

drawnorm — Draw sample from multivariate normal distribution

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Description

`drawnorm` draws a sample from a multivariate normal distribution with desired means and covariance matrix. The default is orthogonal data with mean 0 and variance 1. The covariance matrix may be singular. The values generated are a function of the current random-number seed or the number specified with `set seed()`; see [\[R\] set seed](#).

Quick start

Generate independent variables `x` and `y`, where `x` has mean 2 and standard deviation 0.5 and `y` has mean 3 and standard deviation 1

```
drawnorm x y, means(2,3) sds(.5,1)
```

As above, but create dataset of 1,000 observations on `x` and `y` with means stored in vector `m` and standard deviations stored in vector `sd`

```
drawnorm x y, means(m) sds(sd) n(1000)
```

As above, and set the seed for the random-number generator to reproduce results

```
drawnorm x y, means(m) sds(sd) n(1000) seed(81625)
```

Sample from bivariate standard normal distribution with covariance between `x` and `y` of 0.5 stored in variance–covariance matrix `C`

```
matrix C = (1, .5 \ .5, 1)
drawnorm x y, cov(C)
```

Sample from a trivariate standard normal distribution with correlation between `x` and `y` of 0.4, `x` and `z` of 0.3, and `y` and `z` of 0.6 stored in correlation matrix `C`

```
matrix C = (1, .4, .3 \ .4, 1, .6 \ .3, .6, 1)
drawnorm x y z, corr(C)
```

Same as above, but avoid typing full matrix by specifying correlations in vector `v` treated as a lower triangular matrix

```
matrix v = (1, .4, 1, .3, .6, 1)
drawnorm x y z, corr(v) cstorage(lower)
```

Menu

Data > Create or change data > Other variable-creation commands > Draw sample from normal distribution

Syntax

```
drawnorm newvarlist [, options]
```

<i>options</i>	Description
Main	
<code>clear</code>	replace the current dataset
<code>double</code>	generate variable type as double; default is float
<code>n(#)</code>	generate # observations; default is current number
<code>sds(<i>vector</i>)</code>	standard deviations of generated variables
<code>corr(<i>matrix</i> <i>vector</i>)</code>	correlation matrix
<code>cov(<i>matrix</i> <i>vector</i>)</code>	covariance matrix
<code>cstorage(<u>full</u>)</code>	store correlation/covariance structure as a symmetric $k \times k$ matrix
<code>cstorage(<u>lower</u>)</code>	store correlation/covariance structure as a lower triangular matrix
<code>cstorage(<u>upper</u>)</code>	store correlation/covariance structure as an upper triangular matrix
<code>forcepsd</code>	force the covariance/correlation matrix to be positive semidefinite
<code>means(<i>vector</i>)</code>	means of generated variables; default is <code>means(0)</code>
Options	
<code>seed(#)</code>	seed for random-number generator

Options

Main

`clear` specifies that the dataset in memory be replaced, even though the current dataset has not been saved on disk.

`double` specifies that the new variables be stored as Stata doubles, meaning 8-byte reals. If `double` is not specified, variables are stored as floats, meaning 4-byte reals. See [D] **data types**.

`n(#)` specifies the number of observations to be generated. The default is the current number of observations. If `n(#)` is not specified or is the same as the current number of observations, `drawnorm` adds the new variables to the existing dataset; otherwise, `drawnorm` replaces the data in memory.

`sds(vector)` specifies the standard deviations of the generated variables. `sds()` may not be specified with `cov()`.

`corr(matrix | vector)` specifies the correlation matrix. If neither `corr()` nor `cov()` is specified, the default is orthogonal data.

`cov(matrix | vector)` specifies the covariance matrix. If neither `cov()` nor `corr()` is specified, the default is orthogonal data.

`cstorage(full | lower | upper)` specifies the storage mode for the correlation or covariance structure in `corr()` or `cov()`. The following storage modes are supported:

`full` specifies that the correlation or covariance structure is stored (recorded) as a symmetric $k \times k$ matrix.

`lower` specifies that the correlation or covariance structure is recorded as a lower triangular matrix. With k variables, the matrix should have $k(k + 1)/2$ elements in the following order:

$$C_{11} \ C_{21} \ C_{22} \ C_{31} \ C_{32} \ C_{33} \ \dots \ C_{k1} \ C_{k2} \ \dots \ C_{kk}$$

`upper` specifies that the correlation or covariance structure is recorded as an upper triangular matrix. With k variables, the matrix should have $k(k+1)/2$ elements in the following order:

$$C_{11} \ C_{12} \ C_{13} \ \dots \ C_{1k} \ C_{22} \ C_{23} \ \dots \ C_{2k} \ \dots \ C_{(k-1)(k-1)} \ C_{(k-1)k} \ C_{kk}$$

Specifying `cstorage(full)` is optional if the matrix is square. `cstorage(lower)` or `cstorage(upper)` is required for the vectorized storage methods. See [Example 2: Storage modes for correlation and covariance matrices](#).

`forcepsd` modifies the matrix C to be positive semidefinite (psd), and so be a proper covariance matrix. If C is not positive semidefinite, it will have negative eigenvalues. By setting negative eigenvalues to 0 and reconstructing, we obtain the least-squares positive-semidefinite approximation to C . This approximation is a singular covariance matrix.

`means(vector)` specifies the means of the generated variables. The default is `means(0)`.

Options

`seed(#)` specifies the initial value of the random-number seed used by the `runiform()` function. The default is the current random-number seed. Specifying `seed(#)` is the same as typing `set seed #` before issuing the `drawnorm` command.

Remarks and examples

[stata.com](http://www.stata.com)

► Example 1

Suppose that we want to draw a sample of 1,000 observations from a normal distribution $N(\mathbf{M}, \mathbf{V})$, where \mathbf{M} is the mean matrix and \mathbf{V} is the covariance matrix:

```
. matrix M = 5, -6, 0.5
. matrix V = (9, 5, 2 \ 5, 4, 1 \ 2, 1, 1)
. matrix list M
M[1,3]
   c1  c2  c3
r1   5  -6  .5
. matrix list V
symmetric V[3,3]
   c1  c2  c3
r1   9
r2   5  4
r3   2  1  1
. drawnorm x y z, n(1000) cov(V) means(M)
(obs 1,000)
. summarize
```

Variable	Obs	Mean	Std. Dev.	Min	Max
x	1,000	4.870231	2.974229	-4.404625	13.38458
y	1,000	-6.046418	1.952715	-11.9833	-5.787959
z	1,000	.4647648	1.020487	-2.305723	3.493608

```
. correlate, cov
(obs=1,000)
```

	x	y	z
x	8.84604		
y	4.87138	3.81309	
z	2.03885	1.02233	1.04139

◀

□ Technical note

The values generated by `drawnorm` are a function of the current random-number seed. To reproduce the same dataset each time `drawnorm` is run with the same setup, specify the same seed number in the `seed()` option.

□

▷ Example 2: Storage modes for correlation and covariance matrices

The three storage modes for specifying the correlation or covariance matrix in `corr2data` and `drawnorm` can be illustrated with a correlation structure, C , of 4 variables. In full storage mode, this structure can be entered as a 4×4 Stata matrix:

```
. matrix C = ( 1.0000, 0.3232, 0.1112, 0.0066 \ ///
              0.3232, 1.0000, 0.6608, -0.1572 \ ///
              0.1112, 0.6608, 1.0000, -0.1480 \ ///
              0.0066, -0.1572, -0.1480, 1.0000 )
```

Elements within a row are separated by commas, and rows are separated by a backslash, `\`. We use the input continuation operator `///` for convenient multiline input; see [P] [comments](#). In this storage mode, we probably want to set the row and column names to the variable names:

```
. matrix rnames C = price trunk headroom rep78
. matrix colnames C = price trunk headroom rep78
```

This correlation structure can be entered more conveniently in one of the two vectorized storage modes. In these modes, we enter the lower triangle or the upper triangle of C in rowwise order; these two storage modes differ only in the order in which the $k(k+1)/2$ matrix elements are recorded. The lower storage mode for C comprises a vector with $4(4+1)/2 = 10$ elements, that is, a 1×10 or 10×1 Stata matrix, with one row or column,

```
. matrix C = ( 1.0000, ///
              0.3232, 1.0000, ///
              0.1112, 0.6608, 1.0000, ///
              0.0066, -0.1572, -0.1480, 1.0000)
```

or more compactly as

```
. matrix C = ( 1, 0.3232, 1, 0.1112, 0.6608, 1, 0.0066, -0.1572, -0.1480, 1 )
```

C may also be entered in upper storage mode as a vector with $4(4+1)/2 = 10$ elements, that is, a 1×10 or 10×1 Stata matrix,

```
. matrix C = ( 1.0000, 0.3232, 0.1112, 0.0066, ///
              1.0000, 0.6608, -0.1572, ///
              1.0000, -0.1480, ///
              1.0000 )
```

or more compactly as

```
. matrix C = ( 1, 0.3232, 0.1112, 0.0066, 1, 0.6608, -0.1572, 1, -0.1480, 1 )
```

◀

Methods and formulas

Results are asymptotic. The more observations generated, the closer the correlation matrix of the dataset is to the desired correlation structure.

Let $\mathbf{V} = \mathbf{A}'\mathbf{A}$ be the desired covariance matrix and \mathbf{M} be the desired mean matrix. We first generate \mathbf{X} , such that $\mathbf{X} \sim N(\mathbf{0}, \mathbf{I})$. Let $\mathbf{Y} = \mathbf{A}'\mathbf{X} + \mathbf{M}$, then $\mathbf{Y} \sim N(\mathbf{M}, \mathbf{V})$.

References

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Also see

- [D] [corr2data](#) — Create dataset with specified correlation structure
- [R] [set seed](#) — Specify random-number seed and state