

SMCS course: write and publish R-packages with RStudio

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Getting started

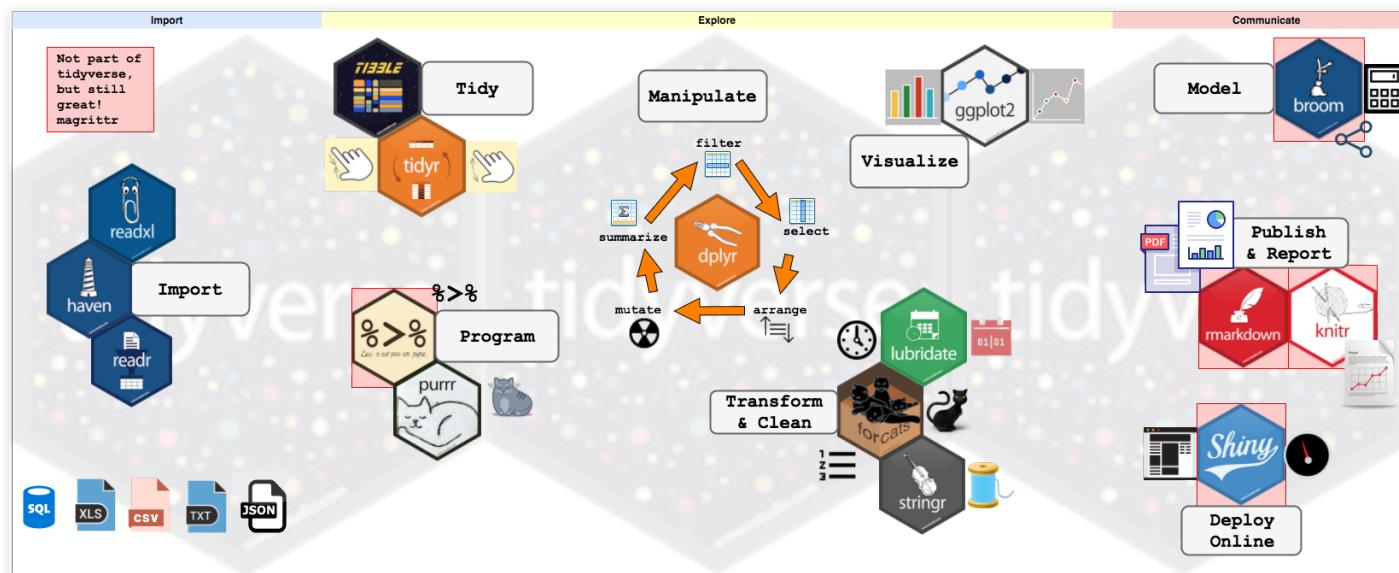
- RStudio
- Demo R-package (`moviesdemo`) and working with existing packages
- `devtools` and creating a package from scratch

Package structure and components

- Package metadata (`DESCRIPTION` and `.Rbuildignore`)
- Code (`.R` files in `R/`)
- Object documentation with Roxygen2 (`.Rd` files in `man/`)
- Imports and exports with namespaces (`NAMESPACE`)
- Data (`data/`)
- Automated testing (`tests/`)
- Vignettes (`vignettes/`)
- Compiled C++ code (`src/`)
- Version control with Git and GitHub
- Check and release your package
- Shiny apps (`inst/`)

RStudio

- RStudio is the most popular interface for R and R-package development with RStudio is (relatively) easy relying on devtools
- RStudio is very versatile. Besides creating/publishing R-packages, RStudio makes it easy to:
 - create Markdown documents, webpages, or slides with RMarkdown + KnitR (e.g. this presentation)
 - create LaTeX documents or slides with RSweave + KnitR
 - create and deploy interactive (web)-applications with R-Shiny
 - setup version control with Git + GitHub
 - and more, go to <https://www.rstudio.com/products/rpackages/> for more info



Demo package

moviesdemo R-package

- We created a demonstration R-package `moviesdemo` accompanying the slides
- This package contains the necessary folders and files for a basic R-package
- You can compare and copy files from `moviesdemo` to your own R-package (created from scratch)

Package details

- The package includes a dataset containing metadata (e.g. title, popularity, plot, etc.) on 4800 movies from The Movie Database (TMDb)
- The goal of the package is to advise similar movies to watch based on a movie selected by the user
- The package includes a Shiny application to give the functions a user-friendly interface

Clone `moviesdemo` to your PC

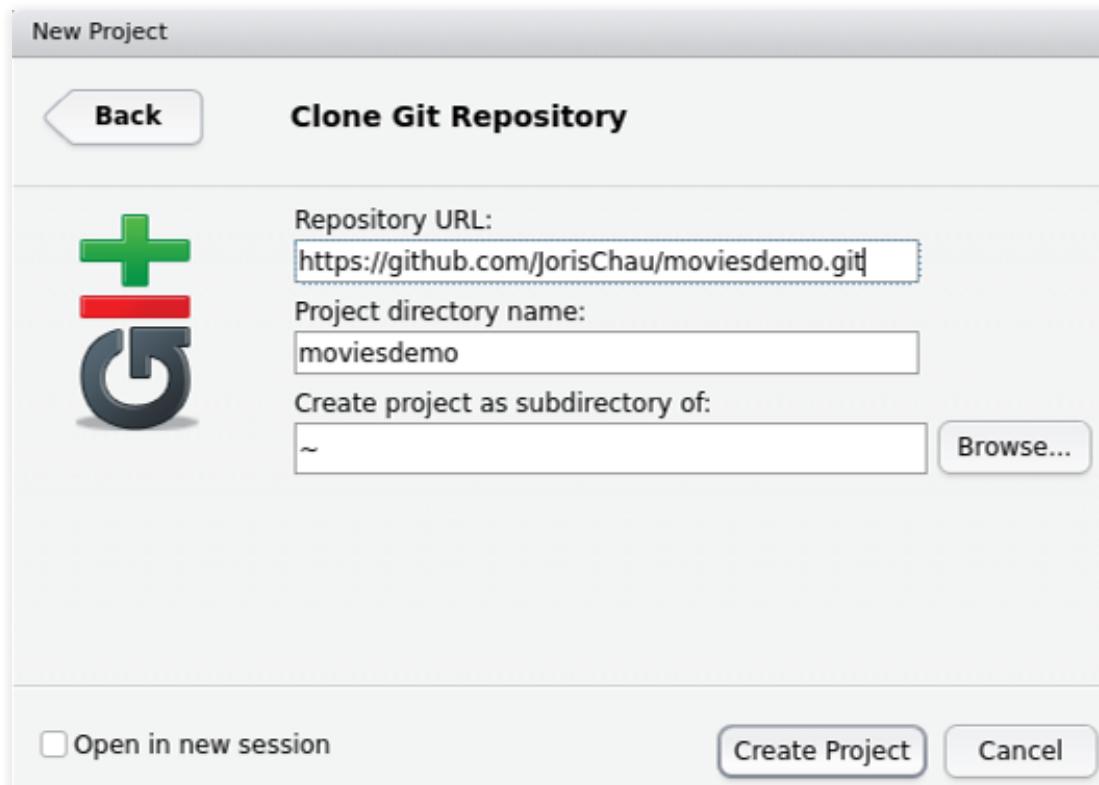
Install **Git** to clone or download (not install) the package to your local PC:

- on Windows: <http://git-scm.com/download/win>
- on OS X: <http://git-scm.com/download/mac>
- on Debian/Ubuntu: sudo apt-get install git-core
- on other Linux distros: <http://git-scm.com/download/linux>

Clone existing Git repository (1)

- In Rstudio: File > New Project > Version Control > Git
- Repository URL: <https://github.com/JorisChau/moviesdemo.git>
- Select path where to clone package on local pc

Note: we do **not** install the package, we *only* download files from Github to local pc.



Clone existing Git repository (2)

- In Git shell type: `git clone https://github.com/JorisChau/moviesdemo.git`
- In RStudio: File > New Project > Existing Directory
- Select path to cloned package on local pc



Work with existing R packages

Published packages (21/11/17): 11.877 on CRAN and 1.476 on Bioconductor

Install and load an R package

```
# ----- INSTALL -----
install.packages("x")
# or
source("https://bioconductor.org/biocLite.R")
biocLite("x")
# or
devtools::install_github("x")

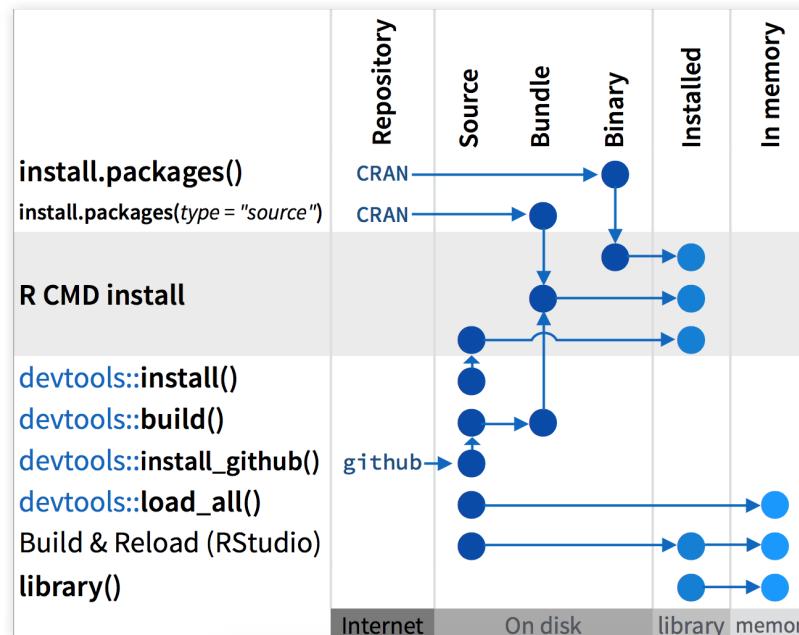
# ----- LOAD and ATTACH -----
library("x")
```

Examples of packages

- <https://github.com/ManonMartin/MBXUCL>
- <https://cran.r-project.org/web/packages/pdSpecEst/>

5 package states

- **source**: the directory where we are currently working on during the package development
- **bundled**: compressed single file (`.tar.gz`); intermediary state (Windows/Mac) or used for Linux distribution
- **binary**: compressed single file used to distribute your package (very different internal structure); platform-specific (optimized): `.zip` (Windows), `.tgz` (Mac)
- **installed**: decompressed package into a package library (i.e. directory containing installed packages)
- **in-memory**: loaded package, necessary to be used



[source: <https://github.com/rstudio/cheatsheets/raw/master/package-development.pdf>]

Why you should write an R package

PROS

Good practices and automation are key for time-saving

- Avoid coding errors
- Functions, data and package documentation
- Conventions and tools standardisation
- Available tests and checks

Portable code

- Easier to share your codes within your team or carry out a group work (with GitHub)
- Open your code to the R community (extra testing for bugs, meet new needs, etc.)
- Publish and value your coding work (along with your articles)
- Deploy Shiny app hosted online (with GitHub)

CONS

- More upstream work
- must pass checks and meet the standards

The "devtools" R package

Motivations

= *Tools to make R packages development easier*

- Simplifies and automates common development tasks
- Encapsulated and developed in parallel with RStudio
- Incorporates the best practices of package development

Useful `devtools` functions

- `create("path-to/package-name")`: Creates a new package skeleton
- `load_all()`: Loads a package in memory
- `document()`: Uses `roxygen2` to document a package
- `check()`: Checks and builds a source package
- `build()`: Builds a source package
- `test()`: Executes the `test_that` tests

More info: <https://cran.r-project.org/web/packages/devtools/>

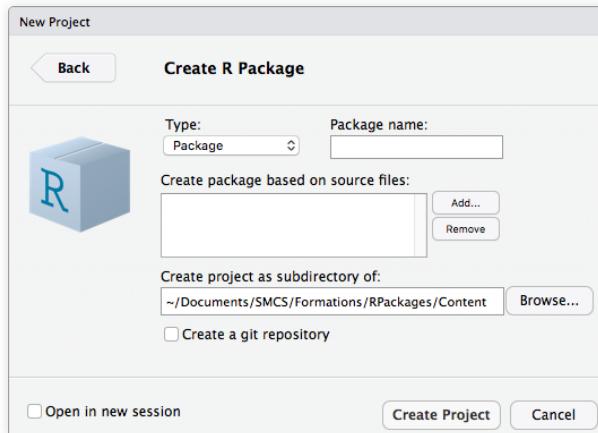
The RStudio interface and start of a package

Useful RStudio facilities

- Only within a project!
- **Build** (tools for building and testing packages) and **Git** (Git and GitHub version control system) **tabs**

Package creation workflow

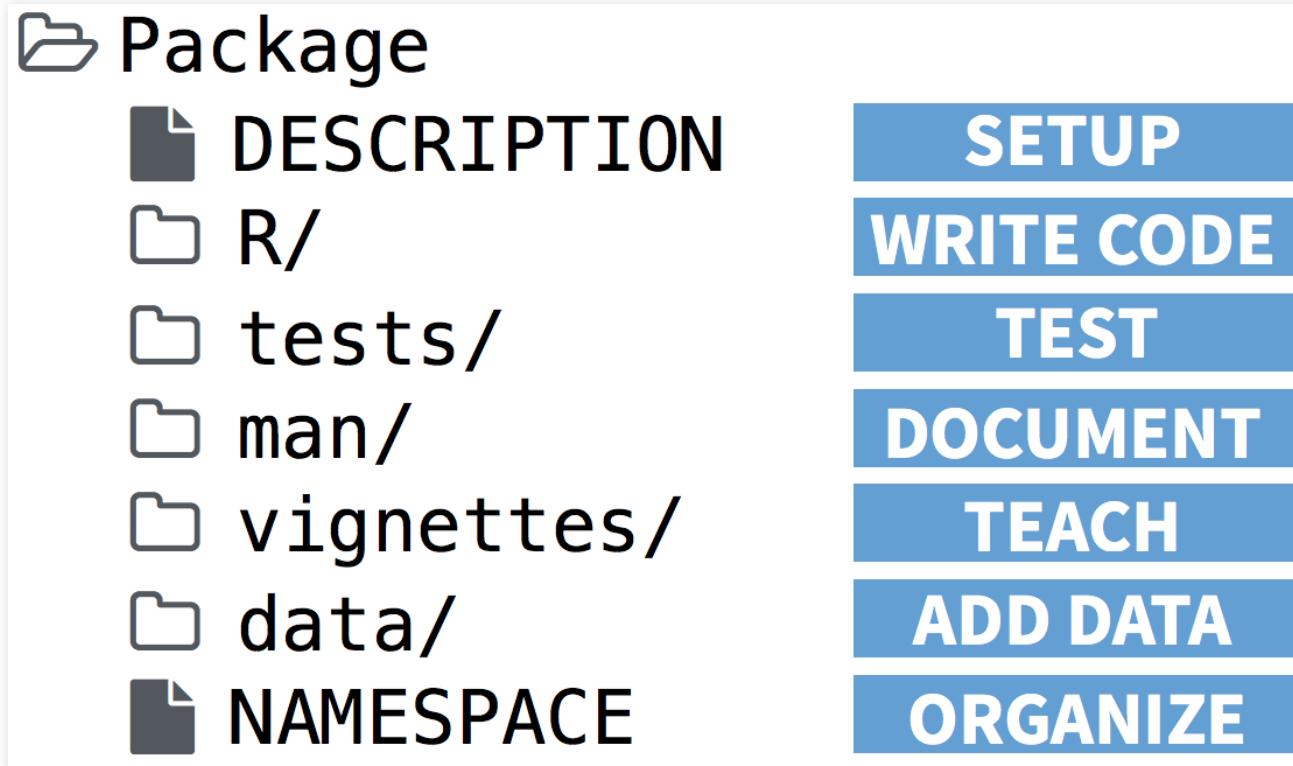
- File > New Project > New Directory > R package (or `devtools:::create()`)



- Set the package name and the project directory
- Select source files (= R scripts) (optional)
- Create a git repository (optional)

Note: The choice of the name is important for your package visibility!! Name it with letters, numbers and periods only.
It must start with a letter and cannot end with a period.

Package structure



(not exhaustive)

[source: <https://github.com/rstudio/cheatsheets/raw/master/package-development.pdf>]

The .Rbuildignore file

Motivation

Files from the *source* package appearing in `.Rbuildignore` are not included in the *bundled* or *binary* package

Best practice

Use `devtools::use_build_ignore("files")` to generate the regular expression in the `.Rbuildignore` file matching the exact file(s) to be excluded

Excerpt from `.Rbuildignore`

```
^.*\.Rproj$      # R project file
^\.Rproj\.user$   # temporary files
^README\.Rmd$     # README.Rmd
^README-.*\.png$  #
^\.travis\.yml$   # Travis test
```

DESCRIPTION (1)

Motivation

Mandatory DCF file that stores the package metadata. Specifies dependencies, who can use it (license) and whom to contact in case of problems, etc.

Structure and main fields

`fieldName: value`

- `Title`: One line description of the package
- `Description`: Multiple sentences short description of the package
- `Authors@R`: Package *Authors* ("aut"), Creator and package *Maintainer* ("cre"), Contributors ("ctb"), etc.
Comprehensive code list: <http://www.loc.gov/marc/relators/relaterm.html>
- `Version`:
 - Released version: <major>.<minor>.<patch>
 - In-development package: add a 4th component, starts at 0.0.0.9000
- `License`: Important for the package release. Explain who and how to use the package (e.g. GPL-3). A `LICENSE` file can be added for more information.
- `LazyData`: If TRUE, the datasets are lazily loaded

DESCRIPTION (2)

Excerpt from moviesdemo/DESCRIPTION

```
Package: moviesdemo
Type: Package
Title: What the Package Does (Title Case)
Version: 0.0.0.9000
Authors@R: c(
  person("Joris", "Chau", email = "j.chau@uclouvain.be", role = c("aut", "cre")),
  person("Manon", "Martin", email = "manon.martin@uclouvain.be", role = "aut"))
Description: More about what it does (maybe more than one line)
  Use four spaces when indenting paragraphs within the Description.
License: CC0
URL: https://github.com/JorisChau/moviesdemo
Encoding: UTF-8
Depends: R (>= 3.3.1)
LazyData: true
Imports: shiny,
         utils
RoxygenNote: 6.0.1
Suggests:
  knitr,
  rmarkdown,
  testthat
VignetteBuilder: knitr
```

Dependencies in DESCRIPTION

Comma separated list of needed package names

- **Imports:** Packages listed must be present and are installed if not.
Tip: ! Imports will only ensure that it is *installed* and will not *attach* it
=> Best practice: refer explicitly to external functions with `package::function()`.
- **Suggests:** The packages are not required for installation but can be used (e.g. for datasets, to run tests or build vignettes, specific function needing the package).

Test if a suggested package is available for a specific function FUN:

```
FUN <- function(x) {  
  if (!requireNamespace("suggestedPackage", quietly = TRUE)) {  
    stop("suggestedPackage installation is necessary for function FUN")  
  }  
}
```

- **Depends:** Used to require a specific version of R i.e. require a version greater than or equal to the currently used version.

Notes:

- Alternative setting of dependencies: NAMESPACE imports
- Versioning to specify a minimum package version: Suggests: knitr(>=1.17)

R scripts good practices (1)

Function names

Should be meaningful and end with .R

Code style

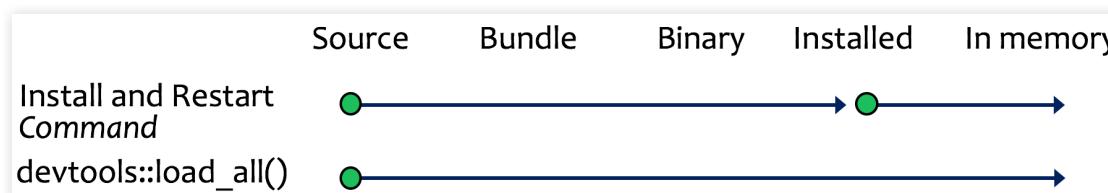
- `formatR::tidy_dir()`: automatically reformats R code
- `lintr::lint_package()`: warns about potential style, syntax or semantic problems
- Check <http://adv-r.had.co.nz/Style.html> for conventions concerning object names, spacing, {}, comments, indentation, etc.

Top-level code rules in the scripts

- Never use `:library()` or `require()` since packages will not be loaded and it modifies the search path; `source()` modifies the current environment
- Use carefully (reset after use with `on.exit()`): the global options(), the graphical parameter `par()`, all functions modifying default directories (e.g. `.libPaths()`, `setwd()`)

`load_all`

Use `devtools::load_all()` for the R functions development workflow to avoid a re-installation



R scripts good practices (2)

Input arguments check

```
FUN <- function(a, type = c("mean", "median")) {  
  switch(type,  
    mean = mean(a),  
    median = median(a))  
}
```

```
FUN(a = c(1, 4, 6, F, 5, 2, 1) , type="mean")
```

```
# [1] 2.714286
```

```
FUN(a = c(1, 4, 6, 5, 5, 2, 1), type="meen")
```

R scripts good practices (3)

Input arguments check

```
FUN <- function(a, type = c("mean", "median")) {  
  if (!is.numeric(a)) {  
    warning(deparse(substitute(a)), " is not numeric")  
  }  
  type <- match.arg(type)  
  switch(type,  
    mean = mean(a),  
    median = median(a))  
}
```

```
FUN(a = c(1, 4, 6, F, 5, 2, 1), type="meen")
```

```
# Error in match.arg(type): 'arg' should be one of "mean", "median"
```

```
FUN(a = c(1, 4, 6, 5, 5, 2, 1), type="mean")
```

```
# [1] 3.428571
```

Object documentation

Motivations

Object documentation (available through `help()` function) acting as a dictionary for the package, the functions and the datasets. Influences the quality of your package ; useful both for package developers and users.

Help file format (`.Rd`) with formatting commands ~ LaTeX

Excerpt from `moviesdemo/man/advise.good.movie.Rd`

```
\name{advise.good.movie}
\alias{advise.good.movie}
\title{Advise movies based on another movie}
\usage{advise.good.movie(similar_to, how_many, draw_scores = FALSE, ...)}
}
\arguments{
\item{similar_to}{character, movie title from the database.}
\item{how_many}{integer, how many movies to advise.}
\item{draw_scores}{if \code{TRUE}, draws a barplot with the similarity scores.}
\item{...}{additional arguments.}
}
\value{A list with the following elements:
\describe{
\item{\code{selected}}{movie title used to advise other movies}
...
}
\description{
Documentation...
}}
```

Writing function help files with Roxygen2 (1)

Motivations

Easier documentation generation: (1) simplified format (+ .Rd syntax) ; (2) the code and documentation are in a same file => both are updated at the same time ; (3) partly automatically generated by Roxygen, avoiding manual errors.

Workflow

- Install the package `roxygen2`
- Write Roxygen comments (starting with `#'`) within your `.R` files
- Run `devtools::document()` to translate your Roxygen comments into a `.Rd` file and update the NAMESPACE (seen later)
- Preview the documentation (Preview button within the `.Rd` file or build and `help()`) and modify/update/correct your comments to improve the documentation

Structure

- Introduction block (Mandatory) is text without tag (first sentence: title ; 2nd paragraph: description)
- Other blocks with tags (main ones):
 - `@param name description`: describes function parameters
 - `@examples`: executable R script applying the function, use `\dontrun{}` to avoid errors check
 - `@return`: describes the outputs of the function
 - `@export` and `@import` (or `@importFrom`): specifies NAMESPACE imports/exports

Writing function help files with Roxygen2 (2)

Excerpt from `moviesdemo/R/advise.R`

```
#' Advise movies based on another movie
#'
#' \code{advise.good.movie} takes as input a movie from the movie database and gives
as
#' output a number of movies that are similar.
#
#' @param similar_to character, movie title from the database.
#' @param how_many integer, how many movies to advise.
#' @param draw_scores if \code{TRUE}, draws a barplot with the similarity scores.
#' @param ... additional arguments.
#
#' @return A list with the following elements:
#' \describe{
#'   \item{\code{selected}}{movie title used to advise other movies}
#'   \item{\code{to_watch}}{advised movie title(s)}
#'   \item{\code{movie_ids}}{line number in the \code{movies} database of the advised
movie(s)}
#'   \item{\code{scores}}{similarity scores of the advised movie(s)}
#' }
#'
#' @import graphics
#' @export

advise.good.movie <- function(similar_to, how_many, ...){
# ---- advise.good.movie function body -----
}
```

Package documentation

Package documentation

- Roxygen package documentation (usually contained in <package-name>.R). Documentation accessed via `help()` or `package?`
- Use the `@docType package` tag

Other documentations

- Vignette(s) (seen later)
- `README.Rmd` with the following suggested structure (from Hadley Wickham):
 1. Describe the high-level purpose of the package
 2. An example where the package is applied
 3. Installation instructions
 4. Overview of the main components of the package (a Vignette is more exhaustive!)

Create the pdf reference manual

In order to create a pdf reference manual from the documentation (.Rd) files, you can run in R:

```
system("R CMD Rd2pdf /path/to/package_root")
```

Tip: use . as your /path/to/package_root while working within your R package project

Note: if you submit your package to CRAN, the reference manual is created automatically by CRAN, (e.g. <https://cran.r-project.org/web/packages/pdSpecEst/pdSpecEst.pdf>)

NAMESPACE*

Motivating example

```
nrow
```

```
# function (x)
# dim(x)[1L]
# <bytecode: 0x7fdf35832190>
# <environment: namespace:base>
```

Now what happens if we overwrite `dim()` in the global environment?

```
dim <- function(x) c(1, 1)
dim(mtcars)
```

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

Does `nrow()` still work?

```
nrow(mtcars)
```

```
# [1] 32
```

NAMESPACE

Motivation

The NAMESPACE file decides which functions/objects to **import** from other packages and which functions/objects to **export** from the created package.

We write **imports** and **exports** through Roxygen comments in our .R files.

Several useful Roxygen comments

- #' @export, exports functions
- #' @importFrom, imports specific functions, e.g. #' @importFrom utils browseURL
- #' @import, imports all functions in a package, e.g. #' @import shiny
- See <http://r-pkgs.had.co.nz/namespace.html> for more details

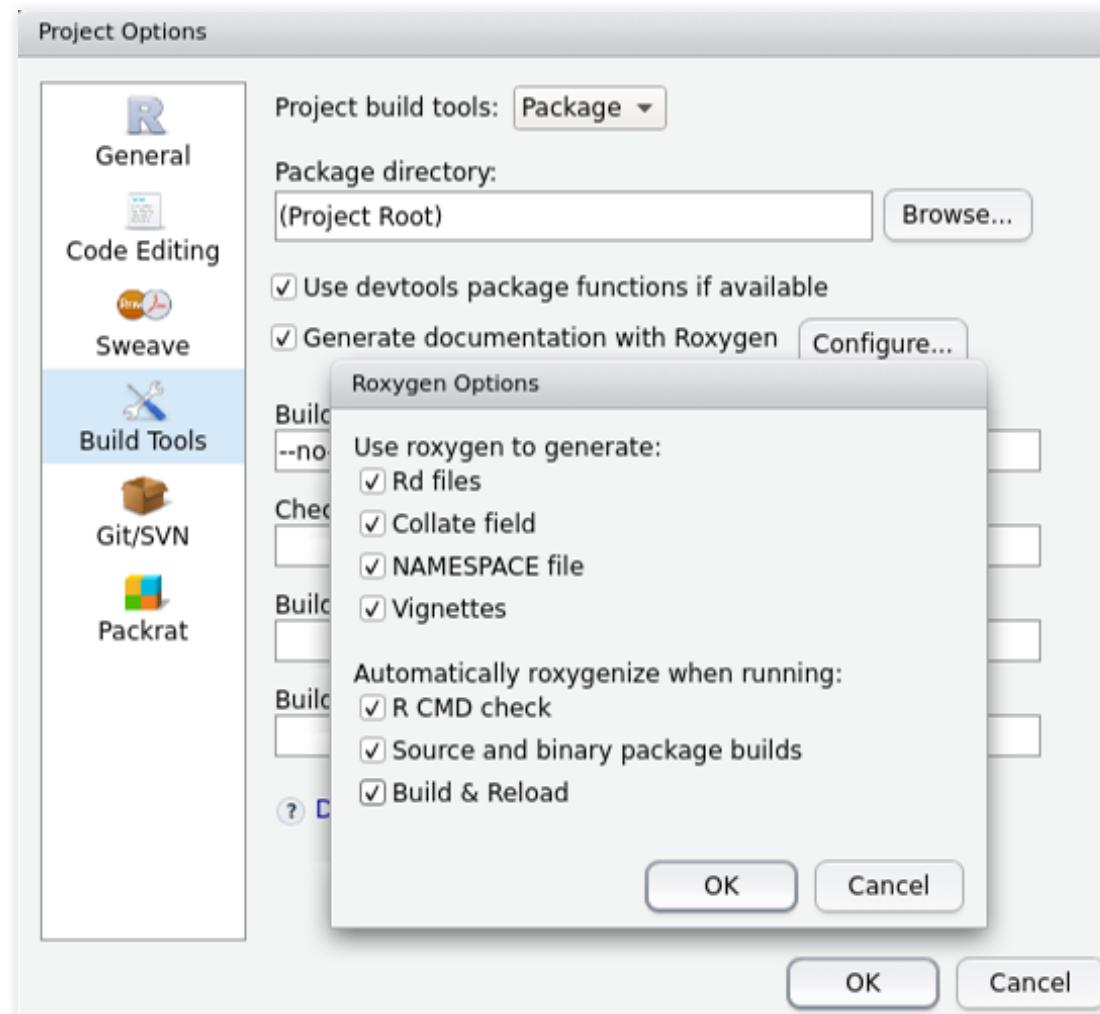
Workflow

1. Add Roxygen comments to .R files
2. Run `devtools::document()` (or Ctrl/Cmd + Shift + D in RStudio) to Roxygenize files
3. Repeat until correct functions are imported and exported

NAMESPACE

Tip: Roxygenize also on Build and Reload (Ctrl/Cmd + Shift + B in RStudio)

- In RStudio: Build > Configure Build Tools > Build Tools



Data

Including data in the package

- Exported data available to the user is stored in `data/`.
- Internal data *not* available to the user is stored in `R/sysdata.rda`
- Raw data can be stored in `inst/extdata`

Exported/Internal data

```
# setwd(/path/to/package_root)
x <- sample(1000)
devtools::use_data(x) ## exported data, writes x to data/x.rda
devtools::use_data(x, internal = T) ## internal data, writes x to R/sysdata.rda
rm(x)
load("data/x.rda")
load("R/sysdata.rda")
```

Tip: set `LazyData:true` in `DESCRIPTION` file, (datasets do not occupy memory until used).

Documenting datasets

Objects in `data/` are always exported and therefore *need* documentation. Documenting data is (almost) the same as documenting a function. Document the name of the dataset and save it in `R/`, e.g. `R/data.R`. See <http://r-pkgs.had.co.nz/data.html> for more details and how to include other types of data.

Data

Excerpt from R/data.R

```
#' TMDb 4800 movie dataset
#'
#' Metadata on 4800 movies from The Movie Database (TMDb) from the Kaggle
#' website.
#'
#' The variables are as follows:
#'   \itemize{
#'     \item{title}{character, title of the film.}
#'     \item{genres}{string of characters, genres of the film.}
#'     \item{popularity}{numeric, popularity of the film in terms of views.}
#'     \item{vote}{numeric, voted rating of the film between 0 and 10.}
#'     \item{language}{factor, original language.}
#'     \item{producers}{string of characters, production companies.}
#'     \item{release}{date, release date of the film.}
#'     \item{runtime}{numeric, runtime in minutes.}
#'     \item{plot}{character, plot summary of the film.}
#'   }
#'
#' @format A data frame with 4800 rows and 9 variables.
#'
#' @source \url{https://www.kaggle.com/tmdb/tmdb-movie-metadata}
"movies"
```

Note: view the resulting help file (after documentation Ctrl/Cmd + Shift + D) e.g. with ?movies.

Automated Testing

Motivation

Automate tests to see if code is (still) working properly. Advantages: confidently make changes without breaking other functionalities, easier to locate bugs, etc.

Setup

```
# install.packages('testthat')
# setwd(/path/to/package_root)
devtools::use_testthat() ## creates necessary files/folders
```

Test structure

- An **expectation** starts with `expect_` and describes expected result of a computation
- A **test** created with `test_that()` groups multiple expectations to test a (simple) function
- A **file** groups together multiple similar tests and is named via `context()`

Workflow

- Modify code or tests
- Test package with `Ctrl/Cmd + Shift + T` or `devtools::test()` or Build > Test Package
- Repeat until all tests pass

Automated Testing

Several useful `expect_` functions

- `expect_equal()` uses `all.equal()` for equality with some numerical error:

```
library(testthat)
expect_equal(10, 10) ## passes
expect_equal(10, 10 + 1E-7) ## passes
expect_equal(10, 11) ## errors
```

- `expect_identical()` uses `identical()` for exact equality
- Other `expect_` functions:

```
## Match character vectors
string <- "Testing is fun!"
expect_match(string, "Testing") ## case-sensitive

## Inspect printed output
expect_output(str(list(1:10, letters)), "List of 2")
expect_message(message("Hello"), "Hello")
expect_warning(log(-1), "NaNs produced")
expect_error(1 / "a", "non-numeric argument")
```

- See <http://r-pkgs.had.co.nz/tests.html> for more details and writing your own `expect_`'s

Automated Testing

Excerpt from `tests > testthat > test-functions.R`

```
context("moviesdemo functions")

test_that("Output similarity measures", {

  ## Test output sim.genres()
  expect_is(sim.genres(movies$title[1], movies$title[2]), "numeric")
  expect_equal(sim.genres(movies$title[1], movies$title[1]), 1)
  expect_error(sim.genres(NA, movies$title[1]))

})

test_that("Output advise.good.movie function", {

  out <- advise.good.movie(movies$title[1], 5, weights = rep(1,4))

  expect_output(str(out), "List of 4")
  expect_match(out[[1]], movies$title[1])
  expect_equal(length(out[[2]]), 5)
  expect_is(out[[2]], "character")
  expect_error(advise.good.movie(movies$title[1], NA),
              "Argument 'how_many' should be a number...")

})
```

Vignettes

Motivation

Vignettes are long-form tutorials written in Markdown (as this presentation). Vignettes are more detailed than function documentation. A vignette can e.g. describe how to combine different functions in the package to solve a complex problem. Example: https://cran.r-project.org/web/packages/pdSpecEst/vignettes/depth_ranktests.html

Setup

- Install rmarkdown and knitr with `install.packages(c("rmarkdown", "knitr"))`
- Install **pandoc** -> <http://pandoc.org/installing.html>
- Run `devtools::use_vignette("my-vignette")` creating necessary files/folders

Workflow

- Modify the vignette
- **Knit** vignette with `Ctrl/Cmd + Shift + K` or clicking the Knit button

Markdown and Knitr

Markdown is a simple text formatting language, not as flexible as LaTeX, but easy to write and read. **Knitr** allows to intermingle code and text by running R code and translating it into formatted Markdown. See <http://r-pkgs.had.co.nz/vignettes.html> for a good intro to Markdown/Knitr with RStudio.

Compiled code*

Speed up your code by including C or C++ code in your package with Rcpp (and RcppArmadillo or RcppEigen).

For more details, see e.g. <http://adv-r.had.co.nz/Rcpp.html> or <http://r-pkgs.had.co.nz/src.html>.

To illustrate

```
## write C++ function
Rcpp::cppFunction(depends = "RcppArmadillo", 'arma::cx_mat mExp_C(arma::cx_mat A) {
  arma::cx_mat A_exp = arma::expmat(A);
  return A_exp;
}')

## write R function
mExp_R <- function(A){
  e <- eigen(A)
  e$vectors %*% diag(exp(e$values)) %*% solve(e$vectors)
}

## Computation times
A <- matrix(complex(real = rnorm(4), imaginary = rnorm(4)), nrow = 2)
microbenchmark::microbenchmark(mExp_R(A), mExp_C(A))
```

```
# Unit: microseconds
#      expr     min      lq    mean   median      uq     max neval
# mExp_R(A) 152.102 167.077 237.29130 175.733 195.562 3165.601    100
# mExp_C(A)    7.412   8.863  20.51772  13.329  15.918   681.155    100
```

Git and GitHub

Motivation

Git is a version control system that tracks changes in your code and allows to undo mistakes. **GitHub** is a website where you can share code and work together with others via e.g. pull requests, branches, ...

- Installing an R-package from GitHub is (very) easy:

```
devtools::install_github("JorisChau/moviesdemo")
```

Set up Git/GitHub with RStudio

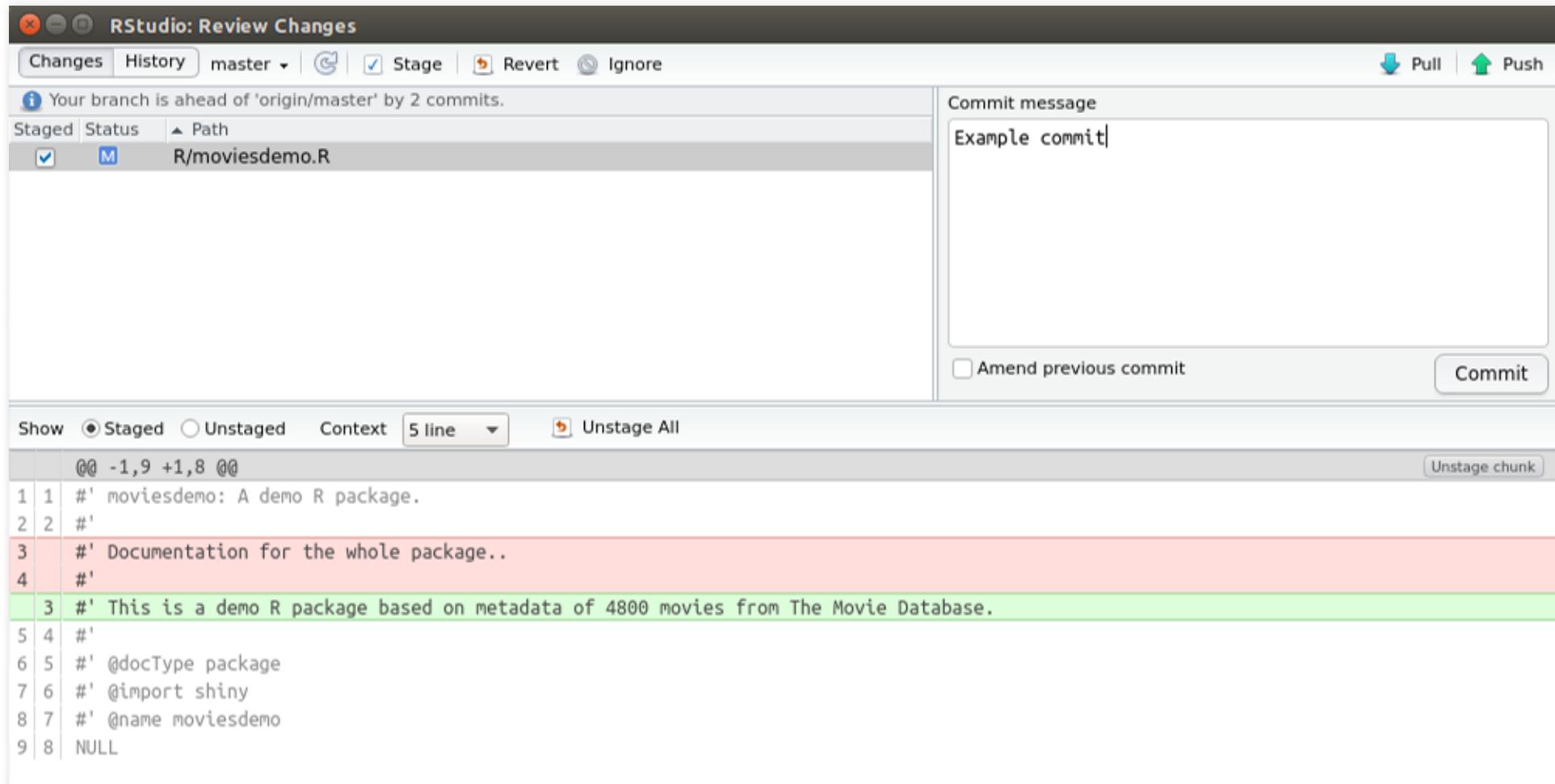
- Install Git
- In a Git shell, configure username and email, (check with `git config --global --list`)

```
git config --global user.name "YOUR FULL NAME"
git config --global user.email "YOUR EMAIL ADDRESS"
```

- Create a GitHub account on <https://github.com> (use the same email as above)
- If needed, generate a SSH key, see <http://r-pkgs.had.co.nz/git.html> for details
- In RStudio project: Tools > Project Options > Git/SVN change Version Control System to Git
- In a Git shell, run `git init` and restart RStudio ...

Git and GitHub

- New **Git** pane tracks changes in the code:



Git and GitHub

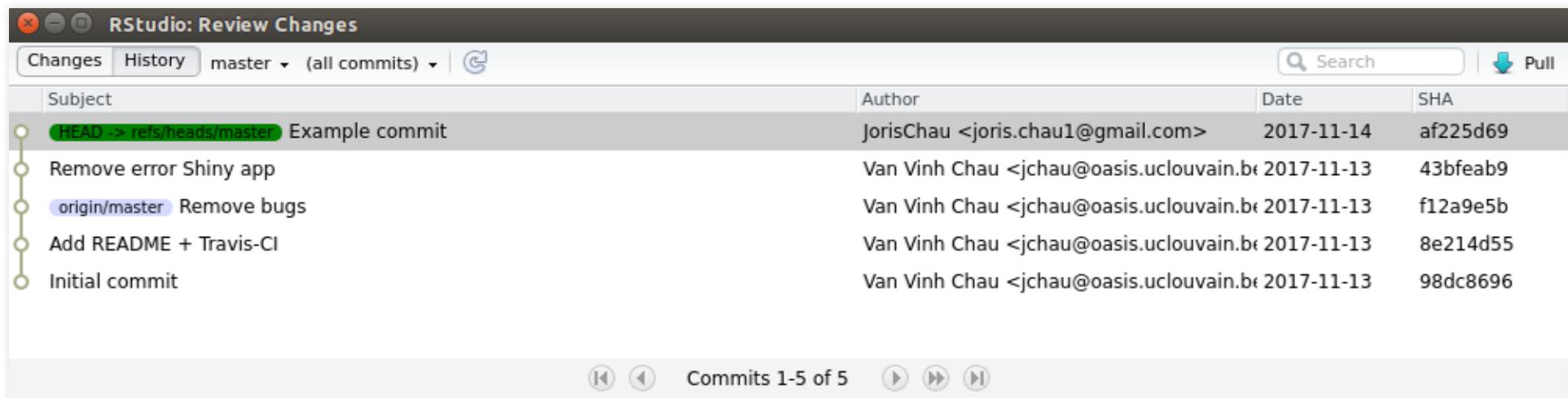
To create a new commit (often)

- Save changes and open commit window in Git pane
- Stage (select) files for inclusion in commit
- Write a (meaningful) commit message and commit

Tip: Add files you do not want to include to `.gitignore` (e.g. temporary folders or large files).

Undo mistakes

- Roll back changes to previous commit by clicking on More > Revert (cannot undo!)
- You can also undo changes to part of a file or individual lines or changes that occurred before the last commit, see e.g. <http://r-pkgs.had.co.nz/git.html> for more details



The screenshot shows the RStudio interface for reviewing git changes. The title bar says "RStudio: Review Changes". The top navigation bar has tabs for "Changes" (which is selected), "History", and "master" (with a dropdown for "(all commits)". There is also a "Pull" button. Below the navigation is a search bar with a magnifying glass icon and the word "Search".

Subject	Author	Date	SHA
HEAD -> refs/heads/master Example commit	JorisChau <joris.chau1@gmail.com>	2017-11-14	af225d69
Remove error Shiny app	Van Vinh Chau <jchau@oasis.uclouvain.be>	2017-11-13	43bfeab9
origin/master Remove bugs	Van Vinh Chau <jchau@oasis.uclouvain.be>	2017-11-13	f12a9e5b
Add README + Travis-CI	Van Vinh Chau <jchau@oasis.uclouvain.be>	2017-11-13	8e214d55
Initial commit	Van Vinh Chau <jchau@oasis.uclouvain.be>	2017-11-13	98dc8696

At the bottom, there are navigation icons for navigating through the commits, and the text "Commits 1-5 of 5".

Git and GitHub

Setup remote repo GitHub

- Create a new repo on Github: <https://github.com/new> with the same name as the package and package title as repo description
- Follow instructions from GitHub, similar to (Git shell):

```
git remote add origin https://github.com/JorisChau/moviesdemo.git  
git push -u origin master
```

(First line assigns remote repo to `origin`. Second line **pushes** (publishes) local repo `master` to remote repo `origin`).

Synchronizing with GitHub

- Commit locally until ready to push
- Press **Push** in Git pane
- Go to GitHub page and verify modifications

Go to, for instance, <http://r-pkgs.had.co.nz/git.html> to learn how to work together with others using Git + GitHub (e.g. *branches, pull requests, tracking issues*, etc.).

Checking package

Workflow

- Run `devtools::check()` or press Ctrl/Cmd + Shift + E
- Fix errors/warnings/notes
- Repeat until there are no more errors/warnings/notes

Check messages

- **ERROR**: severe problem that needs to be fixed in any case
- **WARNING**: problems that must be fixed if you want to submit to CRAN (or Bioconductor)
- **NOTE**: mild problems, if you submit to CRAN try to eliminate all notes, if not explain why the note is not a problem in CRAN submission comments.

Example output `devtools::check()`

```
Functions with \usage entries need to have the appropriate \alias
entries, and all their arguments documented.
The \usage entries must correspond to syntactically valid R code.
See chapter 'Writing R documentation files' in the 'Writing R
Extensions' manual.

checking dependencies in R code ... NOTE
There are ::: calls to the package's namespace in its code. A package
almost never needs to use ::: for its own objects:
  'Impute1D' 'NormF' 'Sqrt' 'iSqrt'
R CMD check results
1 error | 1 warning | 1 note

R CMD check succeeded
```

Checking package and Release

To release package on CRAN, the package need to build (without errors/warnings) on all major platforms. If you do not have access to different operating systems yourself:

- Check on Windows with win-builder <https://win-builder.r-project.org/>
- Check on Linux/OS X with Travis

Setup Travis

- Run `devtools::use_travis()` to set up basic `travis.yaml` configuration

```
## Example travis.yaml config file
language: R
warnings_are_errors: false
sudo: false
cache: packages
os:
  - linux
  - osx
notifications:
  email: false
```

- Go to <https://travis-ci.org/> and enable Travis for repo you want to test
- Push to GitHub and check build results on Travis website

Checking package and Release

Example output Travis (linux, osx)

JorisChau / moviesdemo  build unknown

Current Branches Build History Pull Requests > **Build #1** More options 

 master Example commit	 #1 passed	
-o Commit e22d6d2 	 Ran for 48 min 38 sec	
tl Compare f12a9e5..e22d6d2 	 Total time 28 min 23 sec	
Branch master 	 about 5 hours ago	
 JorisChau authored and committed		

Build Jobs

 # 1.1  </> R	 no environment variables set	 8 min 18 sec	
 # 1.2  </> R	 no environment variables set	 20 min 5 sec	

Checking package and Release

CRAN Release

- Verify that the package passes `devtools::check()` on the major platforms (windows, linux, osx) and you adhere to CRAN policies
- Change the version number in `DESCRIPTION` and update `README.md`, `NEWS.md`, `cran-comments.md`
- Be aware of backward compatibility, see <http://r-pkgs.had.co.nz/release.html>
- Submit to CRAN with `devtools::release()`

After acceptance CRAN builds binary packages for each platform (may uncover further errors).

CRAN Package Check Results for Package pdSpecEst							
Flavor	Version	Tinstall	Tcheck	Ttotal	Status	Flags	
r-devel-linux-x86_64-debian-clang	1.1.1	100.13	54.14	154.27	OK		
r-devel-linux-x86_64-debian-gcc	1.1.1	110.41	51.16	161.56	OK		
r-devel-linux-x86_64-fedora-clang	1.1.1			320.77	OK		
r-devel-linux-x86_64-fedora-gcc	1.1.1			307.14	NOTE		
r-devel-windows-ix86+x86_64	1.1.1	429.00	119.00	548.00	OK		
r-patched-linux-x86_64	1.1.1	109.36	54.54	163.91	OK		
r-patched-solaris-x86	1.1.1			269.90	OK		
r-release-linux-x86_64	1.1.1	110.65	54.99	165.64	OK		
r-release-windows-ix86+x86_64	1.1.1	413.00	124.00	537.00	OK		
r-release-osx-x86_64	1.1.1				OK		
r-oldrel-windows-ix86+x86_64	1.1.1	305.00	107.00	412.00	OK		
r-oldrel-osx-x86_64	1.1.1				OK		

Shiny applications

Motivation

In addition to vignettes, it may be useful (not always) to interactively demonstrate the package functionalities with an R shiny application, e.g. <http://jchau.shinyapps.io/moviesdemo>

Host Shiny app online

- Publish Shiny app to public server (e.g. <http://shinyapps.io>) via the Deploy App button
- Deployed Shiny app can fetch R packages from CRAN or GitHub
- Include link in README.md or DESCRIPTION file

Include Shiny app in package

- add Imports: shiny to DESCRIPTION file
- Place Shiny app in inst/shiny-examples/myapp/ and add runapp.R to R/
- Run app from within R via moviesdemo::runMovieApp(). Excerpt from runapp.R:

```
runMovieApp <- function() {
  appDir <- system.file("shiny-examples", "myapp", package = "moviesdemo")
  if (appDir == ""){
    stop("Could not find example directory. Try re-installing `moviesdemo`.", call. = FALSE)
  }
  shiny::runApp(appDir, display.mode = "normal")
}
```

Useful resources

- R packages by Hadley Wickham: <http://r-pkgs.had.co.nz/intro.html>
- Official (and exhaustive) Writing R Extensions manual: <https://cran.r-project.org/doc/manuals/r-release/R-exts.html>
- RStudio Package development cheatsheet: <https://www.rstudio.com/wp-content/uploads/2015/06/devtools-cheatsheet.pdf>

Now it is your turn

Create an R-package from scratch

Using either your own R functions or the `moviesdemo` source files (.R and .rda)

- The package should contain:
 - a `DESCRIPTION` file
 - R scripts with Roxygen comments
 - exported or internal data in `.rda` format
- Roxygen comments should include at least one package dependency (`import`) and an executable example.
- Generate the documentation and update your `NAMESPACE`
- Check and build your package
- Extra steps: include vignettes, tests, generate the pdf manual, add a `README.Rmd`, ...

Instead you can also ask questions about your personal package