R training for Médecins Sans Frontières

Hello!

We are Didac Fortuny and Paula Subías

We are here because we want to do good through data.

You can find us at /didacfortuny

/paula-subías

Hello!

We are part of dataforgoodBCN

You can find us at @dataforgoodBCN

Goal

- You are self-sufficient to use R for your daily computational tasks
- You know about what R can offer

Planning

Day 1: What we need to know about R and statistics

- Introduction to R
- Statistics hands-on

Day 2: Data frames and reporting tools

- Manipulating data frames.
- Reports

Day 3: Beyond basic R

- Plots
- Dashboards
- Other topics

1

What we need to know about R and statistics

R environment, data structures, and statistics

Introduction to R

- What is programming
- What is R
- What is RStudio
- RStudio basics
- R basics

- Create a list of instructions that can be performed automatically by a computer to fulfill a given task.

Introduction to R

What is programming

- Speed.
- Precision.
- Reproducibility.

Introduction to R

What is R

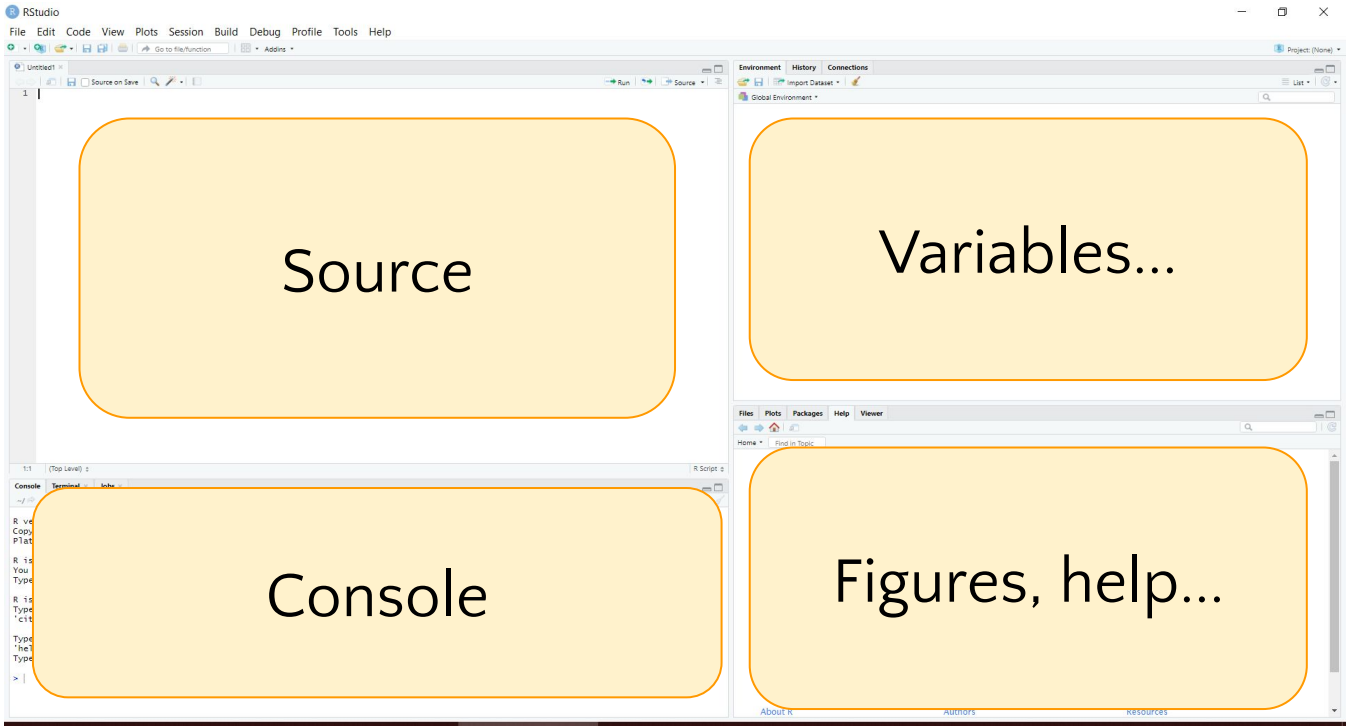
- High-level programming language.
- Interpreted language.
- Open source.
- Not a visual programming language.

What is RStudio®

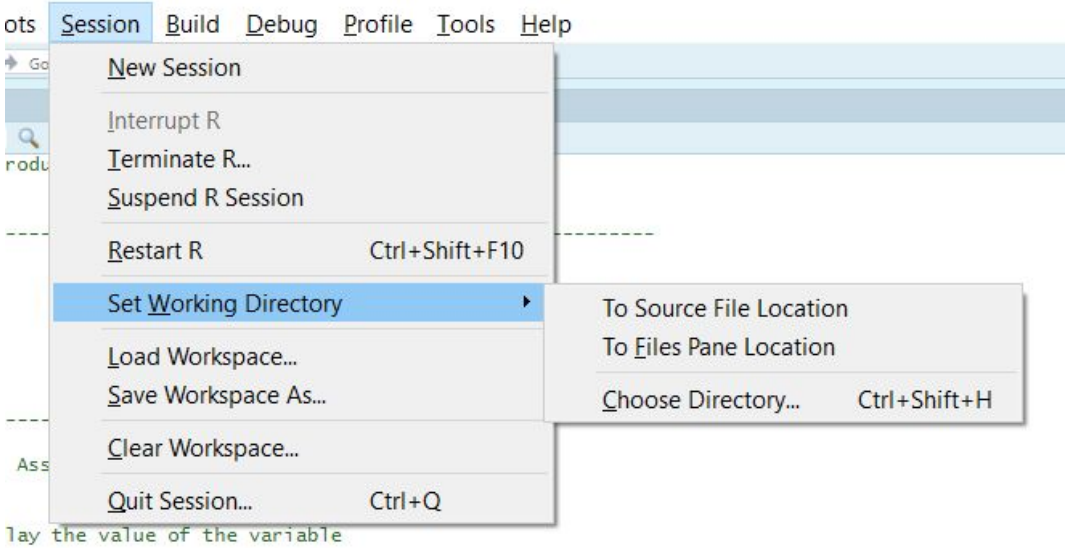
- Integrated Development Environment (IDE).
- Open source.

Introduction to R

RStudio basics



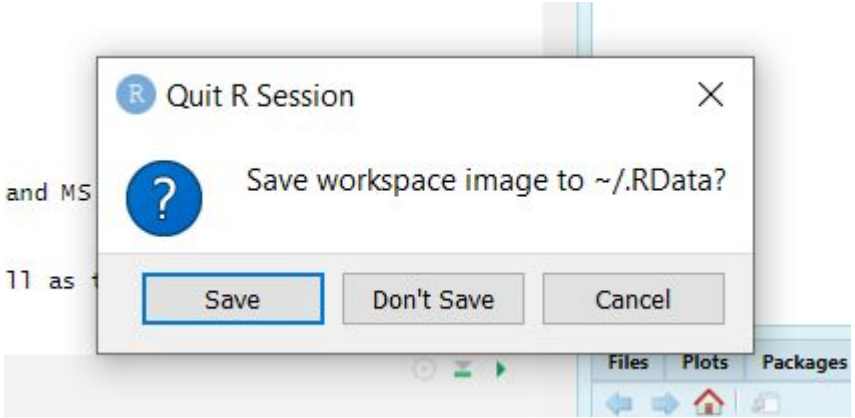
- Working directory:



- Keyboard shortcuts:
  - Ctrl + ENTER: Run one cell.
  - Ctrl + SHIFT + F10: Restart session.

Go to first template.

- Saving data when exiting the session



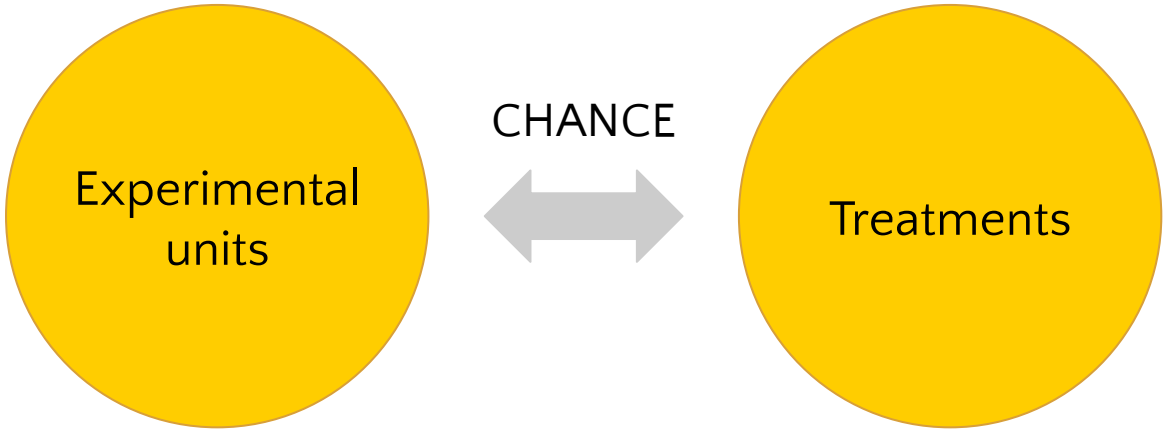
Statistics hands-on

- Types of distribution
- Statistical measures
- Sampling from distributions
- Comparing distributions

Statistics hands-on

Statistics allows to generalise from a sample of data to a true state of nature.

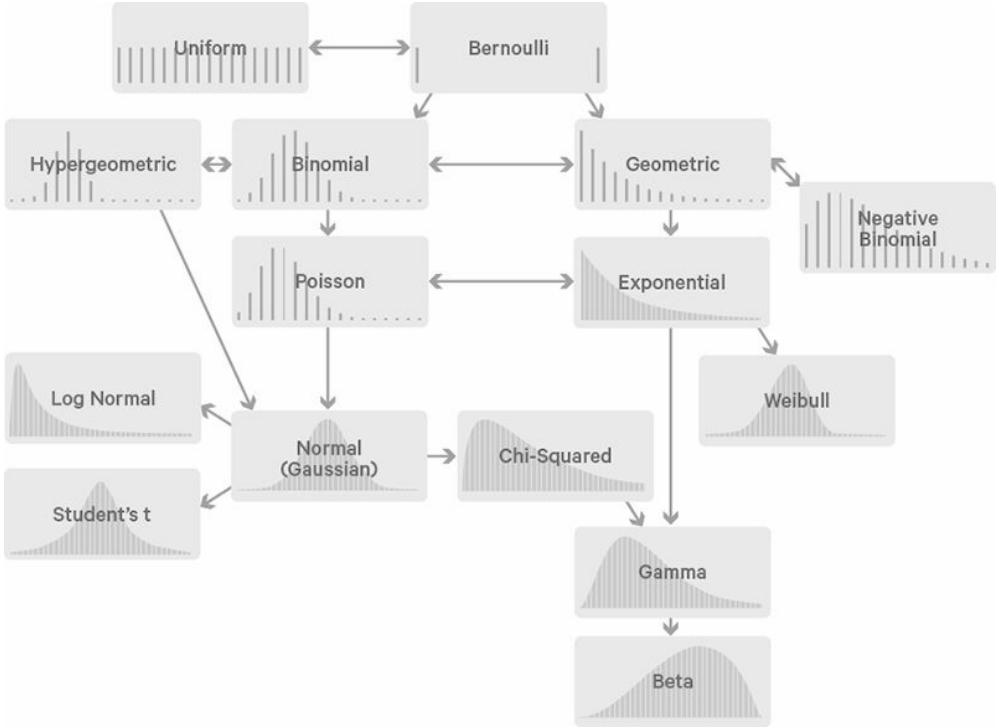
To make this work the data must be obtained by a carefully designed experiment.



Price to pay: we need probability to quantify the chance element in the data.

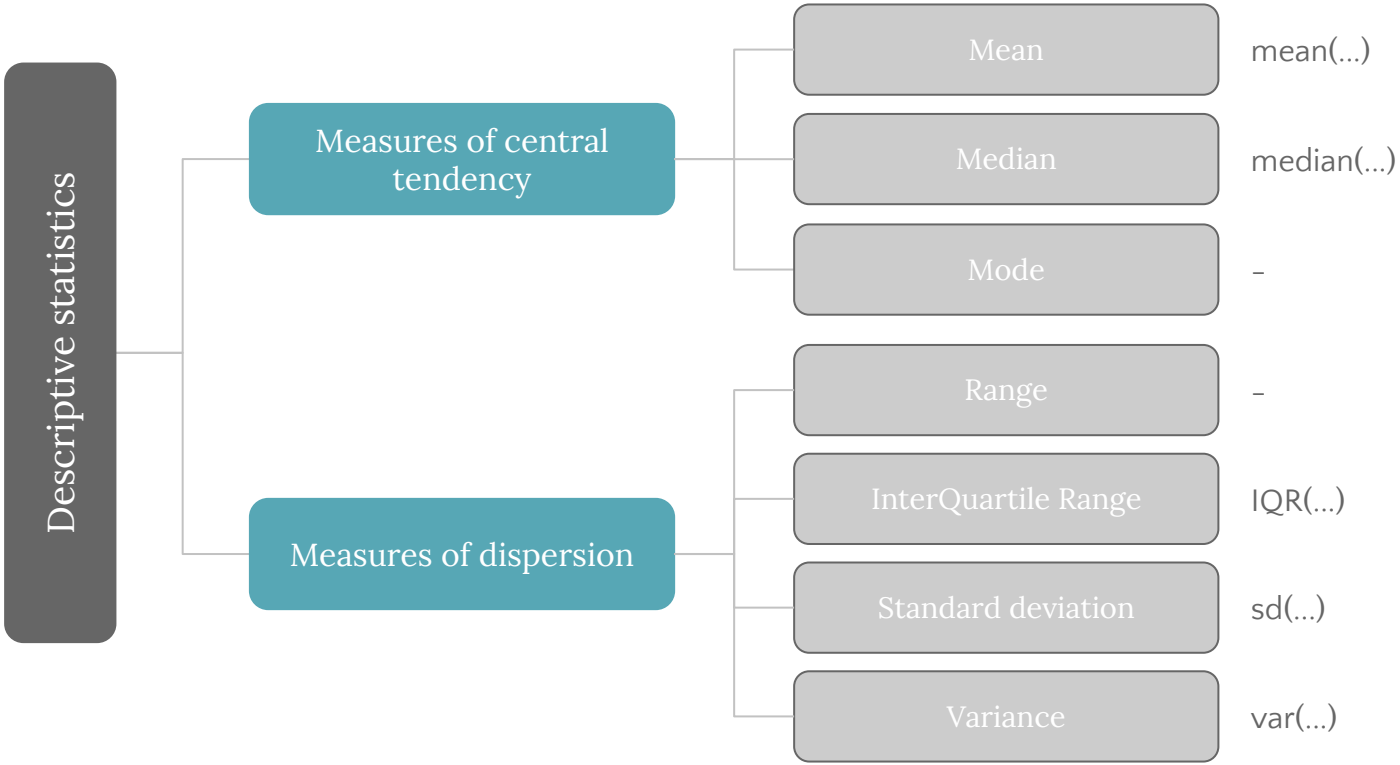
Statistics hands-on

Types of distribution

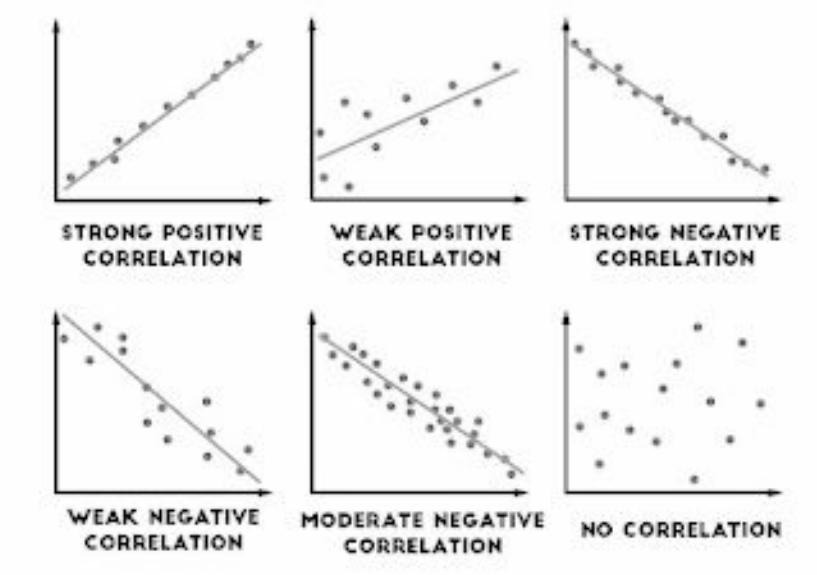


Statistics hands-on

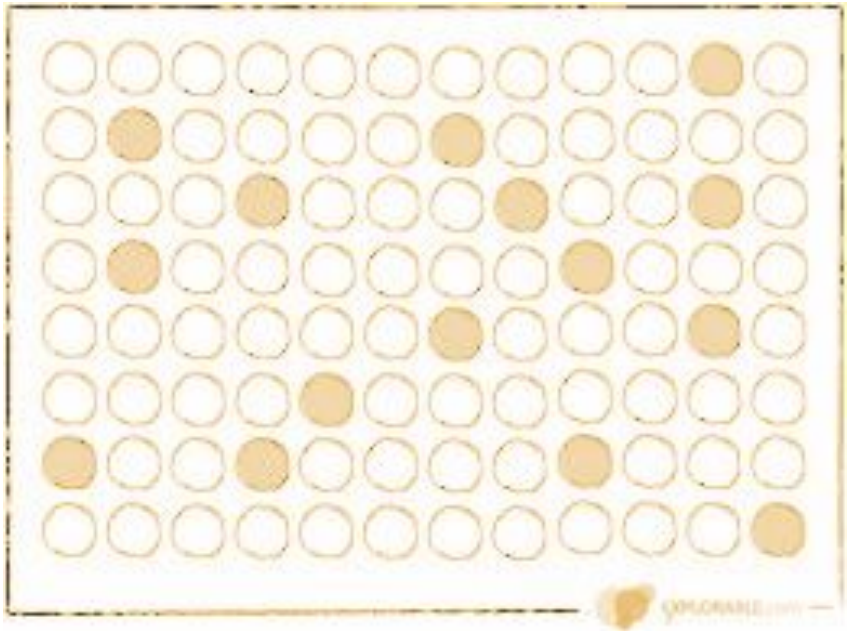
Statistical measures



Statistical measures



cor(...)



The **sampling distribution** of a statistic is the distribution of that statistic, considered as a random variable, when derived from a random sample of size n.

Statistics hands-on

Go to R.

Statistics hands-on

Descriptive statistics univariate with R			
Variable type		**Graphical representation**	**Numerical summary**
Categorical *qualitative*	Nominal	Pie plot: *pie(table(x))*	Absolute Frequency Table: *table(x)* Relative Frequency Table: *prop.table(x)*
	Ordinal	Bar plot: *barplot(table(x))*	Absolute Frequency Table: *table(x)* Relative Frequency Table: *prop.table(x)* Cumulative Absolute Frequency Table: *cumsum(table(x))* Cumulative Relative Frequency Table: *cumsum(prop.table(table(x)))*
Numerical *quantitative*	Discrete	Histogram: *hist(x)*	Summary: *summary(x)* <u>Central Tendency Statistics:</u> Mean: *mean(x)* Median: *median(x)* <u>Positional Statistics:</u> Minimum, Maximum: *min(x), max(x)* Quartiles (Q1,Q3): *quantile(x,0.25), quantile(x,0.75)* Percentile (alpha): *quantile(x,alpha)* <u>Dispersion Statistics:</u> Variance: *var(x)* Standard deviation: *sd(x)* IQR (Interquartile range=Q3-Q1): *IQR(x)*

Statistics hands-on

Descriptive statistics bivariate with R		
Variable type	**Graphical representation**	**Numerical summary**
f: categorical g: categorical	Grouped Bar diagram: *barplot(table(f,g))* Mosaic Plot: *mosaicplot(table(f,g))*	Absolute Contingency Table: *table(f,g)* Relative Contingency Table: *prop.table(table(f,g))*
x: numeric g: categorical	Points Diagram: *plot(g,x)* Grouped BoxPlot: *boxplot(x ~ g)* Grouped Histogram: *by(x,g,hist)*	Group Statistics: *by(x,g,summary)*
x: numeric y: numeric	Scatterplot: plot(x,y)	Linear correlation: cor(x,y)

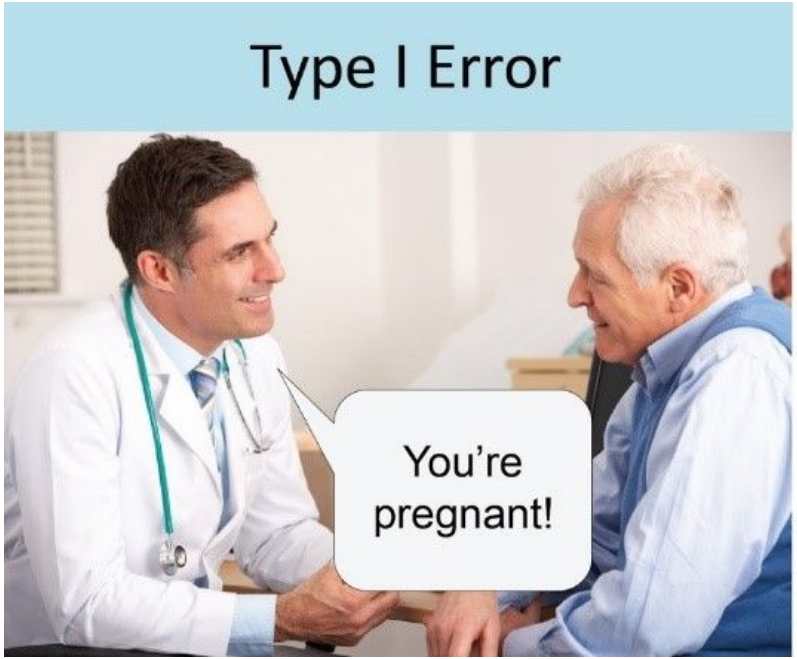
Statistics hands-on

Go to R.

A **statistical test** chooses between two possibilities: the null hypothesis H_0 and the alternative hypothesis H_1 .

Statistics hands-on

Comparing distributions



Statistics hands-on

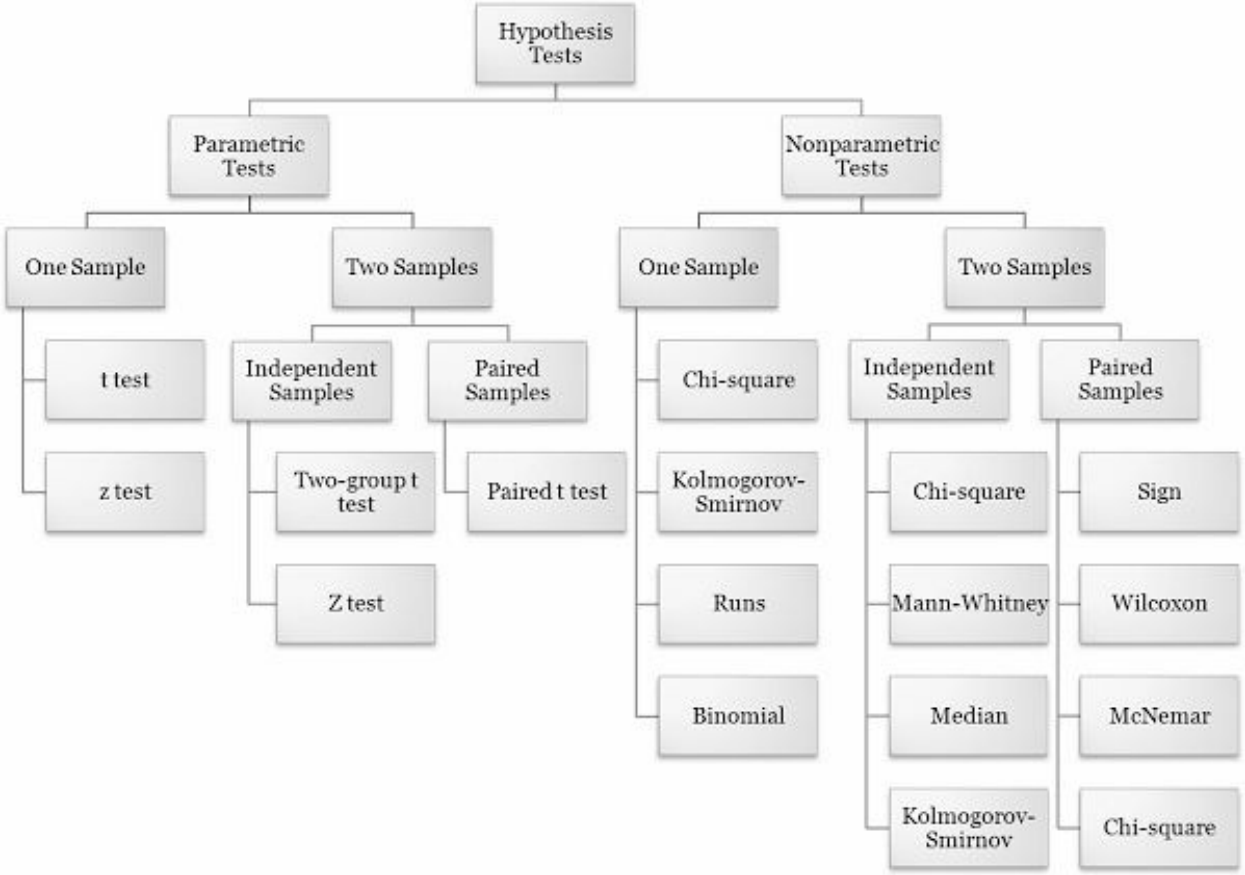
Comparing distributions

Parametric tests assume your data meets some assumptions, which, basically, are:

- Interval level data
- Reasonably normally distributed
- Equal variances
- Reasonable sample size

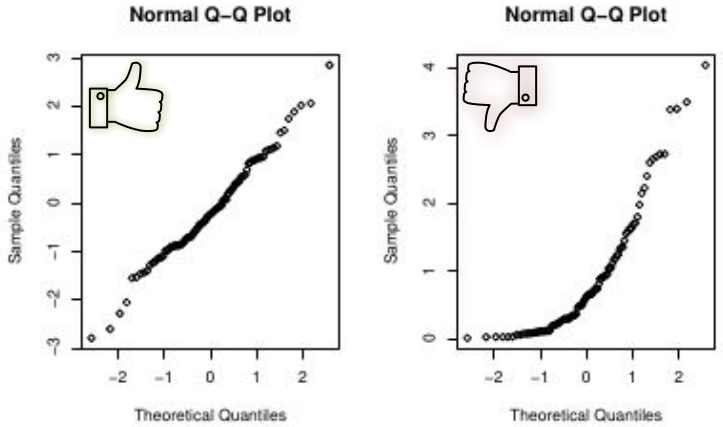
Non-parametric tests:

- Valid for most distributions
- Often easier to compute


Hypothesis Tests
Parametric Tests
Nonparametric Tests
One Sample
Two Samples
One Sample
Two Samples
t test
z test
Independent Samples
Paired Samples
Two-group t test
Z test
Paired t test
Chi-square
Kolmogorov-Smirnov
Runs
Binomial
Independent Samples
Paired Samples
Chi-square
Mann-Whitney
Median
Kolmogorov-Smirnov
Sign
Wilcoxon
McNemar
Chi-square

Checking for normality: QQ-plot

A QQ-plot can reveal whether data (approximately) follows a certain population curve, e.g. the normal curve.



Statistics hands-on

Go to R.

2

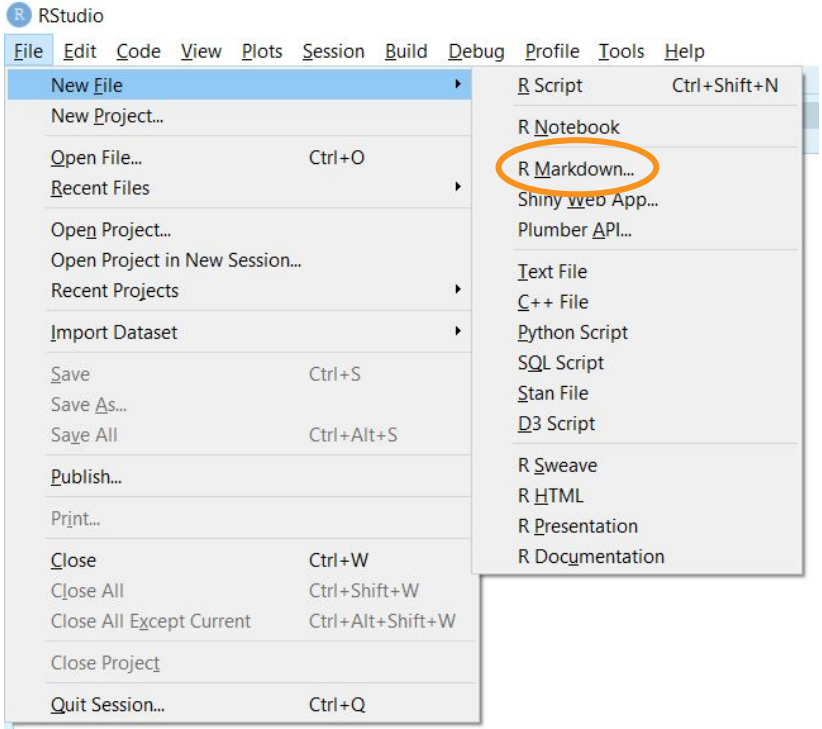
Data frames and reporting tools

Let's create the first analyses and reports

Reports with R Markdown

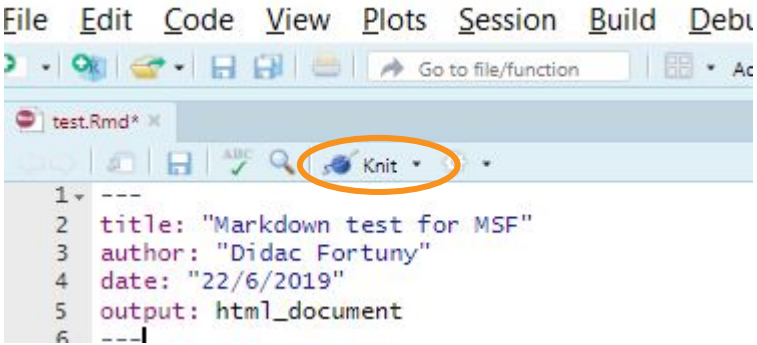
- Tool for automating reports.
- Supporting multiple languages.

Reports with R Markdown



Reports with R Markdown

- Publish report



- Publish in PDF:
  - Needs Latex installed: **miktex.org/download**
  - Needs the **tinytext** package installed:
    - `install.packages("tinytex")`
    - `tinytex::install_tinytex()`

Reports with R Markdown

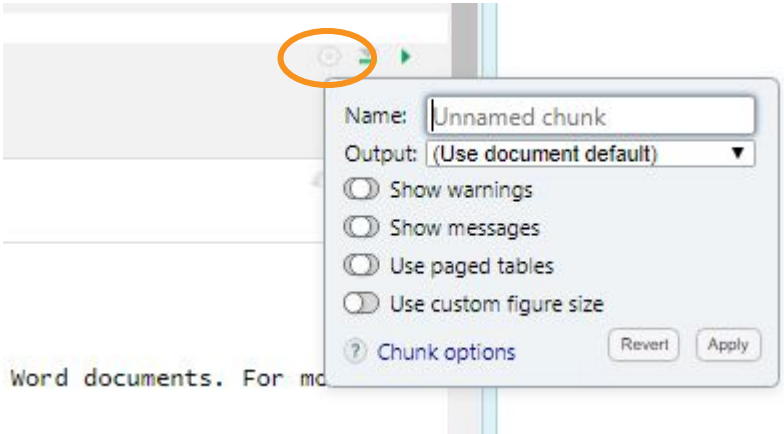
- R Markdown file structure:
  - Header (between ---)
  - Code chunks (between ```)
  - Simple text.

Reports with R Markdown

- Header:
  - Contains basic information about the report.

Reports with R Markdown

- Code chunks



Reports with R Markdown

- Simple text:
  - Markdown format: markdown-guide.readthedocs.io
  - Inline code: `` `r _____` ``

Reports with R Markdown

- Keyboard shortcuts:
  - Ctrl + Alt + C: Run current chunk.
  - Ctrl + Alt + I: Insert new chunk.
  - Ctrl + Shift + K: Publish document.

Reports with R Markdown

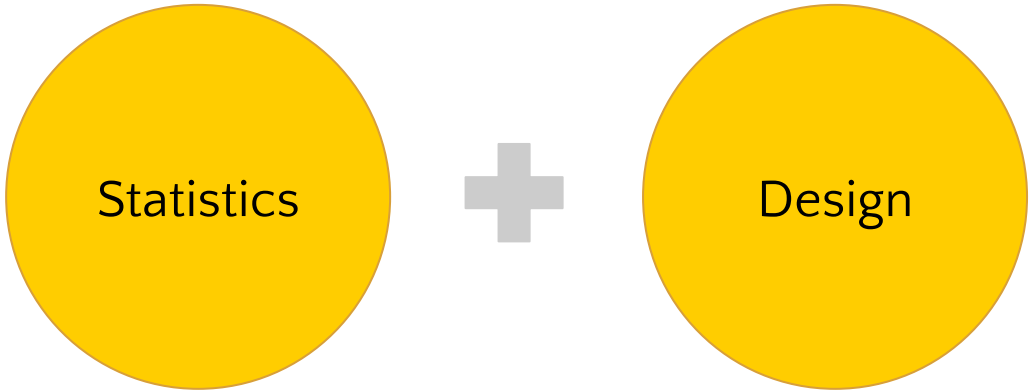
- Online tutorial:
  rmarkdown.rstudio.com

3

Beyond basic R

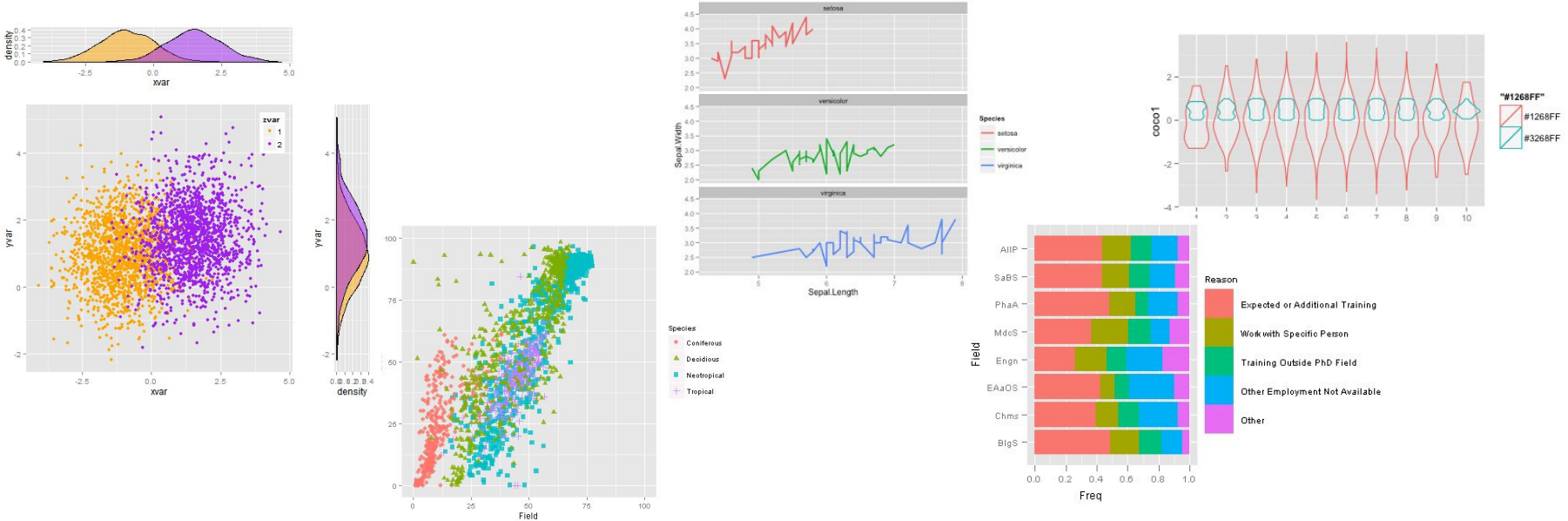
Plots, dashboards and everything else

Plots



Plots

👉 ggplot2: the most powerful library for plots!



Plots

- Distribution: histogram, boxplot
- Correlation: scatterplot
- Ranking: barplot, spider

👉 Check out the R graph gallery!

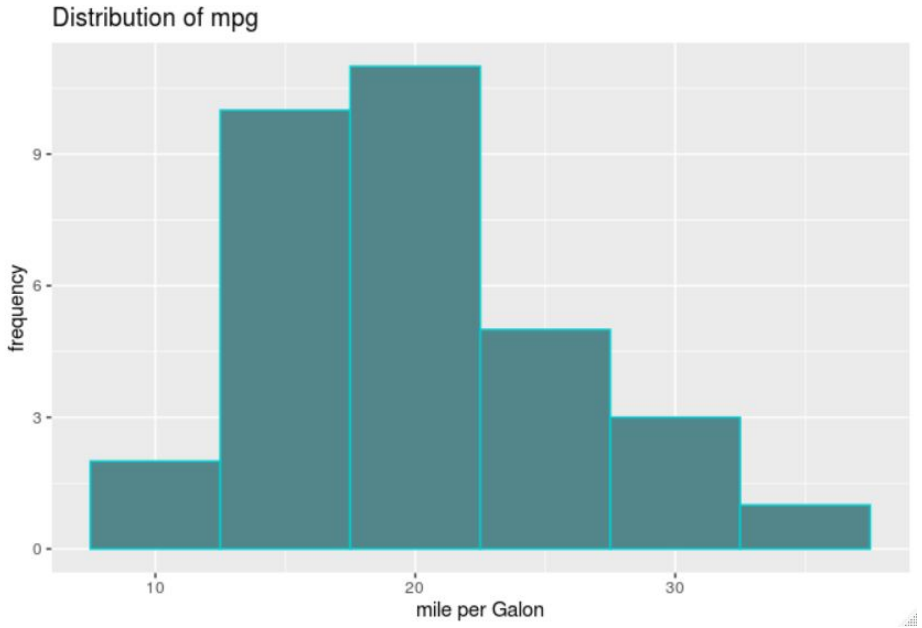
Plots

- ggplot() Create a new ggplot.
- aes() Construct aesthetic mappings.
- + (<gg>) Add components to a plot.
- ggsave Save a ggplot.
- qplot() Quick plot.

👉 Go to cheatsheet.

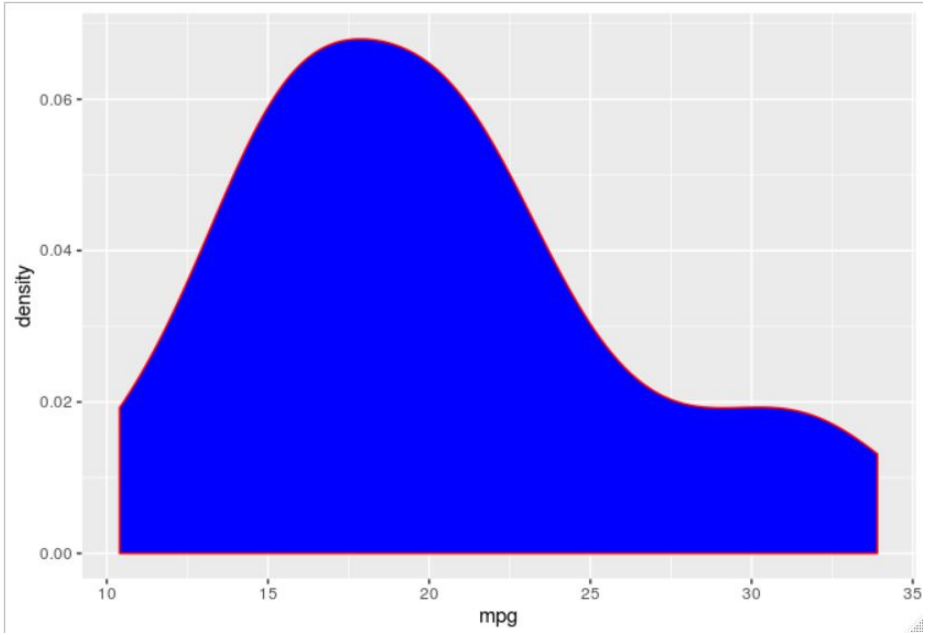
Plots

Histogram



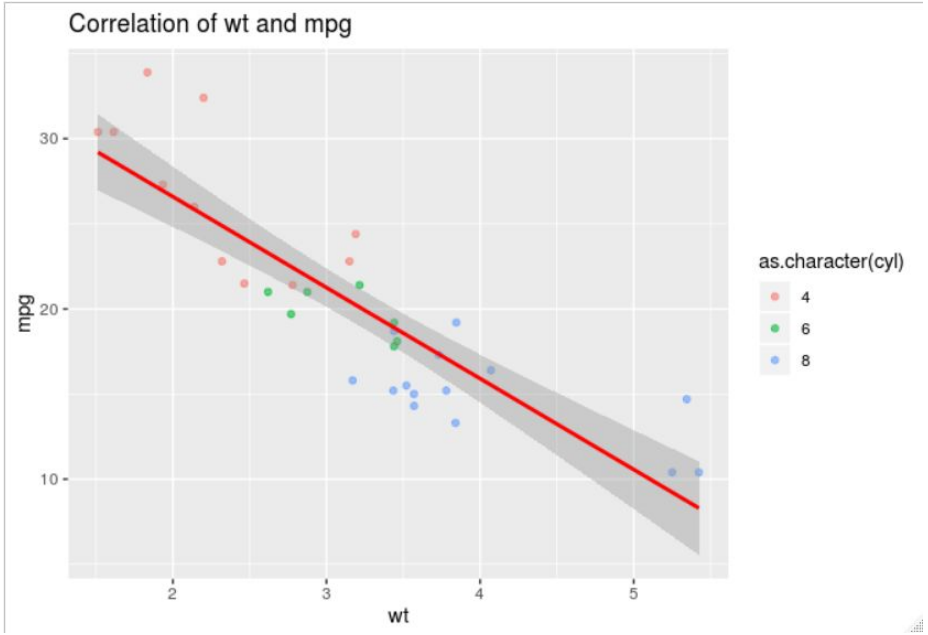
Plots

Density plot



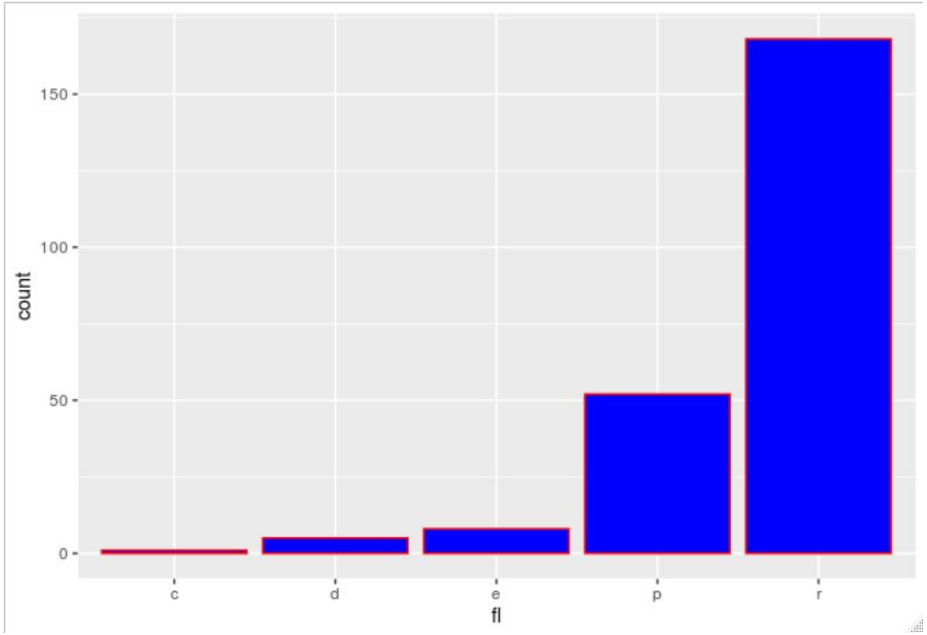
Plots

Scatterplot



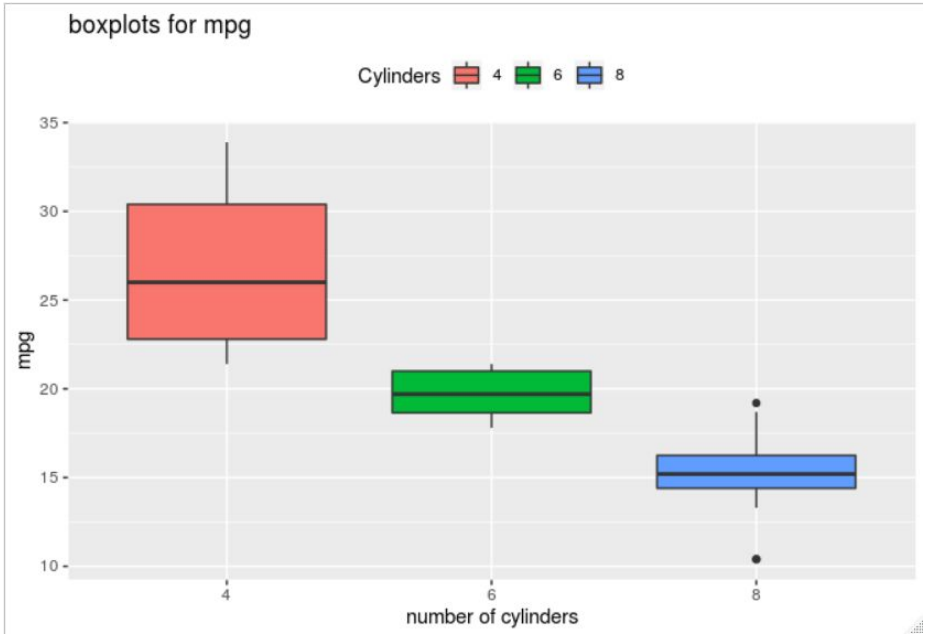
Plots

Barplot



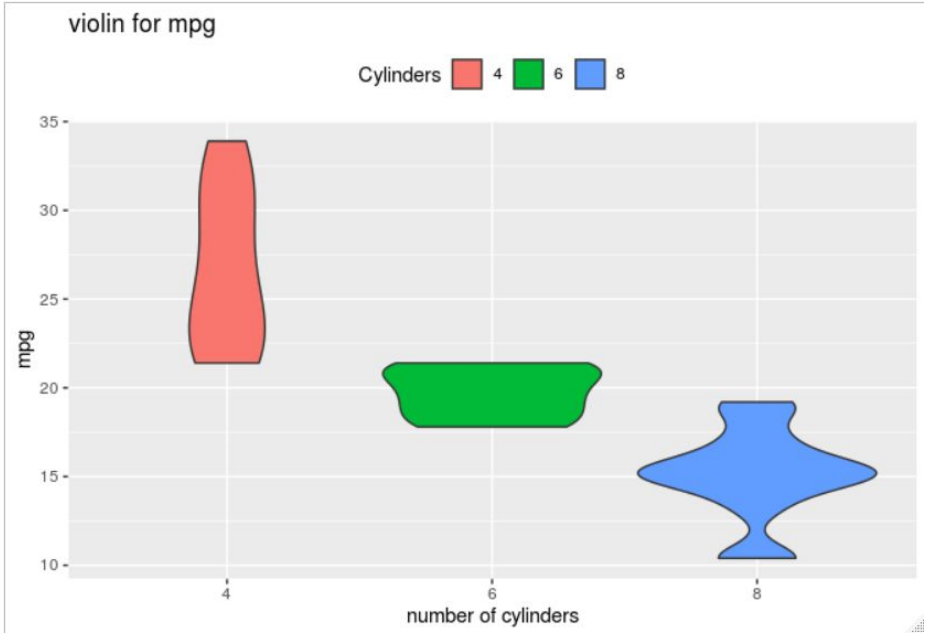
Plots

Boxplot



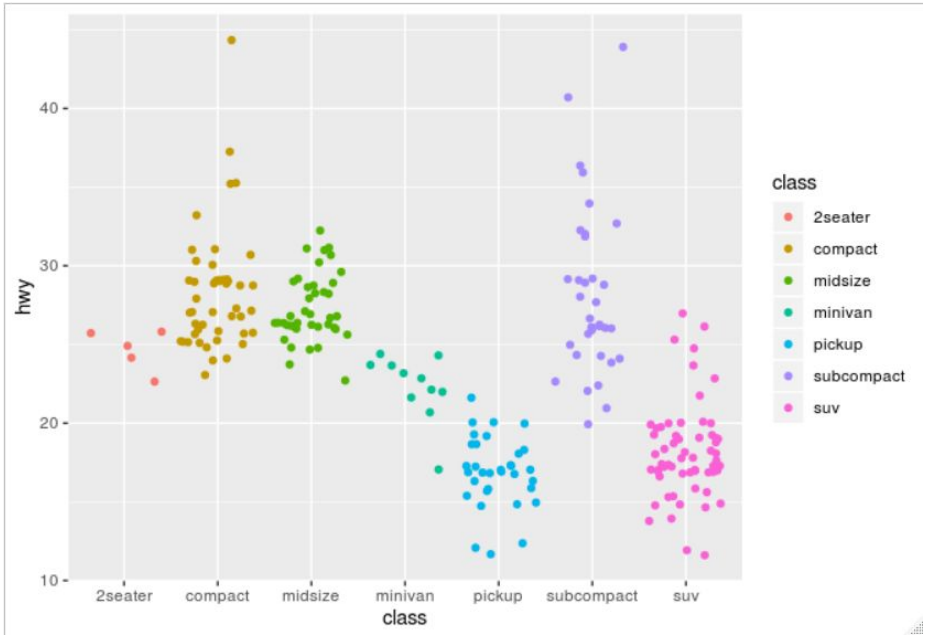
Plots

Violin



Plots

Compare distributions



Plots

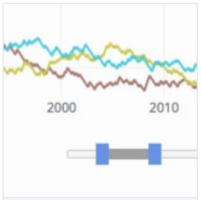
For more details and information, visit this link: https://plot.ly/r/

Plug-in to include them in Powerpoint: here

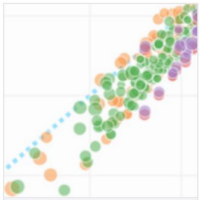
Interactive plots

Time Series

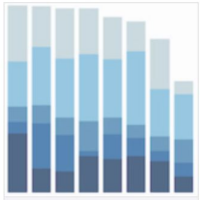

Dashboards

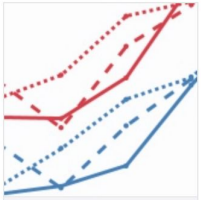


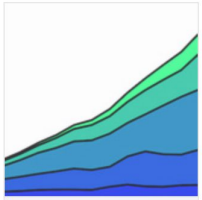
Range Sliders and Selectors

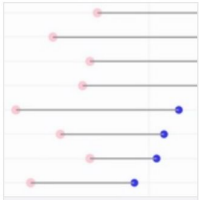

Line and Scatter Plots

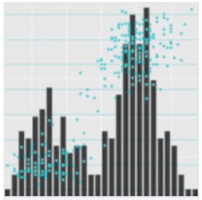
Bubble Charts


Bar Charts


Line Plots


Filled Area Plots


Dumbbell plots


Graphing Multiple Chart Types

Dashboards with Shiny

What is Shiny?

Go to R.

👉 Check out the official tutorial!

Dashboards with Shiny

App

Execution

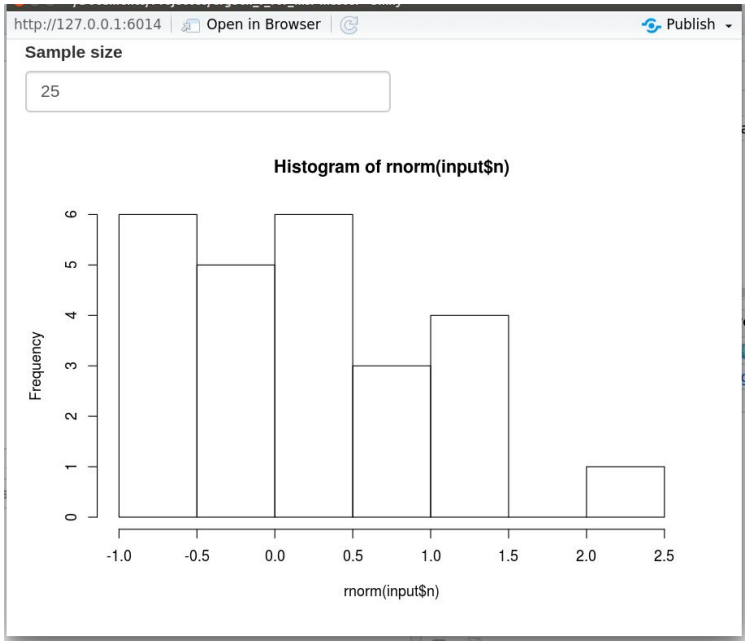
shiny_example.r | app.r

```
1  # install.packages("shiny")
2  library(shiny)
3
4  ui <- fluidPage(
5    numericInput(inputId = "n",
6                 "Sample size",
7                 value = 25),
8    plotOutput(outputId = "hist")
9    )
10
11 server <- function(input, output) {
12   output$hist <- renderPlot({
13     hist(rnorm(input$n))
14     })
15   }
16
17 shinyApp(ui = ui, server = server)
18
```

18:1 (Top Level)

```
> runApp()

Listening on http://127.0.0.1:6014
```



Dashboards with Shiny

Input functions

```
ui <- fluidPage(
  numericInput(inputId = "n",
               "Sample size",
               value = 25),
  plotOutput(outputId = "hist")
  )
```

Output functions

```
server <- function(input, output) {
  output$hist <- renderPlot({
    hist(rnorm(input$n))
    })
  }
```

```
shinyApp(ui = ui, server = server)
```

Dashboards with Shiny

👉 Go to cheatsheet.

Dashboards with Shiny

Go to R.

Thanks!

Any questions ?

You can find us at

- dacfortuny *at* gmail *dot* com
- paulasubias *at* gmail *dot* com

Credits

Special thanks to all the people who made and released these awesome resources for free:

- Presentation template by SlidesCarnival