getpatent: Scraping patent data into Stata

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1 Problem question
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Outline

1. Problem question
2. The HTML source code
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Create database of patent attributes

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  - The EPO (Europe) provides free raw patent data in XML format.
  - The WIPO (World) allows downloads of up to 10,000 records.
  - The SIPO (China) requires *domestic* account registration.
  - The exception is USPTO which provides all data in tab-delimited format.
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There is also the issue of non-standardisation when working across multiple sources.
Google Patent Search

- Google Patent Search consolidates 87 million patent publications from 17 patent offices around the world including the US, Europe, Japan, China, South Korea, WIPO, Russia, Germany, The United Kingdom, Canada, France, Spain, Belgium, Denmark, Finland, Luxembourg, and the Netherlands.
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- This is free data and even though Google does not like mining its website, an efficient and careful code can scrape this information into a database.
Google Patent Search

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- The US-based data is then mirrored onto local services, e.g. in Australia as https://www.google.com.au/patents, in Greece as https://www.google.gr/patents and so on.
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- There are two advantages in working with local servers: (1) they speak your language, (2) they give information for the 'cooperative' classification scheme.
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- The US-based data is then mirrored onto local services, e.g. in Australia as https://www.google.com.au/patents, in Greece as https://www.google.gr/patents and so on.
- There are two advantages in working with local servers: (1) they speak your language, (2) they give information for the 'cooperative' classification scheme.
- The US server contains the more widely recognised standard for international classification for patents, and importantly for us it applies a more consistent structure in its source code making it easier to scrape.
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- We tried writing something with Stata that is more generalisable and could be interpreted in any HTML situation, but the task is beyond our capabilities and patience.

- The point being that scraping source code with Stata must be coded as a webpage-specific task. What works for Google Patent Search does not have to work with any other website.
Google Search Patent HTML source code

```html
<html>
<head>
    <meta> .... </meta>
    <script> .... </script>
    <style> .... </style>
</head>
<body>
    <h1 itemprop="title">Component name extraction system and method </h1>
    <h2>Info</h2>
    <dl>
        <dt>Publication number</dt>
        <dd itemprop="publicationNumber">CN102455997A</dd>
        ...
        <dt>Authority</dt>
        <dd itemprop="countryCode">CN</dd>
        ...
        <dt>Inventor</dt>
        <dd itemprop="inventor" repeat>Donald J. Leary</dd>
        ...
        <h2>Links</h2>
        ...
        <h2>Classifications</h2>
        ...
    </dl>
</body>
</html>
```
Segmenting the HTML code

- Think of the source code as a very long string, and strings are memory hungry.
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2. Segment the remaining `<body>`/<`/body`> by headings as sections.
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4. The remaining `<body>` is segmented by `<h2>`/<`/h2`>.
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4. The remaining `<body>` is segmented by `<h2></h2>`.

5. Within a given `<h2></h2>` we search for the `itemprop=""` attribute, e.g. `itemprop="inventor"`. This is the item’s property name that ends up as a variable name in the new dataset.
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  1. Purge <head></head> that contains mostly formatting code, that is taking up about half of the length of the string.
  2. Segment the remaining <body></body> by headings as sections.
  3. There is only one <h1></h1> that holds the patent’s title.
  4. The remaining <body> is segmented by <h2></h2>.
  5. Within a given <h2></h2> we search for the itemprop="" attribute, e.g. itemprop="inventor". This is the item’s property name that ends up as a variable name in the new dataset.
  6. itemprop="" contains a value that ends up as the observation for that variable and that patent code, e.g. itemprop="inventor">Donald J. Leary<.
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Read source code

- The source code is read as a single very long string, i.e. one source code is a single observation, as for example:

```plaintext
generate source = fileread("https://patents.google.com/patent/USD213421S")
```
Read source code

- The source code is read as a single very long string, i.e. one source code is a single observation, as for example:

  ```stata
  generate source = fileread("https://patents.google.com/patent/USD213421S")
  ```

- `filereaderror()==0` checks that the URL exists. If not, then that observation is recorded as missing.
Simplify source code

- We simplify the source code by removing all conflicting characters with Stata’s syntax, including the tab, carriage return, double quotes, single quotes and the grave-accent. Using the ASCII characters:

```stata
foreach j in char(9) char(10) char(34) char(39) char(96) {
    replace source = subinstr(source,`j'""",.)
}
```
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  ```stata
  foreach j in `char(9)` `char(10)` `char(34)` `char(39)` `char(96)` {
    replace source = substr(source,`char(9)``char(34)``char(39)``char(96)`,.
  }
  ```

- We trim all external and internal extra spaces:

  ```stata
  replace source = strtrim(strtrim(source))
  ```
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  ```stata
  foreach j in char(9) char(10) char(34) char(39) char(96) {
    replace source = subinstr(source,`j',"","",.)
  }
  ```

- We trim all external and internal extra spaces:

  ```stata
  replace source = strtrim(strtrim(source))
  ```

- And make everything lowercase as it is easier to match string patterns and work with regular expressions:

  ```stata
  replace source = lower(source)
  ```
A crash course in regular expressions (ASCII capabilities)

Regular expressions: matching patterns in strings

<table>
<thead>
<tr>
<th>Operator</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>^</td>
<td>Match expression at beginning of the string</td>
<td>^sun matches &quot;sunrise&quot;</td>
</tr>
<tr>
<td>$</td>
<td>Match expression at end of the string</td>
<td>sun$ matches &quot;Monsun&quot;</td>
</tr>
<tr>
<td><strong>Anchors to match the location of expression</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>?</td>
<td>Match preceding expression zero or one times</td>
<td>A? matches nothing or A</td>
</tr>
<tr>
<td>+</td>
<td>Match preceding expression one or more times</td>
<td>A+ matches A, AA, AAA</td>
</tr>
<tr>
<td>*</td>
<td>Match preceding expression zero or more times</td>
<td>A* matches nothing, A, AA, AAA</td>
</tr>
<tr>
<td><strong>Wildcards for counting matches</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.</td>
<td>Match any character except new lines</td>
<td>.* matches anything any times</td>
</tr>
<tr>
<td>-</td>
<td>Match range of alpha characters or integers</td>
<td>[0-1] matches numbers 0 or 1</td>
</tr>
<tr>
<td>[]</td>
<td>Match one character in brackets</td>
<td>[aeiou] matches a lowercase vowel</td>
</tr>
<tr>
<td>[^]</td>
<td>Match one character except those in brackets</td>
<td>[^0-9] matches non-numerical</td>
</tr>
<tr>
<td>()</td>
<td>Match sub-expression to be extracted as string</td>
<td>&lt;(.*)&gt; capture anything within &lt;&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The OR operator</td>
</tr>
<tr>
<td><strong>List operators</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>\</td>
<td>Match ^$.?*[] ()</td>
<td>+ as string literals</td>
</tr>
<tr>
<td><strong>Escape operator</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Purge `<head>` and any remaining `<script>`

- First, get rid of the `<head>`</head>:

  ```stata
  replace source = regexr(source,"<head>.*</head>",,"
  ```
Purge `<head>` and any remaining `<script>`

- First, get rid of the `<head>`:</head>:

  ```
  replace source = regexr(source,"<head>.*</head>" ,"")
  ```

- Then purge any remaining formatting `<script>`:</script>:

  ```
  local check = 1
  while `check'==1 {
    qui replace `pos1' = strpos(`source','<script')
    qui replace `pos2' = strpos(`source','</script')
    qui replace `subt' = substr(`source','`pos1','`pos2'-'pos1'+9)
    qui replace `source' = subinstr(`source','`subt','','1)
    qui sum `pos1' if `touse'
    if r(max)==0 local check = 0
  }
  ```
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    qui replace `source' == substr(`source','`subt','"",1)
    qui sum `pos1' if `touse'
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  }
  ```

- We have since learned that there is a more elegant approach to this using `uregexr()`.
Scrape patent title from within <h1></h1>

- To scrape the patent title, first take an `extract` from the `source` that contains everything within `<h1></h1>` inclusive (extracting smaller strings increases computational efficiency). Then, locate `itemprop=title` and scrape the patent title:

```stata
generate extract = regexs(regexm(source,"(<h1.*</h1>)"))
generate title = strtrim(regexs(regexm(extract,"itemprop=title>(.*)</h1>")))
replace title = regexr(title,"^([a-z])",regexs(regexm(title,"^([a-z])")))
```
Scrape rest of the data from `<h2></h2>`

- The remaining data is segmented in `<h2></h2>` sections.
Scrape rest of the data from `<h2>`</h2>

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- We repeat a similar process as in `<h1>`</h1> for every `<h2>` section, each time accounting for the specific complexity that is pertinent to the data that is scraped.
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- We repeat a similar process as in \(<h1>\)/h1> for every \(<h2>\) section, each time accounting for the specific complexity that is pertinent to the data that is scraped.
- For example, from \(<h2>information\)/h2> we scrape the patent office authority, with itemprop=countrycode, using the following regular expression:

```plaintext
generate auth = regexs(regexm(`extract',"itemprop=countrycode>([^<>][a-z\&\./\-]+)</")
```
Scrape rest of the data from <h2></h2>

- The remaining data is segmented in <h2></h2> sections.
- We repeat a similar process as in <h1></h1> for every <h2> section, each time accounting for the specific complexity that is pertinent to the data that is scraped.
- For example, from <h2>information</h2> we scrape the patent office authority, with itemprop=countrycode, using the following regular expression:

```stata
generate auth = regexs(regexm(\`extract','itemprop=countrycode>(([^<>][a-z \&\./\-]+)</))
```

- For itemprop=inventor there may be multiple inventors, so the process is recursive until these is none left to scrape. The regular expression for inventors is:

```stata
gen invent = regexs(regexm(\`extract','itemprop=inventor.+>(([^<>][a-z /:\./-\(\)\]\]+)</))
```
Scrape rest of the data from <h2></h2>

- The remaining data is segmented in <h2></h2> sections.
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gen invent = regexs(regexm(`extract',"itemprop=inventor.+>([^<>][a-z /:\.\-\(\)\]\]+)</")
```

- There are other specific complexities, too many to list here.
getpatent.ado

`getpatent` requires access to a list of patent codes for reaching the dynamic URLs. If some codes are not valid then it returns missing values. There are two sets of options related to (1) which information should be scraped and (2) how quickly or carefully should this be done:

```
getpatent codevar [if] [in] , [options]
```

- There are actually too many `options` to list here related to (1) and they follow the HTML segmented structure.
getpatent.ado

- Specifying the option all scrapes every itemprop="" from the webpage which is fine for small datasets but would be problematic for large data because all would also scrape narrative text, such as itemprop="abstract" and itemprop="description".
getpatent.ado

- Specifying the option `all` scrapes every `itemprop=""` from the webpage which is fine for small datasets but would be problematic for large data because `all` would also scrape narrative text, such as `itemprop="abstract"` and `itemprop="description"`.
- So, for large data be parsimonious. Specify only what you need. You should definitely specify `info` that gets all patent identifiers (e.g. `pubid`, `auth`, `invent`, `dates`) and then see what you need, e.g. `classifications`, `references`, `breferences`. 
getpatent.ado

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- So, for large data be parsimonious. Specify only what you need. You should definitely specify `info` that gets all patent identifiers (e.g. `pubid`, `auth`, `invent`, `dates`) and then see what you need, e.g. `classifications`, `freferences`, `breferences`.

- There are also some utility options that specify how often should the program visit the Google website and how many calls it should make each time, as there is a risk of being uncovered as a robot and banned from visiting.
Example

```
. getpatent code, pubid pubno pubk auth isgrant lstatus dates class
```
To do list

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- We have recently discovered that Unicode regular expressions have slightly increased capability, e.g. they can do conditional lookahead assertions which is very useful for extracting repeated strings as in `itemprop=="inventor"` and `itemprop=="classification"`. Thus, migrating from ASCII to Unicode regular expressions would simplify our code considerably.

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- At this stage, `getpatent` requires access to a list of patent codes to get to the URLs. The ultimate aim is to design `getpatent` to require access to only 1 patent code and then build a database by expanding forwards and backwards to all patents that are cited *ad infinitum*, or at a cut-off point.