Introduction to R

Lecture 1

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https://github.com/kristineccles/Introduction_to_R

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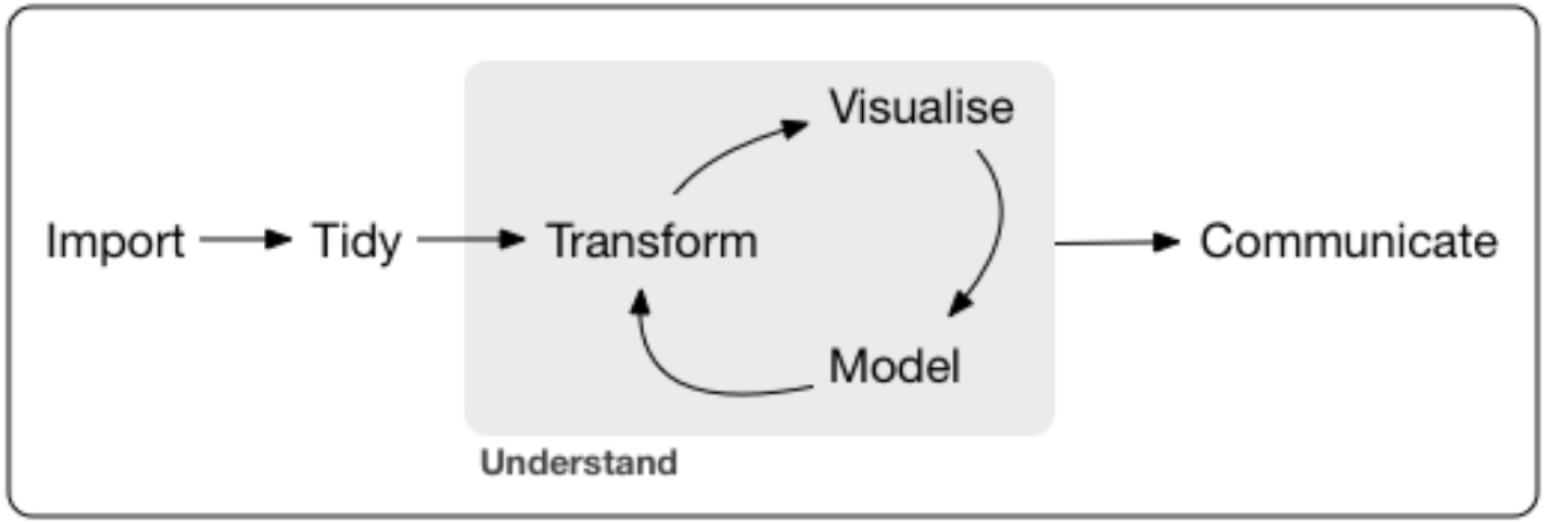
Overview

- January 6th:
  - What can R do?
  - Why and when would you want to use R?
  - How to get help; Working with RStudio
  - Core Language
    - Data types, functions, operations, loading data, saving data
    - R Packages (installing, loading, using)
  - Exploratory Data Analysis
    - Graphs (base, ggplot2)
- January 13th:
  - Standard statistical functions: Descriptive statistics, correlations, linear regression
  - Overview other modelling possibilities (i.e. Generalised linear models, multilevel modelling, structural equation modelling, Bayesian analysis, bootstrapping, meta-analysis)
  - Introduction to mapping in R

What is R?

- "R is a free software environment for statistical computing and graphics" - http://www.r-project.org



- Why the name "R"?
  - First letter of two originators: Ross Ihaka and Robert Gentleman
  - Built on a earlier language called "S"
  - (S-Plus)

Why use R?

- R is free to use
- R is **open source**
  - "denoting software for which the original source code is made freely available and may be redistributed and modified."
- Runs on all operating systems (Windows, OSX, Linux)
- R is very versatile
  - huge library of user-contributed packages (over 6,000 on Comprehensive R Archive Network (CRAN))
- Facilitates reproducible research
- Popular in academia and industry
  - A lot of free online resources (stack overflow, r stats, etc.)

What is used in academia?

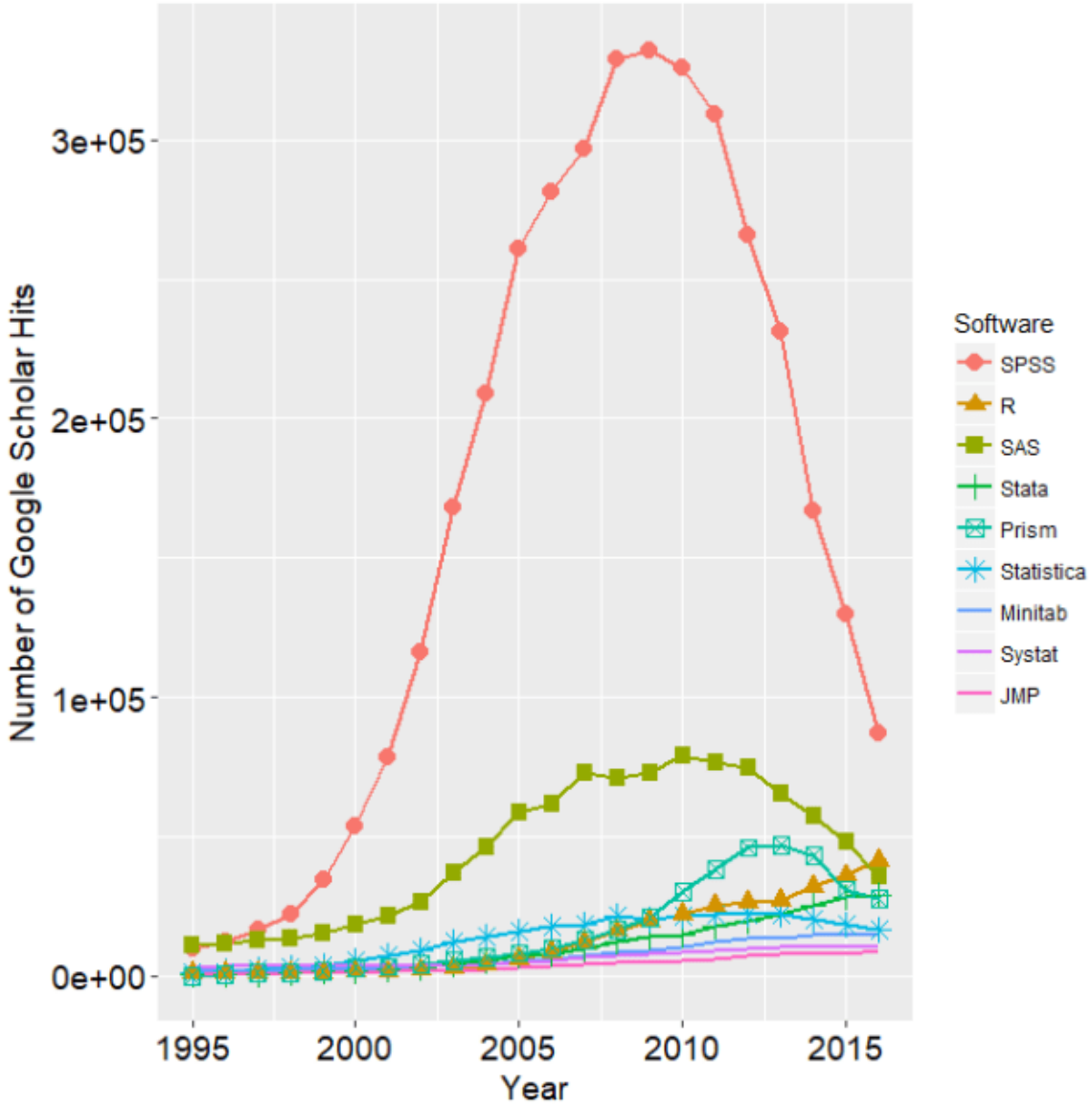


Figure 2d. The number of scholarly articles found in each year by Google Scholar. Only the top six “classic" statistics packages are shown Source: http://r4stats.com/articles/popularity.

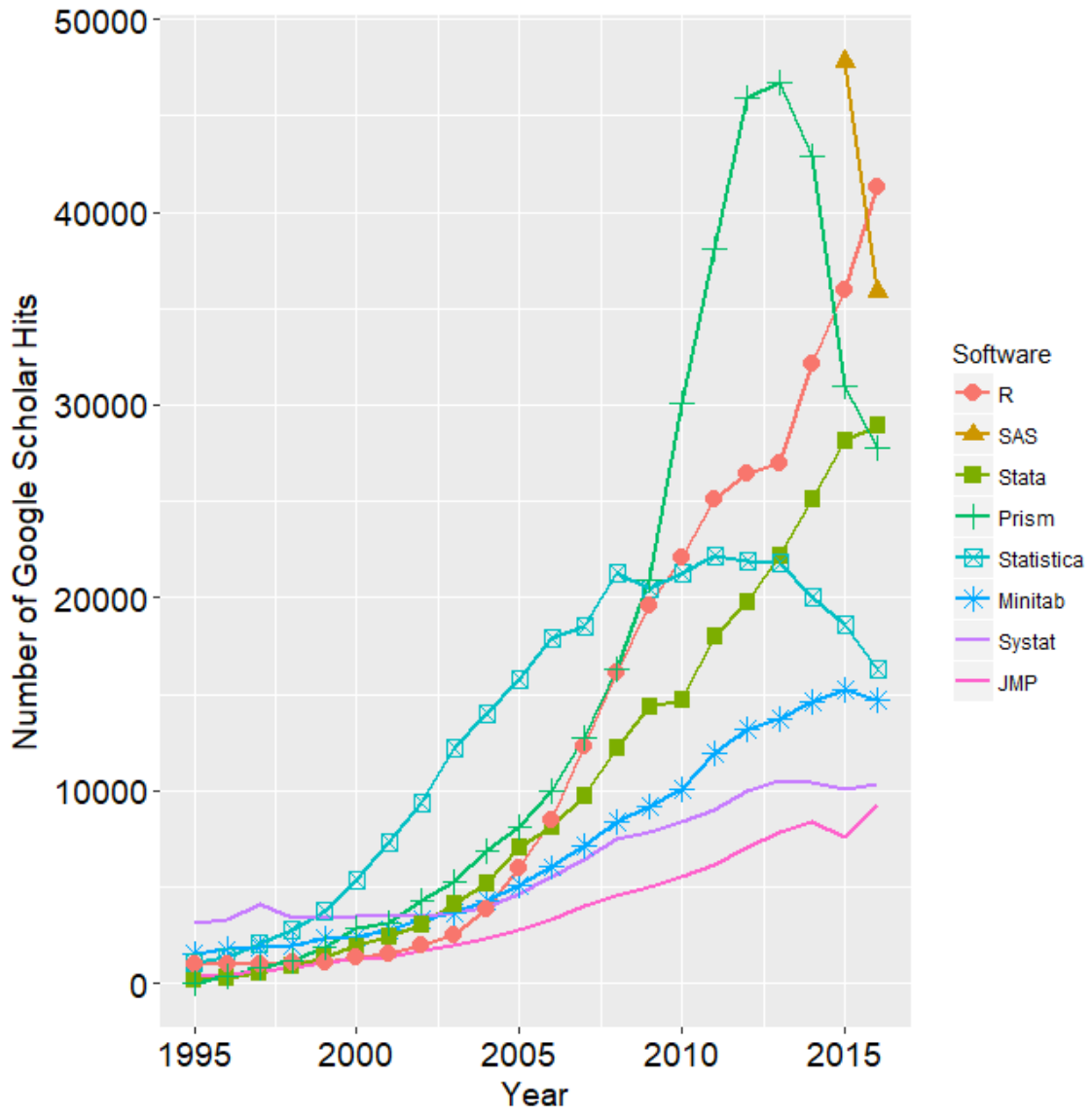
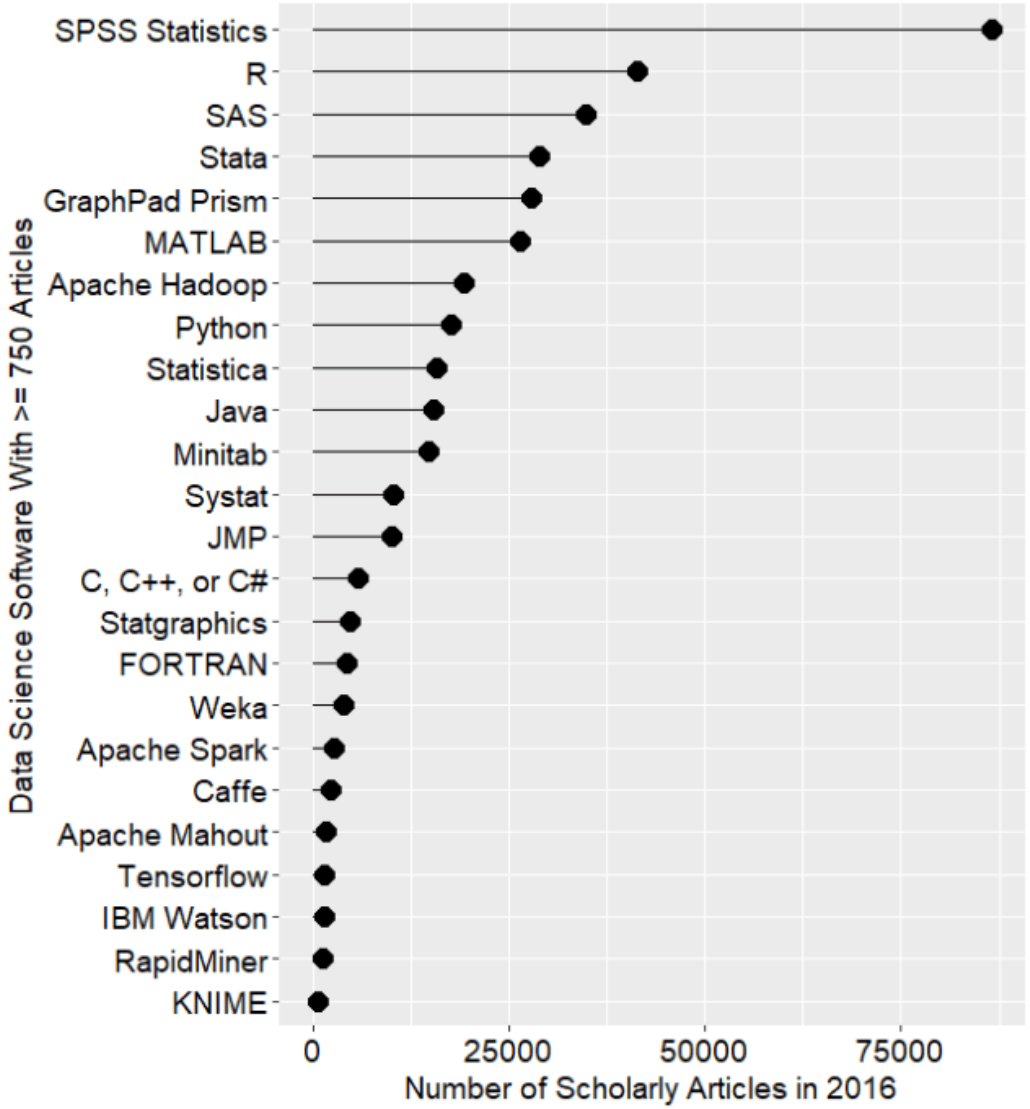


Figure 2e. The number of scholarly articles found in each year by Google Scholar for classic statistics packages after the curves for SPSS and SAS have been removed.Source: http://r4stats.com/articles/popularity.

What is Used in Academic Articles?



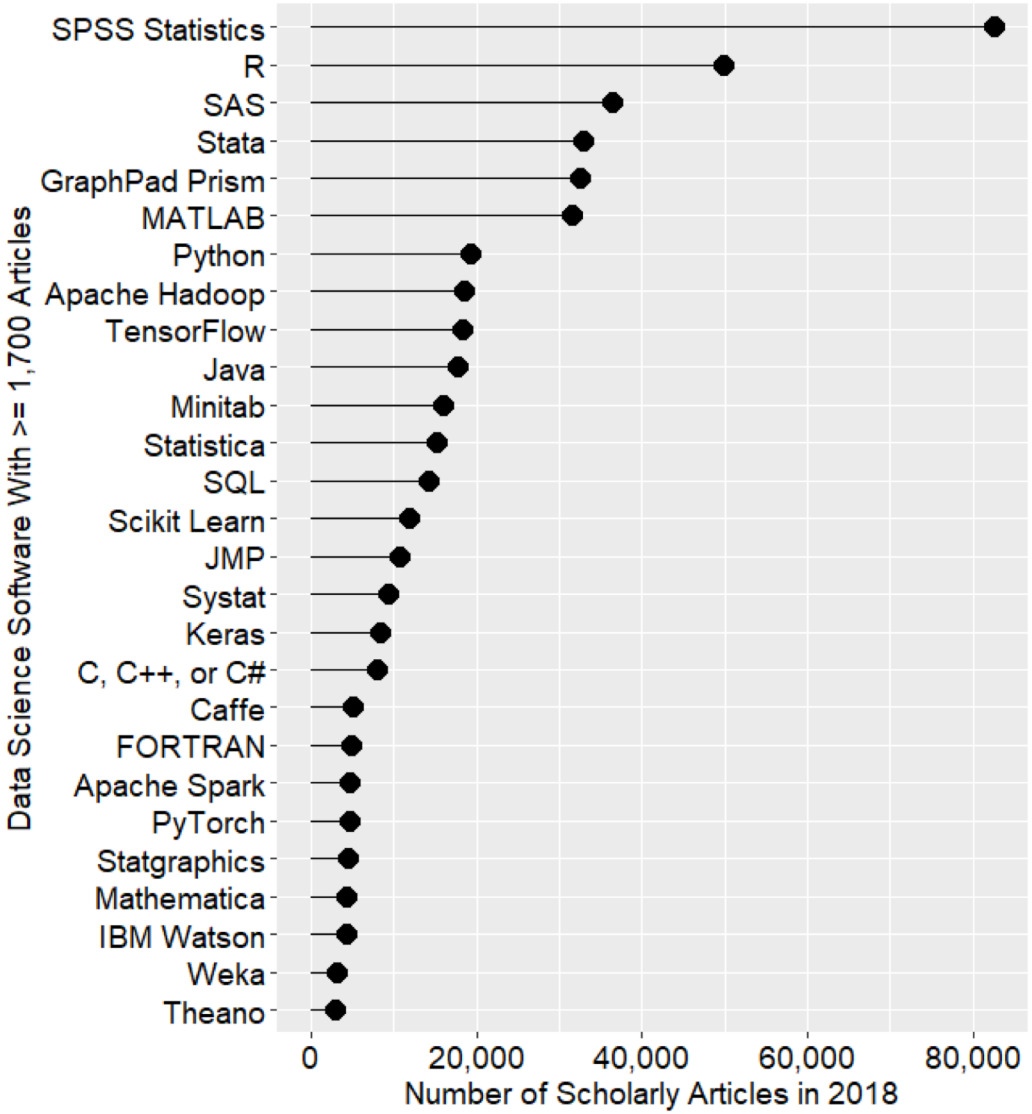


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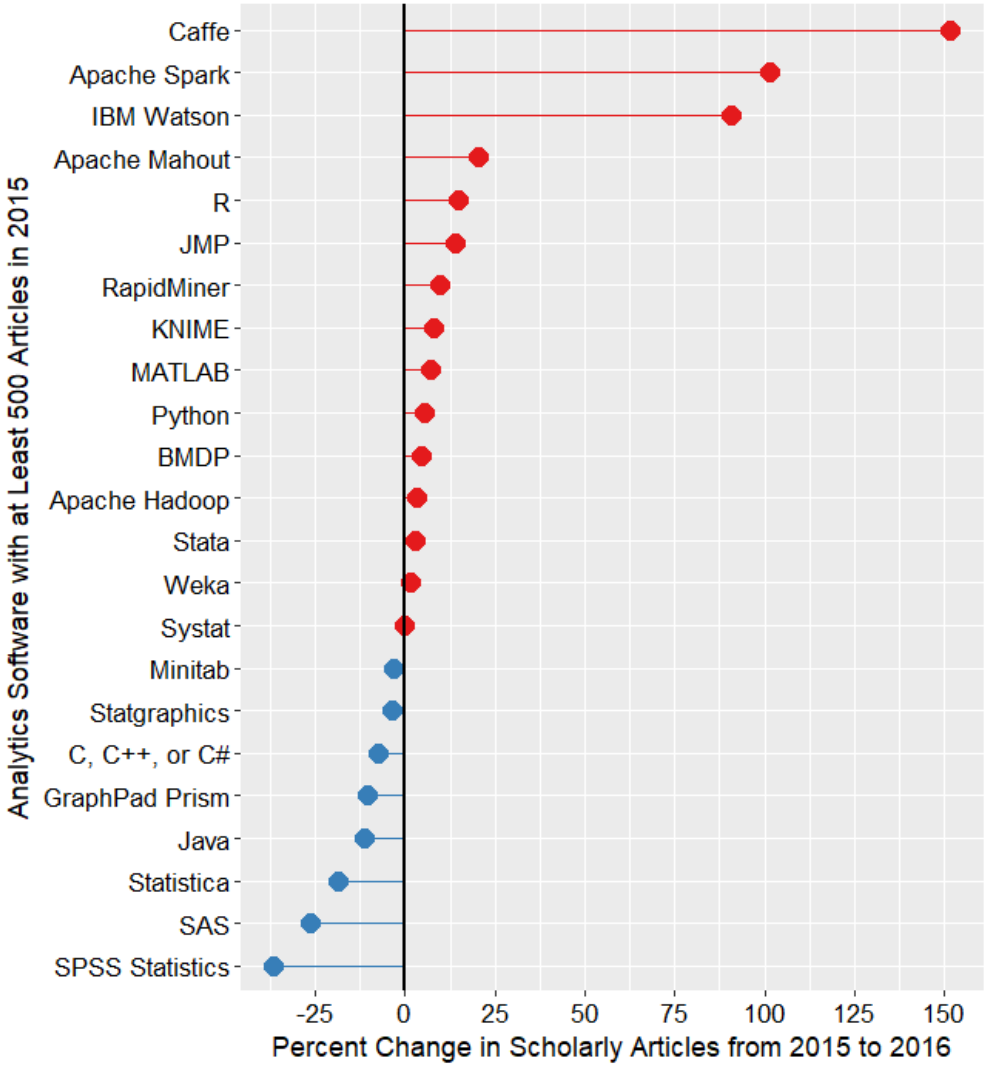
Figure 2a. The number of scholarly articles found on Google Scholar, for data science software. Source: http://r4stats.com/2019/04/01/scholarly-datasci-popularity-2019/

Software with the most academic growth



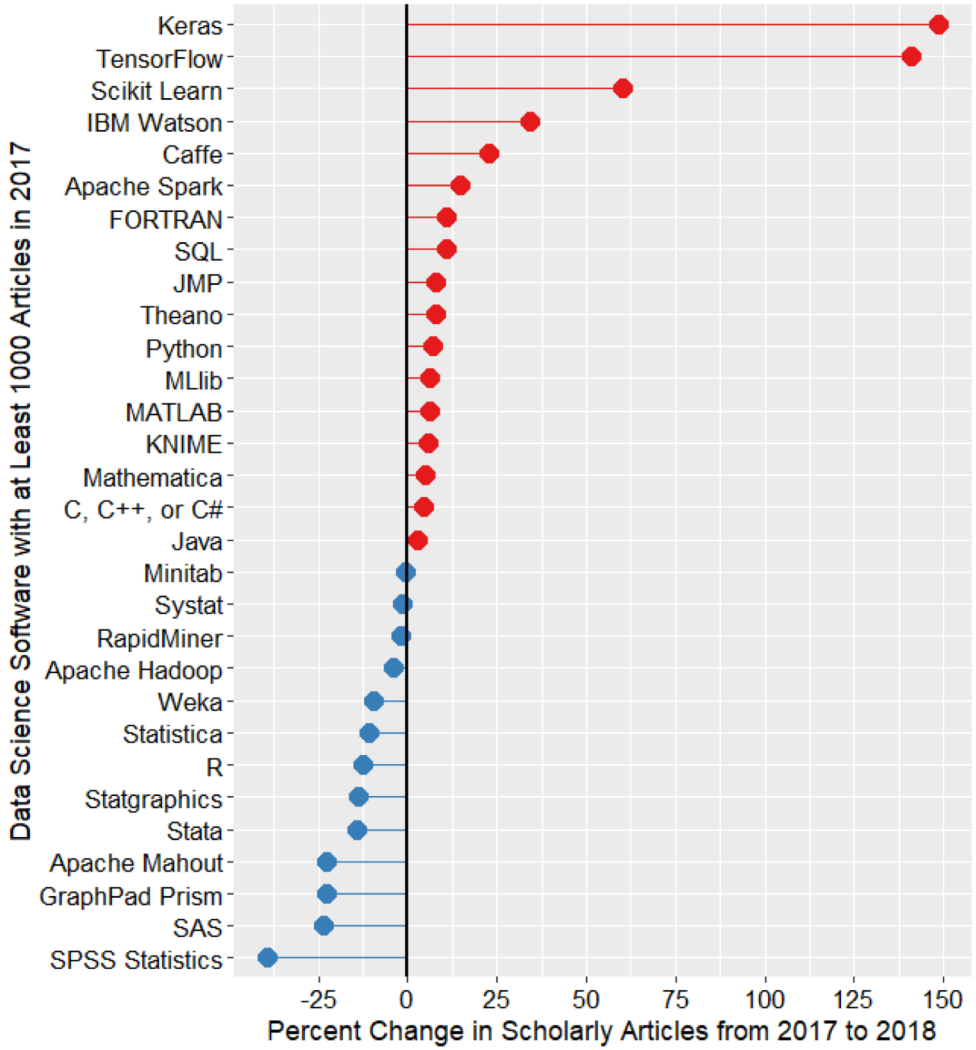


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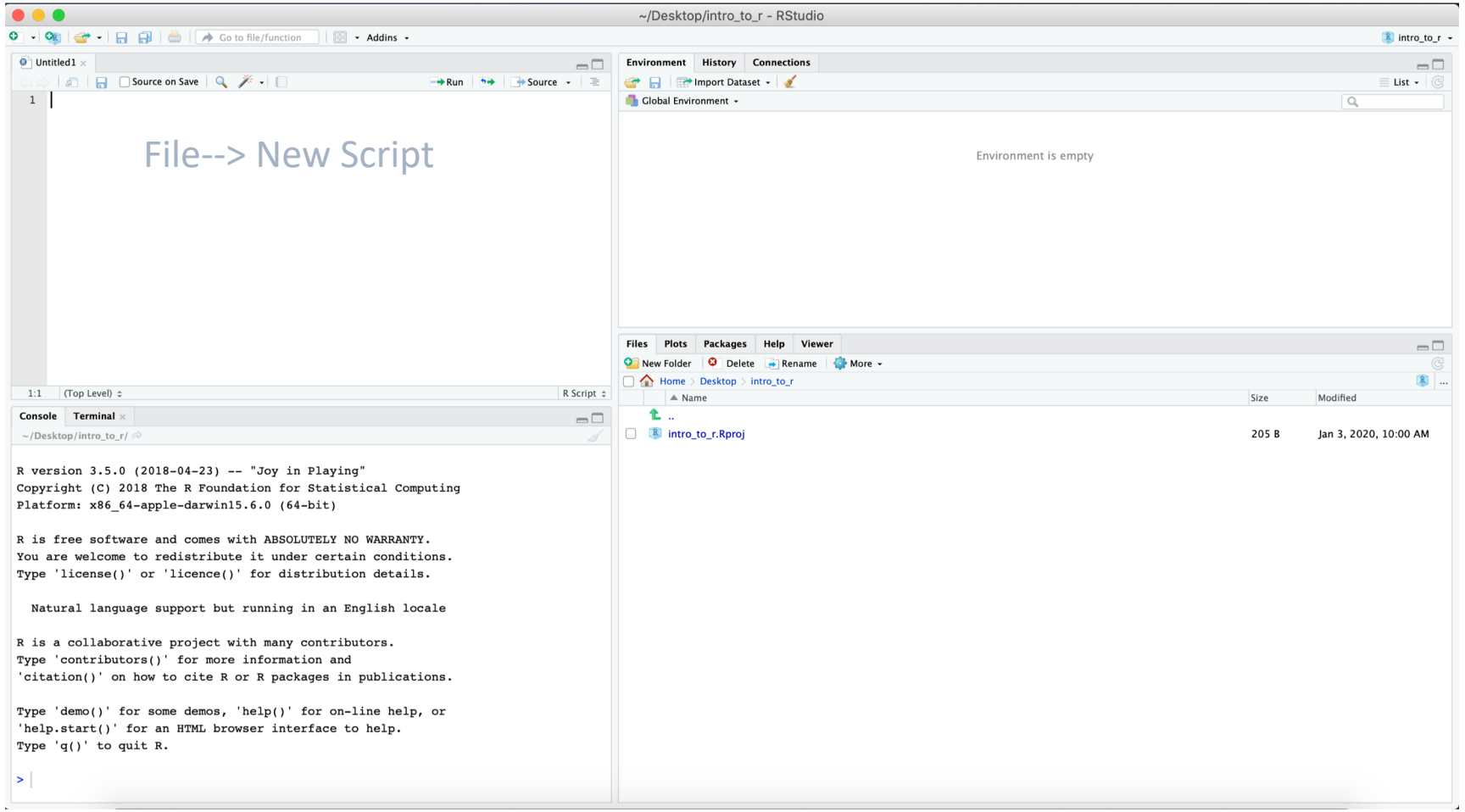
Figure 2c. Change in the number of scholarly articles using each software in the most recent two complete years (2015 to 2016 and 2017-2018. Packages shown in red are “hot" and growing, while those shown in blue are “cooling down" or declining. Source: http://r4stats.com/articles/popularity

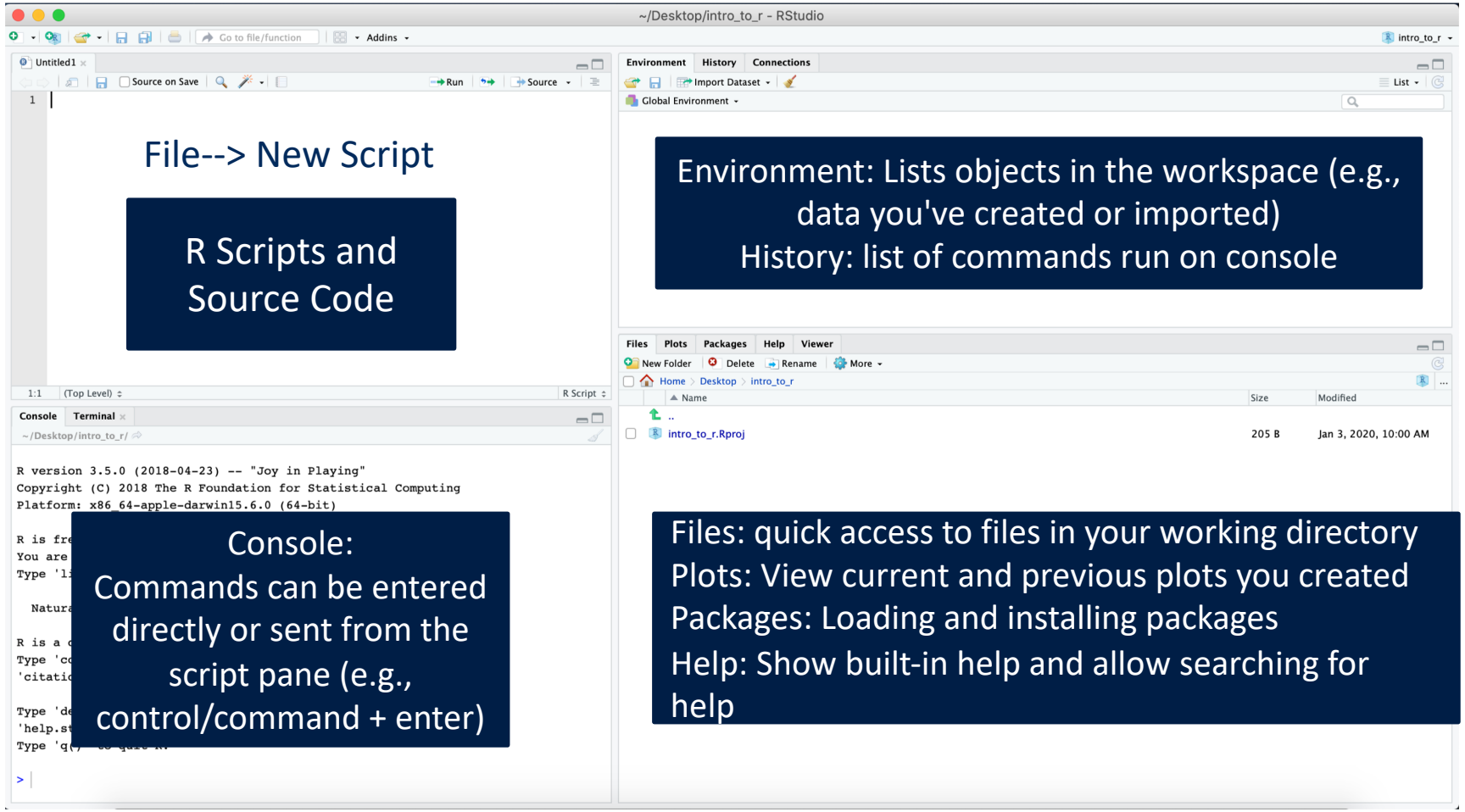
Challenges of using R

- R involves writing scripts
- It does not have a GUI like SPSS, SAS, Stata, etc.
  - But RStudio is a user friendly Integrated Developer Environment (IDE)
- R is more interactive
  - In SPSS and SAS you choose a command and get piles of output which you wade through
  - R is a conversation: You interactively request relevant output

A Guided Tour of RStudio



A Guided Tour of RStudio



RStudio Projects

- It is good practice to store all files related to a particular analysis project in a single directory on your computer
  - I.e. scripts, data files, configuration files, figures, exported tables, etc.
- Rstudio makes this easy to do
  - (Go to: `File → New Project → New Directory → New Project → Create Project`)
  - The directory name: want to call it
  - Create project of a subdirectory of: where on your computer you want it stored
- This generates a folder and a file with an "Rproj" extension (e.g., `projectname.Rproj`)
  - In the future, double click on this file to open the project
  - R studio will open the previous working environment

Overview of common file extensions

- R Specific file formats
  - .r : R script files
  - .rmd : RMarkdown files
  - .Rproj : RStudio project files
  - .rdata : Native format in r for saving R objects
- Other relevant formats
  - .md : Markdown file
  - .csv : comma separated value data file

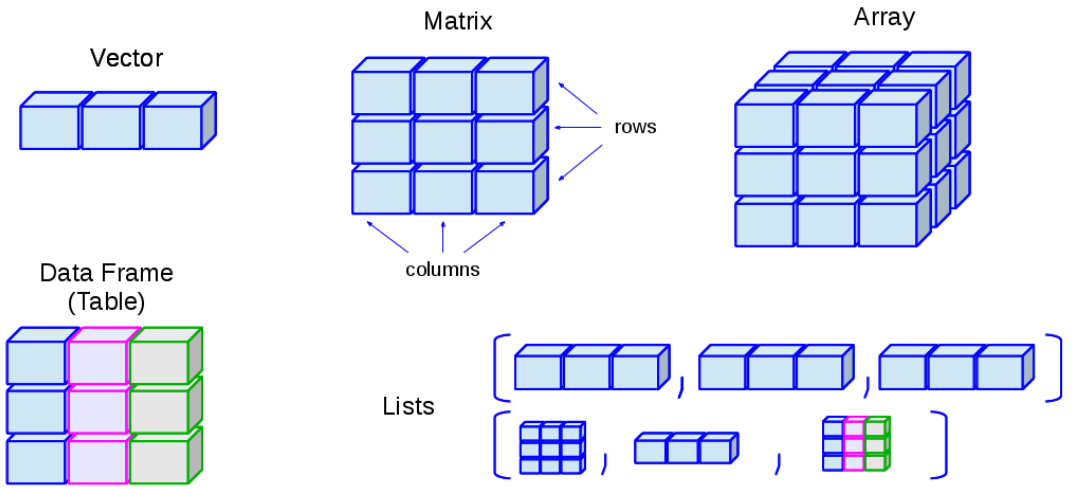
Objects and Classes

- R is an object oriented language
- Everything in R is an object: functions, symbols, and even R expressions.
- Objects may have attributes, such as name, dimension, and class R is an object-oriented language
  - Every object in R has a type
  - Every object in R is a member of a class
  - i.e. vectors, numeric vectors, dataframes, lists, and arrays
- All R code manipulates objects

For more reading: Chapter 7 and 10 of R in a Nutshell

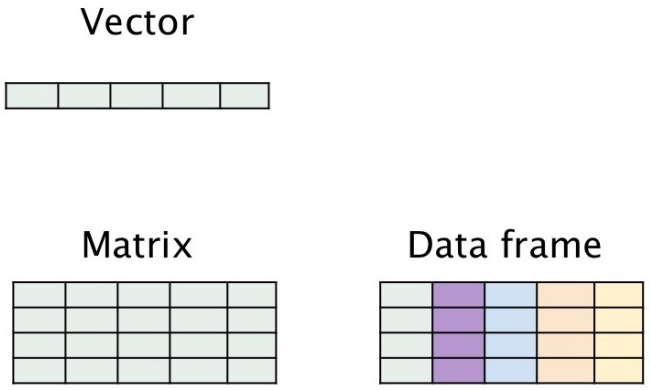
Data structure and types in R

- Data structures: vectors, matrices, arrays, data frames (similar to tables, and lists



- Data types: integer, numeric, logical, and factor

Variables	Example
integer	100
numeric	0.05
character	“hello”
logical	TRUE
factor	“Green”



Introducing R Commands

OPEN R

- R is an interpreted language
- Accessed through a command-line interpreter
  - This requires the user knowledge of commands and their parameters, and the syntax of the language
- Upon starting there is a “>” in the console. R is prompting you to type something, so this is called a prompt.
- The commands that you type into the console are called expressions

Vectors

- Vectors are one dimensional sequences of values
- In R, any number that you enter in the console is interpreted as a vector (numeric or character).
- A vector is an ordered collection of numbers.
  - The “[1]” means that the index of the first item displayed in the row is 1.

```
> # Basic Operations
> 2 + 2 # addition
[1] 4
> 3 - 5 # subtraction
[1] -2
> 3 * 2 # multiplication
[1] 6
> (2 + 2)^(3 / 3.5) # exponents and brackets
[1] 3.281341
```

```
> "Hello world."
[1] "Hello world."
> #This is called a character vector in R.
> c("Hello world", "Hello R interpreter")
[1] "Hello world"          "Hello R interpreter"
```

Functions

- Functions are the workhorses of R
- They take arguments as inputs and return objects as outputs.
- May modify objects in the environment or cause effects outside the R environment
  - I.e. plotting graphics, saving files, or sending data over the network.
- Functions provide information about vectors
- There are probably hundreds of thousands of functions in R.
- E.g.
  - length(x), mean(x), sd(x)

For more reading: Chapter 5 R in a Nutshell

Indexing

- The $ sign is used to reference a column by name
  - df$teams
- Reference a column
  - df[,2:3]
- Reference a row
  - df[2:3,]
- Reference rows and columns
  - df[1:2,1:2]
- R functions work better on columns than rows
  - Try calculating the average of a column
  - How would calculate the average of a row?

```
> df
  teams wins loses
1   PHI   92    70
2   NYM   89    73
3   FLA   94    77
4   ATL   72    90
5   WSN   59   102
```

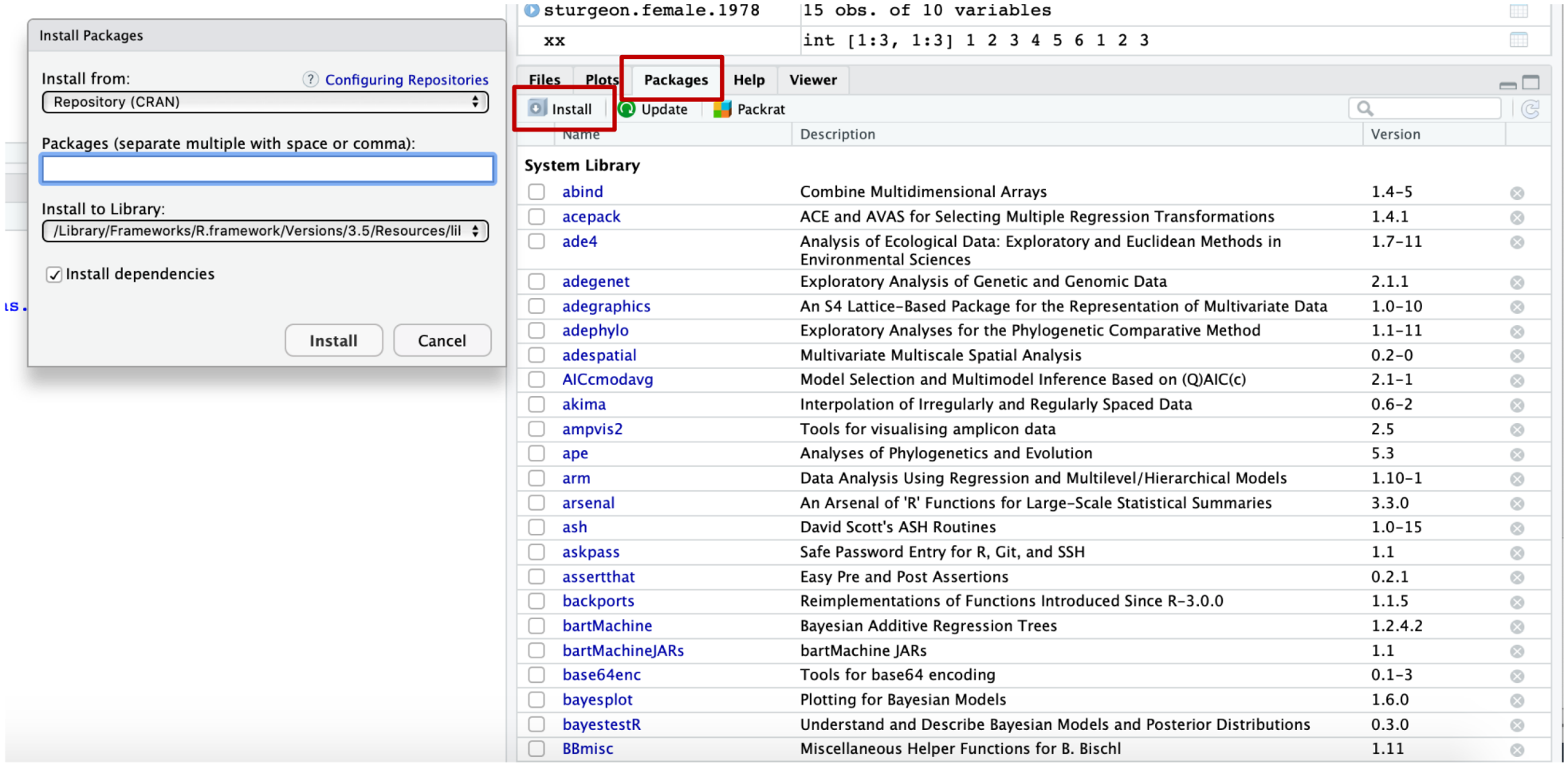
Loading Packages

- A package is a related set of functions, help files, and data files that have been bundled together.
- Typically, all the functions in the package are related
  - i.e. the stats package contains functions for doing statistical analysis
- You first need to make sure that it has been installed into a local library
  - R comes with a number of different packages

Table 4-1. Packages included with R

Package name	Loaded by default	Description
base	✓	Basic functions of the R language, including arithmetic, I/O, programming support
boot		Bootstrap resampling
class		Classification algorithms, including nearest neighbors, self-organizing maps, and learning vector quantization
cluster		Clustering algorithms
codetools		Tools for analyzing R code
compiler		Byte code compiler for R
datasets	✓	Some famous data sets
foreign		Tools for reading data from other formats, including Stata, SAS, and SPSS files
graphics	✓	Functions for base graphics
grDevices	✓	Device support for base and grid graphics, including system-specific functions
grid		Tools for building more sophisticated graphics than the base graphics
KernSmooth		Functions for kernel smoothing
lattice		An implementation of Trellis graphics for R: prettier graphics than the default graphics
MASS		Functions and data used in the book *Modern Applied Statistics with S* by Venables and Ripley; contains a lot of useful

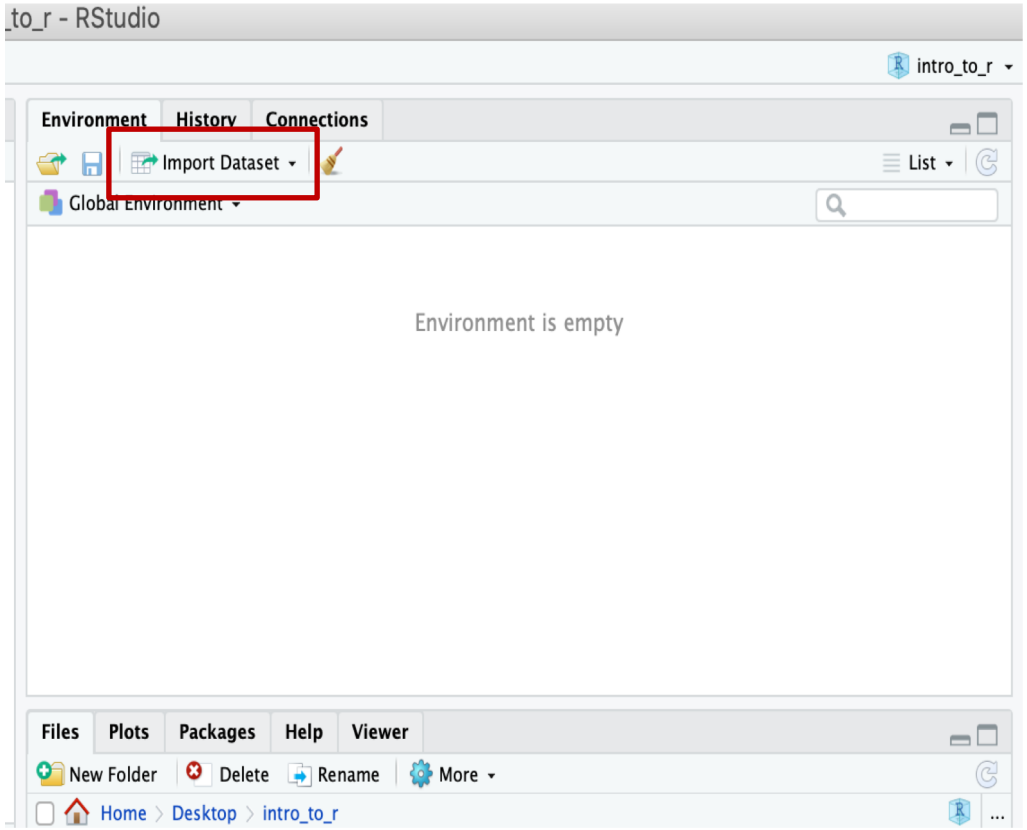
For more info see chapter 4 of R in a Nutshell



Or you can use the command install.packages(package)
Then you must call the library using library(package)

Read data into R

- You can import a variety of data file types, including from other statistics programs like SPSS, Stata, SAS, Minitab
- Common file formats like .xlsx and .csv
- The easiest way to import data is using the Import Dataset button in the Environment window.
- Better to use the command read.csv()



Useful Commands/ Tips

- To bring up help file, in the command line type:
  - ?commandname (searches only installed packages) OR help(commandname)
  - ??commandname (searches whole CRAN repository)
  - i.e. ?ggplot or help(ggplot)
- R is always case sensitive
- Always use a script and work from the editor
- Save your own annotated copy of the script.
- The # symbol means that the line will not be executed in R (useful to annotate scripts)