has five rows: the column headers and four data rows. The specification \texttt{rspec(\&-\&&--)} is detailed in the next table.

<table>
<thead>
<tr>
<th>Element</th>
<th>Purpose</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp;</td>
<td>before row 1</td>
<td>no line is drawn</td>
</tr>
<tr>
<td>−</td>
<td>between rows 1 and 2</td>
<td>a line is drawn</td>
</tr>
<tr>
<td>&amp;</td>
<td>between rows 2 and 3</td>
<td>no line is drawn</td>
</tr>
<tr>
<td>&amp;</td>
<td>between rows 3 and 4</td>
<td>no line is drawn</td>
</tr>
<tr>
<td>−</td>
<td>between rows 4 and 5</td>
<td>a line is drawn</td>
</tr>
<tr>
<td>−</td>
<td>after row 5</td>
<td>a line is drawn</td>
</tr>
</tbody>
</table>

Lines are drawn before and after the last row of the table for matrix \texttt{Htest} to emphasize that this row is an overall (total) test.

Further formatting is possible. For instance, we can specify that the second column (the first numeric column) be in the boldface font and text mode and that the last column be in italic and command mode. We simply insert appropriate qualifiers in the specification part for the respective columns.

\texttt{. matlist Htest, rowt(Variables) title(Test results (again))}
\texttt{> cspec( o4&o2 %10s | b t %8.0g & %4.0f & i c %7.4f o2& )}
\texttt{> rspec( \& − \& & − & )}

Test results (again)

<table>
<thead>
<tr>
<th>Variables</th>
<th>chi2</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>trunk</td>
<td>12.3</td>
<td>2</td>
<td>0.0004</td>
</tr>
<tr>
<td>length</td>
<td>2.17</td>
<td>1</td>
<td>0.3533</td>
</tr>
<tr>
<td>weight</td>
<td>8.81</td>
<td>3</td>
<td>0.0402</td>
</tr>
<tr>
<td>overall</td>
<td>20.05</td>
<td>6</td>
<td>0.0011</td>
</tr>
</tbody>
</table>

In this manual, the boldface font is used for the \texttt{chi2} column and the italic font is used for the \texttt{p} column, but there is no difference due to the requested text mode and command mode. If we run this example interactively, both the font change and color change due to the requested mode can be seen depending on your Results window color scheme. Depending on your settings, the \texttt{chi2} column might display in the boldface font and the green color (text mode); the \texttt{df} column, in the default standard font and the yellow color (result mode); and the \texttt{p} column, in the italic font and the white color (command mode). Or it may look exactly as it does in this manual.
Other output options

Example 4

Finally, we illustrate two options for use with the extended missing value .z and with row and column names that contain underscores.

```
.matrix Z = ( .z, 1 \ .c, .z )
.matrix rownames Z = row_1 row_2
.matrix colnames Z = col1 col2
.matlist Z
```

<table>
<thead>
<tr>
<th></th>
<th>col1</th>
<th>col2</th>
</tr>
</thead>
<tbody>
<tr>
<td>row_1</td>
<td>.z</td>
<td>1</td>
</tr>
<tr>
<td>row_2</td>
<td>.c</td>
<td>.z</td>
</tr>
</tbody>
</table>

The `nodotz` option displays .z as blanks. Underscores in row names are translated into spaces with the `underscore` option.

```
.matlist Z, nodotz underscore
```

<table>
<thead>
<tr>
<th></th>
<th>col1</th>
<th>col2</th>
</tr>
</thead>
<tbody>
<tr>
<td>row_1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>row_2</td>
<td>.c</td>
<td></td>
</tr>
</tbody>
</table>

Also see

[P] matrix — Introduction to matrix commands
[P] matrix utility — List, rename, and drop matrices
[U] 14 Matrix expressions
An introduction to matrices in Stata is found in [U] 14 Matrix expressions. This entry provides an overview of the matrix commands and provides more background information on matrices in Stata.

Beyond the matrix commands, Stata has a complete matrix programming language, Mata, that provides more advanced matrix functions, support for complex matrices, fast execution speed, and the ability to directly access Stata’s data, macros, matrices, and returned results. Mata can be used interactively as a matrix calculator, but it is even more useful for programming; see the Mata Reference Manual.

Remarks are presented under the following headings:

- Overview of matrix commands
- Creating and replacing matrices
- Namespace
- Naming conventions in programs

Documentation on matrices in Stata is grouped below into three categories—Basics, Programming, and Specialized. We recommend that you begin with [U] 14 Matrix expressions and then read [P] matrix define. After that, feel free to skip around.

### Basics

- [U] 14 Matrix expressions: Introduction to matrices in Stata
- [P] matrix define: Matrix definition, operators, and functions
- [P] matrix utility: List, rename, and drop matrices
- [P] matlist: Display a matrix and control its format

### Programming

- [P] matrix accum: Form cross-product matrices
- [R] ml: Maximum likelihood estimation
- [P] ereturn: Post the estimation results
- [P] matrix rownames: Name rows and columns
- [P] matrix rowjoinbyname: Join rows while matching on column names
- [P] matrix score: Score data from coefficient vectors

### Specialized

- [P] makecns: Constrained estimation
- [P] matrix mkmat: Convert variables to matrix and vice versa
- [P] matrix svd: Singular value decomposition
- [P] matrix symeigen: Eigenvalues and eigenvectors of symmetric matrices
- [P] matrix eigenvalues: Eigenvalues of nonsymmetric matrices
- [P] matrix get: Access system matrices
- [P] matrix dissimilarity: Compute similarity or dissimilarity measures
Creating and replacing matrices

Matrices generally do not have to be preallocated or dimensioned before creation, except when you want to create an \( r \times c \) matrix and then fill in each element one by one; see the description of the \( \text{J}(\cdot) \) function in [P] {matrix define}. Matrices are typically created by \texttt{matrix define} or \texttt{matrix accum}; see [P] {matrix accum}.

Stata takes a high-handed approach to redefining matrices. You know that, when dealing with data, you must distinguish between creating a new variable or replacing the contents of an existing variable—Stata has two commands for this: \texttt{generate} and \texttt{replace}. For matrices, there is no such distinction. If you define a new matrix, it is created. If you give the same command and the matrix already exists, then the currently existing matrix is destroyed and the new one is defined. This treatment is the same as that given to macros and scalars.

Namespace

The term “namespace” refers to how names are interpreted. For instance, the variables in your dataset occupy one namespace—other things, such as value labels, macros, and scalars, can have the same name and not cause confusion.

Macros also have their own namespace; macros can have the same names as other things, and Stata can still tell by context when you are referring to a macro because of the punctuation. When you type \texttt{gen newvar= \texttt{myname}}, \texttt{myname} must refer to a variable. When you type \texttt{gen newvar=' \texttt{myname}'}—note the single quotes around \texttt{myname}—\texttt{myname} must refer to a local macro. When you type \texttt{gen newvar=$ \texttt{myname}} , \texttt{myname} must refer to a global macro.

Scalars and matrices share the same namespace; that is, scalars and matrices may have the same names as variables in the dataset, etc., but they cannot have the same names as each other. Thus when you define a matrix called, say, \texttt{myres}, if a scalar by that name already exists, it is destroyed, and the matrix replaces it. Correspondingly, when you define a scalar called \texttt{myres}, if a matrix by that name exists, it is destroyed, and the scalar replaces it.

Naming conventions in programs

If you are writing Stata programs or ado-files using matrices, you may have some matrices that you wish to leave behind for other programs to build upon, but you will certainly have other matrices that are nothing more than leftovers from calculations. Such matrices are called temporary. You should use Stata’s \texttt{tempname} facility (see [P] {macro}) to name such matrices. These matrices will automatically be discarded when your program ends. For example, a piece of your program might read

```stata
tempname YXX XX
matrix accum ‘YXX’ = price weight mpg
matrix ‘XX’ = ‘YXX’[2...,2...]
```

Note the single quotes around the names after they are obtained from \texttt{tempname}; see [U] 18.3 Macros.

Technical note

Let’s consider writing a regression program in Stata. (There is actually no need for such a program because Stata already has the \texttt{regress} command.) A well-written estimation command would allow the \texttt{level(\cdot)} option for specifying the width of confidence intervals, and it would replay results when the command is typed without arguments. Here is a well-written version:
program myreg, eclass
version 17.0
if !replay()
    syntax varlist(min=2 numeric) [if] [in] [, Level(clevel)]
marksample touse // mark the sample
    tempname YXX XX Xy b hat V
    // compute cross products YXX = (Y'Y, Y'X, X'Y, X'X)
    quietly matrix accum 'YXX' = 'varlist' if 'touse'
    local nobs = r(N)
    local df = 'nobs' - (rowsof('YXX') - 1)
    matrix 'XX' = 'YXX'[2...,2...]
    matrix 'Xy' = 'YXX'[1,2...]
    // compute the beta vector
    matrix 'b' = 'Xy' * invsym('XX')
    // compute the covariance matrix
    matrix 'hat' = 'b' * 'Xy''
    matrix 'V' = invsym('XX') * ('YXX'[1,1] - 'hat'[1,1])/'df'
    // post the beta vector and covariance matrix
    ereturn post 'b' 'V', dof('df') obs('nobs') depname('1') /*
*/ esample('touse')
    // save estimation information
    tokenize "'varlist'" // put varlist into numbered arguments
    ereturn local depvar "'1'"
    ereturn local cmd "myreg"
} else { // replay
    syntax [, Level(clevel)]
} if "'e(cmd)'"!="myreg" error 301
// print the regression table
ereturn display, level('level')

end

The syntax of our new command is

```
myreg depvar indepvars [if] [in] [, level(#) ]
```

myreg, typed without arguments, redisplays the output of the last myreg command. After estimation with myreg, the user may use correlate to display the covariance matrix of the estimators, predict to obtain predicted values or standard errors of the prediction, and test to test linear hypotheses about the estimated coefficients. The command is indistinguishable from any other Stata estimation command.

Despite the excellence of our work, we do have some criticisms:

- **myreg** does not display the ANOVA table, $R^2$, etc.; it should and could be made to, although we would have to insert our own display statements before the ereturn display instruction.
- The program makes copious use of matrices with different names, resulting in extra memory use while the estimation is being made; the code could be made more economical, if less readable, by reusing matrices.
- **myreg** makes the least-squares calculation by using the absolute cross-product matrix, an invitation to numerical problems if the data are not consistently scaled. Stata's own regress command is more careful, and we could be, too: matrix accum does have an option for forming the cross-product matrix in deviation form, but its use would complicate this program. This does not overly concern us, although we should make a note of it when we document myreg. Nowadays, users
expect to be protected in linear regression but have no such expectations for more complicated estimation schemes because avoiding the problem can be difficult.

There is one nice feature of our program that did not occur to us when we wrote it. We use \texttt{invsym()} to form the inverse of the cross-product matrix, and \texttt{invsym()} can handle singular matrices. If there is a collinearity problem, \texttt{myreg} behaves just like \texttt{regress}: it omits the offending variables and notes that they are omitted when it displays the output (at the \texttt{ereturn display} step).

\section*{Technical note}

Our linear regression program is longer than we might have written in an exclusively matrix programming language. After all, the coefficients can be obtained from $\left( X'X \right)^{-1} X'y$, and in a dedicated matrix language, we would type nearly that, and obtaining the standard errors would require only a few more matrix calculations. In fact, we did type nearly that to make the calculation; the extra lines in our program have to do mostly with syntax issues and linking to the rest of Stata. In writing your own programs, you might be tempted not to bother linking to the rest of Stata. Fight this temptation.

Linking to the rest of Stata pays off: here we do not merely display the numerical results, but we display them in a readable form, complete with variable names. We made a command that is indistinguishable from Stata's other estimation commands. If the user wants to test $b[\text{denver}]=b[\text{la}]$, the user types literally that; there is no need to remember the matrix equation and to count variables (such as constrain the third minus the 15th variable to sum to zero).

\section*{Reference}


\section*{Also see}

\begin{itemize}
  \item \texttt{ereturn} — Post the estimation results
  \item \texttt{matrix define} — Matrix definition, operators, and functions
  \item \texttt{ml} — Maximum likelihood estimation
  \item \texttt{14 Matrix expressions}
  \item \texttt{18 Programming Stata}
\end{itemize}

\textit{Mata Reference Manual}
matrix accum — Form cross-product matrices

Description

matrix accum accumulates cross-product matrices from the data to form \( A = X'X \).

matrix glsaccum accumulates cross-product matrices from the data by using a specified inner weight matrix to form \( A = X'BX \), where \( B \) is a block diagonal matrix.

matrix opaccum accumulates cross-product matrices from the data by using an inner weight matrix formed from the outer product of a variable in the data to form

\[
A = X'_1e_1'e_1X_1 + X'_2e_2'e_2X_2 + \cdots + X'_K e_K' e_K X_K
\]

where \( X_i \) is a matrix of observations from the \( i \)th group of the \textit{varlist} variables and \( e_i \) is a vector formed from the observations in the \( i \)th group of the \textit{opvar} variable.

matrix vecaccum accumulates the first variable against the remaining variables in \textit{varlist} to form a row vector of accumulated inner products to form \( a = x'_1X \), where \( X = (x_2, x_3, \ldots) \).

Also see \([M-5]\) \texttt{cross()} for other routines for forming cross-product matrices.

Syntax

Accumulate cross-product matrices to form \( X'X \)

\[
\text{matrix accum } A = \text{varlist [if] [in] [weight]} \ [, \text{noconstant}]
\]

\begin{itemize}
\item \texttt{deviations means(\textit{m}) absorb(\textit{varname})}
\end{itemize}

Accumulate cross-product matrices to form \( X'BX \)

\[
\text{matrix glsaccum } A = \text{varlist [if] [in] [weight]}, \text{ group(\textit{groupvar})}
\]

\begin{itemize}
\item \texttt{glsmat(W | \textit{stringvar}) row(\textit{rowvar}) [noconstant]}
\end{itemize}

Accumulate cross-product matrices to form \( \sum X'_i e_i' e_i X_i \)

\[
\text{matrix opaccum } A = \text{varlist [if] [in]}, \text{ group(\textit{groupvar})}
\]

\begin{itemize}
\item \texttt{opvar(\textit{opvar}) [noconstant]}
\end{itemize}

Accumulate first variable against remaining variables

\[
\text{matrix vecaccum } a = \text{varlist [if] [in] [weight]} \ [, \text{noconstant}]
\]
varlist in `matrix accum` and in `matrix vecaccum` may contain factor variables (except for the first variable in `matrix vecaccum varlist`); see [U] 11.4.3 Factor variables.

varlist may contain time-series operators; see [U] 11.4.4 Time-series varlists.

`collect` is allowed with `matrix accum`, `matrix glsaccum`, `matrix opaccum`, and `matrix vecaccum`; see [U] 11.1.10 Prefix commands.

`aweights`, `fweights`, `iweights`, and `pweights` are allowed; see [U] 11.1.6 weight.

Options

`noconstant` suppresses the addition of a “constant” to the \( X \) matrix. If `noconstant` is not specified, it is as if a column of 1s is added to \( X \) before the accumulation begins. For instance, for `matrix accum` without `noconstant`, \( X'X \) is really \( (X, 1)'(X, 1) \), resulting in
\[
\begin{pmatrix}
X'X & X'1 \\
1'X & 1'1
\end{pmatrix}
\]

Thus the last row and column contain the sums of the columns of \( X \), and the element in the last row and column contains the number of observations. If \( p \) variables are specified in `varlist`, the resulting matrix is \( (p+1) \times (p+1) \). Specifying `noconstant` suppresses the addition of this row and column (or just the column for `matrix vecaccum`).

`deviations`, allowed only with `matrix accum`, causes the accumulation to be performed in terms of deviations from the mean. If `noconstant` is not specified, the accumulation of \( X \) is done in terms of deviations, but the added row and column of sums are not in deviation format (in which case they would be zeros). With `noconstant` specified, the resulting matrix divided through by \( N - 1 \), where \( N \) is the number of observations, is a covariance matrix.

`means(m)`, allowed only with `matrix accum`, creates matrix \( m \): \( 1 \times (p+1) \) or \( 1 \times p \) (depending on whether `noconstant` is also specified) containing the means of \( X \).

`absorb(varname)`, allowed only with `matrix accum`, specifies that `matrix accum` compute the accumulations in terms of deviations from the mean within the absorption groups identified by `varname`.

`group(groupvar)` is required with `matrix glsaccum` and `matrix opaccum` and is not allowed otherwise. In the two cases where it is required, it specifies the name of a variable that identifies groups of observations. The data must be sorted by `groupvar`.

In `matrix glsaccum`, `groupvar` identifies the observations to be individually weighted by `glsmat()`. In `matrix opaccum`, `groupvar` identifies the observations to be weighted by the outer product of `opvar()`.

`glsmat(W|stringvar)`, required with `matrix glsaccum` and not allowed otherwise, specifies the name of the matrix or the name of a string variable in the dataset that contains the name of the matrix that is to be used to weight the observations in `group()`. `stringvar` must be `str8` or less.

`row(rowvar)`, required with `matrix glsaccum` and not allowed otherwise, specifies the name of a numeric variable containing the row numbers that specify the row and column of the `glsmat()` matrix to use in the inner-product calculation.

`opvar(opvar)`, required with `matrix opaccum`, specifies the variable used to form the vector whose outer product forms the weighting matrix.
**Remarks and examples**

Remarks are presented under the following headings:

- `matrix accum`
- `matrix glsaccum`
- `matrix opaccum`
- `matrix vecaccum`
- `Treatment of user-specified weights`

**matrix accum**

`matrix accum` is a straightforward command that accumulates one matrix that holds $X'X$ and $X'y$, which is typically used in $b = (X'X)^{-1}X'y$. Say that we wish to run a regression of the variable `price` on `mpg` and `weight`. We can begin by accumulating the full cross-product matrix for all three variables:

```
. use https://www.stata-press.com/data/r17/auto
  (1978 automobile data)
. matrix accum A = price weight mpg
  (obs=74)
. matrix list A
```

```
symmetric A[4,4]   
  price  3.448e+09
  weight  1.468e+09  7.188e+08
  mpg   9132716  4493720  36008
  _cons  456229  223440  1576  74
```

In our accumulation, `matrix accum` automatically added a constant; we specified three variables and got back a $4 \times 4$ matrix. The constant term is always added last. In terms of our regression model, the matrix we just accumulated has $y = \text{price}$ and $X = (\text{weight, mpg, _cons})$ and can be written as

$$A = (y, X')' (y, X) = \begin{pmatrix} y'y & y'X \\ X'y & X'X \end{pmatrix}$$

Thus we can extract $X'X$ from the submatrix of $A$ beginning at the second row and column, and we can extract $X'y$ from the first column of $A$, omitting the first row:

```
. matrix XX = A[2...,2...]
. matrix list XX
```

```
symmetric XX[3,3]   
  weight  7.188e+08
  mpg   4493720  36008
  _cons  223440  1576  74
```

```
. matrix Xy = A[2...,1]
. matrix list Xy
```

```
Xy[3,1]   
  price  1.468e+09
  mpg   9132716
  _cons  456229
```

We can now calculate $b = (X'X)^{-1}X'y$:

```
. matrix b = syminv(XX)\times Xy
```
. matrix list b
  b[3,1]
     price  1.7466592
     weight -49.512221
    _cons  1946.0687

The same result could have been obtained directly from \( A \):

. matrix b = invsym(A[2...,2...])*A[2...,1]

Technical note

\( \text{matrix accum} \), with the deviations and noconstant options, can also be used to obtain covariance matrices. The covariance between variables \( x_i \) and \( x_j \) is defined as

\[
C_{ij} = \frac{\sum_{k=1}^{n}(x_{ik} - \bar{x}_i)(x_{jk} - \bar{x}_j)}{n-1}
\]

Without the deviations option, \( \text{matrix accum} \) calculates a matrix with elements

\[
R_{ij} = \sum_{k=1}^{n} x_{ik}x_{jk}
\]

and with the deviations option,

\[
A_{ij} = \sum_{k=1}^{n} (x_{ik} - \bar{x}_i)(x_{jk} - \bar{x}_j)
\]

Thus the covariance matrix \( C = A/(n-1) \).

. matrix accum Cov = price weight mpg, deviations noconstant
  (obs=74)
  . matrix Cov = Cov/(r(N)-1)
  . matrix list Cov
symmetric Cov[3,3]

<table>
<thead>
<tr>
<th></th>
<th>price</th>
<th>weight</th>
<th>mpg</th>
</tr>
</thead>
<tbody>
<tr>
<td>price</td>
<td>8699526</td>
<td></td>
<td></td>
</tr>
<tr>
<td>weight</td>
<td>1234674.8</td>
<td>604029.84</td>
<td></td>
</tr>
<tr>
<td>mpg</td>
<td>-7996.2829</td>
<td>-3629.4261</td>
<td>33.472047</td>
</tr>
</tbody>
</table>

In addition to calculating the cross-product matrix, \( \text{matrix accum} \) records the number of observations in \( r(N) \), a feature we use in calculating the normalizing factor. With the \text{corr()} \) matrix function defined in \([P]\) \text{matrix define}, we can convert the covariance matrix into a correlation matrix:

. matrix P = corr(Cov)
  . matrix list P
symmetric P[3,3]

<table>
<thead>
<tr>
<th></th>
<th>price</th>
<th>weight</th>
<th>mpg</th>
</tr>
</thead>
<tbody>
<tr>
<td>price</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>weight</td>
<td>.53861146</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>mpg</td>
<td>-.46859669</td>
<td>-.80717486</td>
<td>1</td>
</tr>
</tbody>
</table>
matrix glsaccum

matrix glsaccum is a generalization of matrix accum useful in producing GLS-style weighted accumulations. Whereas matrix accum produces matrices of the form $X'X$, matrix glsaccum produces matrices of the form $X'BX$, where

$$B = \begin{pmatrix}
W_1 & 0 & \ldots & 0 \\
0 & W_2 & \ldots & 0 \\
\vdots & \vdots & \ddots & \vdots \\
0 & 0 & \ldots & W_K
\end{pmatrix}$$

The matrices $W_k$, $k = 1, \ldots, K$ are called the weighting matrices for observation group $k$. In the matrices above, each of the $W_k$ matrices is square, but there is no assumption that they all have the same dimension. By writing

$$X = \begin{pmatrix} X_1 \\ X_2 \\ \vdots \\ X_K \end{pmatrix}$$

the accumulation made by matrix glsaccum can be written as

$$X'BX = X_1'W_1X_1 + X_2'W_2X_2 + \cdots + X_K'W_KX_K$$

matrix glsaccum requires you to specify three options: \texttt{group(groupvar), glsmat(stringvar)} or \texttt{glsmat(matvar)}, and \texttt{row(rowvar)}. Observations sharing the same value of \texttt{groupvar} are said to be in the same observation group—this specifies the group, $k$, in which they are to be accumulated. Before calling matrix glsaccum, you must sort the data by \texttt{groupvar}. How $W_k$ is assembled is the subject of the other two options.

Think of there being a superweighting matrix for the group, which we will call $V_k$. $V_k$ is specified by \texttt{glsmat()}. The same supermatrix can be used for all observations by specifying a \texttt{matname} as the argument to \texttt{glsmat()}, or, if a variable name is specified, different supermatrices can be specified—the contents of the variable will be used to obtain the particular name of the supermatrix. (More correctly, the contents of the variable for the first observation in the group will be used: supermatrices can vary across groups but must be the same within group.)

Weighting matrix $W_k$ is made from supermatrix $V_k$ by selecting the rows and columns specified in \texttt{row(rowvar)}. In the simple case, $W_k = V_k$. This happens when there are $m$ observations in the group and the first observation in the group has \texttt{rowvar} = 1, the second has \texttt{rowvar} = 2, and so on. To fix ideas, let $m = 3$ and write

$$V_1 = \begin{pmatrix} v_{11} & v_{12} & v_{13} \\ v_{21} & v_{22} & v_{23} \\ v_{31} & v_{32} & v_{33} \end{pmatrix}$$

$V$ need not be symmetric. Let’s pretend that the first 4 observations in our dataset contain

<table>
<thead>
<tr>
<th>obs. no.</th>
<th>groupvar</th>
<th>rowvar</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>\ldots</td>
</tr>
</tbody>
</table>
In these data, the first 3 observations are in the first group because they share an equal *groupvar*. It is not important that *groupvar* happens to equal 1; it is important that the values are equal. The *rowvars* are, in order, 1, 2, and 3, so $W_1$ is formed by selecting the first row and column of $V_1$, then the second row and column of $V_1$, and finally the third row and column of $V_1$: 

$$W_1 = \begin{pmatrix} v_{11} & v_{12} & v_{13} \\ v_{21} & v_{22} & v_{23} \\ v_{31} & v_{32} & v_{33} \end{pmatrix}$$

or $W_1 = V_1$. Now consider the same data, but reordered:

<table>
<thead>
<tr>
<th>obs. no.</th>
<th>groupvar</th>
<th>rowvar</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>...</td>
</tr>
</tbody>
</table>

$W_1$ is now formed by selecting the second row and column, then the first row and column, and finally the third row and column of $V_1$. These steps can be performed sequentially, reordering first the rows and then the columns; the result is 

$$W_1 = \begin{pmatrix} v_{22} & v_{21} & v_{23} \\ v_{12} & v_{11} & v_{13} \\ v_{32} & v_{31} & v_{33} \end{pmatrix}$$

This reorganization of the $W_1$ matrix exactly undoes the reorganization of the $X_1$ matrix, so $X_1' W_1 X_1$ remains unchanged. Given how $W_k$ is assembled from $V_k$, the order of the row numbers in the data does not matter.

matrix glsaccum is willing to carry this concept even further. Consider the following data:

<table>
<thead>
<tr>
<th>obs. no.</th>
<th>groupvar</th>
<th>rowvar</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>...</td>
</tr>
</tbody>
</table>

Now *rowvar* equals 1 followed by 3 twice, so the first row and column of $V_1$ are selected, followed by the third row and column twice; the second column is never selected. The resulting weighting matrix is 

$$W_1 = \begin{pmatrix} v_{11} & v_{13} & v_{13} \\ v_{31} & v_{33} & v_{33} \\ v_{31} & v_{33} & v_{33} \end{pmatrix}$$

Such odd weighting would not occur in, say, time-series analysis, where the matrix might be weighting lags and leads. It could well occur in an analysis of individuals in families, where 1 might indicate the head of household, 2 a spouse, and 3 a child. In fact, such a case could be handled with a $3 \times 3$ superweighting matrix $V$, even if the family became large: the appropriate weighting matrix $W_k$ would be assembled, on a group-by-group (family-by-family) basis, from the underlying supermatrix.
matrix opaccum

matrix opaccum is a special case of matrix glsaccum. matrix glsaccum calculates results of the form

\[ A = X'_1W_1X_1 + X'_2W_2X_2 + \cdots + X'_K W_K X_K \]

Often \( W_i \) is simply the outer product of another variable in the dataset; that is,

\[ W_i = e_i e_i' \]

where \( e_i \) is the \( n_i \times 1 \) vector formed from the \( n_i \) groupvar() observations of the variable specified in opvar(). The data must be sorted by groupvar.

Example 1

Suppose that we have a panel dataset that contains five variables: id, t, e (a residual), and covariates x1 and x2. Further suppose that we need to compute

\[ A = X'_1 e'_1 X_1 + X'_2 e'_2 X_2 + \cdots + X'_K e'_K X_K \]

where \( X_i \) contains the observations on x1 and x2 when \( id==i \) and \( e_i \) contains the observations on e when \( id==i \).

Below is the output from xtdescribe for our example data. There are 11 groups and the number of observations per group is not constant.

```
. use https://www.stata-press.com/data/r17/maccumxmpl
. xtdescribe, patterns(11)
```

```
id:  1, 2, ..., 11  n =  11
  t:  1, 2, ..., 15  T =  15
    Delta(t) =  1 unit
    Span(t) =  15 periods
        (id*t uniquely identifies each observation)
Distribution of T_{i,t}:  min  5%  25%  50%  75%  95%  max
      5  5  7  10  13  15  15
Freq.  Percent  Cum.  Pattern
      1  9.09  9.09  11111111111111111111111111111111
      1  9.09  18.18  11111111111111111111111111111111
      1  9.09  27.27  11111111111111111111111111111111
      1  9.09  36.36  11111111111111111111111111111111
      1  9.09  45.45  11111111111111111111111111111111
      1  9.09  54.55  11111111111111111111111111111111
      1  9.09  63.64  11111111111111111111111111111111
      1  9.09  72.73  11111111111111111111111111111111
      1  9.09  81.82  11111111111111111111111111111111
      1  9.09  90.91  11111111111111111111111111111111
      1  9.09 100.00  11111111111111111111111111111111
```

If we were to calculate \( A \) with matrix glsaccum, we would need to form 11 matrices and store their names in a string variable before calling matrix glsaccum. This step slows down matrix glsaccum when there are many groups. Also all the information contained in the \( W_i \) matrices is contained in the variable e. It is this structure that matrix opaccum exploits to make a faster command for this type of problem:
matrix accum — Form cross-product matrices 349

. sort id t
. matrix opaccum A2 = x1 x2, group(id) opvar(e)

matrix vecaccum

The first variable in varlist is treated differently from the others by matrix vecaccum. Think of
the first variable as specifying vector y and the remaining variables as specifying matrix X. matrix
vecaccum makes the accumulation $y'X$ to return a row vector with elements

$$a_i = \sum_{k=1}^{n} y_k x_{ki}$$

Like matrix accum, matrix vecaccum adds a constant, _cons, to X unless noconstant is specified.

matrix vecaccum serves two purposes. First, terms like $y'X$ often occur in calculating derivatives
of likelihood functions; matrix vecaccum provides a fast way of calculating them. Second, it is
useful in time-series accumulations of the form

$$C = \sum_{t=1}^{T} \sum_{\delta=-k}^{k} x_{t-\delta} x_t W_{\delta r_{t-\delta r_t}}$$

In this calculation, X is an observation matrix with elements $x_{tj}$, with t indexing time (observations)
and j variables, $t = 1, \ldots, T$ and $j = 1, \ldots, p$. $x_t$ ($1 \times p$) refers to the tth row of this matrix. Thus C is a $p \times p$ matrix.

The Newey–West covariance matrix uses the definition $W_\delta = 1 - |\delta|/(k + 1)$ for $\delta \leq k$. To make
the calculation, the user (programmer) cycles through each of the j variables, forming

$$z_{tj} = \sum_{\delta=-k}^{k} x_{(t-\delta)j} W_{\delta r_{t-\delta r_t}}$$

Writing $z_j = (z_{1j}, z_{2j}, \ldots, z_{Tj})'$, we can then say that C is

$$C = \sum_{j=1}^{p} z_j'X$$

In this derivation, the user must decide in advance the maximum lag length, k, such that observations
that are far apart in time must have increasingly small covariances to establish the convergence results.

The Newey–West estimator is in the class of generalized method of moments (GMM) estimators. The choice
of a maximum lag length, k, is a reflection of the length in time beyond which the
autocorrelation becomes negligible for estimating the variance matrix. The code fragment given
below is merely for illustration of the matrix commands, because Stata includes estimation with the
Newey–West covariance matrix in the newey command. See [TS] newey or Greene (2018, 999) for
details on this estimator.
Calculations like \( z_j^\prime X \) are made by \texttt{matrix vecaccum}, and \( z_j \) can be treated as a temporary variable in the dataset.

\begin{verbatim}
assume '1','2', etc., contain the xs including constant
assume 'r' contains the r variable
assume 'k' contains the k range
tempname C factor t c
tempvar z
local p : word count '*'
matrix 'C' = J('p','p',0)
generate double 'z' = 0
forvalues d = 0/'k' {
    /* Add each submatrix twice except for
       the lag==0 case */
    scalar 'factor' = cond('d'>0, 1, .5)
    local w = (1 - 'd'/('k'+1))
capture mat drop 't'
    forvalues j = 1/'p' {
        replace 'z' = ''j''[_n-'d']'*'w'*'r'[_n-'d']'*'r'
    }
    mat vecaccum 'c' = 'z' 'r', nocons
    mat 't' = 't' \ 'c'
}
mat 'C' = 'C' + ('t' + 't'')*'factor'
local 'p' = "_cons" // Rename last var to _cons
mat rownames 'C' = '*'
mat colnames 'C' = '*'
assume inverse and scaling for standard error reports
\end{verbatim}

### Treatment of user-specified weights

\texttt{matrix accum}, \texttt{matrix glsaccum}, and \texttt{matrix vecaccum} all allow weights. Here is how they are treated:

All three commands can be thought of as returning something of the form \( X_1'BX_2 \). \texttt{matrix accum}, \( X_1 = X_2 \) and \( B = I \); for \texttt{matrix glsaccum}, \( X_1 = X_2 \); and \texttt{matrix vecaccum}, \( B = I \), \( X_1 \) is a column vector and \( X_2 \) is a matrix.

The commands really calculate \( X_1'W^{1/2}BX_2'W^{1/2}X_2 \), where \( W \) is a diagonal matrix. If no weights are specified, \( W = I \). Now assume that weights are specified, and let \( v: 1 \times n \) be the specified weights. If \texttt{fweights} or \texttt{pweights} are specified, \( W = \text{diag}(v) \). If \texttt{aweights} are specified, \( W = \text{diag}\{v/(1'v)(1'1)\} \), meaning that the weights are normalized to sum to the number of observations. If \texttt{iweights} are specified, they are treated like \texttt{fweights}, except that the elements of \( v \) are not restricted to be positive integers.
Stored results

`matrix accum`, `matrix glsaccum`, `matrix opaccum`, and `matrix vecaccum` store the number of observations in \( r(N) \). `matrix accum` stores the number of absorption groups in \( r(k_{\text{absorb}}) \). `matrix glsaccum` (with aweights) and `matrix vecaccum` also store the sum of the weight in \( r(\text{sum}_w) \), but `matrix accum` does not.

Reference


Also see

[P] `matrix` — Introduction to matrix commands

[M-4] `Statistical` — Statistical functions

[R] `ml` — Maximum likelihood estimation

[U] 14 Matrix expressions
Description

`matrix define` performs matrix computations. The word `define` may be omitted.

`matrix input` provides a method for inputting matrices. The word `input` may be omitted (see the discussion that follows).

For an introduction and overview of matrices in Stata, see [U] 14 Matrix expressions. See [M-2] `exp` for matrix expressions in Mata.

Menu

- **matrix define**
  - Data > Matrices, ado language > Define matrix from expression

- **matrix input**
  - Data > Matrices, ado language > Input matrix by hand

Syntax

**Perform matrix computations**

```
matrix [define] matname = matrix_expression
```

**Input matrices**

```
matrix [input] matname = (# [, # ...] [\ # [, # ...] [\ [ ... ]]])
```

Remarks and examples

Remarks are presented under the following headings:

- Introduction
- Inputting matrices by hand
- Matrix operators
- Matrix functions returning matrices
- Matrix functions returning scalars
- Subscripting and element-by-element definition
- Name conflicts in expressions (namespaces)
- Macro functions
Introduction

`matrix define` calculates matrix results from other matrices. For instance,

```
.matrix define D = A + B + C
```

creates `D` containing the sum of `A`, `B`, and `C`. The word `define` may be omitted,

```
.matrix D = A + B + C
```

and the command may be further abbreviated:

```
.mat D=A+B+C
```

The same matrix may appear on both the left and the right of the equal sign in all contexts, and Stata will not become confused. Complicated matrix expressions are allowed.

With `matrix input`, you define the matrix elements rowwise; commas are used to separate elements within a row, and backslashes are used to separate the rows. Spacing does not matter.

```
.matrix input A = (1,2\3,4)
```

The above would also work if you omitted the `input` subcommand.

```
.matrix A = (1,2\3,4)
```

There is a subtle difference: the first method uses the `matrix input` command, and the second uses the matrix expression parser. Omitting `input` allows expressions in the command. For instance,

```
.matrix X = (1+1, 2*3/4 \ 5/2, 3)
```

is understood but

```
.matrix input X = (1+1, 2*3/4 \ 5/2, 3)
```

would produce an error.

`matrix input`, however, has two advantages. First, it allows input of large matrices. (The expression parser is limited because it must “compile” the expressions and, if the result is too long, will produce an error.) Second, `matrix input` allows you to omit the commas.

**Inputting matrices by hand**

Before turning to operations on matrices, let’s examine how matrices are created. Typically, at least in programming situations, you obtain matrices by accessing one of Stata’s internal matrices (`e(b)` and `e(V)`; see [P] matrix get) or by accumulating it from the data (see [P] matrix accum). Nevertheless, the easiest way to create a matrix is to enter it using `matrix input`—this may not be the normal way to create matrices, but it is useful for performing small, experimental calculations.

▷ **Example 1**

To create the matrix

\[
A = \begin{pmatrix}
1 & 2 \\
3 & 4 \\
\end{pmatrix}
\]

type

```
.matrix A = (1,2 \ 3,4)
```
The spacing does not matter. To define the matrix

$$B = \begin{pmatrix} 1 & 2 & 3 \\ 4 & . & 6 \end{pmatrix}$$

type

. matrix B = (1,2,3 \\ 4,.,6)

To define the matrix

$$C = \begin{pmatrix} 1 & 2 \\ 3 & 4 \\ 5 & 6 \end{pmatrix}$$

type

. matrix C = (1,2 \\ 3,4 \\ 5,6)

If you need more than one line, and you are working interactively, just keep typing; Stata will wrap the line around the screen. If you are working in a do- or ado-file, see [U] 16.1.3 Long lines in do-files.

To create vectors, you enter the elements, separating them by commas or backslashes. To create the row vector

$$D = (1 \ 2 \ 3)$$

type

. matrix D = (1,2,3)

To create the column vector

$$E = \begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix}$$

type

. matrix E = (1\2\3)

To create the $1 \times 1$ matrix $F = (2)$, type

. matrix F = (2)

In these examples, we have omitted the input subcommand. They would work either way.

Matrix operators

In what follows, uppercase letters $A$, $B$, ... stand for matrix names. The matrix operators are

+, meaning addition. matrix $C=A+B$, $A$: $r \times c$ and $B$: $r \times c$, creates $C$: $r \times c$ containing the elementwise addition $A + B$. An error is issued if the matrices are not conformable. Row and column names are obtained from $B$.

-, meaning subtraction or negation. matrix $C=A-B$, $A$: $r \times c$ and $B$: $r \times c$, creates $C$ containing the elementwise subtraction $A – B$. An error is issued if the matrices are not conformable. matrix $C=-A$ creates $C$ containing the elementwise negation of $A$. Row and column names are obtained from $B$. 
*, meaning multiplication. matrix C=A*B, A: \( a \times b \) and B: \( b \times c \), returns C: \( a \times c \) containing the matrix product AB; an error is issued if A and B are not conformable. The row names of C are obtained from the row names of A, and the column names of C from the column names of B.

matrix C=A*s or matrix C=s*A, A: \( a \times b \) and s a Stata scalar (see [P] scalar) or a literal number, returns C: \( a \times b \) containing the elements of A each multiplied by s. The row and column names of C are obtained from A. For example, matrix VC=MYMAT*2.5 multiplies each element of MYMAT by 2.5 and stores the result in VC.

/, meaning matrix division by scalar. matrix C=A/s, A: \( a \times b \) and s a Stata scalar (see [P] scalar) or a literal number, returns C: \( a \times b \) containing the elements of A each divided by s. The row and column names of C are obtained from A.

#, meaning the Kronecker product. matrix C=A#B, A: \( a \times b \) and B: \( c \times d \), returns C: \( ac \times bd \) containing the Kronecker product A \( \otimes \) B, all elementwise products of A and B. The upper-left submatrix of C is the product \( A_{1,1}B \); the submatrix to the right is \( A_{1,2}B \); and so on. Row and column names are obtained by using the subnames of A as resulting equation names and the subnames of B for the subnames of C in each submatrix.

Nothing, meaning copy. matrix B=A copies A into B. The row and column names of B are obtained from A. The matrix rename command (see [P] matrix utility) will rename instead of copy a matrix.

', meaning transpose. matrix B=A', A: \( r \times c \), creates B: \( c \times r \) containing the transpose of A. The row names of B are obtained from the column names of A and the column names of B from the row names of A.

, meaning join columns by row. matrix C=A,B, A: \( a \times b \) and B: \( a \times c \), returns C: \( a \times (b + c) \) containing A in columns 1 through b and B in columns b + 1 through b + c (the columns of B are appended to the columns of A). An error is issued if the matrices are not conformable. The row names of C are obtained from A. The column names are obtained from A and B.

\, meaning join rows by column. matrix C=A\B, A: \( a \times b \) and B: \( c \times b \), returns C: \( (a + c) \times b \) containing A in rows 1 through a and B in rows a + 1 through a + c (the rows of B are appended to the rows of A). An error is issued if the matrices are not conformable. The column names of C are obtained from A. The row names are obtained from A and B.

matrix define allows complicated matrix expressions. Parentheses may be used to control the order of evaluation. The default order of precedence for the matrix operators (from highest to lowest) is

<table>
<thead>
<tr>
<th>Operator</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>parentheses</td>
<td>()</td>
</tr>
<tr>
<td>transpose</td>
<td>'</td>
</tr>
<tr>
<td>negation</td>
<td>-</td>
</tr>
<tr>
<td>Kronecker product</td>
<td>#</td>
</tr>
<tr>
<td>division by scalar</td>
<td>/</td>
</tr>
<tr>
<td>multiplication</td>
<td>*</td>
</tr>
<tr>
<td>subtraction</td>
<td>-</td>
</tr>
<tr>
<td>addition</td>
<td>+</td>
</tr>
<tr>
<td>column join</td>
<td>;</td>
</tr>
<tr>
<td>row join</td>
<td>\</td>
</tr>
</tbody>
</table>

operator precedence

- parentheses
- transpose
- negation
- Kronecker product
- division by scalar
- multiplication
- subtraction
- addition
- column join
- row join

### Example

```stata
matrix A = 1 2
| 3 |
1 2 3

matrix B = 4 5
| 6 |
4 5 6

matrix C = A*B
```

### Output

```
|  8 | 10 |
| 14 | 18 |
```

This example shows the multiplication of matrices A and B, resulting in matrix C.
Example 2

The following examples are artificial but informative:

```stata
.matrix A = (1,2\3,4)
.matrix B = (5,7\9,2)
.matrix C = A+B
.matrix list C
C[2,2]
c1 c2
r1  6  9
r2 12  6
.matrix B = A-B
.matrix list B
B[2,2]
c1 c2
r1 -4 -5
r2 -6  2
.matrix X = (1,1\2,5\8,0\4,5)
.matrix C = 3*X*A'*B
.matrix list C
C[4,2]
c1 c2
r1  -162  -3
r2 -612 -24
r3  -528  24
r4 -744  -18
.matrix D = (X'*X - A'*A)/4
.matrix rownames D = dog cat // see [P] matrix rownames
.matrix colnames D = bark meow // see [P] matrix rownames
.matrix list D
symmetric D[2,2]
  bark  meow
dog  18.75  4.25  37.5  8.5
  cat  4.25  7.75  8.5  15.5
.matrix rownames A = aa bb // see [P] matrix rownames
.matrix colnames A = alpha beta // see [P] matrix rownames
.matrix list A
A[2,2]
  alpha  beta
  aa  1  2
  bb  3  4
.matrix D=A#D
.matrix list D
D[4,4]
  alpha:  alpha:  beta:  beta:
  bark:  meow  bark:  meow
aa:dog  18.75  4.25  37.5  8.5
aa:cat  4.25  7.75  8.5  15.5
bb:dog  56.25 12.75  75  17
bb:cat 12.75 23.25  17  31
.matrix G=A,B\D
```

356 matrix define — Matrix definition, operators, and functions
. matrix list G
G[6,4]
  alpha  beta  c1  c2
  aa  1  2  -4  -5
  bb  3  4  -6  2
  aa:dog  18.75  4.25  37.5  8.5
  aa:cat  4.25  7.75  8.5  15.5
  bb:dog  56.25  12.75  75  17
  bb:cat  12.75  23.25  17  31

. matrix Z = (B - A)'*(B + A'*-B)/4
. matrix list Z
Z[2,2]
  c1  c2
  alpha  -81  -1.5
  beta  -44.5  8.5

Technical note

Programmers: Watch out for confusion when combining ‘’, meaning to transpose with local macros, where ‘’ is one of the characters that enclose macro names: ‘mname’. Stata will not become confused, but you might. Compare:

. matrix ‘new1’ = ‘old’

and

. matrix ‘new2’ = ‘old’

Matrix ‘new2’ contains matrix ‘old’, transposed. Stata will become confused if you type

. matrix ‘C’ = ‘A’\’B’

because the backslash in front of the ‘B’ makes the macro processor take the left quote literally. No substitution is ever made for ‘B’. Even worse, the macro processor assumes that the backslash was meant for it and so removes the character! Pretend that ‘A’ contained a, ‘B’ contained b, and ‘C’ contained c. After substitution, the line would read

. matrix c = a’\ b

which is not at all what was intended. To make your meaning clear, put a space after the backslash,

. matrix ‘C’ = ‘A’ \ ‘B’

which would then be expanded to read

. matrix c = a \ b

Matrix functions returning matrices

In addition to matrix operators, Stata has matrix functions, which allow expressions to be passed as arguments. The following matrix functions are provided:

matrix A=I(dim) defines A as the \( dim \times dim \) identity matrix, where dim is a scalar expression and will be rounded to the nearest integer. For example, matrix A=I(3) defines A as the \( 3 \times 3 \) identity matrix.
matrix A = J(r, c, z) defines A as an \( r \times c \) matrix containing elements \( z, r, c, \) and \( z \) are scalar expressions with \( r \) and \( c \) rounded to the nearest integer. For example, matrix A = J(2, 3, 0) returns a 2 \( \times \) 3 matrix containing 0 for each element.

matrix L = cholesky(mexp) performs Cholesky decomposition. An error is issued if the matrix expression \( mexp \) does not evaluate to a square, symmetric matrix. For example, matrix L = cholesky(A) produces the lower triangular (square root) matrix \( L \), such that \( LL' = A \). The row and column names of \( L \) are obtained from \( A \).

matrix B = invsym(mexp), if \( mexp \) evaluates to a square, symmetric, and positive-definite matrix, returns the inverse. If \( mexp \) does not evaluate to a positive-definite matrix, rows will be inverted until the diagonal terms are zero or negative; the rows and columns corresponding to these terms will be set to 0, producing a g2-inverse. The row names of \( B \) are obtained from the column names of \( mexp \), and the column names of \( B \) are obtained from the row names of \( mexp \).

matrix B = inv(mexp), if \( mexp \) evaluates to a square but not necessarily symmetric or positive-definite matrix, returns the inverse. A singular matrix will result in an error. The row names of \( B \) are obtained from the column names of \( mexp \), and the column names of \( B \) are obtained from the row names of \( mexp \). invsym() should be used in preference to inv(), which is less accurate, whenever possible. (Also see \([p]\) matrix svd for singular value decomposition.)

matrix B = sweep(mexp, n) applies the sweep operator to the \( n \)th row and column of the square matrix resulting from the matrix expression \( mexp. n \) is a scalar expression and will be rounded to the nearest integer. The names of \( B \) are obtained from \( mexp \), except that the \( n \)th row and column names are interchanged. For A: \( n \times n \), B = sweep(A, k) produces B: \( n \times n \), defined as

\[
B_{kk} = \frac{1}{A_{kk}}
\]

\[
B_{ik} = -\frac{A_{ik}}{A_{kk}}, \quad i \neq k \quad \text{(kth column)}
\]

\[
B_{kj} = \frac{A_{ij}}{A_{kk}}, \quad j \neq k \quad \text{(jth row)}
\]

\[
B_{ij} = A_{ij} - \frac{A_{ik}A_{kj}}{A_{kk}}, \quad i \neq k, j \neq k
\]

matrix B = corr(mexp), where \( mexp \) evaluates to a covariance matrix, stores the corresponding correlation matrix in B. The row and column names are obtained from \( mexp \).

matrix B = diag(mexp), where \( mexp \) evaluates to a row or column vector (1 \( \times \) c or c \( \times \) 1), creates \( B \): c \( \times \) c with diagonal elements from \( mexp \) and off-diagonal elements 0. The row and column names are obtained from the column names of \( mexp \) if \( mexp \) is a row vector or the row names if \( mexp \) is a column vector.

matrix B = vec(mexp), where \( mexp \) evaluates to an \( r \times c \) matrix, creates B: rc \( \times \) 1 containing the elements of \( mexp \) starting with the first column and proceeding column by column.

matrix B = vecdiag(mexp), where \( mexp \) evaluates to a square c \( \times \) c matrix, creates B: 1 \( \times \) c containing the diagonal elements from \( mexp \). vecdiag() is the opposite of diag(). The row name is set to r1. The column names are obtained from the column names of \( mexp \).

matrix B = matuniform(r, c) creates B: \( r \times c \) containing uniformly distributed pseudorandom numbers on the interval \([0, 1]\).

matrix B = hadamard(mexp, nexp), where \( mexp \) and \( nexp \) evaluate to \( r \times c \) matrices, creates a matrix whose \((i, j)\) element is \( mexp[i, j] \cdot nexp[i, j] \). If \( mexp \) and \( nexp \) do not evaluate to matrices of the same size, this function reports a conformability error.
nullmat(B) may only be used with the row-join (,) and column-join (\) operators, and informs Stata that B might not exist. If B does not exist, the row-join or column-join operator simply returns the other matrix-operator argument. An example of the use of nullmat() is given in [FN] Matrix functions.

matrix B=get(systemname) returns in B a copy of the Stata internal matrix systemname; see [P] matrix get. You can obtain the coefficient vector and variance–covariance matrix after an estimation command either with matrix get or by reference to e(b) and e(V).

Example 3

The examples are, once again, artificial but informative.

```
. matrix myid = I(3)
. matrix list myid
 symmetric myid[3,3]  
   c1   c2   c3  
   r1   1
   r2   0   1
   r3   0   0   1
.
. matrix new = J(2,3,0)
. matrix list new
 new[2,3]  
   c1   c2   c3  
   r1   0   0   0
   r2   0   0   0
.
. matrix A = (1,2\2,5)
. matrix Ainv = syminv(A)
. matrix list Ainv
 symmetric Ainv[2,2]  
   r1   r2  
   c1   5
   c2  -2   1
.
. matrix L = cholesky(4*I(2) + A'*A)
. matrix list L
 L[2,2]  
   c1   c2  
   c1   3   0  
   c2   4   4.1231056
.
. matrix B = (1,5,9\2,1,7\3,5,1)
. matrix Binv = inv(B)
. matrix list Binv
 Binv[3,3]  
   r1   r2   r3  
   c1  -.27419355  .32258065  .20967742
   c2  .15322581  -.20967742  .08870968
   c3  .05645161  .08064516  -.07258065
.
. matrix C = sweep(B,1)
. matrix list C
 C[3,3]  
   r1   c2   c3  
   r1  1   5   9  
   r2 -2  -9  -11
   r3 -3  -10  -26
.
. matrix C = sweep(C,1)
```
. matrix define — Matrix definition, operators, and functions

C[3,3]
c1  c2  c3
r1  1  5  9
r2  2  1  7
r3  3  5  1

. matrix Cov = (36.6598, -3596.48, -3596.48, 604030)

. matrix R = corr(Cov)

. matrix list R
symmetric R[2,2]
c1   c2
r1   1
r2  -.7642815  1

. matrix d = (1,2,3)

. matrix D = diag(d)

. matrix list D
symmetric D[3,3]
c1  c2  c3
c1   1
c2   0  2
c3   0  0  3

. matrix e = vec(D)

. matrix list e
e[9,1]
c1
c1:c1  1
c1:c2  0
c1:c3  0
c2:c1  0
c2:c2  2
c2:c3  0
c3:c1  0
c3:c2  0
c3:c3  3

. matrix f = vecdiag(D)

. matrix list f
f[1,3]
c1   c2   c3
r1   1   2   3

* matrix function arguments can be other matrix functions and expressions

. matrix G = diag(inv(B) * vecdiag(diag(d) + 4*sweep(B+J(3,3,10),2)'*I(3))')

. matrix list G
symmetric G[3,3]
c1   c2   c3
c1  -3.2170088
 c2   0  -7.686217
 c3   0   0  2.3548387

. set seed 12345

. matrix U = matuniform(3,4)

. matrix list U
U[3,4]
c1   c2   c3   c4
r1  .35762972  .40044262  .68938332  .55973557
r2  .57446129  .20769053  .0286627  .68892448
r3  .46934336  .2071526  .00393225  .01302971
. matrix H = hadamard(B,C)
. matrix list H
H[3,3]
c1  c2  c3
r1  1  25  81
r2  4  1  49
r3  9  25  1

**Matrix functions returning scalars**

In addition to the above functions used with `matrix define`, which can be described as matrix functions returning matrices, there are matrix functions that return mathematical scalars. The list of functions that follow should be viewed as a continuation of [U] 13.3 Functions. If the functions listed below are used in a scalar context (for example, used with `display` or `generate`), then `A`, `B`, ... below stand for matrix names (possibly as a string literal or string variable name—details later). If the functions below are used in a matrix context (in `matrix define` for instance), then `A`, `B`, ... may also stand for matrix expressions.

- `rowsof(A)` and `colsof(A)` return the number of rows or columns of `A`.
- `rownumb(A,string)` and `colnumb(A,string)` return the row or column number associated with the name specified by `string`. For instance, `rownumb(MYMAT,"price")` returns the row number (say, 3) in MYMAT that has the name `price` (subname `price` and equation name blank). `colnumb(MYMAT,"out2:price")` returns the column number associated with the name `out2:price` (subname `price` and equation name `out2`). If row or column name is not found, missing is returned.
- `rownumb()` and `colnumb()` can also return the first row or column number associated with an equation name. For example, `colnumb(MYMAT,"out2:")` returns the first column number in MYMAT that has equation name `out2`. Missing is returned if the equation name `out2` is not found.
- `trace(A)` returns the sum of the diagonal elements of square matrix `A`. If `A` is not square, missing is returned.
- `det(A)` returns the determinant of square matrix `A`. The determinant is the volume of the $(p-1)$-dimensional manifold described by the matrix in $p$-dimensional space. If `A` is not square, missing is returned.
- `diag0cnt(A)` returns the number of zeros on the diagonal of the square matrix `A`. If `A` is not square, missing is returned.
- `issymmetric(A)` returns 1 if the matrix is symmetric and 0 otherwise.
- `matmissing(A)` returns 1 if any elements of the matrix are missing and 0 otherwise.
- `mreldif(A,B)` returns the relative difference of matrix `A` and `B`. If `A` and `B` do not have the same dimensions, missing is returned. The matrix relative difference is defined as

$$
\max_{i,j} \left( \frac{|A[i,j] - B[i,j]|}{|B[i,j]| + 1} \right)
$$

- `el(A,i,j)` and `A[i,j]` return the $(i,j)$ element of `A`. Usually either construct may be used; `el(MYMAT,2,3)` and `MYMAT[2,3]` are equivalent, although `MYMAT[2,3]` is more readable. For the second construct, however, `A` must be a matrix name—it cannot be a string literal or string
variable. The first construct allows \( A \) to be a matrix name, string literal, or string variable. For instance, assume that \( \text{mymat} \) (as opposed to \( \text{MYMAT} \)) is a string variable in the dataset containing matrix names. \( \text{mymat}[2,3] \) refers to the \((2,3)\) element of the matrix named \( \text{mymat} \), a matrix that probably does not exist, and so produces an error. \( \text{el(\text{mymat},2,3)} \) refers to the data variable \( \text{mymat} \); the contents of that variable will be taken to obtain the matrix name, and \( \text{el()} \) will then return the \((2,3)\) element of that matrix. If that matrix does not exist, Stata will not issue an error; because you referred to it indirectly, the \( \text{el()} \) function will return missing.

In either construct, \( i \) and \( j \) may be any expression (an \( \text{exp} \)) evaluating to a real. \( \text{MYMAT}[2,3+1] \) returns the \((2,4)\) element. In programs that loop, you might refer to \( \text{MYMAT}['i','j'+1] \).

In a matrix context (such as \text{matrix define}), the first argument of \( \text{el()} \) may be a matrix expression. For instance, \( \text{matrix A = B*el(B-C,1,1)} \) is allowed, but \( \text{display el(B-C,1,1)} \) would be an error because \( \text{display} \) is in a scalar context.

The matrix functions returning scalars defined above can be used in any context that allows an expression—what is abbreviated \( \text{exp} \) in the syntax diagrams throughout this manual. For instance, \( \text{trace()} \) returns the (scalar) trace of a matrix. Say that you have a matrix called \( \text{MYX} \). You could type

\[
\text{. generate tr = trace(MYX)}
\]

although this would be a silly thing to do. It would force Stata to evaluate the trace of the matrix many times, once for each observation in the data, and it would then store that same result over and over again in the new data variable \( \text{tr} \). But you could do it because, if you examine the syntax diagram for \text{generate} (see [D] \text{generate}), \text{generate} allows an \( \text{exp} \).

If you just wanted to see the trace of \( \text{MYX} \), you could type

\[
\text{. display trace(MYX)}
\]

because the syntax diagram for \text{display} also allows an \( \text{exp} \); see [P] \text{display}. You could do either of the following:

\[
\text{. local tr = trace(MYX)}
\]
\[
\text{. scalar tr = trace(MYX)}
\]

This is more useful because it will evaluate the trace only once and then store the result. In the first case, the result will be stored in a local macro (see [P] \text{macro}); in the second, it will be stored in a Stata scalar (see [P] \text{scalar}).

\section*{Example 4}

Storing the number as a scalar is better for two reasons: it is more accurate (scalars are stored in double precision), and it is faster (macros are stored as printable characters, and this conversion is a time-consuming operation). Not too much should be made of the accuracy issue; macros are stored with at least 13 digits, but it can sometimes make a difference.

In any case, let’s demonstrate that both methods work by using the simple trace function:

\[
\text{. matrix A = (1,6\ 8,4)}
\]
\[
\text{. local tr = trace(A)}
\]
\[
\text{. display ‘tr’}
\]
\[
\text{5}
\]
\[
\text{. scalar sctr = trace(A)}
\]
\[
\text{. scalar list sctr}
\]
\[
\text{sctr = 5}
\]
Subscripting and element-by-element definition

matrix \( \mathbf{B} = \mathbf{A}[r_1, r_2] \), for range expressions \( r_1 \) and \( r_2 \) (defined below), extracts a submatrix from \( \mathbf{A} \) and stores it in \( \mathbf{B} \). Row and column names of \( \mathbf{B} \) are obtained from the extracted rows and columns of \( \mathbf{A} \). In what follows, assume that \( \mathbf{A} \) is \( a \times b \).

A range expression can be a literal number. For example, \( \text{matrix } \mathbf{B} = \mathbf{A}[1,2] \) would return a \( 1 \times 1 \) matrix containing \( A_{1,2} \).

A range expression can be a number followed by two periods followed by another number, meaning the rows or columns from the first number to the second. For example, \( \text{matrix } \mathbf{B} = \mathbf{A}[2..4,1..5] \) would return a \( 3 \times 5 \) matrix containing the second through fourth rows and the first through fifth columns of \( \mathbf{A} \).

A range expression can be a number followed by three periods, meaning all the remaining rows or columns from that number. For example, \( \text{matrix } \mathbf{B} = \mathbf{A}[3,4...] \) would return a \( 1 \times b - 3 \) matrix (row vector) containing the fourth through last elements of the third row of \( \mathbf{A} \).

A range expression can be a quoted string, in which case it refers to the row or column with the specified name. For example, \( \text{matrix } \mathbf{B} = \mathbf{A}[^\text{"price"},^\text{"mpg"}] \) returns a \( 1 \times 1 \) matrix containing the element whose row name is \( \text{price} \) and column name is \( \text{mpg} \), which would be the same as \( \text{matrix } \mathbf{B} = \mathbf{A}[2,3] \) if the second row were named \( \text{price} \) and the third column \( \text{mpg} \). \( \text{matrix } \mathbf{B} = \mathbf{A}[^\text{"price"},1...] \) would return the \( 1 \times b \) vector corresponding to the row named \( \text{price} \). In either case, if there is no row or column with the specified name, an error is issued, and the return code is set to 111. If the row or column names include both an equation name and a subtype, the fully qualified name must be specified, as in \( \text{matrix } \mathbf{B} = \mathbf{A}[^\text{"eq1:price"},1...] \).

A range expression can be a quoted string containing only an equation name, in which case it refers to all rows or columns with the specified equation name. For example, \( \text{matrix } \mathbf{B} = \mathbf{A}[^\text{"eq1:"},^\text{"eq1:"}] \) would return the submatrix of rows and columns that have equation names \( \text{eq1} \).

A range expression containing a quoted string referring to an element (not to an entire equation) can be combined with the .. and ... syntaxes above: For example, \( \text{matrix } \mathbf{B} = \mathbf{A}[^\text{"price"}...,^\text{"price"}...] \) would define \( \mathbf{B} \) as the submatrix of \( \mathbf{A} \) beginning with the rows and columns corresponding to \( \text{price} \). \( \text{matrix } \mathbf{B} = \mathbf{A}[^\text{"price"}...,^\text{"mpg"},^\text{"price"}...,^\text{"mpg"}] \) would define \( \mathbf{B} \) as the submatrix of \( \mathbf{A} \) starting at rows and columns corresponding to \( \text{price} \) and continuing through the rows and columns corresponding to \( \text{mpg} \).

A range expression can be mixed. For example, \( \text{matrix } \mathbf{B} = \mathbf{A}[1..^\text{"price"},2] \) defines \( \mathbf{B} \) as the column vector extracted from the second column of \( \mathbf{A} \) containing the first element through the element corresponding to \( \text{price} \).

Scalar expressions may be used in place of literal numbers. The resulting number will be rounded to the nearest integer. Subscripting with scalar expressions may be used in any expression context (such as \texttt{generate} or \texttt{replace}). Subscripting with row and column names may be used only in a matrix expression context. This is really not a constraint; see the \texttt{rownumb()} and \texttt{colnumb()} functions discussed previously in the section titled \texttt{Matrix functions returning scalars}.

\[ \text{matrix } \mathbf{A}[r,c] = \text{exp} \] changes the \( r,c \) element of \( \mathbf{A} \) to contain the result of the evaluated scalar expression, as defined in [U] 13 Functions and expressions, and as further defined in Matrix functions returning scalars. \( r \) and \( c \) may be scalar expressions and will be rounded to the nearest integer. The matrix \( \mathbf{A} \) must already exist; the matrix function \( \texttt{J()} \) can be used to achieve this.

\[ \text{matrix } \mathbf{A}[r,c] = \text{mexp} \] places the matrix resulting from the \( \text{mexp} \) matrix expression into the already existing matrix \( \mathbf{A} \), with the upper-left corner of the \( \text{mexp} \) matrix located at the \( r,c \) element of \( \mathbf{A} \). If there is not enough room to place the \( \text{mexp} \) matrix at that location, a conformability error will
be issued, and the return code will be set to 503. \( r \) and \( c \) may be scalar expressions and will be rounded to the nearest integer.

Example 5

Continuing with our artificial but informative examples,

```
. matrix A = (1,2,3,4\5,6,7,8\9,10,11,12\13,14,15,16)
. matrix rownames A = mercury venus earth mars
. matrix colnames A = poor average good exc
. matrix list A
A[4,4]
    poor   average   good   exc
mercury   1       2       3       4
venus     5       6       7       8
earth     9      10       11      12
mars      13      14       15      16

. matrix b = A[1,2..3]
. matrix list b
b[1,2]
    average   good
mercury   2       3

. matrix b = A[2...,1..3]
. matrix list b
b[3,3]
    poor   average   good
venus     5       6       7
earth     9      10       11
mars      13      14       15

. matrix b = A["venus".."earth","average"...]
. matrix list b
b[2,3]
    average   good   exc
venus     6       7       8
earth    10      11       12

. matrix b = A["mars",2...]
. matrix list b
b[1,3]
    average   good   exc
mars     14      15       16

. matrix b = A[sqrt(9)+1..substr("xmars",2,4),2.8..2*2] /* strange but valid */
. matrix list b
b[1,2]
    good   exc
mars      15       16
```

. matrix rownames A = eq1:alpha eq1:beta eq2:alpha eq2:beta
. matrix colnames A = eq1:one eq1:two eq2:one eq2:two
. matrix list A
A[4,4]
    eq1: eq1: eq2: eq2:
    one two one two
eq1:alpha  1  2  3  4
eq1:beta  5  6  7  8
eq2:alpha  9 10 11 12
eq2:beta  13 14 15 16

. matrix b = A["eq1:","eq2:"]

. matrix list b
b[2,2]
    eq2: eq2:
    one two
eq2:alpha  3  4
eq1:beta  7  8

. matrix A[3,2] = sqrt(9)

. matrix list A
A[4,4]
    eq1: eq1: eq2: eq2:
    one two one two
eq1:alpha  1  2  3  4
eq1:beta  5  6  7  8
eq2:alpha  9  3 11 12
eq2:beta  13 14 15 16

. matrix X = (-3,0\-1,-6)

. matrix A[1,3] = X

. matrix list A
A[4,4]
    eq1: eq1: eq2: eq2:
    one two one two
eq1:alpha  1  2 -3  0
eq1:beta  5  6 -1 -6
eq2:alpha  9  3 11 12
eq2:beta  13 14 15 16

Technical note

matrix A[i,j]=exp can be used to implement matrix formulas that perhaps Stata does not have built in. Let’s pretend that Stata could not multiply matrices. We could still multiply matrices, and after some work, we could do so conveniently. Given two matrices, A: a \times b and B: b \times c, the (i,j) element of C = AB, C: a \times c, is defined as

\[ C_{ij} = \sum_{k=1}^{b} A_{ik}B_{kj} \]
Here is a Stata program to make that calculation:

```stata
program matmult // arguments A B C, creates C=A*B
    version 17.0 // unload arguments into better names
    args A B C // check conformability
    if colsof('A')!=rowsof('B') { error 503 }
    local a = rowsof('A') // obtain dimensioning information
    local b = colsof('A') // see Matrix functions returning
    local c = colsof('B') // scalars above
    matrix 'C' = J('a','c',0) // create result containing 0s
    forvalues i = 1/'a' {
        forvalues 'j' = 1/'c' {
            forvalues 'k' = 1/'b' {
                matrix 'C'['i','j'] = 'C'['i','j'] + /*
                                     */ 'A'['i','k']*'B'['k','j']
            }
        }
    }
end
```

Now if in some other program, we needed to multiply matrix XXI by Xy to form result beta, we could type `matmult XXI Xy beta` and never use Stata’s built-in method for multiplying matrices (`matrix beta=XXI*Xy`). If we typed the program `matmult` into a file named `matmult.ado`, we would not even have to bother to load `matmult` before using it—it would be loaded automatically; see [U] 17 Ado-files.

### Name conflicts in expressions (namespaces)

See [P] matrix for a description of namespaces. A matrix might have the same name as a variable in the dataset, and if it does, Stata might appear confused when evaluating an expression (an `exp`). When the names conflict, Stata uses the rule that it always takes the data-variable interpretation. You can override this.

First, when working interactively, you can avoid the problem by simply naming your matrices differently from your variables.

Second, when writing programs, you can avoid name conflicts by obtaining names for matrices from `tempname`; see [P] macro.

Third, whether working interactively or writing programs, when using names that might conflict, you can use the `matrix()` pseudofunction to force Stata to take the matrix-name interpretation.

`matrix(name)` says that `name` is to be interpreted as a matrix name. For instance, consider the statement `local new=trace(xx)`. This might work and it might not. If `xx` is a matrix and there is no variable named `xx` in your dataset, it will work. If there is also a numeric variable named `xx` in your dataset, it will not work. Typing the statement will produce a type-mismatch error—Stata assumes that when you type `xx`, you are referring to the data variable `xx` because there is a data variable `xx`. Typing `local new=trace(matrix(xx))` will then produce the desired result. When writing programs using matrix names not obtained from `tempname`, you are strongly advised to state explicitly that all matrix names are indeed matrix names by using the `matrix()` function.

The only exception to this recommendation has to do with the construct `A[i,j]`. The two subscripts indicate to Stata that `A` must be a matrix name and not an attempt to subscript a variable, so `matrix()` is not needed. This exception applies only to `A[i,j]`; it does not apply to `el(A,i,j)`, which would be more safely written as `el(matrix(A),i,j)`.
Technical note

The `matrix()` and `scalar()` pseudofunctions (see [P] scalar) are really the same function, but you do not need to understand this fine point to program Stata successfully. Understanding this might, however, lead to producing more readable code. The formal definition is this:

\[
\text{scalar}(exp) \quad \text{(and therefore } \text{matrix}(exp) \text{)} \quad \text{evaluates } exp \text{ but restricts Stata to interpreting all names in } exp \text{ as scalar or matrix names. Scalars and matrices share the same namespace.}
\]

Therefore, because `scalar()` and `matrix()` are the same function, typing `trace(matrix(xx))` or `trace(scalar(xx))` would do the same thing, even though the second looks wrong. Because `scalar()` and `matrix()` allow an `exp`, you could also type `scalar(trace(xx))` and achieve the same result. `scalar()` evaluates the `exp` inside the parentheses: it merely restricts how names are interpreted, so now `trace(xx)` clearly means the trace of the matrix named `xx`.

How can you make your code more readable? Pretend that you wanted to calculate the trace plus the determinant of matrix `xx` and store it in the Stata scalar named `tpd` (no, there is no reason you would ever want to make such a silly calculation). You are writing a program and want to protect yourself from `xx` also existing in the dataset. One solution would be

\[
\text{scalar } tpd = \text{trace(matrix(xx))} + \text{det(matrix(xx))}
\]

Knowing the full interpretation rule, however, you realize that you can shorten this to

\[
\text{scalar } tpd = \text{matrix(trace(xx) + det(xx))}
\]

and then, to make it more readable, you substitute `scalar()` for `matrix()`:

\[
\text{scalar } tpd = \text{scalar(trace(xx) + det(xx))}
\]

Macro functions

The following macro functions (see [P] macro) are also defined:

- `rownames A` and `colnames A` return a list of all the row or column subnames (with time-series operators if applicable) of `A`, separated by single blanks. The equation names, even if present, are not included.
- `roweq A` and `coleq A` return a list of all the row equation names or column equation names of `A`, separated by single blanks, and with each name appearing however many times it appears in the matrix.
- `rowfullnames A` and `colfullnames A` return a list of all the row or column names, including equation names of `A`, separated by single blanks.

Example 6

These functions are provided as macro functions and standard expression functions because Stata’s expression evaluator works only with strings of no more than 2,045 characters, something not true of Stata’s macro parser. A matrix with many rows or columns can produce an exceedingly long list of names.
In sophisticated programming situations, you sometimes want to process the matrices by row and column names rather than by row and column numbers. Assume that you are programming and have two matrices, \( xx \) and \( yy \). You know that they contain the same column names, but they might be in a different order. You want to reorganize \( yy \) to be in the same order as \( xx \). The following code fragment will create ‘newyy’ (a matrix name obtained from \texttt{tempname}) containing \( yy \) in the same order as \( xx \):

```plaintext
tempname newyy newcol
local names : colfullnames(xx)
foreach name of local names {
    local j = colnumb(yy,"'name'")
    if 'j'>=. {
        display as error "column for 'name' not found"
        exit 111
    }
    matrix 'newcol' = yy[1..., 'j']
    matrix 'newyy' = nullmat('newyy'),'newcol'
}
```

Also see

- [P] \texttt{macro} — Macro definition and manipulation
- [P] \texttt{matrix} — Introduction to matrix commands
- [P] \texttt{matrix get} — Access system matrices
- [P] \texttt{matrix utility} — List, rename, and drop matrices
- [P] \texttt{scalar} — Scalar variables
- [U] 13.3 Functions
- [U] 14 Matrix expressions

\textit{Mata Reference Manual}
matrix dissimilarity — Compute similarity or dissimilarity measures

Description

matrix dissimilarity computes a similarity, dissimilarity, or distance matrix.

Syntax

```
matrix dissimilarity matname = [varlist] [if] [in] [, options]
```

```
options                      Description
measure                     similarity or dissimilarity measure; default is L2 (Euclidean)
observations                compute similarities or dissimilarities between observations; the default
variables                   compute similarities or dissimilarities between variables
names(varname)              row/column names for matname (allowed with observations)
allbinary                   check that all values are 0, 1, or missing
proportions                interpret values as proportions of binary values
dissim(method)             change similarity measure to dissimilarity measure
```

where method transforms similarities to dissimilarities by using

- oneminus: \( d_{ij} = 1 - s_{ij} \)
- standard: \( d_{ij} = \sqrt{s_{ii} + s_{jj} - 2s_{ij}} \)

Options

measure specifies one of the similarity or dissimilarity measures allowed by Stata. The default is L2, Euclidean distance. Many similarity and dissimilarity measures are provided for continuous data and for binary data; see [MV] measure_option.

observations and variables specify whether similarities or dissimilarities are computed between observations or variables. The default is observations.

names(varname) provides row and column names for matname. varname must be a string variable with a length of 32 or less in bytes. You will want to pick a varname that yields unique values for the row and column names. Uniqueness of values is not checked by matrix dissimilarity. names() is not allowed with the variables option. The default row and column names when the similarities or dissimilarities are computed between observations is obs#, where # is the observation number corresponding to that row or column.

allbinary checks that all values are 0, 1, or missing. Stata treats nonzero values as one (excluding missing values) when dealing with what are supposed to be binary data (including binary similarity measures). allbinary causes matrix dissimilarity to exit with an error message if the values are not truly binary. allbinary is not allowed with proportions or the Gower measure.
proportions is for use with binary similarity measures. It specifies that values be interpreted as proportions of binary values. The default action treats all nonzero values as one (excluding missing values). With proportions, the values are confirmed to be between zero and one, inclusive. See [MV] measure_option for a discussion of the use of proportions with binary measures. proportions is not allowed with allbinary or the Gower measure.

dissim(method) specifies that similarity measures be transformed into dissimilarity measures. method may be oneminus or standard. oneminus transforms similarities to dissimilarities by using $d_{ij} = 1 - s_{ij}$ (Kaufman and Rousseeuw 1990, 21). standard uses $d_{ij} = \sqrt{s_{ii} + s_{jj} - 2s_{ij}}$ (Mardia, Kent, and Bibby 1979, 402). dissim() does nothing when the measure is already a dissimilarity or distance. See [MV] measure_option to see which measures are similarities.

Remarks and examples

Commands such as cluster singlelinkage, cluster completelinkage, and mds (see [MV] cluster and [MV] mds) have options allowing the user to select the similarity or dissimilarity measure to use for its computation. If you are developing a command that requires a similarity or dissimilarity matrix, the matrix dissimilarity command provides a convenient way to obtain it.

The similarity or dissimilarity between each observation (or variable if the variables option is specified) and the others is placed in matname. The element in the $i$th row and $j$th column gives either the similarity or dissimilarity between the $i$th and $j$th observation (or variable). Whether you get a similarity or a dissimilarity depends upon the requested measure; see [MV] measure_option.

If the number of observations (or variables) is so large that storing the results in a matrix is not practical, you may wish to consider using the cluster measures command, which stores similarities or dissimilarities in variables; see [MV] cluster programming utilities.

When computing similarities or dissimilarities between observations, the default row and column names of matname are set to obs#, where # is the observation number. The names() option allows you to override this default. For similarities or dissimilarities between variables, the row and column names of matname are set to the appropriate variable names.

The order of the rows and columns corresponds with the order of your observations when you are computing similarities or dissimilarities between observations. Warning: If you reorder your data (for example, using sort or gsort) after running matrix dissimilarity, the row and column ordering will no longer match your data.

Another use of matrix dissimilarity is in performing a cluster analysis on variables instead of observations. The cluster command performs a cluster analysis of the observations; see [MV] cluster. If you instead wish to cluster variables, you can use the variables option of matrix dissimilarity to obtain a dissimilarity matrix that can then be used with clustermat; see [MV] clustermat and example 2 below.

Example 1

Example 1 of [MV] cluster linkage introduces data with four chemical laboratory measurements on 50 different samples of a particular plant. Let’s find the Canberra distance between the measurements performed by lab technician Bill found among the first 25 observations of the labtech dataset.
. use https://www.stata-press.com/data/r17/labtech
. matrix dissim D = x1 x2 x3 x4 if labtech=="Bill" in 1/25, canberra
. matrix list D

By default, the row and column names of the matrix indicate the observations involved. The Canberra
distance between the 23rd observation and the 18th observation is 1.4952796. See [MV] measure_option
for a description of the Canberra distance.

Example 2

Example 2 of [MV] cluster linkage presents a dataset with 30 observations of 60 binary variables,
a1, a2, ..., a30. In [MV] cluster linkage, the observations were clustered. Here we instead cluster
the variables by computing the dissimilarity matrix by using matrix dissimilarity with the
variables option followed by the clustermat command.

We use the matching option to obtain the simple matching similarity coefficient but then
specify dissim(oneminus) to transform the similarities to dissimilarities by using the transformation
\[ d_{ij} = 1 - s_{ij} \]. The allbinary option checks that the variables really are binary (0/1) data.

. use https://www.stata-press.com/data/r17/homework
. matrix dissim Avars = a*, variables matching dissim(oneminus) allbinary
. matrix subA = Avars[1..5,1..5]
. matrix list subA

We listed the first five rows and columns of the 60 \( \times \) 60 matrix. The matrix row and column names
correspond to the variable names.

To perform an average-linkage cluster analysis on the 60 variables, we supply the Avars matrix
created by matrix dissimilarity to the clustermat averagelinkage command; see [MV] cluster
linkage.
. clustermat averagelinkage Avars, clear
Number of observations (_N) was 0, now 60.
cluster name: _clus_1
. cluster generate g5 = groups(5)
. table g5

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>g5</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>21</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
</tr>
</tbody>
</table>

We generated a variable, g5, indicating the five-group cluster solution and then tabulated to show how many variables were clustered into each of the five groups. Group five has only one member.

. list g5 if g5==5

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>13.</td>
</tr>
<tr>
<td>5</td>
</tr>
</tbody>
</table>

The member corresponds to the 13th observation in the current dataset, which in turn corresponds to variable a13 from the original dataset. It appears that a13 is not like the other variables.

Example 3

matrix dissimilarity drops observations containing missing values, except when the Gower measure is specified. The computation of the Gower dissimilarity between 2 observations is based on the variables where the 2 observations both have nonmissing values.

We illustrate using a dataset with 6 observations and 4 variables where only 2 of the observations have complete data.

. use https://www.stata-press.com/data/r17/gower, clear
. list

<table>
<thead>
<tr>
<th>b1</th>
<th>b2</th>
<th>x1</th>
<th>x2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>0</td>
<td>.76</td>
<td>.75</td>
</tr>
<tr>
<td>2.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>3.</td>
<td>1</td>
<td>.72</td>
<td>.88</td>
</tr>
<tr>
<td>4.</td>
<td>.</td>
<td>.4</td>
<td>.</td>
</tr>
<tr>
<td>5.</td>
<td>0</td>
<td>.</td>
<td>.14</td>
</tr>
<tr>
<td>6.</td>
<td>0</td>
<td>.55</td>
<td>.</td>
</tr>
</tbody>
</table>

. matrix dissimilarity matL2 = b* x*, L2
. matlist matL2, format(%8.3f)

<table>
<thead>
<tr>
<th></th>
<th>obs1</th>
<th>obs3</th>
</tr>
</thead>
<tbody>
<tr>
<td>obs1</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>obs3</td>
<td>1.421</td>
<td>0.000</td>
</tr>
</tbody>
</table>
The resulting matrix is $2 \times 2$ and provides the dissimilarity between observations 1 and 3. All other observations contained at least one missing value.

However, with the *gower* measure we obtain a $6 \times 6$ matrix.

```
. matrix dissimilarity matgow = b1 b2 x1 x2, gower
. matlist matgow, format(%8.3f)
```

<table>
<thead>
<tr>
<th></th>
<th>obs1</th>
<th>obs2</th>
<th>obs3</th>
<th>obs4</th>
<th>obs5</th>
<th>obs6</th>
</tr>
</thead>
<tbody>
<tr>
<td>obs1</td>
<td>0.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>obs2</td>
<td>.</td>
<td>0.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>obs3</td>
<td>0.572</td>
<td></td>
<td>0.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>obs4</td>
<td>0.500</td>
<td></td>
<td>0.944</td>
<td>0.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>obs5</td>
<td>0.412</td>
<td></td>
<td>1.000</td>
<td></td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>obs6</td>
<td>0.528</td>
<td></td>
<td>0.491</td>
<td>0.708</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Because all the values for observation 2 are missing, the matrix contains missing values for the dissimilarity between observation 2 and the other observations. Notice the missing value in `matgow` for the dissimilarity between observations 4 and 5. There were no variables where observations 4 and 5 both had nonmissing values, and hence the *Gower* coefficient could not be computed.

References


Also see

*P* [matrix] — Introduction to matrix commands

*MV* [cluster] — Introduction to cluster-analysis commands

*MV* [cluster programming utilities] — Cluster-analysis programming utilities

*MV* [clustermat] — Introduction to clustermat commands

*MV* [mdsmat] — Multidimensional scaling of proximity data in a matrix

*MV* [measure_option] — Option for similarity and dissimilarity measures
**matrix eigenvalues — Eigenvalues of nonsymmetric matrices**

**Description**

`matrix eigenvalues` returns the real part of the eigenvalues in the $1 \times n$ row vector $r$ and the imaginary part of the eigenvalues in the $1 \times n$ row vector $c$. Thus the $j$th eigenvalue is $r[1,j] + i \times c[1,j]$.

The eigenvalues are sorted by their moduli; $r[1,1] + i \times c[1,1]$ has the largest modulus, and $r[1,n] + i \times c[1,n]$ has the smallest modulus.

If you want the eigenvalues for a symmetric matrix, see [P] `matrix symeigen`.

Also see [M-5] `eigensystem()` for alternative routines for obtaining eigenvectors and eigenvalues.

**Menu**

Data > Matrices, ado language > Eigenvalues of square matrices

**Syntax**

```
matrix eigenvalues r c = A
```

where $A$ is an $n \times n$ nonsymmetric, real matrix.

**Remarks and examples**

Typing `matrix eigenvalues r c = A` for $A \ n \times n$ returns

\[
\begin{align*}
r &= (r_1, r_2, \ldots, r_n) \\
c &= (c_1, c_2, \ldots, c_n)
\end{align*}
\]

where $r_j$ is the real part and $c_j$ the imaginary part of the $j$th eigenvalue. The eigenvalues are part of the solution to the problem

\[Ax_j = \lambda_j x_j\]

and, in particular,

\[\lambda_j = r_j + i \times c_j\]

The corresponding eigenvectors, $x_j$, are not saved by `matrix eigenvalues`. The returned $r$ and $c$ are ordered so that $|\lambda_1| \geq |\lambda_2| \geq \cdots \geq |\lambda_n|$, where $|\lambda_j| = \sqrt{r_j^2 + c_j^2}$.
Example 1

In time-series analysis, researchers often use eigenvalues to verify the stability of the fitted model. Suppose that we have fit a univariate time-series model and that the stability condition requires the moduli of all the eigenvalues of a “companion” matrix $A$ to be less than 1. (See Hamilton [1994] for a discussion of these models and conditions.)

First, we form the companion matrix.

```
.matrix A = (0.66151492, .2551595, .35603325, -0.15403902, -.12734386)
.matrix A = A \ (I(4), J(4,1,0))
.matrix list A
```

Next we use `matrix eigenvalues` to obtain the eigenvalues, which we will then list:

```
.matrix eigenvalues re im = A
.matrix list re
```

Finally, we compute and list the moduli, which are all less than 1, although the first is close:

```
.forvalues i = 1/5 {
    display sqrt(re[1,'i']^2 + im[1,'i']^2)
}
```

Methods and formulas

Stata’s internal eigenvalue extraction routine for nonsymmetric matrices is based on the public domain LAPACK routine DGEEV. Anderson et al. (1999) provide an excellent introduction to these routines. Stata’s internal routine also uses, with permission, f2c (©1990–1997 by AT&T, Lucent Technologies, and Bellcore).

References


Also see

[P] matrix — Introduction to matrix commands

[P] matrix symeigen — Eigenvalues and eigenvectors of symmetric matrices


[U] 14 Matrix expressions
matrix get — Access system matrices

Description

The get() matrix function obtains a copy of an internal Stata system matrix. Some system matrices can also be obtained more easily by directly referring to the returned result after a command. In particular, the coefficient vector can be referred to as e(b), the variance–covariance matrix of estimators as e(V), and the constraints matrix as e(Cns) after an estimation command.

mat_put_rr is a programmer’s command that posts matname as the internal Rr matrix. matname must have one more than the number of columns in the e(b) or e(V) matrices. The extra column contains the r vector, and the earlier columns contain the R matrix for the Wald test

\[ Rb = r \]

The matrix ...get(Rr) command provides a way to obtain the current Rr system matrix.

Syntax

Obtain copy of internal Stata system matrix

```
matrix [define] matname = get(systemname)
```

Post matrix as internal Rr matrix

```
mat_put_rr matname
```

where systemname is

- _b coefficients after any estimation command
- VCE covariance matrix of estimators after any estimation command
- Rr constraint matrix after test; see [R] test
- Cns constraint matrix after any estimation command

Remarks and examples

get() obtains copies of matrices containing coefficients and the covariance matrix of the estimators after estimation commands (such as regress and probit) and obtains copies of matrices left behind by other Stata commands. The other side of get() is ereturn post, which allows ado-file estimation commands to post results to Stata’s internal areas; see [P] ereturn.
Example 1

After any model-fitting command, the coefficients are available in _b and the variance–covariance matrix of the estimators in VCE.

```
. use https://www.stata-press.com/data/r17/auto
   (1978 automobile data)
. regress price weight mpg
   (output omitted)
```

Here we can directly use e(b) and e(V) to obtain the matrices:

```
. matrix list e(b)
e(b)[1,3]
   weight   mpg    _cons
      y1  1.7465592  -49.512221   1946.0687
. matrix list e(V)
   symmetric e(V)[3,3]
       weight    mpg    _cons
       weight   .41133468
       mpg       44.601659   7422.863
      _cons   -2191.9032  -292759.82   12938766
```

We can also use the matrix get() function to obtain these matrices:

```
. matrix b = get(_b)
. matrix V = get(VCE)
. matrix list b
   b[1,3]
       weight   mpg    _cons
          y1   1.7465592  -49.512221   1946.0687
. matrix list V
   symmetric V[3,3]
       weight    mpg    _cons
       weight   .41133468
       mpg       44.601659   7422.863
      _cons   -2191.9032  -292759.82   12938766
```

The columns of b and both dimensions of V are properly labeled.
Example 2

After `test`, the restriction matrix is available in `Rr`. Having just estimated a regression of `price` on `weight` and `mpg`, we will run a test and then get the restriction matrix:

```stata
.test weight=1, notest
( 1)  weight = 1
.test mpg=40, accum
( 1)  weight = 1
( 2)  mpg = 40
    F(  2,    71) =  6.29
    Prob > F =  0.0030
.matrix rxtr=get(Rr)
.matrix list rxtr
rxtr[2,4]  
c1  c2  c3  c4
r1   1   0   0   1
r2   0   1   0  40
```

Also see

[P] matrix — Introduction to matrix commands
[U] 13.5 Accessing coefficients and standard errors
[U] 14 Matrix expressions
matrix mkmat — Convert variables to matrix and vice versa

Description

mkmat stores the variables listed in varlist in column vectors of the same name, that is, \( N \times 1 \) matrices, where \( N = \_N \), the number of observations in the dataset. Optionally, they can be stored as an \( N \times k \) matrix, where \( k \) is the number of variables in varlist. The variable names are used as column names. By default, the rows are named r1, r2, ....

svmat takes a matrix and stores its columns as new variables. It is the reverse of the mkmat command, which creates a matrix from existing variables.

matname renames the rows and columns of a matrix. matname differs from the matrix rownames and matrix colnames commands in that matname expands varlist abbreviations and allows a restricted range for the rows or columns. See [P] matrix rownames.

Menu

mkmat
Data > Matrices, ado language > Convert variables to matrix

svmat
Data > Matrices, ado language > Convert matrix to variables

Syntax

Create matrix from variables

\[ \text{mkmat varlist [if] [in] [, matrix(matname) nomissing rownames(varname) roweq(varname) rowprefix(string) obs nchar(#)]} \]

Create variables from matrix

\[ \text{svmat [type] A [, names(col|eqcol|matcol|string)]} \]

Rename rows and columns of matrix

\[ \text{matname A namelist [, rows(range) columns(range) explicit]} \]

where A is the name of an existing matrix, type is a storage type for the new variables, and namelist is one of 1) a varlist, that is, names of existing variables possibly abbreviated; 2) \_cons and the names of existing variables possibly abbreviated; or 3) arbitrary names when the explicit option is specified.
Options

matrix(matname) requests that the vectors be combined in a matrix instead of creating the column vectors.

nomissing specifies that observations with missing values in any of the variables be excluded ("listwise deletion").

rownames(varname) and roweq(varname) specify that the row names and row equations of the created matrix or vectors be taken from varname. varname should be a string variable or an integer positive-valued numeric variable. [Value labels are ignored; use decode (see [D] encode) if you want to use value labels.] Within the names, spaces and periods are replaced by an underscore (_).

rowprefix(string) specifies that the string string be prefixed to the row names of the created matrix or column vectors. In the prefix, spaces and periods are replaced by an underscore (_). If rownames() is not specified, rowprefix() defaults to r, and to nothing otherwise.

obs specifies that the observation numbers be used as row names. This option may not be combined with rownames().

nchar(#) specifies that row names be truncated to # characters, 1 ≤ # ≤ 32. The default is nchar(32).

names(col|eqcol|matcol|string) specifies how the new variables are to be named.
names(col) uses the column names of the matrix to name the variables.
names(eqcol) uses the equation names prefixed to the column names.
names(matcol) uses the matrix name prefixed to the column names.
names(string) names the variables string1, string2, ..., stringn, where string is a user-specified string and n is the number of columns of the matrix.
If names() is not specified, the variables are named A1, A2, ..., An, where A is the name of the matrix.

rows(range) and columns(range) specify the rows and columns of the matrix to rename. The number of rows or columns specified must be equal to the number of names in namelist. If both rows() and columns() are given, the specified rows are named namelist, and the specified columns are also named namelist. The range must be given in one of the following forms:

rows(.) renames all the rows
rows(2..8) renames rows 2–8
rows(3) renames only row 3
rows(4...) renames row 4 to the last row

If neither rows() nor columns() is given, rows(.) columns(.) is the default. That is, the matrix must be square, and both the rows and the columns are named namelist.

explicit suppresses the expansion of varlist abbreviations and omits the verification that the names are those of existing variables. That is, the names in namelist are used explicitly and can be any valid row or column names.

Remarks and examples

Remarks are presented under the following headings:

mkmat
svmat
Although cross products of variables can be loaded into a matrix with the `matrix accum` command (see [P] `matrix accum`), programmers may sometimes find it more convenient to work with the variables in their datasets as vectors instead of as cross products. `mkmat` allows the user a simple way to load specific variables into matrices in Stata’s memory.

### Example 1

`mkmat` uses the variable name to name the single column in the vector. This feature guarantees that the variable name will be carried along in any additional matrix calculations. This feature is also useful when vectors are combined in a general matrix.

```stata
. use https://www.stata-press.com/data/r17/test
. describe
Contains data from https://www.stata-press.com/data/r17/test.dta
Observations: 10
Variables: 3
13 Apr 2020 12:50

Variable Storage Display Value
name type format label
x float %9.0g
y float %9.0g
z float %9.0g
Sorted by:
. list

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>10 2</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>9 4</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>8 3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>7 5</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>6 7</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>5 6</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>4 8</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>3 10</td>
</tr>
<tr>
<td>9</td>
<td>9</td>
<td>2 1</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>1 9</td>
</tr>
</tbody>
</table>

. mkmat x y z, matrix(xyzmat)
. matrix list xyzmat

xyzmat[10,3]
     x     y     z
  r1  1  10  2
  r2  2   9  4
  r3  3   8  3
  r4  4   7  5
  r5  5   6  7
  r6  6   5  6
  r7  7   4  8
  r8  8   3 10
  r9  9   2  1
 r10 10  1  9
```
If the variables contain missing values, so will the corresponding matrix or matrices. Many matrix commands, such as the matrix inversion functions \texttt{inv()} and \texttt{invsym()}, do not allow missing values in matrices. If you specify the \texttt{nomissing} option, \texttt{mkmat} will exclude observations with missing values so that subsequent matrix computations will not be hampered by missing values. Listwise deletion parallels missing-value handling in most Stata commands.

\textbf{svmat}

\textbf{Example 2}

Let's get the vector of coefficients from a regression and use \texttt{svmat} to save the vector as a new variable, save the dataset, load the dataset back into memory, use \texttt{mkmat} to create a vector from the variable, and finally, use \texttt{matname} to rename the columns of the row vector.

```stata
. use https://www.stata-press.com/data/r17/auto
   (1978 automobile data)
. quietly regress mpg weight gear_ratio foreign
. matrix b = get(_b)
. matrix list b
  b[1,4]
    weight  gear_ratio  foreign   _cons
  y1  -.00613903  1.4571134 -2.2216815  36.101353
. matrix c = b'
. svmat double c, name(bvector)
. list bvector1 in 1/5
   bvector1
     1.  -.00613903
     2.   1.4571134
     3.  -2.2216815
     4.   36.101353
     5.       .
. save example
   file example.dta saved
. use example
   (1978 automobile data)
. mkmat bvector1 if bvector1 < .
. matrix list bvector1
  bvector1[4,1]
    bvector1
  r1  -.00613903
  r2   1.4571134
  r3  -2.2216815
  r4   36.101353
. matrix d = bvector1'
. matname d wei gear for _cons, c(.)
. matrix list d
  d[1,4]
    weight  gear_ratio  foreign   _cons
  bvector1  -.00613903  1.4571134 -2.2216815  36.101353
```

Acknowledgment

`mkmat` was written by Ken Heinecke.

References


Also see

[P] `matrix` — Introduction to matrix commands

[P] `matrix accum` — Form cross-product matrices

[M-4] `Stata` — Stata interface functions

[U] 14 Matrix expressions
**matrix rowjoinbyname** — Join rows while matching on column names

**Description**

`matrix rowjoinbyname` and `matrix coljoinbyname` join matrices along one dimension while matching names in the other dimension.

**Syntax**

Join matrix rows while matching on matrix column names

```stata
matrix rowjoinbyname A = matrix_list [, options]
```

Join matrix columns while matching on matrix row names

```stata
matrix coljoinbyname A = matrix_list [, options]
```

`matrix_list` is a list of Stata matrices, including matrices from `e()` and `r()`.

<table>
<thead>
<tr>
<th>options</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>missing(#)</code></td>
<td>missing-value code for unmatched elements; default is <code>missing(.)</code></td>
</tr>
<tr>
<td><code>noconsolidate</code></td>
<td>do not consolidate equations and terms</td>
</tr>
</tbody>
</table>

**Options**

`missing(#)` specifies that elements not matched across all matrices in `matrix_list` be set to #. The default is `missing(.)`.

`noconsolidate` prevents consolidating of equations and terms along the matching dimension. By default, the elements along the matching dimension are reordered so that equations, factor-variable terms, and time-series–operated variables appear together.
Remarks and examples

Example 1

Suppose we want to stack coefficients from a regression model run against different samples. For example, let’s fit a regression of mpg on the levels of rep78 for domestic cars and put the coefficients in a matrix named bdom.

```
. sysuse auto
(1978 automobile data)
. regress mpg i.rep78 if foreign == 0
```

```
Source | SS        df  MS
--------+-----------+---------+---------
Model   | 334.819444 4  83.7048611
Residual | 727.097222 43  16.9092377
Total   | 1061.91667 47 22.5939716

mpg  | Coefficient Std. err. t  P>|t|  [95% conf. interval]
---|---------------------------------+-------------------+--------+
rep78  |                                |                   |
2     | -1.875             3.250888  -0.58  0.567  -8.431041  4.681041
3     | -2.013451  3.013451  -0.66  0.510  -8.077203  4.077203
4     | -2.555556  3.214564  -0.79  0.431  -9.038342  3.927231
5     | 11.000000  4.112084   2.68  0.011  2.707192  19.29281
_cons | 21.000000  2.907683   7.22  0.000  15.136100  26.86390
```

```
. matrix bdom = e(b)
```

Next fit the same model on foreign cars and put the coefficients in a matrix named bfor.

```
. regress mpg i.rep78 if foreign == 1
```

```
Source | SS        df  MS
--------+-----------+---------+---------
Model   | 22.7301587 2  11.3650794
Residual | 773.555556 18  42.9753086
Total   | 796.285714 20  39.8142857

mpg  | Coefficient Std. err. t  P>|t|  [95% conf. interval]
---|---------------------------------+-------------------+--------+
rep78  |                                |                   |
4     | 1.555556  4.37037  0.36  0.726  -7.626252  10.73736
5     | 3.000000  4.37037  0.69  0.501  -6.181807  12.18181
_cons | 23.333333  3.784852  6.16  0.000  15.38165  31.28501
```

```
. matrix bfor = e(b)
```

Based on the output from `regress`, we know that these two row vectors, bdom and bfor, do not have the same number of columns. If you try to join the rows using the \ operator, you will get a conformability error.

```
. matrix b = bdom \ bfor
conformability error
r(503);
```
Use `matrix rowjoinbyname` to join these two row vectors, and their column names will get matched automatically.

```
. matrix rowjoin b = bdom bfor
. matrix list b
b[2,6]
    1.  2.  3.  4.  5.  _cons
    rep78 rep78 rep78 rep78 rep78
   y1     0  -1.875 -2  -2.555556 11  21
   y1     .     .     0  1.5555556 3  23.33333
```

Also see

[P] `macro` — Macro definition and manipulation

[P] `matrix` — Introduction to matrix commands

[P] `matrix define` — Matrix definition, operators, and functions

[U] 14 Matrix expressions
### matrix rownames — Name rows and columns

<table>
<thead>
<tr>
<th>Description</th>
<th>Syntax</th>
<th>Remarks and examples</th>
<th>Also see</th>
</tr>
</thead>
</table>

#### Description

`matrix rownames` and `colnames` reset the row and column names of an already existing matrix. `matrix roweq` and `coleq` also reset the row and column names of an already existing matrix, but if a simple name (a name without a colon) is specified, it is interpreted as an equation name.

In either case, the part of the name not specified is left unchanged.

#### Syntax

**Reset row names of matrix**

```
matrix rownames A = names
```

**Reset column names of matrix**

```
matrix colnames A = names
```

**Reset row names and interpret simple names as equation names**

```
matrix roweq A = names
```

**Reset column names and interpret simple names as equation names**

```
matrix coleq A = names
```

where `names` can be

- a simple name;
- an interaction;
- a colon followed by a simple name;
- a colon followed by an interaction;
- an equation name followed by a colon;
- an equation name, a colon, and a simple name; or
- an equation name, a colon, and an interaction.

A simple name is a sequence of 1 to 32 characters, which can include, for example, digits, spaces, and any Unicode letter; colons should not be used. If the name includes a space, it must be enclosed in double quotes. A simple name may be augmented with time-series operators and factor-variable specifications; these operators do not contribute to the 32-character limit.

An interaction is two or more simple names delimited by `#`. Spaces are not allowed in interactions.
An equation name is a sequence of 1 to 32 characters, which can include, for example, digits, spaces, and any Unicode letter; colons should not be used. If the name includes a space, it must be enclosed in double quotes.

When specifying both an equation name and a simple name, the entire string must be enclosed in quotes if either the equation name or the simple name contains spaces.

**Remarks and examples**

See [U] 14.2 Row and column names for a description of the row and column names bordering a matrix.

**Example 1**

In general, the names bordering matrices are set correctly by Stata because of the tracking of the matrix algebra, and you will not need to reset them. Nevertheless, imagine that you have formed $X'X$ in the matrix named $XX$ and that it corresponds to the underlying variables `price`, `weight`, and `mpg`:

```
.matrix list XX
symmetric XX[3,3]
c1     c2     c3
r1 3.448e+09
r2 1.468e+09 7.188e+08
r3 9132716   4493720   36008
```

You did not form this matrix with `matrix accum` because, had you done so, the rows and columns would already be correctly named. However you formed it, you now want to reset the names:

```
.matrix rownames XX = price weight mpg
.matrix colnames XX = price weight mpg
.matrix list XX
symmetric XX[3,3]
  price     weight     mpg
  price 3.448e+09
  weight 1.468e+09 7.188e+08
  mpg 9132716   4493720   36008
```

**Example 2**

We now demonstrate setting the equation names and names with time-series operators.

```
.matrix list AA
symmetric AA[4,4]
c1     c2     c3     c4
r1 .2967663
r2 .03682017 .57644416
r3 -.87052852 .32713601 20.274957
r4 -1.572579 -.63830843 -12.150097 26.099582
.matrix rownames AA = length L3D2.length mpg L.mpg
.matrix colnames AA = length L3D2.length mpg L.mpg
.matrix roweq AA = eq1 eq1 eq2 eq2
.matrix coleq AA = eq1 eq1 eq2 eq2
```
Factor variables and interactions are much like time-series–operated variables, we specify each level variable.

As in factor-variable varlists, we can combine any time-series lead and lag operators with factor variables.

Technical note

matrix rownames and colnames sometimes behave in surprising ways:

1. If your list of names includes no colons—does not mention the equation names—whatever equation names are in place are left in place; they are not changed.

2. If your list of names has every name ending in a colon—so that it mentions only the equation names and not the subnames—whatever subnames are in place are left in place; they are not changed.

3. If your list of names has fewer names than are required to label all the rows or columns, the last name in the list is replicated. (If you specify too many names, you will get the conformability error message, and no names will be changed.)

These surprises have their uses, but if you make a mistake, the result really may surprise you. For instance, rule 3, by itself, is just odd. Combined with rule 2, however, rule 3 allows you to set all the equation names in a matrix easily. If you type ‘matrix rownames XX = myeq:’, all the equation names in the row are reset while the subnames are left unchanged:

Setting equation names is often done before forming a partitioned matrix so that, when the components are assembled, each has the correct equation name.

Thus to review, to get the result above, we could have typed

```
.matrix rownames XX = myeq:price myeq:weight myeq:mpg
```
or

. matrix rownames XX = price weight mpg
. matrix rownames XX = myeq:

or even

. matrix rownames XX = myeq:
. matrix rownames XX = price weight mpg

All would have resulted in the same outcome. The real surprise comes, however, when you make a mistake:

. matrix rownames XX = myeq:
. matrix rownames XX = price weight
. matrix list XX

symmetric XX[3,3]

<table>
<thead>
<tr>
<th></th>
<th>price</th>
<th>weight</th>
<th>mpg</th>
</tr>
</thead>
<tbody>
<tr>
<td>myeq:price</td>
<td>3.448e+09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>myeq:weight</td>
<td>1.468e+09</td>
<td>7.188e+08</td>
<td></td>
</tr>
<tr>
<td>myeq:weight</td>
<td>9132716</td>
<td>4493720</td>
<td>36008</td>
</tr>
</tbody>
</table>

Our mistake above is that we listed only two names for the subnames of the rows of XX and `matrix rownames` and then labeled both of the last rows with the subname `weight`.

Technical note

The equation name `_:` by itself is special; it means the null equation name. For instance, as of the last technical note, we were left with

. matrix list XX

symmetric XX[3,3]

<table>
<thead>
<tr>
<th></th>
<th>price</th>
<th>weight</th>
<th>mpg</th>
</tr>
</thead>
<tbody>
<tr>
<td>myeq:price</td>
<td>3.448e+09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>myeq:weight</td>
<td>1.468e+09</td>
<td>7.188e+08</td>
<td></td>
</tr>
<tr>
<td>myeq:weight</td>
<td>9132716</td>
<td>4493720</td>
<td>36008</td>
</tr>
</tbody>
</table>

Let’s fix it:

. matrix rownames XX = price weight mpg
. matrix rownames XX = _:
. matrix list XX

symmetric XX[3,3]

<table>
<thead>
<tr>
<th></th>
<th>price</th>
<th>weight</th>
<th>mpg</th>
</tr>
</thead>
<tbody>
<tr>
<td>price</td>
<td>3.448e+09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>weight</td>
<td>1.468e+09</td>
<td>7.188e+08</td>
<td></td>
</tr>
<tr>
<td>mpg</td>
<td>9132716</td>
<td>4493720</td>
<td>36008</td>
</tr>
</tbody>
</table>

Technical note

`matrix roweq` and `matrix coleq` are really the same commands as `matrix rownames` and `matrix colnames`. They differ in only one respect: if a specified name does not contain a colon, `matrix roweq` and `matrix coleq` interpret that name as if it did end in a colon.
matrix rownames, matrix colnames, matrix roweq, and matrix coleq are often used in conjunction with the rowfullnames, colfullnames, rownames, colnames, roweq, and coleq macro functions introduced in [P] matrix define. The rownames and colnames macro functions return only the name, including any time-series or factor-variable operators, but not the equation name.

```
. matrix list AA
symmetric AA[4,4]
                   eq1:       eq1:       eq2:       eq2:        
            L3D2.     L.        
length          length    mpg    mpg
 eq1:length       .2967663
 eq1:L3D2.length  .03682017  .57644416
 eq2:mpg          -.87052852  .32713601  20.274957
 eq2:L.mpg        -1.572579   -.63830843 -12.150097  26.099582
```

```
. local rsubs : rownames AA
. display "The row subnames of AA are -- 'rsubs' --"
The row subnames of AA are -- length L3D2.length mpg L.mpg --
```

Similarly, the roweq macro function returns only the equation names without the trailing colon:

```
. local reqs : roweq AA
. display "The row equations of AA are -- 'reqs' --"
The row equations of AA are -- eq1 eq1 eq2 eq2 --
```

Now consider the problem that you have two matrices named A and B that have the same number of rows. A is correctly labeled and includes equation names. You want to copy the complete names of A to B. You might be tempted to type

```
. local names : rownames A
. matrix rownames B = 'names'
```

This is not adequate. You will have copied the names but not the equation names. To copy both parts of the complete names, you can type

```
. local subs : rownames A
. local eqs : roweq A
. matrix rownames B = 'subs'
. matrix roweq B = 'eqs'
```

This method can be used even when there might not be equation names. The equation name _ is special for two reasons: setting an equation to that name removes the equation name, and when there is no equation name, the roweq and coleq macro functions return that name.

A better way to copy the names is to use the rowfullnames and colfullnames macro functions (see [P] matrix define and [P] macro). You can more compactly type

```
. local rname : rowfullnames A
. matrix rownames B = 'rname'
```
Also see

[P] macro — Macro definition and manipulation

[P] matrix — Introduction to matrix commands

[P] matrix define — Matrix definition, operators, and functions

[U] 14 Matrix expressions
matrix score — Score data from coefficient vectors

Description

matrix score creates \( newvar_j = x_j b' \) (\( b \) being a row vector), where \( x_j \) is the row vector of values of the variables specified by the column names of \( b \). The name \_cons is treated as a variable equal to 1.

Syntax

\[
\text{matrix score} \ [\text{type}] \ newvar = b \ [\text{if}] \ [\text{in}] \\
\quad [\text{, equation(#)#|eqname} \ \text{missval(#)} \ \text{replace forcezero} ]
\]

where \( b \) is a \( 1 \times p \) matrix.

Options

- \text{equation(#)#|eqname} specifies the equation—by either number or name—for selecting coefficients from \( b \) to use in scoring. See [U] 14.2 Row and column names and [P] matrix rownames for more on equation labels with matrices.
- \text{missval(#)} specifies the value to be assumed if any values are missing from the variables referred to by the coefficient vector. By default, this value is taken to be missing (.), and any missing value among the variables produces a missing score.
- \text{replace} specifies that \textit{newvar} already exists. Here observations not included by \textit{if} \textit{exp} and \textit{in} \textit{range} are left unchanged; that is, they are not changed to missing. Be warned that \text{replace} does not promote the storage type of the existing variable; if the variable was stored as an int, the calculated scores would be truncated to integers when stored.
- \text{forcezero} specifies that, should a variable described by the column names of \( b \) not exist, the calculation treat the missing variable as if it did exist and was equal to zero for all observations. It contributes nothing to the summation. By default, a missing variable would produce an error message.

Remarks and examples

Scoring refers to forming linear combinations of variables in the data with respect to a coefficient vector. For instance, let’s create and then consider the vector \textit{coefs}:

\[
\begin{align*}
\text{. use https://www.stata-press.com/data/r17/auto} \\
\text{(1978 automobile data)} \\
\text{. quietly regress price weight mpg} \\
\text{. matrix coefs = e(b)} \\
\text{. matrix list coefs} \\
\text{coefs[1,3]} \\
\text{weight mpg _cons} \\
y1 & 1.7466592 & -49.512221 & 1946.0687
\end{align*}
\]
Scoring the data with this vector would create a new variable equal to the linear combination

$$1.7465592 \text{weight} - 49.512221 \text{mpg} + 1946.0687$$

The vector is interpreted as coefficients; the corresponding names of the variables are obtained from the column names (row names if `coefs` were a column vector). To form this linear combination, we type

```
. matrix score lc = coefs
. summarize lc
```

If the coefficient vector has equation names, `matrix score` with the `eq()` option selects the appropriate coefficients for scoring. `eq(#1)` is assumed if no `eq()` option is specified.

```
. quietly sureg (price weight mpg) (displacement weight)
. matrix coefs = e(b)
. matrix list coefs

coefs[1,5]
price: price: price: displacement displacement
~ ~ ~
weight mpg _cons weight _cons
y1 1.7358275 -51.298248 2016.5101 .10574552 -121.99702

. matrix score lcnoeq = coefs
. matrix score lca = coefs, eq(price)
. matrix score lc1 = coefs, eq(#1)
. matrix score lcb = coefs, eq(displacement)
. matrix score lc2 = coefs, eq(#2)
```

```
. matrix list lcnoeq lca lc1 lcb lc2
```

If the same equation name is scattered in different sections of the coefficient vector, the results may not be what you expect.

```
. matrix list bad

bad[1,5]
price: price: displacement displacement
~ ~ ~ ~
weight mpg weight _cons _cons
y1 1.7358275 -51.298248 2016.5101 .10574552 -121.99702

. matrix score badnoeq = bad
. matrix score bada = bad, eq(price)
. matrix score bad1 = bad, eq(#1)
. matrix score badb = bad, eq(displacement)
. matrix score bad2 = bad, eq(#2)
. matrix score bad3 = bad, eq(#3)
```
. matrix score bad4 = bad, eq(#4)
. summarize bad*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>badnoeq</td>
<td>74</td>
<td>4148.747</td>
<td>1598.264</td>
<td>1380.349</td>
<td>7785.826</td>
</tr>
<tr>
<td>bada</td>
<td>74</td>
<td>4148.747</td>
<td>1598.264</td>
<td>1380.349</td>
<td>7785.826</td>
</tr>
<tr>
<td>bad1</td>
<td>74</td>
<td>4148.747</td>
<td>1598.264</td>
<td>1380.349</td>
<td>7785.826</td>
</tr>
<tr>
<td>badb</td>
<td>74</td>
<td>319.2943</td>
<td>82.18474</td>
<td>186.1121</td>
<td>511.8083</td>
</tr>
<tr>
<td>bad2</td>
<td>74</td>
<td>319.2943</td>
<td>82.18474</td>
<td>186.1121</td>
<td>511.8083</td>
</tr>
<tr>
<td>bad3</td>
<td>74</td>
<td>2016.51</td>
<td>0</td>
<td>2016.51</td>
<td>2016.51</td>
</tr>
<tr>
<td>bad4</td>
<td>74</td>
<td>-121.997</td>
<td>0</td>
<td>-121.997</td>
<td>-121.997</td>
</tr>
</tbody>
</table>

You do not need to worry about a bad matrix score when working with coefficient vectors created by Stata estimation commands. These commands always return coefficient vectors that are appropriately ordered according to equation names.

Also see

[P] matrix — Introduction to matrix commands

[U] 14 Matrix expressions
**Description**

`matrix svd` produces the singular value decomposition (SVD) of `A`.

Also see [M-5] `svd()` for alternative routines for obtaining the singular value decomposition.

**Menu**

Data > Matrices, ado language > Singular value decomposition

**Syntax**

```
matrix svd U w V = A
```

where `U`, `w`, and `V` are matrix names (the matrices may exist or not) and `A` is the name of an existing `m x n` matrix, `m >= n`.

**Remarks and examples**

The singular value decomposition of `m x n` matrix `A`, `m >= n`, is defined as

```
A = U diag(w)V'
```

where `U: m x n`, `w: 1 x n`, `diag(w): n x n`, and `V: n x n`, where `U` is column orthogonal (`U'U = I` if `m = n`), all the elements of `w` are positive or zero, and `V'V = I`.

Singular value decomposition can be used to obtain a g2-inverse of `A` (`A*: n x m`, such that `AA*A = A` and `A*A*A = A*`—the first two Moore–Penrose conditions) via `A* = V{diag(1/w_j)}U'`, where `1/w_j` refers to individually taking the reciprocal of the elements of `w` and substituting 0 if `w_j = 0` or is small. If `A` is square and of full rank, `A* = A^{-1}`.
Example 1

Singular value decomposition is used to obtain accurate inverses of nearly singular matrices and to obtain g2-inverses of matrices that are singular, to construct orthonormal bases, and to develop approximation matrices. Our example will prove that matrix svd works:

```
. matrix A = (1,2,9\2,7,5\2,4,18)
. matrix svd U w V = A
. matrix list U
  U[3,3]
  c1     c2     c3
    r1 .42313293  .89442719  -.1447706
    r2 .3237169  -.6.016e-17  .94615399
    r3 .84626585  -.4472136  -.2895412
. matrix list w
  w[1,3]
  c1     c2     c3
    r1  21.832726  2.612e-16  5.5975071
. matrix list V
  V[3,3]
  c1     c2     c3
    c1  .12655765  -.96974658  .2087456
    c2  .29759672  .23786237  .92458514
    c3  .94626601  .05489132  -.31869671
. matrix newA = U*diag(w)*V'
. matrix list newA
  newA[3,3]
  c1     c2     c3
    r1  1   2   9
    r2  2   7   5
    r3  2   4  18
```

As claimed, newA is equal to our original A.

The g2-inverse of A is computed below. The second element of w is small, so we decide to set the corresponding element of diag(1/wj) to zero. We then show that the resulting Ainv matrix has the properties of a g2-inverse for A.

```
. matrix Winv = J(3,3,0)
. matrix Winv[1,1] = 1/w[1,1]
. matrix Winv[3,3] = 1/w[1,3]
. matrix Ainv = V*Winv*U'
. matrix list Ainv
  Ainv[3,3]
  r1     r2     r3
    c1  -.0029461  .03716103  -.0058922
    c2  -.0181453  .16069635  -.03629059
    c3  .02658185  -.0398393  .05316371
. matrix AAiA = A*Ainv*A
. matrix list AAiA
  AAiA[3,3]
  c1     c2     c3
    r1  1   2   9
    r2  2   7   5
    r3  2   4  18
```
. matrix AiAAi = Ainv*A*Ainv
. matrix list AiAAi
AiAAi[3,3]
     r1     r2     r3
c1 -.0029461 .03716103 -.0058922
c2 -.0181453 .16069635 -.03629059
c3 .02658185 -.0398393 .05316371

Methods and formulas

Stewart (1993) surveys the contributions of five mathematicians—Beltrami, Jordan, Sylvester, Schmidt, and Weyl—who established the existence of the singular value decomposition and developed its theory.

Reference


Also see

[P] matrix — Introduction to matrix commands
[P] matrix define — Matrix definition, operators, and functions
[M-5] svd() — Singular value decomposition
[U] 14 Matrix expressions
**Description**

`matrix symeigen` returns the eigenvectors in the columns of X: $n \times n$ and the corresponding eigenvalues in v: 1 $\times$ n. The eigenvalues are sorted: v[1,1] contains the largest eigenvalue (and X[1,...,1] its corresponding eigenvector), and v[1,n] contains the smallest eigenvalue (and X[1,...,n] its corresponding eigenvector).

If you want the eigenvalues for a nonsymmetric matrix, see [P] matrix eigenvalues.

Also see [M-5] eigensystem() for other routines for obtaining eigenvalues and eigenvectors.

**Menu**

Data $>$ Matrices, ado language $>$ Eigenvalues and eigenvectors of symmetric matrices

**Syntax**

```
matrix symeigen X v = A
```

where A is an $n \times n$ symmetric matrix.

**Remarks and examples**

Typing `matrix symeigen X v = A` for A: $n \times n$ returns

$$v = (\lambda_1, \lambda_2, \ldots, \lambda_n)$$

$$X = (x_1, x_2, \ldots, x_n)$$

where $\lambda_1 \geq \lambda_2 \geq \ldots \geq \lambda_n$. Each $x_i$ and $\lambda_i$ is a solution to

$$Ax_i = \lambda_i x_i$$

or, more compactly,

$$AX = X \diag(v)$$

**Example 1**

Eigenvalues and eigenvectors have many uses. We will demonstrate that `symeigen` returns matrices meeting the definition:

```stata
. use https://www.stata-press.com/data/r17/auto
(1978 automobile data)
. matrix accum A = weight mpg length, noconstant deviation
   (obs=74)
```

400
Methods and formulas

Stata’s internal eigenvalue and eigenvector extraction routines are translations of the public domain EISPACK routines, Smith et al. (1976), which are in turn based on Wilkinson and Reinsch (1971). EISPACK was developed under contract for the Office of Scientific and Technical Information, U.S. Department of Energy, by Argonne National Laboratory and supported by funds provided by the Nuclear Regulatory Commission. Stata’s use of these routines is by permission of the National Energy Software Center of the Argonne National Laboratory. A brief but excellent introduction to the techniques used by these routines can be found in Press et al. (2007, 563–599).

References


Also see

[P] matrix — Introduction to matrix commands

[P] matrix eigenvalues — Eigenvalues of nonsymmetric matrices


[U] 14 Matrix expressions
matrix utility — List, rename, and drop matrices

Description

matrix dir lists the names of currently existing matrices. matrix list lists the contents of a matrix. matrix rename changes the name of a matrix. matrix drop eliminates a matrix.

Menu

matrix list
Data > Matrices, ado language > List contents of matrix

matrix rename
Data > Matrices, ado language > Rename matrix

matrix drop
Data > Matrices, ado language > Drop matrices

Syntax

List matrix names

matrix dir

List contents of matrix

matrix list mname [ , noblank nohalf noheader nonames format( %fmt) title(string) nodotz ]

Rename matrix

matrix rename oldname newname

Drop matrix

matrix drop { _all | mnames }
Options

noblank suppresses printing a blank line before printing the matrix. This is useful in programs.

nohalf specifies that, even if the matrix is symmetric, the full matrix be printed. The default is to print only the lower triangle in such cases.

noheader suppresses the display of the matrix name and dimension before the matrix itself. This is useful in programs.

nonames suppresses the display of the bordering names around the matrix.

format(%) specifies the format to be used to display the individual elements of the matrix. The default is format(%.10g).

title(string) adds the specified title string to the header displayed before the matrix itself. If noheader is specified, title() does nothing because displaying the header is suppressed.

nodotz specifies that .z missing values be displayed as blanks.

Remarks and examples

Example 1

In the example below, matrix list normally displays only the lower half of symmetric matrices. nohalf prevents this.

```
. matrix b = (2, 5, 4 \ 5, 8, 6 \ 4, 6, 3)
. matrix a = (1, 2 \ 2, 4)
. matrix dir
    a[2,2]
    b[3,3]
. matrix rename a z
. matrix dir
    z[2,2]
    b[3,3]
. matrix list b
    symmetric b[3,3]
    c1  c2  c3
    r1   2
    r2   5   8
    r3   4   6   3
. matrix list b, nohalf
    symmetric b[3,3]
    c1  c2  c3
    r1   2   5   4
    r2   5   8   6
    r3   4   6   3
. matrix drop b
. matrix dir
    z[2,2]
. matrix drop _all
. matrix dir
```
Technical note

When writing programs and using matrix names obtained through `tempname` (see [P] macro), it is not necessary to explicitly drop matrices; the matrices are removed automatically at the conclusion of the program.

```
. program define example
  1.   tempname a
  2.   matrix `a' = (1,2\3,4) /* this is temporary */
  3.   matrix b = (5,6\7,8) /* and this permanent */
  4.   display "The temporary matrix a contains"
  5.   matrix list `a', noheader
  6.   end
```

```
. example
The temporary matrix a contains
   c1  c2
   r1  1  2
   r2  3  4
```

```
. matrix dir
   b[2,2]
```

Nevertheless, dropping matrices with temporary names in programs when they are no longer needed is recommended, unless the program is about to exit (when they will be dropped anyway). Matrices consume memory; dropping them frees memory.

Also see

[P] matlist — Display a matrix and control its format

[P] matrix — Introduction to matrix commands

[U] 14 Matrix expressions
more — Pause until key is pressed

Description

more causes Stata to display —more— and pause until any key is pressed if more is set on and does nothing if more is set off.

The current value of set more is stored in c(more); see [P] creturn.

See [R] more for information on set more on and set more off.

Syntax

more

Remarks and examples

Ado-file programmers need take no special action to have —more— conditions arise when the screen is full. Stata handles that automatically if you have indicated you wish to have —more— conditions by specifying set more on.

If, however, you wish to force a —more— condition early, you can include the more command in your program. The syntax of more is

more

more takes no arguments.

Also see

[P] creturn — Return c-class values
[P] sleep — Pause for a specified time
[R] query — Display system parameters
[U] 7 –more– conditions
nopreserve option — nopreserve option

Description

Some Stata commands have a nopreserve option. This option is for use by programmers when stata_command is used as a subroutine of another command.

Syntax

stata_command ... [ , ... nopreserve ... ]

Option

nopreserve specifies that stata_command need not bother to preserve the data in memory. The usual situation is that stata_command is being used as a subroutine by another program, the data in memory have been preserved by the caller, and the caller will not need to access the data again before the data are restored from the caller’s preserved copy.

Remarks and examples

Some commands change the data in memory in the process of performing their task even though the command officially does not change the data in memory. Such commands achieve this by using preserve to make a temporary copy of the data on disk, which is later restored to memory.

Even some commands whose entire purpose is to make a modification to the data in memory sometimes make temporary copies of the data just in case the user should press Break while the changes to the data are still being completed.

This is done using preserve; see [P] preserve.

Assume alpha and beta are each implemented using preserve. Assume that alpha uses beta as a subroutine. If alpha itself does not intend to use the data after calling beta, then beta preserving and restoring the data is unnecessary because alpha already has preserved the data from which memory will be restored. Then alpha should specify the nopreserve option when calling beta.

Also see

[P] preserve — Preserve and restore data
### Description

The `numlist` command expands the numeric list supplied as a string argument and performs error checking based on the options specified. Any numeric sequence operators in the `numlist` string are evaluated, and the expanded list of numbers is returned in `r(numlist)`. See [U] 11.1.8 `numlist` for a discussion of numeric lists.

### Syntax

```plaintext
numlist "numlist" [, ascending descending integer missingokay min(#) max(#) range(operator # [ operator # ]) sort]
```

`numlist` consists of one or more `numlist_elements` shown below.

**operator** is as follows: `< | <= | > | >=`.

There is no space between `operator` and `#`; for example,
- `range(>=0)`
- `range(>0 <=50)`

<table>
<thead>
<tr>
<th><code>numlist_element</code></th>
<th>Example</th>
<th>Expands to</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>#</td>
<td>3.82</td>
<td>3.82</td>
<td>a number</td>
</tr>
<tr>
<td>.</td>
<td>.</td>
<td>.</td>
<td>a missing value</td>
</tr>
<tr>
<td>#1/#2</td>
<td>4/6</td>
<td>4 5 6</td>
<td>starting at #1, increment by 1 to #2</td>
</tr>
<tr>
<td></td>
<td>2.3/5.7</td>
<td>2.3 3.3 4.3 5.3</td>
<td></td>
</tr>
<tr>
<td>#1(#2)#3</td>
<td>2(3)10</td>
<td>2 5 8</td>
<td>starting at #1, increment by #2 to #3</td>
</tr>
<tr>
<td></td>
<td>4.8(2.1)9.9</td>
<td>4.8 6.9 9</td>
<td></td>
</tr>
<tr>
<td>#1[#2]#3</td>
<td>2[3]10</td>
<td>2 5 8</td>
<td>starting at #1, increment by #2 to #3</td>
</tr>
<tr>
<td></td>
<td>4.8[2.1]9.9</td>
<td>4.8 6.9 9</td>
<td></td>
</tr>
<tr>
<td>#1 #2 : #3</td>
<td>5 7 : 13</td>
<td>5 7 9 11 13</td>
<td>starting at #1, increment by (#2 − #1) to #3</td>
</tr>
<tr>
<td></td>
<td>1.1 2.4 : 5.8</td>
<td>1.1 2.4 3.7 5</td>
<td></td>
</tr>
<tr>
<td>#1 #2 to #3</td>
<td>5 7 to 13</td>
<td>same</td>
<td>same</td>
</tr>
<tr>
<td></td>
<td>1.1 2.4 to 5.8</td>
<td>same</td>
<td></td>
</tr>
</tbody>
</table>

*collect* is allowed; see [U] 11.1.10 Prefix commands.
Options

ascending indicates that the user must give the numeric list in ascending order without repeated values. This is different from the sort option.

descending indicates that the numeric list must be given in descending order without repeated values.

integer specifies that the user may give only integer values in the numeric list.

missingokay indicates that missing values are allowed in the numeric list. By default, missing values are not allowed.

min(#) specifies the minimum number of elements allowed in the numeric list. The default is min(1). If you want to allow empty numeric lists, specify min(0).

max(#) specifies the maximum number of elements allowed in the numeric list. The default is max(1600), which is the largest allowed maximum.

range(operator# [operator#]) specifies the acceptable range for the values in the numeric list. The operators are < (less than), <= (less than or equal to), > (greater than), and >= (greater than or equal to). No space is allowed between the operator and the #.

sort specifies that the returned numeric list be sorted. This is different from the ascending option, which places the responsibility for providing a sorted list on the user who will not be allowed to enter a nonsorted list. sort, on the other hand, puts no restriction on the user and takes care of sorting the list. Repeated values are also allowed with sort.

Remarks and examples

Programmers rarely use the numlist command because syntax also expands numeric lists, and it handles the rest of the parsing problem, too, at least if the command being parsed follows standard syntax. numlist is used for expanding numeric lists when what is being parsed does not follow standard syntax.

Example 1

We demonstrate the numlist command interactively.

```
. numlist "5.3 1.0234 3 6:18 -2.0033 5.3/7.3"
. display "'r(numlist)""
5.3 1.0234 3 6 9 12 15 18 -2.0033 5.3 6.3 7.3
. numlist "5.3 1.0234 3 6:18 -2.0033 5.3/7.3", integer
invalid numlist has noninteger elements
r(126);
. numlist "1 5 8/12 15", integer descending
invalid numlist has elements out of order
r(124);
. numlist "1 5 8/12 15", integer ascending
. display "'r(numlist)"
1 5 8 9 10 11 12 15
```
. numlist "100 1 5 8/12 15", integer ascending
    invalid numlist has elements out of order
    r(124);
. numlist "100 1 5 8/12 15", integer sort
    display "'r(numlist)'"
      1 5 8 9 10 11 12 15 100
. numlist "3 5 . 28 -3(2)5"
    invalid numlist has missing values
    r(127);
. numlist "3 5 . 28 -3(2)5", missingokay min(3) max(25)
    display "'r(numlist)'"
      3 5 . 28 -3 -1 1 3 5
. numlist "28 36", min(3) max(6)
    invalid numlist has too few elements
    r(122);
. numlist "28 36 -3 5 2.8 7 32 -8", min(3) max(6)
    invalid numlist has too many elements
    r(123);
. numlist "3/6 -4 -1 to 5", range(>=1)
    invalid numlist has elements outside of allowed range
    r(125);
. numlist "3/6", range(>=0 <30)
    display "'r(numlist)'"
      3 4 5 6

Stored results

numlist stores the following in r():

Macros
    r(numlist)       expanded numeric list

Also see

[P] syntax — Parse Stata syntax
[U] 11.1.8 numlist
Title

**pause — Program debugging command**

### Description

If pause is on, the `pause [message]` command displays `message` and temporarily suspends execution of the program, returning control to the keyboard. Execution of keyboard commands continues until you type `end` or `q`, at which time execution of the program resumes. Typing `BREAK` in pause mode (as opposed to pressing the Break key) also resumes program execution, but the break signal is sent to the calling program.

If pause is off, `pause` does nothing.

Pause is off by default. Type `pause on` to turn pause on. Type `pause off` to turn it back off.

### Syntax

```
pause { on | off | [message] }
```

### Remarks and examples

`pause` assists in debugging Stata programs. The line `pause` or `pause message` is placed in the program where problems are suspected (more than one `pause` may be placed in a program). For instance, you have a program that is not working properly. A piece of this program reads

```
generate 'tmp'=exp('1')/'2'
summarize 'tmp'
local mean=r(mean)
```

You think that the error may be in the creation of `tmp`. You change the program to read

```
generate 'tmp'=exp('1')/'2'
pause Just created tmp /* this line is new */
summarize 'tmp'
local mean=r(mean)
```

Let’s pretend that your program is named `myprog`; interactively, you now type

```
. myprog
(output from your program appears)
```

That is, `pause` does nothing because pause is off, so `pauses` in your program are ignored. If you turn pause on,

```
. pause on
. myprog
(any output myprog creates up to the pause appears)
```

Pause: Just created tmp

```
The “->” is called the pause-mode prompt. You can give any Stata command. You can examine variables and, if you wish, even change them. If while in pause mode, you wish to terminate execution of your program, you type `BREAK` (in capitals):

```
. myprog
(any output myprog creates up to the pause appears)
pause: Just created tmp
-> . list
(output omitted)
-> . BREAK
sending Break to calling program...
—Break—
r(1);
' _
```

The results are the same as if you pressed `Break` while your program was executing. If you press the `Break` key in pause mode (as opposed to typing `BREAK`), however, it means only that the execution of the command you have just given interactively is to be interrupted.

Notes:

- You may put many `pauses` in your programs.

- By default, `pause` is off, so the `pauses` will not do anything. Even so, you should remove the `pauses` after your program is debugged because each execution of a do-nothing `pause` will slow your program slightly.

- `pause` is implemented as an ado-file; this means that the definitions of local macros in your program are unavailable to you. To see the value of local macros, display them in the `pause` message; for instance,

```
pause Just created tmp, i='i'
```

When the line is executed, you will see something like

```
pause: Just created tmp, i=1
-> . _
```

- Remember, temporary variables (for example, `tempvar tmp ... gen 'tmp'=`...) are assigned real names, such as `__00424`, by Stata; see `[P] macro`. Thus, in pause mode, you want to examine `__00424` and not `tmp`. Generally, you can determine the real name of your temporary variables from `describe`’s output, but in the example above, it would have been better if `pause` had been invoked with

```
pause Just created tmp, called 'tmp', i='i'
```

When the line was executed, you would have seen something like

```
pause: Just created tmp, called __00424, i=1
-> . _
```

- When giving commands that include double quotes, you may occasionally see the error message “type mismatch”, but then the command will work properly:

```
pause: Just created tmp, called __00424, i=1
-> . list if __00424=="male"
type mismatch
(output from request appears as if nothing is wrong)
-> . _
```
Also see

[P] program — Define and manipulate programs
[P] more — Pause until key is pressed
[P] trace — Debug Stata programs
[U] 18 Programming Stata
plugin — Load a plugin

Description

In addition to using ado-files and Mata, you can add new commands to Stata by using the C language by following a set of programming conventions and dynamically linking your compiled library into Stata. The `program` command with the `plugin` option finds plugins and loads (dynamically links) them into Stata.

If you are interested in writing plugins for Stata in Java, see [P] Java plugin.

Syntax

```
program handle, plugin [using(filespec)]
```

Options

`plugin` specifies that plugins be found and loaded into Stata.

`using(filespec)` specifies a file, `filespec`, containing the plugin. If you do not specify `using()`, `program` assumes that the file is named `handle.plugin` and can be found along the ado-path (see [U] 17.5 Where does Stata look for ado-files?).

Remarks and examples

Plugins are most useful for methods that require the greatest possible speed and involve heavy looping, recursion, or other computationally demanding approaches. They may also be useful if you have a solution that is already programmed in C.

For complete documentation on plugin programming and loading compiled programs into Stata, see https://www.stata.com/plugins/.

References


Also see

[P] Automation — Automation

[P] program — Define and manipulate programs

Mata Reference Manual
**Description**

These commands are utilities to assist Stata programmers in performing Monte Carlo–type experiments. They post results to a file on disk. To post results to a frame in memory, see [P] frame post.

`postfile` declares the variable names and the filename of a (new) Stata dataset where results will be saved.

`post` adds a new observation to the declared dataset.

`postclose` declares an end to the posting of observations. After `postclose`, the new dataset contains the posted results and may be loaded using `use`; see [D] use.

`postutil dir` lists all open postfiles. `postutil clear` closes all open postfiles.

All five commands manipulate the new dataset without disturbing the data in memory. If `filename` is specified without an extension, .dta is assumed.

**Syntax**

Declare variable names and filename of dataset where results will be saved

```
postfile postname newvarlist using filename [, every(#) replace]
```

Add new observation to declared dataset

```
post postname (exp) (exp) ... (exp)
```

Declare end to posting of observations

```
postclose postname
```

List all open postfiles

```
postutil dir
```

Close all open postfiles

```
postutil clear
```
Options

every(#) specifies that results be written to disk every #th call to post. post temporarily holds results in memory and periodically opens the Stata dataset being built to append the saved results. every() should typically not be specified, because you are unlikely to choose a value for # that is as efficient as the number post chooses on its own, which is a function of the number of results being written and their storage type.

replace indicates that the file specified may already exist, and if it does, that postfile may erase the file and create a new one.

Remarks and examples

The typical use of the post commands is

    tempname memhold
tempfile results ...
postfile 'memhold' ... using "'results'",
... while ... {
    ...
    post 'memhold' ...
    ...
}
postclose 'memhold'
...
use "'results'", clear ...

Two names are specified with postfile: postname is a name assigned to internal memory buffers, and filename is the name of the file to be created. Subsequent posts and the postclose are followed by postname so that Stata will know to what file they refer.

In our sample, we obtain both names from Stata’s temporary name facility (see [P] macro), although, in some programming situations, you may wish to substitute a hard-coded filename. We recommend that postname always be obtained from tempname. This ensures that your program can be nested within any other program and ensures that the memory used by post is freed if anything goes wrong. Using a temporary filename, too, ensures that the file will be erased if the user presses Break. Sometimes, however, you may wish to leave the file of incomplete results behind. That is allowed, but remember that the file is not fully up to date if postclose has not been executed. post buffers results in memory and only periodically updates the file.

Because postfile accepts a newvarlist, storage types may be interspersed, so you could have

    postfile 'memhold' a b str20 c double(d e f) using "'results'",

Note that newvarlist does not allow strL as the variable storage type. A similar utility that allows strL as a variable storage type is frame post.
Example 1

We wish to write a program to collect means and variances from 10,000 randomly constructed 100-observation samples of lognormal data and save the results in results.dta. Suppose that we are evaluating the coverage of the 95%, $t$-based confidence interval when applied to lognormal data. As background, we can obtain a 100-observation lognormal sample by typing

```stata
drop _all
set obs 100
generate z = exp(rnormal())
```

We can obtain the mean and standard deviation by typing

```stata
summarize z
```

Moreover, `summarize` stores the sample mean in $r(mean)$ and variance in $r(Var)$. It is those two values we wish to collect. Our program is

```stata
program lnsim
version 17.0
tempname sim
postfile `sim' mean var using results, replace
quietly {
  forvalues i = 1/10000 {
    drop _all
    set obs 100
    generate z = exp(rnormal())
    summarize z
    post `sim' (r(mean)) (r(Var))
  }
}
postclose `sim'
end
```

The postfile command begins the accumulation of results. `sim` is the name assigned to the internal memory buffers where results will be held; mean and var are the names to be given to the two variables that will contain the information we collect; and variables will be saved in the file named results.dta. Because two variable names were specified on the postfile line, two expressions must be specified following post. Here the expressions are simply $r(mean)$ and $r(Var)$. If we had wanted, however, to store the mean divided by the standard deviation and the standard deviation, we could have typed

```stata
post `sim' (r(mean)/r(sd)) (r(sd))
```
Finally, postclose `sim' concluded the simulation. The dataset results.dta is now complete.

```
. set seed 12345
. lnsim
(file results.dta not found)
. use results, clear
. describe
Contains data from results.dta
Observations: 10,000
Variables: 2
Sorted by:
. summarize
```

We set the random-number seed to an arbitrary value, 12345, so that this example would be reproducible.

References


Also see

[P] frame post — Post results to dataset in another frame

[R] simulate — Monte Carlo simulations
predict — Obtain predictions, residuals, etc., after estimation programming command

## Description

_predict is for use by programmers as a subroutine for implementing the `predict` command for use after estimation; see [R] predict.

## Syntax

**After regress**

```
_predict [type] newvar [if] [in] [, xb stdp stdf stder hat cooksdf residuals rstandard rstudent nolabel]
```

**After single-equation (SE) estimators**

```
_predict [type] newvar [if] [in] [, xb stdp nooffset nolabel]
```

**After multiple-equation (ME) estimators**

```
_predict [type] newvar [if] [in] [, xb stdp stddp nooffset nolabel equation(eqno[, eqno])]
```

## Options

- **xb** calculates the linear prediction from the fitted model. That is, all models can be thought of as estimating a set of parameters $b_1, b_2, \ldots, b_k$, and the linear prediction is $\hat{y}_j = b_1 x_{1j} + b_2 x_{2j} + \cdots + b_k x_{kj}$, often written in matrix notation as $\hat{y}_j = x_j \mathbf{b}$. For linear regression, the values $\hat{y}_j$ are called the predicted values or, for out-of-sample predictions, the forecast. For logit and probit, for example, $\hat{y}_j$ is called the logit or probit index.

- It is important to understand that the $x_{1j}, x_{2j}, \ldots, x_{kj}$ used in the calculation are obtained from the data currently in memory and do not have to correspond to the data on the independent variables used in fitting the model (obtaining the $b_1, b_2, \ldots, b_k$).

- **stdp** calculates the standard error of the prediction after any estimation command. Here the prediction is understood to mean the same thing as the “index”, namely, $x_j \mathbf{b}$. The statistic produced by stdp can be thought of as the standard error of the predicted expected value, or mean index, for the observation’s covariate pattern. This is also commonly referred to as the standard error of the fitted value.

- **stdf** calculates the standard error of the forecast, which is the standard error of the point prediction for 1 observation. It is commonly referred to as the standard error of the future or forecast value. By construction, the standard errors produced by stdf are always larger than those produced by stdp; see Methods and formulas in [R] predict.
stdr calculates the standard error of the residuals.

hat (or leverage) calculates the diagonal elements of the projection hat matrix.

cooksd calculates the Cook’s $D$ influence statistic (Cook 1977).

residuals calculates the residuals.

rstandard calculates the standardized residuals.

rstudent calculates the Studentized (jackknifed) residuals.

nooffset may be combined with most statistics and specifies that the calculation be made, ignoring any offset or exposure variable specified when the model was fit.

This option is available, even if not documented, for predict after a specific command. If neither the offset(varname) option nor the exposure(varname) option was specified when the model was fit, specifying nooffset does nothing.

nolabel prevents _predict from labeling the newly created variable.

stddp is allowed only after you have previously fit a multiple-equation model. The standard error of the difference in linear predictions $(x_1j b - x_2j b)$ between equations 1 and 2 is calculated. Use the equation() option to get the standard error of the difference between other equations.

equation(eqno[, eqno]) is relevant only when you have previously fit a multiple-equation model.

It specifies the equation to which you are referring.

equation() is typically filled in with one eqno—it would be filled in that way with options xb and stddp, for instance. equation(#1) would mean that the calculation is to be made for the first equation, equation(#2) would mean the second, and so on. You could also refer to the equations by their names: equation(income) would refer to the equation named income and equation(hours) to the equation named hours.

If you do not specify equation(), the results are the same as if you specified equation(#1).

Other statistics refer to between-equation concepts; stddp is an example. You might then specify equation(#1,#2) or equation(income,hours). When two equations must be specified, equation() is required.

Methods and formulas

See Methods and formulas in [R] predict and [R] regress.

Reference


Also see

[R] predict — Obtain predictions, residuals, etc., after estimation

[U] 20 Estimation and postestimation commands
**Description**

`preserve` preserves the data, guaranteeing that data will be restored after program termination.  
`restore` forces a restore of the data now.  

`set max_preservemem`, available only in Stata/MP, controls the maximum amount of memory `preserve` will use to store preserved datasets in memory. Once this limit is exceeded, `preserve` will store datasets on disk.

**Syntax**

**Preserve data**

`preserve [ , changed]`

**Restore data**

`restore [ , not preserve]`

**Set maximum memory for fast storage by preserve**

`set max_preservemem `amt` [ , permanently]`

where `amt` is `#` [ b | k | m | g ], and the default unit is b.

**Options**

`changed` instructs `preserve` to preserve only the flag indicating that the data have changed since the last save. Use of this option is strongly discouraged, as explained in the technical note below.  

`not` instructs `restore` to cancel the previous `preserve`.  

`preserve` instructs `restore` to restore the data now, but not to cancel the restoration of the data again at program conclusion. If `preserve` is not specified, the scheduled restoration at program conclusion is canceled.  

`permanently` instructs `set max_preservemem` that, in addition to making the change right now, the new limit be remembered and become the default setting when you invoke Stata.  

`once` is not shown in the syntax diagram but is allowed with `set max_preservemem`. It is for use by system administrators and allows them to set `max_preservemem` such that users cannot modify it; see `Notes for system administrators` in [D] `memory`.
Remarks and examples

`preserve` and `restore` deal with the programming problem where the user’s data must be changed to achieve the desired result but, when the program concludes, the programmer wishes to undo the damage done to the data. When `preserve` is issued, the user’s data are preserved. The data in memory remain unchanged. When the program or do-file concludes, the user’s data are automatically restored.

After a `preserve`, the programmer can also instruct Stata to restore the data now with the `restore` command. This is useful when the programmer needs the original data back and knows that no more damage will be done to the data. `restore, preserve` can be used when the programmer needs the data back but plans further damage. `restore, not` can be used when the programmer wishes to cancel the previous `preserve` and to have the data currently in memory returned to the user.

For speed, Stata/MP uses `frames` to preserve datasets to memory rather than writing them to disk. It does so unless the `max_preservemem` limit has been reached in terms of memory consumed by preserved datasets. Once the limit has been reached, Stata/MP falls back to writing preserved datasets to disk. Stata/SE and Stata/BE are typically used on computers with less memory and as such always preserve datasets on disk.

The default setting for `set max_preservemem` is `1g`, meaning 1 gigabyte. If `amt` is set to `0b` (0 bytes), `preserve` will always use disk storage. If `amt` is set to `1`, `preserve` will use as much memory as the operating system is willing to supply. The memory used by `preserve` is in addition to the memory used by other datasets you may have in memory and is not included in your `max_memory` setting (see [D] memory). Keep this in mind when changing this setting.

Example 1

`preserve` is usually used by itself and is used early in the program. Say that a programmer is writing a program to report some statistic, but the statistic cannot be calculated without changing the user’s data. Here changing does not mean merely adding a variable or two; that could be done with temporary variables as described in [P] `macro`. Changing means that the data really must be changed: observations might be discarded, the contents of existing variables changed, and the like. Although the programmer could just ignore the destruction of the user’s data, the programmer might actually want to use the program herself and knows that she will become exceedingly irritated when she uses it without remembering to first save her data. The programmer wishes to write a programmatically correct, or `PC`, command. Doing so is not difficult:

```
  program myprog
    (code for interpreting—parsing—the user’s request)
    preserve
    (code that destroys the data)
    (code that makes the calculation)
    (code that reports the result)
  end
```

To preserve the data, `preserve` must make a copy of it on disk. Therefore, our programmer smartly performs all the parsing and setup, where errors are likely, before the `preserve`. Once she gets to the point in the code where the damage must be done, however, she preserves the data. After that, she forgets the problem. Stata handles restoring the user’s data, even if the user presses `Break` in the middle of the program.
Example 2

Now let’s consider a program that must destroy the user’s data but needs the data back again, and, once the data are recovered, will do no more damage. The outline is

```stata
program myprog
    (code for interpreting—parsing—the user’s request)
    preserve
    (code that destroys the data)
    (code that makes the first part of the calculation)
    restore
    (code that makes the second part of the calculation)
    (code that reports the result)
end
```

Although there are other ways the programmer could have arranged to save the data and get the data back [snapshot (see [D] snapshot) or save and use with temporary files as described in [P] macro come to mind], this method is better because should the user press Break after the data are damaged but before the data are restored, Stata will handle restoring the data.

Example 3

This time the program must destroy the user’s data, bring the data back and destroy the data again, and finally report its calculation. The outline is

```stata
program myprog
    (code for interpreting—parsing—the user’s request)
    preserve
    (code that destroys the data)
    (code that makes the first part of the calculation)
    restore, preserve
    (code that makes the second part of the calculation)
    (code that reports the result)
end
```

The programmer could also have coded a restore on one line and a preserve on the next. It would have the same result but would be inefficient, because Stata would then rewrite the data to disk. restore, preserve tells Stata to reload the data but to leave the copy on disk for ultimate restoration.

Example 4

A programmer is writing a program that intends to change the user’s data in memory—the damage the programmer is about to do is not damage at all. Nevertheless, if the user pressed Break while the programmer was in the midst of the machinations, what would be left in memory would be useless. The programmatically correct outline is

```stata
program myprog
    (code for interpreting—parsing—the user’s request)
    preserve
    (code that reforms the data)
    restore, not
end
```
Before undertaking the reformation, the programmer smartly preserves the data. When everything is complete, the programmer cancels the restoration by typing `restore, not`.

Technical note

We said above that with `set max_preservemem`, if you set `amt` to `0b` (0 bytes), `preserve` will use disk storage. In fact, if you set `amt` to anything less than the size of one of Stata’s data segments (see `set segmentsize` in [D] `memory`), `preserve` will always use disk storage. You can type `query memory` to see the current `segmentsize` and `max_preservemem` settings.

Technical note

`preserve, changed` is best avoided, although it is very fast. `preserve, changed` does not preserve the data; it merely records whether the data have changed since the data were last saved (as mentioned by `describe` and as checked by `exit` and `use` when the user does not also say `clear`) and restores the flag at the conclusion of the program. The programmer must ensure that the data really have not changed.

As long as the programs use temporary variables, as created by `tempvar` (see [P] `macro`), the changed-since-last-saved flag would not be changed anyway—Stata can track such temporary changes to the data that it will, itself, be able to undo. In fact, we cannot think of one use for `preserve, changed`, and included it only to preserve the happiness of our more imaginative users.

Also see

[P] `nopreserve` option — `nopreserve` option

[D] `snapshot` — Save and restore data snapshots

[P] `macro` — `Macro definition and manipulation`
Title

program — Define and manipulate programs

Description

program define defines and manipulates programs. define is required if program_name is any of the words: define, dir, drop, list, or plugin.

program dir lists the names of all the programs stored in memory.

program list lists the contents of the named program or programs. program list _all lists the contents of all programs stored in memory.

program drop eliminates the named program or programs from memory. program drop _all eliminates all programs stored in memory. program drop _allado eliminates all programs stored in memory that were loaded from ado-files. See [U] 17 Ado-files for an explanation of ado-files.

See [U] 18 Programming Stata for a description of programs. The remarks below address only the use of the program dir, program drop, and program list commands.

See [P] trace for information on debugging programs.

See the Combined subject table of contents, which immediately follows the Contents, for a subject summary of the programming commands.

Syntax

Define program

program [define] program_name [, nclass rclass eclass sclass ]
byable (recall, noheader | onecall) properties (namelist) sort preserve plugin ]

List names of programs stored in memory

program dir

Eliminate program from memory

program drop { program_name [ program_name [ ... ] ]| _all | _allado ]

List contents of program

program list [ program_name [ program_name [ ... ] ]| _all ]
Options

nclass states that the program being defined does not return results in r(), e(), or s(), and is the default.

rclass states that the program being defined returns results in r(). This is done using the return command; see [P] return. If the program is not explicitly declared to be rclass, then it may not change or replace results in r().

eclass states that the program being defined returns results in e() or modifies already existing results in e(). This is done using the ereturn command; see [P] return and [P] ereturn. If the program is not explicitly declared to be eclass, it may not directly replace or change results in e().

sclass states that the program being defined returns results in s(). This is done using the sreturn command; see [P] return. If the program is not explicitly declared to be sclass, then it may not directly change or replace results in s(), but it still may clear s() by using sreturn clear.

byable(recall[, noheader] | onecall) specifies that the program allow Stata’s by varlist: prefix. There are two styles for writing byable programs: byable(recall) and byable(onecall). The writing of byable programs is discussed in [P] byable.

properties(namelist) states that program_name has the specified properties. namelist may contain up to 80 characters, including separating spaces. See [P] program properties.

sortpreserve states that the program changes the sort order of the data and that Stata is to restore the original order when the program concludes; see [P] sortpreserve.

plugin specifies that a plugin (a specially compiled C program) be dynamically loaded and that the plugin define the new command; see [P] plugin.

Remarks and examples

The program dir command lists the names of all the programs stored in memory. program list lists contents of the program or programs.

Example 1

When you start Stata, there are no programs stored in memory. If you type program dir, Stata displays an empty list:

    . program dir
     .

Later during the session, you might see

```
. program dir
(output omitted)
ado  756  _pred_se
ado  644  logit_p.GenScores
ado  306  logit_p.GetRhs
ado  5296  logit_p
ado  339  predict
(output omitted)
ado  559  logit.Replay
ado  4272  logit.Estimate
ado  827  logit
ado  287  webuse.Query
ado  588  webuse.Set
ado  269  webuse.GetDefault
ado  686  webuse
```

The ado in front indicates that the program was automatically loaded and thus can be automatically dropped should memory become scarce; see [U] 17 Ado-files. The number is the size, in bytes, of the program. The total amount of memory occupied by programs is 114,306 bytes. Notice the logit_p.GetRhs and logit_p.GenScores entries. These programs are defined in the logit_p.ado file and were loaded when logit_p was loaded.

Let’s now create two of our own programs with program:

```
. program rng
  1. args n a b
  2. if "."=="" {
  3.   display "You must type three arguments: n a b"
  4.   exit
  5. }
  6. drop _all
  7. set obs 'n'
  8. generate x = (_n-1)/(_N-1)*('b'-'a')+'a'
  9. end

. program smooth
  1. args v1 v2
  2. confirm variable 'v1'
  3. confirm new variable 'v2'
  4. generate 'v2' = cond(_n==1|_n==_N,'v1',('v1'[_n-1]+v1+v1[_n+1])/3)
  5. end
```
After you type `program`, lines are collected until you type a line with the word `end`. For our purposes, it does not matter what these programs do. If we were now to type `program dir`, we would see:

```
. program dir
    286   smooth
    319   rng
(output omitted)
ado    756   _pred_se
ado    644   logit_p.GenScores
ado    306   logit_p.GetRhs
ado    5296  logit_p
ado    339   predict
(output omitted)
ado    559   logit.Replay
ado    4272  logit.Estimate
ado    827   logit
ado    287   webuse.Query
ado    588   webuse.Set
ado    269   webuse.GetDefault
ado    686   webuse
```

We can list a program by using the `program list` command:

```
. program list smooth
smooth:
1. args v1 v2
2. confirm variable `v1`
3. confirm new variable `v2`
4. generate `v2' = cond(_n==1|_n==_N,'v1',('v1'[_n-1]+'v1'+v1[_n+1])/3)
```

If we do not specify the program that we want listed, `program list` lists all the programs stored in memory.
The `program drop` command eliminates programs from memory. Typing `program drop program_name` eliminates `program_name` from memory. Typing `program drop _all` eliminates all programs from memory.

```
. program drop smooth
. program dir
   319   rng
(output omitted)
ado    756   _pred_se
ado    644   logit_p.GenScores
ado    306   logit_p.GetRhs
ado    5296  logit_p
ado     339  predict
(output omitted)
ado     559  logit.Replay
ado    4272  logit.Estimate
ado     827  logit
ado     287  webuse.Query
ado     588  webuse.Set
ado     269  webuse.GetDefault
ado     686  webuse
118506
. program drop _all
. program dir
```

Also see

[P] byable — Make programs byable
[P] discard — Drop automatically loaded programs
[P] sortpreserve — Sort within programs
[P] trace — Debug Stata programs
[D] clear — Clear memory
[R] query — Display system parameters
[U] 18 Programming Stata
Description

User-defined programs can have properties associated with them. Some of Stata’s prefix commands—such as svy and stepwise—use these properties for command validation. You can associate program properties with programs by using the properties() option of program.

```
program [define] command [, properties(namelist) ...]
   // body of the program
end
```

You can retrieve program properties of `command` by using the properties macro function.

```
   global mname : properties command
   local lclname : properties command
```

Option

`properties(namelist)` states that `command` has the specified properties. `namelist` may contain up to 80 characters, including separating spaces.

Remarks and examples

Remarks are presented under the following headings:

- Introduction
- Writing programs for use with nestreg and stepwise
- Writing programs for use with svy
- Writing programs for use with mi
- Properties for survival-analysis commands
- Properties for exponentiating coefficients
- Putting it all together
- Checking for program properties

Introduction

Properties provide a way for a program to indicate to other programs that certain features have been implemented. Suppose that you want to use `stepwise` with the `lr` option so that likelihood-ratio tests are performed in the model-selection process; see [R] stepwise. To do that, `stepwise` must know that the estimation command you are using in conjunction with it is a maximum likelihood estimator. If a command declares itself to have the `swml` property, `stepwise` knows that the command can be used with likelihood-ratio tests.

The next few sections discuss properties that are checked by some of Stata’s prefix commands and how to make your own programs work with those prefix commands.
Writing programs for use with nestreg and stepwise

Some of Stata’s estimation commands can be used with the nestreg and stepwise prefix commands; see [R] nestreg and [R] stepwise. For example, the syntax diagram for the regress command could be presented as

\[
\begin{align*}
\text{[nestreg, ...:] regress ...} \\
\text{or} \\
\text{[stepwise, ...:] regress ...}
\end{align*}
\]

In general, the syntax for these prefix commands is

\[
\text{prefix\_command [ , prefix\_options] : command depvar (varlist) [ (varlist) ... ] [if] [ in] [ , options]}
\]

where \text{prefix\_command} is either \text{nestreg} or \text{stepwise}.

You must follow some additional programming requirements to write programs (ado-files) that can be used with the \text{nestreg} and \text{stepwise} prefix commands. Some theoretical requirements must be satisfied to justify using \text{nestreg} or \text{stepwise} with a given command.

• \text{command} must be eclass and accept the standard estimation syntax; see [P] program, [P] syntax, and [P] mark.

\[
\text{command varlist [if] [ in] [weight] [ , options]}
\]

• \text{command} must store the model coefficients and ancillary parameters in \text{e(b)} and the estimation sample size in \text{e(N)}, and it must identify the estimation subsample in \text{e(sample)}; see [P] ereturn.

• For the likelihood-ratio test, \text{command} must have property \text{swml}. For example, the program definition for \text{poisson} appears as

\[
\text{program poisson, ... properties(... swml ...)}
\]

\text{command} must also store the log-likelihood value in \text{e(ll)} and the model degrees of freedom in \text{e(df\_m)}.

• For the Wald test, \text{command} must have property \text{sw} if it does not already have property \text{swml}. For example, the program definition for \text{qreg} appears as

\[
\text{program qreg, ... properties(... sw ...)}
\]

\text{command} must also store the variance estimates for the coefficients and ancillary parameters in \text{e(V)}; see [R] test.

Writing programs for use with svy

Some of Stata’s estimation commands can be used with the \text{svy} prefix; see [SVY] svy. For example, the syntax diagram for the \text{regress} command could be presented as

\[
\text{[svy, ...:] regress ...}
\]

In general, the syntax for the \text{svy} prefix is

\[
\text{svy [ , svy\_options] : command varlist [if] [ in] [ , options]}
\]
You must follow some additional programming requirements to write programs (ado-files) that can be used with the `svy` prefix. The extra requirements imposed by the `svy` prefix command are from the various variance-estimation methods that it uses: vce(bootstrap), vce(brr), vce(jackknife), vce(sdr), and vce(linearized). Each of these variance-estimation methods has theoretical requirements that must be satisfied to justify using them with a given command.

- **command** must be eclass and allow iweights and accept the standard estimation syntax; see [P] program, [P] syntax, and [P] mark.

  \[
  \text{command} \ \text{varlist} \ [\text{if}] \ [\text{in}] \ [\text{weight}] \ [, \ \text{options}] \]

- command must store the model coefficients and ancillary parameters in e(b) and the estimation sample size in e(N), and it must identify the estimation subsample in e(sample); see [P] ereturn.

- `svy`'s vce(bootstrap), vce(brr), and vce(sdr) require that **command** have svyb as a property. For example, the program definition for `regress` appears as

  \[
  \text{program \ regress, ... properties(... svyb ...)} \]

- vce(jackknife) requires that **command** have svyj as a property.

- vce(linearized) has the following requirements:

  a. **command** must have svyr as a property.

  b. predict after **command** must be able to generate scores with the following syntax:

  \[
  \text{predict} \ [\text{type}] \ \text{stub*} \ [\text{if}] \ [\text{in}], \ \text{scores} \]

  This syntax implies that estimation results with \( k \) equations will cause predict to generate \( k \) new equation-level score variables. These new equation-level score variables are stub1 for the first equation, stub2 for the second equation, \ldots, and stubk for the last equation. Actually `svy` does not strictly require that these new variables be named this way, but this is a good convention to follow.

  The equation-level score variables generated by predict must be of the form that can be used to estimate the variance by using Taylor linearization (otherwise known as the delta method); see [SVY] Variance estimation.

  c. **command** must store the model-based variance estimator for the coefficients and ancillary parameters in e(V); see [SVY] Variance estimation.

**Writing programs for use with mi**

Stata’s `mi` suite of commands provides multiple imputation to provide better estimates of parameters and their standard errors in the presence of missing values; see [MI] Intro. Estimation commands intended for use with the `mi estimate` prefix (see [MI] mi estimate) must have property mi, indicating that the command meets the following requirements:

- The command is eclass.

- The command stores its name in e(cmd).

- The command stores the model coefficients and ancillary parameters in e(b), stores the corresponding variance matrix in e(V), stores the estimation sample size in e(N), and identifies the estimation subsample in e(sample).
• The command stores the number of ancillary parameters in \( e(k_{aux}) \). This information is used for the model \( F \) test, which is reported by `mi estimate` when the command stores model degrees of freedom in \( e(df_m) \).

• If the command employs a small-sample adjustment for tests of coefficients and reports of confidence intervals, the command stores the numerator (residual) degrees of freedom in \( e(df_r) \).

• Because `mi estimate` uses its own routines to display the output, to ensure that results display well the command also stores its title in \( e(title) \). `mi estimate` also uses macros \( e(vcetype) \) or \( e(vce) \) to label the within-imputation variance, but those macros are usually set automatically by other Stata routines.

**Properties for survival-analysis commands**

Stata’s `st` suite of commands have the \( st \) program property, indicating that they have the following characteristics:

• The command should only be run on data that have been previously \( stset \); see \[ ST \] \( stset \).

• No dependent variable is specified when calling that command. All variables in \( varlist \) are regressors. The “dependent” variable is time of failure, handled by \( stset \).

• Weights are not specified with the command but instead obtained from \( stset \).

• If robust or replication-based standard errors are requested, the default level of clustering is according to the ID variable that was \( stset \), if any.

**Properties for exponentiating coefficients**

Stata has several prefix commands—such as `bootstrap`, `jackknife`, and `svy`—that use alternative variance-estimation techniques for existing commands. These prefix commands behave like conventional estimation commands when reporting and saving estimation results. Given the appropriate program properties, these prefix commands can also report exponentiated coefficients. In fact, the property names for the various shortcuts for the `eform()` option are the same as the option names:

<table>
<thead>
<tr>
<th>option/property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>hr</td>
<td>hazard ratio</td>
</tr>
<tr>
<td>nohr</td>
<td>coefficient instead of hazard ratio</td>
</tr>
<tr>
<td>shr</td>
<td>subhazard ratio</td>
</tr>
<tr>
<td>noshr</td>
<td>coefficient instead of subhazard ratio</td>
</tr>
<tr>
<td>irr</td>
<td>incidence-rate ratio</td>
</tr>
<tr>
<td>or</td>
<td>odds ratio</td>
</tr>
<tr>
<td>rrr</td>
<td>relative-risk ratio</td>
</tr>
</tbody>
</table>

For example, the program definition for `logit` looks something like the following:

```stata
program logit, ... properties(... or ...)```

Putting it all together

logit can report odds ratios, works with svy, and works with stepwise. The program definition for logit reads

```
program logit, ... properties(or svyb svyj svyr swml mi) ...
```

Checking for program properties

You can use the `properties` macro function to check the properties associated with a program; see `P macro`. For example, the following macro retrieves and displays the program properties for logit.

```
. local logitprops : properties logit
. display "'logitprops'"
  or svyb svyj svyr swml mi bayes
```

Also see

[P] program — Define and manipulate programs
[M] mi estimate — Estimation using multiple imputations
[R] nestreg — Nested model statistics
[R] stepwise — Stepwise estimation
[SVY] svy — The survey prefix command
[U] 20 Estimation and postestimation commands
The Project Manager is a tool for organizing and navigating Stata files. It allows you to collect all the files associated with a given project into a single interface where you can have quick access to them without navigating through file dialogs. You can open do-files in the Do-file Editor, use Stata data, and draw saved Stata graphs by double-clicking on the files in the Project Manager. There are no limitations to the kinds of files you can add to a project. If you are using Stata for Mac, you can also open non-Stata documents in their default applications just by double-clicking on the files.

To open the Project Manager, from within the Do-file Editor on Windows and Unix or from within the main menu on Mac, select File > New > Project....

Remarks and examples

Remarks are presented under the following headings:

- Getting started with the Project Manager
- Editing projects
- Properties
- Relative versus absolute paths
- Filtering and searching

Getting started with the Project Manager

When a new project is created in the Project Manager, you are first prompted to save it to disk. On Windows and Unix, a Do-file Editor window is opened when a project is created or opened. On Mac, the Project Manager tab in the sidebar is selected when a project is created or opened. Figure 1 shows a new project and an open document in the Do-file Editor.
Figure 1: The Project Manager and Do-file Editor

The left side of the window is the Project Manager. In Windows, the Project Manager pane can be dragged to other positions in the window. The Project Manager shows the contents of a project and their properties. The right side of the window is the Do-file Editor. The Do-file Editor is used to edit Stata text files. See [GSM] 13 Using the Do-file Editor—automating Stata, [GSU] 13 Using the Do-file Editor—automating Stata, or [GSW] 13 Using the Do-file Editor—automating Stata for more information about the Do-file Editor.

The Project Manager shows the groups and files in a project in a hierarchical list called a tree view. Figure 2 shows some of the files and groups in a project we have already created.
The highest level of the hierarchy in the Project Manager is the project. It can contain groups and files. A group appears in the Project Manager as a folder and is a container for other groups and files. It is not a reference to a directory on disk. Although you can organize your project in the Project Manager to reflect the organization of files on disk, moving files into and out of groups does not affect the content of the directory on disk, and moving files into and out of directories on disk does not affect the content of the groups in the Project Manager. A file in the Project Manager is a reference to a file on disk.

Clicking on the disclosure button next to a project or group icon reveals or hides items in the project. Groups and files are displayed alphabetically in the Project Manager, and groups are always displayed before files. If a file in a project does not exist on disk, its filename will be displayed in red.

Below the tree view is the Properties pane, which shows the properties for the current selection. From the Properties pane, you can rename groups and files, change a file’s relative reference location on disk to the project, or change a file’s reference to a different file on disk.

On Windows, there is a Search field above the tree view that allows you to filter or search for files in a project.

On Mac and Unix, the bottom of the Project Manager contains tools for adding or removing groups and files. On the Mac, there is a single button that displays a menu of possible actions such as adding and removing groups and files. On Unix, there are separate buttons for adding and removing groups and files. Next to the buttons is a Search field that allows you to filter or search for files in a project.
Editing projects

When starting a new project, we recommend that you create a new directory on disk and store the project file and the files referenced by the project in the new directory. If you already have a directory of existing Stata files, save the new project in the directory.

You can add files to a project by dragging the files from disk to the Project Manager or by right-clicking on an item in the Project Manager and selecting **Add Files to "name"...** When a directory on disk is added to a project, its organization on disk at that moment is reflected in the project. Groups and files can be moved into and out of groups using drag and drop.

To create a new group, select the location in the Project Manager where you want the group added, right-click, and select **Add New Group**. You can drag files into the group, and you can drag the group to a new location in the Project Manager. You can also create a new group from multiple files by selecting the files, right-clicking on the files, and selecting **Add New Group from Selection**. A new group will be created, and the selected files will be moved into the group. You can change the name of a group by selecting it and entering a new name in the **Name** edit field.

To remove files from a project, select the files in the Project Manager, right-click on the files, and select **Remove from Project**. Removing a file from a project does not delete the file on disk. When removing a file from a project on the Mac, you can choose to also move the file on disk to the Trash folder.

Properties

Below the Project Manager’s tree view is the Properties pane. The Properties pane shows the filename and path for the currently selected item. Figure 3 shows the properties of a do-file that is currently selected.

![Figure 3. Properties of a selected do-file](image)

The **Name** edit field displays the filename for the currently selected group or file. It can be used to rename groups and files. If a file is renamed in the project, the file on disk is also renamed. However, renaming a file on disk does not rename the file in the project and will cause the file to display in red because it cannot be found.

Below the **Name** edit field is the **Type** label. This displays whether the selected item is a project, group, or document.

Below the **Type** edit field is the **Location** pop-up menu. It specifies whether a file’s path is absolute or relative to the project file. Files that are added to a project have their location set to **Relative to Project** by default unless they do not share a common parent directory with the project file. For example, files that are added from a hard drive different from that of the project file will have their location set to absolute. You can change a file’s location setting by selecting the appropriate location setting from the **Location** pop-up menu.
The relative path location setting denotes the file’s path in relation to the location of the project file on disk. If a file is set to use a relative path, the relative path is displayed below the pop-up menu. Relative paths make projects more portable because you can simply copy a project and all the files it references to another computer. The file references will stay intact.

The absolute path location setting denotes that the file is at a fixed location on disk. A file in a project that uses an absolute path will not be affected if its project file is moved. This can be useful for referencing a Stata dataset that is in a fixed location on disk and is referenced by multiple projects.

Below the Location pop-up menu is the Relink button, which allows you to change a file’s reference to a different file on disk. It is useful for resolving files that cannot be found. For example, if you rename a file on disk, the project that references it can no longer find the file. You can use the Relink button to change a file’s reference to the renamed file.

The full path of a selected file is displayed at the bottom of the Properties pane. The full path is always displayed as an absolute path regardless of a file’s location setting. On Mac, there is a button next to the Full Path text field. Pressing this button will open the file’s parent directory on the desktop.

Relative versus absolute paths

A relative path denotes a file’s path in relation to the location of the project file on disk. An absolute path denotes a file’s path at a fixed location on disk. A disadvantage of using absolute paths is that it makes a project less portable and more difficult to transfer to another computer. In most cases, you want to use relative paths in your project. There are some situations, however, where you might want to use absolute paths. For example, you have an extremely large dataset that is used by different projects, and you do not want to have multiple copies of the dataset taking up disk space. Another example would be a do-file that is used by different projects that you modify often; keeping multiple copies of the do-file in sync is difficult.

Relative paths require that projects and their files maintain their relative locations on disk. We recommend that you create a directory in which to store a project and all of its files and use relative paths in the project as much as possible. You can then copy the directory to another computer, including Mac and Unix, and the project can be used as is. By default, the Project Manager uses relative paths when a file is added to a project. However, it is up to users to use relative paths in their do-files. The Project Manager is a tool for organizing Stata files, but it cannot ensure that file references in do-files are maintained, too.

Filtering and searching

The Project Manager can use a filter to display only those files that match a filter text. Click on the button in the Search field below the Properties pane and select Filter if it is not already selected. As you enter text, the Project Manager will update and display only those files and groups and parent groups that contain the text. Figure 4, for example, shows a project filtered to show only do-files (.do).
You can move, rename, remove, or add a file or group while a project is filtered. If a file is added or renamed while a project is filtered, the file will not appear in the filtered list if its filename does not match the filter text. To stop filtering a project, clear the text in the Search field.

You can also search for a filename in a project. Click on the button in the Search field, and select Search if it is not already selected. After entering text in the Search field, press the Enter key to begin the search. If a filename matches the search text, the filename is selected and scrolled into view. Pressing the Enter key again will search for a matching filename again. If there is no matching filename beyond the current selection, the search is resumed from the top of the project. Holding down the Shift key while pressing the Enter key will search in reverse.

Also see

[R] doedit — Edit do-files and other text files
Stata provides two ways for Python and Stata to interact, and we refer to these mechanisms collectively as PyStata.

First, Python can be invoked from a running Stata session so that Python’s extensive language features can be leveraged from within Stata. We call this Python integration. With Python integration, you can embed and execute Python code interactively, or in do-files and ado-files. You can read more about using Python from within Stata in [P] PyStata integration.

Second, Stata can be invoked from a standalone Python environment via the pystata Python package. It includes three IPython (interactive Python) magic commands and a suite of API functions for interacting with Stata from within Python. With these tools, you can access Stata and Mata conveniently in an IPython kernel-based environment (for example, Jupyter Notebook and console, and Jupyter Lab and console), in other environments that support the IPython kernel (for example, Spyder IDE and PyCharm IDE), or when accessing Python from a command line (for example, Windows Command Prompt, macOS terminal, Unix terminal, and Python’s IDLE). See [P] PyStata module for more details about calling Stata from within Python.

Whether you are integrating Python into Stata or Stata into Python, you can use the sfi (Stata Function Interface) module to interact Python’s capabilities with Stata’s core features. Within the module, classes are defined to provide access to Stata’s current dataset, frames, macros, scalars, matrices, value labels, characteristics, global Mata matrices, and more. Refer to Stata’s Python API documentation for more details.

Also see

[P] PyStata integration — Call Python from Stata
[P] PyStata module — Python package pystata to call Stata from Python
PyStata integration — Call Python from Stata

Description

python provides utilities for embedding Python code within Stata. With these utilities, users can invoke Python interactively or in do-files and ado-files. If you are interested in calling Stata from Python, see [P] PyStata module.

python[:] creates a Python environment in which Python code can be executed interactively, just like a Python interpreter. In this environment, the classic “>>>” and “...” prompts are used to indicate the user input. All the objects inside this environment are created in the namespace of the __main__ module.

python: istmt executes one Python simple statement or several simple statements separated by semicolons.

python script executes a Python script .py file. A list of arguments can be passed to the file by using option args().

python set exec pyexecutable sets which Python version to use. pyexecutable specifies the full path of the Python executable. If the executable does not exist or does not meet the minimum version requirement, an error message will be issued.

python set userpath path [...] sets the user’s own module search paths in addition to system search paths. Multiple paths may be specified. When specified, those paths will be loaded automatically when the Python environment is initialized.

python describe lists the objects in the namespace of the __main__ module.

python drop removes the specified objects from the namespace of the __main__ module.

python clear clears all the objects whose names are not prefixed with _ from the namespace of the __main__ module.

python query lists the current Python settings and system information.

python search finds the Python versions installed on the current operating system. Only Python 2.7 and greater will be listed. On Windows, the registry will be searched for official Python installation and versions installed through Anaconda. On Unix or Mac, the registry will be searched for Python installations in the /usr/bin/, /usr/local/bin/, /opt/local/python/bin/, ~/anaconda/bin, or ~/anaconda3/bin directories.

python which checks the availability of a Python module.
Syntax

Enter Python interactive environment

```python
python [:]
```

Execute Python simple statements

```python
python:     istmt
```

Execute a Python script file

```python
python script pyfilename [, args(args_list) global
                userpaths(user_paths[, prepend])]
```

Set which version of Python to use

```python
python set exec pyexecutable [, permanently]
```

set python_exec is a synonym for python set exec.

Set user’s additional module search paths

```python
python set userpath path [path ...] [, permanently prepend]
```

set python_userpath is a synonym for python set userpath.

List objects in the namespace of the `__main__` module

```python
python describe [namelist] [, all]
```

Drop objects from the namespace of the `__main__` module

```python
python drop namelist
```

Clear objects from the namespace of the `__main__` module

```python
python clear
```

Query current Python settings and system information

```python
python query
```

Search for Python installations on the current system

```python
python search
```

Check the availability of a Python module

```python
python which modulename
```
`istmt` is either one Python simple statement or several simple statements separated by semicolons.

`pyfilename` specifies the name of a Python script file with extension `.py`.

`pyexecutable` specifies the executable of a Python installation, such as

```
"C:\Program Files\Python36\python.exe",
"/usr/bin/python",
"/usr/local/bin/python",
"~/anaconda3/bin/python", or
"~/anaconda/bin/python".
```

`namelist` specifies a list of object names, such as `sys`, `spam`, or `foo`. Names can also be specified using the `*` and `?` wildcard characters:

* indicates zero or more characters.

? indicates exactly one character.

`modulename` specifies the name of a Python module. The module can be a system module or a user-written module. The name can be a regular single module name or a dotted module name, such as `sys`, `numpy`, or `numpy.random`.

`collect` is allowed; see [U] 11.1.10 Prefix commands.

### Options

`args(args_list)` specifies a list of arguments, `args_list`, that will be passed to the Python script file and can be accessed through `argv` in Python’s `sys` module. `args_list` may contain one argument or a list of arguments separated by spaces.

`global` specifies that the objects created in the Python script file be appended to the namespace of the `__main__` module so that they can be accessed globally. By default, the objects created in the script file are discarded after execution.

`userpaths(user_paths[, prepend])` specifies the additional module search paths that will be added to the system paths stored in `sys.path`. `user_paths` may be one or a list of paths separated either by spaces or by semicolons. By default, those paths will be added to the end of system paths. If `prepend` is specified, they will be added in front of the system paths.

`permanently` specifies that, in addition to making the change right now, the setting be remembered and become the default setting when you invoke Python.

`prepend` specifies that instead of adding the user’s additional module search paths to the end of system paths, the paths are to be added in front of the system paths.

`all` specifies that all the objects in the namespace of the `__main__` module be listed. By default, only objects that do not begin with an underscore will be listed.

### Remarks and examples

Remarks are presented under the following headings:

- Invoking Python interactively
- The distinction between python and python:
- Embedding Python code in a do-file
- Running a Python script file
- Embedding Python code in an ado-file
- Stata Function Interface (sfi) module
- Configuring Python
Invoking Python interactively

You type `python` or `python:` (with the colon) to enter the interactive environment.

```
. python
python (type end to exit) >>>
```

Within the interactive environment, we use three greater-than signs (```>>>``` as the primary prompt and three dots (```...``` as the secondary prompt for continuation lines. When you type a statement in the environment, the Python interpreter will compile what you typed, and if it is compiled without error, the statement will be executed. Note that within the Python environment, all the statements need to follow Python's style, such as for indentation and line breaks. For example,

```python
>>> word = 'Python'
>>> word[0], word[-1]
('P', 'n')
>>> len(word)
6
>>> squares = [1,4,9,16,25]
>>> squares
[1, 4, 9, 16, 25]
>>> from math import pi
>>> [str(round(pi, i)) for i in range(1,8)]
>>> 
>>> for i in range(3):
...    print(i)
...
0
1
2
```

When you are done using Python, type `end` following the ```>>>``` prompt:

```
>>> end
```

When you exit from the Python interactive environment back into Stata, the environment does not clear itself; so if you later type `python` or `python:` again, you will be right back where you were.

All the objects created in the interactive environment are stored in the namespace of the ```__main__``` module, and they can be accessed later when you exit Python and come back. In Stata, you can use `python describe`, `python drop`, and `python clear` to manipulate those objects.

Within the interactive environment, only Python statements are accepted. To execute a Stata command while in the Python environment, prefix the Stata command with `stata:`. For example, suppose `auto.dta` is in memory and we want to run a regression of `mpg` on `weight` and `foreign` using the `regress` command. We can type

```plaintext
>>> stata: regress mpg weight foreign
```

and the output would match what is produced in Stata. This syntax only works in the Python interactive environment. It will not work in a Python script, nor embedded within compound statements, such as `def` or `if`, in an interactive environment. Instead, use the `stata()` function, one of the functions defined in the Python class `SFIToolkit` within the `sfi` (Stata Function Interface) module, to execute Stata commands within script files and compound statements.
In the interactive environment, when a statement fails to compile, a stack trace will be printed and an error code will be issued. For example,

```python
>>> spam
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
NameError: name 'spam' is not defined
r(7102);
```  

The stack trace issued by the Python interpreter states that a NameError occurs because the variable spam has not been defined. The error code r(7102) tells Stata that something is wrong with the Python environment. See Error codes for a detailed description.

**The distinction between python and python:**

Issuing python (without a colon) will allow you to remain in the Python environment despite errors. Issuing python: will allow you to work in the Python environment but will return control to Stata when you encounter a Python error. For example, consider the following (using python without the colon):

```python
python
a = a + 2
b = 6
end
```

In the above code, the variable a is not defined, so the statement a = a + 2 will throw a Python error. Because we used python without the colon, the incorrect line would be issued, and we would remain in the Python environment until the end statement. Python would not tell Stata that anything went wrong! This could have serious consequences. On the other hand, if we had used python: (with a colon), the same error would return control to Stata and issue an error code; the second statement (b = 6) would not be executed at all.

**Embedding Python code in a do-file**

Typing statements interactively can be prone to error, especially when you type a compound statement using indentation. Instead, you can write Python code within a do-file and run multiple statements consecutively. All you need to do is place the Python code within a python[: ] and end block. By placing your code in a do-file, you can mix Stata code and Python code in a single file, execute it all at once, and even run it multiple times. For example,

```plaintext
begin pyex1.do 
version 17.0 
local a = 2 
local b = 3 
python:
from sfi import Scalar
def calcsum(num1, num2):
    res = num1 + num2
    Scalar.setValue("result", res)
calcsum('a', 'b')
end
display result

end pyex1.do 
```

```
In the above do-file, we defined two local macros in Stata, a and b, which we use as arguments later. Within the python: and end block, we first defined a function, calcsum(), that calculated the sum of two numbers. We passed the result back to Stata as a scalar named result by using the setValue() function of the Scalar class defined in the sfi module. Finally, the function was called.

Typing do pyex1 returns a result of 5.

As you can see, we called the function with calcsum('a', 'b'). After macro expansion, this line became calcsum(2, 3) and the values 2 and 3 were passed to the function. Macro substitution is a convenient way to pass values from Stata to Python. You can use macros when typing Python statements interactively in the Command window or when writing Python statements in a do-file. You just need to follow Stata’s quotes notation.

When you run the do-file and the python: line is executed, it will enter the interactive environment and run Python code line by line. After the end line is executed, it will exit Python and enter Stata again.

Because the Python code is executed in the interactive environment, all objects defined in the Python block within a do-file are automatically added to the namespace of the __main__ module. Thus, they can be accessed later when you enter Python statements interactively or in another Python block within a do-file. For example, we can rewrite the above do-file as follows, and it will lead to the same result:

```
begin pyex2.do

version 17.0
local a = 2
local b = 3

python:
from sfi import Scalar
def calcsum(num1, num2):
    res = num1 + num2
    Scalar.setValue("result", res)
end

python: calcsum('a', 'b')
display result

display result
end pyex2.do
```

Here we called the function calcsum() by using the simple statement syntax outside the first Python block, and the argument values were passed in through macro substitution. We will discuss macro substitution and the simple statement syntax further in *Embedding Python code in an ado-file*. 

**Running a Python script file**

Be aware that Stata and Python use different syntax, data structures and types, language infrastructures, etc. They even have different rules for handling comments and indentations.

Because of these differences, it may be best to isolate Stata and Python code. This can be achieved by writing Python code in a .py script file, and then running python script in Stata to execute it. For example, let’s isolate the Stata and Python code from the example above.
We first write the Python code in a script file, say, pyex.py:

```python
from sfi import Macro, Scalar
def calcsum(num1, num2):
    res = num1 + num2
    Scalar.setValue("result", res)
pya = int(Macro.getLocal("a"))
pyb = int(Macro.getLocal("b"))
calcsum(pya, pyb)
```

In this script file, we first defined the function `calcsum()` as we did before. We called the function `getLocal()`, defined in the `Macro` class within the `sfi` module, to get the local macro values `a` and `b` from Stata. Because `getLocal()` returns a string value, we called Python’s built-in function `int()` to get the numeric values, and we passed them to `calcsum()`.

Next we call this script file in a separate do-file, say, pyex3.do:

```stata
begin pyex3.do
version 17.0
local a = 2
local b = 3
python script pyex.py
display result
end pyex3.do
```

In the do-file, we first defined two local macros and passed them to the `calcsum()` function. Next we ran the script file with the `python script` command and obtained the scalar result.

By default, all the objects defined in the script file are discarded after execution; they are not added to the namespace of the `__main__` module. In other words, the execution of a script file does not share the same namespace with the `__main__` module, which means you cannot access objects defined in the `__main__` module from the script file and vice versa.

To use objects in the namespace of the `__main__` module in a script file, you can import them with the `import` or `import-from` statement. For example, you can include

```python
import __main__
```

in a script file to access each object defined in the `__main__` module.

On the other hand, if you want the interactive environment to have access to the objects defined in the script file after it has been executed, you can specify the `global` option in the `python script` command. By specifying this option, all the objects are copied to the namespace of the `__main__` module, so they can be used directly without having to import them. This is useful when you define functions, classes, etc., in a script file and want to access them interactively or in a do-file. However, you should use this option with caution because those objects will overwrite objects defined in the namespace of the `__main__` module with the same name.

You can pass arguments from Stata to a script file with the `args()` option of `python script`. To access those arguments in the script file, use the `argv` list defined in Python’s `sys` module. Let’s use the above example to illustrate.
We rewrote the script file and the do-file as follows:

```python
import sys
pya = int(sys.argv[1])
pyb = int(sys.argv[2])
from sfi import Macro, Scalar
def calcsum(num1, num2):
    res = num1 + num2
    Scalar.setValue("result", res)
calcsum(pya, pyb)
```

In the script file, we imported the `sys` module and then got the arguments through the `sys.argv` list. Because we will pass two arguments to the script file, we access the argument values with `sys.argv[1]` and `sys.argv[2]`. Note that when executing a script file, `sys.argv[0]` stores the script name, which is `pyex2.py` in this case. In the do-file, we passed the macro values to the Python script file by listing them in the `args()` option of `python script`.

Another option you may find useful when running a script file in Stata is `userpaths()`, which allows you to find and import modules defined in your private paths. By default, the paths you specified are appended to the end of the list. You can prepend them to the beginning of the list by using the `prepend` suboption.

These paths are only added temporarily to `sys.path`, which means they will be used only when executing the script file. After that, they will be discarded from the list. To add a path permanently, use `python set userpath`. See `Locating modules` for a detailed discussion about setting module search paths.

### Embedding Python code in an ado-file

Python code can be embedded and executed in ado-files too. This is useful when you are interested in extending Stata by adding a new command. Below, we use an example to illustrate this purpose.
Suppose that we want to write a new command for Stata that will report the sum of one variable. We might do this as follows:

```stata
begin varsum.ado

program varsum
    version 17.0
    syntax varname [if] [in]
    marksample touse
    python: calcsum('varlist', 'touse')
    display as txt " sum of 'varlist': " as res r(sum)
end
```

```python
version 17.0
from sfi import Data, Scalar
def calcsum(varname, touse):
    x = Data.get(varname, None, touse)
    Scalar.setValue("r(sum)", sum(x))
end
```

end varsum.ado

We load `auto.dta` and run this program from Stata. It will result in the following output:

```
. varsum price
    sum of price: 456229
```

Let’s explain what happened in the ado-file step by step:

1. The ado-file has both ado-code and Python code in it.
2. The ado-code handled all parsing and identified the subsample of the data to be used.
3. The ado-code called the Python function `calcsum()` to perform the calculation using the `python:` statement syntax `isms`
4. The Python code first imported two classes, `Data` and `Scalar`, from the `sfi` module. Then it defined the function `calcsum()`, which received as arguments the names of two variables in the Stata dataset: the variable on which the calculation was to be made and the variable that identified the subsample of the data to be used.
5. The Python function returned the result in `r()`, where the ado-code can access it.

In the ado-file, the Python code was defined within the `python:` and `end` block. You can treat this block as a Python script file, meaning that you can write any Python statement within it. Here we define only one function, `calcsum()`, which acts as a connection between the ado-code and the Python code.

In a connection like this, you have two paramount interests: getting values defined in the ado-code into the Python function, and getting results returned by the function back to your ado-code. For `calcsum()`, the values defined in the ado-code are passed to the function as arguments. When we called the function

```
python: calcsum('varlist', 'touse')
```

this line was automatically expanded and turned into something like

```
python: calcsum("price", "__0001dc")
```

The `__0001dc` variable is a temporary variable created by the `marksample` command earlier in our ado-file. `price` was the variable specified by the user. After expansion, the arguments were nothing more than strings, and those strings were passed to `calcsum()`.
Macro substitution is the most common way values are passed from Stata to Python functions. When writing your Python function, keep in mind the arguments that Stata will find convenient to pass and that Python will make convenient to use:

1. numbers, such as 2 and 3 (‘a’ and ‘b’ in pyex1.do)
2. names of variables, macros, scalars, matrices, etc., such as "price" and "__0001dc" ("'varlist'" and "'touse'")

To receive arguments of type 1, you code numeric type in the function declaration for the argument, and then pass in the value using Stata’s quotes notation. To receive arguments of type 2, you code string type in the function declaration for the argument, and then use classes and functions defined in the sfi module to extract the contents from the name.

On the other hand, you may use other functions defined in those classes to return results to Stata too. For example, you can return results in r()—as we did in our example—or in e() or s(). You can also create Stata macros, scalars, matrices, and even Mata objects from within Python.

Here are some general guidelines for passing values between Python and Stata:

1. If you are dealing with a variable name, you will want to read about the functions defined in the Data and Frame classes.
2. If you are dealing with local or global macros, scalars, or matrices, you will want to see the Macro, Scalar, and Matrix classes.
3. Refer to the sfi module for more detailed descriptions and additional functions.

Remember that all Python objects defined in an ado-file are private and cannot be accessed outside of it. So you cannot use those objects in the interactive environment, in a do-file, or in another ado-file. However, you can still access objects defined in the namespace of the __main__ module by using the import or import-from statement within the python[ ] and end block of an ado-file.

In the above example, we put the calcsum() function in the ado-file within the python: and end block. You can also write the function in a Python module file and import the function from the module to the ado-file. Let’s restructure our ado-file to save calcsum() in a .py file.

First, we simply write the function in a .py file named pyex3.py, as follows:

```python
from sfi import Data, Scalar

def calcsum(varname, touse):
    x = Data.get(varname, None, touse)
    Scalar.setValue("r(sum)", sum(x))
```

In the above example, we put the calcsum() function in the ado-file within the python: and end block. You can also write the function in a Python module file and import the function from the module to the ado-file. Let’s restructure our ado-file to save calcsum() in a .py file.

First, we simply write the function in a .py file named pyex3.py, as follows:

```python
from sfi import Data, Scalar

def calcsum(varname, touse):
    x = Data.get(varname, None, touse)
    Scalar.setValue("r(sum)", sum(x))
```

In the above example, we put the calcsum() function in the ado-file within the python: and end block. You can also write the function in a Python module file and import the function from the module to the ado-file. Let’s restructure our ado-file to save calcsum() in a .py file.
Next, we import the function from the module to our ado-file, so it now reads

```stata
program varsum
  version 17.0
  syntax varname [if] [in]
  marksample touse
  python: calcsum("varlist", "touse")
  display as txt " sum of varlist: " as res r(sum)
end
```

Note the following:

1. All the original Python code within the `python:` and `end` block was moved to the Python module file `pyex3.py`.

2. The `python:` and `end` block now has only one statement, which imports the function `calcsum()` from the module by using the `import-from` syntax. Alternatively, you can import the function from the module by using the `import` syntax, depending on your preference. For example, you can import the whole module by using `import pyex3` and then call `python: pyex3.calcsum("varlist", "touse")` in the ado-code.

3. To make `import` in note 2 work, the module file must be placed where Stata can find it. See `Locating modules` for details on how Stata searches for modules.

Each of the two alternatives to write your Python function has its own advantages. You can choose which one to use based on your preference.

1. Putting the Python code right in the ado-file is easier, and it sure is convenient. You only need to handle a single file.

2. Saving the Python code in a module file makes the Python utilities (`calcsum()` here) available for use in your other ado-files. Compared with the Python code being restricted to the ado-file in note 1, this is more useful if you call the same Python utility in various ado-files.

3. You can combine the two alternatives under some circumstances. For example, suppose you have a few utility functions defined in an existing module file—say, `pyutil.py`—and you want to call those utilities in the `calcsum()` function. You do not need to copy those utilities to the ado-file to use them in `calcsum()`. Instead, you can just import them from the existing module and use them directly in the ado-file.

**Stata Function Interface (sfi) module**

The Stata Function Interface (sfi) module allows users to interact Python’s capabilities with core features of Stata. The module can be used interactively or in do-files and ado-files.

Within the module, classes are defined to provide access to Stata’s characteristics, current dataset, data and time, macros, scalars, matrices, value labels, global Mata matrices, and so on. The following is a summary of them:
Within Python, you can use

```python
import sfi
```

or

```python
from sfi import *
```

to import the whole module. Alternatively, you can import specific classes. For example, to import `Data` and `Macro`, you can use

```python
from sfi import Data, Macro
```

After the classes are imported, you can invoke the various functions defined within them. See Stata’s Python API for detailed documentation about each class and function.

### Configuring Python

Currently, Python has two major versions: Python 2 and Python 3. Stata supports both of them starting from Python 2.7. The first time you call `python` in Stata, Stata will search for Python installations on the system and choose the one with the highest version. Stata will search the official Python installations and Python installations bundled with Anaconda or Miniconda. The installation must contain the corresponding Python dynamically linked library. For example, for Python 3.6, it would be something like `python36.dll` on Windows, `libpython3.6.so` on Linux, and `libpython3.6.dylib` on Mac. Otherwise, it will not be found and used as a candidate. Once Stata finds the candidate with the highest version, it will save that information to use in the future. You can see which Python version Stata will use by typing `python query`.

You can type `python search` to conduct a search. It will list all the Python executables on the system. On Windows, it looks for `python.exe`. On Linux or Mac, it looks for `/usr/bin/python`, `/usr/bin/python3`, `/usr/local/bin/python`, `/usr/local/bin/python3`, `~/anaconda/bin/python`, `~/anaconda3/bin/python`, etc.
If you want to use a Python version different from the default, you can type `python set exec` to change the setting. For example, on Linux, you can type

```
python set exec "/usr/local/bin/python"
```

If `python search` does not find the Python environment you wanted (for example, a user-created virtual environment), you can type `python set exec` to use the version of choice.

Setting the Python version is optional, but if set, it must be done before the initialization of Python. Otherwise, an error will be issued. The setting will be available only for the current Stata session. If you want Stata to remember the setting and use that Python version by default the next time you launch Stata, then use the `permanently` option:

```
python set exec "/usr/local/bin/python", permanently
```

**Locating modules**

According to the Python documentation (sec. 6.1.2 and sec. 6.1.3), "When a module named spam is imported, the interpreter first searches for a built-in module with that name. If not found, it then searches for a file named spam.py in a list of directories given by the variable `sys.path`." When the interpreter is initialized in Stata, Stata’s system directories (`sysdir`) and a `py/` directory within each system directory, except the STATA directory, are added to the list following the default module search paths. For example, on a particular Windows computer, the following paths are added:

```
C:\Program Files\Stata17\C:\Program Files\Stata17\ado\base\C:\Program Files\Stata17\ado\base\py\C:\Program Files\Stata17\ado\site\C:\Program Files\Stata17\ado\site\py\C:\ado\plus\C:\ado\plus\py\C:\ado\personal\C:\ado\personal\py\C:\ado\C:\ado\py\`
```

If you want to add other paths to the module search path list, you can type `python set userpath` to add a list of paths at once. For example,

```
python set userpath "C:\mymodules1" "C:\mymodules2"
```

By default, those paths are added to the end of the list so that modules in those directories are searched last. If you want those paths to be searched first, you can specify the `prepend` option, which will add those paths to the beginning of the module search path. Paths added in this way will be kept in the module search path list and be searched for the whole Stata session. This is different from specifying the `userpaths()` option with `python script`, which removes the paths from the module search path list once the script is executed.

Specifying additional module search paths is optional, but if specified, it must be done before the initialization of Python. Otherwise, an error will be issued. The setting will be available only for the current Stata session. If you want Stata to remember the setting and use the additional paths by default the next time you launch Stata, then use the `permanently` option.

When you want to import third-party Python modules (such as `numpy`, `pandas`, etc.) in your Python code, you need to make sure that they are already installed in the Python version that you are currently using. Otherwise, an error will be issued claiming the specified module is not found. You can type `python which` to check whether a module is available in your current Python settings.
Error codes

When you run Python code within Stata, a Stata error code will be issued with the Python stack trace if an error occurs. Here is a list of them:

<table>
<thead>
<tr>
<th>Code</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>7100</td>
<td>error occurs when loading or freeing the Python dynamically linked library</td>
</tr>
<tr>
<td>7101</td>
<td>attempt to set a different Python version or add additional module search paths after the Python environment is initialized</td>
</tr>
<tr>
<td>7102</td>
<td>error occurs when executing Python in the interactive environment</td>
</tr>
<tr>
<td>7103</td>
<td>error occurs when running a Python script file or importing a Python module</td>
</tr>
</tbody>
</table>

To create custom errors in your Python code, invoke the `exit()` function defined in the Python class `SFIToolkit` within the `sfi` module. This is often used when you want to terminate execution of Python code when handling an error condition or exceptions. Let’s use the following two script files as an illustration.

```
from sfi import SFIToolkit
a = 3
if a > 4:
    SFIToolkit.displayln("continue execution")
else:
    SFIToolkit.errprintln("assertion failed")
    SFIToolkit.exit(198)
# This line will not be executed due to assertion failure.
SFIToolkit.displayln("never reached")
```

```
from sfi import SFIToolkit
try:
    print(a)
except:
    SFIToolkit.errprintln("name a is not defined")
    SFIToolkit.exit(198)
# This line will not be executed due to assertion failure.
SFIToolkit.displayln("never reached")
```

Here `errprintln()` is used to output a string to the Stata Results window as an error. `displayln()` is used to output a string as normal text. They both honor any SMCL tags contained in the string. Executing the above script files results in the following output:

```
. python script pyex4.py
assertion failed
r(198);
. python script pyex5.py
name a is not defined
r(198);
```
Stored results

python query stores the following in $r()$:

Scalars
\[
\begin{align*}
  r(initialized) & \quad \text{whether Python environment initialized (0 or 1)} \\
\end{align*}
\]

Macros
\[
\begin{align*}
  r(execpath) & \quad \text{Python executable path} \\
  r(userpath) & \quad \text{Python user path} \\
  r(version) & \quad \text{Python version} \\
  r(arch) & \quad \text{Python architecture (64-bit or 32-bit)} \\
  r(libpath) & \quad \text{Python shared library} \\
\end{align*}
\]

Acknowledgment

The thought of embedding Python code within Stata was inspired by the Python plugin for Stata, which was written by James Fiedler, Universities Space Research Association.

References


Also see

[P] PyStata intro — Introduction to using Python and Stata together

[P] PyStata module — Python package pystata to call Stata from Python
PyStata module — Python package pystata to call Stata from Python

Description

The pystata Python package allows you to call Stata from within Python. It includes two sets of tools for interacting with Stata from within Python:

1. Three IPython magic commands: `stata`, `mata`, and `pystata`
2. A suite of API functions

The magic commands can be used to access Stata and Mata conveniently in an IPython (interactive Python) kernel-based environment, such as Jupyter Notebook and console, and Jupyter Lab and console, and within other environments that support the IPython kernel, such as Spyder IDE and PyCharm IDE.

The API functions can be used to interact with Stata and Mata from within both IPython and non-IPython environments. For example, they can be used when accessing Python from a Jupyter Notebook or from a command line, such as Python’s IDLE, the Windows Command Prompt, a macOS terminal, or a Unix terminal.

Online documentation for the pystata Python package is available at https://www.stata.com/python/pystata.

The magic commands and API functions both can be used together with the `sfi` (Stata Function Interface) module, making it easier to interact between Stata and Python.

Note that the pystata Python package is to call Stata from within the Python environment. If you are instead interested in calling Python from within Stata, see [P] PyStata integration.

Also see

[P] PyStata intro — Introduction to using Python and Stata together
[P] PyStata integration — Call Python from Stata
Title

quietly — Quietly and noisily perform Stata command

Description

quietly suppresses all terminal output for the duration of command. It is useful both interactively and in programs.

noisily turns back on terminal output, if appropriate, for the duration of command. It is useful only in programs.

set output specifies the output to be displayed. It is useful only in programs and even then is seldom used.

Syntax

Perform command but suppress terminal output

quietly [:] command

Perform command and ensure terminal output

noisily [:] command

Specify type of output to display

set output {proc|inform|error}

Remarks and examples

Remarks are presented under the following headings:

quietly used interactively
quietly used in programs
Note for programmers

quietly used interactively

Example 1

quietly is useful when you are using Stata interactively and want to temporarily suppress the terminal output. For instance, to estimate a regression of mpg on the variables weight, foreign, and headroom and to suppress the terminal output, type

```
. use https://www.stata-press.com/data/r17/auto
(1978 automobile data)
. quietly regress mpg weight foreign headroom
```

Admittedly, it is unlikely that you would ever want to do this in real life.
quietly used in programs

Technical note

quietly is often used in programs. Say that you have the following program to run a regression of $y$ on $x$, calculate the residuals, and then list the outliers, which are defined as points with residuals below the 5th percentile or above the 95th percentile:

```stata
program myprog
    regress '1' '2'
    predict resid, resid
    sort resid
    summarize resid, detail
    list '1' '2' resid if resid< r(p5) | resid> r(p95)
    drop resid
end
```

Although the program will work, it will also fill the screen with the regression output, any notes that predict feels obligated to mention, and the detailed output from summarize. A better version of this program might read:

```stata
program myprog
    quietly regress '1' '2'
    quietly predict resid, resid
    quietly sort resid
    quietly summarize resid, detail
    list '1' '2' resid if resid< r(p5) | resid> r(p95)
    drop resid
end
```

You can also combine quietly with {}::

```stata
program myprog
    quietly {
        regress '1' '2'
        predict resid, resid
        sort resid
        summarize resid, detail
        list '1' '2' resid if resid< r(p5) | resid> r(p95)
        drop resid
    }
end
```

Technical note

noisily is the antonym of quietly, and it too can be used in programs and do-files. In fact, that is its only real use. We could recode our example program to read as follows:

```stata
program myprog
    quietly {
        regress '1' '2'
        predict resid, resid
        sort resid
        summarize resid, detail
        noisily list '1' '2' resid if resid< r(p5) | resid> r(p95)
        drop resid
    }
end
```

Here we have not improved readability.
Technical note

noisily is not really the antonym of quietly. If the user types quietly myprog yvar xvar, the output will be suppressed because that is what the user wants. Here a noisily inside myprog will not display the output—noisily means noisily only if the program was allowed to be noisy when it was invoked.

Technical note

If you think you understand all this, take the following test. Is there any difference between quietly do filename and run filename? How about noisily run filename and do filename? What would happen if you typed quietly noisily summarize myvar? If you typed noisily quietly summarize myvar?

When you are ready, we will tell you the answers.

quietly do filename is equivalent to run filename. Typing run is easier, however.

noisily run filename is not at all the same as do filename. run produces no output, and no matter how noisily you run run, it is still quiet.

Typing quietly noisily summarize myvar is the same as typing summarize myvar. Think of it as quietly {noisily summarize myvar}. It is the inside noisily that takes precedence.

Typing noisily quietly summarize myvar is the same as typing quietly summarize myvar—it does nothing but burn computer time. Again it is the inside term, quietly this time, that takes precedence.

Technical note

set output proc means that all output, including procedure (command) output, is displayed. inform suppresses procedure output but displays informative messages and error messages. error suppresses all output except error messages. In practice, set output is seldom used.

Note for programmers

If you write a program or ado-file, say, mycmd, there is nothing special you need to do so that your command can be prefixed with quietly. That said, c-class value c(noisily) (see [P] creturn) will return 0 if output is being suppressed and 1 otherwise. Thus your program might read

```
program mycmd
...
display ...
display ...
...
end
```
or

```
program mycmd
...
if c(noisily) {
    display ...
    display ...
}
...
end
```

The first style is preferred. If the user executes `quietly mycmd`, the output from `display` itself, along with the output of all other commands, will be automatically suppressed.

If the program must work substantially to produce what is being displayed, however, and the only reason for doing that work is because of the display, then the second style is preferred. In such cases, you can include the extra work within the block of code executed only when `c(noisily)` is true and thus make your program execute more quickly when it is invoked `quietly`.

**Also see**

[P] `capture` — Capture return code

[U] 18 Programming Stata
Description

\_return sets aside and restores the contents of r().

\_return hold stores under name the contents of r() and clears r(). If name is a name obtained from tempname, name will be dropped automatically at the program’s conclusion, if it is not automatically or explicitly dropped before that.

\_return restore restores from name the contents of r() and, unless option hold is specified, drops name.

\_return drop removes from memory (drops) name or, if \_all is specified, all \_return names currently saved.

\_return dir lists the names currently set aside by \_return.

Syntax

Set aside contents of r()

\_return hold name

Restore contents of r() from name

\_return restore name [, hold ]

Drop specified \_return name

\_return drop \{name | \_all\}

List names currently stored by \_return

\_return dir

Option

hold, specified with \_return restore, specifies that results continue to be held so that they can be \_return restored later, as well. If the option is not specified, the specified results are restored and name is dropped.
Remarks and examples

_return is rarely necessary. Most programs open with

```
program example
    version 17.0
    syntax ...
    marksample touse
    if "'exp'" != "" {
        touse e
        qui generate double 'e' = 'exp' if 'touse'
    }
    ... (code to calculate final results)...
end
```

In the program above, no commands are given that change the contents of $r()$ until all parsing is complete and the if $exp$ and $=exp$ are evaluated. Thus the user can type

```
. summarize myvar
. example ... if myvar>r(mean) ...
```

and the results will be as the user expects.

Some programs, however, have nonstandard and complicated syntax, and in the process of deciphering that syntax, other r-class commands might be run before the user-specified expressions are evaluated. Consider a command that reads

```
program example2
    version 17.0
    ...(commands that parse)...
    ...(r() might be reset at this stage)...
    ...(commands that evaluate user-specified expressions)...
    tempvar touse
    mark 'touse' 'if'
    tempvar v1 v2
    generate double 'v1' = 'exp1' if 'touse'
        // 'exp1' specified by user
    generate double 'v2' = 'exp2' if 'touse'
        // 'exp2' specified by user
    ... (code to calculate final results)...
end
```

Here it would be a disaster if the user typed

```
. summarize myvar
. example2 ... if myvar>r(mean) ...
```

because $r(mean)$ would not mean what the user expected it to mean, which is the mean of myvar. The solution to this problem is to code the following:
program example2
    version 17.0  // hold on to r()
    tempname myr
    _return hold ‘myr’
    ...(commands that parse)...  
    ...(r()) might be reset at this stage)...  
    ... commands that evaluate user-specified expressions...  
    // restore r()
    _return restore ‘myr’
    tempvar touse  
    mark ‘touse’ ‘if’  
    tempvar v1 v2  
    generate double ‘v1’ = ‘exp1’ if ‘touse’  
    // ‘exp1’ specified by user  
    generate double ‘v2’ = ‘exp2’ if ‘touse’  
    // ‘exp2’ specified by user  
    ... (code to calculate final results)...
end

In the above example, we hold on to the contents of r() in ‘myr’ and then later bring them back.

Stored results

_return restore restores in r() those results that were stored in r() when _return hold was executed.

Also see

[P] return — Return stored results
Title

**return — Return stored results**

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### Description

Results of calculations are stored by many Stata commands so that they can be easily accessed and substituted into subsequent commands. This entry summarizes for programmers how to store results. If your interest is in using previously stored results, see [R] **Stored results**.

- `return` stores results in `r()`.  
- `ereturn` stores results in `e()`.  
- `sreturn` stores results in `s()`.

Stata also has the values of system parameters and certain constants such as pi stored in `c()`. Because these values may be referred to but not assigned, the c-class is discussed in a different entry; see [P] **creturn**.

### Syntax

*Return results for general commands, stored in r()*

- `return list [, all]`
- `return clear`
- `return scalar name = exp`
- `return local name = exp`
- `return local name ["]string["]`
- `return matrix name [=] matname [, copy]`
- `return add`
Return results for estimation commands, stored in e()

```
ereturn list [, all]
ereturn clear
ereturn post b V Cns] [weight] [, depname(string) obs(#) dof(#)
esample(varname) properties(string)]
ereturn scalar name = exp
ereturn local name = exp
ereturn local name ["string"]
ereturn matrix name [=] matname [, copy]
ereturn repost b = b V = V Cns = Cns] [weight] [, esample(varname)
properties(string) rename]
```

Return results for parsing commands, stored in s()

```
sreturn list
sreturn clear
sreturn local name = exp
sreturn local name ["string"]
```

where b, V, and Cns are *matnames*, which is the name of an existing matrix.

fweights, aweights, iweights, and pweights are allowed; see [U] 11.1.6 weight.

Options

all is for use with return list and ereturn list. all specifies that hidden and historical stored results be listed along with the usual stored results. This option is seldom used. See Using hidden and historical stored results and Programming hidden and historical stored results in Remarks and examples for more information. These sections are written in terms of return list, but everything said there applies equally to ereturn list.

all is not allowed with sreturn list because s() does not allow hidden or historical results.

copy specified with return matrix or ereturn matrix indicates that the matrix is to be copied; that is, the original matrix should be left in place. The default is to “steal” or “rename” the existing matrix, which is fast and conserves memory.

depname(string) is for use with ereturn post. It supplies the name of the dependent variable to appear in the estimation output. The name specified need not be the name of an existing variable.
obs(\#) is for use with \texttt{ereturn post}. It specifies the number of observations on which the estimation was performed. This number is stored in \texttt{e(N)}, and \texttt{obs()} is provided simply for convenience. Results are no different from those for \texttt{ereturn post} followed by \texttt{ereturn scalar N = \#}.

dof(\#) is for use with \texttt{ereturn post}. It specifies the number of denominator degrees of freedom to be used with \texttt{t} and \texttt{F} statistics and so is used in calculating \textit{p}-values and confidence intervals. The number specified is stored in \texttt{e(df\_r)}, and \texttt{dof()} is provided simply for convenience. Results are no different from those for \texttt{ereturn post} followed by \texttt{ereturn scalar df\_r = \#}.

\texttt{esample(varname)} is for use with \texttt{ereturn post} and \texttt{ereturn repost}. It specifies the name of a 0/1 variable that is to become the \texttt{e(sample)} function. \texttt{varname} must contain 0 and 1 values only, with 1 indicating that the observation is in the estimation subsample. \texttt{ereturn post} and \texttt{ereturn repost} will be able to execute a little more quickly if \texttt{varname} is stored as a byte variable.

\texttt{varname} is dropped from the dataset, or more correctly, it is stolen and stashed in a secret place.

\texttt{properties(string)} specified with \texttt{ereturn post} or \texttt{ereturn repost} sets the \texttt{e(properties)} macro. By default, \texttt{e(properties)} is set to \texttt{b V} if \texttt{properties()} is not specified.

\texttt{rename} is for use with the \texttt{b = b} syntax of \texttt{ereturn repost}. All numeric estimation results remain unchanged, but the labels of \texttt{b} are substituted for the variable and equation names of the already posted results.

\section*{Remarks and examples}

Remarks are presented under the following headings:

\texttt{Introduction}
\texttt{Storing results in r()}
\texttt{Storing results in e()}
\texttt{Storing results in s()}
\texttt{Recommended names for stored results}
\texttt{Using hidden and historical stored results}
\texttt{Programming hidden and historical stored results}

\section*{Introduction}

This entry summarizes information that is presented in greater detail in other parts of the Stata documentation. Most particularly, we recommend that you read \texttt{[U 18 Programming Stata]}. The commands listed above are used by programmers to store results, which are accessed by others using \texttt{r()}, \texttt{e()}, and \texttt{s()}; see \texttt{[R Stored results]}

The commands listed above may be used only in programs—see \texttt{[U 18 Programming Stata]} and \texttt{[P program]}—and then only when the program is declared explicitly as being \texttt{rclass}, \texttt{eclass}, or \texttt{sclass}:

\begin{verbatim}
program ..., rclass
  ...
  return ...
  ...
end

program ..., eclass
  ...
  ereturn ...
  ...
end
\end{verbatim}
Storing results in \texttt{r()}

- The program must be declared explicitly to be \texttt{r-class}: \texttt{program ...}, \texttt{rclass}.
- Distinguish between \texttt{r()} (returned results) and \texttt{return()} (results being assembled that will be returned). The program you write actually stores results in \texttt{return()}. Then when your program completes, whatever is in \texttt{return()} is copied to \texttt{r()}. Thus the program you write can consume \texttt{r()} results from other programs, and there is no conflict.
- \texttt{return clear} clears the \texttt{return()} class. This command is seldom used because \texttt{return()} starts out empty when your program begins. \texttt{return clear} is for those instances when you have started assembling results and all is going well, but given the problem at hand, you need to start all over again.
- \texttt{return scalar name = exp} evaluates \texttt{exp} and stores the result in the scalar \texttt{return(name)}. \texttt{exp} must evaluate to a numeric result or missing. If your code has previously stored something in \texttt{return(name)}, whether a scalar, matrix, or whatever else, the previous value is discarded and this result replaces it.
- \texttt{return local name = exp} evaluates \texttt{exp} and stores the result in the macro \texttt{return(name)}. \texttt{exp} may evaluate to a numeric or string result. If your code has previously stored something in \texttt{return(name)}, whether a scalar, matrix, or whatever else, the previous value is discarded and this result replaces it.

Be careful with this syntax: do not code

\begin{verbatim}
  return local name = 'mymacro'
\end{verbatim}

because that will copy just the first 2045 characters of \texttt{'mymacro'}. Instead, code

\begin{verbatim}
  return local name = "'mymacro'"
\end{verbatim}

- \texttt{return local name string} copies \texttt{string} to macro \texttt{return(name)}. If your code has previously stored something in \texttt{return(name)}, whether a scalar, matrix, or whatever else, the previous value is discarded and this result replaces it.

If you do not enclose \texttt{string} in double quotes, multiple blanks in \texttt{string} are compressed into single blanks.
- \texttt{return matrix name matname} destructively copies \texttt{matname} into matrix \texttt{return(name)}, meaning that \texttt{matname} is erased (\texttt{matname} is renamed \texttt{return(name)}). If your code has previously stored something in \texttt{return(name)}, whether a scalar, matrix, or whatever else, the previous value is discarded and this result replaces it.
- \texttt{return add} copies everything new in \texttt{r()} into \texttt{return()}. Say that your program performed a \texttt{summarize}. \texttt{return add} lets you add everything just returned by \texttt{summarize} to the to-be-returned results of your program. If your program had already set \texttt{return(N)}, \texttt{summarize}'s \texttt{r(N)} would not replace the previously set result. The remaining \texttt{r()} results set by \texttt{summarize} would be copied.
Storing results in e()

For detailed guidance on storing in e(), see [P] ereturn. What follows is a summary.

- The program must be declared explicitly to be e-class: `program ... , eclass`.
- The e-class is cleared whenever an `ereturn post` is executed. The e-class is a static, single-level class, meaning that results are posted to the class the instant that they are stored.
- `ereturn clear` clears e(). This is a rarely used command.
- `ereturn post` is how you must begin storing results in e(). Because `ereturn post` clears e(), anything stored in e() prior to the `ereturn post` is lost.
- `ereturn post` stores matrix (vector, really) e(b), matrices e(V) and e(Cns), weight-related macros e(wtype) and e(wexp), and function e(sample). The most common syntax is
  ```plaintext
  ereturn post 'b' 'V', esample('touse') ...
  ```
  where ‘b’ is a row vector containing the parameter estimates, ‘V’ is a symmetric matrix containing the variance estimates, and ‘touse’ is a 0/1 variable recording 1 in observations that appear in the estimation subsample.

The result of this command will be that ‘b’, ‘V’, and ‘touse’ all disappear. In fact, `ereturn post` examines what you specify and, if it is satisfied with them, renames them e(b), e(V), and e(sample).

For more advanced usage that also posts constraint and weight information, see [P] ereturn.

In terms of `ereturn post`’s other options,

a. We recommend that you specify `depname(string)` if there is one dependent variable name that you want to appear on the output. Whether you specify `depname()` or not, remember later to define macro `e(depvar)` to contain the names of the dependent variables.

b. Specify `obs(#)` or remember later to define scalar e(N) to contain the number of observations.

c. Few models require specifying `dof(#)` or, if that is not done, remembering to later define scalar e(df_r). This all has to do with substituting t and F statistics on the basis of # (denominator) degrees of freedom for asymptotic z and χ² statistics in the estimation output.

- `ereturn scalar name = exp` evaluates exp and stores the result in the scalar e(name). exp must evaluate to a numeric result or missing. If your code has previously stored something in e(name), whether that be a scalar, matrix, or whatever else, the previous value is discarded and this result replaces it.

- `ereturn local name = exp` evaluates exp and stores the result in the macro e(name). exp may evaluate to a numeric or string result. If your code has previously stored something in e(name), whether that be a scalar, matrix, or whatever else, the previous value is discarded and this result replaces it.

Be careful with this syntax: do not code
```plaintext
ereturn local name = ‘mymacro’
```
because that will copy just the first 2045 characters of ‘mymacro’. Instead, code
```plaintext
ereturn local name = "‘mymacro’"
```
- `ereturn local name string` copies string to macro e(name). If your code has previously stored something in e(name), whether a scalar, matrix, or whatever else, the previous value is discarded and this result replaces it.
If you do not enclose *string* in double quotes, multiple blanks in *string* are compressed into single blanks.

- *ereturn matrix name* = *matname* destructively copies *matname* into matrix *e(name)*, meaning that *matname* is erased. At least, that is what happens if you do not specify the copy option. What actually occurs is that *matname* is renamed *e(name)*. If your code has previously stored something in *e(name)*, whether a scalar, matrix, or whatever else, the previous value is discarded and this result replaces it, with two exceptions:

  *ereturn matrix* cannot be used to store in *e(b)* or *e(V)*. The only way to post matrices to these special names is to use *ereturn post* and *ereturn repost* so that various tests can be run on them before they are made official. Other Stata commands use *e(b)* and *e(V)* and expect to see a valid estimation result. If *e(b)* is $1 \times k$, they expect *e(V)* to be $k \times k$. They expect that the names of rows and columns will be the same so that the $i$th column of *e(b)* corresponds to the $i$th row and column of *e(V)*. They expect *e(V)* to be symmetric. They expect *e(V)* to have positive or zero elements along its diagonal, and so on. *ereturn post* and *ereturn repost* check these assumptions.

- *ereturn repost* allows changing *e(b)*, *e(V)*, *e(Cns)*, *e(wtype)*, *e(wexp)*, *e(properties)*, and *e(sample)* without clearing the estimation results and starting all over again. As with *ereturn post*, specified matrices and variables disappear after reposting because they are renamed *e(b)*, *e(V)*, *e(Cns)*, or *e(sample)* as appropriate.

- Programmers posting estimation results should remember to store
  a. Macro *e(cmd)*, containing the name of the estimation command. Make this the last thing you store in *e(*)
  b. Macro *e(cmdline)*, containing the command the user typed.
  c. Macro *e(depvar)*, containing the names of the dependent variables.
  d. Scalar *e(N)*, containing the number of observations.
  e. Scalar *e(df_m)*, containing the model degrees of freedom.
  f. Scalar *e(df_r)*, containing the denominator degrees of freedom if estimates are nonasymptotic; otherwise, do not define this result.
  g. Scalar *e(ll)*, containing the log-likelihood value, if relevant.
  h. Scalar *e(ll_0)*, containing the log-likelihood value for the constant-only model, if relevant.
  i. Scalar *e(chi2)*, containing the $\chi^2$ test of the model against the constant-only model, if relevant.
  j. Macro *e(chi2type)*, containing LR, Wald, or other, depending on how *e(chi2)* was obtained.
  k. Scalar *e(r2)*, containing the value of the $R^2$ if it is calculated.
  l. Scalar *e(r2_p)*, containing the value of the pseudo-$R^2$ if it is calculated.
  m. Macro *e(vce)*, containing the name of the *vcetype* that was specified in the *vce()* option; see [R] *vce_option*.
  n. Macro *e(vcetype)*, containing the text to appear above standard errors in estimation output, typically *Robust*, or it is undefined.
  o. Macro *e(clustvar)*, containing the name of the cluster variable, if any.
  p. Scalar *e(N_clust)*, containing the number of clusters.
  q. Scalar *e(rank)*, containing the rank of *e(V)*.
  r. Macro *e(predict)*, containing the name of the command that *predict* is to use; if this is blank, *predict* uses the default _predict.
s. Macro \texttt{e(estat\_cmd)}, containing the name of an \texttt{estat} handler program if you wish to customize the behavior of \texttt{estat}.

\par t. Macro \texttt{e(properties)}, containing properties of the estimation command, typically \texttt{\textbf{b} V}, indicating that the command produces a legitimate coefficient vector and \texttt{VCE} matrix.

**Storing results in \texttt{s()**}

- The program must be declared explicitly to be \texttt{s-class}: \texttt{program \ldots, sclass.}
- The \texttt{s-class} is not cleared automatically. It is a static, single-level class. Results are posted to \texttt{s()} the instant they are stored.
- \texttt{sreturn clear} clears \texttt{s()}. We recommend that you use this command near the top of \texttt{s-class} routines. \texttt{sreturn clear} may be used in non-\texttt{s-class} programs, too.
- The \texttt{s-class} provides macros only and is intended for returning results of subroutines that parse input. At the parsing step, it is important that the \texttt{r-class} not be changed or cleared because some of what still awaits being parsed might refer to \texttt{r()} and the user expects those results to substitute according to what was in \texttt{r()} when he or she typed the command.
- \texttt{sreturn local name = exp} evaluates \texttt{exp} and stores the result in the macro \texttt{s(name)}. \texttt{exp} may evaluate to a numeric or string result. If your code has previously stored something else in \texttt{s(name)}, the previous value is discarded and this result replaces it.

Be careful with this syntax: do not code

\begin{verbatim}
   sreturn local name = 'mymacro'
\end{verbatim}

because that will copy just the first 2045 characters of ‘\texttt{mymacro}’. Instead, code

\begin{verbatim}
   sreturn local name = "'mymacro'",
\end{verbatim}

- \texttt{sreturn local name string} copies \texttt{string} to macro \texttt{s(name)}. If your code has previously stored something else in \texttt{s(name)}, the previous value is discarded and this result replaces it.

If you do not enclose \texttt{string} in double quotes, multiple blanks in \texttt{string} are compressed into single blanks.

**Recommended names for stored results**

Users will appreciate it if you use predictable names for your stored results. We use these rules:

- Mathematical and statistical concepts such as number of observations and degrees of freedom are given short mathematical-style names. Subscripting is indicated with ‘.’. Names are to proceed from the general to the specific. If \texttt{N} means number of observations, \texttt{N\_1} might be the number of observations in the first group.

Suffixes are to be avoided where possible. For instance, a $\chi^2$ statistic would be recorded in a variable starting with \texttt{ch12}. If, in the context of the command, a statement about “the $\chi^2$ statistic” would be understood as referring to this statistic, then the name would be \texttt{ch12}. If it required further modification, such as $\chi^2$ for the comparison test, then the name might be \texttt{ch12\_c}.
Common prefixes are

- \( N \) number of observations
- \( df \) degrees of freedom
- \( k \) count of parameters
- \( n \) generic count
- \( 1b \) and \( ub \) lower and upper bound of confidence interval
- \( \chi^2 \) statistic
- \( t \) \( t \) statistic
- \( F \) \( F \) statistic
- \( p \) \( p \)-values
- \( p \) and \( pr \) probability
- \( ll \) log likelihood
- \( D \) deviance
- \( R^2 \)

- Programming concepts, such as lists of variable names, are given English-style names. Names should proceed from the specific to the general. The name of the dependent variable is \texttt{depvar}, not \texttt{vardep}.

Some examples are

- \texttt{depvar} dependent variable names
- \texttt{eqnames} equation names
- \texttt{model} name of model fit
- \texttt{xvar} \( x \) variable
- \texttt{title} title used

- Popular usage takes precedence over the rules. For example:
  a. \texttt{mss} is model sum of squares, even though, per the first rule of this section, it ought to be \texttt{ss_m}.
  b. \texttt{mean} is used as the prefix to record means.
  c. \texttt{Var} is used as the prefix to mean variance.
  d. The returned results from most Stata commands follow this rule.

**Using hidden and historical stored results**

Most results stored in \texttt{r()} and \texttt{e()} are visible—type \texttt{return list}. Sometimes, other stored results exist, too. For instance, consider the Stata command \texttt{summarize}. Let’s pretend that in addition to everything that \texttt{summarize} stores in \texttt{r()}—you know about \texttt{r(N)}, \texttt{r(mean)}, \texttt{r(sd)}, etc.—\texttt{summarize} also stores \texttt{r(secret)} and \texttt{r(sigma)}. \texttt{summarize} does not do this, but pretend that it did. If \texttt{summarize} stored \texttt{r(secret)} as hidden and \texttt{r(sigma)} as historical, you would not know they existed from the output of \texttt{return list} unless you typed \texttt{return list, all}. If you typed that command, you would discover \texttt{r(secret)} and \texttt{r(sigma)}, and you might learn from the output that \texttt{r(secret)} was hidden whereas \texttt{r(sigma)} was historical. The output is trying to tell you 1) the two stored results exist, 2) you may use them just as you use any other stored result, and 3) the reason why the two stored results were not listed by default.

There are two reasons why \texttt{summarize} might not store results so that you can see them when you type \texttt{return list}.

The first reason is that \texttt{summarize} is designed to work tightly with some other Stata subroutine and is using \texttt{r()} to pass complicated information. The information that is stored is so arcane that you would not want to read documentation about it. Stata puts such stored results into the hidden category where you will not see them by default. If you type \texttt{return list, all} and find hidden
stored results, we recommend that you do not use their contents in your own do- and ado-files. Because hidden stored results are not documented, their names, contents, and even their existence could change in future releases.

The other reason `summarize` might omit a stored result from `return list` concerns backward compatibility. Assume that for Stata 4, `summarize` stored the standard deviation in `r(sigma)` instead of `r(sd)`. Assume that the editors at StataCorp decided later that `r(sd)` would be a better name. The programmers at StataCorp could not simply change the name from `r(sigma)` to `r(sd)`, because users might have already written do- or ado-files before the change. Changing the name could break old do- and ado-files, and it is a hallmark of Stata that your code will continue to work regardless of how long ago users wrote it. Thus the programmers at StataCorp could choose to store the standard deviation in both `r(sigma)` and `r(sd)` in all cases, or they could store the standard deviation in `r(sd)` and store it in `r(sigma)` only when the old do- or ado-file explicitly included a version 4 or earlier statement. Either way, `r(sigma)` is of no interest to modern Stata users, and so the programmers mark `r(sigma)` as historical. Now when you type `return list`, you will not see `r(sigma)` mentioned; and when you type `return list, all`, you will see `r(sigma)` listed, and you are told that it was not mentioned earlier because it is marked as historical.

Typing `return list, all` can be useful when you are debugging or adding new features to an old program and want to see the historical stored results to better understand your old program.

What was just said about `r()` and `return list` applies equally to `e()` and `ereturn list`, and it applies equally to community-contributed additions to Stata and to official Stata commands. That’s the story of all.

Programmers wishing to exploit the hidden and historical markings in their own programs should see the next section.

---

**Programming hidden and historical stored results**

You can mark stored results as hidden or historical by specifying the optional `hcat` argument with the appropriate `return` or `ereturn` command:

```
return [hcat] scalar name = exp
return [hcat] local name = exp
return [hcat] local name ["]string["
return [hcat] matrix name [=] matname [, copy]
```

```
ereturn [hcat] scalar name = exp
ereturn [hcat] local name = exp
ereturn [hcat] local name ["]string["
ereturn [hcat] matrix name [=] matname [, copy]
```

`hcat` specifies the hiddenness of the result and may be

```
visible
hidden
historical[(relno)]
```

where `relno` is `#` `[. [# [#]]]` such as 2, 10, 10., 10.1, or 10.12. `visible` is the default when `hcat` is not specified.
Thus if you are writing an r-class command and wish to store \texttt{r(private)} as a hidden scalar, you can code
\begin{verbatim}
return hidden scalar private = ...
\end{verbatim}
If you wish to store \texttt{r(lastvar)} as a hidden local, you can code
\begin{verbatim}
return hidden local lastvar "..."
\end{verbatim}
If you wanted \texttt{r(lastvar)} to be historical rather than hidden, you would code
\begin{verbatim}
return historical local lastvar "..."
\end{verbatim}
If you wanted \texttt{r(lastvar)} to be historical as of Stata 17, meaning that \texttt{r(lastvar)} was current up to but not including Stata 17, you would code
\begin{verbatim}
return historical(17) local lastvar "..."
\end{verbatim}
If you wish to create \texttt{r(X)} as a hidden matrix, you can code
\begin{verbatim}
return hidden matrix X = ...
\end{verbatim}
All the above examples could be performed using \texttt{ereturn} instead of \texttt{return}. They could not be performed using \texttt{sreturn} because \texttt{s()} does not allow hidden or historical results.

The Mata commands for setting \texttt{r()} and \texttt{e()} also allow an optional argument to set \texttt{hecat}; see \cite{M-5} \texttt{st_numscalar()}, \cite{M-5} \texttt{st_global()}, and \cite{M-5} \texttt{st_matrix()}.

Reference


Also see

\begin{itemize}
\item \texttt{P} \texttt{cretreturn} — Return c-class values
\item \texttt{P} \texttt{ereturn} — Post the estimation results
\item \texttt{P} \texttt{_estimates} — Manage estimation results
\item \texttt{P} \texttt{_return} — Preserve stored results
\item \texttt{RPT} \texttt{putexcel} — Export results to an Excel file
\item \texttt{R} \texttt{Stored results} — Stored results
\item \texttt{U} 18 Programming Stata
\item \texttt{U} 18.10 Storing results
\end{itemize}
Title

_rmcoll — Remove collinear variables

Description

_rmcoll returns in r(varlist) an updated version of varlist that is specific to the sample identified by if, in, and any missing values in varlist. _rmcoll flags variables that are to be omitted because of collinearity. If varlist contains factor variables, then _rmcoll also enumerates the levels of factor variables, identifies the base levels of factor variables, and identifies empty cells in interactions.

The following message is displayed for each variable that _rmcoll flags as omitted because of collinearity:

    note: ______ omitted because of collinearity

The following message is displayed for each empty cell of an interaction that _rmcoll encounters:

    note: ______ identifies no observations in the sample

_ml users: it is not necessary to call _rmcoll because _ml flags collinear variables for you, assuming that you do not specify _ml model’s collinear option. Even so, _ml programmers sometimes use _rmcoll because they need the sample-specific set of variables, and in such cases, they specify _ml model’s collinear option so that _ml does not waste time looking for collinearity again. See [R] _ml.

_rmdcoll performs the same task as _rmcoll and checks that depvar is not collinear with the variables in indepvars. If depvar is collinear with any of the variables in indepvars, then _rmdcoll reports the following message with the 459 error code:

    ______ collinear with ______

Syntax

Identify variables to be omitted because of collinearity

    _rmcoll varlist [if] [in] [weight] [, noconstant collinear expand forcedrop]

Identify independent variables to be omitted because of collinearity

    _rmdcoll depvar indepvars [if] [in] [weight] [, noconstant collinear expand normcoll]

varlist and indepvars may contain factor variables; see [U] 11.4.3 Factor variables.
varlist, depvar, and indepvars may contain time-series operators; see [U] 11.4.4 Time-series varlists.
collect is allowed with _rmcoll and _rmdcoll; see [U] 11.1.10 Prefix commands.
fweights, aweights, iweights, and pweights are allowed; see [U] 11.1.6 weight.
Options

noconstant specifies that, in looking for collinearity, an intercept not be included. That is, a variable that contains the same nonzero value in every observation should not be considered collinear.

collinear specifies that collinear variables not be flagged.

expand specifies that the expanded, level-specific variables be posted to r(varlist). This option will have an effect only if there are factor variables in the variable list.

forcedrop specifies that collinear variables be omitted from the variable list instead of being flagged. This option is not allowed when the variable list already contains flagged variables, factor variables, or interactions.

normcoll specifies that collinear variables have already been flagged in indepvars. Otherwise, _rmcoll is called first to flag any such collinearity.

Remarks and examples

_rmcoll and _rmdcoll are typically used when writing estimation commands.

_rmcoll is used if the programmer wants to flag the collinear variables from the independent variables.

_rmdcoll is used if the programmer wants to detect collinearity of the dependent variable with the independent variables.

Example 1: Flagging variables because of collinearity

Let’s load auto.dta and add a variable called tt that is collinear with variables turn and trunk. The easiest way to do this is to generate tt as the sum of turn and trunk.

. use https://www.stata-press.com/data/r17/auto
   (1978 automobile data)
. generate tt = turn + trunk

Now we can use _rmcoll to identify that we have a collinearity and flag a variable because of it.

. _rmcoll turn trunk tt
   note: tt omitted because of collinearity.
. display r(varlist)
   turn trunk o.tt

_rmcoll reported that tt was being flagged because of collinearity and attached the omit operator to tt resulting in “o.tt” being returned in r(varlist).

Example 2: Factor variables

_rmcoll works with factor variables. Let’s pass rep78 as a factor variable to _rmcoll.

. _rmcoll i.rep78
. display r(varlist)
i(1 2 3 4 5)b1.rep78
The updated variable list now contains the enumerated levels of `rep78` and identifies its base level. Use the `expand` option if you want to be able to loop over the level-specific, individual variables in `r(varlist)`.

```
._rmcoll i.rep78, expand
display r(varlist)
1b.rep78 2.rep78 3.rep78 4.rep78 5.rep78
```

### Example 3: Interactions

`_rmcoll` works with interactions and reports when it encounters empty cells. An empty cell is a combination of factor levels that does not occur in the dataset. Let’s use the `table` command with factor variables `rep78` and `foreign` to see that there are two empty cells:

```
table rep78 foreign, nototals

<table>
<thead>
<tr>
<th>Repair record 1978</th>
<th>Domestic</th>
<th>Foreign</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>27</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>9</td>
</tr>
</tbody>
</table>
```

Now let’s pass the interaction of factor variables `rep78` and `foreign` to `_rmcoll`.

```
._rmcoll rep78#foreign
note: 1.rep78#1.foreign identifies no observations in the sample.
note: 2.rep78#1.foreign identifies no observations in the sample.
display r(varlist)
1b.rep78#0b.foreign 1b.rep78#1o.foreign 2.rep78#0b.foreign 2o.rep78#1o.foreign
> 3.rep78#0b.foreign 3.rep78#1.foreign 4.rep78#0b.foreign 4.rep78#1.foreign
> 5.rep78#0b.foreign 5.rep78#1.foreign
```

### Example 4: Coding fragment for standard variables

A code fragment for a program that uses `_rmcoll` might read

```
syntax varlist [fweight iweight] ... [, noCONSTant ... ]
marksample touse
if "weight" != "" {
    tempvar w
    quietly generate double 'w' = 'exp' if 'touse'
    local wgt ['weight'="w"]
}
else local wgt /* is nothing */
gettoken depvar xvars : varlist
_rmcoll 'xvars' 'wgt' if 'touse', 'constant'
local xvars 'r(varlist)' ...
```
In this code fragment, varlist contains one dependent variable and zero or more independent variables. The dependent variable is split off and stored in the local macro depvar. Then the remaining variables are passed through _rmcoll, and the resulting updated independent variable list is stored in the local macro xvars.

Example 5: Coding fragment for factor variables and time-series operators

Here we modified the above code fragment to allow for factor variables and time-series operators.

```stata
... syntax varlist(fv ts) [fweight iweight] ... [, noCONStant ... ]
marksample touse
if "'weight'" != "" {
    tempvar w
    quietly generate double 'w' = 'exp' if 'touse'
    local wgt ['weight'=w]
}
else    local wgt /* is nothing */
gettoken depvar xvars : varlist
_rmcoll 'xvars' 'wgt' if 'touse', expand 'constant'
local xvars 'r(varlist)'
...  
```

The varlist argument in the syntax command contains the fv specifier to allow factor variables and the ts specifier to allow time-series operators. We also added the expand option in case the remaining code needs to loop over the level-specific, individual variables in the xvars macro.

Stored results

_rmcoll and _rmdcoll store the following in r():

- Scalars
  - r(k_omitted) number of omitted variables in r(varlist)

- Macros
  - r(varlist) the flagged and expanded variable list

Also see

[R] ml — Maximum likelihood estimation
[U] 18 Programming Stata
**Description**

`set rmsg` determines whether the return message is to be displayed at the completion of each command. The initial setting is `off`. The return message shows how long the command took to execute and what time it completed execution.

**Syntax**

```stata
set rmsg {on | off} [, permanently ]
```

**Option**

`permanently` specifies that, in addition to making the change right now, the `rmsg` setting be remembered and become the default setting when you invoke Stata.

**Remarks and examples**

See [U] 8 Error messages and return codes for a description of return messages and for use of this command.

**Also see**

[P] `error` — Display generic error message and exit

[P] `timer` — Time sections of code by recording and reporting time spent

[R] `query` — Display system parameters

[U] 8 Error messages and return codes
_robust is a programmer’s command that computes a robust variance estimator based on `varlist` of equation-level scores and a covariance matrix. It produces estimators for ordinary data (each observation independent), clustered data (data not independent within groups, but independent across groups), and complex survey data from one stage of stratified cluster sampling.

_robust helps implement estimation commands and is rarely used. That is because other commands are implemented in terms of it and are easier and more convenient to use. For instance, if all you want to do is make your estimation command allow the `vce(robust)` and `vce(cluster clustvar)` options, see [R] ml. If you want to make your estimation command work with survey data, it is easier to make your command work with the `svy` prefix—see [P] program properties—rather than to use _robust.

If you really want to understand what `ml` and `svy` are doing, however, this is the section for you. Or if you have an estimation problem that does not fit with the `ml` or `svy` framework, then _robust may be able to help.

Syntax

```
_robust varlist [if] [in] [weight] [, variance(matname) minus(#)  
strata(varname) psu(varname) cluster(varname) fpc(varname)  
subpop(varname) vsrs(matname) srssubpop zeroweight ]
```

_robust works with models that have all types of varlists, including those with factor variables and time-series operators; see [U] 11.4.3 Factor variables and [U] 11.4.4 Time-series varlists.

`collect` is allowed; see [U] 11.1.10 Prefix commands.

`pweights`, `aweights`, `fweights`, and `iweights` are allowed; see [U] 11.1.6 weight.

Options

`variance(matname)` specifies a matrix containing the unadjusted “covariance” matrix, that is, the $D$ in $V = DMD$. The matrix must have its rows and columns labeled with the appropriate corresponding variable names, that is, the names of the $x$’s in $x\beta$. If there are multiple equations, the matrix must have equation names; see [P] matrix rownames. The $D$ matrix is overwritten with the robust covariance matrix $V$. If `variance()` is not specified, Stata assumes that $D$ has been posted using `ereturn post`; _robust will then automatically post the robust covariance matrix $V$ and replace $D$.

`minus(#)` specifies $k = #$ for the multiplier $n/(n - k)$ of the robust variance estimator. Stata’s maximum likelihood commands use $k = 1$, and so does the `svy` prefix. `regress`, `vce(robust)` uses, by default, this multiplier with $k$ equal to the number of explanatory variables in the model, including the constant. The default is `minus(1)`. See Methods and formulas for details.
strata(varname) specifies the name of a variable (numeric or string) that contains stratum identifiers.

psu(varname) specifies the name of a variable (numeric or string) that contains identifiers for the primary sampling unit (PSU). psu() and cluster() are synonyms; they both specify the same thing.

cluster(varname) is a synonym for psu().

fpc(varname) requests a finite population correction for the variance estimates. If the variable specified has values less than or equal to 1, it is interpreted as a stratum sampling rate \( f_h = n_h / N_h \), where \( n_h \) is the number of PSUs sampled from stratum \( h \) and \( N_h \) is the total number of PSUs in the population belonging to stratum \( h \). If the variable specified has values greater than 1, it is interpreted as containing \( N_h \).

subpop(varname) specifies that estimates be computed for the single subpopulation defined by the observations for which \( varname \neq 0 \) (and is not missing). This option would typically be used only with survey data; see [SVY] Subpopulation estimation.

vsrs(matname) creates a matrix containing \( \hat{V}_{srswor} \), an estimate of the variance that would have been observed had the data been collected using simple random sampling without replacement. This is used to compute design effects for survey data; see [SVY] estat for details.

srssubpop can be specified only if vsrs() and subpop() are specified. srssubpop requests that the estimate of simple-random-sampling variance, vsrs(), be computed assuming sampling within a subpopulation. If srssubpop is not specified, it is computed assuming sampling from the entire population.

zeroweight specifies whether observations with weights equal to zero should be omitted from the computation. This option does not apply to frequency weights; observations with zero frequency weights are always omitted. If zeroweight is specified, observations with zero weights are included in the computation. If zeroweight is not specified (the default), observations with zero weights are omitted. Including the observations with zero weights affects the computation in that it may change the counts of PSUs (clusters) per stratum. Stata’s svy prefix command includes observations with zero weights; all other commands exclude them. This option is typically used only with survey data.

### Remarks and examples

Remarks are presented under the following headings:

- Introduction
- Formulas and simple examples
- Clustered data
- Survey data
- Controlling the header display
- Maximum likelihood estimators
- Multiple-equation estimators

### Introduction

Before reading this section, you should be familiar with [U] 20.22 Obtaining robust variance estimates and the Methods and formulas section of [R] regress. We assume that you have already programmed an estimator in Stata and now wish to have it compute robust variance estimates. If you have not yet programmed your estimator, see [U] 18 Programming Stata, [R] ml, and [P] ereturn.
The robust variance estimator goes by many names: Huber/White/sandwich are typically used in the context of robustness against heteroskedasticity. Survey statisticians often refer to this variance calculation as a first-order Taylor-series linearization method. Despite the different names, the estimator is the same.

The equation-level score variables (varlist) consist of one variable for single-equation models or multiple variables for multiple-equation models, one variable for each equation. The “covariance” matrix before adjustment is either posted using ereturn post (see [P] ereturn) or specified with the variance(matname) option. In the former case, _robust replaces the covariance in the post with the robust covariance matrix. In the latter case, the matrix matname is overwritten with the robust covariance matrix.

If you wish to program an estimator for survey data, then you should write the estimator for nonsurvey data first and then use the instructions in [P] program properties (making programs svyable) to get your estimation command to work properly with the svy prefix. See [SVY] Variance estimation for a discussion of variance estimation for survey data.

Formulas and simple examples

This section explains the formulas behind the robust variance estimator and how to use _robust through an informal development with some simple examples. For an alternative discussion, see [U] 20.22 Obtaining robust variance estimates. See the references cited at the end of this entry for more formal expositions.

First, consider ordinary least-squares regression. The estimator for the coefficients is

$$\hat{\beta} = (X'X)^{-1}X'y$$

where y is an \( n \times 1 \) vector representing the dependent variable and X is an \( n \times k \) matrix of covariates.

Because everything is considered conditional on X, \( (X'X)^{-1} \) can be regarded as a constant matrix. Hence, the variance of \( \hat{\beta} \) is

$$V(\hat{\beta}) = (X'X)^{-1}V(X'y)(X'X)^{-1}$$

What is the variance of \( X'y \), a \( k \times 1 \) vector? Look at its first element; it is

$$X'_1y = x_{11}y_1 + x_{21}y_2 + \cdots + x_{n1}y_n$$

where \( X_1 \) is the first column of X. Because X is treated as a constant, you can write the variance as

$$V(X'_1y) = x_{11}^2V(y_1) + x_{21}^2V(y_2) + \cdots + x_{n1}^2V(y_n)$$

The only assumption made here is that the \( y_j \) are independent.

The obvious estimate for \( V(y_j) \) is \( \hat{e}_j^2 \), the square of the residual \( \hat{e}_j = y_j - x_j\hat{\beta} \), where \( x_j \) is the \( j \)th row of X. You must estimate the off-diagonal terms of the covariance matrix for \( X'y \), as well. Working this out, you have

$$\hat{V}(X'y) = \sum_{j=1}^{n} \hat{e}_j^2 x'_j x_j$$

\( x_j \) is defined as a row vector so that \( x'_j x_j \) is a \( k \times k \) matrix.
You have just derived the robust variance estimator for linear regression coefficient estimates for independent observations:

\[
\hat{V}(\hat{\beta}) = (X'X)^{-1} \left( \sum_{j=1}^{n} \hat{e}_j^2 x'_j x_j \right) (X'X)^{-1}
\]

You can see why it is called the sandwich estimator.

Technical note

The only detail not discussed is the multiplier. You will see later that survey statisticians like to view the center of the sandwich as a variance estimator for totals. They use a multiplier of \(n/(n-1)\), just as \(1/(n-1)\) is used for the variance estimator of a mean. However, for survey data, \(n\) is no longer the total number of observations but is the number of clusters in a stratum. See Methods and formulas at the end of this entry.

Linear regression is, however, special. Assuming homoskedasticity and normality, you can derive the expectation of \(\hat{e}_j^2\) for finite \(n\). This is discussed in [R] regress. Under the assumptions of homoskedasticity and normality, \(n/(n-k)\) is a better multiplier than \(n/(n-1)\).

If you specify the minus(#) option, _robust will use \(n/(n-\#)\) as the multiplier. regress, vce(robust) also gives two other options for the multiplier: hc2 and hc3. Because these multipliers are special to linear regression, _robust does not compute them.

Example 1

Before we show how _robust is used, let’s compute the robust variance estimator “by hand” for linear regression for the case in which observations are independent (that is, no clusters).

We need to compute \(D = (X'X)^{-1}\) and the residuals \(\hat{e}_j\). regress with the mse1 option will allow us to compute both easily; see [R] regress.

```
. use https://www.stata-press.com/data/r17/_robust
(1978 automobile data, modified)
. regress mpg weight gear_ratio foreign, mse1
(output omitted)
. matrix D = e(V)
. predict double e, residual
```

We can write the center of the sandwich as

\[
M = \sum_{j=1}^{n} \hat{e}_j^2 x'_j x_j = X'WX
\]

where \(W\) is a diagonal matrix with \(\hat{e}_j^2\) on the diagonal. \texttt{matrix accum} with \texttt{iweights} can be used to calculate this (see [P] \texttt{matrix accum}):

```
. matrix accum M = weight gear_ratio foreign [iweight=e^2]
(obs=813.7814109)
```
We now assemble the sandwich. To match `regress, vce(robust)`, we use a multiplier of \( n/(n-k) \).

```
. matrix V = 74/70 * D*M*D
. matrix list V

```

```
symmetric V[4,4]
weight  gear_ratio  foreign  _cons
weight  3.788e-07
gear_ratio .00039798  1.9711317
foreign  .00008463 -.55488334  1.4266939
 _cons  -.00236851 -6.9153285  1.2149035  27.536291
```

The result is the same as that from `regress, vce(robust)`:

```
. regress mpg weight gear_ratio foreign, vce(robust)
(output omitted)
. matrix Vreg = e(V)
. matrix list Vreg

```

```
symmetric Vreg[4,4]
weight  gear_ratio  foreign  _cons
weight  3.788e-07
gear_ratio .00039798  1.9711317
foreign  .00008463 -.55488334  1.4266939
 _cons  -.00236851 -6.9153285  1.2149035  27.536291
```

If we use `_robust`, the initial steps are the same. We still need \( D \), the “bread” of the sandwich, and the residuals. The residuals \( e \) are the varlist for `_robust`. \( D \) is overwritten and contains the robust variance estimate.

```
. drop e
. regress mpg weight gear_ratio foreign, mse1
(output omitted)
. matrix D = e(V)
. predict double e, residual
. _robust e, v(D) minus(4)
. matrix list D

```

```
symmetric D[4,4]
weight  gear_ratio  foreign  _cons
weight  3.788e-07
gear_ratio .00039798  1.9711317
foreign  .00008463 -.55488334  1.4266939
 _cons  -.00236851 -6.9153285  1.2149035  27.536291
```

Rather than specifying the `variance()` option, we can use `ereturn post` to post \( D \) and the point estimates. `_robust` alters the post, substituting the robust variance estimates.

```
. drop e
. regress mpg weight gear_ratio foreign, mse1
(output omitted)
. matrix D = e(V)
. matrix b = e(b)
. local n = e(N)
. local k = colsof(D)
. local dof = `n' - `k'
. predict double e, residual
. ereturn post b D, dof(`dof')
. _robust e, minus(`k')
```
. ereturn display

|                | Robust Coefficient | std. err. | t     | P>|t|  | [95% conf. interval] |
|----------------|---------------------|-----------|-------|-------|----------------------|
| weight         | -.006139            | .0006155  | -9.97 | 0.000 | -.0073666            | -.0049115           |
| gear_ratio     | 1.457113            | 1.40397   | 1.04  | 0.303 | -1.343016            | 4.257243            |
| foreign        | -2.221682           | 1.194443  | -1.86 | 0.067 | -4.603923            | .1605598            |
| _cons          | 36.10135            | 5.247503  | 6.88  | 0.000 | 25.63554             | 46.56717            |

Again what we did matches `regress, vce(robust)`:  

```
. regress mpg weight gear_ratio foreign, vce(robust)
```

Technical note

Note the simple ways in which `_robust` was called. When we used the `variance()` option, we called it by typing

```
._robust e, v(D) minus(4)
```

As we described, `_robust` computed

\[
\hat{V}(\hat{\beta}) = D \left( \frac{n}{n-k} \sum_{j=1}^{n} \hat{e}_j^2 x'_j x_j \right) D
\]

We passed \( D \) to `_robust` by using the `v(D)` option and specified \( \hat{e}_j \) as the variable `e`. So how did `_robust` know what variables to use for \( x_j \)? It got them from the row and column names of the matrix \( D \). Recall how we generated \( D \) initially:

```
. regress mpg weight gear_ratio foreign, mse1
(output omitted)
.matrix D = e(V)
matrix list D
.symmetric D[4,4]
   weight gear_ratio foreign _cons
   weight 5.436e-08
   gear_ratio .00006295 .20434146
   foreign .00001032 -.08016692 .1311889
   _cons -.00035697 -.782292 .1715426 .3.3988878
```


Stata's estimation commands and the \texttt{ml} commands produce matrices with appropriately labeled rows and columns. If that is how we generate our \texttt{D}, this will be taken care of automatically. But if we generate \texttt{D} in another manner, we must be sure to label it appropriately; see \cite{matrix rownames}. When \texttt{_robust} is used after \texttt{ereturn post}, it gets the variable names from the row and column names of the posted matrices. So again, the matrices must be labeled appropriately.

Let us make another rather obvious comment. \texttt{_robust} uses the variables from the row and column names of the \texttt{D} matrix at the time \texttt{_robust} is called. It is the programmer's responsibility to ensure that the data in these variables have not changed and that \texttt{_robust} selects the appropriate observations for the computation, using an \texttt{if} restriction if necessary (for instance, \texttt{if e(sample)}).

### Clustered data

#### Example 2

To get robust variance estimates for clustered data or for complex survey data, simply use the \texttt{cluster()}, \texttt{strata()}, etc., options when you call \texttt{_robust}.

The first steps are the same as before. For clustered data, the number of degrees of freedom of the \texttt{t} statistic is the number of clusters minus one (we will discuss this later).

```stata
. drop e
. quietly regress mpg weight gear_ratio foreign, msel
. generate byte samp = e(sample)
. matrix D = e(V)
. matrix b = e(b)
. predict double e, residual
. local k = colsof(D)
. tabulate rep78

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>2.90</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>8</td>
<td>11.59</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>30</td>
<td>43.48</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>18</td>
<td>26.09</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>11</td>
<td>15.94</td>
</tr>
</tbody>
</table>

| Total            | 69    | 100.00 |
```

```stata
. local nclust = r(r)
. display 'nclust'
5
. local dof = 'nclust' - 1
. ereturn post b D, dof('dof') esample(samp)
. _robust e, minus('k') cluster(rep78)
```
What you get is, of course, the same as `regress, vce(cluster rep78)`. Wait a minute. It is not the same!

```
. regress mpg weight gear_ratio foreign, vce(cluster rep78)
```

Not even the point estimates are the same. This is the classic programmer’s mistake of not using the same sample for the initial `regress, mse1` call as done with `_robust`. The cluster variable `rep78` is missing for 5 observations. `_robust` omitted these observations, but `regress, mse1` did not.

`_robust` is best used only in programs for just this reason. Thus you can write a program and use `marksample` and `markout` (see [P] mark) to determine the sample in advance of running `regress` and `_robust`. 
program myreg, eclass sortpreserve
    version 17.0
    syntax varlist [if] [in] [, Cluster(varname) ]
    marksample touse
    markout 'touse' 'cluster', strok
    tempvar e count
tempname D b
quietly {
    regress 'varlist' if 'touse', mse1
    matrix 'D' = e(V)
    matrix 'b' = e(b)
    local n = e(N)
    local k = colsof('D')
predict double 'e' if 'touse', residual
    if "'cluster'"!="" {
        sort 'touse' 'cluster'
        by 'touse' 'cluster': gen byte 'count' = 1 if _n==1 & 'touse'
        summarize 'count', meanonly
        local nclust = r(sum)
        local dof = 'nclust' - 1
        local clopt "cluster('cluster')"
    } else local dof = 'n' - 'k'
ereturn post 'b' 'D', dof('dof') esample('touse')
    _robust 'e' if e(sample), minus('k') 'clopt'
}
ereturn display
end

Running this program produces the same results as regress, vce(cluster clustvar).

. myreg mpg weight gear_ratio foreign, cluster(rep78)
(Std. err. adjusted for 5 clusters in rep78)

|          | Robust Coefficient | std. err. | t    | P>|t|  | [95% conf. interval] |
|----------|-------------------|-----------|------|------|---------------------|
| weight   | -0.005893         | 0.0008214 | -7.17| 0.002| -0.0081735 -0.0036126|
| gear_ratio| 1.904503         | 2.18322   | 0.87 | 0.432| -4.157088 7.966093  |
| foreign  | -2.149017         | 1.20489   | -1.78| 0.149| -5.49433 1.196295  |
| _cons    | 34.09959          | 4.215275  | 8.09 | 0.001| 22.39611 45.80307  |
Survey data

Example 3

We will now modify our `myreg` command so that it handles complex survey data. Our new version will allow pweights and iweights, stratification, and clustering.

```stata
begin myreg.ado

program myreg, eclass
    version 17.0
    syntax varlist [if] [in] [pweight iweight] [, /*
        */ STRata(varname) CLuster(varname) ]
    marksample tous, zeroweight
    markout `touse' `cluster' `strata', strok
    if "`weight'"!="" {
        tempvar w
        quietly generate double `w' `exp' if `touse'
        local iwexp 
        if "`weight'" == "pweight" {
            capture assert `w' >= 0 if `touse'
            if c(rc) error 402
        }
    }
    if "`cluster'"!="" {
        local clopt "cluster(`cluster')"
    }
    if "`strata'"!="" {
        local stopt "strata(`strata')"
    }
    tempvar e
    tempname D b
    quietly {
        regress `varlist' `iwexp' if `touse', msel
        matrix `D' = e(V)
        matrix `b' = e(b)
        predict double `e' if `touse', residual
        _robust `e' `iwexp' if `touse', v(`D') `clopt' `stopt' zeroweight
        local dof = r(N_clust) - r(N_strata)
        local depn : word 1 of `varlist'
        ereturn post `b' `D', depn(`depn') dof(`dof') esample(`touse')
    }
    display
    ereturn display

end myreg.ado
```

Note the following details about our version of `myreg` for survey data:

- We called `_robust` before we posted the matrices with `ereturn post`, whereas in our previous version of `myreg`, we called `ereturn post` and then `_robust`. Here we called `_robust` first so that we could use its `r(N_strata)`, containing the number of strata, and `r(N_clust)`, containing the number of clusters; see Stored results at the end of this entry. We did this so that we could pass the correct degrees of freedom (= number of clusters − number of strata) to `ereturn post`. This works even if the `strata()` and `cluster()` options are not specified: `r(N_strata) = 1` if `strata()` is not specified (there truly is one stratum); and `r(N_clust) = number of observations` if `cluster()` is not specified (each observation is a cluster).

- The call to `_robust` was made with iweights, whether `myreg` was called with pweights or iweights. Computationally, `_robust` treats pweights and iweights the same. The only difference is that it puts out an error message if it encounters a negative pweight, whereas
negative _i_weights are allowed. As good programmers, we put out the error message early before any time-consuming computations are done.

- We used the _zeroweight option with the _marksample command so that zero weights would not be excluded from the sample. We gave the _zeroweight option with _robust so that it, too, would not exclude zero weights.

Observations with zero weights affect results only by their effect (if any) on the counts of the clusters. Setting some weights temporarily to zero will, for example, produce subpopulation estimates. If subpopulation estimates are desired, however, it would be better to implement _robust's _subpop() option and restrict the call to _regress, mse1 to this subpopulation.

- Stata's _svyset accepts a _psu variable rather than having a cluster() option. This is only a matter of style. They are synonyms, as far as _robust is concerned.

Our program gives the same results as _svy: _regress. For our example, we add a _strata variable and a _psu variable to auto.dta.

```
. use https://www.stata-press.com/data/r17/auto, clear
   (1978 automobile data)
. set seed 1
. generate strata = int(3*runiform()) + 1
. generate psu = int(5*runiform()) + 1
. myreg mpg weight gear_ratio foreign [pw=displ], strata(strata) cluster(psu)
mpg       Coefficient  Std. err.    t    P>|t|    [95% conf. interval]
weight     -.0057248    .000388   -14.75  0.000   -.0065702  -.0048794
gear_ratio  .7775839    1.20131    0.65  0.530   -1.839845   3.395013
foreign    -1.86776    1.122833   -1.66  0.122  -4.314202   .5786828
_cons      36.64061    3.844625    9.53  0.000    28.26389   45.01733
```

```
. svyset psu [pw=displ], strata(strata)
Sampling weights: displacement
VCE: linearized
  Single unit: missing
  Strata 1: strata
Sampling unit 1: psu
  FPC 1: <zero>
. svy: _regress mpg weight gear_ratio foreign
   (running _regress on estimation sample)
Survey: Linear regression
Number of strata    =      3
Number of PSUs      =     15
Number of obs       =     74
Population size      =  14,600
Design df            =     12
F(3, 10)             =   68.37
Prob > F             =   0.0000
R-squared            =   0.6900
mpg       Coefficient  Std. err.    t    P>|t|    [95% conf. interval]
weight     -.0057248    .000388   -14.75  0.000   -.0065702  -.0048794
gear_ratio  .7775839    1.20131    0.65  0.530   -1.839845   3.395013
foreign    -1.86776    1.122833   -1.66  0.122  -4.314202   .5786828
_cons      36.64061    3.844625    9.53  0.000    28.26389   45.01733
```
Controlling the header display

Example 4

Let’s compare the output for our survey version of `myreg` with the earlier version that handled only clustering. The header for the earlier version was

```
(Std. err. adjusted for 5 clusters in rep78)
```

| Robust          | Coefficient | std. err. | t     | P>|t|  | [95% conf. interval] |
|-----------------|-------------|-----------|-------|------|---------------------|

The header for the survey version lacked the word “Robust” above standard error column, and it lacked the banner “(Std. err. adjusted for # clusters in varname)”.

Both of these headers were produced by `ereturn display`, and programmers can control what it produces. The word above “Std. err.” is controlled by setting `e(vcetype)`. The banner “(Std. err. adjusted for # clusters in varname)” is controlled by setting `e(clustvar)` to the cluster variable name. These can be set using the `ereturn local` command; see [P] ereturn.

When `_robust` is called after `ereturn post` (as it was in the earlier version that produced the above header), it automatically sets these macros. To not display the banner, the code should read

```
ereturn post ...
_robust ...
ereturn local clustvar ""
```

We can also change the phrase displayed above “Std. err.” by resetting `e(vcetype)`. To display nothing there, reset `e(vcetype)` to empty—`ereturn local vcetype ""`

For our survey version of `myreg`, we called `_robust` before calling `ereturn post`. Here `_robust` does not set these macros. Trying to do so would be futile because `ereturn post` clears all previous estimation results, including all `e()` macros, but you can set them yourself after calling `ereturn post`. We make this addition to our survey version of `myreg`:

```
_robust ...
ereturn post ...
ereturn local vcetype "Design-based"
```

The output is

```
. myreg mpg weight gear_ratio foreign [pw=displ], strata(strata) cluster(psu)
```

| mpg             | Coefficient | Std. err. | t     | P>|t| | [95% conf. interval] |
|-----------------|-------------|-----------|-------|------|---------------------|
| weight          | -.0057248   | .000388   | -14.75| 0.000| -.0065702 -.0048794 |
| gear_ratio      | .7775839    | 1.20131   | 0.65  | 0.530| -1.839845 3.395013  |
| foreign         | -1.86776    | 1.122833  | -1.66 | 0.122| -4.314202 .5786828 |
| _cons           | 36.64061    | 3.844625  | 9.53  | 0.000| 28.26389 45.01733  |
Maximum likelihood estimators

Maximum likelihood estimators are basically no different from linear regression when it comes to the use of \_robust. We will first do a little statistics and then give a simple example.

We can write our maximum-likelihood estimation equation as

\[
G(\beta) = \sum_{j=1}^{n} S(\beta; y_j, x_j) = 0
\]

where \(S(\beta; y_j, x_j) = \frac{\partial \ln L_j}{\partial \beta}\) is the score and \(\ln L_j\) is the log likelihood for the \(j\)th observation. Here \(\beta\) represents all the parameters in the model, including any auxiliary parameters. We will discuss how to use \_robust when there are auxiliary parameters or multiple equations in the next section. But for now, all the theory works out fine for any set of parameters.

Using a first-order Taylor-series expansion (that is, the delta method), we can write the variance of \(G(\beta)\) as

\[
\hat{V}\{G(\beta)\}_{\beta=\hat{\beta}} = \frac{\partial G(\beta)}{\partial \beta} \left| \frac{\partial G(\hat{\beta})}{\partial \beta} \right|_{\beta=\hat{\beta}}
\]

Solving for \(\hat{V}(\hat{\beta})\) gives

\[
\hat{V}(\hat{\beta}) = \left\{ \frac{\partial G(\beta)}{\partial \beta} \right\}^{-1} \hat{V}\{G(\beta)\} \left\{ \frac{\partial G(\beta)}{\partial \beta} \right\}^{-1}
\]

but

\[
H = \frac{\partial G(\beta)}{\partial \beta}
\]

is the Hessian (matrix of second derivatives) of the log likelihood. Thus we can write

\[
\hat{V}(\hat{\beta}) = D \hat{V}\{G(\beta)\}_{\beta=\hat{\beta}} D
\]

where \(D = -H^{-1}\) is the traditional covariance estimate.

Now \(G(\beta)\) is simply a sum, and we can estimate its variance just as we would the sum of any other variable—it is \(n^2\) times the standard estimator of the variance of a mean:

\[
\frac{n}{n-1} \sum_{j=1}^{n} (z_j - \bar{z})^2
\]

But here, the scores \(u_j = S(\hat{\beta}; y_j, x_j)\) are (row) vectors. Their sum, and thus their mean, is zero. So we have

\[
\hat{V}\{G(\beta)\}_{\beta=\hat{\beta}} = \frac{n}{n-1} \sum_{j=1}^{n} u_j' u_j
\]

Thus our robust variance estimator is

\[
\hat{V}(\hat{\beta}) = D \left( \frac{n}{n-1} \sum_{j=1}^{n} u_j' u_j \right) D
\]
so we see that the robust variance estimator is just the delta method combined with a simple estimator for totals!

The above estimator for the variance of the total (the center of the sandwich) is appropriate only when observations are independent. For clustered data and complex survey data, this estimator is replaced by one appropriate for the independent units of the data. Clusters (or PSUs) are independent, so we can sum the scores within a cluster to create a “superobservation” and then use the standard formula for a total on these independent superobservations. Our robust variance estimator thus becomes

\[ \hat{V}(\hat{\beta}) = D \left\{ \frac{1}{n_c - 1} \sum_{i=1}^{n_c} \left( \sum_{j \in C_i} u_j \right) \left( \sum_{j \in C_i} u_j \right)' \right\} D \]

where \( C_i \) contains the indices of the observations belonging to the \( i \)th cluster for \( i = 1, 2, \ldots, n_c \), with \( n_c \) the total number of clusters.

See [SVY] Variance estimation for the variance estimator for a total that is appropriate for complex survey data. Our development here has been heuristic. We have, for instance, purposefully omitted sampling weights from our discussion; see [SVY] Variance estimation for a better treatment.


⚠️ Technical note

It is easy to see where the appropriate degrees of freedom for the robust variance estimator come from: the center of the sandwich is \( n^2 \) times the standard estimator of the variance for the mean of \( n \) observations. A mean divided by its standard error has exactly a Student’s \( t \) distribution with \( n - 1 \) degrees of freedom for normal i.i.d. variables but also has approximately this distribution under many other conditions. Thus a point estimate divided by the square root of its robust variance estimate is approximately distributed as a Student’s \( t \) with \( n - 1 \) degrees of freedom.

More importantly, this also applies to clusters, where each cluster is considered a “superobservation”. Here the degrees of freedom is \( n_c - 1 \), where \( n_c \) is the number of clusters (superobservations). If there are only a few clusters, confidence intervals using \( t \) statistics can become quite large. It is just like estimating a mean with only a few observations.

When there are strata, the degrees of freedom is \( n_c - L \), where \( L \) is the number of strata; see [SVY] Variance estimation for details.

Not all of Stata’s maximum likelihood estimators that produce robust variance estimators for clustered data use \( t \) statistics. Obviously, this matters only when the number of clusters is small. Users who want to be rigorous in handling clustered data should use the svy prefix, which always uses \( t \) statistics and adjusted Wald tests (see [R] test). Programmers who want to impose similar rigor should do likewise.

We have not yet given any details about the functional form of our scores \( u_j = \partial \ln L_j / \partial \beta \). The log likelihood \( \ln L_j \) is a function of \( x_j \beta \) (the “index”). Logistic regression, probit regression, and Poisson regression are examples. There are no auxiliary parameters, and there is only one equation.

We can then write \( u_j = \hat{s}_j x_j \), where

\[ \hat{s}_j = \frac{\partial \ln L_j}{\partial (x_j \beta)} \bigg|_{\beta = \hat{\beta}} \]
We refer to $s_j$ as the equation-level score. Our formula for the robust estimator when observations are independent becomes

$$
\hat{V}(\hat{\beta}) = D \left( \frac{n}{n-1} \sum_{j=1}^{n} \hat{s}_j^2 x_j' x_j \right) D
$$

This is precisely the formula that we used for linear regression, with $\hat{e}_j$ replaced by $\hat{s}_j$ and $k = 1$ in the multiplier.

Before we discuss auxiliary parameters, let’s show how to implement `robust` for single-equation models.

>> Example 5

The robust variance implementation for single-equation maximum-likelihood estimators with no auxiliary parameters is almost the same as it is for linear regression. The only differences are that $D$ is now the traditional covariance matrix (the negative of the inverse of the matrix of second derivatives) and that the variable passed to `robust` is the equation-level score $\hat{s}_j$ rather than the residuals $\hat{e}_j$.

Let’s alter our last `myreg` program for survey data to make a program that does logistic regression for survey data. We have to change only a few lines of the program.

---

```
program mylogit, eclass
version 17.0
syntax varlist [if] [in] [pweight] [*, /* */ STRata(varname) CLuster(varname) ]
marksample touse, zeroweight
markout ‘touse’ ‘strata’ ‘cluster’, strok
if "‘weight’"!="" {
    tempvar w
    quietly generate double ‘w’ ‘exp’ if ‘touse’
    local iwexp "[iw=’w’]"
    capture assert ‘w’ >= 0 if ‘touse’
    if c(rc) error 402
}
if "‘cluster’"!="" {
    local clopt "cluster(‘cluster’)"
}
if "‘strata’"!="" {
    local stopt "strata(‘strata’)"
}
tempvar s
tempname D b
quietly {
    logit ‘varlist’ ‘iwexp’ if ‘touse’
    matrix ‘D’ = e(V)
    matrix ‘b’ = e(b)
    predict double ‘s’ if e(sample), score
    _robust ‘s’ ‘iwexp’ if e(sample), v(‘D’) ‘clopt’ ‘stopt’ zeroweight
    local dof = r(N_clust) - r(N_strata)
    local depn : word 1 of ‘varlist’
    replace ‘touse’ = e(sample)
    ereturn post ‘b’ ‘D’, depn(‘depn’) dof(‘dof’) esample(‘touse’) esample(‘touse’)
    ereturn local vcetype "Design-based"
}
display
ereturn display
end
```
---

>`_robust` — Robust variance estimates 495
Note the following about our program:

- We use the score option of predict after logit to obtain the equation-level scores. If predict does not have a score option, then we must generate the equation-level score variable some other way.

- logit is a unique command in that it will sometimes drop observations for reasons other than missing values (for example, when success or failure is predicted perfectly), so our ‘touse’ variable may not represent the true estimation sample. That is why we used the if e(sample) condition with the predict and _robust commands. Then, to provide ereturn post with an appropriate esample() option, we set the ‘touse’ variable equal to the e(sample) from the logit command and then use this ‘touse’ variable in the esample() option.

Our mylogit program gives the same results as svy: logit:

```
.mylogit foreign mpg weight gear_ratio [pw=displ], strata(strata) cluster(psu)
```

| foreign   | Design-based Coefficient std. err. | t    | P>|t| | [95% conf. interval] |
|-----------|-----------------------------------|------|-----|---------------------|
| foreign   |                                   |      |     |                     |
| mpg       | -0.3489011                       | 0.1258802 | -2.77 | 0.017 | -0.6231705 | -0.0746317 |
| weight    | -0.0040789                       | 0.0012508 | -3.26 | 0.007 | -0.0068042 | -0.0013536 |
| gear_ratio| 6.324169                         | 1.729436 | 3.66  | 0.003 | 2.556051   | 10.09229   |
| _cons     | -2.189748                        | 7.75427  | -0.28 | 0.782 | -19.08485  | 14.70536   |

```
svyset psu [pw=displ], strata(strata)
```

Sampling weights: displacement
VCE: linearized
Single unit: missing
Strata 1: strata
Sampling unit 1: psu
FPC 1: <zero>

```
svy: logit foreign mpg weight gear_ratio
(running logit on estimation sample)
```

Survey: Logistic regression

- Number of strata = 3
- Number of PSUs = 15
- Population size = 14,600
- Design df = 12
- F(3, 10) = 6.89
- Prob > F = 0.0085

| foreign   | Linearized Coefficient std. err. | t    | P>|t| | [95% conf. interval] |
|-----------|----------------------------------|------|-----|---------------------|
| mpg       | -0.3489011                       | 0.1258802 | -2.77 | 0.017 | -0.6231705 | -0.0746317 |
| weight    | -0.0040789                       | 0.0012508 | -3.26 | 0.007 | -0.0068042 | -0.0013536 |
| gear_ratio| 6.324169                         | 1.729436 | 3.66  | 0.003 | 2.556051   | 10.09229   |
| _cons     | -2.189748                        | 7.75427  | -0.28 | 0.782 | -19.08485  | 14.70536   |

Technical note

The theory developed here applies to full-information maximum-likelihood estimators. Conditional likelihoods, such as conditional (fixed-effects) logistic regression (clogit) and Cox regression (stcox), use variants on this theme. The vce(robust) option on stcox uses a similar, but not identical, formula; see [ST] stcox and Lin and Wei (1989) for details.
On the other hand, the theory developed here applies not only to maximum likelihood estimators but also to general estimating equations:

\[ G(\beta) = \sum_{j=1}^{n} g(\beta; y_j, x_j) = 0 \]

See Binder (1983) for a formal development of the theory.

Programmers: You are responsible for the theory behind your implementation.

Multiple-equation estimators

The theory for auxiliary parameters and multiple-equation models is no different from that described earlier. For independent observations, just as before, the robust variance estimator is

\[ \hat{V}(\hat{\beta}) = D \left( \frac{n}{n-1} \sum_{j=1}^{n} u'_{j}u_{j} \right) D \]

where \( u_{j} = \partial \ln L_{j}/\partial \beta \) is the score (row) vector and \( D \) is the traditional covariance estimate (the negative of the inverse of the matrix of second derivatives).

With auxiliary parameters and multiple equations, \( \beta \) can be viewed as the vector of all the parameters in the model. Without loss of generality, you can write the log likelihood as

\[ \ln L_{j} = \ln L_{j}(x_{j}(1)^{\beta(1)}, x_{j}(2)^{\beta(2)}, \ldots, x_{j}(p)^{\beta(p)}) \]

An auxiliary parameter is regarded as \( x_{j}^{(i)} \beta^{(i)} \) with \( x_{j} \equiv 1 \) and \( \beta^{(i)} \) a scalar. The score vector becomes

\[ u_{j} = ( s_{j}^{(1)} x_{j}^{(1)} s_{j}^{(2)} x_{j}^{(2)} \ldots s_{j}^{(p)} x_{j}^{(p)}) \]

where \( s_{j}^{(i)} = \partial \ln L_{j}/\partial (x_{j} \beta^{(i)}) \) is the equation-level score for the \( i \)th equation.

This notation has been introduced so that it is clear how to call \texttt{robust}. You use

\[ \texttt{. robust s}_{j}^{(1)} s_{j}^{(2)} \ldots s_{j}^{(p)}, \text{ options} \]

where \( s_{j}^{(1)} \), etc., are variables that contain the equation-level score values. The \( D \) matrix that you pass to \texttt{robust} or post with \texttt{ereturn post} must be labeled with exactly \( p \) equation names.

\texttt{robust} takes the first equation-level score variable, \( s_{j}^{(1)} \), and matches it to the first equation on the \( D \) matrix to determine \( x_{j}^{(1)} \), takes the second equation-level score variable and matches it to the second equation, etc. Some examples will make this perfectly clear.

Example 6

Here is what a matrix with equation names looks like, ending with a call to \texttt{robust}

\[ \texttt{. generate cat = rep78 - 3} \]

\[ \texttt{(5 missing values generated)} \]

\[ \texttt{. replace cat = 2 if cat < 0} \]

\[ \texttt{(10 real changes made)} \]

\[ \texttt{. mlogit cat price foreign, base(0)} \]

\[ \texttt{(output omitted)} \]

\[ \texttt{. matrix D = e(V)} \]
. matrix list D
symmetric D[9,9]

    0:  0:  0:  1:  1:  0:  0:  0:  1:  1:  0:
     price  foreign  _cons  price  foreign
0:0.price  0
0:0.foreign  0  0
0:0._cons  0  0  0
1:price  0  0  0  1.240e-08
1:foreign  0  0  0  -1.401e-06  .59355402
1:_cons  0  0  0  -.00007592  -.13992997
2:price  0  0  0  4.265e-09  -5.366e-07
2:foreign  0  0  0  -1.590e-06  .37202359
2:_cons  0  0  0  -.0000265  -.0343682

1:  2:  2:  2:  2:  2:
     _cons  price  foreign  _cons
1:_cons  .61347545
2:price  -.00002693  1.207e-08
2:foreign  -.02774147  -3.184e-06  .56833686
2:_cons  .20468675  -.00007108  -.1027108  .54017838

. predict s*, scores
._robust s1 s2 s3, v(D)

where s1, s2, and s3 are the equation-level score variables.

Covariance matrices from models with auxiliary parameters look just like multiple-equation matrices. The second equation consists of the auxiliary parameter only. We again end with a call to _robust.

. matrix list D
symmetric D[5,5]

    eq1:       eq1:       eq1:       eq1:       sigma:
       weight  gear_ratio  foreign  _cons  _cons
eq1:weight  5.978e-07
eq1:gear_ratio  .00069222  2.2471526
eq1:foreign  .00011344  -.88159935  1.4426905
eq1:_cons  -.00392566  -8.6029018  1.8864693  37.377729
sigma:_cons  -3.527e-14  -3.915e-10  -1.035e-10  -4.552e-09  .07430437

. _robust s1 s2, v(D)

Example 7

We will now give an example using ml and _robust to produce an estimation command that has vce(robust) and vce(cluster clustvar) options. You can actually accomplish all of this easily by using ml without using the _robust command because ml has robust and cluster() options. We will pretend that these two options are unavailable to illustrate the use of _robust.

To keep the example simple, we will do linear regression as a maximum likelihood estimator. Here the log likelihood is

\[
\ln L_j = -\frac{1}{2} \left\{ \left( \frac{y_j - x_j\beta}{\sigma} \right)^2 + \ln(2\pi\sigma^2) \right\}
\]
There is an auxiliary parameter, $\sigma$; thus, we have two equation-level scores:

$$\frac{\partial \ln L_j}{\partial (x_j \beta)} = \frac{y_j - x_j \beta}{\sigma^2}$$

$$\frac{\partial \ln L_j}{\partial \sigma} = \frac{1}{\sigma} \left\{ \left( \frac{y_j - x_j \beta}{\sigma} \right)^2 - 1 \right\}$$

Here are programs to compute this estimator. We have two ado-files: `mymle.ado` and `likereg.ado`. The first ado-file contains two programs, `mymle` and `Scores`. `mymle` is the main program, and `Scores` is a subprogram that computes the equation-level scores after we compute the maximum likelihood solution. Because `Scores` is called only by `mymle`, we can nest it in the `mymle.ado` file; see [U] 17 Ado-files.
Our \texttt{likereg} program computes the likelihood. Because it is called by Stata’s \texttt{ml} commands, we cannot nest it in the other file.

\begin{verbatim}
program likereg
  version 17.0
  args lf xb s
  qui replace `lf' = -0.5*(((`ML_y1' - `xb')/`s')^2 + log(2*_pi*`s'^2))
end
\end{verbatim}

Note the following:

- Our command \texttt{mymle} will produce robust variance estimates if either the \texttt{robust} or the \texttt{cluster()} option is specified. Otherwise, it will display the traditional estimates.

- We used the \texttt{lf} method with \texttt{ml}; see [R] \texttt{ml}. We could have used the \texttt{d1} or \texttt{d2} methods. Because we would probably include code to compute the first derivatives analytically for the \texttt{vce(robust)} option, there is no point in using \texttt{d0}. (However, we could compute the first derivatives numerically and pass these to \texttt{_robust}.)

- Our \texttt{Scores} program uses \texttt{predict} to compute the index $x_j \beta$. Because we had already posted the results using \texttt{ml}, \texttt{predict} is available to us. By default, \texttt{predict} computes the index for the first equation.

- Again because we had already posted the results by using \texttt{ml}, we can use \texttt{[sigma][-_cons]} to get the value of $\sigma$; see [U] 13.5 \textit{Accessing coefficients and standard errors} for the syntax used to access coefficients from multiple-equation models.

- \texttt{ml} calls \texttt{ereturn post}, so when we call \texttt{_robust}, it alters the posted covariance matrix, replacing it with the robust covariance matrix. \texttt{_robust} also sets \texttt{e(vcetype)}, and if the \texttt{cluster()} option is specified, it sets \texttt{e(clustvar)} as well.

- We let \texttt{ml} produce $z$ statistics, even when we specified the \texttt{cluster()} option. If the number of clusters is small, it would be better to use $t$ statistics. To do this, we could specify the \texttt{dof()} option on the \texttt{ml} command, but we would have to compute the number of clusters in advance. We could also get the number of clusters from \texttt{_robust}’s \texttt{r(N_clust)} and then repost the matrices by using \texttt{ereturn repost}. 

If we run our command with the `cluster()` option, we get

```
. mymle mpg weight gear_ratio foreign, cluster(rep78)
initial: log likelihood = -219.4845
rescale: log likelihood = -219.4845
rescale eq: log likelihood = -219.4845
Iteration 0: log likelihood = -219.4845 (not concave)
Iteration 1: log likelihood = -207.02829 (not concave)
Iteration 2: log likelihood = -202.6134
Iteration 3: log likelihood = -189.96546
Iteration 4: log likelihood = -181.94774
Iteration 5: log likelihood = -181.94473
Iteration 6: log likelihood = -181.94473

MLE linear regression
Number of obs = 69
Wald chi2(3) = 135.82
Log likelihood = -181.94473
Prob > chi2 = 0.0000

(Std. err. adjusted for 5 clusters in rep78)

| Robust | Coefficient | std. err. | z   | P>|z| | [95% conf. interval] |
|--------|-------------|-----------|-----|-----|----------------------|
| mpg    |             |           |     |     |                      |
| weight | -0.005893   | 0.000803  | -7.34| 0.000| -.0074669 -.0043191 |
| gear_ratio | 1.904503 | 2.134518  | 0.89 | 0.372| -2.279075 6.08808 |
| foreign | -2.149017  | 1.178012  | -1.82| 0.068| -4.457879 .1598441 |
| _cons  | 34.09959    | 4.121243  | 8.27 | 0.000| 26.02211 42.17708  |
| sigma  |             |           |     |     |                      |
| _cons  | 3.380223    | .8840543  | 3.82| 0.000| 1.647508 5.112937 |
When _robust alters the post of e(_return post), it also stores the following in e():

Macros

- **e(vcetype)**: Robust variance estimates
- **e(clustvar)**: name of cluster (PSU) variable

`e(vcetype)` controls the phrase that `ereturn display` displays above “std. err.”; `e(vcetype)` can be set to another phrase (or to empty for no phrase). `e(clustvar)` displays the banner “(Std. err. adjusted for # clusters in varname)”, or it can be set to empty (e( *return local clustvar “”* ).

### Methods and formulas

We give the formulas here for complex survey data from one stage of stratified cluster sampling, as this is the most general case.

Our parameter estimates, $\hat{\beta}$, are the solution to the estimating equation

$$
G(\beta) = \sum_{h=1}^{L} \sum_{i=1}^{n_h} \sum_{j=1}^{m_{hi}} w_{hij} S(\beta; y_{hij}, x_{hij}) = 0
$$

where $(h, i, j)$ index the observations: $h = 1, \ldots, L$ are the strata; $i = 1, \ldots, n_h$ are the sampled PSUs (clusters) in stratum $h$; and $j = 1, \ldots, m_{hi}$ are the sampled observations in PSU $(h, i)$. The outcome variable is represented by $y_{hij}$; the explanatory variables are $x_{hij}$ (a row vector); and $w_{hij}$ are the weights.

If no weights are specified, $w_{hij} = 1$. If the weights are `aweight`s, they are first normalized to sum to the total number of observations in the sample: $n = \sum_{h=1}^{L} \sum_{i=1}^{n_h} m_{hi}$. If the weights are `fweight`s, the formulas below do not apply; `fweight`s are treated in such a way to give the same results as unweighted observations duplicated the appropriate number of times.

For maximum likelihood estimators, $S(\beta; y_{hij}, x_{hij}) = \partial \ln L_j / \partial \beta$ is the score vector, where $\ln L_j$ is the log likelihood. For survey data, this is not a true likelihood, but a “pseudolikelihood”; see [SVY] Survey.

Let

$$
D = -\left[ \frac{\partial G(\beta)}{\partial \beta} \right]^{-1}_{\beta = \hat{\beta}}
$$

For maximum likelihood estimators, $D$ is the traditional covariance estimate—the negative of the inverse of the Hessian. In the following, the sign of $D$ does not matter.

The robust covariance estimate calculated by _robust is

$$
\hat{V}(\beta) = DMD
$$

where $M$ is computed as follows. Let $u_{hij} = S(\beta; y_{hij}, x_{hij})$ be a row vector of scores for the $(h, i, j)$ observation. Let

$$
u_{hij} = \sum_{j=1}^{m_{hi}} w_{hij} u_{hij} \quad \text{and} \quad \bar{u}_{h} = \frac{1}{n_h} \sum_{i=1}^{n_h} u_{hij}
$$
M is given by

\[ M = \frac{n - 1}{n - k} \sum_{h=1}^{L} (1 - f_h) \frac{n_h}{n_h - 1} \sum_{i=1}^{n_h} (u_{hi \cdot} - \bar{u}_{h \cdot \cdot})' (u_{hi \cdot} - \bar{u}_{h \cdot \cdot}) \]

where k is the value given in the minus() option. By default, k = 1, and the term \((n - 1)/(n - k)\) vanishes. Stata’s regress, vce(robust) and regress, vce(cluster clustvar) commands use k equal to the number of explanatory variables in the model, including the constant (Fuller et al. 1986). The svy prefix uses \(k = 1\).

The specification \(k = 0\) is handled differently. If minus(0) is specified, \((n - 1)/(n - k)\) and \(n_h/(n_h - 1)\) are both replaced by 1.

The factor \((1 - f_h)\) is the finite population correction. If the fpc() option is not specified, \(f_h = 0\) is used. If fpc() is specified and the variable is greater than or equal to \(n_h\), it is assumed to contain the values of \(N_h\), and \(f_h\) is given by \(f_h = n_h/N_h\), where \(N_h\) is the total number of PSUs in the population belonging to the \(h\)th stratum. If the fpc() variable is less than or equal to 1, it is assumed to contain the values of \(f_h\). See [SVY] Variance estimation for details.

For the vsrs() option and the computation of \(\hat{V}_{srswor}\), the subpop() option, and the srssubpop option, see [SVY] estat and [SVY] Subpopulation estimation.

References


Also see

[P] `ereturn` — Post the estimation results

[R] `ml` — Maximum likelihood estimation

[R] `regress` — Linear regression

[SVY] `Variance estimation` — Variance estimation for survey data

[U] 18 Programming Stata

[U] 20.22 Obtaining robust variance estimates

[U] 27 Overview of Stata estimation commands
**scalar — Scalar variables**

### Description

*scalar define* defines the contents of the scalar variable *scalar_name*. The expression may be either a numeric or a string expression. String scalars can hold arbitrarily long strings, even longer than macros, and unlike macros, can also hold binary data. See [U] 12 Data.

*scalar dir* and *scalar list* both list the contents of scalars.

*scalar drop* eliminates scalars from memory.

### Syntax

**Define scalar variable**

```
scalar [define] scalar_name = exp
```

**List contents of scalars**

```
scalar {dir|list} [_all|scalar_names]
```

**Drop specified scalars from memory**

```
scalar drop { _all|scalar_names }
```

### Remarks and examples

Stata scalar variables are different from variables in the dataset. Variables in the dataset are columns of observations in your data. Stata scalars are named entities that store single numbers or strings, which may include missing values. For instance,

```
. scalar a = 2
. display a + 2
4

. scalar b = a + 3
. display b
5

. scalar root2 = sqrt(2)
. display %18.0g root2
1.414213562373095

. scalar im = sqrt(-1)
. display im

. scalar s = "hello"
. display s
hello
```
Scalar list can be used to display the contents of scalars (as can display for reasons that will be explained below), and scalar drop can be used to eliminate scalars from memory:

```
. scalar list
  s = hello
  im = .
  root2 = 1.4142136
  b = 5
  a = 2

. scalar list a b
  a = 2
  b = 5

. scalar drop a b

. scalar list
  s = hello
  im = .
  root2 = 1.4142136

. scalar drop _all

. scalar list
```

Although scalars can be used interactively, their real use is in programs. Stata has macros and scalars, and deciding when to use which can be confusing.

### Example 1

Let’s examine a problem where either macros or numeric scalars could be used in the solution. There will be occasions in your programs where you need something that we will describe as a mathematical scalar—one number. For instance, let’s assume that you are writing a program and need the mean of some variable for use in a subsequent calculation. You can obtain the mean after `summarize` from `r(mean)` (see Stored results in [R] `summarize`), but you must obtain it immediately because the numbers stored in `r()` are reset almost every time you give a statistical command.

Let’s complicate the problem: to make some calculation, you need to calculate the difference in the means of two variables, which we will call `var1` and `var2`. One solution to your problem is to use macros:

```
summarize var1, meanonly
local mean1 = r(mean)
summarize var2, meanonly
local mean2 = r(mean)
local diff = `mean1' - `mean2'
```

Subsequently, you use ‘diff’ in your calculation. Let’s understand how this works. You `summarize var1, meanonly`; including the meanonly option suppresses the output from the `summarize` command and the calculation of the variance. You then store the contents of `r(mean)’—the just-calculated mean—in the local macro `mean1`. You then `summarize var2`, again suppressing the output, and save that just-stored result in the local macro `mean2`. Finally, you create another local macro called `diff`, which contains the difference. In making this calculation, you must put the `mean1` and `mean2` local macro names in single quotes because you want the contents of the macros. If the mean of `var1` is 3 and the mean of `var2` is 2, you want the numbers 3 and 2 substituted into the formula for `diff` to produce 1. If you omitted the single quotes, Stata would think that you are referring to the difference—not of the contents of macros named `mean1` and `mean2’—but of two variables named `mean1` and `mean2’. Those variables probably do not exist, so Stata would then produce an error message. In any case, you put the names in the single quotes.
Now let’s consider the solution using Stata scalars:

```
summarize var1, meanonly
scalar m1 = r(mean)
summarize var2, meanonly
scalar m2 = r(mean)
scalar df = m1 - m2
```

The program fragments are similar, although this time we did not put the names of the scalars used in calculating the difference—which we called `df` this time—in single quotes. Stata scalars are allowed only in expressions—they are a kind of variable—and Stata knows that you want the contents of those variables.

So, which solution is better? There is certainly nothing to recommend one over the other in terms of program length—both programs have the same number of lines and, in fact, there is a one-to-one correspondence between what each line does. Nevertheless, the scalar-based solution is better, and here is why:

Macros are printable representations of things. When we said `local mean1 = r(mean)`, Stata took the contents of `r(mean)`, converted them into a printable form from its internal (and highly accurate) binary representation, and stored that string of characters in the macro `mean1`. When we created `mean2`, Stata did the same thing again. Then when we said `local diff = ‘mean1’ - ‘mean2’`, Stata first substituted the contents of the macros `mean1` and `mean2`—which are really strings—into the command. If the means of the two variables are 3 and 2, the printable string representations stored in `mean1` and `mean2` are “3” and “2”. After substitution, Stata processed the command `local diff = 3 - 2`, converting the 3 and 2 back into internal binary representation to take the difference, producing the number 1, which it then converted into the printable representation “1”, which it finally stored in the macro `diff`.

All of this conversion from binary to printable representation and back again is a lot of work for Stata. Moreover, although there are no accuracy issues with numbers like 3 and 2, if the first number had been $3.6710823989 \times 10^{-8}$, there would have been. When converting to printable form, Stata produces representations containing up to 17 digits and, if necessary, uses scientific notation. The first number would have become $3.6710823989e-08$, and the last digit would have been lost. In computer scientific notation, 17 printable positions provides you with at least 13 significant digits. This is a lot, but not as many as Stata carries internally.

Now let’s trace the execution of the solution by using scalars. `scalar m1 = r(mean)` quickly copied the binary representation stored in `r(mean)` into the scalar `m1`. Similarly, executing `scalar m2 = r(mean)` did the same thing, although it saved it in `m2`. Finally, `scalar df = m1 - m2` took the two binary representations, subtracted them, and copied the result to the scalar `df`. This produces a more accurate result.

### Naming scalars

Scalars can have the same names as variables in the data and Stata will not become confused. You, however, may. Consider the following Stata command:

```
generate newvar = alpha*beta
```

What does it mean? It certainly means to create a new data variable named `newvar`, but what will be in `newvar`? There are four possibilities:

- Take the data variable `alpha` and the data variable `beta`, and multiply the corresponding observations together.
- Take the scalar `alpha` and the data variable `beta`, and multiply each observation of `beta` by `alpha`. 

```
- Take the data variable \texttt{alpha} and the scalar \texttt{beta}, and multiply each observation of \texttt{alpha} by \texttt{beta}.
- Take the scalar \texttt{alpha} and the scalar \texttt{beta}, multiply them together, and store the result repeatedly into \texttt{newvar}.

How Stata decides among these four possibilities is the topic of this section.

Stata's first rule is that if there is only one \texttt{alpha} (a data variable or a scalar) and one \texttt{beta} (a data variable or a scalar), Stata selects the one feasible solution and does it. If, however, there is more than one \texttt{alpha} or more than one \texttt{beta}, Stata always selects the data-variable interpretation in preference to the scalar.

Assume that you have a data variable called \texttt{alpha} and a scalar called \texttt{beta}:

```stata
. list alpha
    +----+
    |     |
    |  1  |
    |  3  |
    |  5  |
    +----+

. scalar list
   beta =     3

. generate newvar = alpha*beta
. list
    +-----------+------+
    | alpha | newvar |
    +-----------+------+
    |     1 |      3 |
    |     3 |      9 |
    |     5 |     15 |
    +-----------+------+
```

The result was to take the data variable \texttt{alpha} and multiply it by the scalar \texttt{beta}. Now let's start again, but this time, assume that you have a data variable called \texttt{alpha} and both a data variable and a scalar called \texttt{beta}:

```stata
. scalar list
   beta =     3

. list
    +-----+-----+
    | alpha| beta |
    +-----+-----+
    |     1|     2 |
    |     3|     3 |
    |     5|     4 |
    +-----+-----+

. generate newvar = alpha*beta
. list
    +-----+-----+------+
    | alpha| beta | newvar |
    +-----+-----+------+
    |     1|     2 |      2 |
    |     3|     3 |      9 |
    |     5|     4 |     20 |
    +-----+-----+------+
```
The result is to multiply the data variables, ignoring the scalar \texttt{beta}. In situations like this, you can force Stata to use the scalar by specifying \texttt{scalar(beta)} rather than merely \texttt{beta}:

```
. generate newvar2 = alpha*scalar(beta)
. list
```

<table>
<thead>
<tr>
<th>alpha</th>
<th>beta</th>
<th>newvar</th>
<th>newvar2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>20</td>
<td>15</td>
</tr>
</tbody>
</table>

The \texttt{scalar()} pseudofunction, placed around a name, says that the name is to be interpreted as the name of a scalar, even if a data variable by the same name exists. You can use \texttt{scalar()} around all your scalar names if you wish; there need not be a name conflict. Obviously, it will be easiest if you give your data and scalars different names.

\section*{Technical note}

The advice to name scalars and data variables differently may work interactively, but in programming situations, you cannot know whether the name you have chosen for a scalar conflicts with the data variables because the data are typically provided by the user and could have any names whatsoever.

One solution—and not a good one—is to place the \texttt{scalar()} pseudofunction around the names of all your scalars when you use them. A much better solution is to obtain the names for your scalars from Stata's \texttt{tempname} facility; see \cite{tempname}. There are other advantages as well. Let's go back to calculating the sum of the means of variables \texttt{var1} and \texttt{var2}. Our original draft looked like

```
summarize var1, meanonly
scalar m1 = r(mean)
summarize var2, meanonly
scalar m2 = r(mean)
scalar df = m1 - m2
```

A well-written draft would look like

```
tempname m1 m2 df
summarize var1, meanonly
scalar 'm1' = r(mean)
summarize var2, meanonly
scalar 'm2' = r(mean)
scalar 'df' = 'm1' - 'm2'
```

We first declared the names of our temporary scalars. Actually, \texttt{tempname} creates three new local macros named \texttt{m1}, \texttt{m2}, and \texttt{df}, and places in those macros names that Stata makes up, names that are guaranteed to be different from the data. (\texttt{m1}, for your information, probably contains something like \texttt{__000001}.) When we use the temporary names, we put single quotes around them—\texttt{m1} is not the name we want; we want the name that is stored in the local macro named \texttt{m1}.

That is, if we type

```
scalar m1 = r(mean)
```

then we create a scalar named \texttt{m1}. After \texttt{tempname m1 m2 df}, if we type

```
scalar 'm1' = r(mean)
```

then we create a scalar named with whatever name happens to be stored in \texttt{m1}. It is Stata's responsibility to make sure that name is valid and unique, and Stata did that when we issued the \texttt{tempname} command. As programmers, we never need to know what is really stored in the macro \texttt{m1}; all we need to do is put single quotes around the name whenever we use it.
There is a second advantage to naming scalars with names obtained from `tempname`. Stata knows that they are temporary—when our program concludes, all temporary scalars will be automatically dropped from memory. And, if our program calls another program, that program will not accidentally use one of our scalars, even if the programmer happened to use the same name. Consider

```
program myprog
  (lines omitted)
  tempname m1
  scalar `m1' = something
mysub
  (lines omitted)
end

program mysub
  (lines omitted)
  tempname m1
  scalar `m1' = something else
  (lines omitted)
end
```

Both `myprog` and `mysub` refer to a scalar, `m1`; `myprog` defines `m1` and then calls `mysub`, and `mysub` then defines `m1` differently. When `myprog` regains control, however, `m1` is just as it was before `myprog` called `mysub`!

It is unchanged because the scalar is not named `m1`: it is named something returned by `tempname`—a guaranteed unique name—and that name is stored in the local macro `m1`. When `mysub` is executed, Stata safely hides all local macros, so the local macro `m1` in `mysub` has no relation to the local macro `m1` in `myprog`. `mysub` now puts a temporary name in its local macro `m1`—a different name because `tempname` always returns unique names—and `mysub` now uses that different name. When `mysub` completes, Stata discards the temporary scalars and macros and restores the definitions of the old temporary macros, and `myprog` is off and running again.

Even if `mysub` had been poorly written in the sense of not obtaining its temporary names from `tempname`, `myprog` would have no difficulty. The use of `tempname` by `myprog` is sufficient to guarantee that no other program can harm it. For instance, pretend `mysub` looked like

```
program mysub
  (lines omitted)
  scalar m1 = something else
  (lines omitted)
end
```

`mysub` is now directly using a scalar named `m1`. That will not interfere with `myprog`, however, because `myprog` has no scalar named `m1`. Its scalar is named `m1', a name obtained from `tempname`.

---

Technical note

One result of the above is that scalars are not automatically shared between programs. The scalar `m1` in `myprog` is different from either of the scalars `m1` or `m1'` in `mysub`. What if `mysub` needs `myprog`'s `m1`?

One solution is not to use `tempname`; you could write `myprog` to use the scalar `m1` and `mysub` to use the scalar `m1`. Both will be accessing the same scalar. This, however, is not recommended.
A better solution is to pass ‘m1’ as an argument. For instance,

```stata
program myprog
    (lines omitted)
    tempname m1
    scalar ‘m1’ = something
    mysub ‘m1’
    (lines omitted)
end
program mysub
    args m1
    (lines omitted)
    commands using ‘m1’
    (lines omitted)
end
```

We passed the name of the scalar given to us by `tempname`—‘m1’—as the first argument to `mysub`. `mysub` picked up its first argument and stored that in its own local macro by the same name—m1. Actually, `mysub` could have stored the name in any macro name of its choosing; the line reading `args m1` could read `args m2`, as long as we changed the rest of `mysub` to use the name ‘m2’ wherever it uses the name ‘m1’.

Reference


Also see

[P] `macro` — Macro definition and manipulation
[P] `matrix` — Introduction to matrix commands
[U] 18.3 Macros
[U] 18.7.2 Temporary scalars and matrices
Title

**serset — Create and manipulate sersets**

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**Description**

*serset* creates and manipulates sersets.

*file sersetwrite* writes and *file sersetread* reads sersets into files.

The macro function *:serset* reports information about the current serset.

*varlist* may contain *strL* variables or *str#* variables. If it does, only the first 244 bytes of each value will be stored in the serset.

Sersets are primarily used by Stata’s graphics system. If you are interested in working with multiple datasets in memory, you will want to use Stata’s data frames. See [D] frames.

**Syntax**

Create new serset from data in memory

```
serset create varlist [if] [in] [ , omitanymiss omitallmiss
omitdupmiss omitnothing sort(varlist)]
```

Create serset of cross medians

```
serset create_xmedians svn_y svn_x [ svn_w ] [ , bands(#) xmin(#) xmax(#)
logx logy]
```

Create serset of interpolated points from cubic spline interpolation

```
serset create_cspline svn_y svn_x [ , n(#) ]
```

Make previously created serset the current serset

```
serset [set] #
```

Change order of observations in current serset

```
serset sort [svn [svn [...]]]
```

Return summary statistics about current serset

```
serset summarize svn [ , detail]
```
Return in r() information about current serset

\texttt{serset}

Load serset into memory

\texttt{serset use [ , clear]}

Change ID of current serset

\texttt{serset reset\_id \#_s}

Eliminate specified sersets from memory

\texttt{serset drop [numlist | _all]}

Eliminate all sersets from memory

\texttt{serset clear}

Describe existing sersets

\texttt{serset dir}

The \texttt{file} command (see \cite{P file}) is also extended to allow

Write serset into file

\texttt{file sersetwrite handle}

Read serset from file

\texttt{file sersetread handle}

The following macro functions are also available:

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<th>Returns from the current serset</th>
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<tbody>
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<td>ID</td>
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<tr>
<td>\texttt{serset k}</td>
<td>number of variables</td>
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<td>\texttt{serset N}</td>
<td>number of observations</td>
</tr>
<tr>
<td>\texttt{serset varnum \texttt{svn}}</td>
<td>\texttt{svnnum of \texttt{svn}}</td>
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<td>\texttt{serset type \texttt{svn}}</td>
<td>storage type of \texttt{svn}</td>
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<td>\texttt{serset format \texttt{svn}}</td>
<td>display format of \texttt{svn}</td>
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<td>\texttt{serset varnames}</td>
<td>list of \texttt{svns}</td>
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<tr>
<td>\texttt{serset min \texttt{svn}}</td>
<td>minimum of \texttt{svn}</td>
</tr>
<tr>
<td>\texttt{serset max \texttt{svn}}</td>
<td>maximum of \texttt{svn}</td>
</tr>
</tbody>
</table>

Macro functions have the syntax

\texttt{local macname : \ldots}

The current serset is the most recently created or the most recently set by the \texttt{serset set} command.
In the above syntax diagrams,

\[ #_s \] refers to a serset number, \( 0 \leq #_s \leq 1,999 \).

\textit{varlist} refers to the usual Stata varlist, that is, a list of variables that appear in the current dataset, not the current serset.

\textit{svn} refers to a variable in a serset. The variable may be referred to by either its name (for example, \textit{mpg} or \textit{l.gnp}) or its number (for example, 1 or 5); which is used makes no difference.

\textit{svnum} refers to a variable number in a serset.

**Options**

Options are presented under the following headings:

- Options for \textit{serset} create
- Options for \textit{serset} create\_xmedians
- Option for \textit{serset} create\_cspline
- Option for \textit{serset} summarize
- Option for \textit{serset} use

**Options for \textit{serset} create**

\textit{omitanymiss}, \textit{omitallmiss}, \textit{omitdupmiss}, and \textit{omitnothing} specify how observations with missing values are to be treated.

\textit{omitanymiss} is the default. Observations in which any of the numeric variables contain missing are omitted from the serset being created.

\textit{omitallmiss} specifies that only observations in which all the numeric variables contain missing be omitted.

\textit{omitdupmiss} specifies that only duplicate observations in which all the numeric variables contain missing be omitted. Observations omitted will be a function of the sort order of the original data.

\textit{omitnothing} specifies that no observations be omitted (other than those excluded by \textit{if} \textit{exp} and \textit{in} \textit{range}).

\textit{sort(\textit{varlist})} specifies that the serset being created is to be sorted by the specified variables. The result is no different from, after serset creation, using the \textit{serset sort} command, but total execution time is a little faster. The sort order of the data in memory is unaffected by this option.

**Options for \textit{serset} create\_xmedians**

\textit{bands(\#)} specifies the number of divisions along the \textit{x} scale in which cross medians are to be calculated; the default is \textit{bands(200)}. \textit{bands()} may be specified to be between 3 and 200.

Let \( m \) and \( M \) specify the minimum and maximum value of \textit{x}. If the scale is divided into \( n \) bands (that is, \textit{bands(n)} is specified), the first band is \( m \) to \( m + (M - m)/n \), the second \( m + (M - m)/n \) to \( m + 2 \times (M - m)/n \), \ldots, and the \( n \text{th} \) \( m + (n - 1) \times (M - m)/n \) to \( m + n \times (M - m)/n = m + M - m = M \).
\texttt{xmin(\#)} and \texttt{xmax(\#)} specify the minimum and maximum values of the \textit{x} variable to be used in the bands calculation—\textit{m} and \textit{M} in the formulas above. The actual minimum and maximum are used if these options are not specified. Also, if \texttt{xmin()} is specified with a number that is greater than the actual minimum, the actual minimum is used, and if \texttt{xmax()} is specified with a number that is less than the actual maximum, the actual maximum is used.

\texttt{logx} and \texttt{logy} specify that cross medians be created using a “log” scale. The exponential of the median of the log of the values is calculated in each band.

**Option for \texttt{serset create\_cspline}**

\texttt{n(\#)} specifies the number of points to be evaluated between each pair of \textit{x} values, which are treated as the knots. The default is \texttt{n(5)}, and \texttt{n(\#)} may be between 1 and 300.

**Option for \texttt{serset summarize}**

\texttt{detail} specifies additional statistics, including skewness, kurtosis, the four smallest and four largest values, and various percentiles. This option is identical to the \texttt{detail} option of \texttt{summarize}; see \cite{Rsummarize}.

**Option for \texttt{serset use}**

\texttt{clear} permits the serset to be loaded, even if there is a dataset already in memory and even if that dataset has changed since it was last saved.

**Remarks and examples**

Remarks are presented under the following headings:

\begin{verbatim}
Introduction
serset create
serset create\_xmedians
serset create\_cspline
serset set
serset sort
serset summarize
serset
serset use
serset reset\_id
serset drop
serset clear
serset dir
file sersetwrite and file sersetread
\end{verbatim}

**Introduction**

Sersets are used in implementing Stata’s graphics capabilities. When you make a graph, the data for the graph are extracted into a serset and then, at the lowest levels of Stata’s graphics implementation, are graphed from there.

Sersets are like datasets: they contain observations on one or more variables. Each serset is assigned a number, and in your program, you use that number when referring to a serset. Thus multiple sersets can reside simultaneously in memory. (Sersets are, in fact, stored in a combination of memory and temporary disk files, so accessing their contents is slower than accessing the data in memory. Sersets, however, are fast enough to keep up with graphics operations.)
serset create

serset create creates a new serset from the data in memory. For instance,

\[ \text{serset create mpg weight} \]

creates a new serset containing variables mpg and weight. When using the serset later, you can refer to these variables by their names, mpg and weight, or by their numbers, 1 and 2.

serset create also returns the following in \( r() \):

- \( r(N) \) the number of observations placed into the serset
- \( r(k) \) the number of variables placed into the serset
- \( r(id) \) the number assigned to the serset

\( r(N) \) and \( r(k) \) are just for your information; by far the most important returned result is \( r(id) \). You will need to use this number in subsequent commands to refer to this serset.

serset create also sets the current serset to the one just created. Commands that use sersets always use the current serset. If, in later commands, the current serset is not the one desired, you can set the desired one by using serset set, described below.

serset create_xmedians

serset create_xmedians creates a new serset based on the currently set serset. The basic syntax is

\[ \text{serset create_xmedians svn}_y \text{ } svn_x \text{ } [svn_w], \ldots \]

The new serset will contain cross medians. Put that aside. In the serset create_xmedians command, you specify two or three variables to be recorded in the current serset. The result is to create a new serset containing two variables (\( svn_y \) and \( svn_x \)) and a different number of observations. As with serset create, the result will also be to store the following in \( r() \):

- \( r(id) \) the number assigned to the serset
- \( r(k) \) the number of variables in the serset
- \( r(N) \) the number of observations in the serset

The newly created serset will become the current serset.

In actual use, you might code

\[ \begin{align*}
\text{serset create} & \quad yvar \text{ } xvar \text{ } zvar \\
\text{local base} &= r(id) \\
\ldots \\
\text{serset set} & \quad \text{base}
\end{align*} \]

\[ \begin{align*}
\text{serset create_xmedians} & \quad yvar \text{ } xvar \\
\text{local cross} &= r(id) \\
\ldots
\end{align*} \]

serset create_xmedians obtains data from the original serset and calculates the median values of \( svn_y \) and the median values of \( svn_x \) for bands of \( svn_x \) values. The result is a new dataset of \( n \) observations (one for each band) containing median \( y \) and median \( x \) values, where the variables have the same name as the original variables. These results are stored in the newly created serset. If a third variable is specified, \( svn_w \), the medians are calculated with weights.
serset create_cspline

*serset create_cspline* works in the same way as *serset create_xmedians*: it takes one serset and creates another serset from it, leaving the first unchanged. Thus, as with all serset creation commands, returned in $r()$ is

- $r(id)$: the number assigned to the serset
- $r(k)$: the number of variables in the serset
- $r(N)$: the number of observations in the serset

and the newly created serset will become the current serset.

*serset create_cspline* performs cubic spline interpolation, and here the new serset will contain the interpolated points. The original serset should contain the knots through which the cubic spline is to pass. *serset create_cspline* also has the $n(#)$ option, which specifies how many points are to be interpolated, so the resulting dataset will have $N + (N - 1) \times n()$ observations, where $N$ is the number of observations in the original dataset. A typical use of *serset create_cspline* would be

```stata
serset create 'yvar' 'xvar'
local base = r(id)
...
serset set 'base'
serset create_xmedians 'yvar' 'xvar'
local cross = r(id)
...
serset set 'cross'
serset create_cspline 'yvar' 'xvar'
...
```

Here the spline is placed not through the original data but through cross medians of the data.

serset set

*serset set* is used to make a previously created serset the current serset. You may omit the set. Typing

```stata
serset 5
```

is equivalent to typing

```stata
serset set 5
```

You would never actually know ahead of time the number of a serset that you needed to code. Instead, when you created the serset, you would have recorded the identity of the serset created, say, in a local macro, by typing

```stata
local id = r(id)
```

and then later, you would make that serset the current serset by coding

```stata
serset set 'id'
```

serset sort

*serset sort* changes the order of the observations of the current serset. For instance,

```stata
serset create mpg weight
local id = r(id)
serset sort weight mpg
```
would place the observations of the serset in ascending order of variable `weight` and, within equal values of `weight`, in ascending order of variable `mpg`.

If no variables are specified after `serset sort`, `serset sort` does nothing. That is not considered an error.

### `serset summarize`

`serset summarize` returns summary statistics about a variable in the current serset. It does not display output or in any way change the current serset.

Retuned in `r()` is exactly what the `summarize` command returns in `r()`; see [R] `summarize`.

### `serset`

`serset` typed without arguments produces no output but returns in `r()` information about the current serset:

- `r(id)` the number assigned to the current serset
- `r(k)` the number of variables in the current serset
- `r(N)` the number of observations in the current serset

If no serset is in use, `r(id)` is set to $-1$, and `r(k)` and `r(N)` are left undefined; no error message is produced.

### `serset use`

`serset use` loads a serset into memory. That is, it copies the current serset into the current data. The serset is left unchanged.

### `serset reset_id`

`serset reset_id` is a rarely used command. Its syntax is

```
serset reset_id #s
```

`serset reset_id` changes the ID of the current serset—its number—to the number specified, if that is possible. If not, it produces the error message “series #s in use”; `r(111)`.

Either way, the same serset continues to be the current serset (that is, the number of the current serset changes if the command is successful).

### `serset drop`

`serset drop` eliminates (erases) the specified sersets from memory. For instance,

```
serset drop 5
```

would eliminate serset 5, and

```
serset drop 5/9
```
would eliminate sersets 5–9. Using `serset drop` to drop a serset that does not exist is not an error; it does nothing.

Typing `serset drop _all` would drop all existing sersets.

Be careful not to drop sersets that are not yours: Stata’s graphics system creates and holds onto sersets frequently, and, if you drop one of its sersets that are in use, the graph on the screen will eventually “fall apart”, and Stata will produce error messages (Stata will not crash). The graphics system will itself drop sersets when it is through with them.

The `discard` command also drops all existing sersets. This, however, is safe because `discard` also closes any open graphs.

**serset clear**

`serset clear` is a synonym for `serset drop _all`.

**serset dir**

`serset dir` displays a description of all existing sersets.

**file sersetwritewrite and file sersetread**

`file sersetwritewrite` and `file sersetread` are extensions to the `file` command; see [P] `file`. These extensions write and read sersets into files. The files may be opened text or binary, but, either way, what is written into the file will be in a binary format.

`file sersetwritewrite` writes the current serset. A code fragment might read

```stata
serset create ...
local base = r(id)
...
tempname hdl
file open ‘hdl’ using "‘filename’", write ...
...
serset set ‘base’
file sersetwritewrite ‘hdl’
...
file close ‘hdl’
```

`file sersetread` reads a serset from a file, creating a new serset in memory. `file sersetread` returns in `r(id)` the serset ID of the newly created serset. A code fragment might read

```stata
tempname hdl
file open ‘hdl’ using "‘filename’", read ...
...
file sersetread ‘hdl’
local new = r(id)
...
file close ‘hdl’
```

See [P] `file` for more information on the `file` command.
Stored results

serset create, serset create_xmedians, serset create_cspline, serset set, and serset store the following in $r()$:

Scalars

- $r(id)$: the serset ID
- $r(k)$: the number of variables in the serset
- $r(N)$: the number of observations in the serset

serset summarize returns in $r()$ the same results as returned by the summarize command.

serset use returns in macro $r(varnames)$ the names of the variables in the newly created dataset.

file sersetread returns in scalar $r(id)$ the serset ID, which is the identification number assigned to the serset.

Also see

[P] class — Class programming

[P] file — Read and write text and binary files

[D] frames intro — Introduction to frames
set locale_functions — Specify default locale for functions

Description

set locale_functions sets the locale to be used by functions that take locale as an optional argument: ustrupper(), ustrlower(), ustrtitle(), ustrword(), ustrwordcount(), ustrcompare(), and ustrsortkey() and their Mata equivalents. When the argument is not specified, the locale_functions setting is used. If locale_functions is not set, the default ICU locale is used.

For example, if your operating system is Microsoft Windows English version, the system locale may be "en". If you chose the specific country to be the United States during installation of your OS, then the system locale is most likely "en_US". If locale_functions is not set or is set to default, then calling ustrupper("istanbul") is equivalent to calling ustrupper("istanbul", "en_US"), which returns ISTANBUL. However, if locale_functions is set to "tr" for Turkish, then calling ustrupper("istanbul") is equivalent to calling ustrupper("istanbul", "tr"), which returns İSTANBUL. For further discussion of locales, see [U] 12.4.2.4 Locales in Unicode.

Note that although ICU does not validate locales, Stata validates the language subtag of the locale_functions setting. It must be a valid ISO-639-2 language code. See the ISO-639-2 list at http://www.loc.gov/standards/iso639-2/.

The current locale_functions setting is stored in c(locale_functions). c(locale_functions) is reset to its original value when a program or do-file exits.

Syntax

Use the system locale for Unicode functions

    set locale_functions default [, permanently]

Specify a locale for Unicode functions

    set locale_functions locale [, permanently]

Option

permanently specifies that, in addition to making the change right now, the setting be remembered and become the default setting when you invoke Stata.

Also see

[P] creturn — Return c-class values
[R] query — Display system parameters
[R] set — Overview of system parameters
Description

`set locale ui locale` sets the locale that Stata uses for the user interface (UI). For example, the command `set locale ui ja` causes Stata to display menus and various other UI text in Japanese. If a localization package can be matched to the specified `locale`, the language contained in that package will be used to display various UI elements (menus, dialogs, message boxes, etc.). The setting takes effect the next time Stata starts. If a locale specified in `set locale ui` cannot be matched, the UI will be displayed using English.

`set locale ui default` sets the locale that Stata uses to the system default. With this default setting, Stata will attempt to match the locale set in your computer’s operating system. If the system default can be matched to one of Stata’s installed localization packages, the UI elements will be displayed in the corresponding language. If Stata does not provide a localization package that can be matched to your operating system’s locale, then English will be used.

For further discussion of locales, see [U] 12.4.2.4 Locales in Unicode.

The current UI setting is stored in `c(locale_ui)`.

Syntax

**Specify a locale for user interface localization**

```
set locale ui locale
```

**Use the system locale for user interface localization**

```
set locale ui default
```

<table>
<thead>
<tr>
<th><code>locale</code></th>
<th>Supported localization packages</th>
</tr>
</thead>
<tbody>
<tr>
<td>default</td>
<td>System default</td>
</tr>
<tr>
<td>zh_CN</td>
<td>Chinese (simplified)</td>
</tr>
<tr>
<td>en</td>
<td>English</td>
</tr>
<tr>
<td>ja</td>
<td>Japanese</td>
</tr>
<tr>
<td>ko</td>
<td>Korean</td>
</tr>
<tr>
<td>es</td>
<td>Spanish</td>
</tr>
<tr>
<td>sv</td>
<td>Swedish</td>
</tr>
</tbody>
</table>
Also see

[P] **creturn** — Return c-class values

[R] **query** — Display system parameters

[R] **set** — Overview of system parameters
set sortmethod — Specify a sort method

Description

The default sort method was changed in Stata 17 to offer faster performance. The new method is designated `fsort`. Prior to Stata 17, the method was `qsort`. `set sortmethod` lets you explicitly choose between the two methods.

Syntax

```
set sortmethod {default|fsort|qsort}
```

`fsort` is the current, faster sort.
`qsort` is the sort prior to Stata 17.
`default` is whichever of `fsort` or `qsort` was the default for the currently set user version.

Remarks and examples

Remarks are presented under the following headings:

- Overview and version control
- Controlling the sorter within a program
- Reproducibility

Overview and version control

The default sort method was changed in Stata 17 to offer improved sort performance. The new sorter is a modified quicksort with a three-way partition and switches to an insertion sort algorithm when the problem size is less than 8. This method is designated `fsort`. Prior to Stata 17, the method was `qsort`—a standard quicksort algorithm.

`sort` follows `user version` control, so all existing programs and ado-file commands will automatically use the new faster `fsort` regardless of the version specified in the program. Conversely, version-controlled do-files will use whichever `sort` was the default at the time of the version specified in the do-file. Likewise, interactive use of `sort` will use whichever version was the default for the current version.

Controlling the sorter within a program

In the unlikely case that you want to require the straight quicksort be used in a program, add `set sortmethod qsort` to the program. Be aware that setting the `sortmethod` is a global action. All future `sorts` will use the old `qsort` program, both within the program and after the program terminates.
The safest way to force the method to be qsort within a program is to save the current setting in your program and reset that setting when your sorts are complete. Do all this while being sure that your program does not exit before you get the setting restored. Here is the safest construct that protects against both errors and user-entered break keys.

```stata
nobreak {
    local holdsortmeth = c(sortmethod)
    capture noisily {
        ... your code ...
    }
    local rc = _rc
    set sortmethod 'holdsortmeth'
}
if ('rc') exit 'rc'
```

Reproducibility

If your sort keys produce a unique ordering of the data, your results are obviously and automatically reproducible. Every time you sort on those keys in any version of Stata or in any flavor of Stata, you will get the same results. And that is truly the right way to address reproducible sorts.

If you are sorting on keys that do not produce a unique sort but instead have observations with tied values of all the sort variables, you should think long and hard about why you want such an indeterminate ordering. We can think of no case where you would want to perform a sort that does not produce a unique ordering. See Sorting with ties in [D] sort for a discussion of creating unique sort keys for your sort, even when you want the ties broken randomly.

That said, Stata allows you to perform sorts with ties that cannot lead to a unique ordering. Moreover, that ordering will not be the same when you rerun the same sort command. If you have ties in the variable `xyz` and type

```
.sorxyz
```
And then, after some other commands have changed the sort order, again type

```
.sorxyz
```
The orderings of the data after each of those commands will be different!

Both the `fsort` and `qsort` methods require an initial jumbling of the order of the data to avoid potentially severe speed penalties for some specific initial orderings. This jumbling is done pseudorandomly using a fast random-number generator. This is not the excellent random-number generator used in all of Stata’s random-number functions; see [R] set seed for the specifics. The jumbler’s purpose is to be fast, not to have good properties in the pseudo-random numbers that are generated. What’s more, the ordering will differ across Stata/SE and Stata/MP, when Stata/MP is set to use multiple cores, almost always. Again, this comes down to performance. Stata/MP performs the initial jumbling in parallel. What’s more, methods `fsort` and `qsort` also use the initial jumbling in different ways and will produce different orderings of tied observations.

So if you want reproducible orderings, do not sort on variables with tied values in some observations. If you want to break the ties randomly, create a random number using `runiform()`, and sort on it. Again, see Sorting with ties in [D] sort.
Also see

[P] creturn — Return c-class values

[P] set sortrngstate — Set the state of sort’s randomizer

[D] sort — Sort data

[R] set — Overview of system parameters
Title

**set sortrngstate — Set the state of sort’s randomizer**

Description

Stata’s `sort` command jumbles the data into a random order before sorting it. This means that tied values of the sort variables may result in observations being sorted differently across multiple runs of the same `sort` command. `set sortrngstate`, combined with the c-class system parameter `c(sortrngstate)`, allows you to hold and restore the state of the randomizer (really a jumbler) that `sort` uses prior to sorting. It affects the commands `sort` and `gsort`, as well as any commands that use sorting as part of their computation.

This is a low-level utility that even the most sophisticated programmers are unlikely to need. If you are looking to perform reproducible sorts when you have tied values of the key variables for some observations, instead see *Sorting with ties* in [D] `sort`.

Syntax

```
set sortrngstate #

set sortrngstate statecode

local statecode = `c(sortrngstate)`
```

# is any number between 0 and $2^{31} - 1$ (or 2,147,483,647).

`statecode` is a random-number state previously obtained from `creturn` value `c(sortrngstate)`.

Remarks and examples

Remarks are presented under the following headings:

- Holding and restoring the jumbler state
- Reproducibility

Holding and restoring the jumbler state

`sort` prejumbles the data using a simple and fast pseudo–random process. This dramatically enhances the performance of `sort` if the original ordering has long runs of presorted key variables. Because the jumbler is a pseudo–random process, it has an internal state that determines how the jumbling will occur. This state can be fetched by typing

```
. local mysortstate = `c(sortrngstate)`
```

Then, after you have performed some other sorts, you can type

```
. set sortrngstate ‘mysortstate’
```
to reset the state of sort’s jumbler. Then sort will act as though those other sorts had not occurred and henceforth prejumble the data as though you had never performed those other sorts.

If this all seems esoteric, it is. `set sortrngstate` exists solely so we at StataCorp could continue to use numerous certification scripts while inserting new certification scripts amongst the existing scripts. There is a better way to do that; again see *Sorting with ties* in [D] `sort`, but the die was already cast. We wanted to “save” several thousand existing scripts.

**Reproducibility**

In addition to accepting a stored state, `set sortrngstate` can accept a seed, much like a pseudo-random-number generator.

You can, for example, type

```
.set seed 12345
```

to set the internal state of the jumbler to a value derived from 12345.

Every time you type

```
.set seed 12345
```

the jumbler will be set to the same value and will jumble in exactly the same way.

This can be used as a crude way to coax `sort` into performing the same sort even when there are observations with ties in the key variables, that is to say, when the sort order is not uniquely defined by the keys. That is indeed a crude form of reproducibility but not a good form of reproducibility. Do not rely on this.

Here are just a few of the problems with such an approach.

First, it is only reproducible when your data always start in exactly the same order prior to each sort. If `x1` has observations with the same value and you type

```
.set seed 845
.sort x1
....
.sort x2
....
.set seed 845
.sort x1
```

Your data will not be in the same order after the first and third sorts. How the jumbler works depends on both its state and the current order of the data.

Second, and a corollary of the first reason, you cannot easily recover the ordering from `sort`. You may not think so today, but someday you are likely to wish to retrieve the same order that one of your sorts created. You can only do that reliably if the original `sort` produced a unique ordering.

Third, sorts that produce a nonunique ordering of the data are obscuring something about your data, your analysis, or your method. Many data manipulations depend on sorts being specified fully and correctly, and setting `sortrngstate` can disguise logic problems in data management. Even if the ties “do not matter” and should be broken randomly, there are better ways to do that than to rely on a jumbler whose sole job is to be fast. sort’s jumbler does not have the nice statistical properties of the random-number generator behind `runiform()` and other Stata random-number generators.

Fourth, it is crucial that `sort` be fast, and Stata makes no attempt to blunt that speed with false reproducibility. Stata/SE and Stata/MP use the jumbler differently and so produce different orderings of ties, even when starting from the same seed/state. What’s more, Stata/MP with two processors
set sortngstate — Set the state of sort’s randomizer

and Stata/MP with four processors also produce different orderings of ties. The older qsort (prior to Stata 17) and the newer fsort (Stata 17 and beyond) also use the jumbler differently and produce different orderings of ties, even when starting from the same seed/state. (See [P] set sortmethod for a discussion of qsort and fsort.) So any reproducibility produced by set sortngstate is specific to the edition of Stata that you are running and which sort method is being used.

See Sorting with ties in [D] sort for reliable ways of dealing with ties.

Also see

[P] creturn — Return c-class values

[P] set sortmethod — Specify a sort method

[D] sort — Sort data

[R] set — Overview of system parameters
signestimationsample — Determine whether the estimation sample has changed

Description

signestimationsample and checkestimationsample are easy-to-use interfaces into datasignature for use with estimation commands; see [D] datasignature.

signestimationsample obtains a data signature for the estimation sample and stores it in e().

checkestimationsample obtains a data signature and compares it with that stored by signestimationsample and, if they are different, reports “data have changed since estimation”; r(459).

If you just want to know whether any of the data in memory have changed since they were last saved, see [D] describe. Examine stored result r(changed) after describe; it will be 0 if the data have not changed and 1 otherwise.

Syntax

signestimationsample varlist

checkestimationsample

Remarks and examples

Remarks are presented under the following headings:

Using signestimationsample and checkestimationsample
Signing
Checking
Handling of weights
Do not sign unnecessarily

Using signestimationsample and checkestimationsample

Estimators often come as a suite of commands: the estimation command itself (say, myest) and postestimation commands such as predict, estat, or even myest_stats. The calculations made by the postestimation commands are sometimes appropriate for use with any set of data values—not just the data used for estimation—and sometimes not. For example, predicted values can be calculated with any set of explanatory variables, whereas scores are valid only if calculated using the original data.

Postestimation calculations that are valid only when made using the estimation sample are the exception, but when they arise, signestimationsample and checkestimationsample provide the solution. The process is as follows:

1. At the time of estimation, sign the estimation sample (store the data’s signature in e()).
2. At the time of use, obtain the signature of the data in memory and compare it with the original stored previously.
Signing

To sign the estimation sample, include in your estimation command the following line after `e(sample)` is set (that is, after `ereturn post`):

```
    . signestimationsample 'varlist'
```

`varlist` should contain all variables used in estimation, string and numeric, used directly or indirectly, so you may in fact code

```
    . signestimationsample 'lhsvar' 'rhsvars' 'clustervar'
```
or something similar. If you are implementing a time-series estimator, do not forget to include the time variable:

```
    . quietly tsset
    . signestimationsample 'r(timevar)' 'lhsvar' 'rhsvars' 'othervars'
```

The time variable may be among the `rhsvars`, but it does not matter if time is specified twice.

If you are implementing an `xt` estimator, do not forget to include the panel variable and the optional time variable:

```
    . quietly xtset
    . signestimationsample 'r(panelvar)' 'r(timevar)' 'lhsvar' 'rhsvars' 'clustervar'
```

In any case, specify all relevant variables and don't worry about duplicates. `signestimationsample` produces no output, but behind the scenes, it adds two new results to `e()`:

- `e(datasignature)` — the signature formed by the variables specified in the observations for which `e(sample) = 1`
- `e(datasignaturevars)` — the names of the variables used in forming the signature

Checking

Now that the signature is stored, include the following line in the appropriate place in your postestimation command:

```
    . checkestimationsample
```

`checkestimationsample` will compare `e(datasignature)` with a newly obtained signature based on `e(datasignaturevars)` and `e(sample)`. If the data have not changed, the results will match, and `checkestimationsample` will silently return. Otherwise, it will issue the error message “data have changed since estimation”; `r(459)`.

Handling of weights

When you code

```
    . signestimationsample 'lhsvar' 'rhsvars' 'clustervar'
```
and

```
    . checkestimationsample
```
weights are handled automatically.

That is, when you `signestimationsample`, the command looks for `e(wexp)` and automatically includes any weighting variables in the calculation of the checksum. `checkestimationsample` does the same thing.
Do not sign unnecessarily

`signestimationsample` and `checkestimationsample` are excellent solutions for restricting postestimation calculations to the estimation sample. However, most statistics do not need to be so restricted. If none of your postestimation commands need to `checkestimationsample`, do not bother to `signestimationsample`.

Calculation of the checksum requires time. It’s not much, but neither is it zero. On a 2.8-GHz computer, calculating the checksum over 100 variables and 50,000 observations requires about a quarter of a second.

Stored results

`signestimationsample` stores the following in `e()`:

Macros

- `e(datasignaturevars)` variables used in calculation of checksum
- `e(datasignature)` the checksum

The format of the stored signature is that produced by `datasignature, fast nonames`; see `[D] datasignature`.

Also see

- `[D] datasignature` — Determine whether data have changed
- `[D] describe` — Describe data in memory or in file
sleep — Pause for a specified time

Description

sleep tells Stata to pause for # ms before continuing with the next command.

Syntax

sleep #

where # is the number of milliseconds (1,000 ms = 1 second).

Remarks and examples

Use sleep when you want Stata to wait for some amount of time before executing the next command.

. sleep 10000

pauses Stata for 10 seconds.
Title

smcl — Stata Markup and Control Language

Description

SMCL, which stands for Stata Markup and Control Language and is pronounced “smickle”, is Stata’s output language. SMCL directives, such as “{it:...}” in

You can output {it:italics} using SMCL

affect how output appears:

You can output italics using SMCL

All Stata output is processed by SMCL: help files, statistical results, and even the output of display (see [P] display) in the programs you write.

Remarks and examples

Remarks are presented under the following headings:

Introduction
SMCL modes
Command summary—general syntax
Help file preprocessor directive for substituting repeated material
Formatting directives for use in line and paragraph modes
Link directives for use in line and paragraph modes
Formatting directives for use in line mode
Formatting directives for use in paragraph mode
Directive for entering the as-is mode
Inserting values from constant and current-value class
Displaying characters using ASCII and extended ASCII codes
Advice on using display
Advice on formatting help files

Introduction

You will use SMCL mainly in the programs you compose and in the help files you write to document them, although you can use it in any context. Everything Stata displays on the screen is processed by SMCL. You can even use some of SMCL’s features to change how text appears in graphs; see [G-4] text.

Your first encounter with SMCL was probably in the Stata session logs created by the log using command. By default, Stata creates logs in SMCL format and gives them the file suffix .smcl. The file suffix does not matter; that the output is in SMCL format does. Files containing SMCL can be redisplayed in their original rendition, and SMCL output can be translated to other formats through the translate command; see [R] translate.

SMCL is mostly just plain text, for instance,

. display "this is SMCL"
this is SMCL

but that text can contain SMCL directives, which are enclosed in braces. Try the following:
. display "{title:this is SMCL, too}"
\texttt{this is SMCL, too}

The \{"title:...\}" directive told SMCL to output what followed the colon in title format. Exactly how the title format appears on your screen—or on paper if you print it—will vary, but SMCL will ensure that it always appears as a recognizable title.

Now try this:

. display "now we will try \{help summarize:clicking\}"
\texttt{now we will try clicking}

The word \texttt{clicking} will appear as a link—probably in some shade of blue. Click on the word. This will bring up Stata's Viewer and show you the help for the \texttt{summarize} command. The SMCL \{help:...\} directive is an example of a \texttt{link}. The directive \texttt{\{help summarize:clicking\}} displayed the word \texttt{clicking} and arranged things so that when the user clicked on the highlighted word, help for \texttt{summarize} appeared.

Here is another example of a link:

. display "You can also run Stata commands by \{stata summarize mpg:clicking\}"
\texttt{You can also run Stata commands by clicking}

Click on the word, and this time the result will be exactly as if you had typed the command \texttt{summarize mpg} into Stata. If you have the automobile data loaded, you will see the summary statistics for the variable \texttt{mpg}.

Simply put, you can use SMCL to make your output look better and to add links.

\subsection*{SMCL modes}

SMCL is always in one of three modes:

1. SMCL line mode
2. SMCL paragraph mode
3. As-is mode

Modes 1 and 2 are nearly alike—in these two modes, SMCL directives are understood, and the modes differ only in how they treat blanks and carriage returns. In paragraph mode—so called because it is useful for formatting text into paragraphs—SMCL joins one line to the next and splits lines to form output with lines that are of nearly equal length. In line mode, SMCL shows the line much as you entered it. For instance, in line mode, the input text

\begin{verbatim}
Variable name  mean  standard error
\end{verbatim}

(which might appear in a help file) would be spaced in the output exactly as you entered it. In paragraph mode, the above would be output as “Variable name mean standard error”, meaning that it would all run together. On the other hand, the text

\begin{verbatim}
The two main uses of SMCL are in the programs you compose and in the help files you write to document them, although SMCL may be used in any context.
Everything Stata displays on the screen is processed by SMCL.
\end{verbatim}

would display as a nicely formatted paragraph in paragraph mode.

In mode 3, as-is mode, SMCL directives are not interpreted. \{title:...\}, for instance, has no special meaning—it is just the characters open brace, t, i, and so on. If \{title:...\} appeared in SMCL input text,

\{title:My Title\}
it would be displayed exactly as it appears: \{title:My Title\}. In as-is mode, SMCL just displays text as it was entered. As-is mode is useful only for those wishing to document how SMCL works because, with as-is mode, they can show examples of what SMCL input looks like.

Those are the three modes, and the most important of them are the first two, the SMCL modes, and the single most important mode is SMCL line mode—mode 1. Line mode is the mother of all modes in that SMCL continually returns to it, and you can get to the other modes only from line mode. For instance, to enter paragraph mode, you use the \{p\} directive, and you use it from line mode, although you typically do not think of that. Paragraphs end when SMCL encounters a blank line, and SMCL then returns to line mode. Consider the following lines appearing in some help file:

\{p\}
The two main uses of SMCL are in the programs you compose and the help files you write to document them, although SMCL may be used in any context. Everything Stata displays on the screen is processed by SMCL.
\{p\}
Your first encounter with SMCL was probably the Stata session ...

Between the paragraphs above, SMCL returned to line mode because it encountered a blank line. SMCL stayed in paragraph mode as long as the paragraph continued without a blank line, but once the paragraph ended, SMCL returned to line mode. There are ways of ending paragraphs other than using blank lines, but they are the most common. Regardless of how paragraphs end, SMCL returns to line mode.

In another part of our help file, we might have

\{p\}
SMCL, which stands for Stata Markup and Control Language and is pronounced "smickle", is Stata's output language.
SMCL directives, for example, the \{c -(\it:...\c )-\} in the following, One can output \{it:italics\} using SMCL
\{p\} affects how output appears: ...

Between the paragraphs, SMCL entered line mode (again, because SMCL encountered a blank line), so the "One can output..." part will appear as you have spaced it, namely, indented. It will appear that way because SMCL is in line mode.

The other mode is invoked using the \{asis\} directive and does not end with a blank line. It continues until you enter the \{smcl\} directive, and here \{smcl\} must be followed by a carriage return. You may put a carriage return at the end of the \{asis\} directive—it will make no difference—but to return to SMCL line mode, you must put a carriage return directly after the \{smcl\} directive.

To summarize, when dealing with SMCL, begin by assuming that you are in line mode; you almost certainly will be. If you wish to enter a paragraph, you will use the \{p\} directive, but once the paragraph ends, you will be back in line mode and ready to start another paragraph. If you want to enter as-is mode, perhaps to include a piece of text output, use the \{asis\} directive, and at the end of the piece, use the \{smcl\}(carriage return) directive to return to line mode.

Command summary—general syntax

Pretend that \{xyz\} is a SMCL directive, although it is not. \{xyz\} might have any of the following syntaxes:

Syntax 1: \{xyz\}

Syntax 2: \{xyz:\text\}
Syntax 3: \{xyz args\}

Syntax 4: \{xyz args: text\}

Syntax 1 means “do whatever it is that \{xyz\} does”. Syntax 2 means “do whatever it is that \{xyz\} does, do it on the text text, and then stop doing it”. Syntax 3 means “do whatever it is that \{xyz\} does, as modified by args”. Finally, syntax 4 means “do whatever it is that \{xyz\} does, as modified by args, do it on the text text, and then stop doing it”.

Not every SMCL directive has all four syntaxes, and which syntaxes are allowed is made clear in the descriptions below.

In syntaxes 3 and 4, text may contain other SMCL directives, so the following is valid:

\{center:The use of \{ul:SMCL\} in help files\}

The text of one SMCL directive may itself contain other SMCL directives. However, the braces must not only match but also match on the same physical (input) line. Typing

\{center:The use of \{ul:SMCL\} in help files\}

is correct, but

\{center:The use of \{ul:SMCL\} in help files\}

is an error. When SMCL encounters an error, it simply displays the text in the output it does not understand, so the result of making the error above would be to display

\{center:The use of SMCL in help files\}

SMCL understood \{ul:...\} but not \{center:...\} because the braces did not match on the input line, so it displayed only that part. If you see SMCL directives in your output, you have made an error.
Help file preprocessor directive for substituting repeated material

INCLUDE help arg follows syntax 3.
INCLUDE specifies that SMCL substitute the contents of a file named arg.ihlp. This is useful when you need to include the same text multiple times. This substitution is performed only when the file is viewed using help.

Example:
We have several commands that accept the replace option. Instead of typing the description under Options of each help file, we create the file replace.ihlp, which contains something like the following:

{* 01apr2019}{...}
{phang}
{opt replace} overwrite existing {it:filename}{p_end}

To include the text in our help file, we type

INCLUDE help replace

Formatting directives for use in line and paragraph modes

{sf}, {it}, and {bf} follow syntaxes 1 and 2.
These directives specify how the font is to appear. {sf} indicates standard face, {it} italic face, and {bf} boldface.

Used in syntax 1, these directives switch to the font face specified, and that rendition will continue to be used until another one of the directives is given.

Used in syntax 2, they display text in the specified way and then switch the font face back to whatever it was previously.

Examples:
the value of {it}varlist {sf}may be specified ...
the value of {it:varlist} may be specified ...

{iinput}, {ierror}, {iresult}, and {ittext} follow syntaxes 1 and 2.
These directives specify how the text should be rendered: in the style that indicates user input, an error, a calculated result, or the text around calculated results.

These styles are often rendered as color. In the Results window, on a white background, Stata by default shows input in black and bold, error messages in red, calculated results in black and bold, and text in black. However, the relationship between the real colors and {input}, {error}, {result}, and {text} may not be the default (the user could reset it), and, in fact, these renditions may not be shown in color at all. The user might have set {result}, for instance, to show in yellow, or in highlight, or in something else. However the styles are rendered, SMCL tries to distinguish among {input}, {error}, {result}, and {text}.

Examples:
{text} the variable mpg has mean {result:21.3} in the sample.
{text} mpg {c |} {result}21.3
{text} mpg {c |} {result:21.3}
{error:variable not found}
{inp}, {err}, {res}, and {txt} follow syntaxes 1 and 2.

These four commands are synonyms for {input}, {error}, {result}, and {text}.

Examples:
{txt}the variable mpg has mean {res:21.3} in the sample.
{txt}mpg {c |} {res}21.3
{txt}mpg {c |} {res:21.3}

{err:variable not found}

{cmd} follows syntaxes 1 and 2.

{cmd} is similar to the “color” styles and is the recommended way to show Stata commands in help files. Do not confuse {cmd} with {inp}. {inp} is the way commands actually typed are shown, and {cmd} is the recommended way to show commands you might type. We recommend that you present help files in terms of {txt} and use {cmd} to show Stata commands; use any of {sf}, {it}, or {bf} in a help file, but we recommend that you not use any of the “colors” {inp}, {err}, or {res}, except where you are showing actual Stata output.

Example:
When using the {cmd:summarize} command, specify ...

{cmdab:text1:text2} follows a variation on syntax 2 (note the double colons).

{cmdab} is the recommended way to show minimum abbreviations for Stata commands and options in help files; text1 represents the minimum abbreviation, and text2 represents the rest of the text. When the entire command or option name is the minimum abbreviation, you may omit text2 along with the extra colon. {cmdab:txt} is then equivalent to {cmd:txt}; it makes no difference which you use.

Examples:
{cmdab:summarize} [{it:varlist}] [{it:weight}] [{cmdab:if} {it:exp}]
the option {cmdab:ef:orm}{cmd:(}{it:varname}{cmd:)}

{opt option}, {opt option (arg)}, {opt option(a,b)}, and {opt option(a|b)} follow syntax 3; alternatives to using {cmd}.

{opt option1:option2}, {opt option1:option2(arg)}, {opt option1:option2(a,b)}, and {opt option1:option2(a|b)} follow syntaxes 3 and 4; alternatives to using {cmdab}.

{opt} is the recommended way to show options. {opt} allows you to easily include arguments.

<table>
<thead>
<tr>
<th>SMCL directive ...</th>
<th>is equivalent to typing ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>{opt option}</td>
<td>{cmd:option}</td>
</tr>
<tr>
<td>{opt option(arg)}</td>
<td>{cmd:option({it:arg}{cmd:})}</td>
</tr>
<tr>
<td>{opt option(a,b)}</td>
<td>{cmd:option({it:a}{cmd:,}{it:b}{cmd:})}</td>
</tr>
<tr>
<td>{opt option(a</td>
<td>b)}</td>
</tr>
<tr>
<td>{opt option1:option2}</td>
<td>{cmd:option1:option2}</td>
</tr>
<tr>
<td>{opt option1:option2(arg)}</td>
<td>{cmd:option1:option2({it:arg}{cmd:})}</td>
</tr>
<tr>
<td>{opt option1:option2(a,b)}</td>
<td>{cmd:option1:option2({it:a}{cmd:,}{it:b}{cmd:})}</td>
</tr>
<tr>
<td>{opt option1:option2(a</td>
<td>b)}</td>
</tr>
</tbody>
</table>

option1 represents the minimum abbreviation, and option2 represents the rest of the text.
a, b and a|b may have any number of elements. Available elements that are displayed in {cmd} style are ,, =, :, *, %, and (). Several elements are displayed in plain text style: [], {}, and [].
Also, {opt option(arg)} is equivalent to {opt}, except that arg is displayed as a link to help; see Link directives for use in line and paragraph modes for more details.
Examples:
{
    opt replace
    opt bseunit(varname)
    opt format
    opt separator(#)
}

{hilite} and {hi} follow syntaxes 1 and 2.
{hilite} and {hi} are synonyms. {hilite} is the recommended way to highlight (draw attention to) something in help files. You might highlight, for example, a reference to a manual, the Stata Journal, or a book.

Examples:
see {hilite:[R] anova} for more details.
see {hi:[R] anova} for more details.

{ul} follows syntaxes 2 and 3.
{ul on} starts underlining mode. {ul off} ends it. {ul:text} underlines text.

Examples:
You can {ul on}underline{ul off} this way or
you can {ul:underline} this way

{=} follows syntaxes 2 and 4.
{=} indicates a comment. What follows it (inside the braces) is ignored.

Examples:
{=* this text will be ignored}
{=:as will this}

{hline} follows syntaxes 1 and 3.
{hline} (syntax 1) draws a horizontal line the rest of the way across the page.
{hline #} (syntax 3) draws a horizontal line of # characters.
{hline} (either syntax) is generally used in line mode.

Examples:
{hline}
{hline 20}

{.-} follows syntax 1.
{.-} is a synonym for {hline} (syntax 1).

Example:
{.-}

{dup #:text} follows syntax 4.
{dup} repeats text # times.

Examples:
{dup 20:A}
{dup 20:ABC}
{char code} and {c code} are synonyms and follow syntax 3.

These directives display the specified characters that otherwise might be difficult to type on your keyboard. See Displaying characters using ASCII and extended ASCII codes below.

Examples:
C{c o’}rdoba es una joya arquitect{c o’}nica.
{c S|}57.20
The ASCII character 206 in the current font is {c 206}
The ASCII character 5a (hex) is {c 0x5a}
{c -(} is open brace and {c )-} is close brace

{reset} follows syntax 1.
{reset} is equivalent to coding {txt}{sf}.
Example:
{reset}

Link directives for use in line and paragraph modes

All the link commands share the feature that when syntax 4 is allowed,

Syntax 4: {xyz args:text}

then syntax 3 is also allowed,

Syntax 3: {xyz args}

and if you specify syntax 3, Stata treats it as if you specified syntax 4, inserting a colon and then repeating the argument. For instance, {help} is defined below as allowing syntaxes 3 and 4. Thus the directive

{help summarize}

is equivalent to the directive

{help summarize:summarize}

Coding {help summarize} or {help summarize:summarize} both display the word summarize, and if the user clicks on that, the action of help summarize is taken. Thus you might code

See help for {help summarize} for more information.

This would display “See help for summarize for more information” and make the word summarize a link. To make the words describing the action different from the action, use syntax 4.

You can also {help summarize:examine the summary statistics} if you wish.

which results in “You can also examine the summary statistics if you wish.”

The link directives, which may be used in either line mode or paragraph mode, are the following:

{help args[:text]} follows syntaxes 3 and 4.
{help} displays args as a link to help args; see [R] help. If you also specify the optional :text, text is displayed instead of args, but you are still directed to the help file for args.

Examples:
{help epitab}
{help summarize:the mean}
{helpb args[:text]} follows syntaxes 3 and 4.
   {helpb} is equivalent to {help}, except that args or text is displayed in boldface.

Examples:
   {helpb summarize}
   {helpb generate}

{manhelp args1 args2[:text]} follows syntaxes 3 and 4.
   {manhelp} displays [args2] args1 as a link to help args1; thus our first example below would display [R] summarize as a link to help summarize. Specifying the optional :text displays text instead of args1, but you are still directed to the help file for args1.

Examples:
   {manhelp summarize R}
   {manhelp weight U:14 Language syntax}
   {manhelp graph_twoway G:graph twoway}

{manhelpi args1 args2[:text]} follows syntaxes 3 and 4.
   {manhelpi} is equivalent to {manhelp}, except that args or text is displayed in italics.

Examples:
   {manhelpi twoway_options G}
   {manhelpi mata M:Mata Reference Manual}

{help args##markername|viewername [:text]} and {marker markername} follow syntax 3.
   They let the user jump to a specific location within a file, not just to the top of the file. {help args##markername} displays args##markername as a link that will jump to the location marked by {marker markername}. Specifying the optional |viewername will display the results of {marker markername} in a new Viewer window named viewername; _new is a valid viewername that assigns a unique name for the new Viewer. Specifying the optional :text displays text instead of args##markername. args represents the name of the file where the {marker} is located. If args contains spaces, be sure to specify it within quotes.

   We document the directive as {help ...}; however, view, net, ado, and update may be used in place of help, although you would probably want to use only help or view.

Examples:
   {pstd}You can change the style of the text using the {cmd} directive; see {help example##cmd} below.
   You can underline a word or phrase with the {ul} directive; see {help example##ul:below}.
   {marker cmd}{...}
   {phang}{cmd} follows syntaxes 1 and 2.{break}
   {cmd} is another style not unlike the ...{break}
   {marker ul}{...}
   {phang}{ul} follows syntaxes 2 and 3.{break}
   {ul on} starts underlining mode. {ul} ...

{help_d: :text} follows syntax 2.
   {help_d} displays text as a link that will display a help dialog box from which the user may obtain interactive help on any Stata command.

Example:
   ... using the {help_d:help system} ...
{newvar[{:args}]}, {var[{:args}]}, {varname[{:args}]}, {vars[{:args}]}, {varlist[{:args}]}, {depvar[{:args}]}, {depvars[{:args}]}, and {indepvars[{:args}]}, follow syntaxes 1 and 2.

{newvar} displays newvar as a link to help newvar. If you also specify the optional :args, Stata concatenates args to newvar to display newvarargs.

Examples:

{newvar}
{newvar:2}

{var[{:args}]}, {varname[{:args}]}, {vars[{:args}]}, and {varlist[{:args}]}, follow syntaxes 1 and 2.

{var} and {varname} display varname as a link to help varname. If you also specify the optional :args, Stata concatenates args to varname to display varnameargs.

Examples:

{var}
{var:1}
{varname}
{varname:2}

{vars[{:args}]}, and {varlist[{:args}]}, follow syntaxes 1 and 2.

{vars} and {varlist} display varlist as a link to help varlist. If you also specify the optional :args, Stata concatenates args to varlist to product varlistargs.

Examples:

{vars}
{vars:1}
{varlist}
{varlist:2}

{depvar[{:args}]}, follows syntaxes 1 and 2.

{depvar} displays depvar as a link to help depvar. If you also specify the optional :args, Stata concatenates args to depvar to display depvarargs.

Examples:

{depvar}
{depvar:1}

{depvars[{:args}]}, and {depvarlist[{:args}]}, follow syntaxes 1 and 2.

{depvars} and {depvarlist} display depvarlist as a link to help depvarlist. If you also specify the optional :args, Stata concatenates args to depvarlist to display depvarlistargs.

Examples:

{depvars}
{depvars:1}
{depvarlist}
{depvarlist:2}

{indepvars[{:args}]}, follows syntaxes 1 and 2.

{indepvars} displays indepvars as a link to help varlist. If you also specify the optional :args, Stata concatenates args to indepvars to display indepvarsargs.

Examples:

{indepvars}
{indepvars:1}
{ifin} follows syntax 1.
   {ifin} displays [{if}] and [{in}], where {if} is a link to the help for the {if} qualifier and {in} is a link to the help for the {in} qualifier.
   Example:
   {ifin}

{weight} follows syntax 1.
   {weight} displays [{weight}], where {weight} is a link to the help for the {weight} specification.
   Example:
   {weight}

{dtype} follows syntax 1.
   {dtype} displays [{type}], where {type} is a link to help data types.
   Example:
   {dtype}

{search args[:text]} follows syntaxes 3 and 4.
   {search} displays {text} as a link that will display the results of search on {args}; see [R] search.
   Examples:
   {search anova:click here} for the latest information on ANOVA
   Various programs are available for {search anova}

{search_d: text} follows syntax 2.
   {search_d} displays {text} as a link that will display a Keyword Search dialog box from which the user can obtain interactive help by entering keywords of choice.
   Example:
   ... using the {search_d:search system} ...

{dialog args[:text]} follows syntaxes 3 and 4.
   {dialog} displays {text} as a link that will launch the dialog box for {args}. {args} must contain the name of the dialog box and may optionally contain , {message(string)}, where {string} is the message to be passed to the dialog box.
   Example:
   ... open the {dialog regress:regress dialog box} ...

{browse args[:text]} follows syntaxes 3 and 4.
   {browse} displays {text} as a link that will launch the user’s browser pointing at {args}. Because {args} is typically a URL containing a colon, {args} usually must be specified within quotes.
   Example:
   ... you can {browse "https://www.stata.com" : visit the Stata website} ...

{view args[:text]} follows syntaxes 3 and 4.
   {view} displays {text} as a link that will present in the Viewer the filename {args}. If {args} is a URL, be sure to specify it within quotes. {view} is seldom used in a SMCL file (such as a help file) because you will seldom know of a fixed location for the file unless it is a URL. {view} is sometimes used from programs because the program knows the location of the file it created.
   {view} can also be used with {marker}; see {help args##markernamem[\viewername][:text]} and {marker markernamem}, earlier in this section.
Examples:
see {view "https://www.stata.com/man/readme.smcl"}
display '{view "newfile":click here} to view the file created'

{view_d:} follows syntax 2.
{view_d} displays text as a link that will display the Choose File to View dialog box in which
the user may type the name of a file or a URL to be displayed in the Viewer.

Example:
{view_d:Click here} to view your current log

{manpage args[:text]} follows syntaxes 3 and 4.
{manpage} displays text as a link that will launch the user’s PDF viewer pointing at args. args
are a Stata manual (such as R or SVY) and a page number. The page number is optional. If the
page number is not specified, the PDF viewer will open to the first page of the file.

Example:
The formulas are given on {manpage R 342:page 342 of [R] manual}.

{mansection args[:text]} follows syntaxes 3 and 4.
{mansection} displays text as a link that will launch the user’s PDF viewer pointing at args.
args are a Stata manual (such as R or SVY) and a named destination within that manual (such
as predict or regress postestimation). The named destination is optional. If the named
destination is not specified, the PDF viewer will open to the first page of the file.

Example:
See {mansection R clogitpostestimation:[R] clogit postestimation}.

{manlink man entry} and {manlinki man entry} follow syntax 3.
{manlink} and {manlinki} display man and entry using the {mansection} directive as a link
that will launch the user’s PDF viewer pointing at that manual entry. man is a Stata manual (such
as R or SVY) and entry is the name of an entry within that manual (such as predict or regress
postestimation). The named destination should be written as it appears in the title of the manual
entry.

<table>
<thead>
<tr>
<th>SMCL directive</th>
<th>is equivalent to typing</th>
</tr>
</thead>
<tbody>
<tr>
<td>{manlink man entry}</td>
<td>{bf:{mansection man entry_ns:[man] entry}}</td>
</tr>
<tr>
<td>{manlinki man entry}</td>
<td>{bf:{mansection man entry_ns:[man] it:entry}}</td>
</tr>
</tbody>
</table>

entry_ns is entry with the following characters removed: space, left and right quotes (‘ and ’), #,
$, ~, {, }, [, and ].
{net args[::text]} follows syntaxes 3 and 4.

{net} displays args as a link that will display in the Viewer the results of net args; see [R] net. Specifying the optional :text, displays text instead of args. For security reasons, net get and net install cannot be executed in this way. Instead, use {net describe ...} to show the page, and from there, the user can click on the appropriate links to install the materials. Whenever args contains a colon, as it does when args is a URL, be sure to enclose args within quotes.

{net cd .::text} displays text as a link that will display the contents of the current net location. {net} can also be used with {marker}; see {help args##markername[|viewername][::text]} and {marker markername}, earlier in this section.

Examples:

programs are available from \{net "from https://www.stata.com":Stata\}
Nicholas Cox has written a series of matrix commands which you can obtain by \{net "describe https://www.stata.com/stb/stb56/dm79":clicking here\}.

{net_d::text} follows syntax 2.

{net_d} displays text as a link that will display a Keyword Search dialog box from which the user can search the Internet for additions to Stata.

Example:

To search the Internet for the latest additions to Stata available, {net_d:click here}.

{netfrom_d::text} follows syntax 2.

{netfrom_d} displays text as a link that will display a Choose Download Site dialog box into which the user may enter a URL and then see the contents of the site. This directive is seldom used.

Example:

If you already know the URL, {netfrom_d:click here}.

{ado args[::text]} follows syntaxes 3 and 4.

{ado} displays text as a link that will display in the Viewer the results of ado args; see [R] net. For security reasons, ado uninstall cannot be executed in this way. Instead, use {ado describe ...} to show the package, and from there, the user can click to uninstall (delete) the material.

{ado} can also be used with {marker}; see {help args##markername[|viewername][::text]} and {marker markername}, earlier in this section.

Example:

You can see the community-contributed packages you have installed (and uninstall any that you wish) by {ado dir:clicking here}.

{ado_d::text} follows syntax 2.

{ado_d} displays text as a link that will display a Search Installed Programs dialog box from which the user can search for community-contributed routines previously installed (and uninstall them if desired).

Example:

You can search the community-contributed ado-files you have installed by {ado_d:clicking here}.

{update args[::text]} follows syntaxes 3 and 4.

{update} displays text as a link that will display in the Viewer the results of update args; see [R] update. If args contains a URL, be careful to place the args in quotes.
args can be omitted because the update command is valid without arguments. \{update:\text\} is really the best way to use the \{update\} directive because it allows the user to choose whether and from where to update their Stata.

\{update\} can also be used with \{marker\}; see \{help args##markernamelviewernamtext\} and \{marker markernamel\}, earlier in this section.

\textbf{Examples:}
Check whether your Stata is \{update:up to date\}.
Check whether your Stata is \{update "from https://www.stata.com":up to date\}.

\{update_d:\text\} follows syntax 2.
\{update_d\} displays \text as a link that will display a \textit{Choose Official Update Site} dialog box into which the user may type a source (typically https://www.stata.com, but perhaps a local CD drive) from which to install official updates to Stata.

\textbf{Example:}
If you are installing from CD or some other source, \{update_d:click here\}.

\{back:\text\} follows syntax 2.
\{back\} displays \text as a link that will take an action equivalent to pressing the Viewer’s \textbf{Back} button.

\textbf{Example:}
\{back:go back to the previous page\}

\{clearmore:\text\} follows syntax 2.
\{clearmore\} displays \text as a link that will take an action equivalent to pressing Stata’s \textbf{Clear –more– Condition} button. \{clearmore\} is of little use to anyone but the developers of Stata.

\textbf{Example:}
\{clearmore:{hline 2}more{hline 2}\}

\{stata args\text\} follows syntaxes 3 and 4.
\{stata\} displays \text as a link that will execute the Stata command \textit{args} in the Results window. Stata will first ask before executing a command that is displayed in a web browser. If \textit{args} (the Stata command) contains a colon, remember to enclose the command in quotes.

\textbf{Example:}
\[\ldots \{stata summarize mpg:to obtain the mean of mpg\} \ldots\]

Remember, like all SMCL directives, \{stata\} can be used in programs as well as files. Thus you could code
\begin{verbatim}
display "\ldots \{stata summarize mpg:to obtain the mean of mpg\}\ldots"
\end{verbatim}
or, if you were in the midst of outputting a table,
\begin{verbatim}
di "\{stata summarize mpg:mpg\} \{c |\}" \ldots
\end{verbatim}

However, it is more likely that, rather than being hardcoded, the variable name would be in a macro, say, ‘\textit{vn}’:
\begin{verbatim}
di "\{stata summarize ‘vn’:‘vn’\} \{c |\}" \ldots
\end{verbatim}
Here you probably would not know how many blanks to put after the variable name because it could be of any length. Thus you might code
\begin{verbatim}
di "\{ralign 12:{stata summ ‘vn’:‘vn’}\} \{c |}\" \ldots
\end{verbatim}
thus allocating 12 spaces for the variable name, which would be followed by a blank and the vertical bar. Then you would want to allow for a ‘vn’ longer than 12 characters:

```
local vna = abbrev('vn',12)
di "{ralign 12:{stata summ 'vn':'vna'}} {c |}" ... 
```

There you have a line that will output a part of a table, with the linked variable name on the left and with the result of clicking on the variable name being to `summ vn`. Of course, you could make the action whatever else you wanted.

```
{matacmd args[[:text]]} follows syntaxes 3 and 4.
{matacmd} works the same as `{stata}`, except that it submits a command to Mata. If Mata is not already active, the command will be prefixed with `mata` to allow Stata to execute it.
```

### Formatting directives for use in line mode

```
{title: text} (carriage return) follows syntax 2.
{title: text} displays text as a title. {title: ...} should be followed by a carriage return and, usually, by one more blank line so that the title is offset from what follows. (In help files, we precede titles by two blank lines and follow them by one.)

Example:  
{title: Command summary -- general syntax}
{p}  
Pretend that `{cmd:{c -({xyz}c )-}}` is a SMCL directive, although ...
```

```
{center: text} and {centre: text} follow syntax 2.
{center #: text} and {centre #: text} follow syntax 4.
{center: text} and {centre: text} are synonyms; they center the text on the line. {center: text} should usually be followed by a carriage return; otherwise, any text that follows it will appear on the same line. With `syntax 4`, the directives center the text in a field of width #.

Examples:  
{center: This text will be centered}  
{center: This text will be centered} and this will follow it  
{center 60: This text will be centered within a width of 60 columns}
```

```
{rcenter: text} and {rcentre: text} follow syntax 2.
{rcenter #: text} and {rcentre #: text} follow syntax 4.
{rcenter: text} and {rcentre: text} are synonyms. {rcenter} is equivalent to {center}, except that text is displayed one space to the right when there are unequal spaces left and right. {rcenter: text} should be followed by a carriage return; otherwise, any text that follows it will appear on the same line. With `syntax 4`, the directives center the text in a field of width #.

Example:
{rcenter: this is shifted right one character}
```

```
{right: text} follows syntax 2.
{right} displays text with its last character aligned on the right margin. {right: text} should be followed by a carriage return.

Examples:
{right: this is right-aligned}  
{right: this is shifted left one character}
```
{lalign #:text} and {ralign #:text} follow syntax 4.
    {lalign} left-aligns text in a field # characters wide, and {ralign} right-aligns text in a field #
    characters wide.

    Example:
    {lalign 12:mpg}{ralign 15:21.2973}

{dlgtab [# [#]]:text} follows syntaxes 2 and 4.
    {dlgtab} displays text as a dialog tab. The first # specifies how many characters to indent the
dialog tab from the left-hand side, and the second # specifies how much to indent from the
right-hand side. The default is {dlgtab 4 2{text}}.

    Examples:
    {dlgtab:Model}
    {dlgtab 8 2:Model}

{...} follows syntax 1.
    {...} specifies that the next carriage return be treated as a blank.

    Example:
    Sometimes you need to type a long line and, while {...}
    that is fine with SMCL, some word processors balk. {...}
    In line mode, the above will appear as one long line to SMCL.

{col #} follows syntax 3.
    {col #} skips forward to column #. If you are already at or beyond that column in the output,
    then {col #} does nothing.

    Example:
    mpg{col 20}21.3{col 30}5.79

{space #} follows syntax 3.
    {space} is equivalent to typing # blank characters.

    Example:
    20.5{space 20}17.5

{tab} follows syntax 1.
    {tab} has the same effect as typing a tab character. Tab stops are set every eight spaces.

    Examples:
    {tab}This begins one tab stop in
    {tab}{tab}This begins two tab stops in

    Note: SMCL also understands tab characters and treats them the same as the {tab} command, so
    you may include tabs in your files.

Formatting directives for use in paragraph mode

{p} follows syntax 3. The full syntax is {p # # # #}.
    {p # # # #} enters paragraph mode. The first # specifies how many characters to indent the first
    line; the second #, how much to indent the second and subsequent lines; the third #, how much
to bring in the right margin on all lines; and the fourth # is the total width for the paragraph.
    Numbers, if not specified, default to zero, so typing {p} without numbers is equivalent to typing
    {p 0 0 0 0}; {p #} is equivalent to {p # 0 0 0}; and so on. A zero for the fourth # means use
    the default paragraph width; see set linesize in [R] log. {p} (with or without numbers) may
    be followed by a carriage return or not; it makes no difference.
Paragraph mode ends when a blank line is encountered, the \{p\_end\} directive is encountered, or \{smcl\}(carriage return) is encountered.

**Examples:**

\{p\}
\{p 4\}
\{p 0 4\}
\{p 8 8 8 60\}

Note concerning paragraph mode: In paragraph mode, you can have either one space or two spaces at the end of sentences, following the characters '.', '?', '!', and ':'. In the output, SMCL puts two spaces after each of those characters if you put two or more spaces after them in your input, or if you put a carriage return; SMCL puts one space if you put one space. Thus

\{p\}
Dr. Smith was near panic. He could not reproduce the result.
Now he wished he had read about logging output in Stata.

will display as

Dr. Smith was near panic. He could not reproduce the result. Now he wished he had read about logging output in Stata.

Several shortcut directives have also been added for commonly used paragraph mode settings:

<table>
<thead>
<tr>
<th>SMCL directive ...</th>
<th>is equivalent to typing ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>{pstd}</td>
<td>{p 4 4 2}</td>
</tr>
<tr>
<td>{psee}</td>
<td>{p 4 13 2}</td>
</tr>
<tr>
<td>{phang}</td>
<td>{p 4 8 2}</td>
</tr>
<tr>
<td>{pmore}</td>
<td>{p 8 8 2}</td>
</tr>
<tr>
<td>{pin}</td>
<td>{p 8 8 2}</td>
</tr>
<tr>
<td>{phang2}</td>
<td>{p 8 12 2}</td>
</tr>
<tr>
<td>{pmore2}</td>
<td>{p 12 12 2}</td>
</tr>
<tr>
<td>{pin2}</td>
<td>{p 12 12 2}</td>
</tr>
<tr>
<td>{phang3}</td>
<td>{p 12 16 2}</td>
</tr>
<tr>
<td>{pmore3}</td>
<td>{p 16 16 2}</td>
</tr>
<tr>
<td>{pin3}</td>
<td>{p 16 16 2}</td>
</tr>
</tbody>
</table>

\{p\_end\} follows syntax 1.

\{p\_end\} is a way of ending a paragraph without having a blank line between paragraphs. \{p\_end\} may be followed by a carriage return or not; it will make no difference in the output.

**Example:**

\{p\_end\}

\{p2colset \# \# \#\} follows syntax 3.
\{p2col \# \# \#: [first\_column\_text] \} [second\_column\_text] follows syntaxes 2 and 4.
\{p2line \# \#\} follows syntaxes 1 and 3.
\{p2colreset\} follows syntax 1.

\{p2colset\} sets column spacing for a two-column table. The first \# specifies the beginning position of the first column, the second \# specifies the placement of the second column, the third \# specifies the placement for subsequent lines of the second column, and the last \# specifies the number to indent from the right-hand side for the second column.

\{p2col\} specifies the rows that make up the two-column table. Specifying the optional numbers redefines the numbers specified in \{p2colset\} for this row only. If the first\_column\_text or the second\_column\_text is not specified, the respective column is left blank.
\{p2line\} draws a dashed line for use with a two-column table. The first \# specifies the left indentation, and the second \# specifies the right indentation. If no numbers are specified, the defaults are based on the numbers provided in \{p2colset\}.

\{p2colreset\} restores the \{p2col\} default values.

**Examples:**
\begin{verbatim}
\{p2colset 9 26 27 2\}\{...\}
\{p2col:\{keyword\}\}rules\{p_end\}
\{p2line\}
\{p2col:\{opt nonm:issing\}\}all nonmissing values not changed by the rules\{p_end\}
\{p2col 7 26 27 2:* \{opt m:issing\}\}all missing values not changed by the rules\{p_end\}
\{p2line\}
\{p2colreset\}\{...\}
\end{verbatim}

\{synoptset \[#\]|\[tabbed|\[notes\]|\]\} follows syntaxes 1 and 3.
\{synopthdr:\{first\_column\_header\}\} follows syntaxes 1 and 2.
\{syntab:\text\} follows syntax 2.
\{synopt: \{first\_column\_text\}|\[second\_column\_text\]\} follows syntax 2.
\{p2coldent: \{first\_column\_text\}|\[second\_column\_text\]\} follows syntax 2.
\{synoptline\} follows syntax 1.

\{synoptset\} sets standard column spacing for a two-column table used to document options in syntax diagrams. \# specifies the width of the first column; the width defaults to 20 if \# is not specified. The optional argument \[tabbed\] specifies that the table will contain headings or “tabs” for sets of options. The optional argument \[notes\] specifies that some of the table entries will have footnotes and results in a larger indentation of the first column than the \[tabbed\] argument implies.

\{synopthdr\} displays a standard header for a syntax-diagram-option table. \[first\_column\_header\] is used to title the first column in the header; if \[first\_column\_header\] is not specified, the default title “options” is displayed. The second column is always titled “Description”.

\{syntab\} displays \text positioned as a subheading or “tab” in a syntax-diagram-option table.

\{synopt\} specifies the rows that make up the two-column table; it is equivalent to \{p2col\} (see above).

\{p2coldent\} is the same as \{synopt\}, except the \[first\_column\_text\] is displayed with the standard indentation (which may be negative). The \[second\_column\_text\] is displayed in paragraph mode and ends when a blank line, \{p_end\}, or a carriage return is encountered. The location of the columns is determined by a prior \{synoptset\} or \{p2colset\} directive.

\{synoptline\} draws a horizontal line that extends to the boundaries of the previous \{synoptset\} or, less often, \{p2colset\} directive.

**Examples:**
\begin{verbatim}
\{synoptset 21 \[tabbed\]|\}\{...\}
\{synopthdr\}
\{synoptline\}
\{syntab:Model\}
\{p2coldent:* \{opt a:bsorb(varname)\}\}categorical variable to be absorbed\{p_end\}
\{synopt: \{opt clear\}\}reminder that untransposed data will be lost if not previously saved\{p_end\}
\{synoptline\}
\{p2colreset\}\{...\}
\end{verbatim}
{bind:\text} follows syntax 2.

{bind:...} keeps \text together on a line, even if that makes one line of the paragraph unusually short. {bind:...} can also be used to insert one or more real spaces into the paragraph if you specify \text as one or more spaces.

Example:
Commonly, bind is used \{bind:to keep words together\} on a line.

{break} follows syntax 1.

{break} forces a line break without ending the paragraph.

Example:
{p 4 8 4}
{it:Example:}{break}
Commonly,...

Directive for entering the as-is mode

{asis} follows syntax 1.

{asis} begins as-is mode, which continues until {smcl}(carriage return) is encountered. {asis} may be followed by a carriage return or not; it makes no difference, but {smcl} must be immediately followed by a carriage return. {smcl} returns SMCL to line mode. No other SMCL commands are interpreted in as-is mode.

Inserting values from constant and current-value class

The {ccl} directive outputs the value contained in a constant and current-value class (c()) object. For instance, {ccl pi} provides the value of the constant pi (3.14159...) contained in c(pi). See [P] creturn for a list of all the available c() objects.

Displaying characters using ASCII and extended ASCII codes

The {char} directive—synonym {c}—allows you to output any ASCII or extended ASCII character in Latin1 encoding. Extended ASCII characters in Latin1 encoding are converted to the equivalent Unicode characters in the UTF-8 encoding. For instance, {c 232} is equivalent to typing the letter ê because extended ASCII code 232 in Latin1 is defined as the letter “e” with a grave accent. You may also type the Unicode character ê (code point \u00e8) directly.

You can get to all the ASCII and extended ASCII characters in Latin1 encoding by typing \{c \#, where \# is between 1 and 255. Or, if you prefer, you can type \{c 0x\#, where \# is a hexadecimal number between 1 and ff. Thus \{c 0x6a\} is also j because the hexadecimal number 6a is equal to the decimal number 106.

Also, so that you do not have to remember the numbers, \{c\} provides special codes for characters that are, for one reason or another, difficult to type. These include

\{c $\} \quad (dollar sign)
\{c 'g\} \quad (open single quote)
\{c -{\} \quad (left curly brace)
\{c }{-} \quad (right curly brace)
{c $S|$} and {c ’g} are included not because they are difficult to type or cause SMCL any problems but because in Stata display statements, they can be difficult to display, since they are Stata’s macro substitution characters and tend to be interpreted by Stata. For instance,

```
. display "shown in $US"
```
drops the $US part because Stata interpreted $US as a macro, and the global macro was undefined. A way around this problem is to code

```
. display "shown in {c S|}US"
```

{c -(} and {c )-} are included because { and } are used to enclose SMCL directives. Although { and } have special meaning to SMCL, SMCL usually displays the two characters correctly when they do not have a special meaning. SMCL follows the rule that, when it does not understand what it thinks ought to be a directive, it shows what it did not understand in unmodified form. Thus

```
. display "among the alternatives {1, 2, 4, 7}"
```

works, but

```
. display "in the set {result}"
```
does not because SMCL interpreted {result} as a SMCL directive to set the output style (color) to that for results. The way to code the above is to type

```
. display "in the set {c -(}result{c )-}"
```

SMCL also provides the following line-drawing characters:

- {c -} a wide dash character
- {c |} a tall | character
- {c +} a wide dash on top of a tall |
- {c TT} a top T
- {c BT} a bottom T
- {c LT} a left T
- {c RT} a right T
- {c TLC} a top-left corner
- {c TRC} a top-right corner
- {c BRC} a bottom-right corner
- {c BLC} a bottom-left corner

{hline} constructs the line by using the {c -} character. The above are not really characters; they are instructions to SMCL to draw lines. The “characters” are, however, one character wide and one character tall, so you can use them as characters in your output. The result is that Stata output that appears on your screen can look like

```
. summarize mpg weight
                      Variable |     Obs  Mean    Std. dev.    Min     Max
-------------+-----------------------------+-----------------------------+-----------------------------+-----------------------------+-----------------------------+
           mpg  |         74  21.2973  5.785503        12        41
           weight |         74  3019.459  777.1936       1760       4840
```
but, if the result is translated into plain text, it will look like

```
.summarize mpg weight

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>mpg</td>
<td>74</td>
<td>21.2973</td>
<td>5.785503</td>
<td>12</td>
<td>41</td>
</tr>
<tr>
<td>weight</td>
<td>74</td>
<td>3019.46</td>
<td>777.1936</td>
<td>1760</td>
<td>4840</td>
</tr>
</tbody>
</table>
```

because SMCL will be forced to restrict itself to the characters.

Finally, SMCL provides the following Western European characters:

```
{c a’}   á    {c e’}   é    {c i’}   í    {c o’}   ó    {c u’}   ú
{c A’}   Á    {c E’}   É    {c I’}   Í    {c O’}   Ö    {c U’}   Ú
{c a’g}  à    {c e’g}  è    {c i’g}  ï    {c o’g}  ò    {c u’g}  ù
{c A’g}  À    {c E’g}  È    {c I’g}  Ì    {c O’g}  Ö    {c U’g}  Ú
{c a¨}   â    {c e¨}   ê    {c i¨}   î    {c o¨}   ô    {c u¨}   û
{c A¨}   Â    {c E¨}   È    {c I¨}   Ì    {c O¨}   Ö    {c U¨}   Ú
{c a~}   ã    {c e~}   ã    {c o~}   õ    {c a~}   Õ
{c A~}   Â    {c o~}   Õ
{c a:}   ä    {c e:}   ë    {c i:}   ì    {c o:}   ò    {c u:}   ù
{c A:}   Á    {c E:}   É    {c I:}   Í    {c O:}   Ö    {c U:}   Ú
{c aë}   æ    {c c,}   ç    {c n-}   ñ    {c o/}   ø    {c y’}   ý
{c AE}   Æ    {c C,}   Ç    {c N-}   Ñ    {c o/}   Ø    {c Y’}   Ý
{c y}    ý    {c ss}   ß    {c r?}   ¿    {c r!}   ¡
{c L-}   £    {c Y=}   (yen)
```

SMCL uses UTF-8 to render the above characters. For instance, \{c e’\} is equivalent to \{c 0xe9\}, if you care to look it up. \{c 0xe9\} will display as ´e if you are using a Latin1 encoding.

**Advice on using display**

Do not think twice; you can just use SMCL directives in your display statements, and they will work. What we are really talking about, however, is programming, and there are two things to know.

First, remember how display lets you display results as text, as result, as input, and as error, with the abbreviations as txt, as res, as inp, and as err. For instance, a program might contain the lines

```
program ...
...
quietly summarize 'varname'
  display as txt "the mean of 'varname' is " as res r(mean)
...
end
```

Results would be the same if you coded the display statement

```
display "{txt}"the mean of 'varname' is "{res}" r(mean)
```

That is, the display directive as txt just sends \{txt\} to SMCL, the display directive as res just sends \{res\} to SMCL, and so on.

However, as err does not just send \{err\}. as err also tells Stata that what is about to be displayed is an error message so that, if output is being suppressed, Stata knows to display this message anyway. For example,

```
display as err "varname undefined"
```
is the right way to issue the error message “varname undefined”.

    display "{err}varname undefined"

would not work as well; if the program’s output were suppressed, the error message would not be displayed because Stata would not know to stop suppressing output. You could code

    display as err "{err}varname undefined"

but that is redundant. display’s as error directive both tells Stata that this is an error message and sends the {err} directive to SMCL. The last part makes output appear in the form of error messages, probably in red. The first part is what guarantees that the error message appears, even if output is being suppressed.

    If you think about this, you will now realize that you could code

    display as err "{txt}varname undefined"

to produce an error message that would appear as ordinary text (meaning that it would probably be in black) and yet still display in all cases. Please do not do this. By convention, all error messages should be displayed in SMCL’s {err} (default red) rendition.

    The second thing to know is how Stata sets the state of SMCL the instant before display displays its output. When you use display interactively—when you use it at the keyboard or in a do-file—Stata sets SMCL in line mode, font face {sf}, and style {res}. For instance, if you type

    . display 2+2
    4

the 4 will appear in {sf}{res}, meaning in standard font face and in result style, which probably means in black and bold. On the other hand, consider the following:
Here the 4 will appear in {sf}{inp}, meaning that the result is probably also shown in black and bold. However, if your preferences are set to display input differently than results, the output from the program will be different from the interactive output.

When display is executed from inside a program, no changes are made to SMCL. SMCL is just left in the mode it happens to be in, and here it happened to be in line mode {sf}{inp} because that was the mode it was in after the user typed the command demonstrate_display.

This is an important feature of display because it means that, in your programs, one display can pick up where the last left off. Perhaps you have four or five displays in a row that produce the text to appear in a paragraph. The first display might begin paragraph mode, and the rest of the displays finish it off, with the last display displaying a blank line to end paragraph mode. Here it is of great importance that SMCL stay in the mode you left it in between displays.

That leaves only the question of what mode SMCL is in when your program begins. You should assume that SMCL is in line mode but make no assumptions about the style (color) {txt}, {res}, {err}, or {inp}. Within a program, all display commands should be coded as

    display as ... ...

or

    display "one of {txt}, {res}, {err}, or {inp} ..." ...

although you may violate this rule if you really intend one display to pick up where another left off. For example,

    display as text "{p"
    display "This display violates the rule, but that is all right"
    display "because it is setting a paragraph, and we want all"
    display "these displays to be treated as a whole."
    display "We did follow the rule with the first display in the"
    display "sequence."
    display
    display "Now we are back in line mode because of the blank line"

You could even code

    program example2
    display as text "{p"
    display "Below we will call a subroutine to contribute a sentence"
    display "to this paragraph being constructed by example2:"
    example2_subroutine
    display "The text that example2_subroutine contributed became"
    display "part of this single paragraph. Now we will end the paragraph."
    display
    end

    program example2_subroutine
    display "This sentence is being displayed by"
    display "example2_subroutine."
The result of running this would be

```
.example2
```

Below we will call a subroutine to contribute a sentence to this paragraph being constructed by example2: This sentence is being displayed by `example2_subroutine`. The text that `example2_subroutine` contributed became part of this single paragraph. Now we will end the paragraph.

Advice on formatting help files

Help files are just files named `filename.sthlp` that Stata displays when the user types `help filename`. The first line of a help file should read

```
{smcl}
```

After that, it is a matter of style. To see examples of our style, type

```
.viewsource assert.sthlp
.viewsource centile.sthlp
.viewsource regress.sthlp
.viewsource regress_postestimation.sthlp
```

(normal example with a couple of options)

(example with an options table)

(example of an estimation command)

(example of a postestimation entry)

We recommend opening a second Viewer window (one way is to right-click within an existing Viewer and select “Open New Viewer”) to look at the help file and the raw source file side by side.

Also see

[P] display — Display strings and values of scalar expressions

[RPT] dyndoc — Convert dynamic Markdown document to HTML or Word (.docx) document

[RPT] markdown — Convert Markdown document to HTML file or Word (.docx) document

[R] log — Echo copy of session to file
**sortpreserve — Sort within programs**

### Description

This entry discusses the use of `sort` (see [D] sort) within programs.

### Syntax

```
program [define] program_name [ , ... sortpreserve ...]
```

### Option

`sortpreserve` specifies that the program, during its execution, will re-sort the data and that therefore Stata itself should take action to preserve the order of the data so that the order can be reestablished afterward.

`sortpreserve` is in fact independent of whether a program is byable() but byable() programs often specify this option.

Pretend you are writing the program `myprog` and that, in performing its calculations, it needs to sort the data. It is very jolting for a user to experience,

```
. by pid: myprog ...
. by pid: sum newvar
    not sorted
    r(5);
```

Specifying `sortpreserve` will prevent this and still allow `myprog` to sort the data freely. byable() programs that sort the data should specify `sortpreserve`. It is not necessary to specify `sortpreserve` if your program does not change the sort order of the data and, in that case, things are a little better if you do not specify `sortpreserve`.

`sortpreserve` takes time, although less than you might suspect. `sortpreserve` does not actually have to re-sort the data at the conclusion of your program—an O(n ln n) operation—it is able to arrange things so that it can reassert the original order of the data in O(n) time, and `sortpreserve` is, in fact, very quick about it. Nonetheless, there is no reason to waste the time if the data never got out of order.

Concerning sort order, when your byable() program is invoked for the first time, it will be sorted on _byvars but, in subsequent calls (in the case of byable(recall) programs), the sort order will be just as your program leaves it even if you specify `sortpreserve`. `sortpreserve` restores the original order after your program has been called for the last time.
Remarks and examples

Remarks are presented under the following headings:

Introduction

sortpreserve

The cost of sortpreserve

How sortpreserve works

Use of sortpreserve with preserve

Use of sortpreserve with subroutines that use sortpreserve

Introduction

Properly written programs do one of three things:

1. Report results
2. Add new variables to the dataset
3. Modify the data in memory

These are known as class-1, class-2, and class-3 programs.

However, you do not want to get carried away with the idea. A properly written program might, for instance, report results and yet still have an option to add a new variable to the dataset, but a properly written program would not do all three. The user should be able to obtain reports over and over again by simply retying the command, and if a command both reports results and modifies the data, that will not be possible.

Properly written programs of the first two types should also not change the sort order of the data. If the data are sorted on mpg and foreign before the command is given, and all the command does is report results, the data should still be sorted on mpg and foreign at the conclusion of the command. Yet the command might find it necessary to sort the data to obtain the results it calculates.

This entry deals with how to easily satisfy both needs.

sortpreserve

You may include sort commands inside your programs and leave the user’s data in the original order when your program concludes by specifying the sortpreserve option on the program definition line:

```
program whatever, sortpreserve
    ...
end
```

That is all there is to it. sortpreserve tells Stata when it starts your program to first record the information about how the data are currently sorted and then later use that information to restore the order to what it previously was. Stata will do this no matter how your program ends, whether as you expected, with an error, or because the user pressed the Break key.

The cost of sortpreserve

There is a cost to sortpreserve, so you do not want to specify the option when it is not needed, but the cost is not much. sortpreserve will consume a little computer time in restoring the sort order at the conclusion of your program. Rather than talking about this time in seconds or milliseconds, which can vary according to the computer you use, let’s define our unit of time as the time to execute:

```
. generate long x = _n
```
Pretend that you added that command to your program, just as we have typed it, without using temporary variables. You could then make careful timings of your program to find out just how much extra time your program would take to execute. It would not be much. Let’s call that amount of time one \textit{genlong} unit. Then

- \texttt{sortpreserve}, if it has to restore the order because your program has changed it, takes 2 \textit{genlong} units.
- \texttt{sortpreserve}, if it does not need to change the order because your program has not changed it yet, takes one-half a \textit{genlong} unit.

The above results are based on empirical timings using 100,000 and 1,000,000 observations.

\section*{How \texttt{sortpreserve} works}

\texttt{sortpreserve} works by adding a temporary variable to the dataset before your program starts, and if you are curious about the name of that variable, it is recorded in the macro ‘\texttt{\_sortindex}’. Sometimes you will want to know that name. It is important that the variable ‘\texttt{\_sortindex}’ still exist at the conclusion of your program. If your program concludes with something like

\begin{verbatim}
keep 'id' 'varlist'
\end{verbatim}

you must change that line to read

\begin{verbatim}
keep 'id' 'varlist' \texttt{\_'sortindex}'
\end{verbatim}

If you fail to do that, Stata will report the error message “could not restore sort order because variables were dropped”. Actually, even that little change may be insufficient because the dataset in its original form might have been sorted on something other than ‘id’ and ‘varlist’. What you really need to do is add, early in your program and before you change the sort order,

\begin{verbatim}
local sortvars : sort
\end{verbatim}

and then change the \texttt{keep} statement to read

\begin{verbatim}
keep 'id' 'varlist' 'sortvars' \texttt{\_'sortindex}'
\end{verbatim}

This discussion concerns only the use of the \texttt{keep} command. Few programs would even include a \texttt{keep} statement because we are skirting the edge of what is a properly written program.

\texttt{sortpreserve} is intended for use in programs that report results or add new variables to the dataset, not programs that modify the data in memory. Including \texttt{keep} at the end of your program really makes it a class-3 program, and then the idea of preserving the sort order makes no sense anyway.

\section*{Use of \texttt{sortpreserve} with \texttt{preserve}}

\texttt{sortpreserve} may be used with \texttt{preserve} (see [P] \texttt{preserve} for a description of \texttt{preserve}). We can imagine a complicated program that re-sorts the data, and then, under certain conditions, discovers it has to do real damage to the data to calculate its results, and so then \texttt{preserves} the data to boot:
program ..., sortpreserve
    ...
    sort ...
    ...
    if ... {
        preserve
        ??
    }
...
end

The above program will work. When the program ends, Stata will first restore any preserved data and then reestablish the sort of the original dataset.

Use of sortpreserve with subroutines that use sortpreserve

Programs that use sortpreserve may call other programs that use sortpreserve, and this can be a good way to speed up code. Consider a calculation where you need the data first sorted by ‘i’ ‘j’, then by ‘j’ ‘i’, and finally by ‘i’ ‘j’ again. You might code

    program ..., sortpreserve
    ...
    sort ‘i’ ‘j’
    ...
    sort ‘j’ ‘i’
    ...
    sort ‘i’ ‘j’
    ...
end

but executing

    program ..., sortpreserve
    ...
    sort ‘i’ ‘j’
    mysubcalculation ‘i’ ‘j’ ...
    ...
end

    program mysubcalculation, sortpreserve
        args i j ...
        sort ‘j’ ‘i’
        ...
end

will be faster.

Also see

[P] byable — Make programs byable
[P] program — Define and manipulate programs
There are two ways that a Stata program can interpret what the user types:

1. positionally, meaning first argument, second argument, and so on, or

2. according to a grammar, such as standard Stata syntax.

`args` does the first. The first argument is assigned to `macroname1`, the second to `macroname2`, and so on. In the program, you later refer to the contents of the macros by enclosing their names in single quotes: `‘macroname1’, ‘macroname2’, ...`:

```stata
program myprog
    version 17.0
    args varname dof beta
    (the rest of the program would be coded in terms of ‘varname’, ‘dof’, and ‘beta’)
    ...
end
```

`syntax` does the second. You specify the new command’s syntax on the `syntax` command; for instance, you might code

```stata
program myprog
    version 17.0
    syntax varlist [if] [in] [, DOF(integer 50) Beta(real 1.0)]
    (the rest of the program would be coded in terms of ‘varlist’, ‘if’, ‘in’, ‘dof’, and ‘beta’)
    ...
end
```

`syntax` examines what the user typed and attempts to match it to the syntax diagram. If it does not match, an error message is issued and the program is stopped (a nonzero return code is returned). If it does match, the individual components are stored in particular local macros where you can subsequently access them. In the example above, the result would be to define the local macros ‘varlist’, ‘if’, ‘in’, ‘dof’, and ‘beta’.

For an introduction to Stata programming, see [U] 18 Programming Stata and especially [U] 18.4 Program arguments.

Standard Stata syntax is

```stata
    cmd [ varlist | namelist | anything ]
    [ if ]
    [ in ]
    [ using filename ]
    [ = exp ]
    [ weight ]
    [ , options ]
```

Each of these building blocks, such as `varlist`, `namelist`, and `if`, is outlined below.
Syntax

Parse Stata syntax positionally

    args macroname1 [ macroname2 [ macroname3 ... ]]  

Parse syntax according to a standard syntax grammar

    syntax description_of_syntax

Syntax, continued

The description_of_syntax allowed by syntax includes

<table>
<thead>
<tr>
<th>description_of_varlist:</th>
<th>nothing</th>
</tr>
</thead>
<tbody>
<tr>
<td>type</td>
<td>nothing</td>
</tr>
<tr>
<td>or</td>
<td>[</td>
</tr>
<tr>
<td>optionally type</td>
<td>varlist varname newvarlist newvarname</td>
</tr>
<tr>
<td>then type one of</td>
<td>(varlist_specifiers)</td>
</tr>
<tr>
<td>optionally type</td>
<td>]</td>
</tr>
<tr>
<td>type</td>
<td>(if you typed [ at the start)</td>
</tr>
</tbody>
</table>

varlist_specifiers are default=none min=# max=# numeric string str# strL fv ts generate (newvarlist and newvarname only)

Examples:

    syntax varlist ...
    syntax [varlist] ...
    syntax varlist(min=2) ...
    syntax varlist(max=4) ...
    syntax varlist(min=2 max=4 numeric) ...
    syntax varlist(default=none) ...
    syntax newvarlist(max=1) ...
    syntax varname ...
    syntax [varname] ...

If you type nothing, the command does not allow a varlist.

Typing [ and ] means that the varlist is optional.

default= specifies how the varlist is to be filled in when the varlist is optional and the user does not specify it. The default is to fill it in with all the variables. If default=none is specified, it is left empty.

min= and max= specify the minimum and maximum number of variables that may be specified. Typing varname is equivalent to typing varlist(max=1).

numeric, string, str#, and strL restrict the specified varlist to consist of entirely numeric, entirely string (meaning str# or strL), entirely str#, or entirely strL variables.

fv allows the varlist to contain factor variables.

ts allows the varlist to contain time-series operators.

generate specifies, for newvarlist or newvarname, that the new variables be created and filled in with missing values.

After the syntax command, the resulting varlist is returned in ‘varlist’. If there are new variables (you coded newvarname or newvarlist), the macro ‘typlist’ is also defined, containing the storage type of each new variable, listed one after the other.
**description_of_namelist:**

- **type** `nothing`
  - optionally type `[` namelist name `(namelist_specifiers)` `]`

  (if you typed `[` at the start)

  **namelist_specifiers are** `name=name id="text" local min=# (namelist only) max=# (namelist only)`

**Examples:**

- `syntax namelist ...`
- `syntax [namelist] ...`
- `syntax name(id="equation name") ...`
- `syntax [namelist(id="equation name") ...`
- `syntax namelist(name=eqlist id="equation list") ...`
- `syntax [name(name=eqname id="equation name") ...`
- `syntax namelist(min=2 max=2) ...`

**namelist** is an alternative to **varlist**; it relaxes the restriction that the names the user specifies be of variables. **name** is a shorthand for **namelist(max=1)**.

**namelist** is for use when you want the command to have the nearly standard syntax of command name followed by a list of names (not necessarily variable names), followed by if, in, options, etc. For instance, perhaps the command is to be followed by a list of variable-label names.

If you type nothing, the command does not allow a namelist. Typing `[` and `]` means that the namelist is optional.

After the **syntax** command, the resulting namelist is returned in `‘namelist’` unless `name=name` is specified, in which case the result is returned in `‘name’`.

**id=** specifies the name of namelist and is used in error messages. The default is `id=namelist`. If **namelist** were required and `id=` was not specified, and the user typed “mycmd if...” (omitting the namelist), the error message would be “namelist required”. If you specified `id="equation name"`, the error message would be “equation name required”.

**name=** specifies the name of the local macro to receive the namelist; not specifying the option is equivalent to specifying `name=namelist`.

**local** specifies that the names that the user specifies satisfy the naming convention for local macro names. If this option is not specified, standard naming convention is used (names may begin with a letter or underscore, may thereafter also include numbers, and must not be longer than 32 characters). If the user specifies an invalid name, an error message will be issued. If **local** is specified, specified names are allowed to begin with numbers but may not be longer than 31 characters.
**description_of Anything:**

- **nothing**
- Optionally type:
  - `[]` anything
  - `(anything_specifiers)`

If you typed `[` at the start, anything is optional.

Examples:
- `syntax anything ...`
- `syntax [anything] ...`
- `syntax anything(id="equation name") ...`
- `syntax [anything(name=0 id=clist equalok)] ...

**Anything Specifiers:**
- `name`=name
- `id`=text
- `equalok`
- `everything`

- anything is for use when you want the command to have the nearly standard syntax of command name followed by something followed by *if*, *in*, *options*, etc. For instance, perhaps the command is to be followed by an expression or expressions or a list of numbers.

If you type nothing, the command does not allow an “anything”. Typing `[` and `]` means the “anything” is optional. After the `syntax` command, the resulting “anything list” is returned in ‘anything’ unless `name=name` is specified, in which case the result is returned in ‘name’.

- `id=` specifies the name of “anything” and is used only in error messages. For instance, if anything were required and `id=` was not specified, and the user typed “mycmd if...” (omitting the “anything”), the error message would be “something required”. If you specified `id="expression list"`, the error message would be “expression list required”.

- `name=` specifies the name of the local macro to receive the “anything”; not specifying the option is equivalent to specifying `name=anything`.

- `equalok` specifies that `=` is not to be treated as part of `exp` in subsequent standard syntax but instead as part of the anything.

- `everything` specifies that *if*, *in*, and *using* are not to be treated as part of standard syntax but instead as part of the anything.

- `varlist`, `varname`, `namelist`, `name`, and `anything` are alternatives; you may specify at most one.

**description_of_if:**

- **nothing**
- Optionally type:
  - `[` if
  - `]`

If you typed `[` at the start, `if` is optional.

Examples:
- `syntax ... if ...
- `syntax ... [if] ...
- `syntax ... [if/] ...
- `syntax ... if/ ...

If you type nothing, the command does not allow an if expression.

Typing `[` and `]` means that the if expression is optional.

After the `syntax` command, the resulting if expression is returned in ‘if’. The macro contains if followed by the expression, unless you specified `/`, in which case the macro contains just the expression.
566 syntax — Parse Stata syntax

description_of_in:

- **nothing**
- optionally type **[**
- optionally type **/**
- optionally type **]**

Examples: `syntax ... in ...`

If you type nothing, the command does not allow an **in** **range**.

Typing **[** and **]** means that the **in** **range** is optional.

After the **syntax** command, the resulting **in** **range** is returned in `‘in’`. The macro contains **in** followed by the range, unless you specified **/**, in which case the macro contains just the range.

description_of_using:

- **nothing**
- optionally type **[**
- optionally type **/**
- optionally type **]**

Examples: `syntax ... using ...`

If you type nothing, the command does not allow **using filename**.

Typing **[** and **]** means that the **using filename** is optional.

After the **syntax** command, the resulting filename is returned in `‘using’`. The macro contains **using** followed by the filename in quotes, unless you specified **/**, in which case the macro contains just the filename without quotes.

description_of_=exp:

- **nothing**
- optionally type **[**
- optionally type **/**
- optionally type **]**

Examples: `syntax ... =exp ...`

If you type nothing, the command does not allow an **=exp**.

Typing **[** and **]** means that the **=exp** is optional.

After the **syntax** command, the resulting expression is returned in `‘exp’`. The macro contains **=**, a space, and the expression, unless you specified **/**, in which case the macro contains just the expression.

Note that **exp** must be a numeric expression; string expressions are not allowed.
description_of_weights:

<table>
<thead>
<tr>
<th>type</th>
<th>nothing</th>
</tr>
</thead>
<tbody>
<tr>
<td>or type</td>
<td>[</td>
</tr>
<tr>
<td>type any</td>
<td>fweight, aweight, pweight, iweight</td>
</tr>
<tr>
<td>optionally</td>
<td>/</td>
</tr>
<tr>
<td>type</td>
<td>]</td>
</tr>
</tbody>
</table>

Examples:  
syntax 
 syntax [fweight] ...  
syntax [fweight pweight] ...  
syntax [pweight fweight] ...  
syntax [fweight pweight iweight/] ...

If you type nothing, the command does not allow weights. A command may not allow both a weight and \( \text{=exp} \).

You must type [ and ]; they are not optional. Weights are always optional.

The first weight specified is the default weight type.

After the \text{syntax} command, the resulting weight and expression are returned in `weight` and `exp`. `weight` contains the weight type or nothing if no weights were specified. `exp` contains `=`, a space, and the expression, unless you specified `/`, in which case the macro contains just the expression.

description_of_options:

<table>
<thead>
<tr>
<th>type</th>
<th>nothing</th>
</tr>
</thead>
<tbody>
<tr>
<td>or type</td>
<td>[</td>
</tr>
<tr>
<td>type</td>
<td>,</td>
</tr>
<tr>
<td>optionally</td>
<td>option_descriptors</td>
</tr>
<tr>
<td>option</td>
<td>*</td>
</tr>
<tr>
<td>optionally</td>
<td>]</td>
</tr>
<tr>
<td>or type</td>
<td>,</td>
</tr>
<tr>
<td>type</td>
<td>option_descriptors</td>
</tr>
<tr>
<td>optionally</td>
<td>[</td>
</tr>
<tr>
<td>optionally</td>
<td>option_descriptors</td>
</tr>
<tr>
<td>option</td>
<td>*</td>
</tr>
<tr>
<td>optionally</td>
<td>]</td>
</tr>
</tbody>
</table>

Examples:  
syntax ... [, Myopt Thisopt]  
syntax ..., Myopt Thisopt  
syntax ..., Myopt [Thisopt]  
syntax ... [, MyOpt Thisopt *]

If you type nothing, the command does not allow options.

The brackets distinguish optional from required options. All options can be optional, all options can be required, or some can be optional and others be required.

After the \text{syntax} command, options are returned to you in local macros based on the first 31 letters of each option's name. If you also specify `*`, any remaining options are collected and placed, one after the other, in `options`.

If you do not specify `*`, an error is returned if the user specifies any options that you do not list.

\textit{option_descriptors} include the following; they are documented below.

- \textit{optionally_on}
- \textit{optionally_off}
- \textit{optional_integer_value}
- \textit{optional_real_value}
- \textit{optional_confidence_interval}
- \textit{optionalcredible_interval}
- \textit{optional_numlist}
- \textit{optional_varlist}
- \textit{optional_namelist}
- \textit{optional_string}
- \textit{optional_passthru}
option_descriptor optionally on:


type OPname

Examples: syntax ..., ... replace ...
syntax ..., ... REPLACE ...
syntax ..., ... detail ...
syntax ..., ... Detail ...
syntax ..., ... CONStant ...

The result of the option is returned in a macro name formed by the first 31 letters of the option’s name. Thus option replace is returned in local macro ‘replace’; option detail, in local macro ‘detail’; and option constant, in local macro ‘constant’.

The macro contains nothing if not specified, or else it contains the macro’s name, fully spelled out.

Warning: Be careful if the first two letters of the option’s name are no, such as the option called notice. You must capitalize at least the N in such cases.

option_descriptor optionally off:


type no OPname

Examples: syntax ..., ... noreplace ...
syntax ..., ... noREPLACE ...
syntax ..., ... nodetail ...
syntax ..., ... noDetail ...
syntax ..., ... noCONStant ...

The result of the option is returned in a macro name formed by the first 31 letters of the option’s name, excluding the no. Thus option noreplace is returned in local macro ‘replace’; option nodetail, in local macro ‘detail’; and option noconstant, in local macro ‘constant’.

The macro contains nothing if not specified, or else it contains the macro’s name, fully spelled out, with a no prefixed. That is, in the noREPLACE example above, macro ‘replace’ contains nothing, or it contains noreplace.

option_descriptor optional integer_value:


type OPname

type (integer # (unless the option is required) )

Examples: syntax ..., ... Count(integer 3) ...
syntax ..., ... SEQuence(integer 1) ...
syntax ..., ... dof(integer -1) ...

The result of the option is returned in a macro name formed by the first 31 letters of the option’s name.

The macro contains the integer specified by the user, or else it contains the default value.

option_descriptor optional real_value:


type OPname

type (real # (unless the option is required) )

Examples: syntax ..., ... Mean(real 2.5) ...
syntax ..., ... SD(real -1) ...

The result of the option is returned in a macro name formed by the first 31 letters of the option’s name.

The macro contains the real number specified by the user, or else it contains the default value.
option_descriptor optional_confidence_interval:
  type OPname (capitalization indicates minimal abbreviation)
  type (cilevel)

Example: syntax ..., ... Level(cilevel) ...

The result of the option is returned in a macro name formed by the first 31 letters of the option’s name.

If the user specifies a valid level for a confidence interval, the macro contains that value; see [R] level. If the user specifies an invalid level, an error message is issued, and the return code is 198.

If the user does not type this option, the macro contains the default level obtained from c(level).

option_descriptor optional_credible_interval:
  type OPname (capitalization indicates minimal abbreviation)
  type (crlevel)

Example: syntax ..., ... CLEVEL(crlevel) ...

The result of the option is returned in a macro name formed by the first 31 letters of the option’s name.

If the user specifies a valid level for a credible interval, the macro contains that value; see [BAYES] set clevel. If the user specifies an invalid level, an error message is issued, and the return code is 198.

If the user does not type this option, the macro contains the default level obtained from c(clevel).

option_descriptor optional_numlist:
  type OPname (capitalization indicates minimal abbreviation)
  type (numlist asc\结尾 or desc\结尾 or nothing
  optionally type integer
  optionally type missingokay
  optionally type min=#
  optionally type max=#
  optionally type >=# or >=# or nothing
  optionally type <=# or <=# or nothing
  optionally type sort
  type )

Examples: syntax ..., ... VALUES(numlist) ...
syntax ..., ... VALUES(numlist max=10 sort) ...
syntax ..., ... TIME(numlist >0) ...
syntax ..., ... FREQUENCY(numlist >0 integer) ...
syntax ..., ... OCCUR(numlist missingokay >=0 <1e+9) ...

The result of the option is returned in a macro name formed by the first 31 letters of the option’s name.

The macro contains the values specified by the user, but listed out, one after the other. For instance, the user might specify time(1(1)4,10) so that the local macro ‘time’ would contain “1 2 3 4 10”.

min and max specify the minimum and maximum number of elements that may be in the list.

<, <=, >, and >= specify the range of elements allowed in the list.

integer indicates that the user may specify integer values only.

missingokay indicates that the user may specify missing values as list elements.

ascending specifies that the user must give the list in ascending order without repeated values. descending specifies that the user must give the list in descending order without repeated values.

sort specifies that the list be sorted before being returned. Distinguish this from modifier ascending, which states that the user must type the list in ascending order. sort says that the user may type the list in any order but it is to be returned in ascending order. ascending states that the list may have no repeated elements. sort places no such restriction on the list.
option_descriptor optional_varlist:

<table>
<thead>
<tr>
<th>type</th>
<th>OPname</th>
<th>(capitalization indicates minimal abbreviation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>optionally type</td>
<td>numeric or string</td>
<td></td>
</tr>
<tr>
<td>optionally type</td>
<td>min=#</td>
<td></td>
</tr>
<tr>
<td>optionally type</td>
<td>max=#</td>
<td></td>
</tr>
<tr>
<td>optionally type</td>
<td>fv</td>
<td></td>
</tr>
<tr>
<td>optionally type</td>
<td>ts</td>
<td></td>
</tr>
<tr>
<td>type</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Examples: syntax ..., ... ROW(varname) ...  
syntax ..., ... BY(varlist) ...  
syntax ..., ... Counts(varname numeric) ...  
syntax ..., ... TItlevar(varname string) ...  
syntax ..., ... Sizes(varlist numeric min=2 max=10) ...

The result of the option is returned in a macro name formed by the first 31 letters of the option’s name. The macro contains the names specified by the user, listed one after the other.

min indicates the minimum number of variables to be specified if the option is given. min=1 is the default.

max indicates the maximum number of variables that may be specified if the option is given. max=800 is the default for varlist (you may set it to be larger), and max=1 is the default for varname.

numeric specifies that the variable list must consist entirely of numeric variables. string specifies that the variable list must consist entirely of string variables, meaning str# or strL. str# and strL specify that the variable list must consist entirely of str# or strL variables, respectively.

fv specifies that the variable list may contain factor variables.

ts specifies that the variable list may contain time-series operators.

option_descriptor optional_namelist:

<table>
<thead>
<tr>
<th>type</th>
<th>OPname</th>
<th>(capitalization indicates minimal abbreviation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>optionally type</td>
<td>namelist or name</td>
<td></td>
</tr>
<tr>
<td>optionally type</td>
<td>min=#</td>
<td></td>
</tr>
<tr>
<td>optionally type</td>
<td>max=#</td>
<td></td>
</tr>
<tr>
<td>optionally type</td>
<td>local</td>
<td></td>
</tr>
<tr>
<td>type</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Examples: syntax ..., ... GENerate(name) ...  
syntax ..., ... MATrix(name) ...  
syntax ..., ... REsults(namelist min=2 max=10) ...

The result of the option is returned in a macro name formed by the first 31 letters of the option’s name. The macro contains the variables specified by the user, listed one after the other.

Do not confuse namelist with varlist. varlist is the appropriate way to specify an option that is to receive the names of existing variables. namelist is the appropriate way to collect names of other things—such as matrices—and namelist is sometimes used to obtain the name of a new variable to be created. It is then your responsibility to verify that the name specified does not already exist as a Stata variable.

min indicates the minimum number of names to be specified if the option is given. min=1 is the default.

max indicates the maximum number of names that may be specified if the option is given. The default is max=1 for name. For namelist, the default is the maximum number of variables allowed in Stata.

local specifies that the names the user specifies are to satisfy the naming convention for local macro names.
option_description optional_string:

<table>
<thead>
<tr>
<th>type</th>
<th>OPname</th>
</tr>
</thead>
<tbody>
<tr>
<td>optionally type</td>
<td>string</td>
</tr>
<tr>
<td>type</td>
<td>asis</td>
</tr>
</tbody>
</table>

Examples:

- syntax ..., ..., Title(string) ...
- syntax ..., ..., XTRAvars(string) ...
- syntax ..., ..., SAVING(string asis) ...

The result of the option is returned in a macro name formed by the first 31 letters of the option's name. The macro contains the string specified by the user, or else it contains nothing.

asis specifies that the option's arguments be returned just as the user typed them, with quotes (if specified) and with any leading and trailing blanks. asis should be specified if the option's arguments might contain suboptions or expressions that contain quoted strings. If you specify asis, be sure to use compound double quotes when referring to the macro.

option_description optional_passthru:

<table>
<thead>
<tr>
<th>type</th>
<th>OPname</th>
</tr>
</thead>
<tbody>
<tr>
<td>type</td>
<td>passthru</td>
</tr>
</tbody>
</table>

Examples:

- syntax ..., ..., Title(passthru) ...
- syntax ..., ..., SAVING(passthru) ...

The result of the option is returned in a macro name formed by the first 31 letters of the option's name. The macro contains the full option—unabbreviated option name, parentheses, and argument—as specified by the user, or else it contains nothing. For instance, if the user typed ti("My Title"), the macro would contain title("My Title").

Remarks and examples

Remarks are presented under the following headings:

Introduction

The args command

The syntax command

Introduction

Stata is programmable, making it possible to implement new commands. This is done with the program definition statement:

```
program newcmd
    ...
end
```

The first duty of the program is to parse the arguments that it receives.

Programmers use positional argument passing for subroutines and for some new commands with exceedingly simple syntax. It is so easy to program. If program myprog is to receive a variable name (call it varname) and two numeric arguments (call them dof and beta), all they need to code is

```
program myprog
    args varname dof beta
    (the rest of the program would be coded in terms of 'varname', 'dof', and 'beta')
    ...
end
```
The disadvantage of this is from the caller’s side, because problems would occur if the caller got the arguments in the wrong order or did not spell out the variable name, etc.

The alternative is to use standard Stata syntax. `syntax` makes it easy to make new command `myprog` have the syntax

```stata
myprog varname [, dof(#) beta(#)]
```

and even to have defaults for `dof()` and `beta()`:

```stata
program myprog
    syntax varlist(max=1) [, Dof(integer 50) Beta(real 1.0)]
    (the rest of the program would be coded in terms of 'varlist', 'dof', and 'beta')
    ... end
```

### The args command

`args` splits what the user typed into words and places the first word in the first macro specified; the second, in the second macro specified; and so on:

```stata
program myprog
    args arg1 arg2 arg3...
    do computations using local macros 'arg1', 'arg2', 'arg3',... 
    end
```

`args` never produces an error. If the user specified more arguments than the macros specified, the extra arguments are ignored. If the user specified fewer arguments, the extra macros are set to contain "".

A better version of this program would read

```stata
program myprog
    version 17.0 ← new 
    args arg1 arg2 arg3...
    do computations using local macros 'arg1', 'arg2', 'arg3',...
    end
```

Placing `version 17.0` as the first line of the program ensures that the command will continue to work with future versions of Stata; see [U] 16.1.1 Version and [P] version. We will include the `version` line from now on.

#### Example 1

The following command displays the three arguments it receives:

```
. program argdisp
  1.       version 17.0
  2.       args first second third
  3.       display "1st argument = 'first'"
  4.       display "2nd argument = 'second'"
  5.       display "3rd argument = 'third'"
  6.       end
. argdisp cat dog mouse
1st argument = cat
2nd argument = dog
3rd argument = mouse
. argdisp 3.456 2+5-12 X*3+cat
1st argument = 3.456
2nd argument = 2+5-12
3rd argument = X*3+cat
```
Arguments are defined by the spaces that separate them. “X*3+cat” is one argument, but if we had typed “X*3 + cat”, that would have been three arguments.

If the user specifies fewer arguments than expected by `args`, the additional local macros are set as empty. By the same token, if the user specifies too many, they are ignored:

```
. argdisp cat dog
1st argument = cat
2nd argument = dog
3rd argument =

. argdisp cat dog mouse cow
1st argument = cat
2nd argument = dog
3rd argument = mouse
```

**Technical note**

When a program is invoked, exactly what the user typed is stored in the macro ‘0’. Also the first word of that is stored in ‘1’; the second, in ‘2’; and so on. `args` merely copies the ‘1’, ‘2’, … macros. Coding

```
args arg1 arg2 arg3
```

is no different from coding

```
local arg1 `"1"`
local arg2 `"2"`
local arg3 `"3"`
```

**The syntax command**

`syntax` is easy to use. `syntax` parses standard Stata syntax, which is

```
command varlist if exp in range [weight] using filename, options
```

Actually, standard syntax is a little more complicated than that because you can substitute other things for `varlist`. In any case, the basic idea is that you code a `syntax` command describing which parts of standard Stata syntax you expect to see. For instance, you might code

```
syntax varlist if in, title(string) adjust(real 1)
```

or

```
syntax [varlist] [if] [in] [, title(string) adjust(real 1)]
```

In the first example, you are saying that everything is required. In the second, everything is optional. You can make some elements required and others optional:

```
syntax varlist [if] [in], adjust(real) [title(string)]
```

or

```
syntax varlist [if] [in] [, adjust(real 1) title(string)]
```

or many other possibilities. Square brackets denote that something is optional. Put them around what you wish.
You code what you expect the user to type. `syntax` then compares that with what the user actually did type, and, if there is a mismatch, `syntax` issues an error message. Otherwise, `syntax` processes what the user typed and stores the pieces, split into categories, in macros. These macros are named the same as the syntactical piece:

The varlist specified will go into ‘varlist’
The if exp will go into ‘if’
The in range will go into ‘in’
The adjust() option’s contents will go into ‘adjust’
The title() option’s contents will go into ‘title’

Go back to the section `Syntax, continued`; where each element is stored is explicitly stated. When a piece is not specified by the user, the corresponding macro is cleared.

### Example 2

The following program simply displays the pieces:

```
. program myprog
 1. version 17.0
 2. syntax varlist [if] [in] [ , adjust(real 1) title(string)]
 3. display "varlist contains |'varlist'|"
 4. display " if contains |'if'|"
 5. display " in contains |'in'|"
 6. display " adjust contains |'adjust'|"
 7. display " title contains |'title'|"
 8. end

. myprog mpg weight
varlist required
r(100);
```

Well, that should not surprise us; we said that the varlist was required in the `syntax` command, so when we tried `myprog` without explicitly specifying a varlist, Stata complained.

```
. myprog mpg weight
varlist contains |mpg weight|
   if contains ||
in contains ||
adjust contains |1|
title contains ||

. myprog mpg weight if foreign
varlist contains |mpg weight|
   if contains |if foreign|
in contains ||
adjust contains |1|
title contains ||

. myprog mpg weight in 1/20
varlist contains |mpg weight|
   if contains ||
in contains |in 1/20|
adjust contains |1|
title contains ||

. myprog mpg weight in 1/20 if foreign
varlist contains |mpg weight|
   if contains |if foreign|
in contains |in 1/20|
adjust contains |1|
title contains ||
```
Example 3

After completing the last example, it would not be difficult to actually make myprog do something. For lack of a better example, we will change myprog to display the mean of each variable, with said mean multiplied by adjust():

```stata
program myprog
    version 17.0
    syntax varlist [if] [in] [ , adjust(real 1) title(string) ]
    display 
        if "'title'" != "" {
            display "'title':"
        }
    foreach var of local varlist {
        quietly summarize 'var' 'if' 'in'
        display %9s "'var':" %9.0g r(mean)*'adjust'
    }
end
```

`myprog mpg weight`

```
mpg  21.2973
weight  3019.459
```

`myprog mpg weight if foreign==1`

```
mpg  24.77273
weight  2315.909
```

`myprog mpg weight if foreign==1, title("My title")`

```
My title:
mpg  24.77273
weight  2315.909
```

`myprog mpg weight if foreign==1, title("My title") adjust(2)`

```
My title:
mpg  49.54545
weight  4631.818
```

Technical note

myprog is hardly deserving of any further work, given what little it does, but let’s illustrate two ideas that use it.
First, we will learn about the `marksample` command; see [P] `mark`. A common mistake is to use one sample in one part of the program and a different sample in another part. The solution is to create at the outset a variable that contains 1 if the observation is to be used and 0 otherwise. `marksample` will do this correctly because `marksample` knows what `syntax` has just parsed:

```
program myprog
    version 17.0
    syntax varlist [if] [in] [, adjust(real 1) title(string)]
    marksample touse ← new
    display if "'title'" != "" {
        display 'title':"
    }
    foreach var of local varlist {
        quietly summarize 'var' if 'touse' ← changed
        display %9s 'var' " " %9.0g r(mean)*'adjust'
    }
end
```

Second, we will modify our program so that what is done with each variable is done by a subroutine. Pretend here that we are doing something more involved than calculating and displaying a mean.

We want to make this modification to show you the proper use of the `args` command. Passing arguments by position to subroutines is convenient, and there is no chance of error due to arguments being out of order (assuming that we wrote our program properly):

```
program myprog
    version 17.0
    syntax varlist [if] [in] [, adjust(real 1) title(string)]
    marksample touse display if "'title'" != "" {
        display 'title':"
    }
    foreach var of local varlist {
        doavar 'touse' 'var' 'adjust'
    }
end

program doavar
    version 17.0
    args touse name value
    quietly summarize 'name' if 'touse'
    display %9s 'name' " " %9.0g r(mean)*'value'
end
```
Also see

[P] gettoken — Low-level parsing
[P] mark — Mark observations for inclusion
[P] numlist — Parse numeric lists
[P] program — Define and manipulate programs
[P] tokenize — Divide strings into tokens
[P] unab — Unabbreviate variable list
[TS] tsrevar — Time-series operator programming command
[U] 11 Language syntax
[U] 16.1.1 Version
[U] 18 Programming Stata
[U] 18.3.1 Local macros
[U] 18.3.5 Double quotes
sysdir — Query and set system directories

Description

sysdir lists Stata’s system directories.

sysdir set changes the path to Stata’s system directories.

personal displays the path of the PERSONAL directory. personal dir gives a directory listing of the files contained in the PERSONAL directory.

adopath displays the ado-file path stored in the global macro $ADO.

adopath + adds a new directory or moves an existing directory to the end of the search path stored in the global macro $ADO.

adopath ++ adds a new directory or moves an existing directory to the beginning of the search path stored in the global macro $ADO.

adopath - removes a directory from the search path stored in the global macro $ADO.

set adosize sets the maximum amount of memory in kilobytes that automatically loaded do-files may consume. The default is set adosize 1000. To view the current setting, type display c(adosize).

These commands have to do with technical aspects of Stata’s implementation. Except for sysdir list, you should never have to use them.

Syntax

List Stata’s system directories

sysdir [list]

Reset Stata’s system directories

sysdir set codeword ["]path["]

Display path of PERSONAL directory and list files in it

personal [dir]

Display ado-file path

adopath

Add directory to end of ado-path

adopath + path_or_codeword
Add directory to beginning of ado-path

    adopath ++ path_or.codeword

Remove directory from ado-path

    adopath - \{ path_or.codeword | # \}

Set maximum memory ado-files may consume

    set adosize # [, permanently ] 10 ≤ # ≤ 10000

where path must be enclosed in double quotes if it contains blanks or other special characters and codeword is \{ STATA | BASE | SITE | PLUS | PERSONAL | OLDPLACE \}.

Option

permanently specifies that, in addition to making the change right now, the adosize setting be remembered and become the default setting when you invoke Stata.

Remarks and examples

Remarks are presented under the following headings:

    Introduction
    sysdir
    adopath
    set adosize

Introduction

In various parts of the Stata documentation, you will read that “Stata searches along the ado-path” for such-and-such. When we say that, what we really mean is “Stata searches along the path stored in the global macro $S AD0”. Equivalently, we could say “searches along the path stored in c(adopath)” because c(adopath) = $S AD0. These are just two different ways of saying the same thing. If you wanted to change the path, however, you would change the $S AD0 because there is no way to change c(adopath).

Do not, however, directly change $S AD0. Even if you have good reason to change it, you will find it easier to change it via the adopath command.

If you were to look inside $S AD0 (and we will), you would discover that it does not actually contain directory names—although it could—but contains codewords that stand for directory names. The sysdir command will show you the meaning of the codewords and allow you to change them.
sysdir

Stata expects to find various parts of itself in various directories (folders). Rather than describing these directories as C:\Program Files\Stata17\ado\base or /usr/local/stata/ado, these places are referred to by codewords. Here are the definitions of the codewords on a particular Windows computer:

```
.sysdir
   STATA: C:\Program Files\Stata17\
   BASE: C:\Program Files\Stata17\ado\base\n   SITE: C:\Program Files\Stata17\ado\site\n   PLUS: C:\ado\plus\n   PERSONAL: C:\ado\personal\n   OLDPLACE: C:\ado\n```

Even if you use Stata for Windows, when you type `sysdir`, you might see different directories listed.

The `sysdir` command allows you to obtain the correspondence between codeword and actual directory, and it allows you to change the mapping. Each directory serves a particular purpose:

- **STATA** refers to the directory where the Stata executable is to be found.
- **BASE** is where the original official ado-files that were shipped with Stata and any updated official ado-files that have been made available since then are installed.
- **SITE** is relevant only on networked computers. It is where administrators may place ado-files for sitewide use on networked computers. No Stata command writes to this directory, but administrators may move files into the directory or obtain ado-files by using `net` and choose to install them into this directory; see [R] `net`.
- **PLUS** is relevant on all systems. It is where ado-files written by other people that you obtain using the `net` command are installed; by default, `net` installs files to this directory; see [R] `net`.
- **PERSONAL** is where you are to copy ado-files that you write and that you wish to use regardless of your current directory when you use Stata. (The alternative is to put ado-files in your current directory, and then they will be available only when you are in that directory.)
- **OLDPLACE** is included for backward compatibility. Stata 5 users used to put ado-files here, both the personal ones and the ones written by others. Nowadays, they are supposed to put their personal files in `PERSONAL` and the ones written by others in `PLUS`.

Do not change the definitions of **BASE**. You may want to change the definitions of **SITE**, **PERSONAL**, **PLUS**, or especially **OLDPLACE**. For instance, if you want to change the definition of **OLDPLACE** to d:\ado, type

```
.sysdir set OLDPLACE "d:\ado"
```

Resetting a system directory affects only the current session; the next time you enter Stata, the system directories will be set back to being as they originally were. If you want to reset a system directory permanently, place the `sysdir set` command in your `profile.do`; see [GSW] B.3 Executing commands every time Stata is started, [GSM] B.1 Executing commands every time Stata is started, or [GSU] B.1 Executing commands every time Stata is started.
adopath

adopath displays and resets the contents of the global macro $S_ADO$, the path over which Stata searches for ado-files. The default search path is

```
  . adopath
  1 (BASE) "C:\Program Files\Stata17\ado\base"
  2 (SITE) "C:\Program Files\Stata17\ado\site"
  3  
  4 (PERSONAL) "C:\ado\personal"
  5 (PLUS) "C:\ado\plus"
  6 (OLDPLACE) "C:\ado"
  7 "C:\myprogs"
```

Focus on the codewords on the left. adopath mentions the actual directories, but if you changed the meaning of a codeword by using sysdir, that change would affect adopath.

The above states that, when Stata looks for an ado-file, first it looks in BASE. If the ado-file is found, then that copy is used. If it is not found, then Stata next looks in SITE, and if it is found there, then that copy is used. And so the process continues. At the fourth step, Stata looks in the current directory (for which there is no codeword).

adopath merely presents the information in $S_ADO$ in a more readable form:

```
  . display "$S_ADO"
  BASE;SITE;.;PERSONAL;PLUS;OLDPLACE
```

adopath can also change the contents of the path. In general, you should not do this unless you are sure of what you are doing because many features of Stata will stop working if you change the path incorrectly. At worst, however, you might have to exit and reenter Stata, so you cannot do any permanent damage. Moreover, it is safe to add to the end of the path.

The path may include actual directory names, such as C:\myprogs, or codewords, such as PERSONAL, PLUS, and OLDPLACE. To add C:\myprogs to the end of the path, type

```
  . adopath + C:\myprogs
  1 (BASE) "C:\Program Files\Stata17\ado\base"
  2 (SITE) "C:\Program Files\Stata17\ado\site"
  3  
  4 (PERSONAL) "C:\ado\personal"
  5 (PLUS) "C:\ado\plus"
  6 (OLDPLACE) "C:\ado"
  7 "C:\myprogs"
```

If later you want to remove C:\myprogs from the ado-path, you could type adopath - C:\myprogs, but easier is

```
  . adopath - 8
  1 (BASE) "C:\Program Files\Stata17\ado\base"
  2 (SITE) "C:\Program Files\Stata17\ado\site"
  3  
  4 (PERSONAL) "C:\ado\personal"
  5 (PLUS) "C:\ado\plus"
  6 (OLDPLACE) "C:\ado"
```

When followed by a number, 'adopath -' removes that element from the path. If you cannot remember what the numbers are, you can first type adopath without arguments.

Technical note

adopath ++ path works like adopath + path, except that it adds to the beginning rather than to the end of the path. Our recommendation is that you not do this. When looking for name.ado, Stata
loads the first file it encounters as it searches along the path. If you did not like our implementation of the command `ci`, for instance, even if you wrote your own and stored it in `ci.ado`, Stata would continue to use the one in the Stata directory because that is the directory listed earlier in the path. To force Stata to use yours rather than ours, you would have to put at the front of the path the name of the directory where your ado-file resides.

You should not, however, name any of your ado-files the same as we have named ours. If you add to the front of the path, you assume exclusive responsibility for the Stata commands working as documented in this manual.

set adosize

Stata keeps track of the ado-commands you use and discards from memory commands that have not been used recently. Stata discards old commands to keep the amount of memory consumed by such commands less than `adosize`. The default value of 1,000 means the total amount of memory consumed by ado-commands is not to exceed 1,000 KB. When an ado-command has been discarded, Stata will have to reload the command the next time you use it.

You can increase `adosize`. Typing `set adosize 1550` would allow up to 1,550 KB to be allocated to ado-commands. This would improve performance slightly if you happened to use one of the not-recently-used commands, but at the cost of some memory no longer being available for your dataset. In practice, there is little reason to increase `adosize`.

`adosize` must be between 10 and 10,000.

Also see

[R] net — Install and manage community-contributed additions from the Internet
[R] query — Display system parameters
[R] update — Check for official updates
[U] 17.5 Where does Stata look for ado-files?
Description

`tabdisp` displays data in a table. `tabdisp` calculates no statistics and is intended for use by programmers.

For the corresponding command that calculates statistics and displays them in a table, see `[R] table`. Although `tabdisp` is intended for programming applications, it can be used interactively for listing data.

Syntax

```
tabdisp rowvar [ colvar [ supercolvar ] ] [ if ] [ in ], cellvar(varnames)

[ by(superrowvars) format(,%fmt) center left concise missing totals
dotz cellwidth(#) csepwidth(#) scsepwidth(#) stubwidth(#)
```

by is allowed; see [D] by.

`rowvar`, `colvar`, and `supercolvar` may be numeric or string variables. Rows, columns, supercolumns, and superrows are thus defined as

<table>
<thead>
<tr>
<th></th>
<th>supercol 1</th>
<th>supercol 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>col 1</td>
<td>col 2</td>
</tr>
<tr>
<td>row 1</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>row 2</td>
<td>.</td>
<td>.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>superrow 1:</th>
<th>superrow 2:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>col 1</td>
<td>col 2</td>
</tr>
<tr>
<td>superrow 1:</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>row 1</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>row 2</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>superrow 2:</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>row 1</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>row 2</td>
<td>.</td>
<td>.</td>
</tr>
</tbody>
</table>
Options

cellvar(\texttt{varnames}) is required; it specifies the numeric or string variables containing the values to be displayed in the table’s cells. Up to five variable names may be specified.

by(\texttt{superrowvars}) specifies numeric or string variables to be treated as superrows. Up to four variables may be specified.

format(\%\texttt{fmt}) specifies the display format for presenting numbers in the table’s cells. \texttt{format(\%9.0g)} is the default; \texttt{format(\%9.2f)} is a popular alternative. The width of the format you specify does not matter, except that \%\texttt{fmt} must be valid. The width of the cells is chosen by \texttt{tabdisp} to be what it thinks looks best. The cellwidth() option allows you to override \texttt{tabdisp}'s choice.

center specifies that results be centered in the table’s cells. The default is to right-align results. For centering to work well, you typically need to specify a display format as well. center format(\%9.2f) is popular.

left specifies that column labels be left-aligned. The default is to right-align column labels to distinguish them from supercolumn labels, which are left-aligned. If you specify left, both column and supercolumn labels are left-aligned.

concise specifies that rows with all missing entries not be displayed.

missing specifies that, in cells containing missing values, the missing value (., .a, .b, ..., or .z) be displayed. The default is that cells with missing values are left blank.

totals specifies that observations where \texttt{rowvar}, \texttt{colvar}, \texttt{supercolvar}, or \texttt{superrowvars} contain the system missing value (.) be interpreted as containing the corresponding totals of \texttt{cellvar()}, and that the table be labeled accordingly. If the dotz option is also specified, observations where the stub variables contain .z will be thus interpreted.

dotz specifies that the roles of missing values . and .z be interchanged in labeling the stubs of the table. By default, if any of \texttt{rowvar}, \texttt{colvar}, \texttt{supercolvar}, and \texttt{superrowvars} contains missing (., .a, .b, ..., or .z), then “.” is placed last in the ordering. dotz specifies that .z be placed last. Also, if option totals is specified, .z values rather than “.” values will be labeled “Total”.

cellwidth(#) specifies the width of the cell in units of digit widths; 10 means the space occupied by 10 digits, which is 0123456789. The default cellwidth() is not a fixed number but rather a number chosen by \texttt{tabdisp} to spread the table out while presenting a reasonable number of columns across the page.

csepwidth(#) specifies the separation between columns in units of digit widths. The default is not a fixed number but rather a number chosen by \texttt{tabdisp} according to what it thinks looks best.

scsepwidth(#) specifies the separation between supercolumns in units of digit widths. The default is not a fixed number but rather a number chosen by \texttt{tabdisp} according to what it thinks looks best.

stubwidth(#) specifies the width, in units of digit widths, to be allocated to the left stub of the table. The default is not a fixed number but rather a number chosen by \texttt{tabdisp} according to what it thinks looks best.

Remarks and examples

Remarks are presented under the following headings:

- Limits
- Introduction
- Treatment of string variables
- Treatment of missing values
Limits

Up to four variables may be specified in the by() option, so with the three row, column, and supercolumn variables, seven-way tables may be displayed.

Up to five variables may be displayed in each cell of the table.

The sum of the number of rows, columns, supercolumns, and superrows is called the number of margins. A table may contain up to 3,000 margins. Thus a one-way table may contain 3,000 rows. A two-way table could contain 2,998 rows and 2 columns, 2,997 rows and 3 columns, ..., 1,500 rows and 1,500 columns, ..., or 2 rows and 2,998 columns. A three-way table is similarly limited by the sum of the number of rows, columns, and supercolumns. An \( r \times c \times d \) table is feasible if \( r + c + d \leq 3,000 \). The limit is set in terms of the sum of the rows, columns, supercolumns, and superrows—not, as you might expect, their product.

Introduction

If you have not read [R] table, please do so. tabdisp is what table uses to display the tables.

tabdisp calculates nothing. tabdisp instead displays the data in memory. In this, think of tabdisp as an alternative to list. Consider the following little dataset:

```stata
.use https://www.stata-press.com/data/r17/tabdxmpl1
.list

<table>
<thead>
<tr>
<th></th>
<th>a</th>
<th>b</th>
<th>c</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>0</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>2.</td>
<td>0</td>
<td>2</td>
<td>26</td>
</tr>
<tr>
<td>3.</td>
<td>0</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>4.</td>
<td>1</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>5.</td>
<td>1</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>6.</td>
<td>1</td>
<td>3</td>
<td>7</td>
</tr>
</tbody>
</table>
```

We can use tabdisp to list it:

```
.tabdisp a b, cell(c)
```

<table>
<thead>
<tr>
<th></th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>1 2 3</td>
</tr>
<tr>
<td></td>
<td>15 26 11</td>
</tr>
<tr>
<td>1</td>
<td>14 12  7</td>
</tr>
</tbody>
</table>

tabdisp is merely an alternative way to list the data. It is when the data in memory are statistics by category that tabdisp becomes really useful. table provides one prepackaging of that idea.

Unlike list, tabdisp is unaffected by the order of the data. Here are the same data in a different order:
. use https://www.stata-press.com/data/r17/tabdxmpl2
. list

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

and yet the output of `tabdisp` is unaffected.

. tabdisp a b, cell(c)

<table>
<thead>
<tr>
<th></th>
<th>b</th>
<th>c</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td></td>
<td>a</td>
</tr>
<tr>
<td>0</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>14</td>
<td>1</td>
</tr>
</tbody>
</table>

Nor does `tabdisp` care if one of the cells is missing in the data.

. drop in 6
   (1 observation deleted)
. tabdisp a b, cell(c)

<table>
<thead>
<tr>
<th></th>
<th>b</th>
<th>c</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td></td>
<td>a</td>
</tr>
<tr>
<td>0</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>14</td>
<td>1</td>
</tr>
</tbody>
</table>

On the other hand, `tabdisp` assumes that each value combination of the row, column, superrow, and supercolumn variables occurs only once. If that is not so, `tabdisp` displays the earliest occurring value:

. input
da   b   c
   6. 0 1 99
   7. end
. list

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
Thus our previous claim that `tabdisp` was unaffected by sort order has this one exception.

Finally, `tabdisp` uses variable and value labels when they are defined:

```
. label var a "Sex"
. label define sex 0 male 1 female
. label values a sex
. label var b "Treatment Group"
. label def tg 1 "controls" 2 "low dose" 3 "high dose"
. label values b tg
. tabdisp a b, cell(c)
```

<table>
<thead>
<tr>
<th>Sex</th>
<th>Treatment Group</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>controls</td>
<td>low dose</td>
</tr>
<tr>
<td>male</td>
<td>15</td>
<td>11</td>
</tr>
<tr>
<td>female</td>
<td>14</td>
<td>12</td>
</tr>
</tbody>
</table>

There are two things you can do with `tabdisp`. 

```
. tabdisp a, cell(c)

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>15 11</td>
</tr>
<tr>
<td>1</td>
<td>14 12 7</td>
</tr>
</tbody>
</table>
```
You can use it to list data, but be certain that you have a unique identifier. In the automobile dataset, the variable make is unique:

```
. use https://www.stata-press.com/data/r17/auto2, clear
   (1978 automobile data)
. list make mpg weight displ rep78
```

<table>
<thead>
<tr>
<th>make</th>
<th>mpg</th>
<th>weight</th>
<th>displ</th>
<th>rep78</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMC Concord</td>
<td>22</td>
<td>2,930</td>
<td>121</td>
<td>Average</td>
</tr>
<tr>
<td>AMC Pacer</td>
<td>17</td>
<td>3,350</td>
<td>258</td>
<td>Average</td>
</tr>
<tr>
<td>AMC Spirit</td>
<td>22</td>
<td>2,640</td>
<td>121</td>
<td></td>
</tr>
<tr>
<td>Buick Century</td>
<td>20</td>
<td>3,250</td>
<td>196</td>
<td>Average</td>
</tr>
<tr>
<td>Buick Electra</td>
<td>15</td>
<td>4,080</td>
<td>350</td>
<td></td>
</tr>
<tr>
<td>Buick LeSabre</td>
<td>18</td>
<td>3,670</td>
<td>231</td>
<td>Average</td>
</tr>
<tr>
<td>Buick Opel</td>
<td>26</td>
<td>2,230</td>
<td>304</td>
<td></td>
</tr>
<tr>
<td>Buick Regal</td>
<td>20</td>
<td>3,280</td>
<td>196</td>
<td>Average</td>
</tr>
<tr>
<td>Buick Riviera</td>
<td>16</td>
<td>3,880</td>
<td>231</td>
<td>Average</td>
</tr>
<tr>
<td>Buick Skylark</td>
<td>19</td>
<td>3,400</td>
<td>231</td>
<td>Average</td>
</tr>
<tr>
<td>Cad. Deville</td>
<td>14</td>
<td>4,330</td>
<td>425</td>
<td>Average</td>
</tr>
<tr>
<td>Cad. Eldorado</td>
<td>14</td>
<td>3,900</td>
<td>350</td>
<td>Fair</td>
</tr>
<tr>
<td>Cad. Seville</td>
<td>21</td>
<td>4,290</td>
<td>350</td>
<td>Average</td>
</tr>
<tr>
<td>Chev. Chevette</td>
<td>29</td>
<td>2,110</td>
<td>231</td>
<td>Average</td>
</tr>
<tr>
<td>Chev. Impala</td>
<td>16</td>
<td>3,690</td>
<td>250</td>
<td>Good</td>
</tr>
<tr>
<td>Chev. Malibu</td>
<td>22</td>
<td>3,180</td>
<td>200</td>
<td>Average</td>
</tr>
<tr>
<td>Chev. Monte Carlo</td>
<td>22</td>
<td>3,220</td>
<td>200</td>
<td>Fair</td>
</tr>
<tr>
<td>Chev. Monza</td>
<td>24</td>
<td>2,750</td>
<td>151</td>
<td>Fair</td>
</tr>
<tr>
<td>Chev. Nova</td>
<td>19</td>
<td>3,430</td>
<td>250</td>
<td>Average</td>
</tr>
<tr>
<td>Dodge Colt</td>
<td>30</td>
<td>2,120</td>
<td>98</td>
<td>Excellent</td>
</tr>
<tr>
<td>Dodge Diplomat</td>
<td>18</td>
<td>3,600</td>
<td>318</td>
<td>Fair</td>
</tr>
<tr>
<td>Dodge Magnum</td>
<td>16</td>
<td>3,600</td>
<td>318</td>
<td>Fair</td>
</tr>
<tr>
<td>Dodge St. Regis</td>
<td>17</td>
<td>3,740</td>
<td>225</td>
<td>Fair</td>
</tr>
<tr>
<td>Ford Fiesta</td>
<td>28</td>
<td>1,800</td>
<td>98</td>
<td>Good</td>
</tr>
<tr>
<td>Ford Mustang</td>
<td>21</td>
<td>2,650</td>
<td>140</td>
<td>Average</td>
</tr>
<tr>
<td>Linc. Continental</td>
<td>12</td>
<td>4,840</td>
<td>400</td>
<td>Average</td>
</tr>
<tr>
<td>Linc. Mark V</td>
<td>12</td>
<td>4,720</td>
<td>400</td>
<td>Average</td>
</tr>
<tr>
<td>Linc. Versailles</td>
<td>14</td>
<td>3,830</td>
<td>302</td>
<td>Average</td>
</tr>
<tr>
<td>Merc. Bobcat</td>
<td>22</td>
<td>2,580</td>
<td>140</td>
<td>Good</td>
</tr>
<tr>
<td>Merc. Cougar</td>
<td>14</td>
<td>4,060</td>
<td>302</td>
<td>Good</td>
</tr>
<tr>
<td>Merc. Marquis</td>
<td>15</td>
<td>3,720</td>
<td>302</td>
<td>Average</td>
</tr>
<tr>
<td>Merc. Monarch</td>
<td>18</td>
<td>3,370</td>
<td>250</td>
<td>Average</td>
</tr>
<tr>
<td>Merc. XR-7</td>
<td>14</td>
<td>4,130</td>
<td>302</td>
<td>Good</td>
</tr>
<tr>
<td>Merc. Zephyr</td>
<td>20</td>
<td>2,830</td>
<td>140</td>
<td>Average</td>
</tr>
<tr>
<td>Olds 98</td>
<td>21</td>
<td>4,060</td>
<td>350</td>
<td>Good</td>
</tr>
<tr>
<td>Olds Cutl Supr</td>
<td>19</td>
<td>3,310</td>
<td>231</td>
<td>Average</td>
</tr>
<tr>
<td>Olds Cutlass</td>
<td>19</td>
<td>3,300</td>
<td>231</td>
<td>Average</td>
</tr>
<tr>
<td>Olds Delta 88</td>
<td>18</td>
<td>3,690</td>
<td>231</td>
<td>Good</td>
</tr>
<tr>
<td>Olds Omega</td>
<td>19</td>
<td>3,370</td>
<td>231</td>
<td>Average</td>
</tr>
<tr>
<td>Olds Starfire</td>
<td>24</td>
<td>2,730</td>
<td>151</td>
<td>Poor</td>
</tr>
<tr>
<td>Olds Toronado</td>
<td>16</td>
<td>4,030</td>
<td>350</td>
<td>Average</td>
</tr>
<tr>
<td>Plym. Arrow</td>
<td>28</td>
<td>3,260</td>
<td>156</td>
<td>Average</td>
</tr>
<tr>
<td>Plym. Champ</td>
<td>34</td>
<td>1,800</td>
<td>86</td>
<td>Excellent</td>
</tr>
<tr>
<td>Make and model</td>
<td>Mileage (mpg)</td>
<td>Weight (lbs.)</td>
<td>displacement</td>
<td>rep78</td>
</tr>
<tr>
<td>------------------</td>
<td>---------------</td>
<td>---------------</td>
<td>--------------</td>
<td>-------</td>
</tr>
<tr>
<td>AMC Concord</td>
<td>22</td>
<td>2,930</td>
<td>121</td>
<td>Average</td>
</tr>
<tr>
<td>AMC Pacer</td>
<td>17</td>
<td>3,350</td>
<td>258</td>
<td>Average</td>
</tr>
<tr>
<td>AMC Spirit</td>
<td>22</td>
<td>2,640</td>
<td>121</td>
<td>Average</td>
</tr>
<tr>
<td>Audi 5000</td>
<td>17</td>
<td>2,830</td>
<td>131</td>
<td>Excellent</td>
</tr>
<tr>
<td>Audi Fox</td>
<td>23</td>
<td>2,070</td>
<td>97</td>
<td>Average</td>
</tr>
<tr>
<td>BMW 320i</td>
<td>25</td>
<td>2,650</td>
<td>121</td>
<td>Good</td>
</tr>
<tr>
<td>Buick Century</td>
<td>20</td>
<td>3,250</td>
<td>196</td>
<td>Average</td>
</tr>
<tr>
<td>Buick Electra</td>
<td>15</td>
<td>4,080</td>
<td>350</td>
<td>Good</td>
</tr>
<tr>
<td>Buick LeSabre</td>
<td>18</td>
<td>3,670</td>
<td>231</td>
<td>Average</td>
</tr>
<tr>
<td>Buick Opel</td>
<td>26</td>
<td>2,230</td>
<td>304</td>
<td></td>
</tr>
<tr>
<td>Buick Regal</td>
<td>20</td>
<td>3,280</td>
<td>196</td>
<td>Average</td>
</tr>
<tr>
<td>Buick Riviera</td>
<td>16</td>
<td>3,880</td>
<td>231</td>
<td>Average</td>
</tr>
<tr>
<td>Buick Skylark</td>
<td>19</td>
<td>3,400</td>
<td>231</td>
<td>Average</td>
</tr>
<tr>
<td>Cad. Deville</td>
<td>14</td>
<td>4,330</td>
<td>425</td>
<td>Average</td>
</tr>
<tr>
<td>Cad. Eldorado</td>
<td>14</td>
<td>3,900</td>
<td>350</td>
<td>Fair</td>
</tr>
<tr>
<td>Cad. Seville</td>
<td>21</td>
<td>4,290</td>
<td>350</td>
<td>Average</td>
</tr>
<tr>
<td>Chev. Chevette</td>
<td>29</td>
<td>2,110</td>
<td>231</td>
<td>Average</td>
</tr>
<tr>
<td>Chev. Impala</td>
<td>16</td>
<td>3,690</td>
<td>250</td>
<td>Good</td>
</tr>
<tr>
<td>Chev. Malibu</td>
<td>22</td>
<td>3,180</td>
<td>200</td>
<td>Average</td>
</tr>
<tr>
<td>Chev. Monte Carlo</td>
<td>22</td>
<td>3,220</td>
<td>200</td>
<td>Fair</td>
</tr>
<tr>
<td>Car Model</td>
<td>Engine Size</td>
<td>Horsepower</td>
<td>Condition</td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
<td>------------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>Chev. Monza</td>
<td>24</td>
<td>2,750</td>
<td>Fair</td>
<td></td>
</tr>
<tr>
<td>Chev. Nova</td>
<td>19</td>
<td>3,430</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Datsun 200</td>
<td>23</td>
<td>2,370</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>Datsun 210</td>
<td>35</td>
<td>2,020</td>
<td>Excellent</td>
<td></td>
</tr>
<tr>
<td>Datsun 510</td>
<td>24</td>
<td>2,280</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>Datsun 810</td>
<td>21</td>
<td>2,750</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>Dodge Colt</td>
<td>30</td>
<td>2,120</td>
<td>Excellent</td>
<td></td>
</tr>
<tr>
<td>Dodge Diplomat</td>
<td>18</td>
<td>3,600</td>
<td>Fair</td>
<td></td>
</tr>
<tr>
<td>Dodge Magnum</td>
<td>16</td>
<td>3,600</td>
<td>Fair</td>
<td></td>
</tr>
<tr>
<td>Dodge St. Regis</td>
<td>17</td>
<td>3,740</td>
<td>Fair</td>
<td></td>
</tr>
<tr>
<td>Fiat Strada</td>
<td>21</td>
<td>2,130</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Ford Fiesta</td>
<td>28</td>
<td>1,800</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>Ford Mustang</td>
<td>21</td>
<td>2,650</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Honda Accord</td>
<td>25</td>
<td>2,240</td>
<td>Excellent</td>
<td></td>
</tr>
<tr>
<td>Honda Civic</td>
<td>28</td>
<td>1,760</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>Linc. Continental</td>
<td>12</td>
<td>4,840</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Linc. Mark V</td>
<td>12</td>
<td>4,720</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Linc. Versailles</td>
<td>14</td>
<td>3,830</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Mazda GLC</td>
<td>30</td>
<td>1,980</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>Merc. Bobcat</td>
<td>22</td>
<td>2,580</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>Merc. Cougar</td>
<td>14</td>
<td>4,060</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>Merc. Marquis</td>
<td>15</td>
<td>3,720</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Merc. Monarch</td>
<td>18</td>
<td>3,370</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Merc. XR-7</td>
<td>14</td>
<td>4,130</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>Merc. Zephyr</td>
<td>20</td>
<td>2,830</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Olds 98</td>
<td>21</td>
<td>4,060</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>Olds Cutl Supr</td>
<td>19</td>
<td>3,310</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Olds Cutlass</td>
<td>19</td>
<td>3,300</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Olds Delta 88</td>
<td>18</td>
<td>3,690</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>Olds Omega</td>
<td>19</td>
<td>3,370</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Olds Starfire</td>
<td>24</td>
<td>2,730</td>
<td>Poor</td>
<td></td>
</tr>
<tr>
<td>Olds Toronado</td>
<td>16</td>
<td>4,030</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Peugeot 604</td>
<td>14</td>
<td>3,420</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Plymouth Arrow</td>
<td>28</td>
<td>3,260</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Plymouth Champ</td>
<td>34</td>
<td>1,800</td>
<td>Excellent</td>
<td></td>
</tr>
<tr>
<td>Plymouth Horizon</td>
<td>25</td>
<td>2,200</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Plymouth Sapporo</td>
<td>26</td>
<td>2,520</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Plymouth Volare</td>
<td>18</td>
<td>3,330</td>
<td>Fair</td>
<td></td>
</tr>
<tr>
<td>Pont. Catalina</td>
<td>18</td>
<td>3,700</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>Pont. Firebird</td>
<td>18</td>
<td>3,470</td>
<td>Poor</td>
<td></td>
</tr>
<tr>
<td>Pont. Grand Prix</td>
<td>19</td>
<td>3,210</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Pont. Le Mans</td>
<td>19</td>
<td>3,200</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Pont. Phoenix</td>
<td>19</td>
<td>3,420</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Pont. Sunbird</td>
<td>24</td>
<td>2,690</td>
<td>Fair</td>
<td></td>
</tr>
<tr>
<td>Renault Le Car</td>
<td>26</td>
<td>1,830</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Subaru</td>
<td>35</td>
<td>2,050</td>
<td>Excellent</td>
<td></td>
</tr>
<tr>
<td>Toyota Celica</td>
<td>18</td>
<td>2,410</td>
<td>Excellent</td>
<td></td>
</tr>
<tr>
<td>Toyota Corolla</td>
<td>31</td>
<td>2,200</td>
<td>Excellent</td>
<td></td>
</tr>
<tr>
<td>Toyota Corona</td>
<td>18</td>
<td>2,670</td>
<td>Excellent</td>
<td></td>
</tr>
<tr>
<td>VW Dasher</td>
<td>23</td>
<td>2,160</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>VW Diesel</td>
<td>41</td>
<td>2,040</td>
<td>Excellent</td>
<td></td>
</tr>
<tr>
<td>VW Rabbit</td>
<td>25</td>
<td>1,930</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>VW Scirocco</td>
<td>25</td>
<td>1,990</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>Volvo 260</td>
<td>17</td>
<td>3,170</td>
<td>Excellent</td>
<td></td>
</tr>
</tbody>
</table>
Mostly, however, `tabdisp` is intended for use when you have a dataset of statistics that you want to display:

```
. collapse (mean) mpg, by(foreign rep78)
. list

<table>
<thead>
<tr>
<th>rep78</th>
<th>foreign</th>
<th>mpg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Poor</td>
<td>Domestic</td>
<td>21</td>
</tr>
<tr>
<td>2. Fair</td>
<td>Domestic</td>
<td>19.125</td>
</tr>
<tr>
<td>3. Average</td>
<td>Domestic</td>
<td>19</td>
</tr>
<tr>
<td>4. Good</td>
<td>Domestic</td>
<td>18.4444</td>
</tr>
<tr>
<td>5. Excellent</td>
<td>Domestic</td>
<td>32</td>
</tr>
<tr>
<td>6. .</td>
<td>Domestic</td>
<td>23.25</td>
</tr>
<tr>
<td>7. Average</td>
<td>Foreign</td>
<td>23.3333</td>
</tr>
<tr>
<td>8. Good</td>
<td>Foreign</td>
<td>24.8889</td>
</tr>
<tr>
<td>9. Excellent</td>
<td>Foreign</td>
<td>26.3333</td>
</tr>
<tr>
<td>10. .</td>
<td>Foreign</td>
<td>14</td>
</tr>
</tbody>
</table>
```

```
. tabdisp foreign rep78, cell(mpg)
```

```
<table>
<thead>
<tr>
<th>Car origin</th>
<th>Poor</th>
<th>Fair</th>
<th>Average</th>
<th>Good</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic</td>
<td>21</td>
<td>19.125</td>
<td>19</td>
<td>18.4444</td>
<td>32</td>
</tr>
<tr>
<td>Foreign</td>
<td>23.3333</td>
<td>24.8889</td>
<td>26.3333</td>
<td>14</td>
<td></td>
</tr>
</tbody>
</table>
```

```
. drop if rep78==.
(2 observations deleted)
. tabdisp foreign rep78, cell(mpg) format(%9.2f) center
```

```
<table>
<thead>
<tr>
<th>Car origin</th>
<th>Poor</th>
<th>Fair</th>
<th>Average</th>
<th>Good</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic</td>
<td>21.00</td>
<td>19.12</td>
<td>19.00</td>
<td>18.44</td>
<td>32.00</td>
</tr>
<tr>
<td>Foreign</td>
<td>23.33</td>
<td>24.89</td>
<td>26.33</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

**Treatment of string variables**

The variables specifying the rows, columns, supercolumns, and superrows may be numeric or string. Also, the variables specified for inclusion in the table may be numeric or string. In the example below, all variables are strings, including `reaction`:

```
. use https://www.stata-press.com/data/r17/tabdxmpl3, clear
. tabdisp agecat sex party, c(reaction) center
```

```
<table>
<thead>
<tr>
<th>Age category</th>
<th>Party Affiliation and Sex</th>
<th>Party Affiliation and Sex</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Democrat</td>
<td>Republican</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td>Old</td>
<td>Favor</td>
<td>Favor</td>
</tr>
<tr>
<td>Young</td>
<td>Strongly Favor</td>
<td>Indifferent</td>
</tr>
</tbody>
</table>
```
Treatment of missing values

The `cellvar()` variables specified for inclusion in the table may contain missing values, and whether the variable contains a missing value or the observation is missing altogether makes no difference:

```
. use https://www.stata-press.com/data/r17/tabdxmpl4
. list

<table>
<thead>
<tr>
<th>sex</th>
<th>response</th>
<th>pop</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>0</td>
<td>2</td>
<td>.a</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>11</td>
</tr>
</tbody>
</table>
```

. `tabdisp` sex response, cell(pop)

<table>
<thead>
<tr>
<th>Sex</th>
<th>Response</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>15</td>
<td>11</td>
</tr>
</tbody>
</table>

In the above output, the (1, 3) cell is empty because the observation for `sex = 0` and `response = 2` has a missing value for `pop`. The (2, 3) cell is empty because there is no observation for `sex = 1` and `response = 2`.

If you specify the `missing` option, rather than cells being left blank, the missing value will be displayed:

```
. `tabdisp` sex response, cell(pop) missing
```

<table>
<thead>
<tr>
<th>Sex</th>
<th>Response</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>15</td>
<td>11</td>
</tr>
</tbody>
</table>

Missing values of the row, column, superrow, and supercolumn variables are allowed, and, by default, missing values are given no special meaning. The output below is from a different dataset.
. use https://www.stata-press.com/data/r17/tabdxmpl5

. list

<table>
<thead>
<tr>
<th></th>
<th>sex</th>
<th>response</th>
<th>pop</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>0</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>2.</td>
<td>0</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>3.</td>
<td>0</td>
<td>.</td>
<td>26</td>
</tr>
<tr>
<td>4.</td>
<td>1</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>5.</td>
<td>1</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td>6.</td>
<td>1</td>
<td>.</td>
<td>44</td>
</tr>
<tr>
<td>7.</td>
<td>.</td>
<td>.</td>
<td>70</td>
</tr>
<tr>
<td>8.</td>
<td>.</td>
<td>0</td>
<td>35</td>
</tr>
<tr>
<td>9.</td>
<td>.</td>
<td>1</td>
<td>35</td>
</tr>
</tbody>
</table>

. tabdisp sex response, cell(pop)

<table>
<thead>
<tr>
<th>sex</th>
<th>response</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>15 11 26</td>
</tr>
<tr>
<td>1</td>
<td>20 24 44</td>
</tr>
<tr>
<td>.</td>
<td>35 35 70</td>
</tr>
</tbody>
</table>

If you specify the `total` option, however, the system missing values are labeled as reflecting totals:

. tabdisp sex response, cell(pop) total

<table>
<thead>
<tr>
<th>sex</th>
<th>response</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>15 11 26</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>20 24 44</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>35 35 70</td>
<td></td>
</tr>
</tbody>
</table>

tabdisp did not calculate the totals; it merely labeled the results as being totals. The number 70 appears in the lower right because there happens to be an observation in the dataset where both `sex` and `response` contain a system missing value and `pop` = 70.

Here the row and column variables were numeric. If they had been strings, the `total` option would have given the special interpretation to `sex = ""` and `response = ""`.

Also see

[R] table — Table of frequencies, summaries, and command results
[R] tabstat — Compact table of summary statistics
[R] tabulate oneway — One-way table of frequencies
[R] tabulate, summarize() — One- and two-way tables of summary statistics
[R] tabulate twoway — Two-way table of frequencies
[D] collapse — Make dataset of summary statistics
timer — Time sections of code by recording and reporting time spent

Description

timer starts, stops, and reports up to 100 interval timers. Results are reported in seconds.
timer clear resets timers to zero.
timer on begins a timing. timer off stops a timing. A timing may be turned on and off repeatedly without clearing, which causes the timer to accumulate.
timer list lists the timings. If # is not specified, timers that contain zero are not listed.

Syntax

Reset timers to zero

timer clear [#]

Turn a timer on

timer on #

Turn a timer off

timer off #

List the timings

timer list [#]

where # is an integer, 1–100.

Remarks and examples

timer can be used to time sections of code. For instance,

```plaintext
program tester
  version ...
  timer clear 1
  forvalues repeat=1(1)100 {
    timer on 1
    mycmd ...
    timer off 1
  }
  timer list 1
end
```

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Stored results

timer list stores the following in r():

Scalars

\[ r(t1) \quad \text{value of first timer} \]
\[ r(nt1) \quad \text{# of times turned on and off} \]
\[ r(t2) \quad \text{value of second timer} \]
\[ r(nt2) \quad \text{# of times turned on and off} \]

\[ \ldots \]

\[ r(t100) \quad \text{value of 100th timer} \]
\[ r(nt100) \quad \text{# of times turned on and off} \]

Only values for which \( r(nt#) \neq 0 \) are stored.

r() results produced by other commands are not cleared.

Also see

[P] rmsg — Return messages
Title

<table>
<thead>
<tr>
<th>tokenize — Divide strings into tokens</th>
</tr>
</thead>
</table>

Description

`tokenize` divides `string` into tokens, storing the result in ‘1’, ‘2’, ... (the positional local macros). Tokens are determined based on the parsing characters `pchars`, which default to a space if not specified.

Syntax

```plaintext
    tokenize [ [''] [''] string [''] |', parse("pchars")]
```

Option

`parse("pchars")` specifies the parsing characters. If `parse()` is not specified, `parse(" ")` is assumed, and `string` is split into words. Note that `pchars` is treated as a sequence of bytes. Any Unicode character in multibyte UTF-8 encoding, which applies to all Unicode characters except ASCII characters, is treated as a sequence of bytes rather than as a single character. For example, `parse()` will not work as expected when trying to break a string into tokens based on a Unicode whitespace character \u2000.

Remarks and examples

`tokenize` may be used as an alternative or supplement to the `syntax` command (see [P] syntax) for parsing command-line arguments. Generally, it is used to further process the local macros created by `syntax`, as shown below.

```plaintext
    program myprog
    version 17.0
    syntax [varlist] [if] [in]
    marksample touse
    tokenize 'varlist'
    local first '1'
    macro shift
    local rest '*'
    ...
    end
```

Example 1

We interactively apply `tokenize` and then display several of the numbered macros to illustrate how the command works.

```
. tokenize some words
. display "1=|'1'|, 2=|'2'|, 3=|'3'|"
1=|some|, 2=|words|, 3=||
. tokenize "some more words"
. display "1=|'1'|, 2=|'2'|, 3=|'3'|, 4=|'4'|"
1=|some|, 2=|more|, 3=|words|, 4=||
```

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These examples illustrate that the quotes surrounding the string are optional; the space parsing character is not saved in the numbered macros; nonspace parsing characters are saved in the numbered macros together with the tokens being parsed; and more than one parsing character may be specified. Also, when called with no string argument, `tokenize` resets the local numbered macros to empty.

Also see

- [P] `foreach` — Loop over items
- [P] `gettoken` — Low-level parsing
- [P] `macro` — Macro definition and manipulation
- [P] `syntax` — Parse Stata syntax
- [M-5] `invtokens()` — Concatenate string rowvector into string scalar
- [M-5] `tokenget()` — Advanced parsing
- [M-5] `tokens()` — Obtain tokens from string
- [M-5] `ustrsplit()` — Split string into parts based on a Unicode regular expression
- [U] 18 Programming Stata
**trace — Debug Stata programs**

**Description**

set trace on traces the execution of programs for debugging. set trace off turns off tracing after it has been set on.

set tracedepth specifies how many levels to descend in tracing nested programs. The default is 32000, which is equivalent to \( \infty \).

set traceexpand indicates whether the lines before and after macro expansion are to be shown. The default is on.

set tracedepth indicates whether to display a horizontal separator line that displays the name of the subroutine whenever a subroutine is entered or exited. The default is on.

set traceindent indicates whether displayed lines of code should be indented according to the nesting level. The default is on.

set tracenumber indicates whether the nesting level should be displayed at the beginning of the line. Lines in the main program are preceded with 01; lines in subroutines called by the main program, with 02; etc. The default is off.

set tracehilite causes the specified *pattern* to be highlighted in the trace output.

**Syntax**

**Whether to trace execution of programs**

```
set trace {on|off}
```

**Show # levels in tracing nested programs**

```
set tracedepth #
```

**Whether to show the lines after macro expansion**

```
set traceexpand {on|off} [, permanently]
```

**Whether to display horizontal separator lines**

```
set tracedepth {on|off} [, permanently]
```

**Whether to indent lines according to nesting level**

```
set traceindent {on|off} [, permanently]
```
Whether to display nesting level

```
set tracenumber {on|off} [, permanently]
```

Highlight pattern in trace output

```
set tracehilite "pattern" [, word]
```

### Options

- `permanently` specifies that, in addition to making the change right now, the `traceexpand`, `tracesep`, `traceindent`, and `tracenumber` settings be remembered and become the default settings when you invoke Stata.

- `word` highlights only tokens that are delimited by nonalphanumeric characters. These would include tokens at the beginning or end of each line that are delimited by nonalphanumeric characters.

### Remarks and examples

The `set trace` commands are extremely useful for debugging your programs.

#### Example 1

Stata does not normally display the lines of your program as it executes them. With `set trace on`, however, it does:

```
. program list simple
simple:
  1. args msg
  2. if ""msg""=="hello" {
      3.       display "you said hello"
      4.   }
  5. else display "you did not say hello"
  6. display "good-bye"
. set trace on
. simple
```

```
- begin simple —
-   - args msg
-   - if ""msg""=="hello" {
-      = if ""=="hello" {
-          display "you said hello"
-      }
-      - else display "you did not say hello"
-      you did not say hello
-      - display "good-bye"
-      good-bye
- end simple —
```

Lines that are executed are preceded by a dash. The line is shown before macro expansion, just as it was coded. If the line has any macros, it is shown again, this time preceded by an equal sign and with the macro expanded, showing the line exactly as Stata sees it.

In our simple example, Stata substituted nothing for `"msg"`, as we can see by looking at the macro-expanded line. Because nothing is not equal to “hello”, Stata skipped the display of “you said hello”, so a dash did not precede this line.
Stata then executed lines 5 and 6. (They are not reshown preceded by an equal sign because they contained no macros.)

To suppress the printing of the macro-expanded lines, type `set traceexpand off`. To suppress the printing of the trace separator lines, type `set tracesep off`.

The output from our program is interspersed with the lines that caused the output. This can be greatly useful when our program has an error. For instance, we have written a more useful program called `myprog`. Here is what happens when we run it:

```
. myprog mpg, prefix("new")
invalid syntax
r(198);
```

We did not expect this, and, look as we will at our program code, we cannot spot the error. Our program contains many lines of code, however, so we have no idea even where to look. By setting `trace on`, we can quickly find the error:

```
. set trace on
. myprog mpg, prefix("new")
begin myprog
- version 17.0
- syntax varname, [Prefix(string)]
- local newname "'prefix'varname"
= local newname "new"
invalid syntax
end myprog
r(198);
```

The error was close to the top—we omitted the closing quote in the definition of the local `newname` macro.

---

**Technical note**

If you are looking for a command similar to `set trace` for use in Mata, see `mata set matalnum in [M-3] mata set.`

---

**Example 2**

`set tracedepth, set tracesep, set traceindent, and set tracenumber` are useful when debugging nested programs. Imagine that we have a program called `myprog1`, which calls `myprog2`, which then calls a modified version of our `simple` program from example 1.

With the default settings, we get:

```
. program list _all
simple2:
1.     args msg
2.     if "'msg'"=""hello" {}  
3.     display "you said hello"
4. }
```
else {
    display "you did not say hello"
}

myprog2:
  1. args msg
  2. simple2 "'msg'",
  3. display "good"

myprog1:
  1. args msg
  2. myprog2 "'msg'",
  3. display "bye"

.set trace on
.myprog1 hello

- args msg
- myprog2 "'msg'",
  = myprog2 "'hello'",

  - args msg
  - simple2 "'msg'",
    = simple2 "'hello'",

    - args msg
    - if "'msg'"=="hello" {
      = if "'hello'"=="hello" {
        - display "you said hello"
      }
    - else {
      display "you did not say hello"
    }

  - display "good"

.end simple2

.end myprog2

.end myprog1

.set trace off

To see the nesting level for each line, you could use set tracenumber on.

.set trace on
.set tracenumber on
.myprog1 hello

01 - args msg
01 - myprog2 "'msg'",
    = myprog2 "'hello'",

02 - args msg
02 - simple2 "'msg'",
    = simple2 "'hello'",

03 - args msg
03 - if "'msg'"=="hello" {
    = if "'hello'"=="hello" {
      - display "you said hello"
    }
03 - else {


If you are interested only in seeing a trace of the first two nesting levels, you could set tracedepth 2.

```
. set trace on
. set tracedepth 2
. myprog1 hello
    begin myprog1
    - args msg
    - myprog2 "msg"
    = myprog2 "hello"
    begin myprog2
    - args msg
    - simple2 "msg"
    = simple2 "hello"
    you said hello
    - display "good"
    good
    - display "bye"
    bye
    begin simple2
    - args msg
    - if "msg"=="hello" {
    = if "hello"=="hello" {
    - display "you said hello"
    you said hello
    - }
    - else {
```
Grace Murray Hopper (1906–1992) was a mathematician, computer scientist, and programmer. She was born in New York City and received a BA in mathematics and physics from Vassar College. Hopper went on to teach at Vassar while earning an MA and a PhD in mathematics from Yale. She joined the Navy during World War II and remained in the Naval Reserve during a long career in academia and private industry. In 1967, she was recalled to active duty to direct the Navy’s Programming Languages Group.

Hopper is best known for developing the first compiler. She also worked extensively to develop programming languages and effective programming techniques. Known as “Grandma COBOL”, Hopper led a team that developed some of the first compiler-based programming languages during the 1950s, work that would lead to the development of COBOL. Hopper is also credited with coining the term “debugging” after her team removed a moth from the Mark II computer she was testing. The moth is still on display at the U.S. Naval Surface Warfare Center Museum.

Among many honors, Hopper was awarded the first ever “computer sciences man of the year” award in 1969. She was the first person from the United States and the first woman to become a Distinguished Fellow of the British Computer Society. She also received the National Medal of Technology and IEEE Emanuel R. Piore Award. In 1997, the U.S. Navy commissioned the USS Hopper in her honor.

Also see

[P] program — Define and manipulate programs
[R] query — Display system parameters
[R] set — Overview of system parameters
[U] 18 Programming Stata
unab — Unabbreviate variable list

Description

unab expands and unabbreviates a varlist (see [U] 11.4 varname and varlists) of existing variables, placing the results in the local macro `lmacname`. unab is a low-level parsing command. The `syntax` command is a high-level parsing command that, among other things, also unabbreviates variable lists; see [P] syntax.

The difference between unab and tsunab is that tsunab allows time-series operators in `varlist`; see [U] 11.4.4 Time-series varlists.

The difference between tsunab and fvunab is that fvunab allows factor variables in `varlist`; see [U] 11.4.3 Factor variables.

Syntax

Expand and unabbreviate standard variable lists

```
unab lmacname : [varlist] [, min(#) max(#) name(string)]
```

Expand and unabbreviate variable lists that may contain time-series operators

```
tsunab lmacname : [varlist] [, min(#) max(#) name(string)]
```

Expand and unabbreviate variable lists that may contain time-series operators or factor variables

```
fvunab lmacname : [varlist] [, min(#) max(#) name(string)]
```

Options

min(#) specifies the minimum number of variables allowed. The default is min(1).
max(#) specifies the maximum number of variables allowed. The default is max(120000).

name(string) provides a label that is used when printing error messages.

Remarks and examples

Usually, the `syntax` command will automatically unabbreviate variable lists; see [P] syntax. In a few cases, unab will be needed to obtain unabbreviated variable lists.

If the user has previously set varabbrev off, then variable abbreviations are not allowed. Then typing in a variable abbreviation results in a syntax error. See [R] set.
Example 1

The `separate` command (see [D] separate) provides an example of the use of `unab`. Required option `by(byvar | exp)` takes either a variable name or an expression. This is not handled automatically by the `syntax` command.

Here the `syntax` command for `separate` takes the form

```
syntax varname [if] [in], BY(string) [other options]
```

After `syntax` performs the command-line parsing, the local variable `by` contains what the user entered for the option. We now need to determine if it is an existing variable name or an expression. If it is a variable name, we may need to expand it.

```
capture confirm var 'by'
if _rc == 0 {
    unab by: 'by', max(1) name(by())
}
else {
    (parse 'by' as an expression)
}
```

Example 2

We interactively demonstrate the `unab` command with `auto.dta`.

```
. use https://www.stata-press.com/data/r17/auto
   (1978 automobile data)
. unab x : mpg wei for, name(myopt())
. display "'x'"
mpg weight foreign
. unab x : junk
   variable junk not found
   r(111);
. unab x : mpg wei, max(1) name(myopt())
   myopt(): too many variables specified
   1 variable required
   r(103);
. unab x : mpg wei, max(1) name(myopt()) min(0)
   myopt(): too many variables specified
   0 or 1 variables required
   r(103);
. unab x : mpg wei, min(3) name(myopt())
   myopt(): too few variables specified
   3 or more variables required
   r(102);
. unab x : mpg wei, min(3) max(10)
   myopt(): too few variables specified
   3 - 10 variables required
   r(102);
. unab x : mpg wei, min(3) max(10)
   mpg weight:
   too few variables specified
   r(102);
```
Example 3

If we created a time variable and used \texttt{tsset} to declare the dataset as a time series, we can also expand time-series variable lists.

\begin{verbatim}
. generate time = _n
. tsset time
. tsunab mylist : l(1/3).mpg
. display "'mylist'", L.mpg L2.mpg L3.mpg
. tsunab mylist : l(1/3).(price turn displ)
\end{verbatim}

Example 4

If \texttt{set varabbrev off} has been issued, variable abbreviations are not allowed:

\begin{verbatim}
. unab varn : mp
. display "'varn'", mpg
. set varabbrev off
. unab varn : mp
  \textit{variable mp not found}
  r(111);
. set varabbrev on
. unab varn : mp
. display "'varn'", mpg
\end{verbatim}

Reference


Also see

[P] \texttt{syntax} — Parse Stata syntax
[P] \texttt{varabbrev} — Control variable abbreviation
[U] 11 Language syntax
[U] 18 Programming Stata
unabcmd — Unabbreviate command name

Description

unabcmd verifies that commandname_or_abbreviation is a Stata command name or an abbreviation of a Stata command name. unabcmd makes this determination by looking at both built-in commands and ado-files. If commandname_or_abbreviation is a valid command, unabcmd returns in local r(cmd) the unabbreviated name. If it is not a valid command, unabcmd displays an appropriate error message.

Syntax

unabcmd commandname_or_abbreviation

Remarks and examples

Stata’s built-in commands can be abbreviated. For instance, the user can type gen for generate or an for anova. Commands implemented as ado-files cannot be abbreviated.

Given a command name c, unabcmd applies the same lookup rules that Stata applies internally. If it is found, the full command name is returned in r(cmd).

Example 1

. unabcmd gen
. return list
macros:
    r(cmd) : "generate"

. unabcmd kappa // kappa is an ado-file
. return list
macros:
    r(cmd) : "kappa"

. unabcmd ka
command ka not found as either built-in or ado-file
r(111);

unabcmd is included just in case you, as a programmer, want the command name spelled out. There is no reason why you should.

Also see

[P] findfile — Find file in path
[R] which — Display location of an ado-file
varabbrev — Control variable abbreviation

Description

`novarabbrev` temporarily turns off variable abbreviation if it is on. `varabbrev` temporarily turns on variable abbreviation if it is off. Also see `set varabbrev` in [R] `set`.

Syntax

```
novarabbrev `stata_command`

varabbrev `stata_command`
```

Typical usage is

```
novarabbrev {
         ... /* perform task */ ... 
} 
```

Remarks and examples

Example 1

```
program ... 
         ... /* parse input */ ... 
         novarabbrev {
         ... /* perform task */ ... 
         }
         ... 
end
```

Also see

[P] `break` — Suppress Break key

[P] `unab` — Unabbreviate variable list

[R] `set` — Overview of system parameters
At the top of every do-file or program that you create, type

```
version 17
```

That single step ensures that your do-file or program will continue to run in all future versions of Stata, even if that future version has changes in the syntax of some of the commands or programming constructs that you use in your do-file or program. The few other ways to use `version` are in support of this functionality and are unimportant by comparison.

**Syntax**

Display version number to which command interpreter is set

```
version
```

Set command interpreter to version #

```
version #
```

```
version #: command
```

Set supplemental version number, rarely used

```
version #, user
```

```
version #, user: command
```

**Option**

`user` sets the version for a supplemental form of version control; see `User version` below.

**Remarks and examples**

Remarks are presented under the following headings:

- Version
- Version a single command
- User version
- Version and random numbers
Version

Stata is continually improving, and sometimes that means that commands or language elements in the interpreter need to change. `version` ensures that do-files, ado-files, and other programs continue to work. They will continue to work in all future versions of Stata regardless of the version of Stata in which they were written.

`version #` sets the interpretation of all language elements and commands to be the same as it was in version #. All do-files, ado-files, and other programs written for the current version of Stata should include `version 17` as the first executable statement.

Here is what that looks like in a do-file:
```
begin mydofile.do
version 17
... contents of your do-file ...
end mydofile.do
```

Here is what that looks like in an ado-file:
```
begin mycommand.ado
program
version 17
... contents of your ado program ...
end
end mycommand.ado
```

For programs outside of ado-files, versioning looks just like it does for programs in ado-files.

When Stata first starts, it sets its version number to the current version of Stata, which is 17.0 as of this writing. Typing `version` without arguments displays the current setting of version:
```
.version
version 17.0
```

The `version` command simply sets this current version to a different value.
```
.version 8.0
.version
.version 8.0
```

That is all Stata needs to ensure that your do-files, ado-files, and other programs continue to work in all future versions of Stata.

Version a single command

You can version individual commands by prefixing them with `version #`. For example, you can use the old `anova` syntax by typing
```
.version 10: anova ...
```

This single command sets Stata’s version to 10, runs the `anova` command, and then resets Stata’s version to whatever it was before the command was executed. This usage is much less common.
User version

There is a supplement to version control called “user version”. User version works alongside version, and you are unlikely to ever care about or need to separately control the user version. Very few people need to read this section.

Stata has always had version control. User version was created later to handle big improvements to some commands and functions that we wanted all existing ado-files and other programs to use, regardless of the version settings in those existing programs.

User version is not affected by version statements in ado-files and other programs. User version is only reset when version # is typed interactively or it appears in a do-file.

The argument is that users type commands and users write do-files to script sets of commands. If the user says they want version #, then they always get version #, even if there are some improvements. Programmers write programs that users then run to perform their tasks. Programmers primarily use version control to be sure their programs continue to run, even when Stata syntax is changed. If there is an improvement that does not affect syntax or stored results, then programmers will not care whether that improvement is included in their program.

For some features, the user should be in control of which version of that feature is run, not the programmer—thus, user version.

Let’s consider some improvements that have been put under user-version control. To date, there have been only three:

1. The KISS random number was replaced by the 64-bit Mersenne Twister random number starting in version 14.
2. How Stata interprets factor-variable statements like \texttt{i(2 3).rep78} was improved in version 11.
3. A faster algorithm for \texttt{sort} was introduced in version 17.

We will ignore item 2 because it is difficult to explain succinctly, but be assured you are glad we made the change. And despite how things sound, it was not a syntactical change that affected programs.

Items 1 and 2 are simply improvements. The Mersenne Twister has even better statistical properties than the already great properties of the KISS random-number generator. And it has a whoppingly long period. Regarding item 2, a faster \texttt{sort} is just always better. Moreover, neither change has syntactical implications for previously written code.

Why not make these three changes new defaults regardless of the version set in do-files or interactively? The changes are not without consequence. The new random-number generator returns different sequences of numbers. The new sorter orders observations with tied sort keys differently.

A user cares about these consequences because the results will change. A programmer does not care because the program is simply grabbing the random numbers or performing the sort on behalf of the user. It is the version that the user wants to run that is important.

For example, changing the random-number generator clearly affects the results of \texttt{bootstrap} and \texttt{mi impute} because those commands draw random numbers. The commands do not, however, truly care how those numbers are drawn so long as they have good properties. The user, on the other hand, needs to know exactly how and what is drawing the random numbers—first, so they can be confident that the random-number generator is fit for their purpose, and second, because they may need to reproduce the results.

The dichotomy between the role of user and programmer is not perfect. Often, they are the same person. More importantly, sometimes we write programs as part of our analyses and sometimes we write do-files that are really more like tools or programs.
We can handle those cases. If you have a program and you want it to use the random-number generator, the factor-variables interpreter, and the sorter that were the defaults as of version 12, then put

```
version 12, user
```
at the top of your program. You are probably wanting to set everything to version 12, so you will need two version statements at the top of your program:

```
version 12
version 12, user
```

That sets both version and user version to 12. `version 12, user` does not set the normal version.

If you want version 12 to remain the version for the entirety of your program, and you likely do, then you do not have to do anything more. When your program concludes, for any reason, Stata will reset the version and user version to their state prior to running your program.

If you ever want to know the current user version, it is stored in `c(userversion)`.

If you have an old do-file and it is, say, version 12, but you want it to use a modern sort, you will need to change each `sort` command. This is an uncommon desire. Regardless, find each `sort` command and prepend it with `version 17:` as follows:

```
version 17: sort ...
```

Note that the do-file will now run only in Stata 17 and beyond. Stata 12 cannot run version 17 commands. How could it? That is fine; you have obviously already moved to Stata 17. And you did not put that version statement at the top of your do-file to help it run in Stata 12. You put it there so that all the commands in the file would continue to work using Stata 12 syntax no matter which future version of Stata you were running.

### Version and random numbers

As of Stata 14, Stata’s RNGs were improved, renamed, and restructured; see [R] `set seed`. The default RNG in modern Stata is the 64-bit Mersenne Twister (mt64). Before Stata 14, the RNG was the 32-bit KISS (kiss32). If user version is 14 or higher, RNG results are based on mt64. If user version is less than 14, RNG results are based on kiss32. This also affects the results of commands that use the RNGs, such as `bootstrap`, `bsample`, and the `mi` suite of commands.

Version control within a RNG is specified at the time the `set seed` command is given, not at the time the random-number generation function such as `rnormal()` is used. For instance, typing

```
. (assume version is set to be 11.2)
. set seed 123456789
. any_command ...
```

causes `any_command` to use the Stata 11.2 version of `rnormal()` even if `any_command` is an ado-file containing an explicit `version` statement setting the version to less than 11.2. This occurs because the version of `rnormal()` that is used was determined at the time the seed was set, and the seed was set under version 11.2 or later.

This works in both directions. Consider

```
. version 11.1: set seed 123456789
. any_command ...
```
In this case, *any_command* uses the older version of `rnormal()` because the seed was set under version 11.1, before `rnormal()` was updated. *any_command* uses the older version of `rnormal()` even if *any_command* itself includes an explicit `version` statement setting the version to 11.2 or later.

Thus both older and newer ado-files can use the newer or older `rnormal()`, and they can do so without modification. The only case in which you need to modify a do-file or ado-file is when it is older, it contains `set seed`, and you now want it to use the new `rnormal()`. In that case, find the `set seed` command in the do-file or ado-file,

```plaintext
version 10 // for example
... 
set seed 123456789
... 
```

and change it to read

```plaintext
version 10 // for example
... 
version 11.2: set seed 123456789
... 
```

You need to change only the one line.

Everything written above about prefixing `set seed` with a `version` is irrelevant if you are restoring the seed to a state previously obtained from `c(rngstate)`:  

```plaintext
set rngstate X075bcd151f123bb5159a55e50022865700023e53
```

The string state `X075bcd151f123bb5159a55e50022865700023e53` includes the version number at the time the seed was set. Prefixing the above with `version`, whether older or newer, will do no harm but is unnecessary.

For an up-to-date summary of version changes, see help `version`.

Also see

[U] 18.11.1 Version
**Description**

`viewsource` searches for `filename` along the ado-path and displays the file in the Viewer. No default file extension is provided; if you want to see, for example, `kappa.ado`, type `viewsource kappa.ado`.

**Syntax**

```
viewsource filename
```

**Remarks and examples**

Say that you wish to look at the source for `ml` (documented in `[R] ml`). You know that `ml` is an ado-file, and therefore the filename is `ml.ado`. You type

```
.viewsource ml.ado
```

`program` (documented in `[P] program`) is not implemented as an ado-file:

```
.viewsource program.ado
file "program.ado" not found
r(601);
```

By the way, you can find out where the file is stored by typing

```
.findfile ml.ado
C:\Program Files\Stata17\ado\base\m\ml.ado
```

See `[P] findfile`.

`viewsource` is not limited to displaying ado-files. If you wish to see, for example, `panelsetup.mata`, type

```
.viewsource panelsetup.mata
```

**Also see**

- `[P] findfile` — Find file in path
- `[R] view` — View files and logs
- `[R] which` — Display location of an ado-file
while — Looping

Description

while evaluates \( exp \) and, if it is true (nonzero), executes the \( \text{stata\_commands} \) enclosed in the braces. It then repeats the process until \( exp \) evaluates to false (zero). \( \text{while} \)s may be nested within \( \text{while} \)s. If the \( exp \) refers to any variables, their values in the first observation are used unless explicit subscripts are specified; see [U] 13.7 Explicit subscripting.

Also see [P] \texttt{foreach} and [P] \texttt{forvalues} for alternatives to \texttt{while}.

Syntax

\begin{verbatim}
while \text{\textit{exp}} \{ 
\text{\textit{stata\_commands}}
\}
\end{verbatim}

Braces must be specified with \texttt{while}, and

1. the open brace must appear on the same line as \texttt{while};
2. nothing may follow the open brace, except, of course, comments; the first command to be executed must appear on a new line; and
3. the close brace must appear on a line by itself.

Remarks and examples

while may be used interactively, but it is most often used in programs. See [U] 18 Programming Stata for a description of programs.

The \( \text{stata\_commands} \) enclosed in the braces may be executed once, many times, or not at all. For instance,

```
program demo
    local i = "i"
    while "i">0 {
        display "i is now "i"
        local i = "i" - 1
    }
    display "done"
end
```

```
demo 2
i is now 2
i is now 1
done
```

```
demo 0
done
```
The above example is a bit contrived in that the best way to count down to one would be

```
program demo
  forvalues i = `1'(-1)`1 {
    display "i is now `i'"
  }
  display "done"
end
```

`while` is used mostly in parsing contexts

```
program ...
...
  gettoken tok 0 : 0
  while "'tok'" != "" {
    ...
    gettoken tok 0 : 0
  }
...
end
```
or in mathematical contexts where we are iterating

```
program ...
...
  scalar 'curval' = .
  scalar 'lastval' = .
  while abs('lastval' - 'curval') > 'epsilon' {
    scalar 'lastval' = 'curval'
    scalar 'curval' = ...
  }
...
end
```
or in any context in which loop termination is based on calculation (whether it be numeric or string).

You can also create endless loops by using `while`,

```
program ...
...
  while 1 {
    ...
  }
end
```
which is not really an endless loop if the code reads

```
program ...
...
  while 1 {
    if (...) exit
    ...
  }
  // this line is never reached
end
```

Should you make a mistake and really create an endless loop, you can stop program execution by pressing the `Break` key.
Also see

[P] continue — Break out of loops
[P] foreach — Loop over items
[P] forvalues — Loop over consecutive values
[P] if — if programming command
[U] 13 Functions and expressions
[U] 18 Programming Stata
window programming — Programming menus and windows

Description

The `window` command lets you open, close, and manage the windows in Stata’s interface. Using the subcommands of `window menu`, you can also add and delete menu items from the User menu from Stata’s main menu bar. `window push` adds `command_line` to the Review window.

For documentation on creating dialog boxes, see [P] Dialog programming.

Syntax

```
window fopen ...          Display open dialog box
window fsave ...          Display save dialog box
window manage subcmd ...  Manage window characteristics
window menu subcmd ...    Create menus
window push subcmd ...    Copy command into History window
window stopbox subcmd ... Display message box
```

Also see

[P] Dialog programming — Dialog programming
[U] 18 Programming Stata
window fopen — Display open/save dialog box

Description

window fopen and window fsave allow Stata programmers to use standard File > Open... and File > Save dialog boxes in their programs.

Syntax

```stata
window { fopen | fsave } macroname "title" "filter" [ extension ]
```

Remarks and examples

window fopen and window fsave call forth the operating system’s standard File > Open... and File > Save dialog boxes. The commands do not themselves open or save any files; they merely obtain from the user the name of the file to be opened or saved and return it to you. The filename returned is guaranteed to be valid and includes the full path.

The filename is returned in the global macro macroname. In addition, if macroname is defined at the outset, its contents will be used to fill in the default filename selection.

`title` is displayed as the title of the dialog.

`filter` must be specified. One possible specification is "", meaning no filter. Alternatively, `filter` consists of pairs of descriptions and wildcard file selection strings separated by '|', such as

"Stata Graphs|*.gph|All Files|*. *
```

Stata uses the filter to restrict the files the user sees. The above example allows the user either to see Stata graph files or to see all files. The dialog will display a drop-down list from which the user can select a file type (extension). The first item of each pair (Stata Graphs and All Files) will be listed as the choices in the drop-down list. The second item of each pair restricts the files displayed in the dialog box to those that match the wildcard description. For instance, if the user selects Stata Graphs from the list box, only files with extension .gph will be displayed in the file dialog box.

Finally, `extension` is optional. It may contain a string of characters to be added to the end of filenames by default. For example, if the `extension` were specified as xyz, and the user typed a filename of abc in the file dialog box, abc.xyz would be returned in macroname.

In Windows, the default `extension` is ignored if a `filter` other than *. * is in effect. For example, if the user’s current filter is *. gph, the default extension will be .gph, regardless of the `extension` specified.

Because Windows allows long filenames, `extension` can lead to unexpected results. For example, if `extension` were specified as xyz and the user typed a filename of abc .def, Windows would append .xyz before returning the filename to Stata, so the resulting filename is abc .def .xyz. Windows users should be aware that if they want to specify an extension different from the default, they must enter a filename in the file dialog box enclosed in double quotes: "abc .def". This applies to all programs, not just Stata.
If the user presses the **Cancel** button on the file dialog, `window fopen` and `window fsave` set `macroname` to be empty and exit with a return code of 601. Programmers should use the `capture` command (see [P] capture) to prevent the 601 return code from appearing to the user.

```
begin dtaview.ado

program dtaview
    version 17.0
    capture window fopen D_dta "Select a dataset to use:" */
    * "Stata Data (*.dta)|*.dta|All Files (*.*)|*.*
    if _rc==0 {
        display "User chose $D_dta as the filename."
        use "$D_dta"
    }
end
```

Also see

[P] window programming — Programming menus and windows

[P] window stopbox — Display message box
**Description**

`window manage` allows Stata programs to invoke features from Stata’s main menu.

**Syntax**

*Minimize or restore the main Stata window*

```
window manage minimize

window manage restore
```

*Manage window preferences*

```
window manage prefs {load "prefname" | save "prefname" | default}
```

*Restore file associations (Windows only)*

```
window manage associate
```

*Reset main window title (Unix and Windows only)*

```
window manage maintitle {reset | "title"}
```

*Set Dock icon’s label (Mac only)*

```
window manage docklabel ["label"]
```

*Bring windows forward*

```
window manage forward window-name
```

Where `window-name` can be `command`, `doeditor`, `graph`, `help`, `history`, `results`, `review`, `variables`, or `viewer`. 

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Commands to manage Graph windows

`window manage print graph`

`window manage forward graph ["graphname"]`

`window manage close graph [{"graphname" | _all}]`

`window manage rename graph oldgraphname newgraphname`

Commands to manage Viewer windows

`window manage print viewer ["viewername"]`

`window manage forward viewer ["viewername"]`

`window manage close viewer [{"viewername" | _all}]`

Remarks and examples

`window manage` accesses various parts of Stata’s windowed interface that would otherwise be available only interactively. For instance, say that a programmer wanted to ensure that the Graph window was brought to the front. An interactive user would do that by selecting Graph from the Window menu. A Stata program could be made to do the same thing by coding `window manage forward graph`.

Remarks are presented under the following headings:

- Minimizing or restoring the main window
- Windowing preferences
- Restoring file associations (Windows only)
- Resetting the main window title
- Setting Dock icon’s label (Mac only)
- Bringing windows forward
- Commands to manage Graph windows
- Commands to manage Viewer windows

Minimizing or restoring the main window

`window manage minimize` minimizes (hides) the Stata window. With Stata for Windows and Stata for Unix, this has the same effect as clicking on the minimize button on Stata’s title bar. With Stata for Mac, this has the same effect as selecting Hide Stata from the Stata menu.
For example,

```
window manage minimize
```

minimizes the overall Stata window if you are using Stata for Windows or Stata for Unix and hides Stata’s windows if you are using Stata for Mac.

```
window manage restore
```

restores the Stata window if necessary.

With Stata for Windows, this command has the same effect as clicking the Stata button on the taskbar. With Stata for Mac, this command has the same effect as clicking on the Stata icon on the Dock. With Stata for Unix, this command has the same effect as clicking on the Stata icon in the Window Manager.

For example,

```
window manage restore
```

restores Stata’s overall window to its normal, nonminimized state.

### Windowing preferences

```
window manage prefs { load "prefname" | save "prefname" | default }
```

loads, saves, and restores windowing preferences.

```
window manage prefs load "prefname"
```

is equivalent to selecting `Edit > Preferences > Load preference set` and loading a named preference set. `window manage prefs save "prefname"` is equivalent to selecting `Edit > Preferences > Save preference set` and naming a new preference set.

```
window manage prefs default
```

is equivalent to selecting `Edit > Preferences > Load preference set > Widescreen layout (default)`. In Stata for Mac, the `Preferences` menu is located in the `Stata` menu.

For example,

```
window manage prefs default
```

restores Stata’s windows to their “factory” appearance.

### Restoring file associations (Windows only)

In Stata for Windows, `window manage associate` restores the default actions for Stata file types. For example, another application could take over the `.dta` extension so that double-clicking on a Stata dataset would no longer launch Stata. `window manage associate` restores the association between all Stata file extensions (such as `.dta`) and Stata. This is equivalent to selecting `Edit > Preferences > Reset file associations`.

### Resetting the main window title

In Stata for Unix and Stata for Windows, `window manage maintitle "title"` changes the title of the main Stata Window. The title may be reset to the default with `window manage maintitle reset`. 
Setting Dock icon’s label (Mac only)

In Stata for Mac, `window manage docklabel "label"` sets the label to be displayed in the badge area of Stata’s application icon in the Dock. To clear the badge label, enter the command with no label. You should limit the label to 6 characters or fewer; otherwise, the label will be truncated.

`window manage docklabel` can be useful for displaying the progress of a do-file.

For example,

```stata
begin test.do
  do test1.do
  window manage docklabel "25%"
  do test2.do
  window manage docklabel "50%"
  do test3.do
  window manage docklabel "75%"
  do test4.do
  window manage docklabel
end test.do
```

Bringing windows forward

`window manage forward window-name` brings the specified window to the top of all other Stata windows. This command is equivalent to selecting one of the available windows from the Window menu. The following table lists the `window-names` that `window manage forward` understands:

<table>
<thead>
<tr>
<th><code>window-name</code></th>
<th>Stata window</th>
</tr>
</thead>
<tbody>
<tr>
<td>command</td>
<td>Command window</td>
</tr>
<tr>
<td>doeditor</td>
<td>Do-file editor window</td>
</tr>
<tr>
<td>graph</td>
<td>Graph window</td>
</tr>
<tr>
<td>help</td>
<td>Help/search window</td>
</tr>
<tr>
<td>history</td>
<td>History window</td>
</tr>
<tr>
<td>results</td>
<td>Results window</td>
</tr>
<tr>
<td>review</td>
<td>synonym for history</td>
</tr>
<tr>
<td>variables</td>
<td>Variables window</td>
</tr>
<tr>
<td>viewer</td>
<td>Viewer window</td>
</tr>
</tbody>
</table>

If a window had not been available on Stata’s Window menu (if it had been grayed out), specifying `window-name` after `window manage forward` would do nothing. For example, if there is no current graph, `window manage forward graph` will do nothing; it is not an error.

For example,

```stata
window manage forward results
```

brings the Results window to the top of the other Stata windows.

Under Stata for Mac and Stata for Unix, specifying the Command, History, Results, or Variables windows will bring the main Stata window forward because these windows are all contained within one window.
Commands to manage Graph windows

Printing

`window manage print graph` invokes the action of the `File > Print > Graph (Graph)` menu item. If there is no current graph, `window manage print` does nothing; it does not return an error.

For example,

```
window manage print graph
```
displays the print dialog box just as if you pulled down `File > Print > Graph (Graph)`.

Bringing forward

`window manage forward graph [graphname]` brings the Graph window named `graphname`, if it exists, to the top of other windows. If `graphname` is not specified and there are multiple graph windows open, `window manage forward graph` brings the topmost Graph window to the top of other windows.

Closing

`window manage close graph [graphname | _all]` closes the Graph windows named `graphname`, if it exists. If `_all` is specified, all Graph windows are closed. If `graphname` is not specified and an unnamed Graph window exists, the unnamed Graph window will be closed. Note that this command is not intended for end users; it is a utility to be used by `graph close`. End users should use `graph close`.

Renaming

`window manage rename graph oldgraphname newgraphname` renames the Graph window named `oldgraphname`, if it exists, to `newgraphname`. Note that this command is not intended for end users; it is a utility to be used by `graph rename`. End users should use `graph rename`.

Commands to manage Viewer windows

Printing

`window manage print viewer [viewername]` prints the Viewer window named `viewername`, if it exists. If `viewername` is not specified and there are multiple Viewer windows open, `window manage print` prints the topmost Viewer window. If there is no current Viewer window, `window manage print` does nothing; it does not return an error.

Bringing forward

`window manage forward viewer [viewername]` brings the Viewer window named `viewername`, if it exists, to the top of other windows. If `viewername` is not specified and there are multiple Viewer windows open, `window manage` brings the topmost Viewer window to the top of other windows.

Closing

`window manage close viewer [viewername | _all]` closes the Viewer window named `viewername`, if it exists. If `_all` is specified, all Viewer windows are closed. If `viewername` is not specified and an unnamed Viewer window exists, the unnamed Viewer window will be closed.

Also see

[P] `window programming` — Programming menus and windows
window menu — Create menus

Description

window menu allows you to add new menu hierarchies.

Syntax

Clear previously defined menu additions

`window menu clear`

Define submenus

`window menu append submenu "defined_menu" "appending_menu"`

Define menu item

`window menu append item "defined_menu" "entry_text" "command_to_execute"`

Define separator bars

`window menu append separator "defined_menu"`

Activate menu changes

`window menu refresh`

Add files to the Open recent menu

`window menu add_recentfiles "filename" [, rlevel(#)]`

The quotation marks above are required.

"defined_menu" is the name of a previously defined menu or one of the user-accessible menus "stUser", "stUserData", "stUserGraphics", or "stUserStatistics".
Remarks and examples

Remarks are presented under the following headings:

- Overview
- Clear previously defined menu additions
- Define submenus
- Define menu items
- Define separator bars
- Activate menu changes
- Add files to the Open recent menu
- Keyboard shortcuts (Windows only)
- Examples
- Advanced features: Dialogs and built-in actions
- Advanced features: Creating checked menu items
- Putting it all together

Overview

A menu is a list of choices. Each choice may be another menu (known as a submenu) or an item. When you click on an item, something happens, such as a dialog box appearing or a command being executed. Menus may also contain separators, which are horizontal bars that help divide the menu into groups of related choices.

Stata provides the top-level menus **Data, Graphics, Statistics**, and **User** to which you may attach your own submenus, items, or separators.

A menu hierarchy is the collection of menus and how they relate.

**window menu** allows you to create menu hierarchies, set the text that appears in each menu, set the actions associated with each menu item, and add separators to menus.

New menu hierarchies are defined from the top down, not from the bottom up. Here is how you create a new menu hierarchy:

1. You append to some existing Stata menu a new submenu using **window menu append submenu**. That the new submenu is empty is of no consequence.

2. You append to the new submenu other submenus, items, or separators, all done with **window menu append**. In this way, you fill in the new submenu you already appended in step 1.

3. If, in step 2, you appended submenus to the menu you defined in step 1, you append to each of them so that they are fully defined. This requires even more **window menu append** commands.

4. You keep going like this until the full hierarchy is defined. Then you tell Stata’s menu manager that you are done using **window menu refresh**.

Everything you do up to step 4 is merely definitional. At step 4, what you have done takes effect.

You can add menus to Stata. Then you can add more menus. Later, you can add even more menus. What you cannot do, however, is ever delete a little bit of what you have added. You can add some menus and **window menu refresh**, then add some more and **window menu refresh**, but you cannot go back and remove part of what you added earlier. What you can do is remove all the menus you have added, restoring Stata to its original configuration. **window menu clear** does this.
So, in our opening example, how did the Regression submenu ever get defined? By typing

```
   . window menu append submenu "stUserStatistics" "Regression"
   . window menu append item "Regression" "Simple" ...
   . window menu append item "Regression" "Multiple" ...
   . window menu append item "Regression" "Multivariate" ...
   . window menu refresh
```

The special name for Stata’s User—Statistics built-in menu. The first command appended a submenu to stUserStatistics named Regression. At this point, Regression is an empty submenu.

The next three commands filled in Regression by appending to it. All three are items, meaning that when chosen, they invoke some Stata command or program. (We have not shown you what the Stata commands are; we just put “...” to indicate them.)

Finally, window menu refresh told Stata we were done and to make our new additions available.

---

**Clear previously defined menu additions**

```
   window menu clear
```

clears any additions that have been made to Stata’s menu system.

**Define submenus**

```
   window menu append submenu "defined_menu_name" "appending_menu_name"
```

defines a submenu. This command creates a submenu with the text appending_menu_name (the double-quote characters do not appear in the submenu when displayed) attached to the "defined_menu_name". It also declares that the "appending_menu_name" can later have further submenus, items, and separators appended to it. Submenus may be appended to Stata’s built-in User menu using the command

```
   window menu append submenu "stUser" "appending_menu_name"
```

For example,

```
   window menu append submenu "stUser" "New Menu"
```

appends New Menu to Stata’s User menu. Likewise, submenus may be appended to the built-in submenus of User—Data, Graphics, and Statistics—by using stUserData, stUserGraphics, or stUserStatistics as the defined_menu_name.

**Define menu items**

```
   window menu append item "defined_menu_name" "entry_text" "command_to_execute"
```

defines menu items. This command creates a menu item with the text "entry_text", which is attached to the "defined_menu_name". When the item is selected by the user, "command_to_execute" is invoked.

For example,

```
   window menu append item "New Menu" "Describe" "describe"
```

appends the menu item Describe to the New Menu submenu defined previously and specifies that if the user selects Describe, the describe command is to be executed.
Define separator bars

`window menu append separator "defined_menuname"`
defines a separator bar. The separator bar will appear in the position in which it is declared and is attached to an existing submenu.

For example,

`window menu append separator "New Menu"`

adds a separator bar to New Menu.

Activate menu changes

`window menu refresh`
activates the changes made to Stata’s menu system.

Add files to the Open recent menu

The Open recent menu is a list of datasets recently used or saved by the user. Selecting a dataset from the menu causes Stata to execute a use command on the dataset to load the data. The datasets are represented in the list as the absolute path or URL to the dataset.

A dataset is added to the list if the dataset is loaded by the command use or saved by the command save. The list is ordered from the most recently used datasets to the least recently used datasets. The maximum number of datasets in the list is twenty and datasets are removed from the bottom of the list when the maximum is reached. If a dataset already exists in the list when it is to be added, the existing entry is moved to the top of the list.

The list of datasets from the Open recent menu is saved when exiting Stata and loaded when starting Stata. Stata removes datasets that do not exist from the list when it exits and starts but not during a session. Stata does not attempt to determine if a URL is valid.

`window menu add recentfiles "filename" [, rlevel(#) ]`
adds a dataset to the Open recent menu under the File menu. Only datasets should be added to the Open recent menu.

To prevent temporary files from being added to the Open recent menu, Stata does not add datasets used or saved by do-files and ado-files or when running a batch file. However, for the cases where you do wish to add a dataset used or saved by an ado-file or do-file, you may use the rlevel() option.

The rlevel() option determines the maximum run level an ado-file issuing the window menu add_recentfiles may run at for a dataset to be added to the Open recent menu. If no ado-file is running, the run level is 0. If an ado-file executes another ado-file which executes another ado-file before returning to the previous ado-file, the run level is 3. rlevel(0) adds a dataset only if no ado-file or do-file is running and is the default. rlevel(3) adds a dataset if an ado-file is up to 3 levels deep when called. rlevel(-1) adds a dataset regardless of the run level and is the only way to add a dataset from a do-file.

For example, sysuse is implemented as an ado-file. We want to add datasets loaded by sysuse to the Open recent menu only if the user entered sysuse from the command line. We add to sysuse.ado

`window menu add recentfiles "filename", rlevel(1)`
If we had used a run level of 2, any dataset loaded by \texttt{sysuse} from an ado-file would be added to the \texttt{Open recent} menu, which is not what we want.

**Keyboard shortcuts (Windows only)**

When you define a menu item, you may assign a keyboard shortcut. A shortcut (or keyboard accelerator) is a key that allows a menu item to be selected via the keyboard in addition to the usual point-and-click method.

By placing an ampersand (\&) immediately preceding a character, you define that character to be the shortcut. The ampersand will not appear in the menu item, but the character following the ampersand will be underlined to alert the user of the shortcut. The user may then choose the menu item by either clicking with the mouse or holding down \textit{Alt} and pressing the shortcut key. Actually, you only have to hold down \textit{Alt} for the top-level menu. For the submenus, once they are pulled down, holding down \textit{Alt} is optional.

If you need to include an ampersand as part of the "entry_text", place two ampersands in a row.

It is your responsibility to avoid creating conflicting keyboard shortcuts. When the user types in a keyboard shortcut, Stata finds the first item with the defined shortcut.

Example:

```plaintext
window menu append submenu "stUserStatistics" "&Regression"
```

defines a new submenu named \texttt{Regression} that will appear in the \texttt{User–Statistics} menu and that users may access by pressing \textit{Alt-U} (to open the \texttt{User} menu), then \texttt{S} (to open the \texttt{Statistics} menu), and finally \texttt{R}, the shortcut defined for \texttt{Regression}.

**Examples**

Below we use the \texttt{window menu} commands to add to Stata’s existing top-level menu. The following may be typed interactively:

```plaintext
window menu clear
window menu append submenu "stUser" "&My Data"
window menu append item "My Data" "&Describe data" "describe"
window menu refresh
```

\texttt{window menu clear}

Clears any user-defined menu items and restores the menu system to the default.

\texttt{window menu append submenu "stUser" "&My Data"}

Appends to the \texttt{User} a new submenu called \texttt{My Data}. Note that you may name this new menu anything you like. You can capitalize its name or not. You may include spaces in it. The new menu appears as the last item on the \texttt{User} menu.

\texttt{window menu append item "My Data" "&Describe data" "describe"}

Defines a menu item (including a keyboard shortcut) named \texttt{Describe data} to appear within the \texttt{My Data} submenu. This name is what the user will actually see. It also specifies the command to execute when the user selects the menu item. In this case, we will run the \texttt{describe} command.

\texttt{window menu refresh}

Causes all the menu items that have been defined and appended to the default system menus to become active and to be displayed.
Advanced features: Dialogs and built-in actions

Recall that menu items can have associated actions:

```stata
window menu append item "defined_menuname" "entry_text" "command_to_execute"
```

Actions other than Stata commands and programs can be added to menus. In the course of designing a menu system, you may include menu items that will invoke dialogs, open a Stata dataset, save a Stata graph, or perform some other common Stata menu command.

You can specify "command_to_execute" as one of the following:

"DB dialog_to_invoke"
invokes the dialog box defined by the file `dialog_to_invoke.dlg`. For example, specifying "DB regress" as the "command_to_execute" results in the dialog box for Stata’s `regress` command being invoked when the item is selected.

"XEQ about"
displays Stata’s About dialog box. The About dialog box is accessible from the default system menu by selecting About from the File menu.

"XEQ save"
displays Stata’s Save dialog box to save the dataset in memory. This dialog box is accessed from the default system menu by selecting Save from the File menu.

"XEQ saveas"
displays Stata’s Save Data As dialog box to save the dataset in memory. This dialog box is accessible from the default system menu by selecting Save as... from the File menu.

"XEQ savegr"
displays the Save Stata Graph File dialog box, which saves the currently displayed graph. This dialog box is accessible from the default system menu by selecting Save as... from the File menu of the Graph Editor.

"XEQ printgr"
prints the graph displayed in the Graph window. This is available in the default menu system by selecting Print Graph from the File menu. Also see [P] window manage.

"XEQ use"
displays Stata’s Open dialog box, which loads a Stata dataset. This is available in the default menu system by selecting Open... from the File menu.

"XEQ exit"
exits Stata. This is available from the default menu system by selecting Exit from the File menu (or selecting Quit from the Stata menu on Mac).

"XEQ conhelp"
opens the Stata help system to the default welcome topic. This is available by clicking on the Help! button in the help system.

Advanced features: Creating checked menu items

```stata
command_to_execute in
```

```
window menu append item "defined_menuname" "entry_text" "command_to_execute"
```

may also be specified as CHECK `macroname`.
Another detail that menu designers may want is the ability to create checked menu items. A checked menu item is one that appears in the menu system as either checked (includes a small check mark to the right) or not.

"CHECK macroname" specifies that the global macro macroname should contain the value as to whether or not the item is checked. If the global macro is not defined at the time that the menu item is created, Stata defines the macro to contain zero, and the item is not checked. If the user selects the menu item to toggle the status of the item, Stata will place a check mark next to the item on the menu system and redefine the global macro to contain one. In this way, you may write programs that access information that you gather via the menu system.

Note that you should treat the contents of the global macro associated with the checked menu item as “read only”. Changing the contents of the macro will not be reflected in the menu system.

Putting it all together

In the following example, we create a larger menu system. Note that each submenu defined using window menu append submenu contains other submenus, items defined with window menu append item that invoke commands, or both.

```
begin lgmenu.do

capture program drop mylgmenu
program mylgmenu
  version 17.0
  win m clear
  win m append submenu "stUserStatistics" "&Regression"
  win m append item "Regression" "&OLS" "DB regress"
  win m append item "Regression" "Multi&variate" "choose multivariate"
  win m append item "stUserGraphics" "&Scatterplot" "choose scatterplot"
  win m append item "stUserGraphics" "&Histogram" "myprog1"
  win m append item "stUserGraphics" "Scatterplot &Matrix" "choose matrix"
  win m append item "stUserGraphics" "&Pie chart" "choose pie"
  win m append submenu "Tests" "Test of &mean"
  win m append item "Tests" "Test of &variance" "choose variance"
  win m append item "Test of mean" "&Unequal variances" "CHECK DB紫外线"
  win m append separator "Test of mean"
  win m append item "Test of mean" "t-test &by variable" "choose by"
  win m append item "Test of mean" "t-test two &variables" "choose 2var"
  win m refresh
end

capture program drop choose
program choose
  version 17.0
  if "'1'" == "by" | "'1'" == "2var" {
    display as result "'1'" as text " from the menu system"
    if $DB紫外线 {
      display as text " use unequal variances"
    } else {
      display as text " use equal variances"
    }
  } else {
    display as result "'1'" as text " from the menu system"
  }
end

capture program drop myprog1
```
Running this do-file will define a program mylgmenu that we may use to set the menus. Note that, other than the OLS item, which launches the `regress` dialog box, the menu items will not run any interesting commands, as the focus of the example is in the design of the menu interface only. To see the results, type `mylgmenu` in the Command window after you run the do-file. Below is an explanation of the example.

The command

```
win m append submenu "stUserStatistics" "&Regression"
```

adds a submenu named Regression to the built-in menu Statistics under the User menu. If the user clicks on Regression, we will display another menu with items defined by

```
win m append item "Regression" "&OLS" "DB regress"
win m append item "Regression" "Multi&variate" "choose multivariate"
```

Because none of these entries open further menus, they use the item version instead of the submenu version of the `window menu append` command.

Similarly, the built-in User–Graphics menu is populated using `window menu item` commands.

```
win m append item "stUserGraphics" "&Scatterplot" "choose scatterplot"
win m append item "stUserGraphics" "&Histogram" "myprog1"
win m append item "stUserGraphics" "Scatterplot &Matrix" "choose matrix"
win m append item "stUserGraphics" "&Pie chart" "choose pie"
```

For the Tests submenu, we decided to have one of the entries be another submenu for illustration. First, we declared the Tests menu to be a submenu of User–Statistics using

```
win m append submenu "stUserStatistics" "&Tests"
```

We then defined the entries that were to appear below the Tests menu. There are two entries: one of them is another submenu, and the other is an item. For the submenu, we then defined the entries that are below it.

Finally, note how the commands that are run when the user makes a selection from the menu system are defined. For most cases, we simply call the same program and pass an argument that identifies the menu item that was selected. Each menu item may call a different program if you prefer. Also note how the global macro that was associated with the checked menu item is accessed in the programs that are run. When the item is checked, the global macro will contain 1. Otherwise, it contains zero. Our program merely has to check the contents of the global macro to see if the item is checked or not.

Also see

[P] Dialog programming — Dialog programming

[P] window manage — Manage window characteristics

[P] window programming — Programming menus and windows
window push — Copy command into History window

Description

window push copies the specified command-line onto the end of the command history. command-line will appear as the most recent command in the #review list and will appear as the last command in the History window.

Syntax

window push command-line

Remarks and examples

window push is useful when one Stata command creates another Stata command and executes it. Normally, commands inside ado-files are not added to the command history, but an ado-file such as a dialog interface to a Stata command might exist solely to create and execute another Stata command.

window push allows the interface to add the created command to the command history (and therefore to the History window) after executing the command.

begin example.do
  program example
    version 17.0
    display "This display command is not added to the command history"
    display "This display command is added to the command history"
    window push display "This display command is added to the command history"
  end
end example.do

. example
This display command is not added to the command history
This display command is added to the command history
. #review
  3
  2 example
  1 display "This display command is added to the command history"

Also see

[P] window programming — Programming menus and windows
[R] #review — Review previous commands
Description

window stopbox allows Stata programs to display message boxes. Up to four lines of text may be displayed on a message box.

Syntax

window stopbox {stop|note|rusure} ["line 1" ["line 2" ["line 3" ["line 4"]]]]

Remarks and examples

There are three types of message boxes available to Stata programmers. The first is the stop message box. window stopbox stop displays a message box intended for error messages. This type of message box always exits with a return code of 1.

   . window stopbox stop "You must type a variable name." "Please try again."
   (stop message box is displayed)
   —Break—
   r(1);

The second message box is the note box. window stopbox note displays a message box intended for information messages or notes. This type of message box always exits with a return code of 0.

   . window stopbox note "You answered 3 of 4 questions correctly."
   > "Press OK to continue."
   (note message box is displayed)

   The only way to close the first two types of message boxes is to click the OK button displayed at the bottom of the box.

   The third message box is the rusure (say, “Are you sure?”) box. This message box lets a Stata program ask the user a question. The user can close the box by clicking either Yes or No. The message box exits with a return code of 0 if the user clicks Yes, or exits with a return code of 1 if the user clicks No.

   A Stata program should use the capture command to determine whether the user clicked Yes or No.

   . capture window stopbox rusure
   > "Do you want to clear the current dataset from memory?"
   (rusure message box is displayed)
   . if _rc == 0 clear
Also see

[P] capture — Capture return code

[P] window programming — Programming menus and windows
ASCII. ASCII stands for American Standard Code for Information Interchange. It is a way of representing text and the characters that form text in computers. It can be divided into two sections: plain, or lower, ASCII, which includes numbers, punctuation, plain letters without diacritical marks, whitespace characters such as space and tab, and some control characters such as carriage return; and extended ASCII, which includes letters with diacritical marks as well as other special characters.

Before Stata 14, datasets, do-files, ado-files, and other Stata files were encoded using ASCII.

Automation. Automation, formerly known as OLE Automation, is a communication mechanism between Microsoft Windows applications that provides an infrastructure whereby Windows applications can access and manipulate functions and properties implemented in another application. In Stata, an Automation object enables users to directly access Stata macros, scalars, stored results, and dataset information in ways besides the usual log files.

binary 0. Binary 0, also known as the null character, is traditionally used to indicate the end of a string, such as an ASCII or UTF-8 string.

Binary 0 is obtained by using char(0) and is sometimes displayed as \0. See [U] 12.4.10 strL variables and binary strings for more information.

byte. Formally, a byte is eight binary digits (bits), the units used to record computer data. Each byte can also be considered as representing a value from 0 through 255. Do not confuse this with Stata’s byte variable storage type, which allows values from −127 to 100 to be stored. With regard to strings, all strings are composed of individual characters that are encoded using either one byte or several bytes to represent each character.

For example, in UTF-8, the encoding system used by Stata, byte value 97 encodes “a”. Byte values 195 and 161 in sequence encode “ ´a”.

characteristics. Characteristics are one form of metadata about a Stata dataset and each of the variables within the dataset. They are typically used in programming situations. For example, the xt commands need to know the name of the panel variable and possibly the time variable. These variable names are stored in characteristics within the dataset. See [U] 12.8 Characteristics for an overview and [P] char for a technical description.

class. A class is an implementation of object-oriented programming. A class is a set of variables or related functions or both tied together under one name. Stata has two class implementations, one for ado-programming (see [P] class) and one for Mata (see [M-2] class).

code pages. A code page maps extended ASCII values to a set of characters, typically for a specific language or set of languages. For example, the most commonly used code page is Windows-1252, which maps extended ASCII values to characters used in Western European languages. Code pages are essentially encodings for extended ASCII characters.

code point. A code point is the numerical value or position that represents a single character in a text system such as ASCII or Unicode. The original ASCII encoding system contains only 128 code points and thus can represent only 128 characters. Historically, the 128 additional bytes of extended ASCII have been encoded in many different and inconsistent ways to provide additional sets of 128 code points. The formal Unicode specification has 1,114,112 possible code points, of which roughly 250,000 have been assigned to actual characters. Stata uses UTF-8 encoding for Unicode. Note that the UTF-8–encoded version of a code point does not have the same numeric value as the code point itself.
display column. A display column is the space required to display one typical character in the fixed-width display used by Stata’s Results window and Viewer. Some characters are too wide for one display column. Each character is displayed in one or two display columns.

All plain ASCII characters (for example, “M” and “9”) and many UTF-8 characters that are not plain ASCII (for example, “é”) require the same space when using a fixed-width font. That is to say, they all require a single display column.

Characters from non-Latin alphabets, such as Chinese, Cyrillic, Japanese, and Korean, may require two display columns.

See [U] 12.4.2.2 Displaying Unicode characters for more information.

encodings. An encoding is a way of representing a character as a byte or series of bytes. Examples of encoding systems are ASCII and UTF-8. Stata uses UTF-8 encoding.

For more information, see [U] 12.4.2.3 Encodings.

extended ASCII. Extended ASCII, also known as higher ASCII, is the byte values 128 to 255, which were not defined as part of the original ASCII specification. Various code pages have been defined over the years to map the extended ASCII byte values to many characters not supported in the original ASCII specification, such as Latin letters with diacritical marks, such as “á” and “Á”; non-Latin alphabets, such as Chinese, Cyrillic, Japanese, and Korean; punctuation marks used in non-English languages, such as “<”, complex mathematical symbols such as “±”, and more.

Although extended ASCII characters are stored in a single byte in ASCII encoding, UTF-8 stores the same characters in two to four bytes. Because each code page maps the extended ASCII values differently, another distinguishing feature of extended ASCII characters is that their meaning can change across fonts and operating systems.

frames. Frames, also known as data frames, are in-memory areas where datasets are analyzed. Stata can hold multiple datasets in memory, and each dataset is held in a memory area called a frame. A variety of commands exist to manage frames and manipulate the data in them. See [D] frames.

global macro. See local macro and global macro.

higher ASCII. See extended ASCII.

local macro and global macro. A local macro is private, meaning it can be viewed only by the program in which it is defined. A global macro is public, meaning the global macro is available to all programs. See [U] 18.3.1 Local macros, [U] 18.3.2 Global macros, [U] 18.3.3 The difference between local and global macros, and [P] macro. Also see macro, macroname, and macro contents.

locale. A locale is a code that identifies a community with a certain set of rules for how their language should be written. A locale can refer to something as general as an entire language (for example, “en” for English) or something as specific as a language in a particular country (for example, “en_HK” for English in Hong Kong).

A locale specifies a set of rules that govern how the language should be written. Stata uses locales to determine how certain language-specific operations are carried out. For more information, see [U] 12.4.2.4 Locales in Unicode.

looping. Looping is repeatedly executing a piece of code as long as a condition is true. In Stata, while, foreach, and forvalues are all looping commands. See [P] while, [P] foreach, and [P] forvalues. Also see [M-2] for, [M-2] do, and [M-2] while.
lower ASCII. See plain ASCII.

**macro, macroname, and macro contents.** A macro is a string of characters, called the macroname, that stands for another string of characters, called the macro contents. When a macroname is referenced, the macro contents are substituted in place of the macroname. See [U] 18.3 Macros and [P] macro. Also see local macro and global macro.

**macro expansion.** Macro expansion is the process of substituting the macro contents for the macro name. See [P] macro.

**null-terminator.** See binary 0.

**numlist.** A numlist is a list of numbers. That list can be one or more arbitrary numbers or can use certain shorthands to indicate ranges, such as 5/9 to indicate integers 5, 6, 7, 8, and 9. Ranges can be ascending or descending and can include an optional increment or decrement amount, such as 10.5(-2)4.5 to indicate 10.5, 8.5, 6.5, and 4.5. See [U] 11.1.8 numlist for a list of shorthands to indicate ranges.

**object-oriented programming.** Object-oriented programming is a programming style where code is based around objects, and those objects may have both data and code methods that can operate on the data associated with an object. An object is constructed, and other objects inherit from or are built on top of that object. For instance, an object could be a point, an object built on top of that could be a line, and objects built on top of that could be polygons. Mata, C++, and Java are examples of programming languages that support object-oriented programming.

**OLE Automation.** See Automation.

**plain ASCII.** We use plain ASCII as a nontechnical term to refer to what computer programmers call lower ASCII. These are the plain Latin letters “a” to “z” and “A” to “Z”; numbers “0” through “9”; many punctuation marks, such as “!”; simple mathematical symbols, such as “+”; and whitespace and control characters such as space (“ “), tab, and carriage return.

Each plain ASCII character is stored as a single byte with a value between 0 and 127. Another distinguishing feature is that the byte values used to encode plain ASCII characters are the same across different operating systems and are common between ASCII and UTF-8.

Also see ASCII and encodings.

**plugin.** A plugin is a piece of software written in another language that adds features to a software package. Stata can call plugins written in C/C++ or Java. Plugins are useful when desired functionality is not available in Stata’s ado or Mata languages or for custom methods that require speed and involve heavy looping, recursion, or other computationally demanding approaches. See [P] plugin, [P] Java intro, and [P] PyStata integration.

**PyStata.** PyStata refers to the integration between Python and Stata. PyStata includes Python integration via the python suite of commands, which enables you to call Python from within Stata; the pystata Python package, which allows you to invoke Stata from a standalone Python environment; and the Stata Function Interface module. See [P] PyStata intro, [P] PyStata integration, and [P] PyStata module.

**recursion.** Recursion is a programming technique where a problem is solved by a function calling itself repeatedly in a nested fashion. Each call is intended to solve a smaller piece of the original problem.

**str1, str2, . . . , str2045.** See strL.

**strL.** strL is a storage type for string variables. The full list of string storage types is str1, str2, . . . , str2045, and strL.

str1, str2, . . . , str2045 are fixed-length storage types. If variable mystr is str8, then 8 bytes
are allocated in each observation to store mystr’s value. If you have 2,000 observations, then 16,000 bytes in total are allocated.

Distinguish between storage length and string length. If myvar is str8, that does not mean the strings are 8 characters long in every observation. The maximum length of strings is 8 characters. Individual observations may have strings of length 0, 1, ..., 8. Even so, every string requires 8 bytes of storage.

You need not concern yourself with the storage length because string variables are automatically promoted. If myvar is str8, and you changed the contents of myvar in the third observation to “Longer than 8”, then myvar would automatically become str13.

If you changed the contents of myvar in the third observation to a string longer than 2,045 characters, myvar would become strL.

strL variables are not necessarily longer than 2,045 characters; they can be longer or shorter than 2,045 characters. The real difference is that strL variables are stored as varying length. Pretend that myothervar is a strL and its third observation contains “this”. The total memory consumed by the observation would be 64 + 4 + 1 = 69 bytes. There would be 64 bytes of tracking information, 4 bytes for the contents (there are 4 characters), and 1 more byte to terminate the string. If the fifth observation contained a 2,000,000-character string, then 64 + 2,000,000 + 1 = 2,000,069 bytes would be used to store it.

Another difference between str1, str2, ..., str2045, and strLs is that the str# storage types can store only ASCII strings. strL can store ASCII or binary strings. Thus a strL variable could contain, for instance, the contents of a Word document or a JPEG image or anything else.

strL is pronounce sturl.

titlecase, title-cased string, and Unicode title-cased string. In grammar, titlecase refers to the capitalization of the key words in a phrase. In Stata, titlecase refers to (a) the capitalization of the first letter of each word in a string and (b) the capitalization of each letter after a nonletter character. There is no judgment of the word’s importance in the string or whether the letter after a nonletter character is part of the same word. For example, “it’s” in titlecase is “It’S”.

A title-cased string is any string to which the above rules have been applied. For example, if we used the strproper() function with the book title Zen and the Art of Motorcycle Maintenance, Stata would return the title-cased string Zen And The Art Of Motorcycle Maintenance.

A Unicode title-cased string is a string that has had Unicode title-casing rules applied to Unicode words. This is almost, but not exactly, like capitalizing the first letter of each Unicode word. Like capitalization, title-casing letters is locale-dependent, which means that the same letter might have different titlecase forms in different locales. For example, in some locales, capital letters at the beginning of words are not supposed to have accents on them, even if that capital letter by itself would have an accent.

If you do not have characters beyond plain ASCII and your locale is English, there is no distinction in results. For example, ustrtitle() with an English locale locale also would return the title-cased string Zen And The Art Of Motorcycle Maintenance.

Use the ustrtitle() function to apply the appropriate capitalization rules for your language (locale).

token. A token is a single piece of a text string. Tokens are usually delimited by whitespace or special characters such as commas, brackets, and parentheses.

Unicode. Unicode is a standard for encoding and dealing with text written in almost any conceivable living or dead language. Unicode specifies a set of encoding systems that are designed to hold (and, unlike extended ASCII, to keep separate) characters used in different languages. The Unicode
standard defines not only the characters and encodings for them, but also rules on how to perform various operations on words in a given language (locale), such as capitalization and ordering. The most common Unicode encodings are UTF-8, UTF-16, and UTF-32. Stata uses UTF-8.

**Unicode character.** Technically, a Unicode character is any character with a Unicode encoding. Colloquially, we use the term to refer to any character other than the plain ASCII characters.

**Unicode normalization.** Unicode normalization allows us to use a common representation and therefore compare Unicode strings that appear the same when displayed but could have more than one way of being encoded. This rarely arises in practice, but because it is possible in theory, Stata provides the `ustrnormalize()` function for converting between different normalized forms of the same string.

For example, suppose we wish to search for “ñ” (the lowercase n with a tilde over it from the Spanish alphabet). This letter may have been encoded with the single code point U+00F1. However, the sequence U+006E (the Latin lowercase “n”) followed by U+0303 (the tilde) is defined by Unicode to be equivalent to U+00F1. This type of visual identicalness is called canonical equivalence. The one-code-point form is known as the canonical composited form, and the multiple-code-point form is known as the canonical decomposed form. Normalization modifies one or the other string to the opposite canonical equivalent form so that the underlying byte sequences match. If we had strings in a mixture of forms, we would want to use this normalization when sorting or when searching for strings or substrings.

Another form of Unicode normalization allows characters that appear somewhat different to be given the same meaning or interpretation. For example, when sorting or indexing, we may want the code point U+FB00 (the typographic ligature “ff”) to match the sequence of two Latin “f” letters encoded as U+0066 U+0066. This is called compatible equivalence.

**Unicode title-cased string.** See `titlecase`, `title-cased string`, and Unicode title-cased string.

**UTF-8.** UTF-8 stands for Universal character set + Transformation Format—8-bit. It is a type of Unicode encoding system that was designed for backward compatibility with ASCII and is used by Stata 14.

**version and version control.** Version refers to the internal number to which Stata’s command interpreter is set. Version control is the process of specifying which version Stata should use for the command interpreter when it processes a command, do-file, or ado-file. For instance, if you write a Stata ado-file and you put `version 15` at the top of your ado-file, then Stata will interpret your ado-file using the syntax that Stata 15 supported even if the version of Stata is now Stata 16 or even Stata 20. Version control is an important feature of Stata because it ensures reproducibility. See `P version`.
Subject and author index

See the combined subject index and the combined author index in the *Stata Index*. 