

# Introduction to R

## Getting started with R

Jan-Philipp Kolb

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# COURSE OBJECTIVES

- Perform your data analysis in a literate programming environment
- Import and manage structured and unstructured data
- Manipulate, transform, and summarize your data
- Join disparate data sources
- Methodically explore and visualize your data
- Perform iterative functions
- Write your own functions

... all with R!

# Introduction round

Please tell me shortly...

- Where are you from? What are you studying/working?
- What is your experience level in R/other programming languages?
- What are your expectations of this course?
- Where do you think you can use R in the future?

# Preliminaries

- Usually we have big differences in knowledge and abilities of the participants - please tell, if it is too fast or slow.
- We have lots of hands-on coding **exercises** - at the end you can only learn on your own.
- We have many **examples** - try them.
- If there are questions - always ask.
- R is more fun together - ask your neighbor - strong proponent of collaborative work!

# Sources of this course

## Sources for figures, text, exercises etc:

- If the source is a website, the links are often in the header or in pink somewhere on the slide.
- At the end of a chapter, you'll find additional links to read on.
- Please ask, if something is unclear.

# Reasons for using R

- ... because it is an **open source language**



- ... outstanding graphs - **graphics, graphics, graphics**
- ... relates to other languages - **R can be used in combination with other programs** - e.g. **data linking**
- ...R can be used **for automation**
  - ... Vast Community - **you can use the intelligence of other people ;-)**
- ...

# Advantages of R

- R can be downloaded for **free**.



[\[Home\]](#)

**Download**

[CRAN](#)

## The R Project for Statistical Computing

### Getting Started

R is a free software environment for statistical computing and graphics. It compiles and runs on a wide variety of UNIX platforms, Windows and MacOS. To [download R](#), please choose your preferred [CRAN mirror](#).

- R is a **scripting language**
- R is becoming more **popular**
- **Good** possibilities for **visualization**

# R can be used in combination...

The collage includes the following elements:

- Top Left:** A red and yellow book cover for "Use R!" by Richard M. Heiberger and Erich Neuwirth, with the title "R Through Excel" in yellow.
- Top Center:** The Stata logo, which features a stylized 'R' and the word 'Stata'.
- Top Right:** The text "SASmixed" in a serif font.
- Middle Center:** The "R-Forge" logo and the text "rPython R package".
- Bottom Left:** A screenshot of the "IBM SPSS Statistics Essentials for R" project page. It includes a sidebar with "Open Source Software" and links for "Users", "Download IBM SPSS Statistics Essentials for R files", "Donate money", "Project detail and discuss", and "Get support". The main content area is empty.
- Bottom Right:** A blue and yellow book cover for "R for Stata Users" by Robert A. Muenchen and Joseph M. Hilbe, with the subtitle "Statistics and Computing".

- Interface to: **Python**, **Excel**, **SPSS**, **SAS**, **Stata**



# The popularity of R-packages



# Download R:

<http://www.r-project.org/>



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## The Comprehensive R Archive Network

### Download and Install R

Precompiled binary distributions of the base system and contributed packages, **Windows and Mac** users most likely want one of these versions of R:

- [Download R for Linux](#)
- [Download R for \(Mac\) OS X](#)
- [Download R for Windows](#)

R is part of many Linux distributions, you should check with your Linux package management system in addition to the link above.

### Source Code for all Platforms

Windows and Mac users most likely want to download the precompiled binaries listed in the upper box, not the source code. The sources have to be compiled before you can use them. If you do not know what this means, you probably do not want to do it!

- The latest release (Friday 2017-04-21, You Stupid Darkness)  
[R-3.4.0.tar.gz](#), read [what's new](#) in the latest version.

# Open Source Programm R

- R is a free, non-commercial implementation of the S programming language (by AT&T Bell Laboratories)
- Free participation - modular structure

This is base R:

# Graphical user interface

But many people use a graphical user interface (GUI) or a integrated development interface (IDE).

For the following reasons:

- Syntax highlighting
- Auto-completion
- Better overview on graphics, libraries, files, ...

# Various text editors / IDEs

- **Gedit** with R-specific Add-ons for Linux
- **Emacs** and ESS (Emacs speaks statistics)- An extensible, customizable, free/libre text editor — and more.
- I use **Rstudio!**



## An IDE that was built just for R

- Syntax highlighting, code completion, and smart indentation
- Execute R code directly from the source editor
- Quickly jump to function definitions



## Bring your workflow together

- Integrated R help and documentation
- Easily manage multiple working directories using projects
- Workspace browser and data viewer



## Powerful authoring & Debugging

- Interactive debugger to diagnose and fix errors quickly
- Extensive package development tools
- Authoring with Sweave and R Markdown

# RStudio

## The functionality of the panes in Rstudio

### Script files

- Saves your script
- Allows code & comments
- Can have multiple files open at a time

### Console/Command line

- Can use as calculator
- Does not save code
- This is where your output is displayed

The screenshot shows the RStudio interface with the following panes:

- Script Editor (Top Left):** Contains R code for a function `block_summary` and its execution. The code includes comments and a `stop` message for non-numeric inputs.
- Environment/History (Top Right):** Shows the current workspace environment with variables `m`, `n`, `r`, and `t` having values 10, 100, 0.77, and 5 respectively. It also lists functions like `block_summary`, `cum_appx`, `cum_exact`, `lc_rate`, `midpoint`, `natural_slope`, and `unit_curve`.
- Console (Bottom Left):** Displays the output of the script execution, including the results of `block_summary` and the output of the `sum` function.
- Files/Plots/Packages/Help/Viewer (Bottom Right):** Shows the file explorer with the current directory and the R documentation for the `mean` function.

### Workspace environment

- Holds your objects
- Can review history

### Misc - Displays:

- files in working directory
- plots when produced
- help files/search

# Rstudio - script and console

## Script files

- Saves your script
- Allows code & comments
- Can have multiple files open at a time

## Console/Command line

- Can use as calculator
- Does not save code
- This is where your output is displayed

The screenshot shows the RStudio interface. The top pane displays a script file named 'Initial\_functions.R' with the following R code:

```

231 }
232 }
233
234
235 # Provides the summary for the block containing units m through n, n > m
236 # t = time for firsts unit
237 # m = lower bound unit of production block
238 # n = upper bound unit of production block
239 # r = learning curve rate
240 block_summary <- function(t, m, n, r, na.rm = FALSE){
241
242   if(!is.numeric(t) | !is.numeric(m) | !is.numeric(n) | !is.numeric(r)){
243     stop('This function only works for numeric inputs!\n',
244         'You have provided objects of the following classes:\n',
245         't: ', class(t), '\n',
246         'm: ', class(m), '\n',
247         'n: ', class(n), '\n',
248         'r: ', class(r))
249   }
250
276:20 block_summary(t, m, n, r, na.rm)
  
```

The bottom pane shows the console output for the function call:

```

Console ~/Desktop/Personal/Academia/Learning Curve R Package/
$`block hours`
[1] 3668.436

$`midpoint unit`
[1] 44.03189

$`midpoint hours`
[1] 40.31249
  
```

# Rstudio - Environment and help



# Important Rstudio Buttons



create a new script



open an existing script



run line where cursor is

# R as a calculator

```
3 + 2 / 10^2 # Uses PEMDAS convention (order of operations)
```

```
## [1] 3.02
```

```
3 + (2 / 10^2)
```

```
## [1] 3.02
```

```
(3 + 2) / 10^2
```

```
## [1] 0.05
```

```
1 / 19^4 # scientific notation is used for large numbers
```

```
## [1] 7.67336e-06
```

```
1/0 # Undefined calculations
```

```
## [1] Inf
```

# Exercise: Preparation

- Check if R is installed on your computer.
- If not, download **R** and install it.
- Check if Rstudio is installed.
- If not - **install** Rstudio.
- Start RStudio. Go to the console (lower left window) and write

3+2

- If there is not already an editor open in the upper left window, then go to the file menu and open a new script. Check the date with `date()` and the R version with `sessionInfo()`.

```
date()
```

```
sessionInfo()
```

# Exercise: See where things happen

- Create a new .R script named `my_first_script.R`
- Write and execute the following code in the .R script and identify where in Rstudio the outputs can be found.

```
mtcars  
?sum  
hist(mtcars$mpg)  
random_numbers <- runif(40)  
history()
```

# R is a object-oriented language

## Vectors and assignments

- R is a object-oriented language
- `<-` is the assignment operator

```
b <- c(1,2) # create an object with the numbers 1 and 2
```

- A function can be applied to this object:

```
mean(b) # computes the mean
```

```
## [1] 1.5
```

We can learn something about the properties of the object:

```
length(b) # b has the length 2
```

```
## [1] 2
```

```
sqrt(b) # the square root of b
```

# Functions in base-package

Function	Meaning	Example
str()	Object structure	str(b)
max()	Maximum	max(b)
min()	Minimum	min(b)
sd()	Standard deviation	sd(b)
var()	Variance	var(b)
mean()	Mean	mean(b)
median()	Median	median(b)

These functions only need one argument.

# Functions with more arguments

Other functions need more arguments:

Argument	Meaning	Example
quantile()	90 % Quantile	quantile(b,.9)
sample()	Draw a sample	sample(b,1)

```
quantile(b,.9)
```

```
## 90%
```

```
## 1.9
```

```
sample(b,1)
```

```
## [1] 2
```

# Examples - Functions with more than one argument

```
max(b); min(b)
```

```
## [1] 2
```

```
## [1] 1
```

```
sd(b); var(b)
```

```
## [1] 0.7071068
```

```
## [1] 0.5
```

## Functions with one argument

```
mean(b); median(b)
```

```
## [1] 1.5
```

```
## [1] 1.5
```



# Exercise: Assignments and functions

Create a vector `b` with the numbers from 1 to 5 and calculate ...

1. the mean
2. the variance
3. the standard deviation
4. the square root from the mean

# Overview commands

<http://cran.r-project.org/doc/manuals/R-intro.html>

# Exercise: Economic Order Quantity Model

## Economic order quantity

---

From Wikipedia, the free encyclopedia

In [inventory management](#), **economic order quantity (EOQ)** is the order quantity that minimizes the total [holding costs](#) and [ordering costs](#). It is one of the oldest classical [production scheduling](#) models. The model was developed by [Ford W. Harris](#) in 1913, but R. H. Wilson, a consultant who applied it extensively, and K. Andler are given credit for their in-depth analysis.<sup>[1]</sup>

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## Economic Order Quantity Model

$$Q = \sqrt{\frac{2DK}{h}}$$

Calculate  $Q$  where:

- $D = 1000$
- $K = 5$
- $h = 0.25$

# R Data Types

- R supports a few basic data types: integer, numeric, logical, character/string, factor, and complex

## Logical

– binary, two possible values represented by TRUE and FALSE

```
x <- c(3, 7, 1, 2)
x > 2
```

```
## [1] TRUE TRUE FALSE FALSE
```

```
x == 2
```

```
## [1] FALSE FALSE FALSE TRUE
```

```
!(x < 3)
```

```
## [1] TRUE TRUE FALSE FALSE
```

# Character vectors

```
y <- c("a", "bc", "def")  
length(y)
```

```
## [1] 3
```

```
nchar(y)
```

```
## [1] 1 2 3
```

```
y == "a"
```

```
## [1] TRUE FALSE FALSE
```

```
y == "b"
```

```
## [1] FALSE FALSE FALSE
```

# Object structure

```
str(b) # b is a numeric vector
```

```
## num [1:2] 1 2
```

## Variable type character

```
a <- letters  
length(letters)
```

```
## [1] 26
```

```
a[1:4]
```

```
## [1] "a" "b" "c" "d"
```

```
str(a)
```

```
## chr [1:26] "a" "b" "c" "d" "e" "f" "g" "h" "i" "j" "k" "l" "m" "n" "o" "p"
```

# Problems with character vector

```
mean(b)
```

```
## [1] 1.5
```

```
(b1 <- c(b, "a"))
```

```
## [1] "1" "2" "a"
```

```
mean(b1)
```

```
## Warning in mean.default(b1): argument is not numeric or logical: returning
```

```
## [1] NA
```

# Coercion

- All elements in a vector must be of the same type. R coerces the elements to a common type
- In the following case all elements are coerced to numeric.

```
x <- c(TRUE, FALSE, TRUE)
c(1.2, x)
```

```
## [1] 1.2 1.0 0.0 1.0
```

- To character:

```
y <- c("2", "3", ".2")
c(1.2, y, x)
```

```
## [1] "1.2" "2" "3" ".2" "TRUE" "FALSE" "TRUE"
```

- The following arithmetic operation works:

```
1 + x
```

```
## [1] 2 1 2
```



# Perform the coercion

- Other times we need to perform the coercion

```
c(1.2,y)
```

```
## [1] "1.2" "2"   "3"   ".2"
```

```
c(1.2,as.numeric(y))
```

```
## [1] 1.2 2.0 3.0 0.2
```

# Information about Vectors

- Aggregator functions - `sum`, `mean`, `range`, `min`, `max`, `summary`, `table`, `cut`, ...
- `class(x)` – returns the type of an object.
- `is.logical(x)` – tells us whether the object is a logical type. There is also `is.numeric`, `is.character` and `is.integer`
- `is.null` – determines whether an object is empty.
- `NULL` is used mainly to represent the lists with zero length, and is often returned by expressions and functions whose value is undefined.

# Coerce objects from one to another

- `as.numeric(x)` – we use the as-type functions to coerce objects from one type (e.g. logical) to another, in this case numeric.
- There are several of these functions, including `as.integer`, `as.character`, `as.logical`

```
x <- c("1", 2, "one", "1plus", "2_and")  
as.numeric(x)
```

```
## [1]  1  2 NA NA NA
```

# How to get help?

- **To get help in general:**

```
help.start()
```

- Use ? to get help.

```
?mean
```

- `example(lm)` gives an example for a linear regression

```
example(lm)
```

- **Online documentation for most of the functions:**

# Again, we get help with the question mark

```
?paste
```

Different sections in the help:

- Description
- Usage
- Arguments
- Value
- Author(s)
- See Also
- Examples

# Vignettes

- A vignette is a paper that present the most important functions of a package
- You get many reproducible examples
- Vignettes are a rather new tool, that is why not every package has a vignette

```
browseVignettes()
```

- to get a vignette:

```
vignette("osmdata")
```

# An example for a vignette - package `osmdata`

---

<https://cran.r-project.org/web/packages/osmdata/vignettes/osmdata.html>

---

## 1. Introduction

`osmdata` is an R package for downloading and using data from OpenStreetMap ([OSM](#)). OSM is a global open access mapping project, which is free and open under the [ODbL licence](#) [[@OpenStreetMap](#)]. This has many benefits, ensuring transparent data provenance and ownership, enabling real-time evolution of the database and, by allowing anyone to contribute, encouraging democratic decision making and citizen science [[@johnson\\_models\\_2017](#)]. See the [OSM wiki](#) to find out how to contribute to the world's open geographical data commons.

Unlike the [openStreetMap](#) package, which facilitates the download of raster tiles, `osmdata` provides access to the vector data underlying OSM.

`osmdata` can be installed from CRAN with

```
install.packages("osmdata")
```

and then loaded in the usual way:

```
library(osmdata)
```

```
## Data (c) openStreetMap contributors, ODbL 1.0. http://www.openstreetmap.org/copyright
```

The development version of `osmdata` can be installed with the `devtools` package using the following command:

```
devtools::install_github('osmdatar/osmdata')
```

# Demos

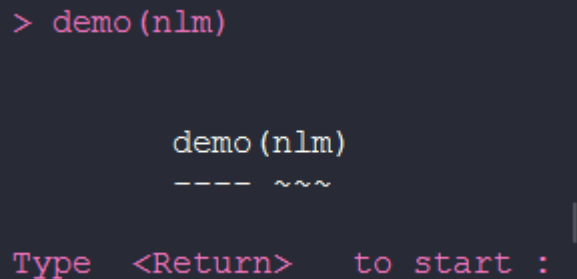
- for some packages you have demos:

```
demo() # shows all available demos
demo(package = "httr") # Show all demos in a package

# Run a specific demo:
demo("oauth1-twitter", package = "httr")
```

- if you run a demo, the code is shown in the console

```
demo(nlm)
```



```
> demo(nlm)

demo(nlm)
---- ~~~

Type <Return> to start :
```



# The function `apropos`

- searches everything about the given string

```
apropos("lm")
```

```
## [1] ".colMeans"      ".lm.fit"         "colMeans"        "confint.lm"
## [5] "contr.helmert"   "dummy.coef.lm"   "getAllMethods"    "glm"
## [9] "glm.control"     "glm.fit"         "KalmanForecast"   "KalmanLike"
## [13] "KalmanRun"       "KalmanSmooth"    "kappa.lm"         "lm"
## [17] "lm.fit"          "lm.influence"    "lm.wfit"          "model.matrix.l
## [21] "nlm"            "nlminb"          "predict.glm"      "predict.lm"
## [25] "residuals.glm"   "residuals.lm"    "summary.glm"      "summary.lm"
```

# Search engine for the R-Site

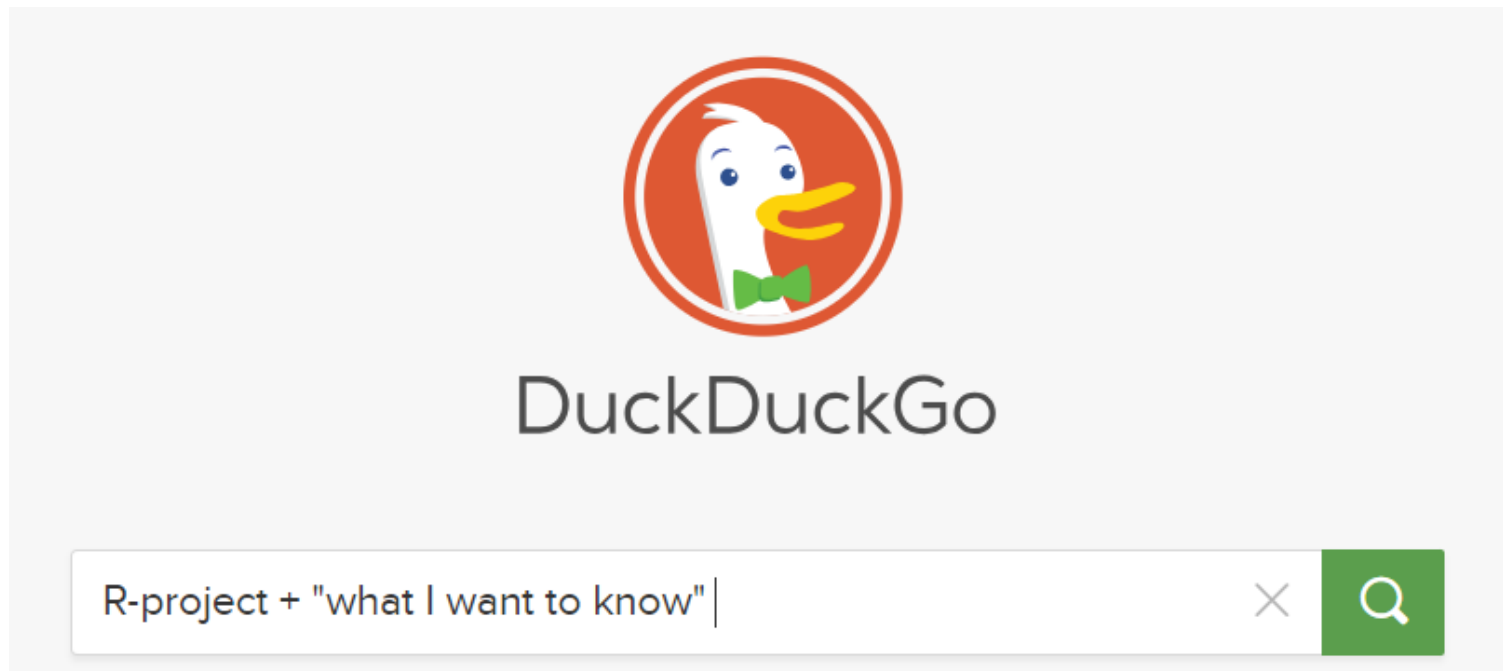
```
RSiteSearch("glm")
```

# Usage of search engines

- I use **duckduckgo**:
- just add "with R" at the end of any search. Or:

R-project + "what I want to know"

- this works of course for all search engines!



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# Stackoverflow

- A searchable Q&A site oriented toward programming issues.
- Is not focused on R - but **many discussions on R**
- Very detailed discussions

The screenshot shows the Stack Overflow website interface. At the top, there's a navigation bar with links for Questions, Jobs, Documentation (marked BETA), Tags, and Users. A search bar contains the text '[r]'. To the right are links for Log In and Sign Up. Below the navigation bar, the 'Tagged Questions' section is active, with filters for info, newest, 8 featured, frequent (selected), votes, active, and unanswered. A description of R is provided: 'R is a free, open-source programming language and software environment for statistical computing, bioinformatics, and graphics. Please supplement your question with a minimal reproducible example. Use dput() for data and specify all non-base packages with library calls. For statistical questions ...'. Below this, a question titled 'How to make a great R reproducible example?' is shown with 1776 votes, 22 answers, and 147k views. The question text is: 'When discussing performance with colleagues, teaching, sending a bug report or searching for guidance on mailing lists and here on SO, a reproducible example is often asked and always helpful. What ...'. Tags for 'r' and 'r-faq' are visible. To the right, a box for 'R Language DOCUMENTATION' includes a link to 'Find a request to handle or browse 121 topics.' Below this, a 'Related Tags' section lists 'ggplot2' (2875), 'dataframe' (1351), and 'plot' (1105).

stackoverflow Questions Jobs Documentation BETA Tags Users [r] ? ☰ Log In Sign Up

Tagged Questions info newest 8 featured frequent votes active unanswered

R is a free, open-source programming language and software environment for statistical computing, bioinformatics, and graphics. Please supplement your question with a minimal reproducible example. Use `dput()` for data and specify all non-base packages with library calls. For statistical questions ...

[learn more...](#) [top users](#) [synonyms \(2\)](#) [r jobs](#)

1776 votes  
22 answers  
147k views

**How to make a great R reproducible example?**

When discussing performance with colleagues, teaching, sending a bug report or searching for guidance on mailing lists and here on SO, a reproducible example is often asked and always helpful. What ...

[r](#) [r-faq](#)

community wiki  
11 revs, 8 users 54%  
Hack-R

22,187 frequent questions tagged  
[r](#) [about »](#)

**R Language**  
DOCUMENTATION

[Find a request to handle or browse 121 topics.](#)

**Related Tags**

[ggplot2](#) × 2875  
[dataframe](#) × 1351  
[plot](#) × 1105

# A cheatsheet for base R

<https://www.rstudio.com/resources/cheatsheets/>

## Base R

### Cheat Sheet

#### Getting Help

Accessing the help files

**?mean**  
Get help of a particular function.  
**help.search('weighted mean')**  
Search the help files for a word or phrase.  
**help(package = 'dplyr')**  
Find help for a package.

More about an object

**str(iris)**  
Get a summary of an object's structure.  
**class(iris)**  
Find the class an object belongs to.

#### Using Packages

**install.packages('dplyr')**  
Download and install a package from CRAN.

**library(dplyr)**  
Load the package into the session, making all its functions available to use.

**dplyr::select**  
Use a particular function from a package.

**data(iris)**  
Load a built-in dataset into the environment.

#### Vectors

##### Creating Vectors

<b>c(2, 4, 6)</b>	2 4 6	Join elements into a vector
<b>2:6</b>	2 3 4 5 6	An integer sequence
<b>seq(2, 3, by=0.5)</b>	2.0 2.5 3.0	A complex sequence
<b>rep(1:2, times=3)</b>	1 2 1 2 1 2	Repeat a vector
<b>rep(1:2, each=3)</b>	1 1 1 2 2 2	Repeat elements of a vector

##### Vector Functions

<b>sort(x)</b> Return x sorted.	<b>rev(x)</b> Return x reversed.
<b>table(x)</b> See counts of values.	<b>unique(x)</b> See unique values.

##### Selecting Vector Elements

By Position

<b>x[4]</b>	The fourth element.
<b>x[-4]</b>	All but the fourth.
<b>x[2:4]</b>	Elements two to four.
<b>x[-(2:4)]</b>	All elements except two to four.
<b>x[c(1, 5)]</b>	Elements one and five.

#### Programming

##### For Loop

```
for (variable in sequence){
  Do something
}
```

Example

```
for (i in 1:4){
  j <- i + 10
  print(j)
}
```

##### While Loop

```
while (condition){
  Do something
}
```

Example

```
while (i < 5){
  print(i)
  i <- i + 1
}
```

##### If Statements

```
if (condition){
  Do something
} else {
  Do something different
}
```

Example

```
if (i > 3){
  print('Yes')
} else {
  print('No')
}
```

##### Functions

```
function_name <- function(var){
  Do something
  return(new_variable)
}
```

Example

```
square <- function(x){
  squared <- x*x
  return(squared)
}
```

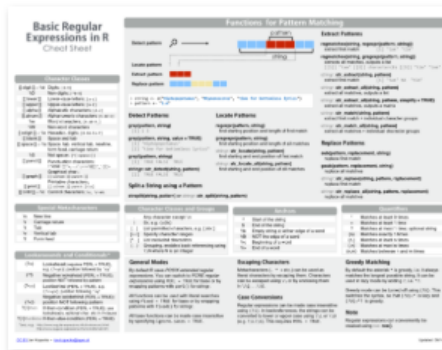
#### Reading and Writing Data

Also see the **readr** package.

Input	Output	Description
<b>df &lt;- read.table('file.txt')</b>	<b>write.table(df, 'file.txt')</b>	Read and write a delimited text file.

# More cheatsheets

## Regular Expressions



Basics of regular expressions and pattern matching in R by Ian Kopacka. Updated 09/16.

DOWNLOAD

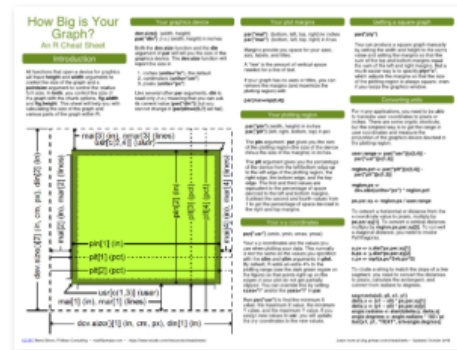
## The leaflet package



Interactive maps in R with leaflet, by Kejia Shi. Updated 05/17.

DOWNLOAD

## How big is your graph?



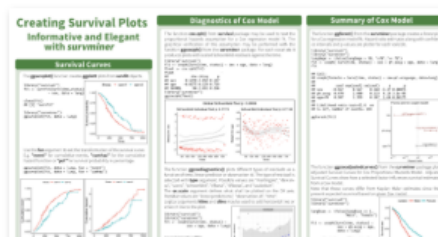
Graph sizing with base R by Stephen Simon. Updated 10/16.

DOWNLOAD

## The eurostat package



## The survminer package



## The sjmisc package



# Quick R

- Always a page with examples and help concerning a topic
- Example: **Quick R - Getting Help**



R Tutorial | R Interface | Data Input | Data Management | Statistics | Advanced Statistics | Graphs | Advanced Graphs

## < R Interface

### Getting Help

The Workspace

Input/Output

Packages

Graphic User Interfaces

Customizing Startup

Publication Quality Output

Batch Processing

Reusing Results

## Getting Help

Once R is installed, there is a comprehensive built-in help system. At the program's command prompt you can use any of the following:

```
help.start()  # general help
help(foo)     # help about function foo
?foo          # same thing
apropos("foo") # list all functions containing string foo
example(foo)  # show an example of function foo
```

# Exercise: Getting help

## Exercise on help

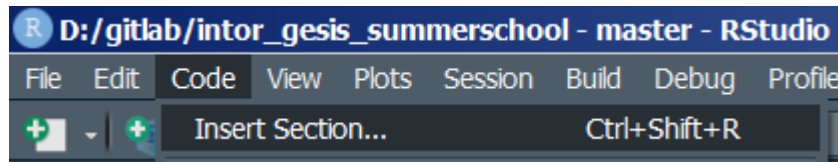
- Try the command `?which.min` This opens a help page in the lower right window of RStudio. What does the function do?
- You must know the name of the function in order to open the help page as above. Sometimes you do not know the name of the R functions; then a **search engine** can often help you. Try, for example, to search the text `R minimum vector`.



# Structure your code

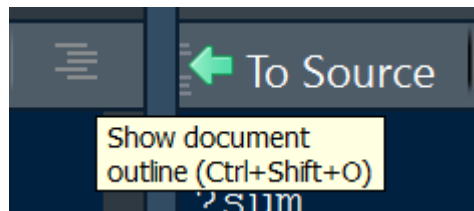
## Work with sections

- In a Rscript you can use "Ctrl + Shift + R" to include a section



## Outline R-code

- Use as many comments as possible
- Use shortcut "Ctrl + Shift + R" to insert a new section



# Save your Work

- When conducting research, keeping all of your code, data, and files in the same place is useful.
- Many journals now require that you make, e.g., your data and code publicly available.
- Now is the time to invest in file structures and versioning programs (e.g., Dropbox and Github).
- Save your script file often to prevent loss of your work.
- Also save your workspace in R in order to save time.
- If you do this, you will be able to load your console in the future as though you had already completed all of the operations that you ran from your script file.

# Where to find routines

- Many functions are included in basic R
- Many specific functions are integrated in additional libraries
- R can be modularly extended by so-called packages or libraries
- Most important packages hosted on CRAN (15367 at Fr Mrz 06)
- Further packages can be found e.g. at **bioconductor**

## Overview R packages

# Installation of packages

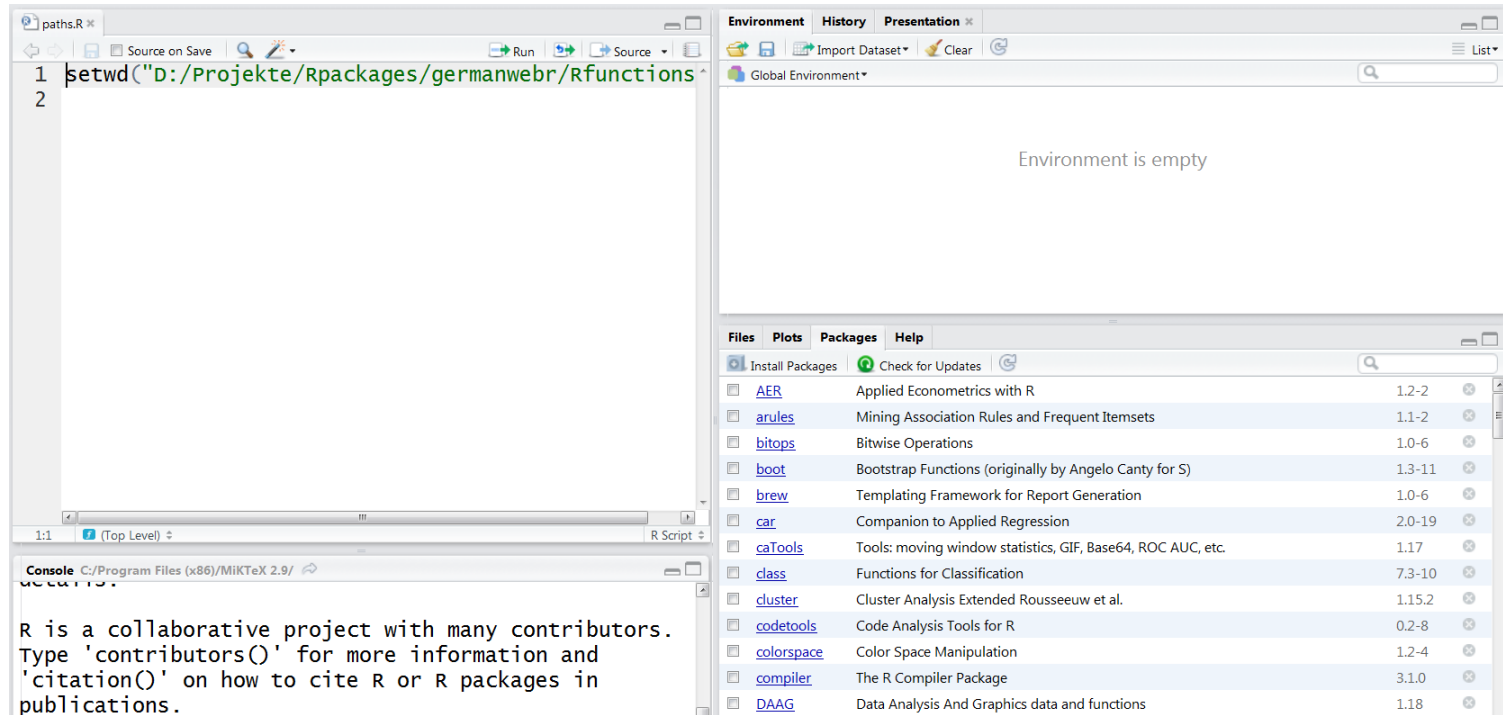
## Install and load a package

- The quotes around the package name are necessary for the command `install.packages`.
- They are optional for the command `library`.

```
install.packages("lme4")
```

```
library(lme4)
```

# Installation of packages with RStudio



The screenshot shows the RStudio interface with the following components:

- Script Editor:** Contains the R code `setwd("D:/Projekte/Rpackages/germanwehr/Rfunctions")` on line 1.
- Environment:** Shows "Global Environment" and "Environment is empty".
- Packages Panel:** Displays a list of installed and available packages.
 

Package Name	Description	Version	Status
<a href="#">AER</a>	Applied Econometrics with R	1.2-2	Installed
<a href="#">arules</a>	Mining Association Rules and Frequent Itemsets	1.1-2	Installed
<a href="#">bitops</a>	Bitwise Operations	1.0-6	Installed
<a href="#">boot</a>	Bootstrap Functions (originally by Angelo Canty for S)	1.3-11	Installed
<a href="#">brew</a>	Templating Framework for Report Generation	1.0-6	Installed
<a href="#">car</a>	Companion to Applied Regression	2.0-19	Installed
<a href="#">caTools</a>	Tools: moving window statistics, GIF, Base64, ROC AUC, etc.	1.17	Installed
<a href="#">class</a>	Functions for Classification	7.3-10	Installed
<a href="#">cluster</a>	Cluster Analysis Extended Rousseeuw et al.	1.15.2	Installed
<a href="#">codetools</a>	Code Analysis Tools for R	0.2-8	Installed
<a href="#">colorspace</a>	Color Space Manipulation	1.2-4	Installed
<a href="#">compiler</a>	The R Compiler Package	3.1.0	Installed
<a href="#">DAAG</a>	Data Analysis And Graphics data and functions	1.18	Installed
- Console:** Displays the message: "R is a collaborative project with many contributors. Type 'contributors()' for more information and 'citation()' on how to cite R or R packages in publications."


# Existing packages and installation

Files


Plots

Packages


Help




Install Packages



Check for Updates






☐

[AER](#)

Applied Econometrics with R

1.2-2




☐

[arules](#)

Mining Association Rules and Frequent Itemsets

1.1-2




☐

[bitops](#)

Bitwise Operations

1.0-6




☐

[boot](#)

Bootstrap Functions (originally by Angelo Canty for S)

1.3-11




☐

[brew](#)

Templating Framework for Report Generation

1.0-6



# Exercise: Download packages

Download and install the following packages from CRAN:

- tidyverse
- nycflights13
- cluster
- ggplot2
- tmap

Have a look at the package documentation. What are these packages for?

# Overview of many useful packages:

- Luhmann - **Table with many useful packages**

## Other interesting packages:

- Package for Import/Export - **foreign**
- **sampling-package for survey Sampling**
- xtable Package for integrating LaTeX in R (**xtable Galerie**)
- **dummies package for creating dummies**
- **Package mvtnorm for getting a multivariate normal distribution**
- **Package maptools for creating maps**



# Install packages from various sources

## Install packages from CRAN Server

```
install.packages("lme4")
```

## Install packages from Bioconductor Server

```
source("https://bioconductor.org/biocLite.R")  
biocLite(c("GenomicFeatures", "AnnotationDbi"))
```

## Install packages from Github

```
install.packages("devtools")  
library(devtools)  
  
install_github("hadley/ggplot2")
```

# Packages

```
# load the package to use in the current R session  
library(stringr)  
  
# use a particular function within a package  
# without loading the package  
?stringr::str_replace
```

## Getting help on packages

```
# provides details regarding contents of a package  
help(package = "tidyr")  
# list vignettes available for a specific package  
vignette(package="tidyr")  
# view specific vignette  
vignette("tidy-data")
```

# How do I get an overview

- **Discover packages recently uploaded to CRAN**
- Look at the Shiny web app that shows the **packages recently downloaded from CRAN**
- Have a look at a **quick-list of useful packages**,...
- ..., or at a list with the **best packages for data processing and analysis**,...
- ..., or at **the 50 most used packages**

# CRAN Task Views

- For some topics all possibilities are arranged in R. (**Overview of Task Views**)
- Currently there are 35 task views.
- All packages of a task view can be installed with the following **command**:

```
install.packages("ctv")
library("ctv")
install.views("Bayesian")
```

## CRAN Task Views

<a href="#">Bayesian</a>	Bayesian Inference
<a href="#">ChemPhys</a>	Chemometrics and Computational Physics
<a href="#">ClinicalTrials</a>	Clinical Trial Design, Monitoring, and Analysis
<a href="#">Cluster</a>	Cluster Analysis & Finite Mixture Models
<a href="#">DifferentialEquations</a>	Differential Equations
<a href="#">Distributions</a>	Probability Distributions
<a href="#">Econometrics</a>	Econometrics
<a href="#">Environmetrics</a>	Analysis of Ecological and Environmental Data
<a href="#">ExperimentalDesign</a>	Design of Experiments (DoE) & Analysis of Experimental Data
<a href="#">ExtremeValue</a>	Extreme Value Analysis
<a href="#">Finance</a>	Empirical Finance

# Exercise: additional packages

Go for example to:

<https://cran.r-project.org/>

<https://awesome-r.com/>

or search for

most interesting r packages

and search for packages ...

- for descriptive data analysis.
- with functions to work with date-times and time-spans.
- to use an interface to python.
- to import foreign data (e.g. SPSS data).
- to handle large amounts of data

# How to learn after this workshop

*How to actually learn any new programming concept*



*Essential*

Changing Stuff and

# The `swirl` package

## Learn R, in R

```
install.packages("swirl")
```

```
library(swirl)
```

```
# type the following into the console:
```

```
swirl()
```

# The tutorial functionality in Rstudio

- You need RStudio v1.3.869-1 Preview for this:
- 

```
install.packages("learnr")
```



# Some links to read on

- Six **reasons** to use **Rstudio**.
- **Why you should learn R first for data science**
- **RStudio – Infoworld 2015 Technology of the Year Award Recipient!**
- **Why the R programming language is good for business?**
- **Have a look at R-bloggers** <!--
- **Intro R**
- **Intro R II** -->
- **Comparisson between python and R**
- **R and Stata Side-by-side**
- **AWESOME R**
- **1000 R tutorials/Links**
- **Learn R by watching two-minute videos**

# Further Links

- **Overview - how to get help in R**



[\[Home\]](#)

**Download**

[CRAN](#)

## Getting Help with R

### Helping Yourself

Before asking others for help, it's generally a good idea for you to try to help yourself. R includes extensive facilities for accessing documentation and searching for help. There are also specialized search engines for accessing information about R on the internet, and general internet search engines can also prove useful ([see below](#)).

- **A list with HowTo`s**
- **A list with the most important R-commands**
- **R-bloggers:** a central hub of content from over 500 bloggers who provide news and tutorials about R.

# Shiny App - Intro R

www.intro-stats.com

