Accelerytics

Data Analytics in R

github.com/Mathijs995/Data-Analytics-in-R

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Introducing R

What is R?

- Programming language & free software environment
- Statistical computing and data visualization
- First appeared: August 1993
- Written in C, Fortran and R itself

What can R be used for?

- Data manipulation
- Data visualization
- Analyzing data
  - Advanced statistical methods
  - Machine learning
- And much more!

Why you should learn R

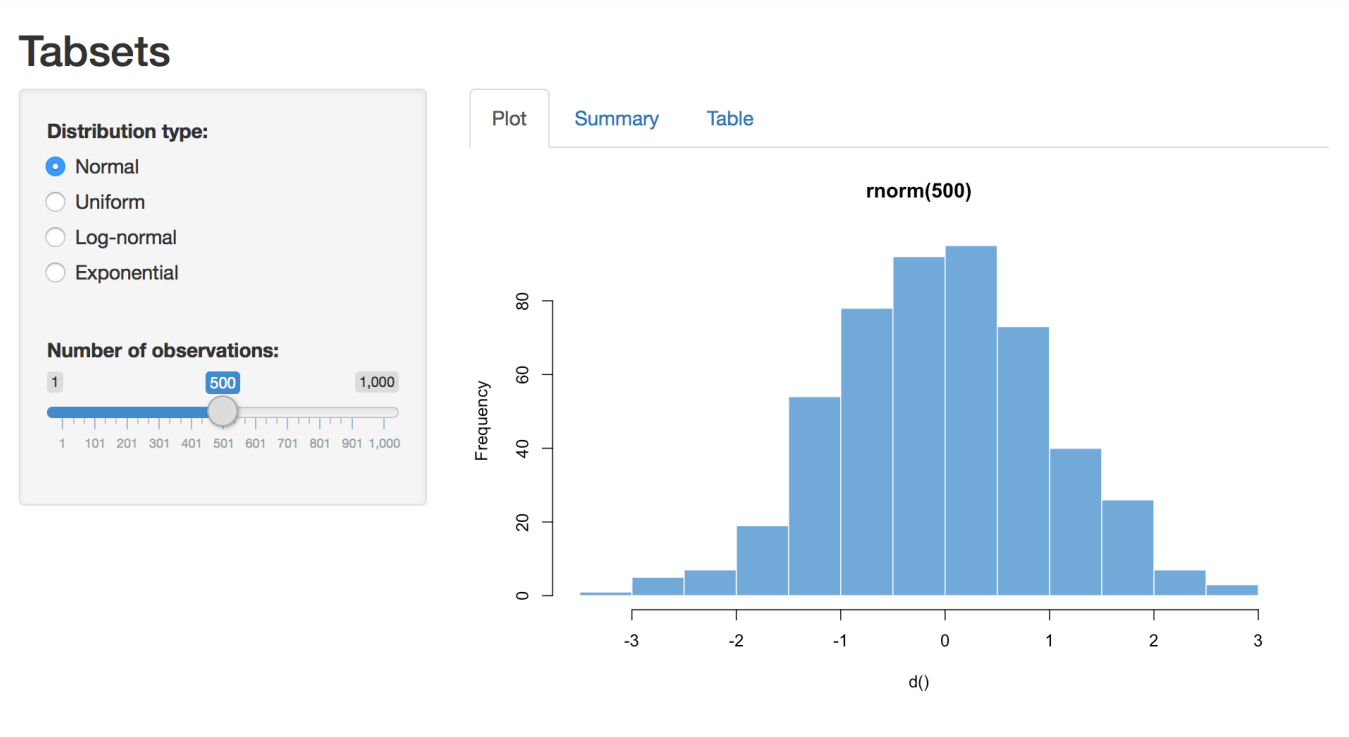
- Very powerful for data analytics
- Simple and relatively easy to learn
- Popular both in academia and in the business world
- Open source & excellent package support
- Supported by main data analytics software including Alteryx, Power BI and Tableau.

Programming environment

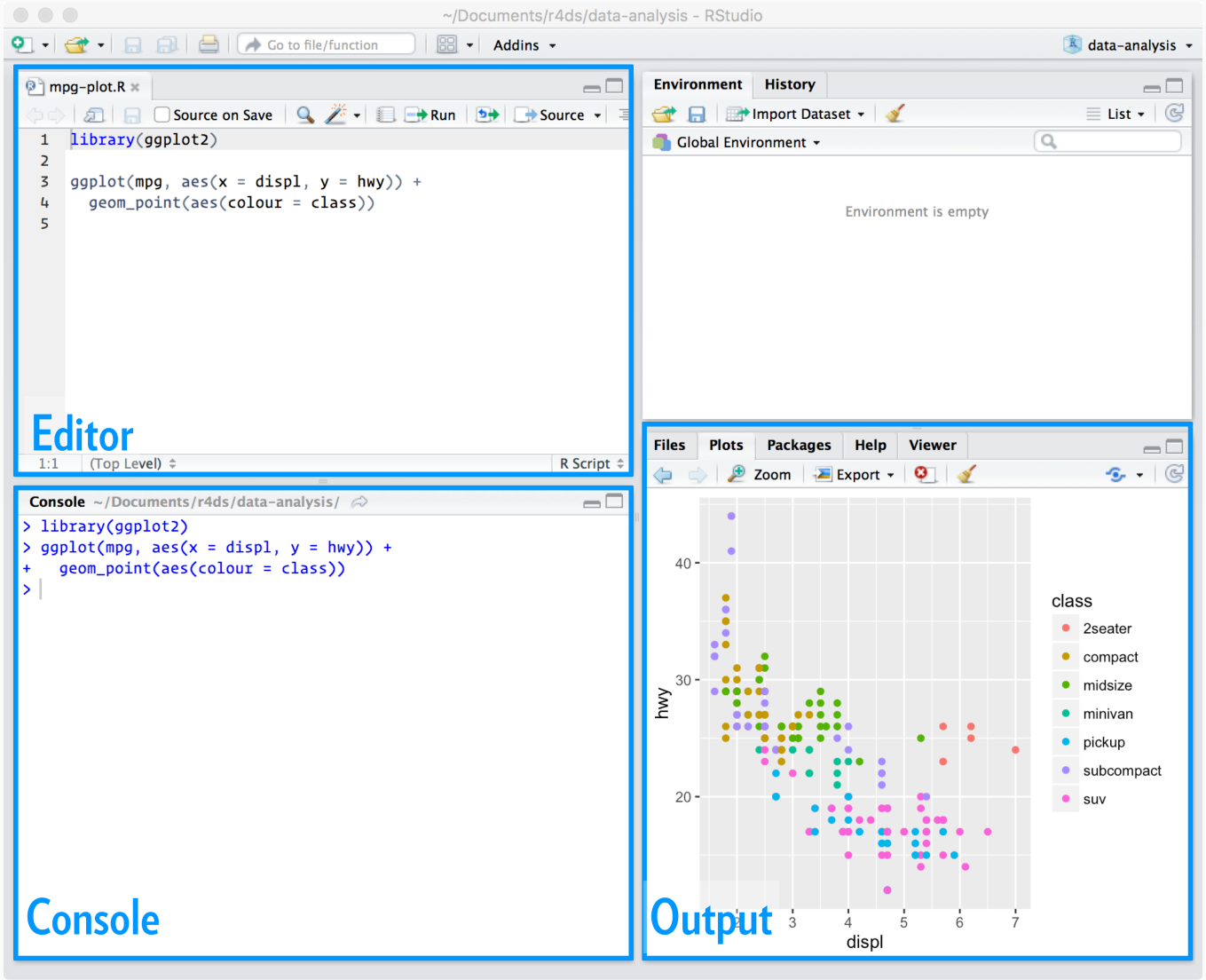
Programming environment

- Download RStudio or use RStudio Cloud
- Available on all computers at the EUR
- When you are comfortable with R, you can switch to
  - R Markdown
  - Jupyter notebooks
  - Shiny

- Interactive web applications
- Best library for dashboarding



RStudio


~/Documents/r4ds/data-analysis - RStudio
Go to file/function
Addins
data-analysis
mpg-plot.R
Source on Save
Run
Source
1 library(ggplot2)
2
3 ggplot(mpg, aes(x = displ, y = hwy)) +
4 geom_point(aes(colour = class))
5
Editor
1:1
(Top Level)
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Environment is empty
Console ~/Documents/r4ds/data-analysis/
> library(ggplot2)
> ggplot(mpg, aes(x = displ, y = hwy)) +
+ geom_point(aes(colour = class))
>
Console
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R fundamentals

Variables

- Building blocks used for storing information
- Dynamically typed, meaning that the type of data is determined when the statement is run

Defining variables

```
1 # Text behind the # is ignored; these are comments.
2 a = 10  # Store 10 in the variable a
3 a <- 10 # Same as above, not recommended
```

Data types (1/3)

- Data types:
  - **character** – String
  - **integer** – Integers
  - **numeric** – Integers + Fractions
  - **logical** – Boolean (true or false)
  - **factor** – Element in a given set

Data types (2/3)

Different data types

```
1  sentence = "Hello world!"
2  class(sentence) # character
3
4  x = 1L # or as.integer(1)
5  class(x) # integer
6
7  pi = 3.14159265359
8  class(pi) # numeric
9
10 is_clear = T # or TRUE
11 class(is_clear) # boolean
```

Data types (3/3)

- Sometimes you want to restrict the number of options a variable can take
- R introduced the factor data type for this purpose
- Always check whether you are working with character or with factor variables

Working with factors

```
1 my_gender = factor("female", levels = c("female", "male"))
2 my_gender = factor("unspecified", levels = c("female", "male"))
```

Data structures

- Data structures:
  - **vector** – A collection of elements of the same class
  - **matrix** – A matrix (table) of elements of the same class
  - **data.frame** – A matrix (table) with columns containing elements of the same class
  - **list** – A collection of elements of different classes

Dimension	Homogeneous	Heterogeneous
1	Atomic vector	List
2	Matrix	Data frame
n[1]	Array	

[1] For any $n = 1, 2, 3, \ldots$

Importing and exporting data

- RStudio GUI
- Using the R console:

Importing and exporting Excel data

```
1  # First make sure you are in the right directory using setwd() and getwd()
2
3  # Import a csv file and store it in data
4  data = read.csv("SMT1920casus - data.csv", sep = ";")
5
6  # Install the required library
7  install.packages("xlsx")
8
9  # Export a data structure as the Excel file 'output.xlsx'
10 xlsx::write.xlsx(data, "output.xlsx")
```

Basic operations for a data frame (1/3)

- You will mostly be working with data frames to store your data
- Think of a data frame as a table in Excel
- It contains columns with a name (header) and an equal number of rows per column

Basic operations for a data frame (2/3)

Commonly used functions

```
1  view(airquality)          # view the data frame
2  class(airquality)         # get class
3  sapply(airquality, class) # get class of all columns
4  str(airquality)           # structure
5  summary(airquality)       # summary of airquality
6  head(airquality)          # view the first 6 obs
7  fix(airquality)           # view spreadsheet like grid
8  rownames(airquality)      # row names
9  colnames(airquality)      # columns names
10 nrow(airquality)          # number of rows
11 ncol(airquality)          # number of columns
```

Basic operations for a data frame (3/3)

Data frame operations

```
1 cbind(myDf1, myDf2)  # columns append DFs with same no. rows
2 rbind(myDf1, myDf1)  # row append DFs with same no. columns
3 myDf1$vec1  # vec1 column
4 myDf1[, 1]  # df[row.num, col.num]
5 myDf1[, c(1,2)]  # columns 1 and 3
6 myDf1[c(1:5), c(2)]  # first 5 rows in column 2
7 myDf1[c(1:5), -c(2)]  # first 5 rows in all columns but column 2
```

If-Else condition (1/2)

- To add logic to your workflow, you can use conditional statements
- The standard conditional statement is the If-Else condition:

If-Else condition

```
1 if(checkConditionIfTrue) {
2   ....statements..
3   ....statements..
4 } else {   # place the 'else' in same line as '}'
5   ....statements..
6   ....statements..
7 }
```

If-Else condition (2/2)

- Alternatively, you can use the ifelse() function for vector based conditional statements

Application of the ifelse() function

```
1 possible_grades = 1:10
2 pass = ifelse(possible_grades >= 6, TRUE, FALSE)
```

Loops in R (1/2)

- Standard for-loop:

For loop

```
1  for(counterVar in c(1:n)){
2      .... statements..
3  }
```

Loops in R (2/2)

- The apply family
  - **apply()**: Apply FUN through a data frame or matrix by rows or columns.

Demonstration of the apply function

```
1  myData = matrix(seq(1,16), 4, 4)    # make a matrix
2  apply(myData, 1, FUN=min)           # apply 'min' by rows
3  # => [1] 1 2 3 4
4
5  apply(myData, 2, FUN=min)           # apply 'min' by columns
6  # => [1] 4 8 12 16
```

Functions in R

- Reusable block of code

Creating functions

```
1  myfunction = function(arg1, arg2, ... ){
2      .... statements
3      return(object)
4  }
```

Getting help

- Build-in support
- Google
- Source code

Getting help

```
1 help(merge)     # get help page for 'merge'
2 ?merge          # lookup 'merge' from installed pkgs
3 ??merge         # vague search
4 example(merge)  # show code examples
5 help
```

What is a R package?

- Packages are collections of
  - R functions
  - R data
  - compiled code
- Can be created by anyone
- Academics and companies often create and share their own packages

Adding packages

- Using the RStudio GUI
- From the R console:

Installing and loading a package

```
1 install.packages("tidyverse")  # install 'tidyverse' package (and its dependencies)
2 library(tidyverse)    # initialize the 'tidyverse' package
3 require(tidyverse)    # another way to initialize
```

Data visualization using ggplot2

Workflow of a data science project

- Workflow of a data science project:

Step 1: Collect data

Step 2: Manipulate data

Step 3: Visualize data

Step 4: Apply statistical methods

Step 5: IF results are not satisfactory THEN return to Step 2.

- Why is R a better option for this type of projects than Excel? When would Excel be a better choice?

Introducing ggplot2 (1/2)

- ggplot2 is a system for declaratively creating graphics, based on The Grammar of Graphics
- Best package for visualization available
- Check out the cheat cheat sheets using the link or the last two slides of this presentation!

Introducing ggplot2 (2/2)

- Let's get started!

Install and load the parent library

```
1 # Run this block to install and load the tidyverse package
2 install.packages("tidyverse")
3 library(tidyverse)
```

Graph structure

- To create graphs using ggplot2 you have to specify:
  - What do you want to use (preferably as a data frame)
  - Which visualization you want to use (geom_function)
  - How the data is mapped in the visualization (aesthetics)

Graph structure

```
ggplot2::ggplot(data = <DATA>) +
    <GEOM_FUNCTION>(mapping = ggplot2::aes(<MAPPINGS>))
```

Example: Plotting gender distribution

- Let's say we want to visualize the distribution of the gender of students in the Applied Business Methods (ABM, DUTCH: Statistische Methoden en Technieken) data set
- The code below creates a histogram of the distribution of the genders in the data set:

Gender distribution plot

```
1  ggplot(data = data, mapping = aes(x = dGender))
2      + geom_histogram(stat = "count")
```

Time to practice

- The best way to learn how to code is by trial and error!
- Start by working your way through the following tutorial:
  - ggplot2 short tutorial
- Afterwards, continue with the assignments on the next slides.
- Optionally: Go through the following tutorials:
  - ggplot2 tutorial 1 - Introduction
  - ggplot2 tutorial 2 - Theme
  - ggplot2 tutorial 3 - Masterlist

Assignments

Assignment 1

- Create a distribution plot for the year of birth of the students in the ABM data set using ggplot2 with a histogram.
- Add a legend, title and rename the *x*-axis and the *y*-axis.

Assignment 2

- Transform the gender column in the ABM data set into a factor column with levels "female" and "male".
- Transform the living conditions column in the ABM data set into a factor column with appropriate levels.
- Create a stacked column chart for the living conditions of the students grouped by gender.
- Add a legend, title and rename the *x*-axis and the *y*-axis.

Assignment 3

- Transform the stacked column chart of the previous assignment into a grouped column chart.

Assignment 4 (1/3)

- Interpret the code below.

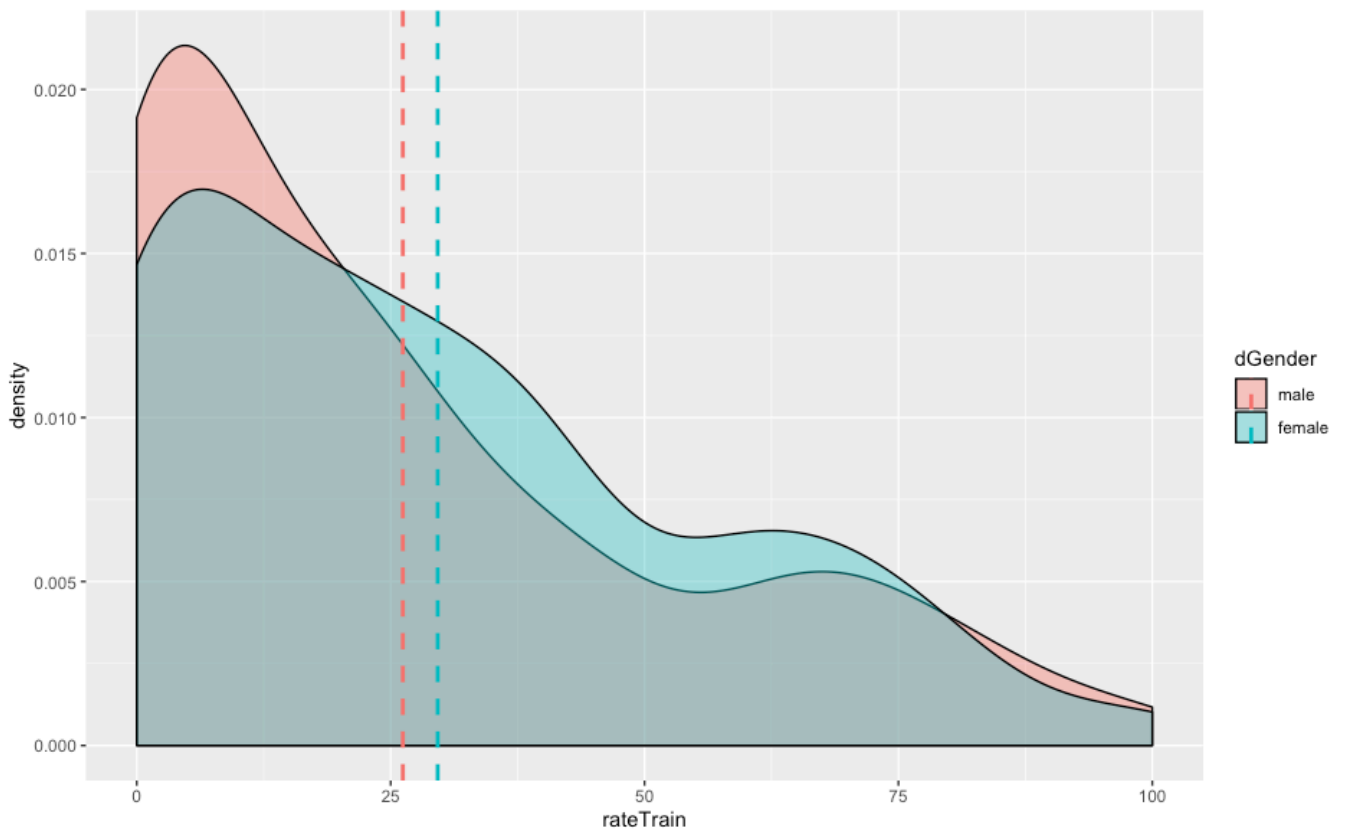
Assignment 4 (2/3)

Distribution of train ratings by gender

```
1 # Distribution of train ratings by gender
2 library(plyr)
3 mu = ddply(data, "dGender", summarise, grp.mean=mean(rateTrain))
4 ggplot(data = data, mapping = aes(x = rateTrain, fill = dGender)) +
  ↪ geom_density(alpha=0.4) +
5   geom_vline(data = mu, aes(xintercept=grp.mean, color = dGender),
    ↪ linetype="dashed", size=1)
```

- Have a look at the graph produced by the code above on the next slide.
- Adapt the code above to display the distribution of airplane ratings by gender.

Assignment 4 (3/3)



Assignment 5

- Go through the resources for using facets.
- Use facets to plot the rating distributions of traveling by train and airplane for each of the different experiment designs, that is, use the different designs for the facets and have plots for the distributions per design.

Questions?

Thank you!

For questions, you can always contact me at
mathijs@accelerytics.com.

Feedback

You would help us out a great deal if oyu could fill in the following form:

https://yassin970939.typeform.com/to/y5P71Z

ggplot2 cheat sheets (1/2)

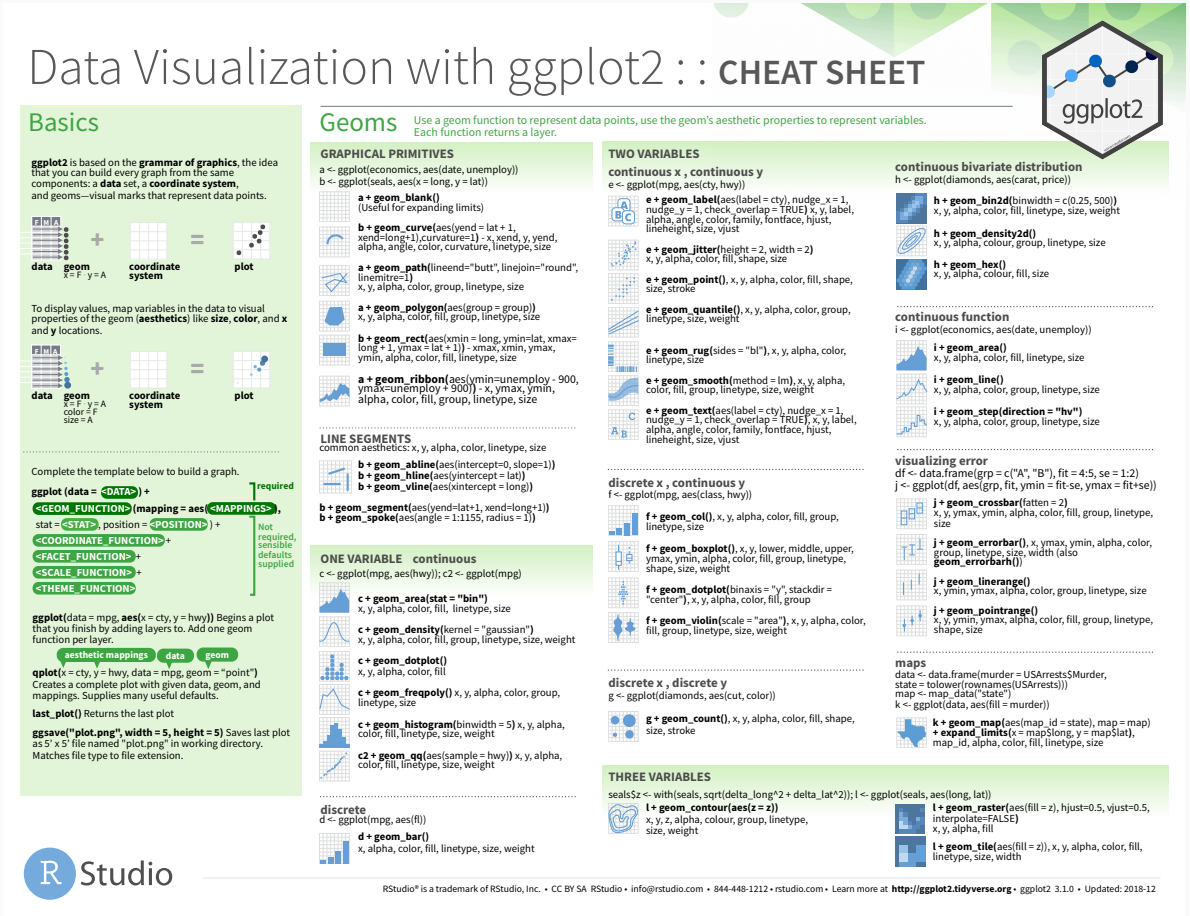


Figure 1: Page 1 of the cheat sheet. Source:
https://github.com/rstudio/cheatsheets/blob/master/data-visualization-2.1.pdf

ggplot2 cheat sheets (2/2)

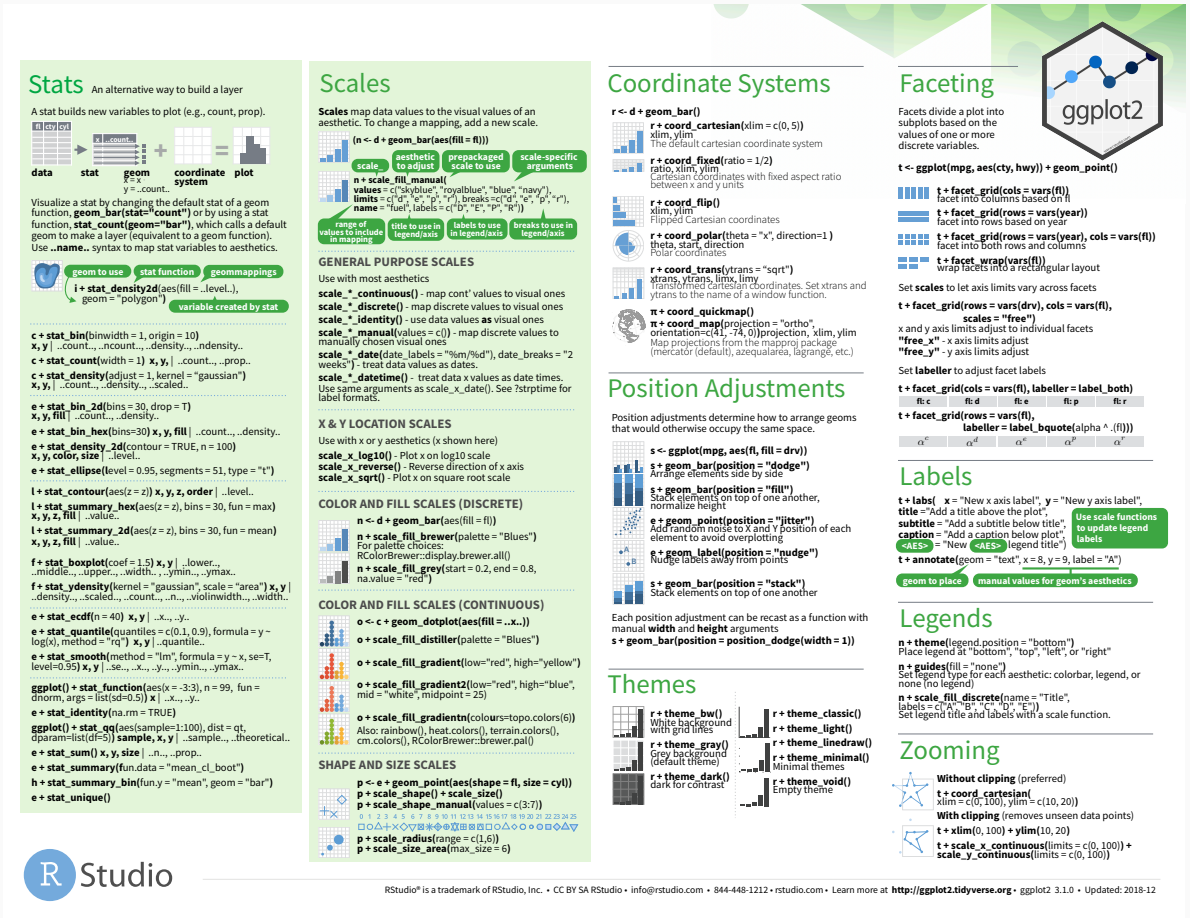


Figure 2: Page 2 of the cheat sheet. Source:
https://github.com/rstudio/cheatsheets/blob/master/data-visualization-2.1.pdf