Unit tests

DEVELOPING R PACKAGES

Jasmin Ludolf
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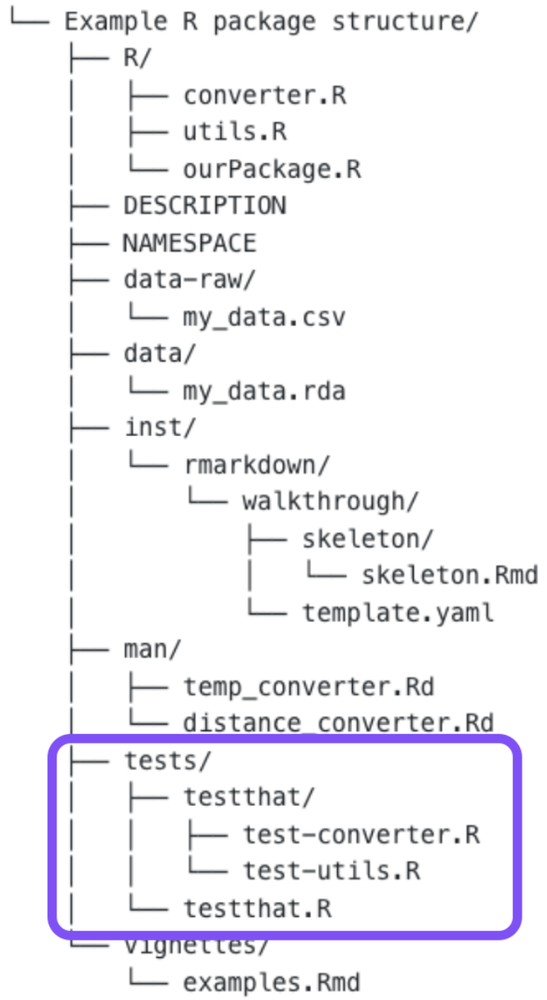
R package structure



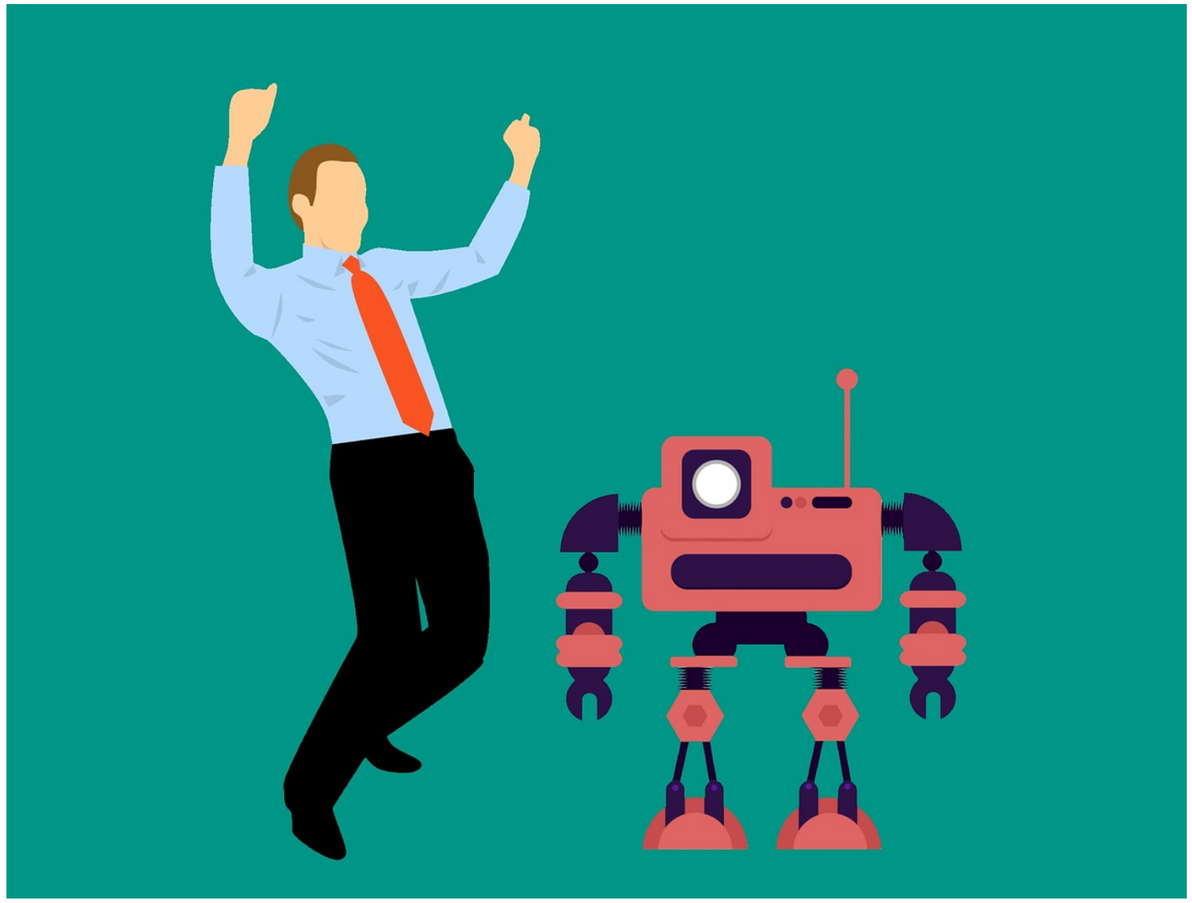
Tests

Testing your code works

- Documentation helps our users
- And helps the package author with development and maintenance
- Manually checking functions can be difficult

What are unit tests?

- Automated and run all at once
- Verify functionality of package units
- Ensure expected behavior and correct output
- Catch bugs early
- Support clean and testable code, supporting collaboration



Structuring unit testing in R

- Testing framework with `usethis` + `testthat`

```
library(usethis)
use_testthat()
```

- `testthat` package: simple and intuitive syntax for writing unit tests

`use_testthat()` output :

```
✔ Adding 'testthat' to Suggests field in DESCRIPTION
✔ Adding '3' to Config/testthat/edition
✔ Creating 'tests/testthat/'
✔ Writing 'tests/testthat.R'
● Call `use_test()` to initialize a basic test file and open it for editing.
```

Creating test template files

- Match names of `.R` files in `R` directory to names in `tests/testthat`
  - `R/temp_converter.R`
  - `R/time_converter.R`
- Corresponding files in `tests/testthat`
  - `tests/testthat/test-temp_converter.R`
  - `tests/testthat/test-time_converter.R`

A function for creating these files

```
use_test(name = "temp_converter")
use_test(name = "time_converter")
```

✔ Writing 'tests/testthat/test-temp_converter.R'
● Modify 'tests/testthat/test-temp_converter.R'

✔ Writing 'tests/testthat/test-time_converter.R'
● Modify 'tests/testthat/test-time_converter.R'

Let's practice!

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Exploring expect statements

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Most common expect statements

- Expect statements validate R functions, or units

In `testthat` package:

- `expect_equal()` : equality with small tolerance allowed
- `expect_identical()` : exact equality
- `expect_output()` : matching text from `object` call

- `expect_error()` : error from `object` call
  - Errors stop code execution; warnings don't
- `expect_warning()` : warning produced by `object` call

From example to unit test

```
#' @examples
#' # Convert 32F to C
#' temp_converter(32, "Fahrenheit", "Celsius")
```

```
[1] 0
```

In the `tests/testthat/test-temp_converter.R` file:

```
library(testthat)
expect_equal(
  object = temp_converter(32, "Fahrenheit", "Celsius"),
  expected = 0
)
```

Expecting identical and expecting equal

`expect_identical()`

```
expect_identical(sqrt(3) ^ 2, 3)
```

```
Error: sqrt(3)^2 (`actual`) not
identical to 3 (`expected`).

  `actual`: 2.9999999999999996
`expected`: 3.0000000000000000
```

`expect_equal()`

- Use `expect_equal()` when comparing numeric values

```
expect_equal(sqrt(3) ^ 2, 3)
```

- `expect_equal()`
  - Allows for small differences
  - Has a `tolerance` argument, default usually good

Expecting output

```
expect_output(
    print("Testing R Packages is fun"),
   "funk"
)
```

```
Error: `print\("Testing R Packages is
fun"\)` does not match "funk".
Actual value: "\[1\] "Testing R
Packages is fun""
```

OUTPUT

Expecting warning

```
expect_warning(
  temp_converter(-40,
                 "Celsius",
                 "Celsius")
)
```

Expecting error

```
expect_error(
  temp_converter(300,
                 "Kelvin",
                 "Fahrenheit")
)
```

Recap

- Each expectation should test an aspect of a function
- When combined together, 100% of function aspects should be covered by unit tests

Let's practice!

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Storing expectations as unit tests and running tests

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Workflow

1. Create examples to show how our function works
2. Write expectations to check function behavior
3. Group expectations that test common aspect into a unit test
4. Run all unit tests in a file
5. Run all unit tests throughout a package

Grouping similar function expectations together

```
expect_equal(temp_converter(32, "Fahrenheit", "Celsius"), 0)
expect_warning(temp_converter(-40, "Celsius", "Celsius"))
expect_error(temp_converter(300, "Kelvin", "Fahrenheit"))
```

```
library(testthat)
test_that("Conversion from F to C and C to F works", {
  expect_equal(temp_converter(32, "Fahrenheit", "Celsius"), 0)
  expect_warning(temp_converter(-40, "Celsius", "Celsius"))
  expect_error(temp_converter(300, "Kelvin", "Fahrenheit"))
})
```

```
Test passed 🎉
```

What if tests failed?

```
library(testthat)
test_that("Conversion from F to C and C to F works", {
      expect_equal(temp_converter(32,  "Fahrenheit", "Celsius")), 1)
      expect_warning(temp_converter(-40), "Celsius", "Fahrenheit")
      expect_error(temp_converter(25))
})
```

```
X Conversion from F to C and C to F works
-- 1. Error: `temp_converter(32,  "Fahrenheit", "Celsius")` not equal to 1
(@test_conversion.R:2)
--
-- 2. Error: `temp_converter(-40)` did not throw the expected warning.
(@test_conversion.R:3)
--
temp_converter(25) did not throw an error.
```

Running all tests in a file

- To run all of the tests in a file, use `test_file()`

```
library(testthat)
test_file("test-temp_conversion.R")
```

```
Conversion from F to C and C to F works
```

Run tests on the examples

```
#' @examples
#' # Convert 25 degrees Celsius to Fahrenheit
#' temp_converter(25, unit_from = "Celsius", unit_to = "Fahrenheit")
#' # Convert 100 degrees Fahrenheit to Celsius
#' temp_converter(100, unit_from = "Fahrenheit", unit_to = "Celsius")
```

- `roxygenize()` generates a help file for `temp_converter` in `man` directory

```
test_example("man/temp_converter.Rd")
```

Test passed 🎉

You gotta run 'em all!

- Use `test_file()` if you want to focus on a particular file
- Don't have to run `test_file()` on each testing file each time
- Can instead run `test_package()` to run them all!

```
test_package("unitConverter")
```

Let's practice!

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Final steps

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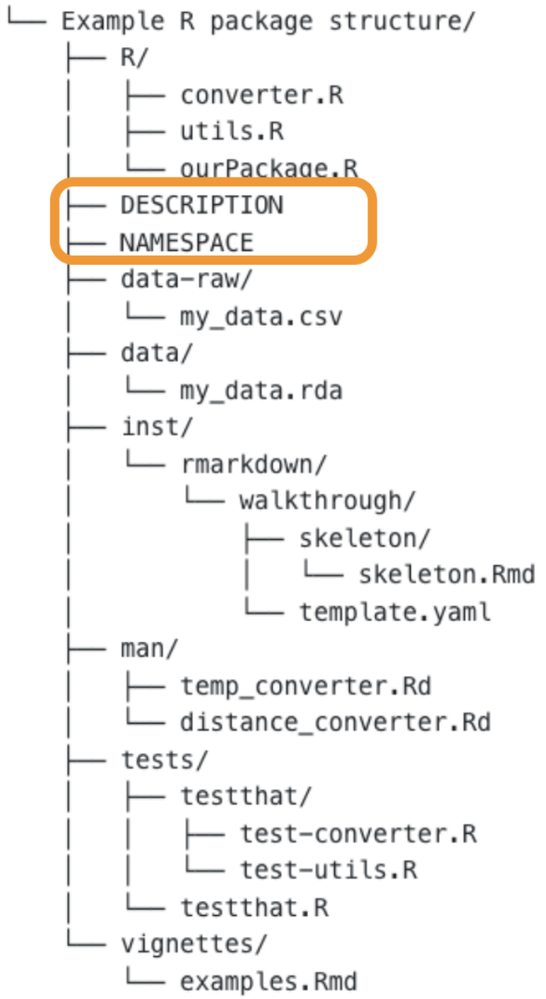
Supporting Files



Package versions

Example: `tidyr` `1.3.0`

- Format: `<major>.<minor>.<patch>.<dev>`
- Default: `0.0.0.9000`
- `9000` : package in development

Package version incrementing guidelines

Format: `<major>.<minor>.<patch>.<dev>`

- `dev` : rarely changed, remove for release
- `patch` : changed for bug fixes
  - More bugs before functionality change
- `minor` : small additional functionality added to package before initial release
  - `patch` number reset to `0`
- `major` : package considered stable to release
  - From `1.5.3` to `2.0.0` : old code could break

- Not in development: `0.0.0.9000` -> `0.0.0`
- One bug fixed: `0.0.1`
- One more bug fixed: `0.0.2`
- Additional functionality: `0.1.0`

- Stable for release: `1.0.0`
- Big changes: `2.0.0`

Update title, author, version, and description

```
Package: unitConverter
Title: What the Package Does (One Line, Title Case)
Version: 0.0.0.9000
Authors@R:
    person("First", "Last", ,
           "first.last@example.com",
           role = c("aut", "cre"),
           comment = c(ORCID = "YOUR-ORCID-ID"))
Description: What the package does (one paragraph).
```

```
Package: unitConverter
Title: Unit Conversion Utilities for Distance,
    Time, Weight, and Temperature
Version: 0.1.0
Authors@R:
    person("Jasmin", "Ludolf", ,
           "myemail@example.com",
           role = c("aut", "cre"))
Description: The `unitConverter` package provides
    a collection of utility functions for
    converting distance, time, weight, and
    temperature values. It offers seamless
    conversion between various units within each
    category, allowing users to easily transform
    measurement data.
```

Documenting a data file

```
use_r("temperature_data")
```

Edit `R/temperature_data.R`:

```
#' Temperature values and units
#'
#' Temperature values and corresponding unit (Celsius, Fahrenheit, or Kelvin)
#' @format Data frame with two columns and 1000 rows
#' \describe{
#' \item{value}{Numeric temperature value.}
#' \item{unit}{Temperature unit.}
#' }
#' @examples
#'   temperature_data
"temperature_data"
```

```
roxygenize()
```

What does devtools::check() look for?

`devtools::check()`

- Can the package be installed
- `DESCRIPTION` information is correct
- Package dependencies
- Syntax errors in code
- Complete documentation
- Successful tests running
- Successful vignettes building

Running devtools::check()

Let's practice!

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Congratulations!

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Chapter 1 review

- R package structure: directories, `DESCRIPTION`, `NAMESPACE`
  - `usethis::create_package()`
- Including data in the package
  - `usethis::use_data()`
- Writing R functions for package development
  - `dump()`
- Installing and testing the package locally
  - `devtools::install()`

Chapter 2 review

- Compare packages vs. scripts
- Choose informative package name
- Check package name availability on CRAN
  - `available::available()`
- Explore different license options
  - `usethis::use_mit_license()`
- Load package components and check packages
  - `devtools::load_all()` and `devtools::check()`

Chapter 3 review

- Help file components and exported functions
- Importance of examples in documentation
- Creating function examples with `roxygen2`
  - `roxygen2::roxygenize()`
- Understanding purpose of vignettes
- Browsing and assessing vignettes
  - `browseVignettes()`
- Designing and building vignettes
  - `usethis::use_vignette()` and `devtools::build_vignettes()`

Chapter 4 review

- Recognizing and creating unit tests
  - `usethis::use_testthat()` and `usethis::use_test()`
- Exploring expect statements for testing
  - `testthat::expect_equal()` and `testthat::expect_error()`
- Organizing and running unit tests
  - `testthat::test_that()`
- Updating package metadata and documentation
- Discussing package versioning
- Running a package check
  - `devtools::check()`

Next steps

- Sharing your package online/with others
- Using `devtools::release()` for package release to CRAN
- Implementing continuous integration for your package

Hooray!

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