Statistical analysis

[R]

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Outline

Today

- Reproducible statistical analysis
- Reinhart & Rogoff: a textbook example of the power of replication
- `R`: what is it and why should I care?
- R overview
  - Libraries and help
  - Reading data
  - Exploring the `data.frame`
  - Manipulate a `data.frame`
  - Analyze data
  - Visualize data
  - Export results

Introduction

Reproducible statistical analysis

Open principles applied to the way you conduct statistical data analysis:

- Make the process explicit and transparent
- Provide every input required to reproduce the analysis carried out and obtain the same results, as reported in the final document published

This typically involves three levels:

- **Data** used for the study
- **Code** created to perform the analysis
- **Platform** required to run the code

Being fully open on the three is not always possible (e.g. proprietary data/software), but that should be goal to which to get as close as possible.

Getting halfway is better than not starting

In this session we will focus on the last two: **code** and **platform**

Reinhart & Rogoff

- In 2010, C. Reinhart and K. Rogoff put together a paper claiming to show how economic growth is seriously dampened once the ratio of debt to GDP goes above 90%
- The paper was very influential and became one of the most commonly cited ones to argue for austerity measures
- In 2013, **Thomas Herndon**, a PhD student at UMass, tried to replicate the results for a class assignment
- He could not, so finally he obtained from Reinhart the original (Excel) code and data only to find **results diverged** because of:
  - Selective exclusion of available data
  - Unconventional weighting of summary statistics
  - Coding errors
- The **replication** is posted online, together with the data and R code used for the paper

Reinhart & Rogoff

Lessons:

- **No one is free from mistakes** (even Harvard top economists!)
- **Posting your data and code** but, if you don't, sharing them honestly upon request is a good second best
- **Replication** should be much more widespread
- . . . you should not underestimate PhD students without a big name but with lots of time!

R

R: what is it?

R is a language and environment for statistical computing and graphics

- **language & environment**
- **statistical computing**
- **graphics**

Characteristics:

- It is a Free implementation of the S language created by **R**oss Ihaka and **R**obert Gentleman in 1993
- **Cross-platform**: runs on many *nix (included Linux) systems, Windows and MacOS.
- It is licensed under GPL, which makes it **free**...
  - ... as in **beer**
  - ... as in **speech**

Why should I care about R?

- Philosophy behind the project
- Convenience (once you get ahead the learning curve)

Some people who care about R:

- Many top universities use R in teaching and research
- Google and Facebook
- New York Times

The R Philosophy

. . . Then sit back, relax, and enjoy being part of something big. . .
[Tom Preston-Werner]

Being Free Software ("the users have the freedom to run, copy, distribute, study, change and improve the software") has enhanced:

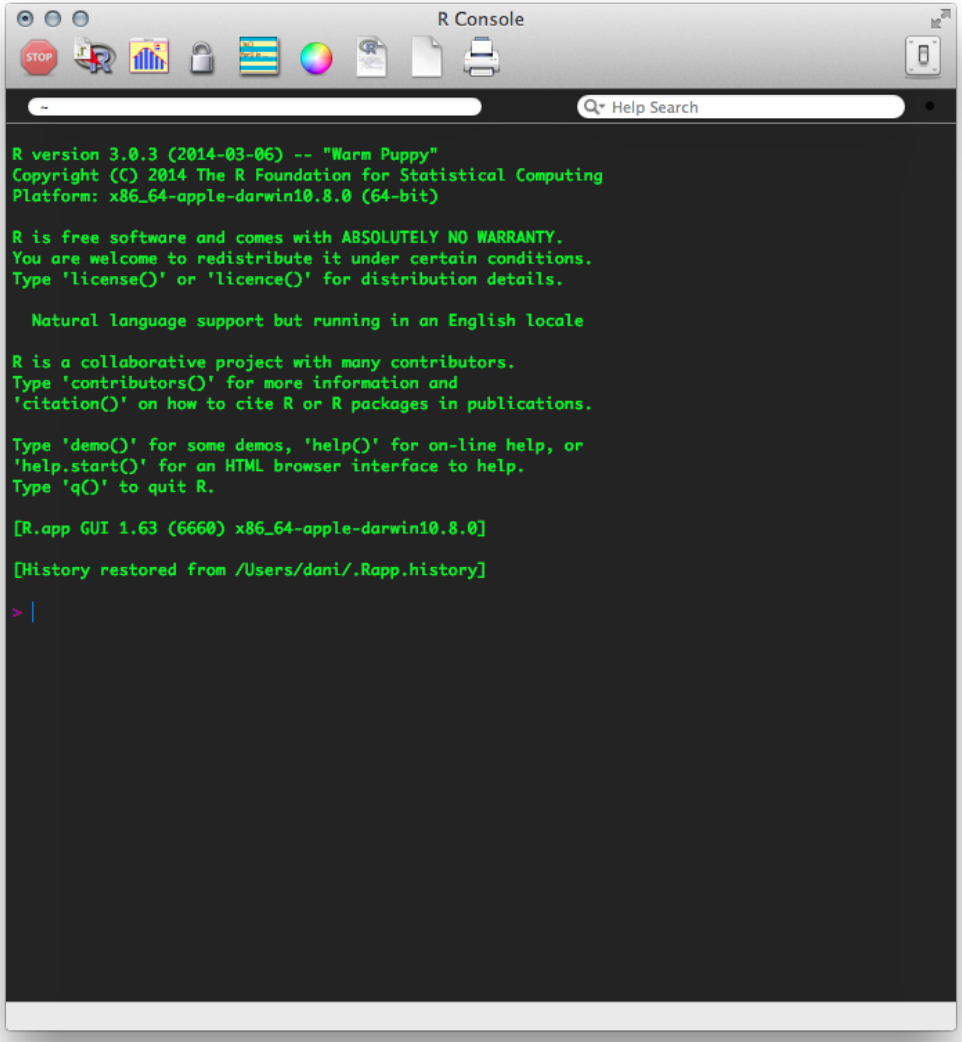
- **Worldwide community** of dedicated and enthusiastic users, contributors and developers that:
  - Lowers the entry barriers (mailing lists, blog posts, online tutorials, workshops. . .)
  - Continuously expands the capability and functionality
- Becoming an instrument for **democratization** of academic software and technology transfer
- Becoming the **lingua franca** in academia
- Facilitating reproductibility and Open Science

R as free beer

- The price is right
  - Education
  - Installation across multiple machines
- The *beer selection* is wide (CRAN hosts 3,669 available packages as of March 10th. 2012)
  - Makes R a good one stop-shop and a good investment of your time to learn it
  - No market profitability constraints put it at the cutting edge (research sandbox)
- Linus' Law: *"given enough eyeballs, all bugs are shallow"*
  - More reliable and stable

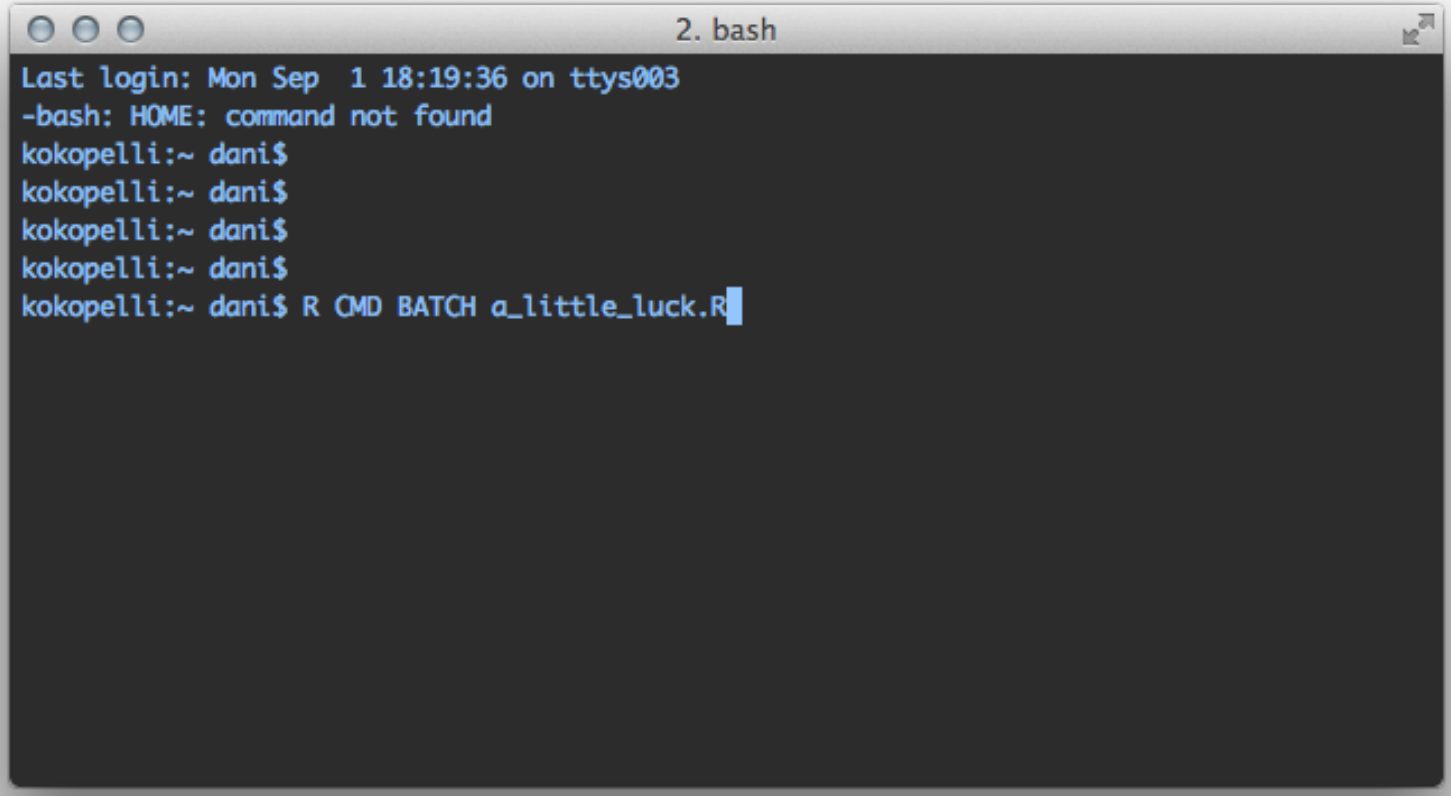
Ways to interact with R

- Interactive shell



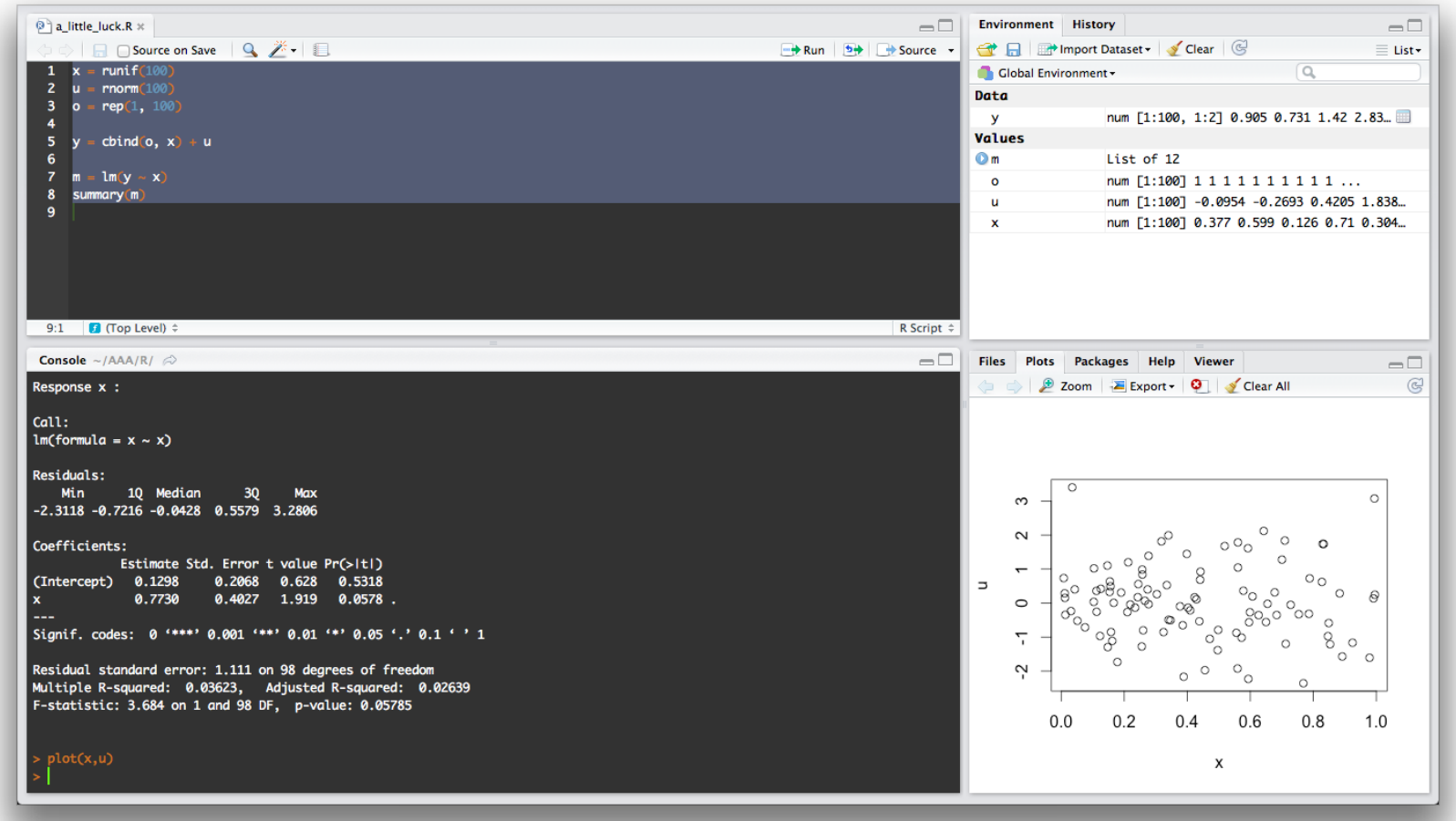
Ways to interact with R

- Batch mode from the command line



Ways to interact with R

- IDEs (e.g. RStudio)



R overview

Packages

Look for R info and packages

- Project website: `http://r-project.org`
- The Comprehensive R Archive Network (CRAN)
- The R-Journal (and JoSS)
- R bloggers
- Twitter: the `#rstats` hashtag
- Google (good luck on that)

Install and load packages

- Windows and MacOS GUIs have installers
- Command line with `instal.packages` function
- Command `library` (e.d. `library(maptools)` to load the package `maptools`)

Help and documentation

- R built-in search capability

Command	Function
`?read.csv`	Check local documentation for `read.csv` function
`spdep::moran.test`	Check local documentation in package `spdep` for `moran.test`
`help("read.csv")`	Check local documentation for `read.csv` function
`help.search("read.csv")`	Search for "read.csv" in all help files
`RSiteSearch("plot maps")`	Search for the term "plot maps" in the RSiteSearch website (requires connectivity)

- StackOverflow

Reading data

Exploring a `data.frame`

Manipulating a `data.frame`

Analyze data: regression

Visualization

Export results

More

Additional resources