02 - R and RStudio

02-Rintro.pdf

Intro

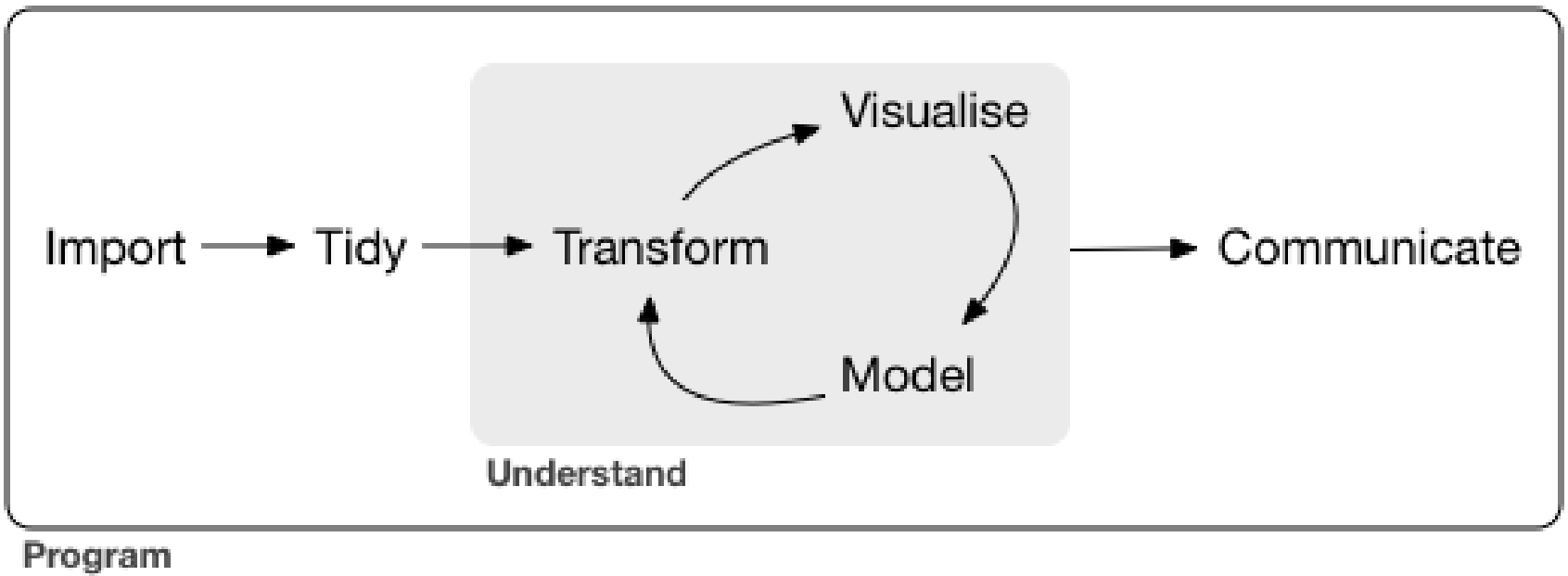
Installing R and RStudio

If you haven't already done so, install R and RStudio now:

- R (http://cran.r-project.org/)
- R Studio (http://www.rstudio.com/products/rstudio/download/)

And start up RStudio.

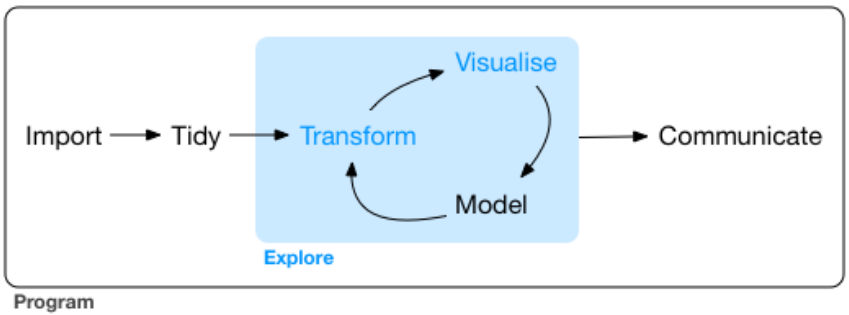
The Data Analytics Process



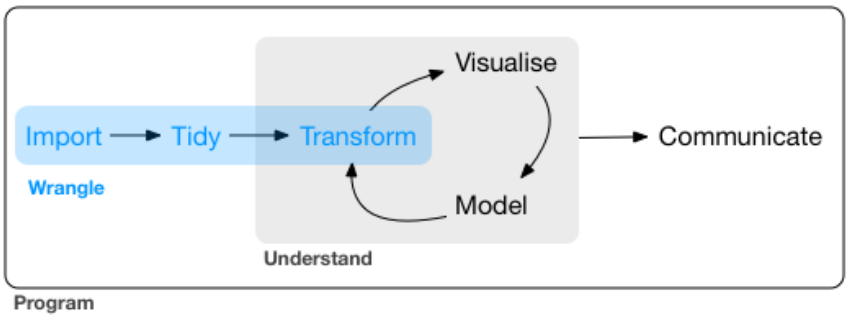
http://r4ds/diagrams/data-science.png/

Details

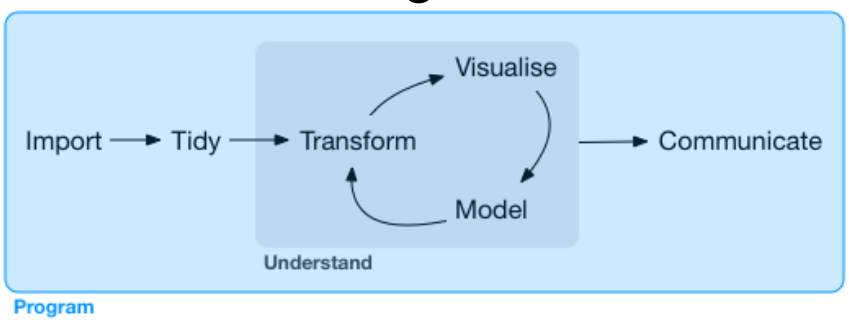
Explore



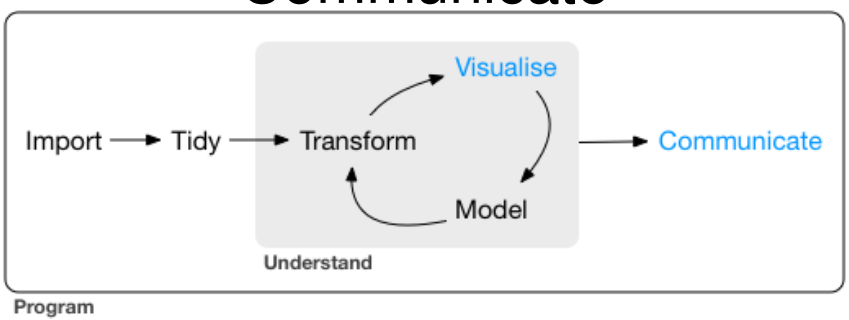
Wrangle



Program



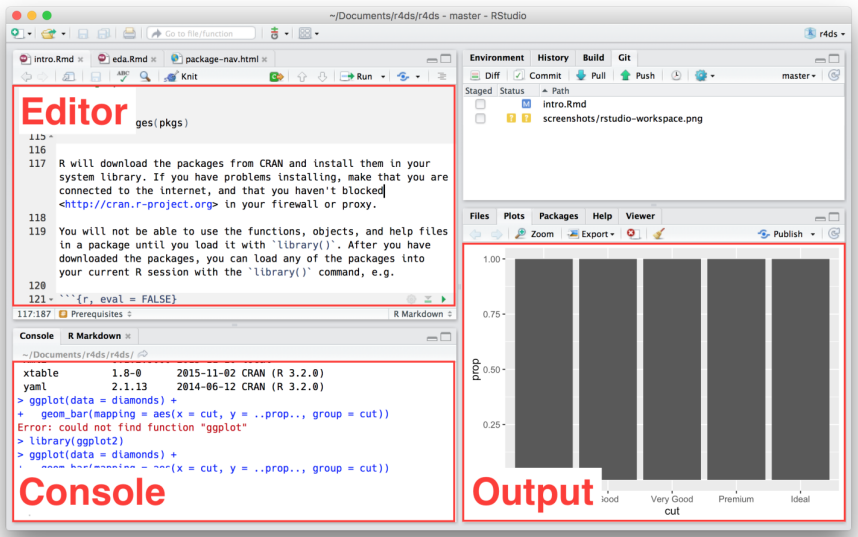
Communicate



http://r4ds/diagrams/

RStudio

RStudio IDE



http://raw.githubusercontent.com/hadley/r4ds/master/screenshots/rstudio-layout.png

The RStudio IDE provides four “panes”. There are two primary panes:

- Console: Where you run “live” R code.
- Source: The editor where you can write scripts to save (for reproducibility).

The two other panes will show:

- Plots
- Help: Documentation for R functions
- Environment: the R objects you have created (also called *Workspace*)
- History: list of all the R code that is run in the console.
- . . . (many other things)

Customizing the Rstudio IDE

The RStudio IDE can be customized:

- `Tools -> Global Options ...`

Description of the options can be found here: http://support.rstudio.com/hc/en-us/articles/200549016-Customizing-RStudio

Under General:

- *Uncheck "Restore .RData into workspace at startup"*
- *Save workspace to .RData on exit to* ***Never***

R Projects

- It's good practice to keep all your files associated with a project in one place (data, scripts, figures, reports, etc.).
- RStudio facilitates this with **Projects**
  - Each Project has its own working directory, workspace, history, and source documents

R Project Details

- When a new project is created, RStudio:
  - Creates a project file (with an .Rproj extension) within the project directory. This file contains various project options and can also be used as a shortcut for opening the project directly from the filesystem.
  - Creates a hidden directory (named .Rproj.user) where project-specific temporary files (e.g. auto-saved source documents, window-state, etc.) are stored.
  - Loads the project into RStudio and display its name in the Projects toolbar (which is located on the far right side of the main toolbar).

RStudio documentation for Projects: http://support.rstudio.com/hc/en-us/articles/200526207-Using-Projects

Your Turn #1 : Create a R Project

Create a new R Project for this class by clicking on drop-down at top right section of RStudio.

- It gives you the option to start a new directory (i.e., folder)
- Avoid using spaces in the project name (e.g., SYS2202, SYS-2202, SYS_2202)
- I usually create projects in google drive or dropbox so I can access the files from multiple computers

Using RStudio: Console Pane

Go to the console pane and let's do some math.

```
5+6-1
#> [1] 10
```

Save the results as an *object* named `x`

```
x = 5+6-1
```

To see the value of `x`, just enter `x` at the prompt

```
x
#> [1] 10
```

Note: Most resources for R will use `<-` (the two symbols `<` and `-`) instead of `=` to *assign* `x` the numeric value of `5+6-1`.

R Variables

Make another object `y` and add it to `x`

```
y = 90
x + y
#> [1] 100
```

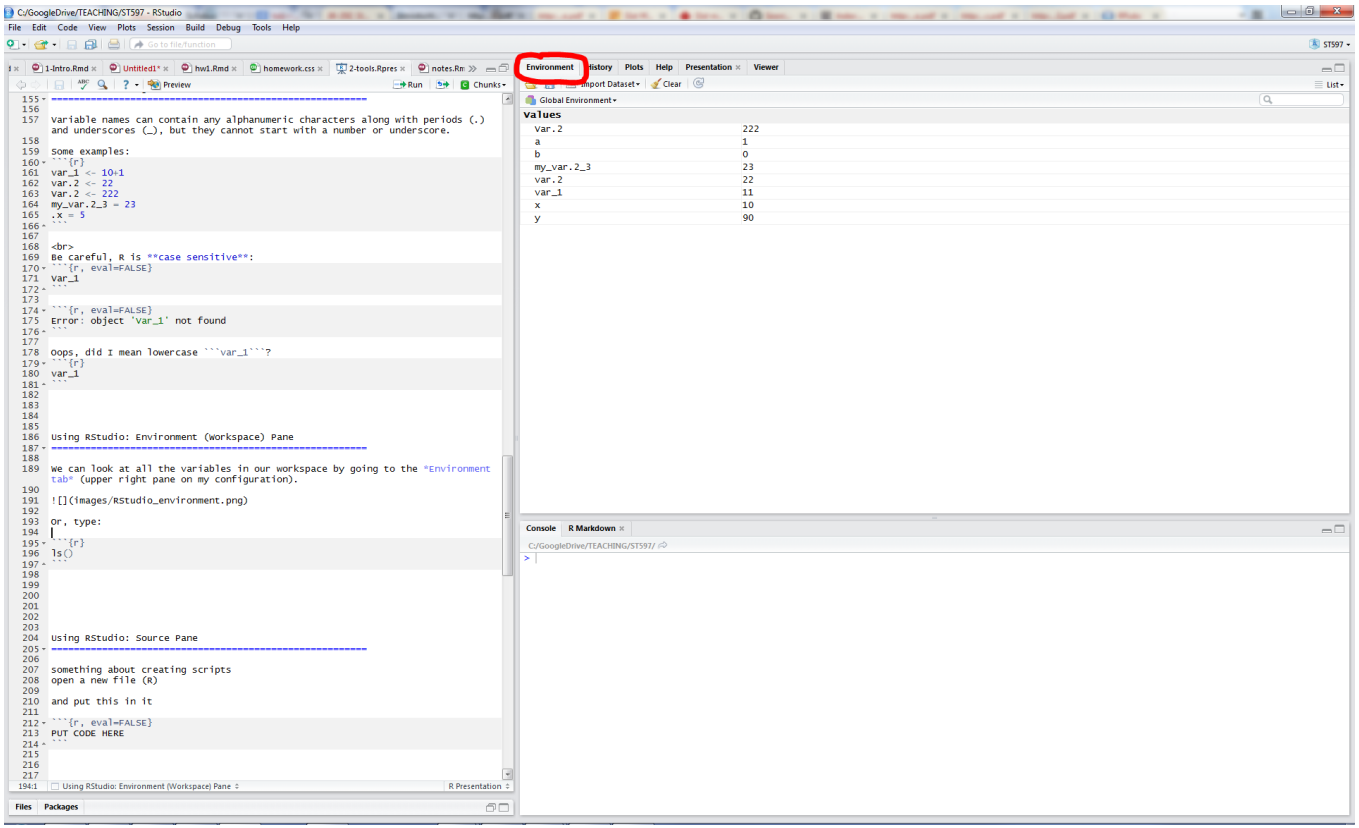
We can assign multiple variables to the same value

```
a = b = 0
```

```
a
#> [1] 0
b
#> [1] 0
```

Using RStudio: Environment (Workspace) Tab

We can look at all the variables in our workspace by going to the *Environment tab* (upper right pane on my configuration).



Or, type `ls()` for a list in the console:

```
ls()
#> [1] "a"                "b"                "course_url" "para
```

R Packages

- Contributed **R Packages** are what makes R so great.
- An R package can contain: R functions, data, help pages, vignettes, non-R code (e.g., C++, Fortran)
- The Base R distribution actually consists of 14 packages
- There are 15 Recommended packages that come shipped with all binary distributions.
- And over 12,000 additional packages
- We will use several packages for this class; good thing they are so simple to use!

Using R Packages

It takes two steps to use the functions and data in an R package

1. Install the package
   - i.e. download the package to your computer
   - this only needs to be done one time
   - `install.packages()`
2. Load the package
   - i.e. tell R to look for the package functions and/or data
   - this needs to be done every time R is started (and you want to use the package)
   - `library()`

R Package Installation

1. *Install* the package on your computer
   - `Tools -> install.packages...`
   - Or, in the console type: `install.packages(pkgnames)`
   - Packages only need to be installed one time on a computer; do not *re*-install
2. Then, *load* into workspace to have access to all functions, datasets, and help files
   - Click on *Packages* tab and check boxes
   - Or, type `library(pkgname)` or `require(pkgname)`
3. Packages can be *updated* to ensure latest functionality and bug fixes
   - `Tools -> Check for Package Updates...`
   - Or, in console `update.packages()`
   - This just re-installs and writes over the old package

If you don't have root permission, then use the `lib=` argument.

Installing and Loading Packages

Your Turn #2

1. **Install** the package `tidyverse`
2. **Load** the packages into the workspace
3. Did you get any warnings? Make a note of these.
4. Ensure you have loaded it correctly:
   - Type `?mpg` in the console to see the help documentation for the data `mpg` from the `ggplot2` package.
   - Type `?ggplot` in the console to see the help documentation for the function `ggplot()`

Note on `tidyverse` package

- The `tidyverse` package is really just a wrapper to load several related R packages
  - `ggplot2` for graphics
  - `dplyr` for data manipulation
  - `tidyr` for getting data into tidy form
  - `readr` for loading in data
  - `tibble` for improved data frames
  - `purrr` for functional programming
- This provides a nice shortcut to load all of these packages with `library(tidyverse)` instead of each separately:

```
#- the hard way
library(ggplot2)
library(dplyr)
library(tidyr)
library(readr)
library(tibble)
library(purrr)
```

Function conflicts

- Sometime you will come across functions from different packages that have the same name
  - For example, `filter` from package:dplyr and `filter` from package:stats
- If both packages are loaded, the function in the package that was loaded *last* will be invoked when calling the function.
- The other functions are said to be *masked*.
  - E.g., loading dplyr:

```
Attaching package: 'dplyr'
The following object is masked from 'package:stats':
    filter, lag
```

- If you want a specific function, add the package name separated by two colons

```
?filter
?stats::filter
?dplyr::filter
```

Note on using `library()`

- Packages only need to be *installed* (`install.packages()`) one time on your computer
- But packages need to be *loaded* (`library()`) every time you start a new R session

Using RStudio: Source Pane

- The source pane can save you lots of pain.
- This is where you will do most of your work.
- By executing commands from within the source editor rather than the console it is much easier to reproduce sequences of commands as well as package them for re-use as a function.
- Scripts can be saved for later use or sharing.

RStudio documentation: http://support.rstudio.com/hc/en-us/articles/200484448-Editing-and-Executing-Code

Your Turn #3

1. Create a new R script
   - `File -> New File -> R Script`
2. Copy and paste the following code (to make a scatter plot) into the new R script

```
#- Load the fuel economy data
library(tidyverse)   # note: mpg data is from ggplot2 pa
data(mpg)            # loads the data (not necessary, bu
                     # to specify)

#- Make plot
ggplot(data=mpg) +
  geom_point(aes(x=displ, y=hwy))

#- Save plot
ggsave("mpg.pdf")

#- Save data
write_csv(mpg, path="mpg.csv")
```

Your Turn #4

3. Run the code in the console (Highlight all code and `Ctrl+Enter`)
4. Open the plot (mpg.pdf) in a pdf viewer and open the data (mpg.csv) in a spreadsheet program
   - where did you find these files?
5. Add the following properties to `geom_point()` and re-run:
   - Map the color of the points to the class (`color=class`)
   - Map the size of the points to the number of cylinders (hint: `size=cyl`)

Scripts for interactive analysis and reproducibility

- Working in the source pane instead of the console will save you time as you interact with the data.
- For example, you now have the code to produce a nice scatter plot with control for point size and colors.
- Working with a script will help with Reproducible Data Analysis
- Dangers of Point and Click Approach
- The # symbol marks a comment. The rest of the line is commented (not read by R).

```
y = 10          # set y equal to 10
y = 5           # set y equal to 5
# y = 1         # set y equal to 1  (Note: this will n
y
#> [1] 5
```

Your Turn #5

Save your plot script in the project directory.

1. Create a subdirectory `R` to keep all your R scripts.
2. Use the extension (.R) for R scripts
   - For example: `mpg-plot.R`
3. Save `mpg-plot.R` in the `R` subdirectory
4. (Optional) Create subdirectories `data` and `figures`. Modify the script to add the components to the correct subdirectory
   - `ggsave("figures/mpg.pdf")`
   - `write_csv(mpg, path="data/mpg.csv")`

History

- RStudio keeps track of everything entered into the console in the **History** tab (top right pane in my config)
- Here you can send lines of code to the console or source
- When working in the console, you can also use `Up-arrow` to scroll through recent commands
- Or type the first few characters of your command and use `Ctrl+Up-arrow`
  - Example: Type `gg`, then `Ctrl+Up-arrow` to see a list of your recent commands that started with "gg"
- It is a good idea to save anything from the history that you may need again in a script.
- If you are working under an R Project, then your history should save automatically and be available next time to start up that project.

RStudio documentation: http://support.rstudio.com/hc/en-us/articles/200526217-Command-History

RStudio Keyboard Shortcuts

- You can improve your productivity by learning keyboard shortcuts
- In editor:
  - `Ctrl+Enter`: send code to console
    - (`Command+Enter` on Mac)
  - `Ctrl+2`: move cursor to console
  - `Ctrl+a`: select all
- In console
  - `Up_arrow`: retrieve previous command
  - `Ctrl+up arrow`: search commands
  - `Ctrl+1`: move cursor to editor
- Tab complete
  - start typing a variable or function name and then `Tab`
  - For functions, enter function name then parenthesis "(" then `Tab` and it will show you possible function arguments.

```
mean( + Tab
```

  - We will explore this more when we introduce functions

RStudio Help Pages

- Check out `Help` tab
- RStudio Main Help Page
- cheat sheets
- RStudio IDE
- Keyboard Shortcuts
  - Or `Alt+Shift+K`
- Getting R Help

Using R

R Resources

There is no shortage of free resources for learning R.

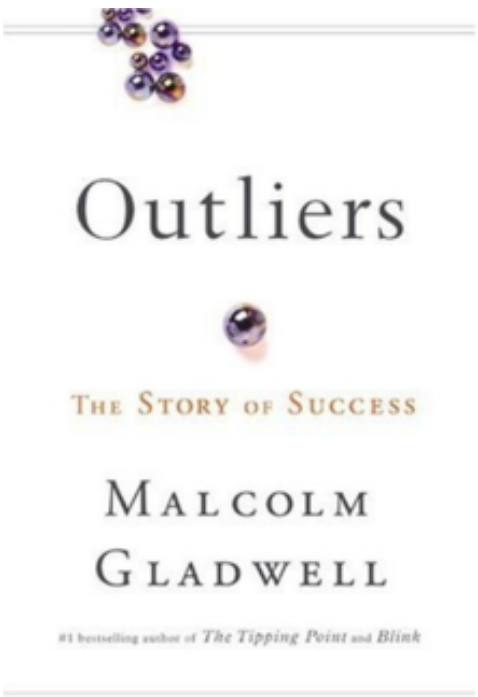
The official reference list is here:
http://cran.r-project.org/other-docs.html

- Look for options that are more recent. E.g.,
  - Base R Cheatsheet
  - http://cran.r-project.org/doc/contrib/Baggott-refcard-v2.pdf
  - http://cran.r-project.org/doc/contrib/Torfs+Brauer-Short-R-Intro.pdf

Birth Month Hypothesis

Birth Month and Performance

Does the month of your birth impact your chances of success?



Several researchers have found evidence to support this!

- Interview with Gladwell
- Australia

Birth Months and Baseball

The `Lahman` package has lots of baseball data.

Your Turn #6

1. Install the `Lahman` R package
2. Load the `Lahman` package and the `Master` data

```
library(Lahman)
data(Master)
```

3. Take a peek (or `glimpse`) at the `Master` data. Does it contain what we need to test the birth month hypothesis?

Visualizing the Data

Your Turn #7

1. What calculations do we need to perform?
2. What type of plot should we make?

Testing the hypothesis

Your Turn #8

1. How should we test the hypothesis?
2. Any other considerations before we make a conclusion?