Computational Sociology (PGSP11583)

Christopher Barrie

2022-08-23T00:00:00+03:00

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Computational Sociology

This is the course book we will be using for Computational Sociology (PGSP11583).

```
print("Computational Sociology")
```

```
[1] "Computational Sociology"
```

> The book is a "live" document meaning I will be updating as we progress together through the course.

License

Course Overview

This below gives details of course structure, outcomes, and assessment.

Learning outcomes

This course will give students training in the use of various computational methods in the social sciences. The course will prepare students for dissertation work that uses digital trace data and/or computational methods and will provide hands-on training in the use of the R programming language and (some) Python.

The course will provide a venue for seminar discussion of examples using these methods in the empirical social sciences as well as lectures on the technical and/or statistical dimensions of their application.

Course structure

We will be using this online book for the ten-week course in "Computational Sociology" (PGSP11583). Each chapter contains the readings for that week. The book also includes worksheets with example code for how to conduct some of the text analysis techniques we discuss each week.

Each week (with the partial exception of week 1), we will be discussing, alternately, the substantive and technical dimensions of published research in the empirical social sciences.

Course theme

In order to discipline the course, I have decided to focus on one theme that is currently making headlines: the political consequences of social media.

With this in mind, every two weeks we will be studying a different phenomenon that has gained media attention: e.g., echo chambers, misinformation, violence.

On alternate weeks, we will discuss how these phenomena have been studied—using both computational and non-computational methods. In the subsequent week, we will then go through some of the technical dimensions of the methods used in the papers we study.

Course pre-preparation

NOTE: Before the lecture in Week 2, students should complete two introductory R exercises.

1. First, you should consult the worksheet here, which is an introduction to setting up and understanding the very basics of working in R. S
2. Second, Ugur Ozdemir has provided such a more comprehensive introductory R course for the Research Training Centre at the University of Edinburgh and you can follow the instructions here to access this.

Reference sources

There are two main reference texts that will be of use during this course:

- Wickham, Hadley and Garrett Grolemund. R for Data Science: https://r4ds.had.co.nz/
- Salganik, Matt. Bit by Bit: Social Research in the Digital Age: https://www.bitbybitbook.com/

Assessment

Fortnightly worksheets

Each fortnight, I will provide you with one worksheet that walks you through how to implement a different computational technique. At the end of these worksheets you will find a set of questions. **You should buddy up with someone else in your class and go through these together.**

This is called "pair programming" and there's a reason we do this. Firstly, coding can be an isolating and difficult thing—it's good to bring a friend along for the ride! Secondly, if there's something you don't know, maybe your buddy will. This saves you both time. Thirdly, your buddy can check your code as you write it, and vice versa. Again, this means both of you are working together to produce and check something as you go along.

At the subsequent week's lecture, I will pick on a pair at random to answer each one of that worksheet's questions (i.e., there is ~1/3 chance you're going to get picked each week). I will ask you to walk us through your code. And remember: it's also fine if you struggled and didn't

get to the end! If you encountered an obstacle, we can work through that together. All that matters to me is that you **try**.

Fortnightly flash talks

On the weeks where you are not going to be tasked with a coding assignment, you're not off the hook… I will again be selecting a pair at random (the same as your coding pair) to talk me through one of the readings. I will pick a different pair for each reading (i.e., $\sim 1/3$ chance again).

Don't let this be cause of great anguish: I just want **two or three minutes** where you lay out for me: 1) the research question; 2) the data source; 3) the method; 4) the findings; 5) what you thought its limitations were. The main portion of your flash talk should focus on element 5).

For this last one, you will want to think about 1)-4); i.e., you will want to think about whether it really answered the research question, whether the data was appropriate for answering that question, whether the method was appropriate for answering that question, and whether the results show what the author claims they show. **I will provide you wish an example flash talk at the first lecture.**

Final assessment

Assessment takes the form of **one** summative assessment. This will be a 4000 word essay on a subject of your choosing (with prior approval by me). For this, you will be required to select from a range of data sources I will provide. You may also suggest your own data source.

You will be asked to: a) formulate a research question; b) use at least one computational technique that we have studied; c) conduct an analysis of the data source you have provided; d) write up the initial findings; and e) outline potential extensions of your analysis.

You will then provide the code you used in reproducible (markdown) format and will be assessed on both the substantive content of your essay contribution (the social science part) as well as your demonstrated competency in coding and text analysis (the computational part).

Introduction to R

This section is designed to ensure you are familiar with the R environment.

Getting started with R at home

Given that we're all working from home these days, you'll need to download R and RStudio onto your own devices. R is the name of the programming language that we'll be using for coding exercises; RStudio is the IDE ("Integrated Development Environment"), i.e., the piece of software that almost everyone uses when working in R.

You can download both of these on Windows and Mac easily and for free. This is one of the first reasons to use an "open-source" programming language: it's free and everyone can contribute!

IT Services at the University of Edinburgh have provided a walkthrough of what is needed for you to get started. I also break this down below:

1. Install R for Mac from here: https://cran.r-project.org/bin/macosx/. Install R for Windows from here: https://cran.r-project.org/bin/windows/base/.
2. Download RStudio for Windows or Mac from here: https://rstudio.com/products/rstudio/download/, choosing the Free version: this is what most people use and is more than enough for all of our needs.

All programs are free. Make sure to load everything listed above for your operating system or R will not work properly!

Some basic information

- A script is a text file in which you write your commands (code) and comments.
- If you put the # character in front of a line of text this line will not be executed; this is useful to add comments to your script!
- R is case sensitive, so be careful when typing.

- To send code from the script to the console, highlight the relevant line of code in your script and click on Run, or select the line and hit ctrl+enter on PCR or cmd+enter on Mac
- Access help files for R functions by preceding the name of the function with ? (e.g., ?table)
- By pressing the up key, you can go back to the commands you have used before
- Press the tab key to auto-complete variable names and commands

Getting Started in RStudio

Begin by opening RStudio (located on the desktop). Your first task is to create a new script (this is where we will write our commands). To do so, click:

```
File --> NewFile --> RScript
```

Your screen should now have four panes:

- the Script (top left)
- the Console (bottom left)
- the Environment/History (top right)
- Files/Plots/Packages/Help/Viewer (bottom right)

A simple example

The Script (top left) is where we write our commands for R. You can try this out for a first time by writing a small snipped of code as follows:

```
x <- "I can't wait to learn Computational Text Analysis" #Note the quotation marks!
```

To tell R to run the command, highlight the relevant row in your script and click the Run button (top right of the Script) - or hold down ctrl+enter on Windows or cmd+enter on Mac - to send the command to the Console (bottom left), where the actual evaluation and calculations are taking place. These shortcut keys will become very familiar to you very quickly!

Running the command above creates an object named 'x', that contains the words of your message.

You can now see 'x' in the Environment (top right). To view what is contained in x, type in the Console (bottom left):

```
print(x)
```

```
[1] "I can't wait to learn Computational Text Analysis"
```

```
# or alternatively you can just type:

x
```

```
[1] "I can't wait to learn Computational Text Analysis"
```

Loading packages

The 'base' version of R is very powerful but it will not be able to do everything on its own, at least not with ease. For more technical or specialized forms of analysis, we will need to load new packages.

This is when we will need to install a so-called 'package'—a program that includes new tools (i.e., functions) to carry out specific tasks. You can think of them as 'extensions' enhancing R's capacities.

To take one example, we might want to do something a little more exciting than print how excited we are about this course. Let's make a map instead.

This might sound technical. But the beauty of the packaged extensions of R is that they contain functions to perform specialized types of analysis with ease.

We'll first need to install one of these packages, which you can do as below:

```
install.packages("tidyverse")
```

After the package is installed, we then need to load it into our environment by typing library(). Note that, here, you don't need to wrap the name of the package in quotation marks. So this will do the trick:

```
library(tidyverse)
```

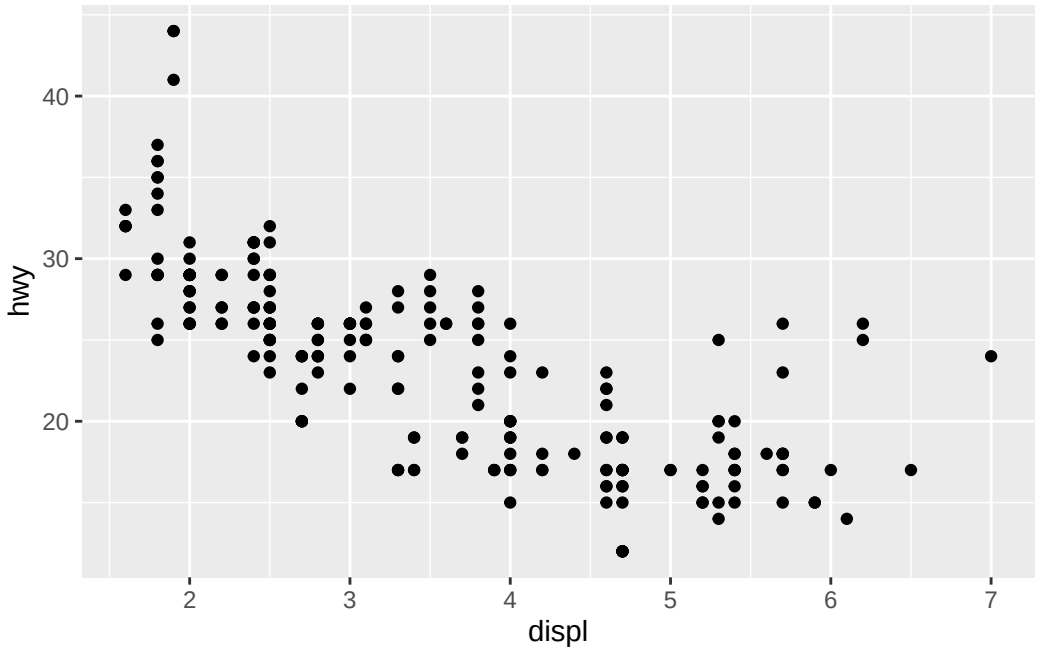
```
-- Attaching packages --------------------------------------- tidyverse 1.3.1 --
```

```
v ggplot2 3.3.6     v purrr   0.3.4
v tibble  3.1.7     v dplyr   1.0.9
v tidyr   1.2.0     v stringr 1.4.0
v readr   2.1.2     v forcats 0.5.1

-- Conflicts ---------------------------------------- tidyverse_conflicts() --
x dplyr::filter() masks stats::filter()
x dplyr::lag()    masks stats::lag()
```

What now? Well, let's see just how easy it is to visualize some data using ggplot which is a package that comes bundled into the larger tidyverse package.

```
ggplot(data = mpg) +
  geom_point(mapping = aes(x = displ, y = hwy))
```



If we wanted to save where we'd got to with making our plots, we would want to save our scripts, and maybe the data we used as well, so that we could return to it at a later stage.

Saving your objects, plots and scripts

- Saving scripts: To save your script in RStudio (i.e. the top left panel), all you need to do is click File –> Save As (and choose a name for your script). Your script will be

something like: myfilename.R.

- Saving plots: If you have made any plots you would like to save, click Export (in the plotting pane) and choose a relevant file extension (e.g. .png, .pdf, etc.) and size.
- To save **individual** objects (for example x from above) from your environment, run the following command (choosing a suitable filename):

```
save(x,file="myobject.RData")
load(file="myobject.RData")
```

- To save **all** of your objects (i.e. everything in the top right panel) at once, run the following command (choosing a suitable filename):

```
save.image(file="myfilname.RData")
```

- Your objects can be re-loaded into R during your next session by running:

```
load(file="myfilename.RData")
```

There are many other file formats you might use to save any output. We will encounter these as the course progresses.

Knowing where R saves your documents

If you are at home, when you open a new script make sure to check and set your working directory (i.e. the folder where the files you create will be saved). To check your working directory use the getwd() command (type it into the Console or write it in your script in the Source Editor):

```
getwd()
```

To set your working directory, run the following command, substituting the file directory of your choice. Remember that anything following the '#' symbol is simply a clarifying comment and R will not process it.

```
## Example for Mac
setwd("/Users/Documents/mydir/")
## Example for PC
setwd("c:/docs/mydir")
```

Practicing in R

The best way to learn R is to use it. These workshops on text analysis will not be the place to become fully proficient in R. They will, however, be a chance to conduct some hands-on analysis with applied examples in a fast-expanding field. And the best way to learn is through doing. So give it a shot!

For some further practice in the R programming language, look no further than (**wickham_r_2017?**) and, for tidy text analysis, (**silge_text_2017?**).

- The free online book by Hadley Wickham "R for Data Science" is available here
- The free online book by Julia Silge and David Robinson "Text Mining with R" is available here
- For more practice with R, you may want to consult a set of interactive tutorials, available through the package "learnr." Once you've installed this package, you can go through the tutorials yourselves by calling:

```
library(learnr)

available_tutorials() # this will tell you the names of the tutorials available

run_tutorial(name = "ex-data-basics", package = "learnr") #this will launch the interactiv
```

One final note

Once you've dipped into the "R for Data Science" book you'll hear a lot about the so-called tidyverse in R. This is essentially a set of packages that use an alternative, and more intuitive, way of interacting with data.

The main difference you'll notice here is that, instead of having separate lines for each function we want to run, or wrapping functions inside functions, sets of functions are "piped" into each other using "pipe" functions, which look have the appearance: `%>%`.

I will be using "tidy" syntax in the weekly exercises for these computational text analysis workshops. If anything is unclear, I can provide the equivalents in "base" R too. But a lot of the useful text analysis packages are now composed with 'tidy' syntax.

Managing data and code

> The following introductory section is taken, in slightly adapted form, from Jae Yeon Kim's "Computational Thinking for Social Scientists." It is reproduced here for ease of access. To consult the full book, go to https://jaeyk.github.io/comp_thinking_social_science/.

The Command Line

What is the command line? The command line or "terminal" is what you'll recognize from Hollywood portrayals of hackers and script kids—a black screen containing single lines of code, sometimes cascading down the page.

But you all have one on your computers.

On Windows computers, you'll find this under the name "Command Prompt." See this guide on how to open.

On Mac, this is called "Terminal". See this guide. Some also prefer to use an application called "iTerm 2" but they both essentially do the same thing.

The Big Picture

As William Shotts the author of *The Linux Command Line* put it:

> graphical user interfaces make easy tasks easy, while command-line interfaces make difficult tasks possible.

Why bother using the command line?

Suppose that we want to create a plain text file that contains the word "test." If we want to do this in the command line, you need to know the following commands.

1. `echo`: "Write arguments to the standard output" This is equivalent to using a text editor (e.g., nano, vim, emacs) and writing something.

2. `> test` Save the expression in a file named test.

We can put these commands together like the following:

```
echo "sth" > test
```

Don't worry if you are worried about memorizing these and more commands. Memorization is a far less important aspect of learning programming. In general, if you don't know what a command does, just type `<command name> --help`. You can do `man <command name>` to obtain further information. Here, `man` stands for manual. If you need more user-friendly information, please consider using `tldr`.

Let's make this simple case complex by scaling up. Suppose we want to make 100 duplicates of the `test` file. Below is the one-line code that performs the task!

```
for i in {1..100}; do cp test "test_$i"; done
```

Let me break down the seemingly complex workflow.

1. `for i in {1..100}`. This is a for loop. The numbers 1..100 inside the curly braces `{}` indicates the range of integers from 1 to 100. In R, this is equivalent to for (i in 1:100) {}

2. `;` is used to use multiple commands without making line breaks. ; works in the same way in R.

3. `$var` returns the value associated with a variable. Type `name=<Your name>`. Then, type `echo $name`. You should see your name printed. Variable assignment is one of the most basic things you'll learn in any programming. In R, we do this by using ->

If you have zero experience in programming, I might have provided too many concepts too early, like variable assignment and for loop. However, you don't need to worry about them at this point. We will cover them in the next chapter.

I will give you one more example to illustrate how powerful the command line is. Suppose we want to find which file contains the character "COVID." This is equivalent to finding a needle in a haystack. It's a daunting task for humans, but not for computers. Commands are verbs. So, to express this problem in a language that computers could understand, let's first find what command we should use. Often, a simple Google or Stack Overflow search leads to an answer.

In this case, `grep` is the answer (there's also grep in R). This command finds PATTERNS in each FILE. What follows - are options (called flags): `r` (recursive), `n` (line number), `w` (match only whole words), `e` (use patterns for matching). `rnw` are for output control and `e` is for pattern selection.

So, to perform the task above, you just need one-line code: `grep -r -n -w -e "COVID''`

Quick reminders - `grep`: command - `-rnw -e`: flags - `COVID`: argument (usually file or file paths)

Let's remove (=`rm`) all the duplicate files and the original file. `*` (any number of characters) is a wildcard (if you want to identify a single number of characters, use `?`). It finds every file whose name starts with `test_`.

```
rm test_* test
```

Enough with demonstrations. What is this black magic? Can you do the same thing using a graphical interface? Which method is more efficient? I hope that my demonstrations give you enough sense of why learning the command line could be incredibly useful. In my experience, mastering the command line helps automate your research process from end to end. For instance, you don't need to write files from a website using your web browser. Instead, you can run the `wget` command in the terminal. Better yet, you don't even need to run the command for the second time. You can write a Shell script (`*.sh`) that automates downloading, moving, and sorting multiple files.

UNIX Shell

The other thing you might have noticed is that there are many overlaps between the commands and base R functions (R functions that can be used without installing additional packages). This connection is not coincident. UNIX preceded and influenced many programming languages, including R.

The following materials on UNIX and Shell are adapted from [the software carpentry](https://bids.GitHub.io/201
06-04-berkeley/shell/00-intro.html.

Unix

UNIX is an **operating system + a set of tools (utilities)**. It was developed by AT & T employees at Bell Labs (1969-1971). From Mac OS X to Linux, many of the current operation systems are some versions of UNIX. Command-line INTERFACE is a way to communicate with your OS by typing, not pointing, and clicking.

For this reason, if you're using Mac OS, then you don't need to do anything else to experience UNIX. You're already all set.

If you're using Windows, you need to install either GitBash (a good option if you only use Bash for Git and GitHub) or Windows Subsystem (highly recommended if your use case goes beyond Git and GitHub). For more information, see this installation guideline. If you're a Windows user and don't use Windows 10, I recommend installing VirtualBox.