INWT Statistics

# INWT Statistics GmbH
# Writing R Packages

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# About me

- Data Scientist at INWT Statistics
- M. Sc. Statistics and Psychology
- R and Python
- Example Projects:
  - Customer segmentation (cluster analysis)
  - Callcenter forecast
  - Customer lifetime value
  - Planning surveys and analyzing the results
  - Trainings

# Survey

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- Who has ever become desparate understanding a function that someone else had written?
- Who has ever become desparate understanding a function that she had written herself?

# Agenda

# Why R packages?

Advantages:

- Functions or lists are accessible for the whole team
- Changes are administered centrally
- Clear documentation, accessible via F1, `?fun` or `help(fun)`
- Automated checks and customized tests ensure that problems are found early
- Faster than including functions via `source(myFunctions.R)`

And: Free online resource under `http://r-pkgs.had.co.nz/`

# Creating a package

First install some helpful packages:

```
install.packages(c("devtools", "roxygen2", "testthat", "knitr"))
```

Under Windows, install “rtools” (not an R package): https://cran.r-project.org/bin/windows/Rtools/

# Creating a package in a new project

```
devtools::create(path = "some/path/myPackageName")
```

The following directories and files are created in the subfolder “myPackageName”:

| Name | Änderungsdatum | Typ | Größe |
|---|---|---|---|
| R | 13.07.2018 13:05 | Dateiordner | |
| .gitignore | 13.07.2018 13:05 | Textdokument | 1 KB |
| .Rbuildignore | 13.07.2018 13:05 | RBUILDIGNORE-D... | 1 KB |
| DESCRIPTION | 13.07.2018 13:05 | Datei | 1 KB |
| myPackageName.Rproj | 13.07.2018 13:05 | R Project | 1 KB |
| NAMESPACE | 13.07.2018 13:05 | Datei | 1 KB |

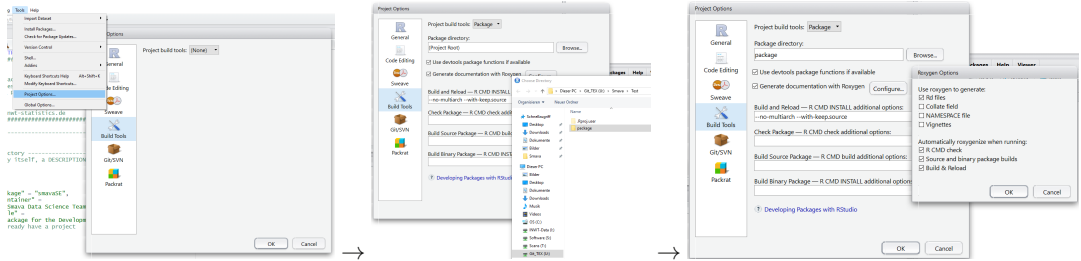
- Just open the R project and start working on your package.

# Creating a package in an existing project

When you are already in a project, you can create a package in two steps. First, run:

```
devtools::create(path = "package", rstudio = FALSE)
```

In addition, configure the build tools as mentioned before and change the package directory from "(Project Root)" to "package":



# Code (R/)

- Functions live in the folder `R/`
- No subdirectories possible

**Organizing your functions:**
one File with all Functions $\leftrightarrow$ **optimum** $\leftrightarrow$ one file per function

# Agenda

# DESCRIPTION stores important package metadata

Plain text, just use a text editor for changes:

```
Package: myPackageName
Title: What the Package Does (one line, title case)
Version: 0.0.0.9000
Authors@R: person("First", "Last", email = "first.last@example.com", role = c("aut", "cre"))
Description: What the package does (one paragraph).
Depends: R (>= 3.5.1)
Imports: ggplot2 (>= 3.0.0)
License: What license is it under?
```

# Author: who are you?

This `Authors@R:` field contains executable R code.

```
Authors@R: c(
    person("Mira Céline", "Klein", email = "mira.klein@inwt-statistics.de", role = "cre"),
    person("This could", "be you", email = "name@something.com", role = "aut")
    )
```

Roles:

- [`cre`] the creator or maintainer, the person you should bother if you have problems
- [`aut`] authors, those who have made significant contributions to the package
- [`ctb`] contributors, those who have made smaller contributions, like patches.
- [`cph`] copyright holder. This is used if the copyright is held by someone other than the author, typically a company

# Documentation (man/)

**Documentation is one of the most important aspects of a good package.**
A good documentation helps others and ***the future you*** to use the functions in the right way.

- Folder man/ will contain documentation files
- Files are created automatically with the `roxygen2` package
- One file per function is created: myFun.Rd
- You won't access the .Rd files directly

# Roxygen comments

```
#' @title Say hello
#' @description This function says hello in a nice way.
#' @param who character: name of person you want to greet
#' @examples greet("Sarah")
greet <- function(who) {
  paste("Hello", who)
}
```

# Create .Rd files

Create documentation by one of

- Type: `devtools::document()`
- Click: Build → More → Document
- Press: Ctrl + Shift + D

**Result:** .Rd files are created in directory `/man`
Access documentation via

- `?myFun` or
- RStudio: Putting cursor on function name in code and pressing F1

Text formatting reference sheet: `http://r-pkgs.had.co.nz/man.html#text-formatting`

# The documentation workflow

1. Add roxygen comments to your `.R` files
2. Create documentation semi-automatically
3. Access and Check Documentation
4. Repeat until the documentation looks the way you want

# Agenda

# NAMESPACE: Motivation

- There can be multiple functions with the same name from different packages.
- **Namespaces** tell R where to look for an object with a given name.
- You also control which functions your package provides.

- Imports and exports are controlled via the **NAMESPACE** file
- Don't write the NAMESPACE file by hand
- Use `roxygen2` instead.

# Create NAMESPACE entries with `roxygen2`

Add additional lines to your `roxygen` documentation block:

**Imports:**

- `#' @importFrom ggplot2 ggplot geom_histogram aes`
  (import specific function from a package)
- `#' @import ggplot2`
  (import the whole package)
- Don't forget to add required packages to the DESCRIPTION file

**Exports:**

- `#' @export` to export the function
- without `#' @export`, the function is invisible outside the package enviroment

# Clarification on imports

- Roxygen comments (`@importFrom packagename fun1 fun2 ...`) control which functions from which packages are ***used***
- DESCRIPTION file: Imports in the DESCRIPTION file control which packages need to be ***installed*** to use this package

# Agenda

# R CMD CHECK: Automated Checking

**R CMD CHECK**: important part of the package development process
It checks . . .

- automatically
- your code
- for common problems.

Run R CMD check via

- Clicking on the “Check” button in the Build-Pane of Rstudio or
- Pressing Ctrl + Shift + E

# R CMD CHECK: Automated Checking

What are **common problems**?

- Are there objects in the functions that where neither defined nor passed to the function?
- Are there any problematic characters?
- Is the documentation complete?
- Is the namespace properly defined?
- Are all required packages (Imports) installed on your PC?
- Further potential problems in the code, e.g., `library()` statements
- ...

# R CMD check: Problems

Three possible types of problems:

- `ERROR`s: Severe problems you have to fix. No discussion!
- `WARNING`s: Problems that don't stop your package from working. But you have to fix them anyhow in most cases!
- `NOTE`s: Smaller problems probably irrelevant for internal use. Check and fix them anyhow - broken window theory!

# Why tests?

**Tests**. . .

- ensure that your functions do what they should do
- survive changes without being broken

# Test Workflow

To set your package to use test (via the `testthat` package), run `devtools::use_testthat()`
This will...

- ...create a `tests/testthat` directory
- ...add `testthat` to the `Suggests` field in DESCRIPTION
- ...create a file `test/testthat.R` that runs all your tests via `R CMD check`

File structure:

- Tests live in files that live in `tests/testthat`
- Test files must **start with** `test_`

# Test Hierarchy

Test are organized hierarchically:

- ***Test file***, e.g. "test_mean.R"
- ***tests***, e.g. to test how `mean()` deals with `NA` values
  - ***expectations*** test whether the result looks as expected

The `testthat` package contains almost 20 expectations.

**expectations**...

- ... start with `expect_`
- ... have two arguments: actual result and expectation
- ... throw an error if actual result and expectation differ

# Examples

```r
context("Greeting functions")

test_that("Greetings return correct text", {
  expect_equal(object = hello(who = "you"),
               expected = "Hello you!")
})

test_that("Greetings returns correct type", {
  expect_is(hello(who = "all"), "character")
})
```

# When should you write tests?

- Before writing the function (“test-driven development”)
- While writing the function (“playing around” in the console)
- Each time you fix a bug
- Each time you add a functionality

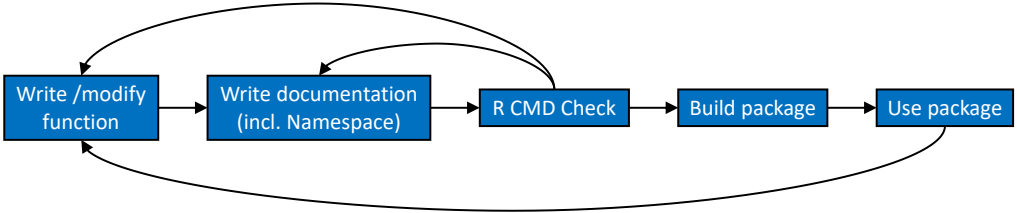
# Agenda

# Sharing a package

When your package is finished, you can share it in one single file:

- For Windows: “Build” → “More” → “Build **Binary** Package”
- For Linux: “Build” → “More” → “Build **Source** Package”

# Recap: Package delevopment workflow



# There is even more!

- High-level documentation with vignettes
- Include data in packages
- Write code in C++ to make it faster
- Publish packages on GitHub or CRAN
- ...

# Agenda

# How to write functions

- One function does one thing
  ***Example:*** split plotting and data preparation into (at least) two functions
- It's okay to use the function only once if it enhances readability and testability ***Example:*** `keepOnlyValidAnswers()` instead of 20 lines of code
- Split your code into meaningful units with respect to ***content***, not existing code chunks
- Order of the functions in a file: from general to specific

# Agenda

# Hands-on

This is your chance to try around with R packages and ask me if you have any problem!
For example:

- Create a new package
- Create a simple function in the package and build the package
- Write a documentation for the function
- Run the R CMD check
- Write a simple test
- Make mistakes on purpose and see how the check reacts
- ...

Or just have a drink, chat and relax :)

INWT Statistics

*Thanks for your attention!*

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