Fundamentals of Package Development

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Department of Fisheries and Oceans
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Welcome!

- Instructors:
  - Andy Teucher
    - andyteucher.ca
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    - Mastodon: @andyteucher@fosstodon.org
  - Sam Albers
    - samalbers.science
    - GitHub: boshek

Welcome!

- This is a three part course for people looking to learn how to build R packages in an efficient way, make them easy to maintain, and easy for users to use.
- Code of Conduct:
  - https://github.com/ateucher/pkg-dev-psc-2024-04-29/blob/main/CODE_OF_CONDUCT.md
  - 💙 Treat everyone with respect
  - 🧡 Everyone should feel welcome

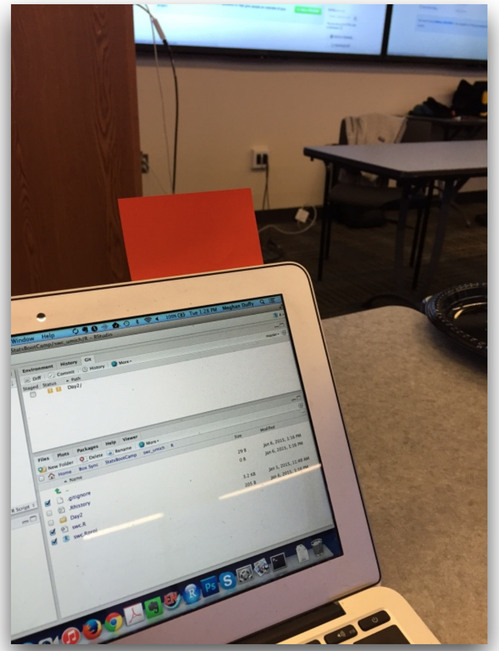
Sticky Notes

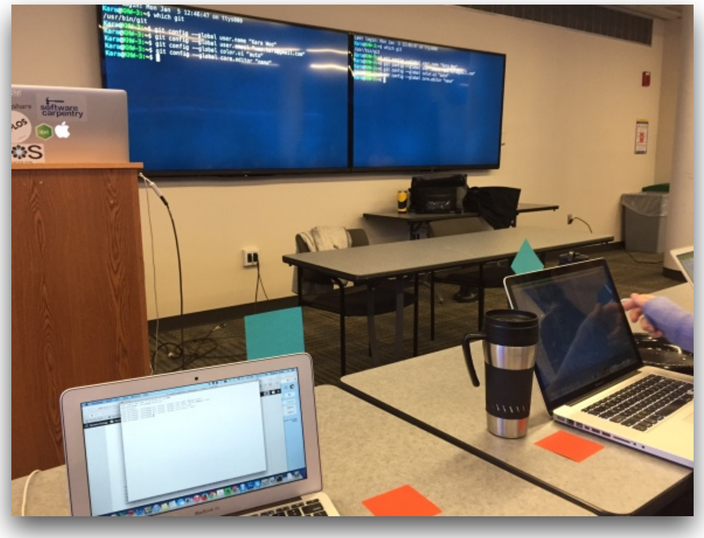
PINK

I'm stuck, please send help

GREEN

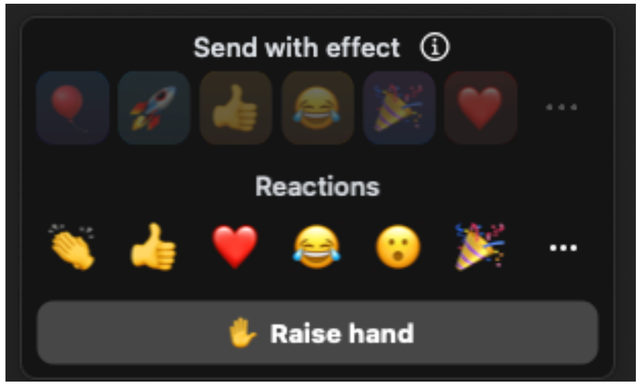
I'm good, let's move on

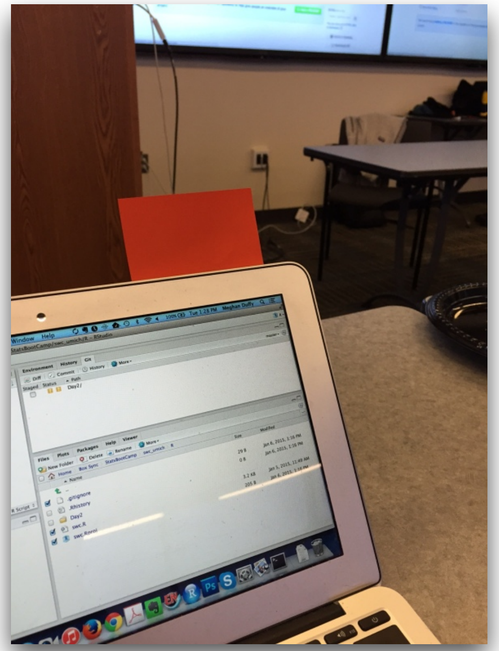


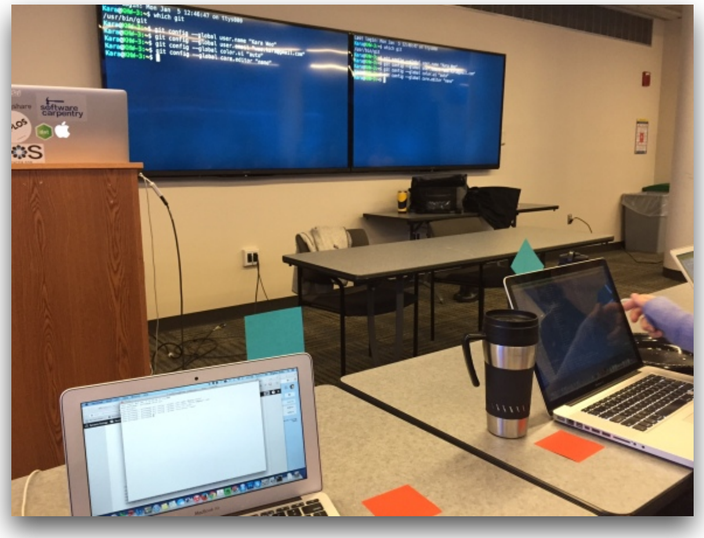


Sticky Notes

I’m stuck, please send help







I’m good, let’s move on

Discussions / Q & A

- Zoom Chat
- GitHub Discussions:

  https://github.com/ateucher/pkg-dev-dfo-2024-11/discussions

- Open the welcome discussion:
  - Introduce yourself:
    - Office/department, city/town
    - Why you're here
    - Share something you're good at

Resources

- Prework:

  https://andyteucher.ca/pkg-dev-dfo-2024-11/setup.html
- Workshop website:

  https://andyteucher.ca/pkg-dev-dfo-2024-11/
- Cheatsheet:

  https://rstudio.github.io/cheatsheets/html/package-development.html

Day 1: Schedule and Learning Objectives

08:00 - 09:20	What is a Package? Package Structure and State	80 min
09:20 - 09:35	Break	15 min
09:35 - 10:55	Package Creation and Metadata	80 min
10:55 - 11:10	Break	15 min
11:10 - 12:30	Documentation	80 min

Day 2: Schedule and Learning Objectives

08:00 - 09:20	Testing & Dependencies	80 min
09:20 - 09:35	Break	15 min
09:35 - 10:55	Continuous Integration & Design Principles	80 min
10:55 - 11:10	Break	15 min
11:10 - 12:30	Design Principles cont'd & Website Creation	80 min

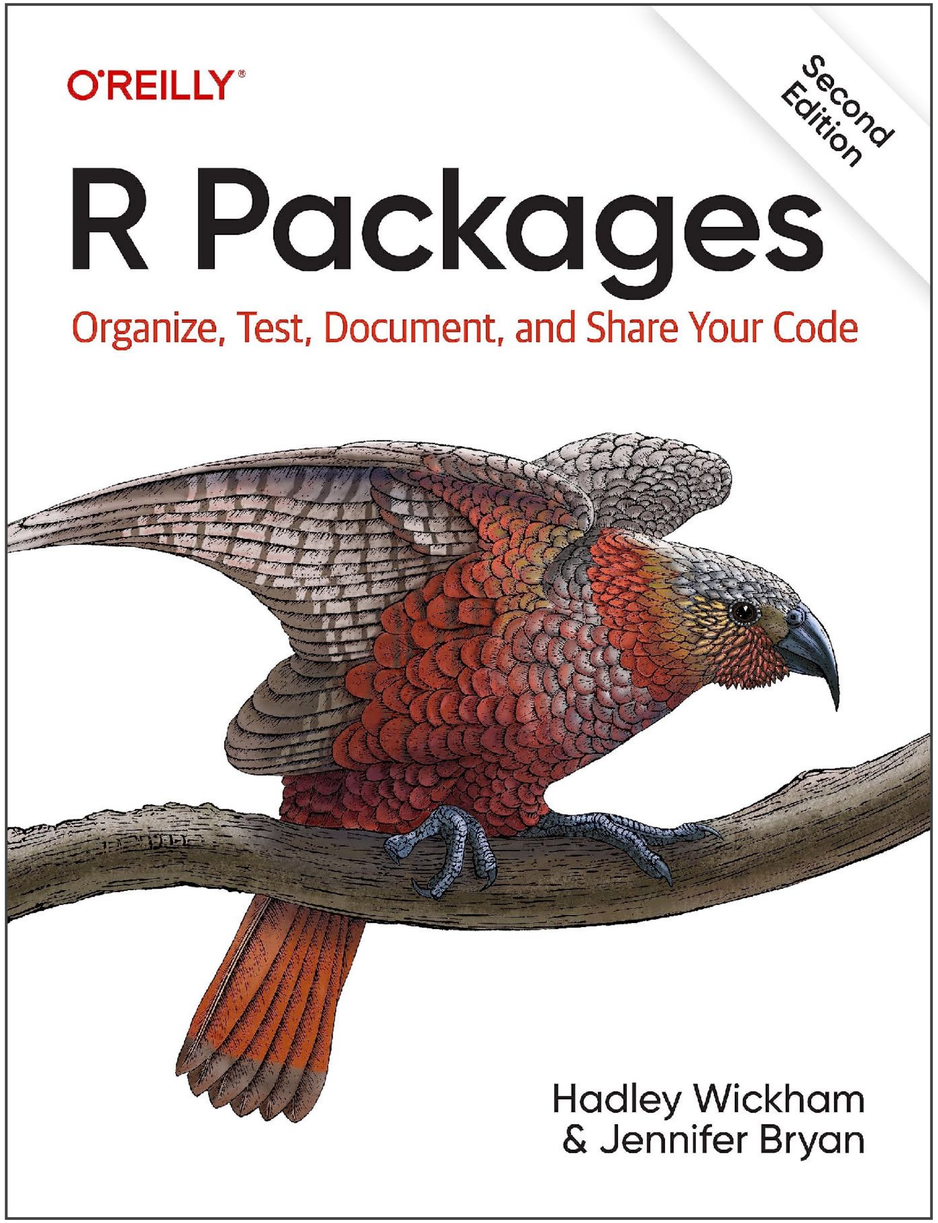
Day 3: Schedule and Learning Objectives

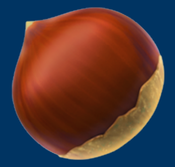
08:00 - 09:20	Using the Tidyverse in Your Package	80 min
09:20 - 09:35	Break	15 min
09:35 - 10:55	Communicating with your Users	80 min
10:55 - 11:10	Break	15 min
11:10 - 12:30	Distribution & General Package Discussion	80 min

R Packages (2e)

Hadley Wickham
Jenny Bryan

https://r-pkgs.org



Packages in a nutshell 

Have you ever worked on a package before?

What do you feel the most confused or curious about?

Why make a package?

- Easier to reuse functions you write
- A consistent framework which encourages you to better organize, document, and test your code
- This framework means you can use many standardized tools
- Easiest way to distribute code (and data)
  - To your team
  - To the world

Script vs Package

https://r-pkgs.org/package-within.html

Script

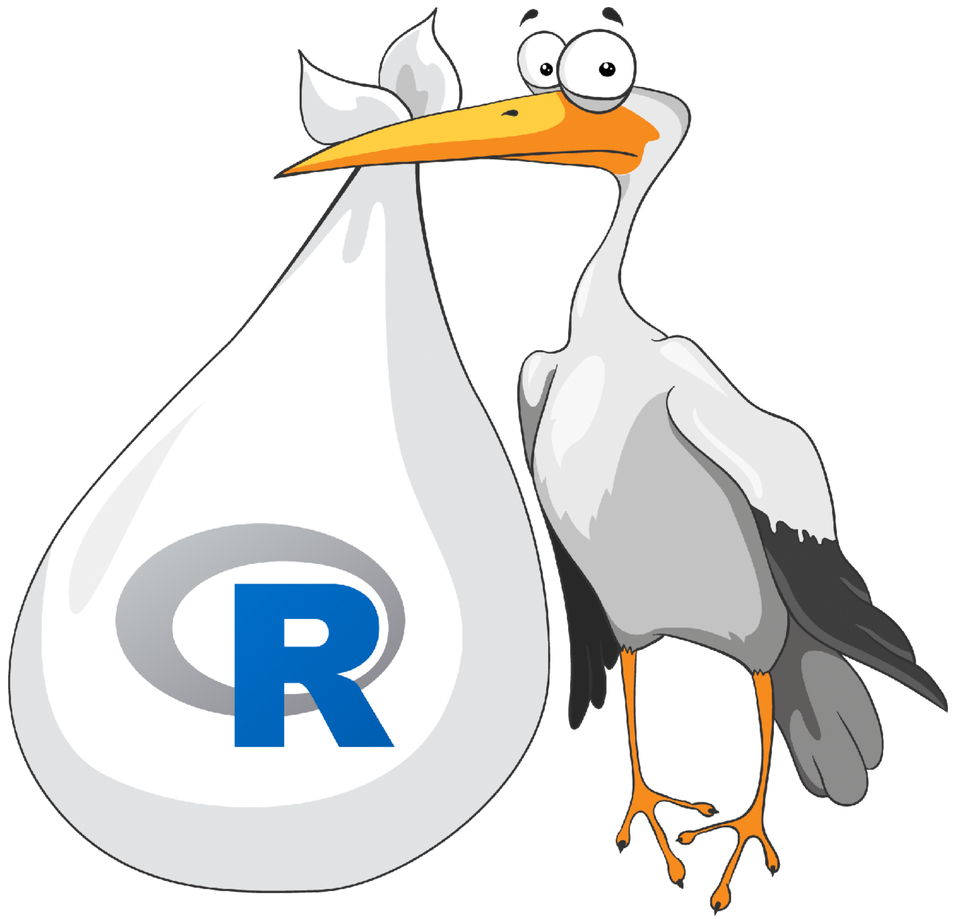
- Performs data analysis
- Collection of one or more .R files
- library() calls
- Documentation in # comments
- Run with source() or select+run

Package

- Reusable functions to use in analyses
- Defined by particular file organization
- Required packages in DESCRIPTION
- Documentation in Roxygen comments and “man” files
- Functions available when package attached

Where do packages come from?

- Discuss with your neighbour and put up a green sticky when you have:
  - Your favourite package
  - 2 **places** from which you install packages
  - 2 **functions** you can use to install packages
- Write them in the Chat



R Libraries - where do packages live?

- A **library** is a directory containing installed **packages**
- You have at least one library on your computer
- Common (and recommended) to have two libraries:
    1. A **system** library with **base** (14) and **recommended** (15) packages; installed with R.
    2. A **user** library with user-installed packages
- We use library(pkg) function to **attach** a package
- 7 base packages are always attached (base, methods, utils, stats, grDevices, datasets, graphics)

Your turn

Type .libPaths() to see your libraries

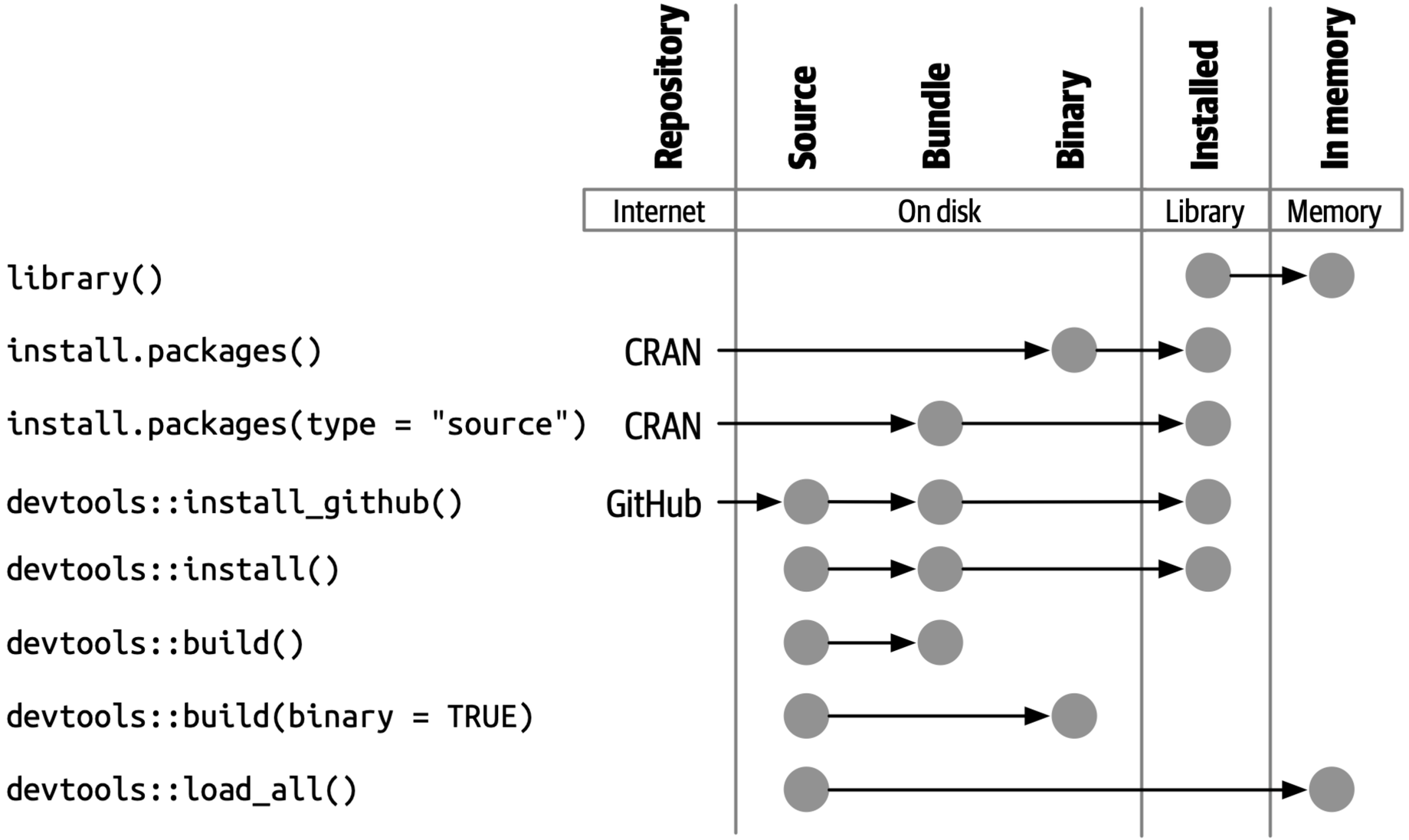
- How many libraries do you have?
- What are they? (Put them in the Chat)

Package Structure and State

Five forms

Source	• Directory of files with specific structure • What you interact with as you build a package
Bundle	• Package compressed into a single file (tar.gz) via devtools::build() -> R CMD build • Vignettes are built and files listed in .Rbuildignore are left behind
Binary	• Platform-specific compressed file (.tgz, .zip) • Made with devtools::build(binary = TRUE) -> R CMD INSTALL --build
Installed	• Binary package decompressed into a user's library • install.packages()
In Memory	• Loaded and ready for use in an R session • library()

Package Structure and State



Wickham, Hadley, and Jennifer Bryan. 2023. R Packages. 2nd ed.

Let’s make a package together

We will:

- Create a simple package
- Use git to track our changes
- Push the code to a repository on GitHub
- Create tests for our functions
- Create documentation for our functions
- Create a package website
- Focus on workflows

We (probably) won’t:

- Talk (much) about function writing
- Talk about how to include data in your package (even though it’s possible and often helpful)

libminer

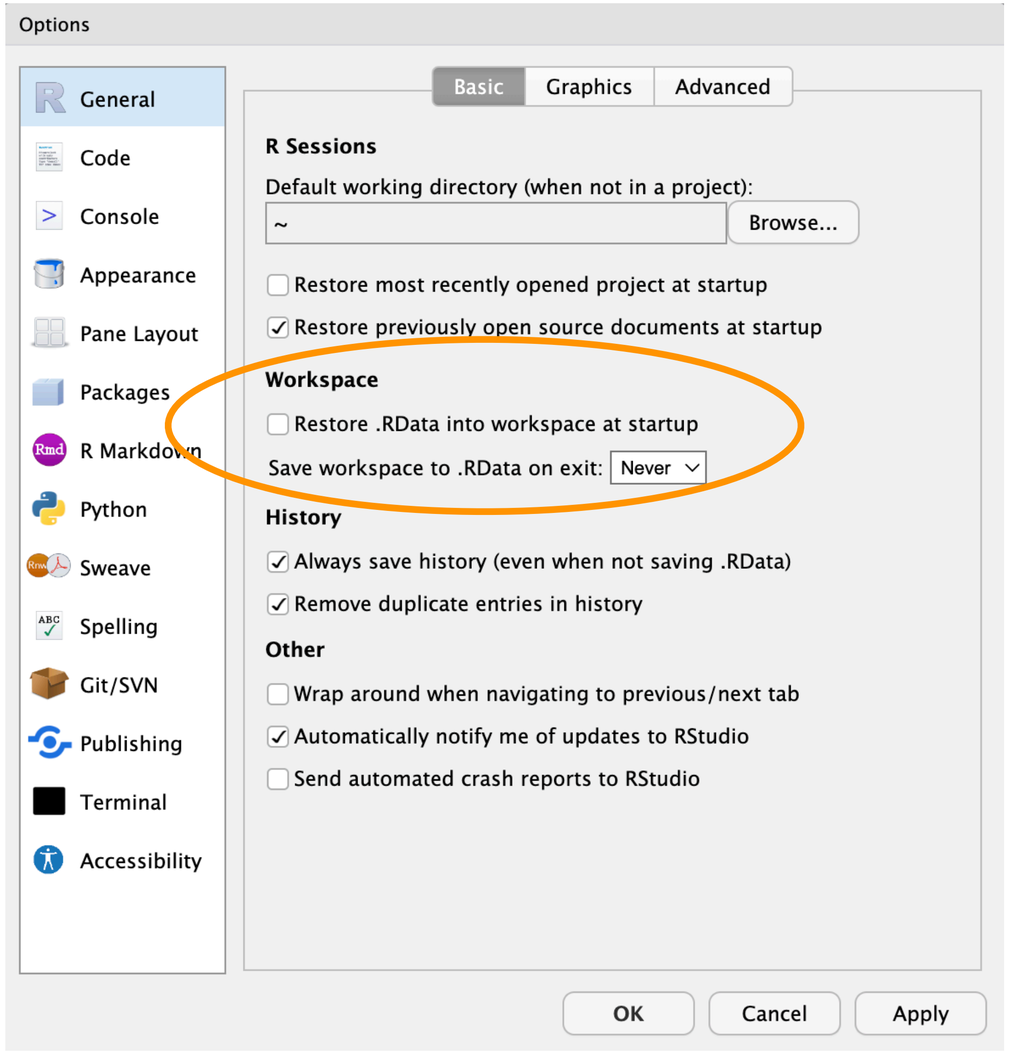
Sneak peak of our end goal on GitHub

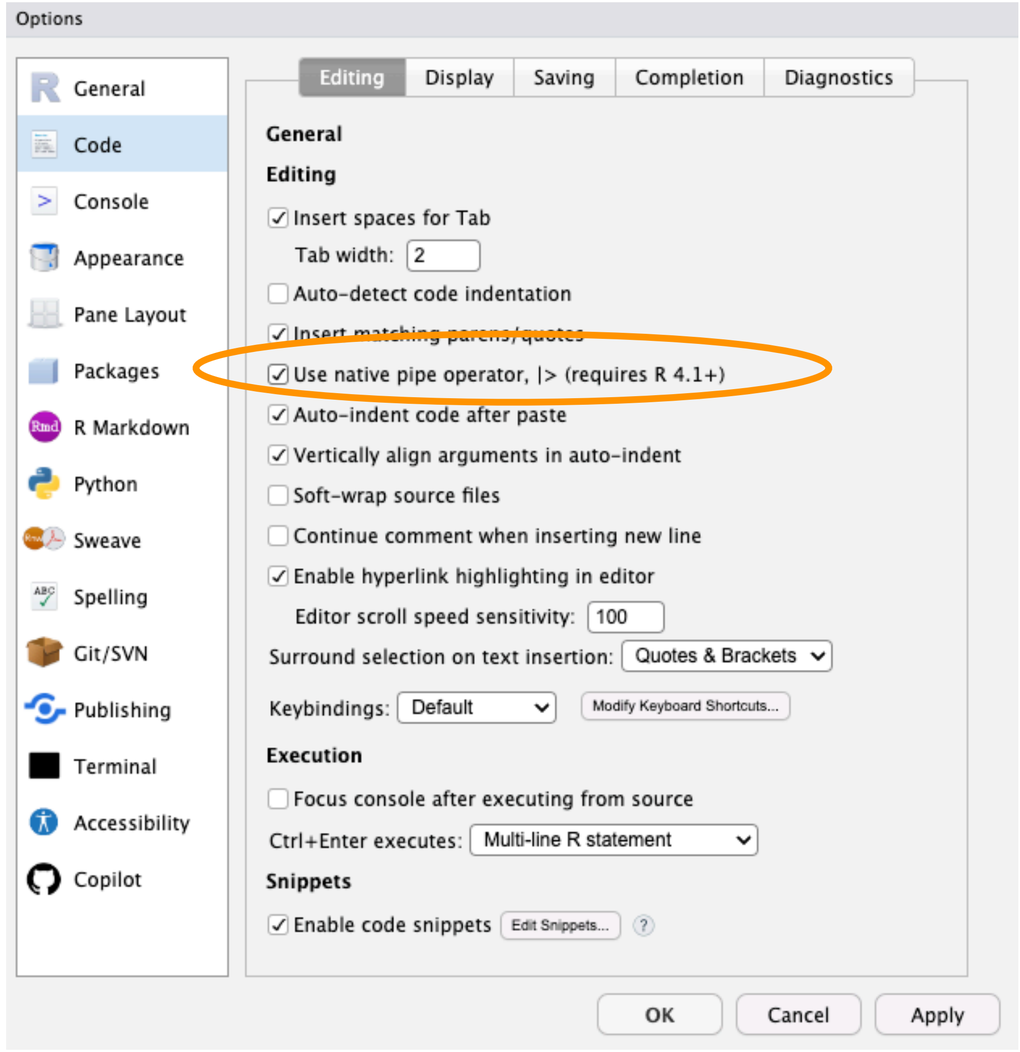
- https://github.com/ateucher/libminer.final
- A package to explore our local R package libraries

Get Ready

Configure RStudio

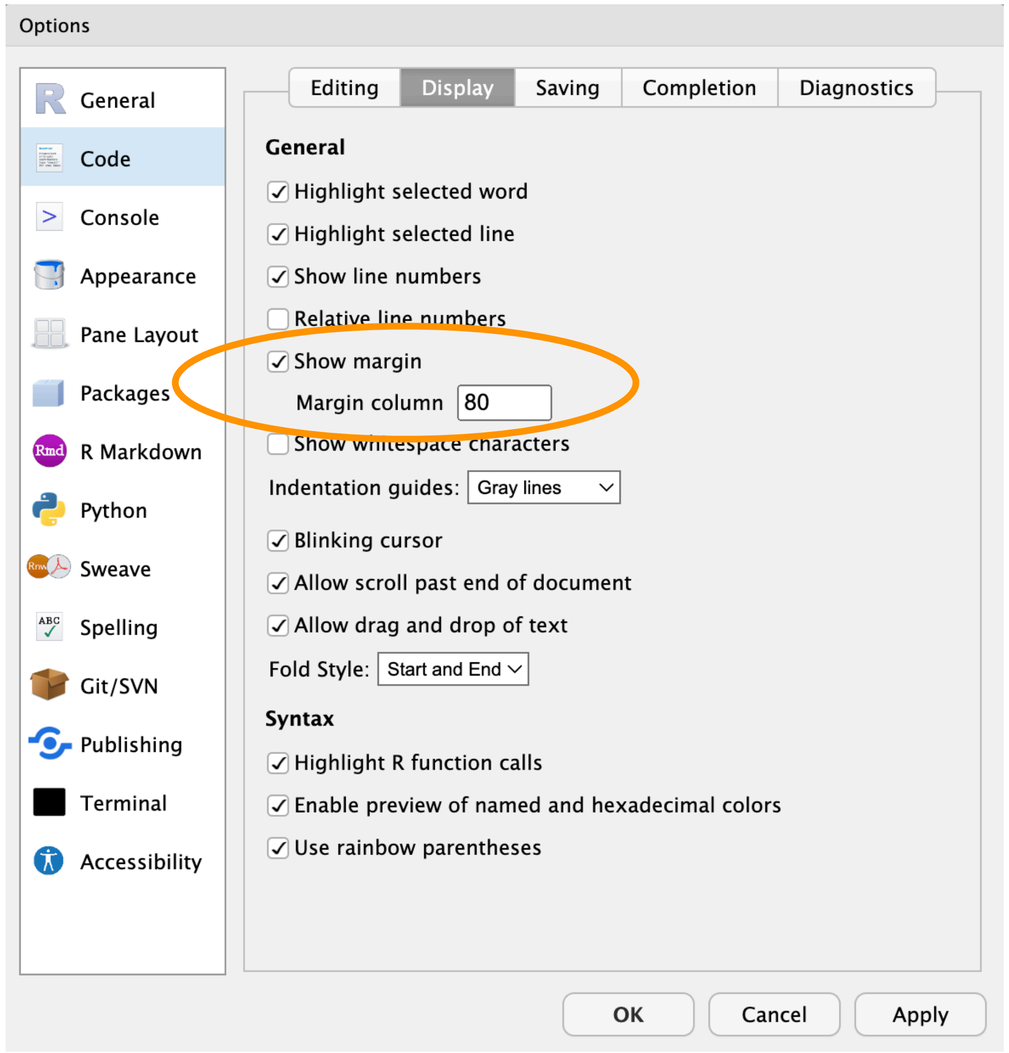
Tools > Global Options

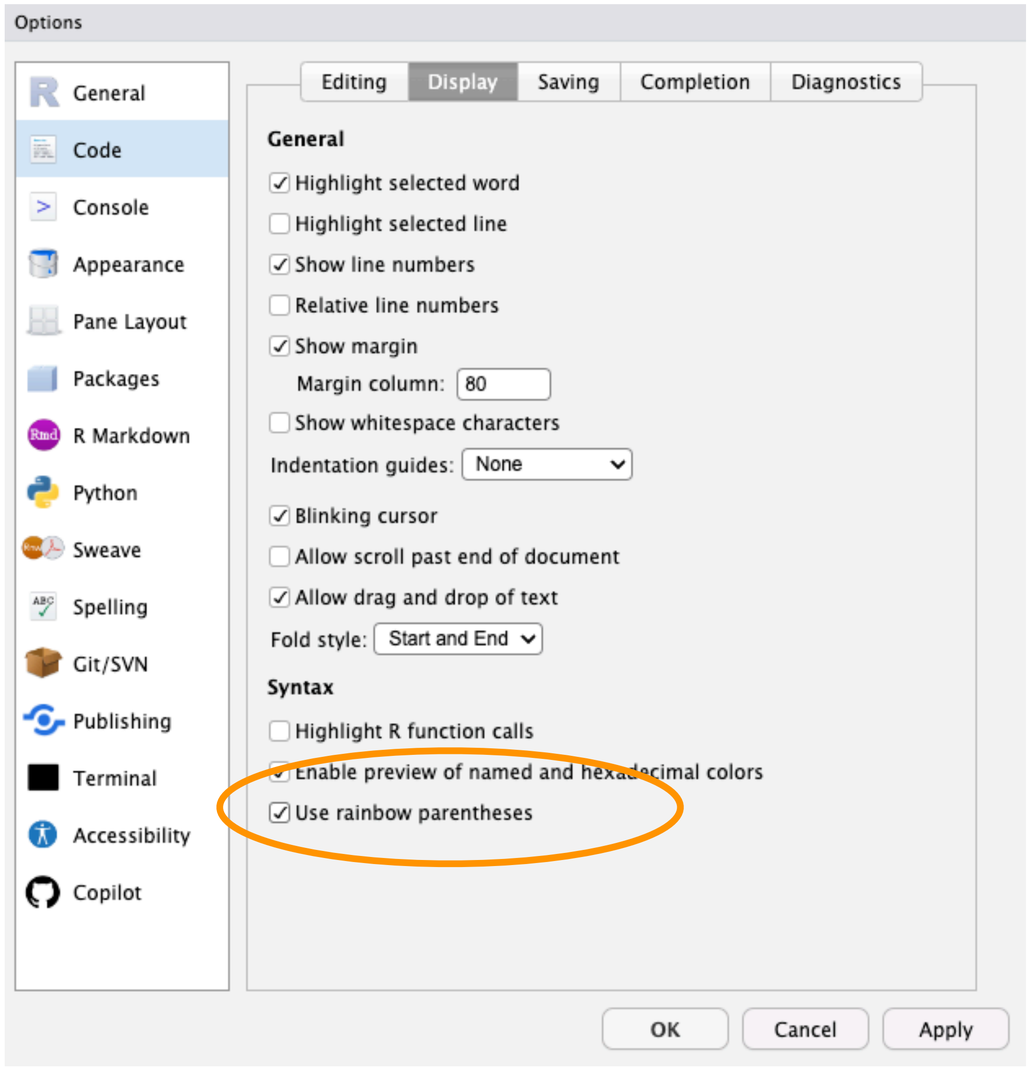




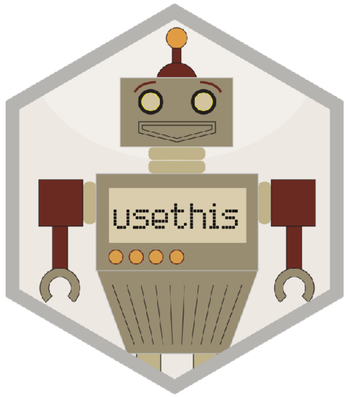
Configure RStudio

Tools > Global Options





Tools 🧰



- R >= 4.3.0
- RStudio (https://posit.co/download/rstudio-desktop/)
- Packages:

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

Check your setup

```
library(devtools)
# package development "situation report"
dev_sitrep()
# git/github "situation report"
git_sitrep()
```

Your Turn

Break Time!

Create a package

Load devtools 📦

```
library(devtools)
#> Loading required package: usethis

packageVersion("devtools")
#> [1] '2.4.5'
```

- Update if necessary!
- Provides a suite of functions to aid package development
- Loads **usethis**, the source of most functions we will be using

create_package() 

```
create_package("~/Desktop/mypackage")

├── .Rbuildignore
├── .Rproj.user
├── .gitignore
├── DESCRIPTION
├── NAMESPACE
├── R
└── mypackage.Rproj
```

- Creates directory
  - Final part of path will be the package name
- Sets up basic package skeleton
- Opens a new RStudio project
- Activates "build" pane in RStudio

create_package() 

```
create_package("~/Desktop/mypackage")
#> ✔ Creating '/Users/jane/Desktop/mypackage/'
#> ✔ Setting active project to '/Users/jane/Desktop/mypackage'
#> ✔ Creating 'R/'
#> ✔ Writing 'DESCRIPTION'
#> Package: mypackage
#> Title: What the Package Does (One Line, Title Case)
#> Version: 0.0.0.9000
#> Authors@R (parsed):
#>     * First Last <first.last@example.com> [aut, cre] (YOUR-ORCID-ID)
#> Description: What the package does (one paragraph).
#> License: `use_mit_license()`, `use_gpl3_license()` or friends to pick a license
#> Encoding: UTF-8
#> Roxygen: list(markdown = TRUE)
#> RoxygenNote: 7.2.3
#> ✔ Writing 'NAMESPACE'
#> ✔ Writing 'mypackage.Rproj'
#> ✔ Adding '^mypackage\\.Rproj$' to '.Rbuildignore'
#> ✔ Adding '.Rproj.user' to '.gitignore'
#> ✔ Adding '^\\.Rproj\\.user$' to '.Rbuildignore'
#> ✔ Setting active project to '<no active project>'
```

Your Turn

use_git()

- `use_git_config(`
  `user.name = "Jane Doe",`
  `user.email = "jane@example.org"`
  `)`
- `use_git()`
- Turns package directory into a git repository
- Commits your files (with a prompt)
- Restarts RStudio (with a prompt)
  - Activates "git" pane in RStudio

```
use_git()

#> ✔ Setting active project to
#>      '/Users/Jane/rrr/mypackage'
#> ✔ Adding '.Rhistory', '.Rdata',
#>     '.httr-oauth', '.DS_Store',
#>     '.quarto' to '.gitignore'
#> There are 5 uncommitted files:
#> * '.gitignore'
#> * '.Rbuildignore'
#> * 'DESCRIPTION'
#> * 'metrify.Rproj'
#> * 'NAMESPACE'
#> Is it ok
#>
#> 1: Absc
#> 2: Not
#> 3: Yeah
```

Your Turn

usethis::use_devtools()

Automatically load devtools when R starts

- Opens .Rprofile file
- Copies code to your clipboard
- Paste into .Rprofile
- Restart R

```
if (interactive()) {
  # Load package dev packages:
  suppressMessages(require("devtools"))
}
```

⌨ Ctrl+Shift+F10 (Windows &

Your Turn

use_r()

Write your first function

- R code goes in R/
- Name the file after the function it defines

```
use_r("my-fun")

#> ✔ Setting active project to '/Users/jane/rrr/mypackage'
#> • Edit 'R/my-fun.R'
```

Try your function in the new package

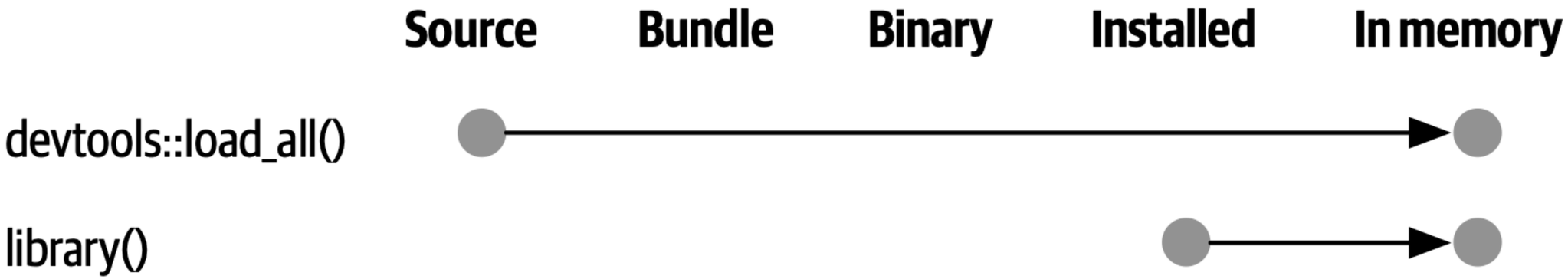
But how?

- ~~source("R/my-fun.R")~~
- ~~Send function to console using RStudio (Ctrl/CMD+Return)~~
- `devtools::load_all()`

⌨ Ctrl+Shift+L (Windows & Linux)

load_all()

~= install.packages() + library()

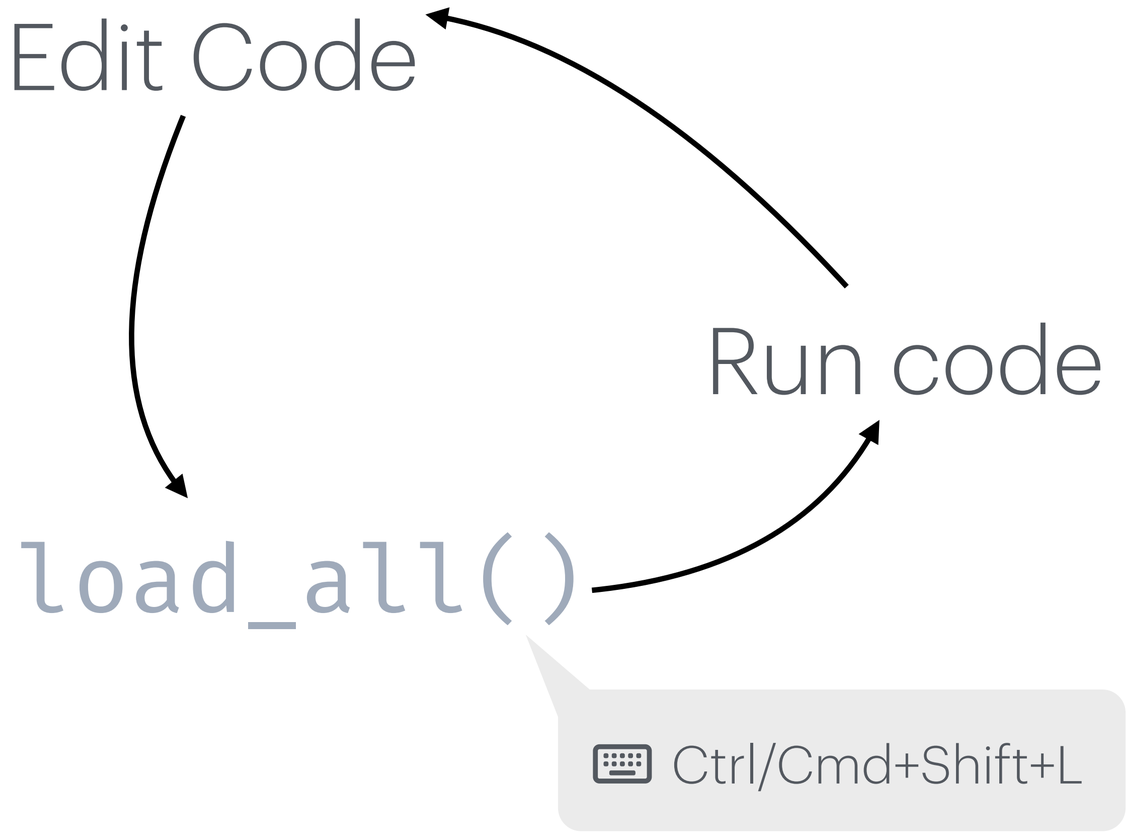


- Simulates building, installing, and attaching your package
- Makes all of the functions from your package immediately available to use
- Allows fast iteration of editing and test-driving your functions
- Good reflection of how users will interact with your package*

Wickham, Hadley, and Jennifer Bryan. 2023. R Packages. 2nd ed.

Try it out, and commit your changes 

Workflow



check()

Run R CMD check from within R

```
check()

#> ── R CMD check results ──────────────────────────────────────
#> Duration: 3.1s
#>
#> ❯ checking DESCRIPTION meta-information ... WARNING
#>   Invalid license file pointers: LICENSE
#>
#> 0 errors ✔ | 1 warning ✖ | 0 notes ✔
```

- Reduce future pain by catching problems early*
- https://github.com/wch/r-source/blob/97a5806aed3dceb174c
  library/tools/R/check.R#L314

Your Turn

https:

R CMD check

3 types of messages

- **ERRORs:** Severe problems - always fix.
- **WARNINGs:** Problems that you should fix, and must fix if you're planning to submit to CRAN.
- **NOTEs:** Mild problems or, in a few cases, just an observation.
  - When submitting to CRAN, try to eliminate all NOTEs.

Licenses

use_*_license()

- Permissive:
  - **MIT:** simple and permissive.
  - **Apache 2.0:** MIT + provides patent protection.
- Copyleft:
  - Requires sharing of improvements.
  - **GPL (v2 or v3)**
  - **AGPL, LGPL** (v2.1 or v3)

- Creative commons licenses:
  - Appropriate for data packages.
  - **CC0:** dedicated to public domain.
  - **CC-BY:** Free to share and adapt, must give appropriate credit.

use_mit_license()

```
✔ Adding 'MIT + file LICENSE' to License
✔ Writing 'LICENSE'
✔ Writing 'LICENSE.md'
✔ Adding '^LICENSE\\.md$' to '.Rbuildignore'
```

The DESCRIPTION file

Package metadata

- Make yourself the author
  - Name & Email
  - Role
  - ORCID (optional)
- Write descriptive
  - Title:
  - Description:

Ctrl+.

start typing DESCRIPTION

```
Package: mypackage
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 do
License: `use_mit_license()`, `use
  friends to pick a license
Encoding: UTF-8
Roxygen: list(markdown = TRUE)
RoxygenNote: 7.3.
```

Your Turn

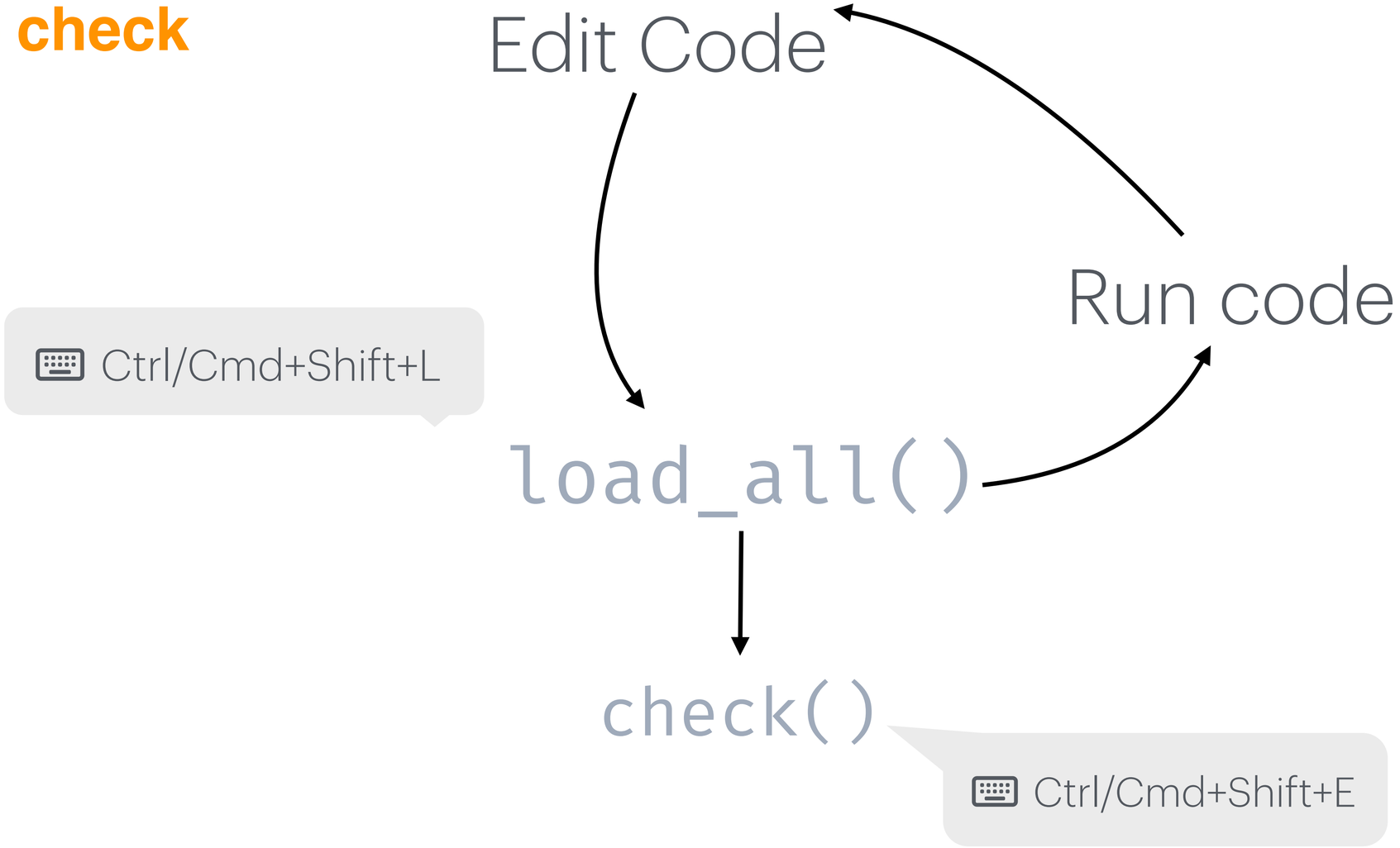
The DESCRIPTION file

Package metadata

- Take a look at the DESCRIPTION for ggplot2.
  - CRAN Package page
  - DESCRIPTION on GitHub
    - Note other Author roles:
      - ‘cph’ (copyright holder, often your employer)
      - ‘fnd’ (funder)

Workflow

Code + check

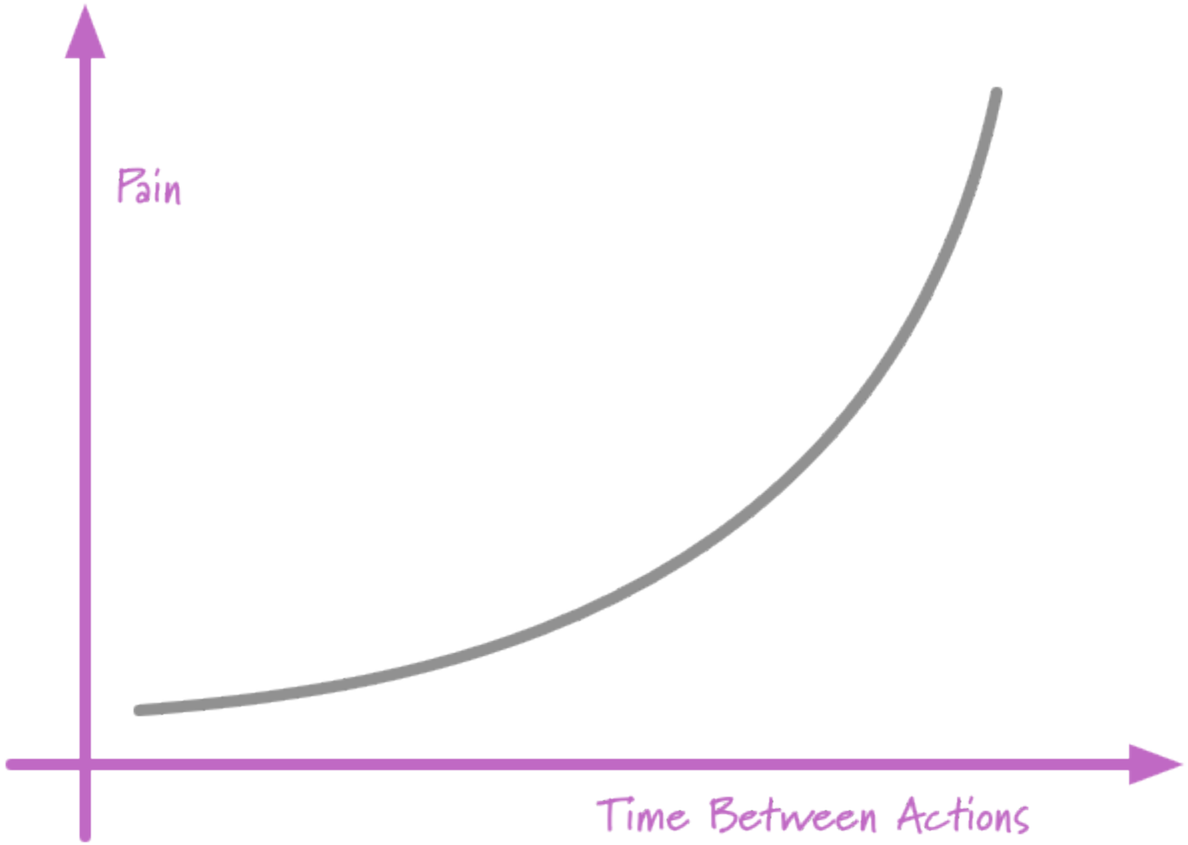


check() again

```
check()

#> ═══ Documenting
═══════════════════════════════════════════════════════════════════════
═══════════════

…
#> ═══ Building
═══════════════════════════════════════════════════════════════════════
═══════════════════════

…
#> ═══ Checking
```


TED
LASSO

"If it hurts, do it more often."



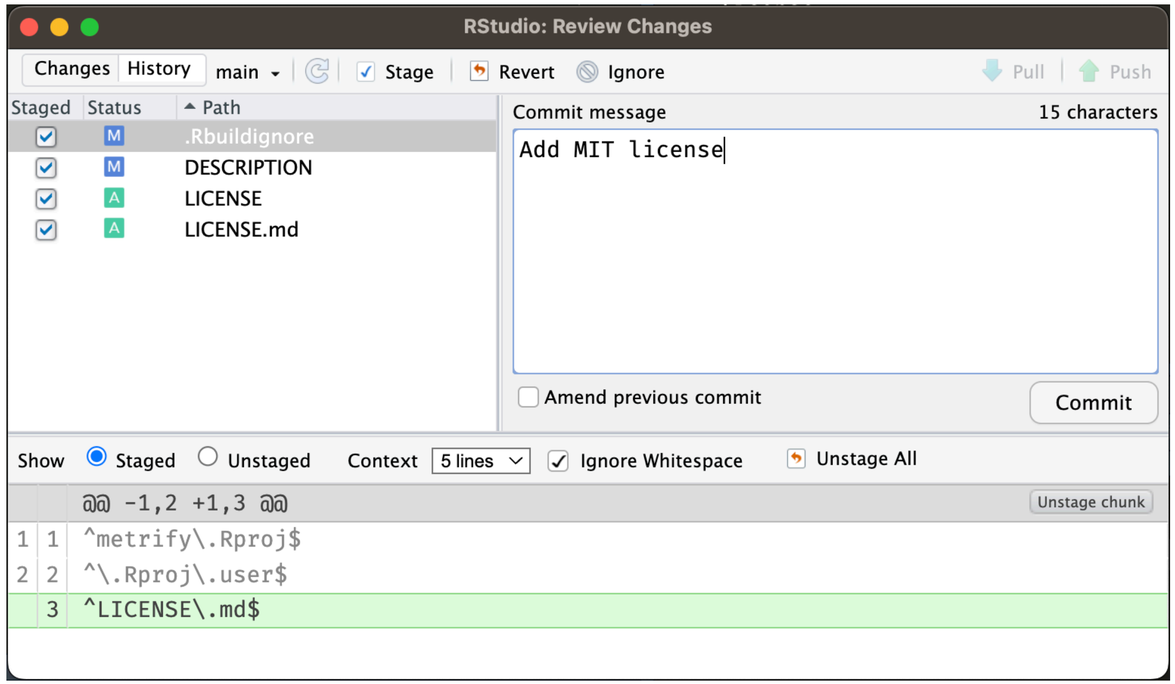
https://martinfowler.com/bliki/FrequencyReducesDifficulty.html

"If it hurts, do it more often."

- If `check()` goes from passing to failing after you've tinkered with one function or touched 10 lines of code, it's clear what to troubleshoot.
- If you've added 15 functions that all call each other and touched 100s of lines of code, bless your heart.
- Better to learn of a regrettable choice before you've built upon it for days or weeks.

Commit changes to git

```
$ git add DESCRIPTION \
        LICENSE \
        LICENSE.md \
        .Rbuildignore

$ git commit -m "Add MIT license"
```



GitHub

Put your package code on GitHub

- Prerequisites:
  - GitHub account
  - Followed instructions to get GitHub PAT
    - https://andyteucher.ca/pkg-dev-dfo-2024-11/setup.html#github
  - Verify
    - `git_sitrep()`
  - Some things really are magic:
    - `use_github()`

Avoid some pain of package setup: edit_r_profile()

And set default DESCRIPTION values

```
# Set usethis options:
options(
  usethis.description = list(
    "Authors@R" = utils::person(
      "Jane", "Doe",
      email = "jane@example.com",
      role = c("aut", "cre"),
      comment = c(ORCID = "0000-1111-2222-3333")
    )
  )
)
```

*https://usethis.r-lib.org/articles/usethis-setup.html

While you’re in there…

Set some other helpful defaults

```
options(
  warnPartialMatchArgs = TRUE,
  warnPartialMatchDollar = TRUE,
  warnPartialMatchAttr = TRUE
)
```

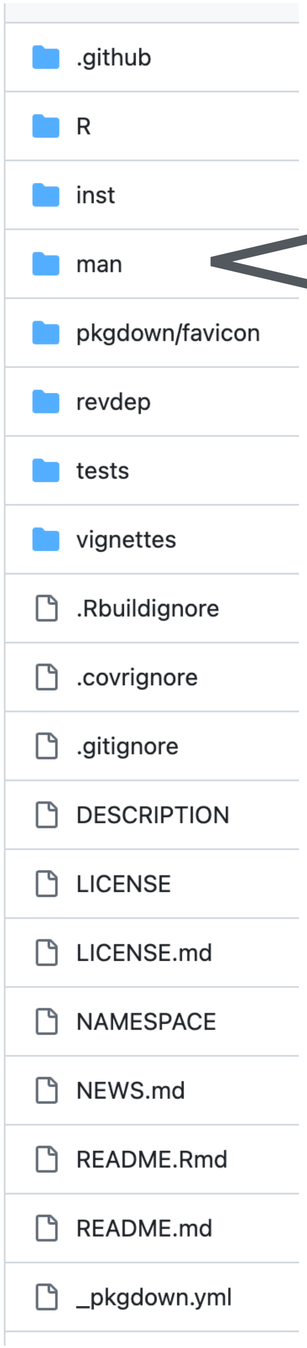
Documentation

Documentation

R2

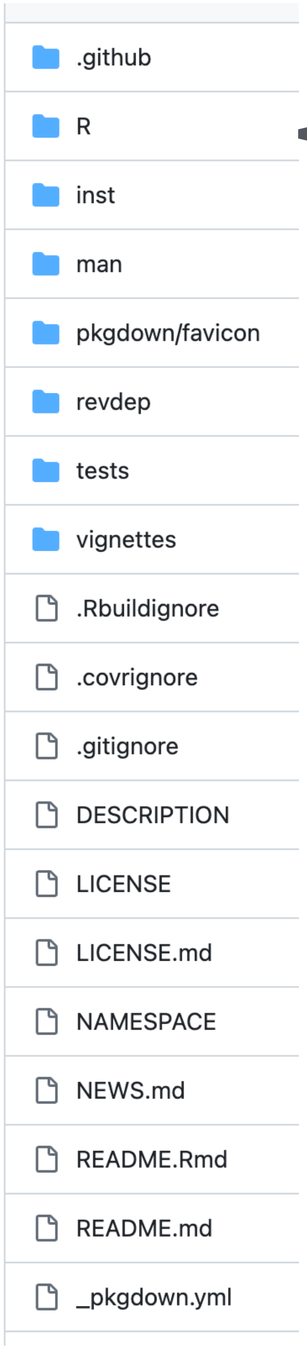
roxygen2

knitr



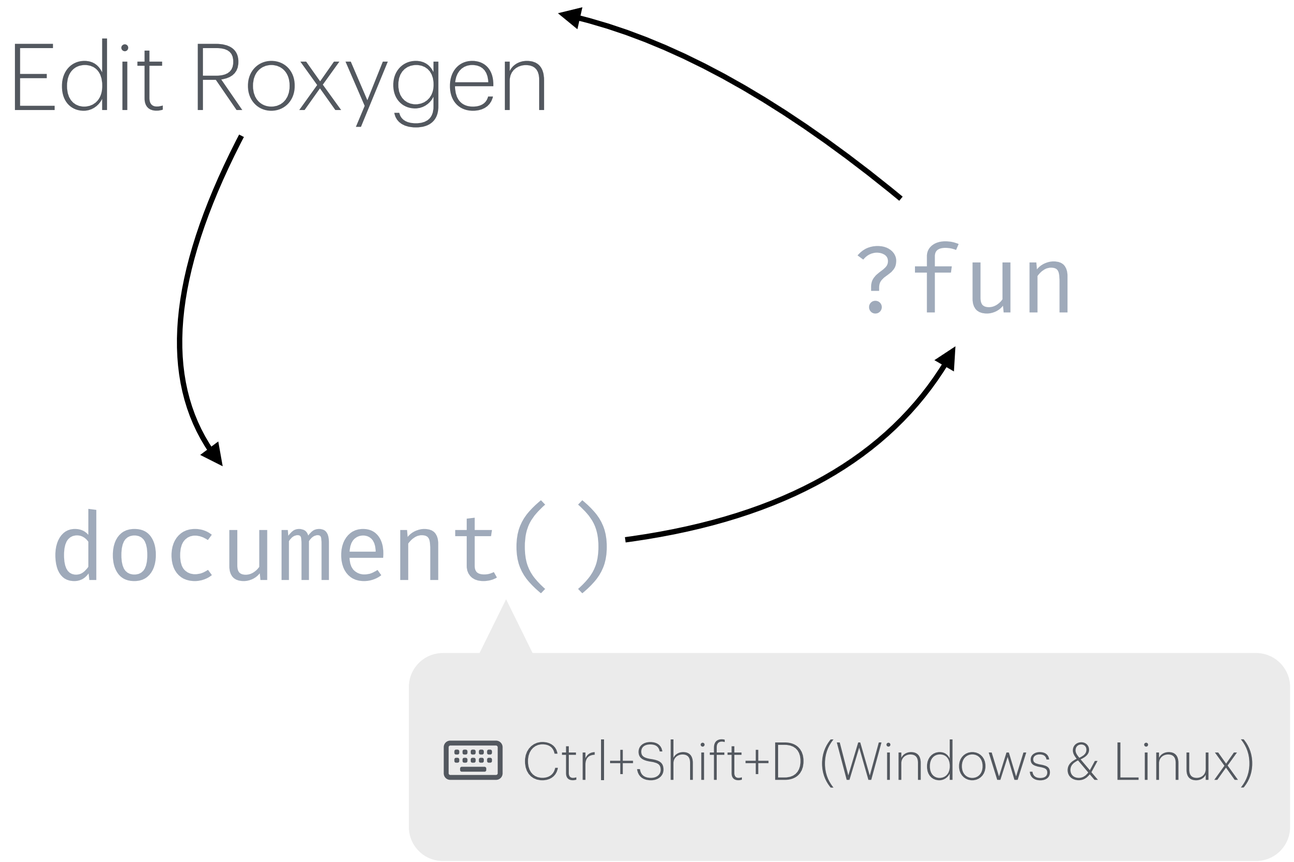
Help topics live here, in `.Rd` files

But you (mostly) don't write to `man/` with your bare hands.



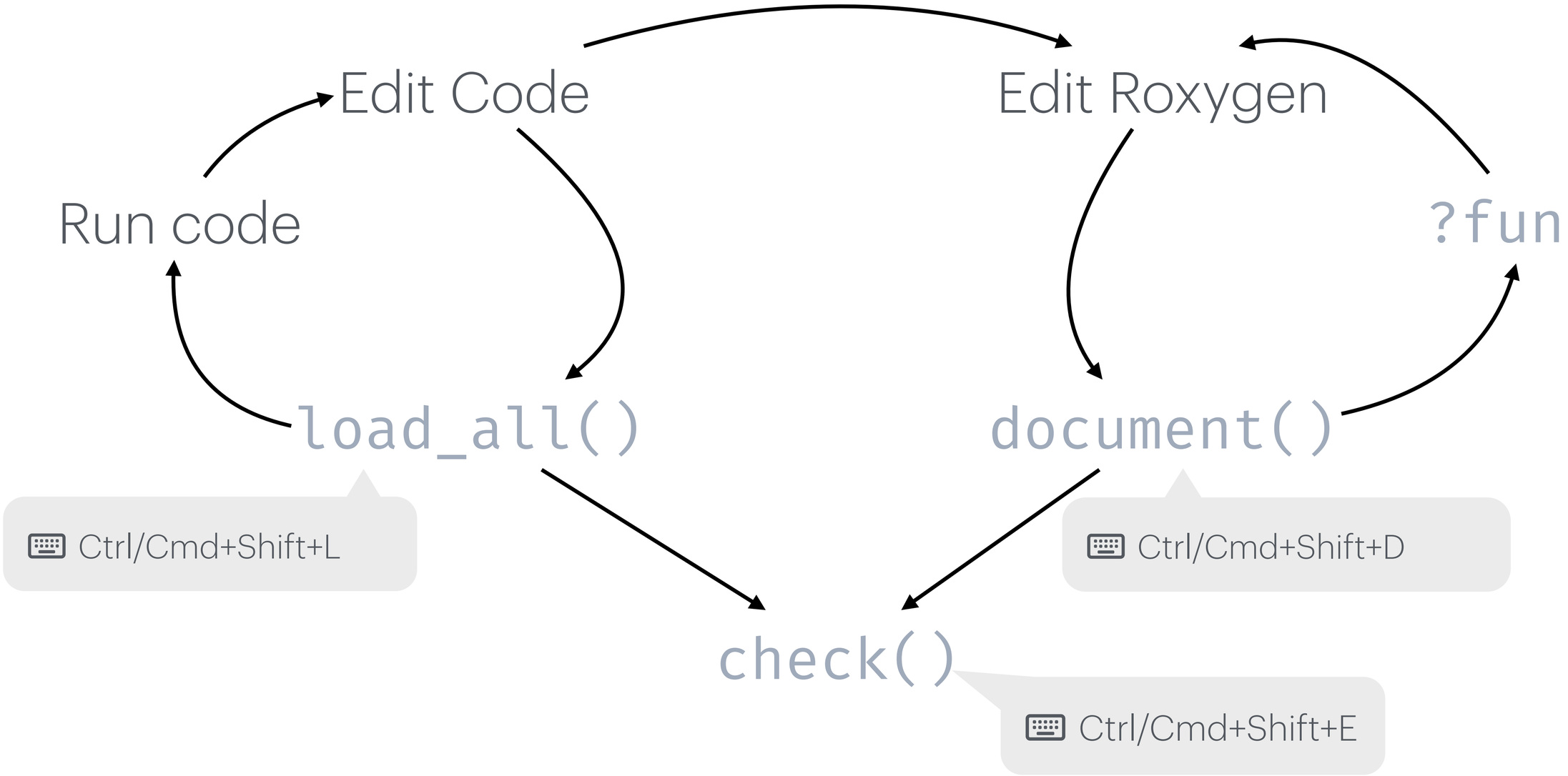
Help topics are generated from the roxygen comments you write alongside your functions (or other objects), inside `R/`.

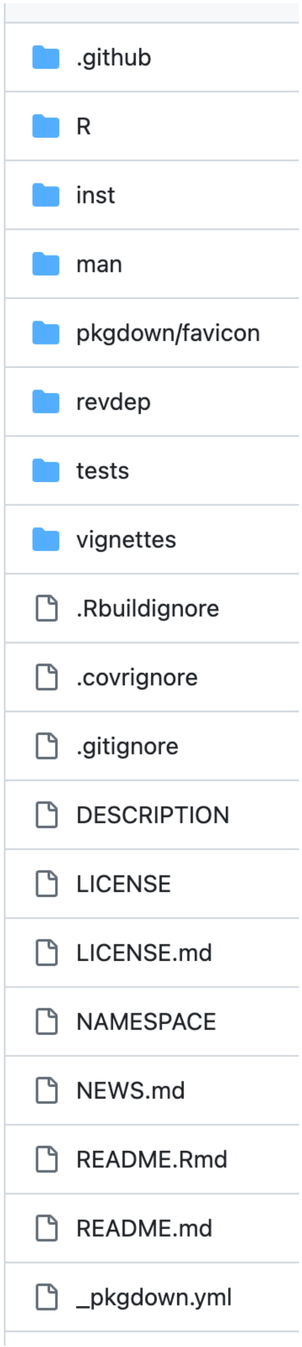
Documentation workflow



Workflow

Code + documentation + check



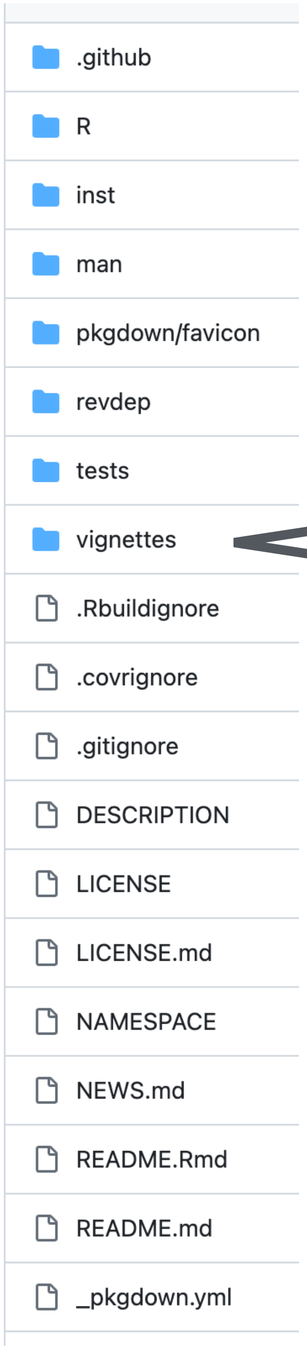


`README.md` is important:

- on CRAN
- on GitHub
- in the pkgdown site (it's the default `index.html`)

Ideally, `README.md` is generated from `README.Rmd`.

`build_readme()` is the best way to convert `README.Rmd` to `README.md`, because it actually installs the current dev package prior to rendering.

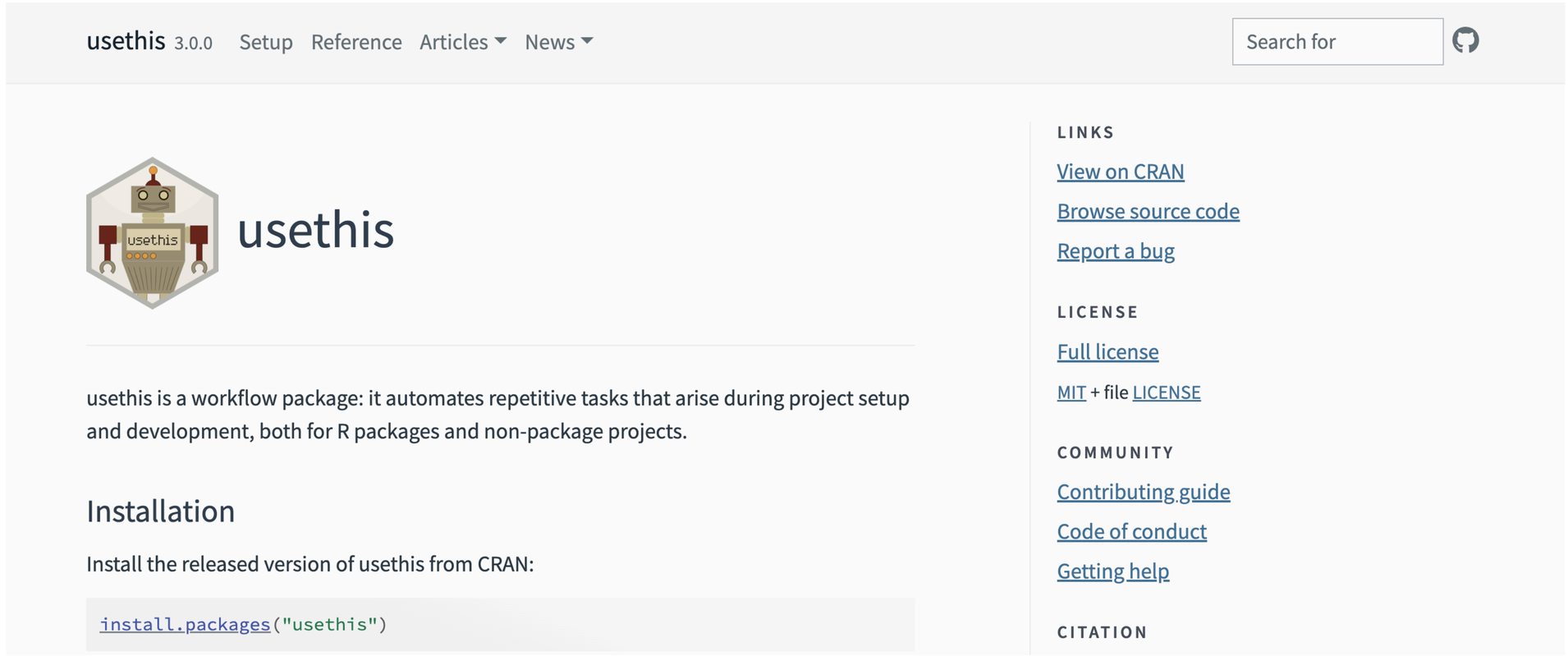


Vignettes are a great way to show truly authentic usage, combining multiple functions in your package to accomplish a realistic task.

If authentic usage involves moves that are impossible on CRAN, demonstrate that in an **article** instead. An article appears only in the pkgdown site.

- .github
- R
- inst
- man
- pkgdown/favicon
- revdep
- tests
- vignettes
- .Rbuildignore
- .covrignore
- .gitignore
- DESCRIPTION
- LICENSE
- LICENSE.md
- NAMESPACE
- NEWS.md
- README.Rmd
- README.md
- _pkgdown.yml

A user's experience with the pkgdown website is top of my mind when writing docs.

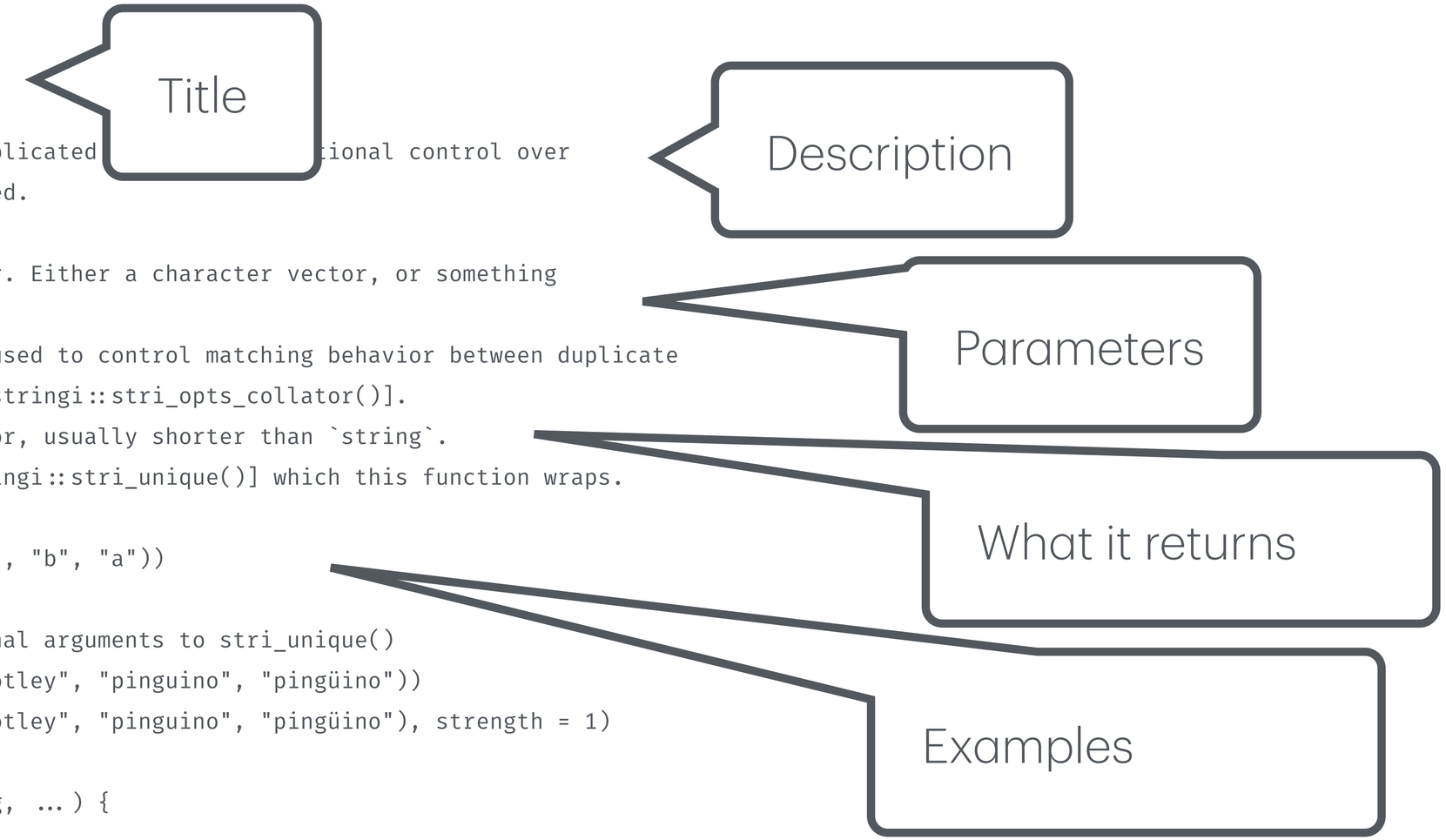


Items Needed for a help topic

- Insert a roxygen skeleton in RStudio with *Code > Insert Roxygen Skeleton*. Or do the equivalent "by hand".
- Complete the prepared fields
  - (Usually implicit) title and description
  - `@param` for function arguments
  - `@returns` for the return value
  - `@examples` for usage
  - `@export` to put in NAMESPACE
- Related workflow happiness: Cmd/Ctrl + Enter helps you develop your examples. Plays nicely with `load_all()` for staying synced with package source.

Typical roxygen comment

```
#' Remove duplicated strings
#'
#' `str_unique()` removes duplicated                tional control over
#' how duplication is measured.
#'
#' @param string Input vector. Either a character vector, or something
#'  coercible to one.
#' @param ... Other options used to control matching behavior between duplicate
#'   strings. Passed on to [stringi::stri_opts_collator()].
#' @returns A character vector, usually shorter than `string`.
#' @seealso [unique()], [stringi::stri_unique()] which this function wraps.
#' @examples
#' str_unique(c("a", "b", "c", "b", "a"))
#'
#' # Use ... to pass additional arguments to stri_unique()
#' str_unique(c("motley", "mötley", "pinguino", "pingüino"))
#' str_unique(c("motley", "mötley", "pinguino", "pingüino"), strength = 1)
#' @export
str_unique ← function(string, ...) {
  ...
}
```



Hard and/or fiddly but worth it

- Links!
  - Other help topics in same package
  - Topics in other packages
  - Vignettes in same or other package
  - Other URLs
- Examples
  - Show authentic usage that hopefully does not …
  - Create huge headaches in CI and on CRAN

Backticks to format as code. Typical way to refer to a function in its own topic. Use trailing parentheses.

```
#' It's obvious that `thisfunction()` is better than
#' [otherpkg::otherfunction()] or even our own [olderfunction()].

#' Read more in our own `vignette("stuff")` or elsewhere in
#' `vignette("things", package = "otherpkg")`.
```

```
#' It's obvious that `thisfunction()` is better than
#' [otherpkg::otherfunction()] or even our own [olderfunction()].
#'
#' Rea                                                    elsewhere in
#' `vignette("things", package = "otherpkg")`.
```

Square brackets and parentheses for an auto-link to another function, in same package or other package.

See the (R)Markdown support article, Function links

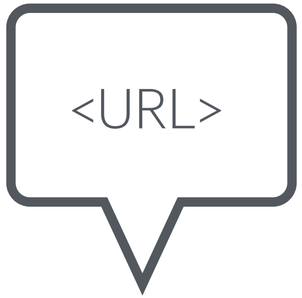
```
#' It's obvious that `thisfunction()` is better than
#' [otherpkg::otherfunction()] or even our own [olderfunction()].
```

This vignette syntax is auto-linked in pkgdown (and elsewhere) and gives working code, otherwise.

```
#' Read more in our own `vignette("stuff")` or elsewhere in
#' `vignette("things", package = "otherpkg")`.
```

URL links


```
#' Use C++ via the cpp11 package
#'
#' Adds infrastructure needed to use the [cpp11](https://cpp11.r-lib.org)
#' package, a header-only R package that helps R package developers handle R
#' objects with C++ code: ...
```




```
#' See <https://happygitwithr.com/common-remote-setups.html> for more about
#' GitHub remote configurations and, e.g., what we mean by the source repo. This
#' function works for the configurations `"ours"`, `"fork"`, and `"theirs"`.
```

URL links

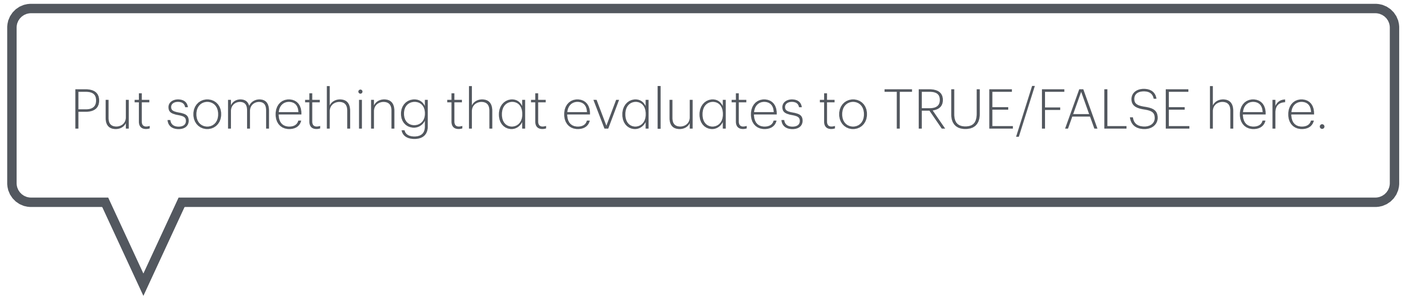
- "The goal of urlchecker is to run the URL checks from R 4.1 in older versions of R and automatically update URLs as needed."
- Extracts the URL-checking logic inside `R CMD check` and exposes as `urlchecker::url_check()`.

```
library(urlchecker)


# `url_check()` will check all URLs in a package, as is done by CRAN when
# submitting a package.
url_check("path/to/pkg")


# `url_update()` will check all URLs in a package, then update any 301
# redirects automatically to their new location.
url_update("path/to/pkg")
```

What's tricky about examples?

- Tension between
  - Showing readable and realistic code
  - However, there's
    - no user, i.e. for interaction or credentials
    - side effects are forbidden
    - can't throw an error
- It's tempting to use `\dontrun{}` but you can get pushback from CRAN

@examplesIf is a mighty weapon




```
#' @examplesIf rlang::is_interactive()
#' # load/refresh existing credentials, if available
#' # otherwise, go to browser for authentication and authorization
#' drive_auth()
#'
#' # see user associated with current token
#' drive_user()
```

`@examplesIf` is a mighty weapon

Examples

```
if (FALSE) { # rlang::is_interactive()
# load/refresh existing credentials, if available
# otherwise, go to browser for authentication and authorization
drive_auth()

# see user associated with current token
drive_user()
```

Examples should not change the world

- If at all possible, just don't do anything like this:
  - write a file
  - set an option
  - change working directory
- If you must change the world, put it back the way you found it, e.g.
  - write to the temp directory AND delete the file
  - restore the option or working directory to original state
- Sadly, withr functions don't work here. Neither does `on.exit()`.
- Sadly, nothing like `@examplesIf` is available to hide the machinery.

Use try() to show an error

```
#' @examples
#'  ...
#' # Row sizes must be compatible when column-binding
#' try(bind_cols(tibble(x = 1:3), tibble(y = 1:2)))
```

Put code that errors inside try().

```
# Row sizes must be compatible when column-binding
try(bind_cols(tibble(x = 1:3), tibble(y = 1:2)))
#> Error in bind_cols(tibble(x = 1:3), tibble(y = 1:2)) :
#>   Can't recycle `..1` (size 3) to match `..2` (size 2).
```

Create roxygen comments

- Go to function definition
- Cursor in function definition
- Insert roxygen skeleton
- Complete the roxygen fields
- `document()`
- `?myfunction`
- 🎉

⌨ Ctrl+.
(Start typing function name...)

⌨ Cmd/Ctrl+Alt+Shift+R

⌨ Cmd/Ctrl+Shift+D

Your Turn

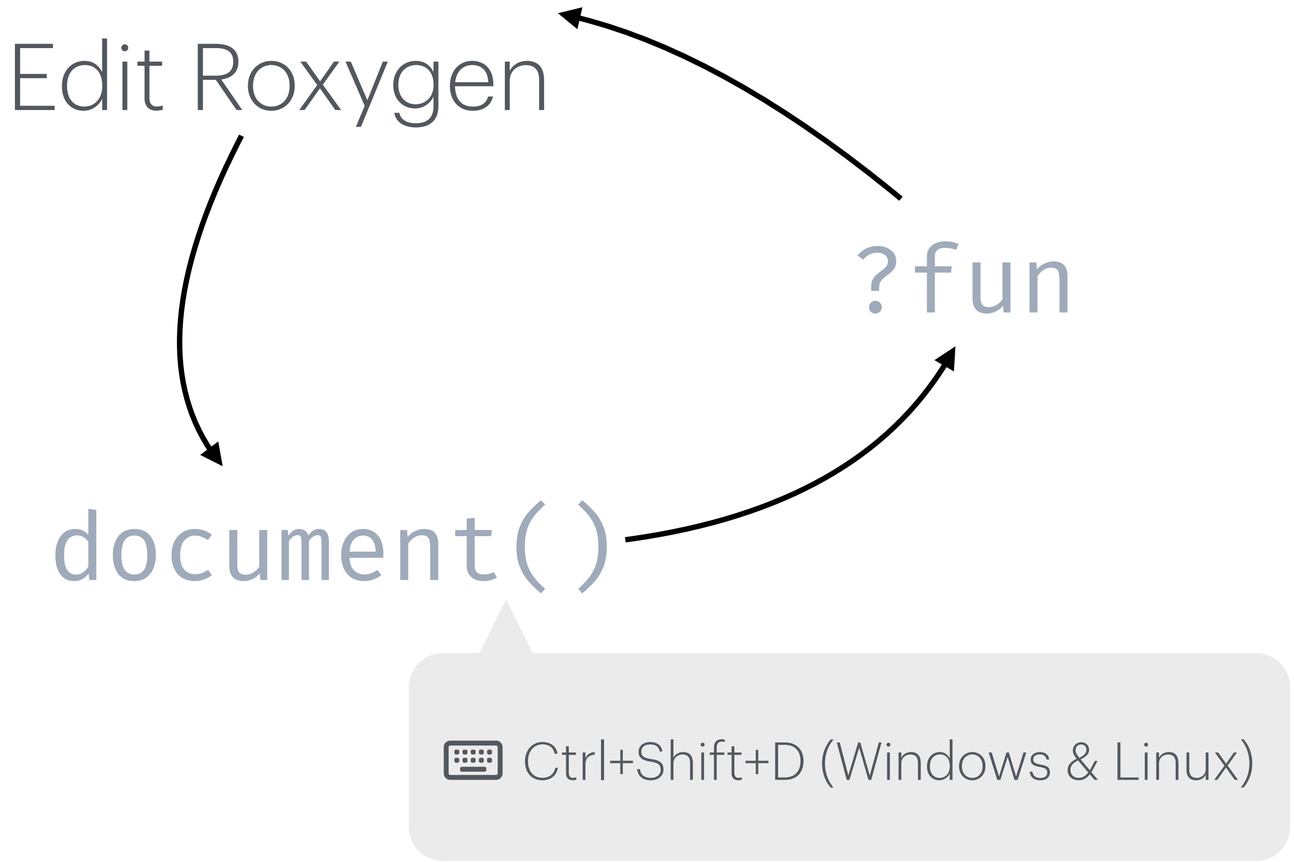
check()
Commit your changes
Push to GitHub

NAMESPACE

An introduction

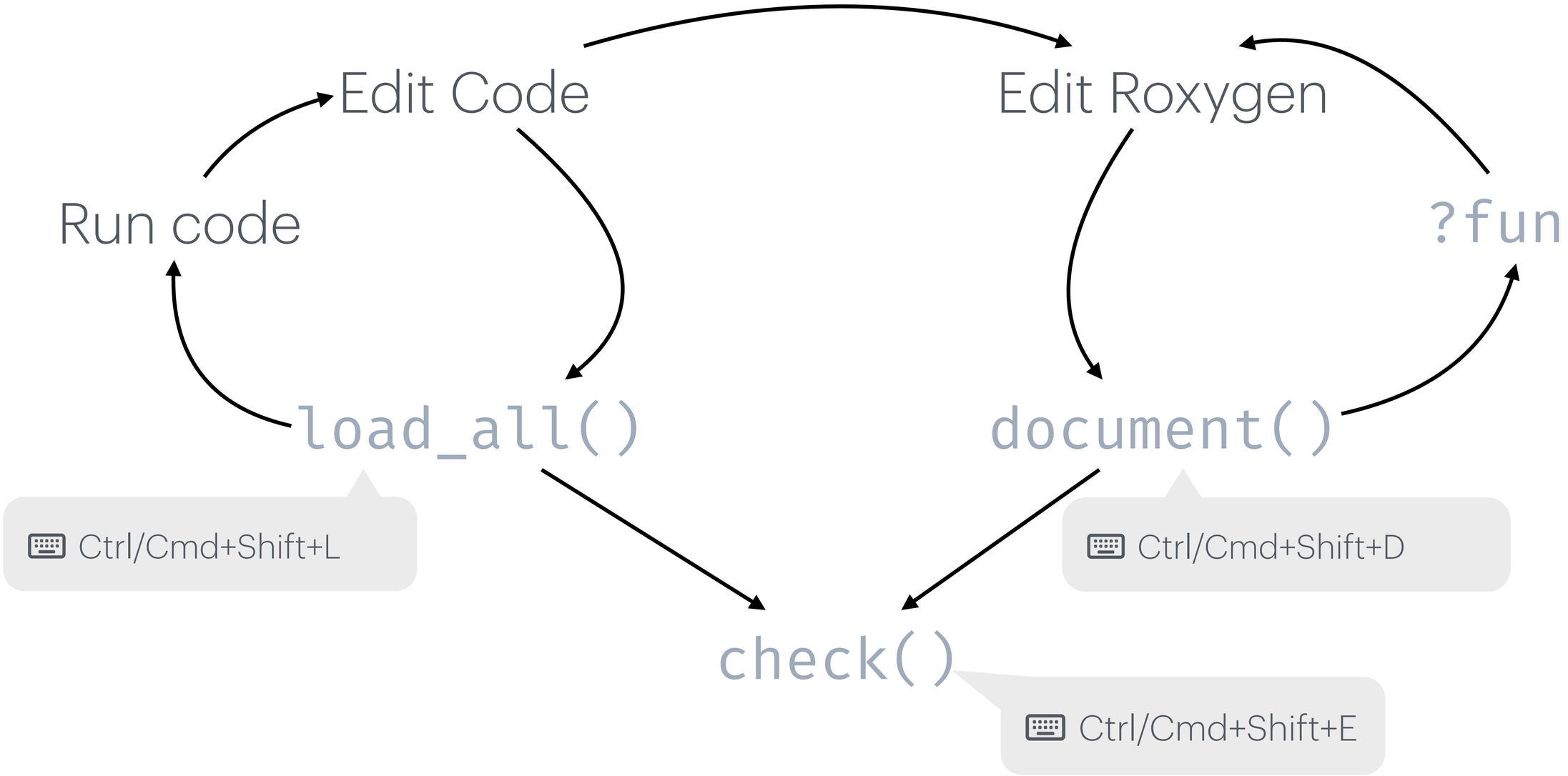
- Lists R objects that are:
  - **Exported** from your package to be used by package users
    - `export(), S3method(), …`
  - **Imported** from another package to be used internally by your package
    - `import(), importFrom(), …`
- document() updates the NAMESPACE file with directives from Roxygen comments in your R code.

Documentation workflow



Workflow

Code + documentation + check



Package-level documentation

use_package_doc()

```
use_package_doc()

#> ✔ Writing 'R/mypackage-package.R'
#> • Modify ‘R/mypackage-package.R’

document()
```

- Package-level help available via ?mypackage
- Creates relevant .Rd file from DESCRIPTION
- A good place for roxygen dependency directives

Your Turn

check() again

```
check()

#> ══ Documenting
═══════════════════════════════════════════════════════════════════
═══════════════

…
#> ══ Building
═══════════════════════════════════════════════════════════════════
═══════════════════

…
#> ══ Checking
```

install()

Install package to your library

- R CMD INSTALL

Ctrl+Shift+B (Windows & Linux)

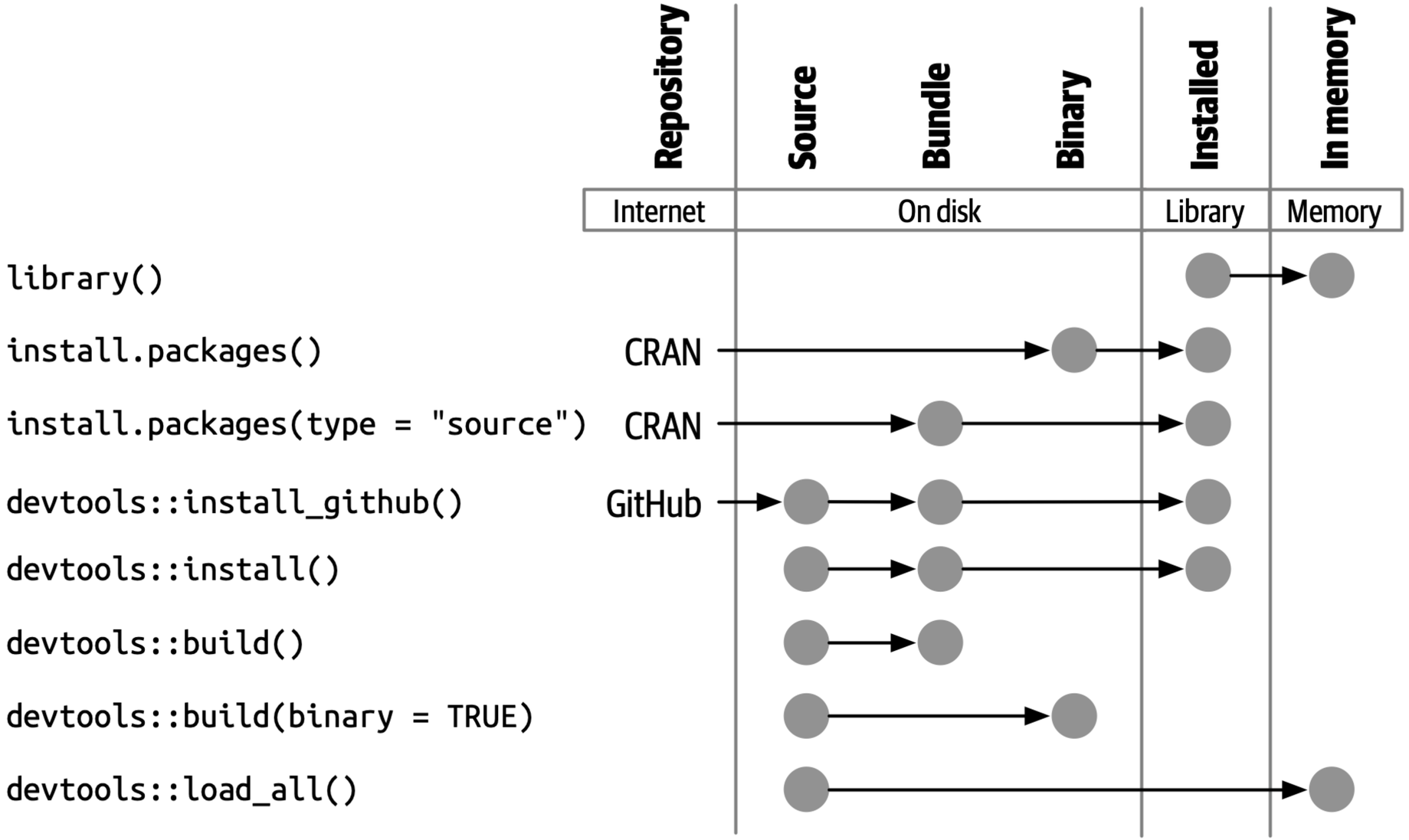
- Restart R

Ctrl+Shift+F10 (Windows & Linux)

- Attach package with library() like any other package

Your Turn

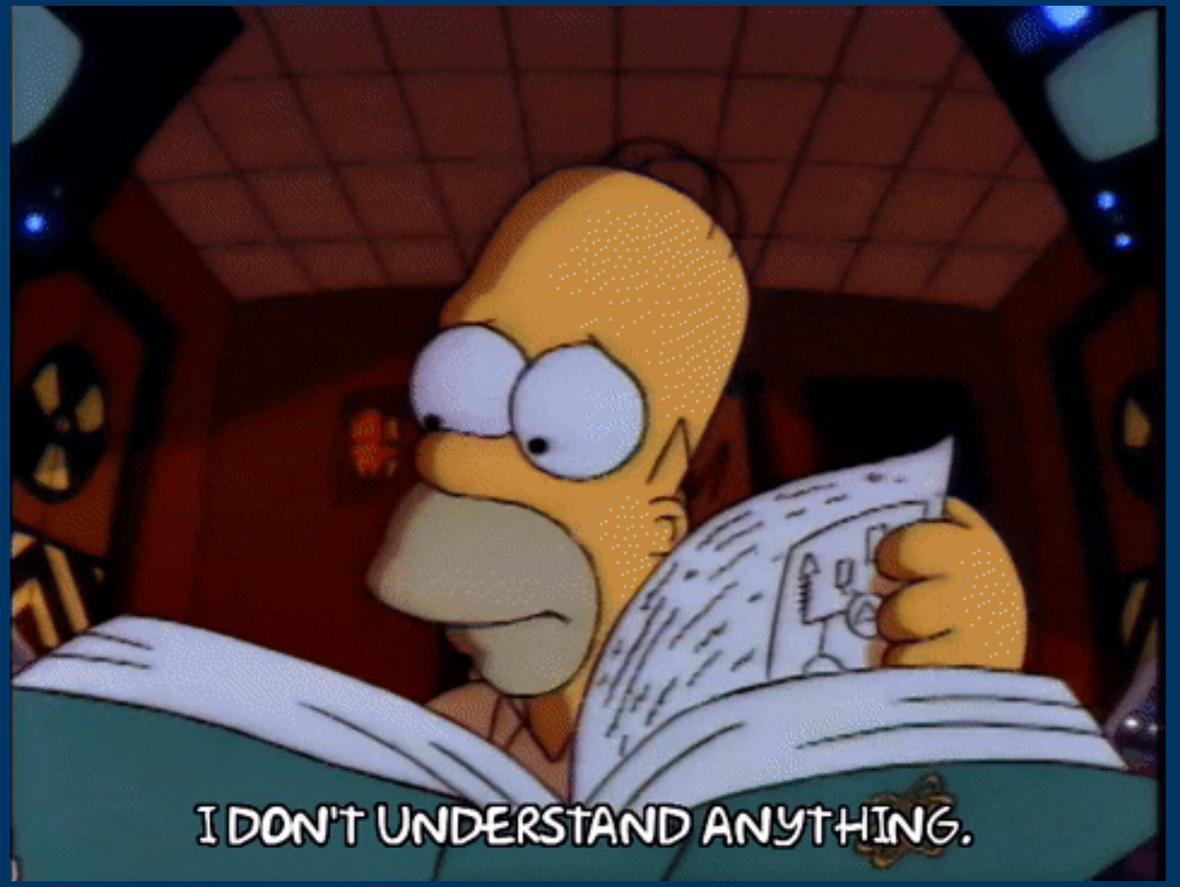
Package Structure and State



Wickham, Hadley, and Jennifer Bryan. 2023. R Packages. 2nd ed.

Commit your changes
Push to GitHub

README



use_readme_rmd()

Generates README.md**, your package's home page on GitHub**

- The purpose of the package
- Installation instructions
- Example usage
- Contributing guide

```
use_readme_rmd()

#> ✔ Writing 'README.Rmd'
#> ✔ Adding '^README\\.Rmd$' to '.Rbuildignore'
#> • Update 'README.Rmd' to include installation instructions.
#> ✔ Writing '.git/hooks/pre-commit'
```

build_readme()

README.Rmd -> README.md

- Installs package to a temporary directory before rendering
- README.md renders on the front page of your GitHub repo

Your Turn

Final check() **and** install()

You did it!

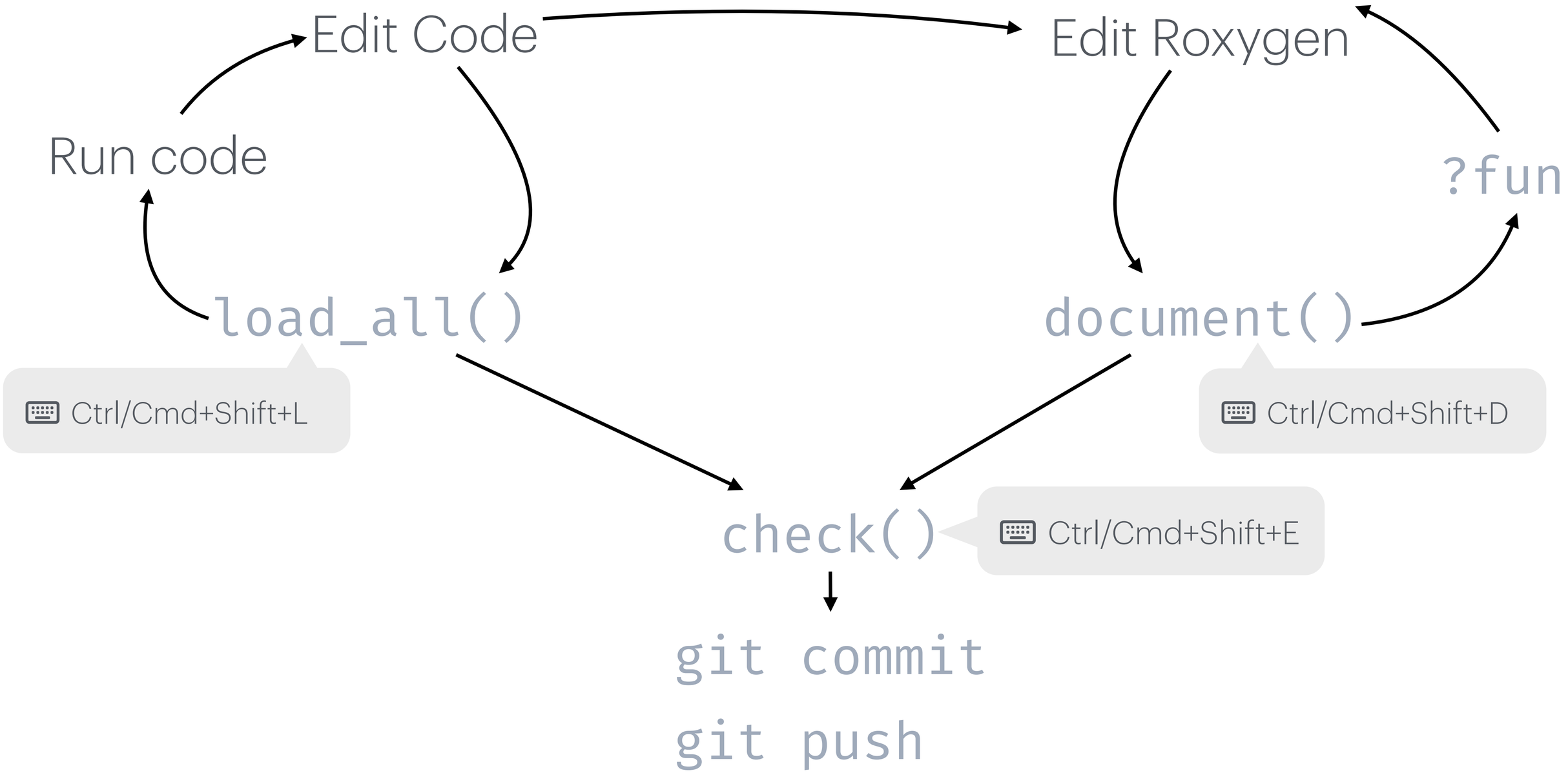
check()

```
#> ── R CMD check results ──────────────────────
#> Duration: 3.1s
#>
#> 0 errors ✔ | 0 warnings ✔ | 0 notes ✔
```

install()

```
#> ── R CMD build ──────────────────────────────────────────────────
#> checking for file '/Users/jane/rrr/mypackage/DESCRIPTION' ... ✔
#> preparing 'mypackage':
#> checking DESCRIPTION meta-information ... ✔
#> checking for LF line-endings in source and make files and shell scripts
#> checking for empty or unneeded directories
#> building 'mypackage_0.0.0.9000.tar.gz'
#> Running /usr/local/bin/R CMD INSTALL \
#>   /tmp/RtmpK6WnOX/mypackage_0.0.0.9000.tar.gz --install-tests
#> * installing to library '/Users/jane/Library/R/arm64/4.3/library'
#> * installing *source* package 'mypackage' ...
#> ** using staged installation
#> ** help
#> *** installing help indices
#> ** building package indices
#> ** testing if installed package can be loaded from temporary location
#> ** testing if installed package can be loaded from final location
#> ** testing if installed package keeps a record of temporary installation path
#> * DONE (mypackage)
```

Review: Workflow



Commit your changes
Push to GitHub

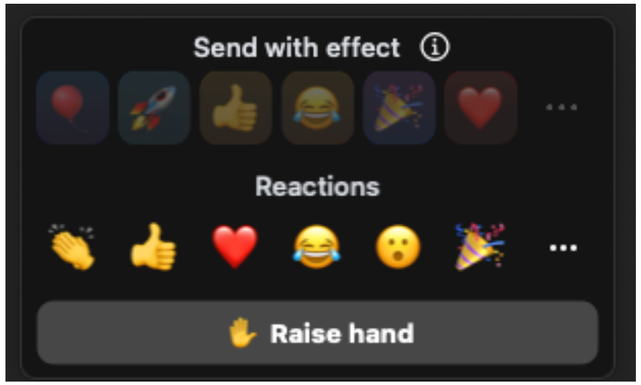
Break Time!

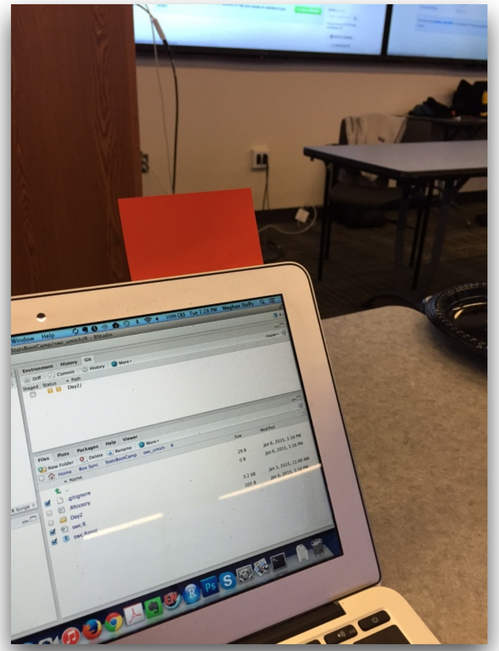
Day one complete!

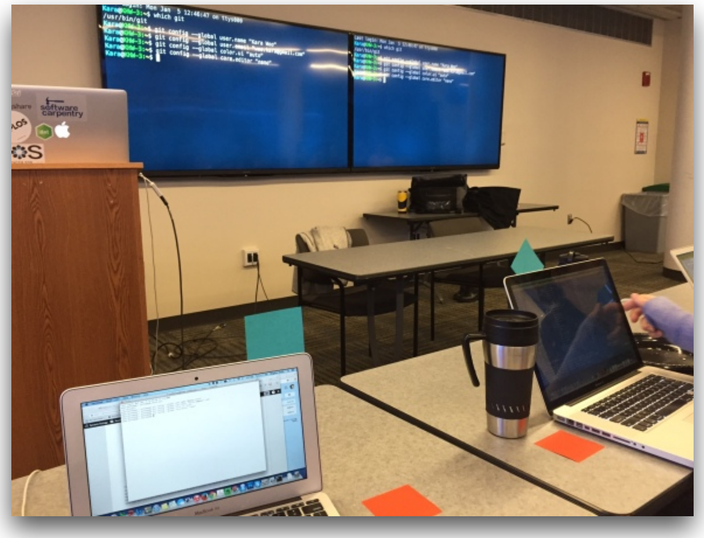
Welcome back to day two

Sticky Notes

I’m stuck, please send help







I’m good, let’s move on

Testing

Day 2: Schedule and Learning Objectives

08:00 - 09:20	Testing & Dependencies	80 min
09:20 - 09:35	Break	15 min
09:35 - 10:55	Continuous Integration & Design Principles	80 min
10:55 - 11:10	Break	15 min
11:10 - 12:30	Design Principles cont'd & Website Creation	80 min

Review: functions

Run once

- `create_package()`
- `use_git()`
- `use_mit_license()`
- `use_readme_rmd()`

Run periodically

- `use_r()`
- `build_readme()`

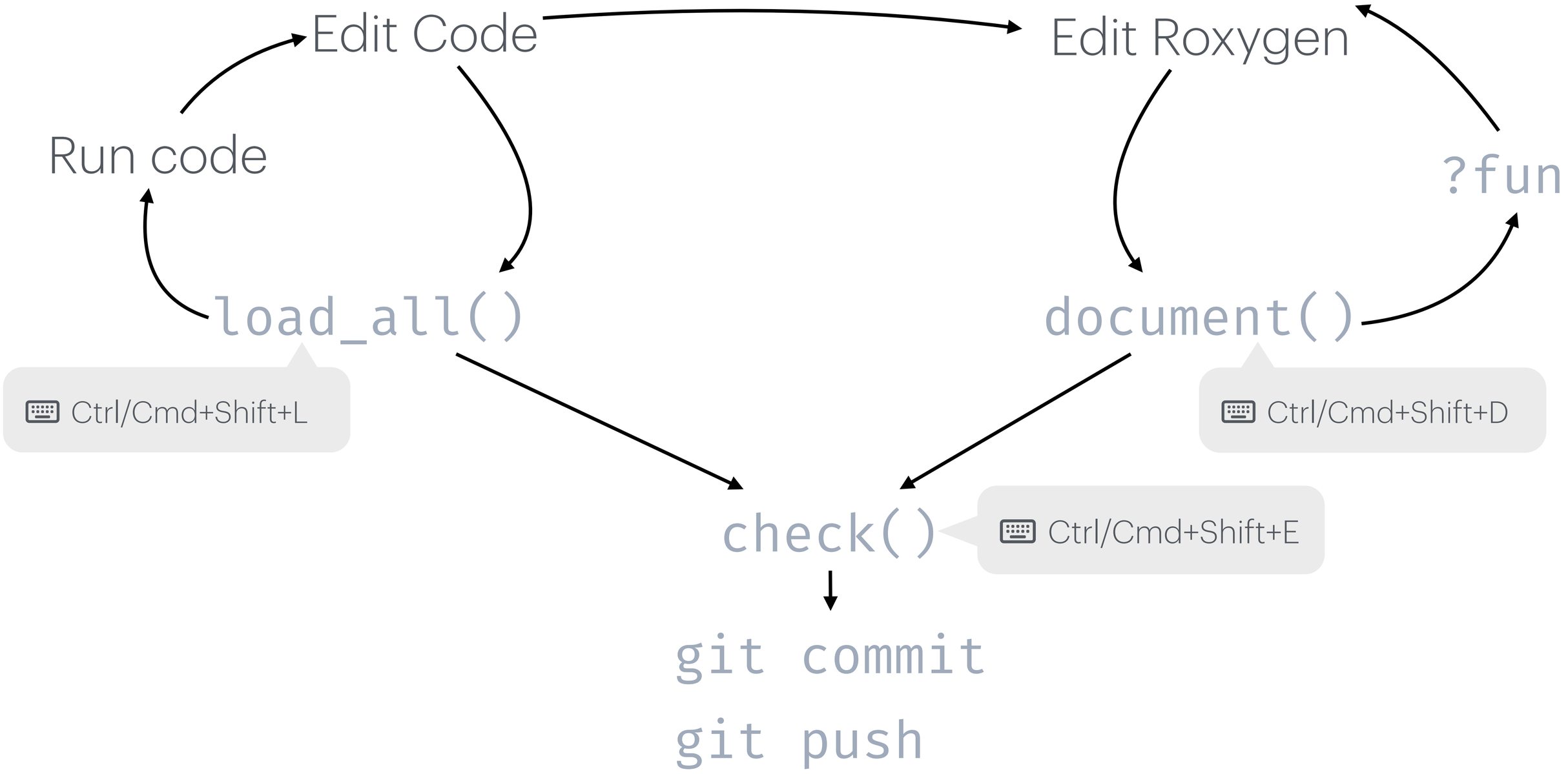
Run frequently

- `load_all()`

- `document()`

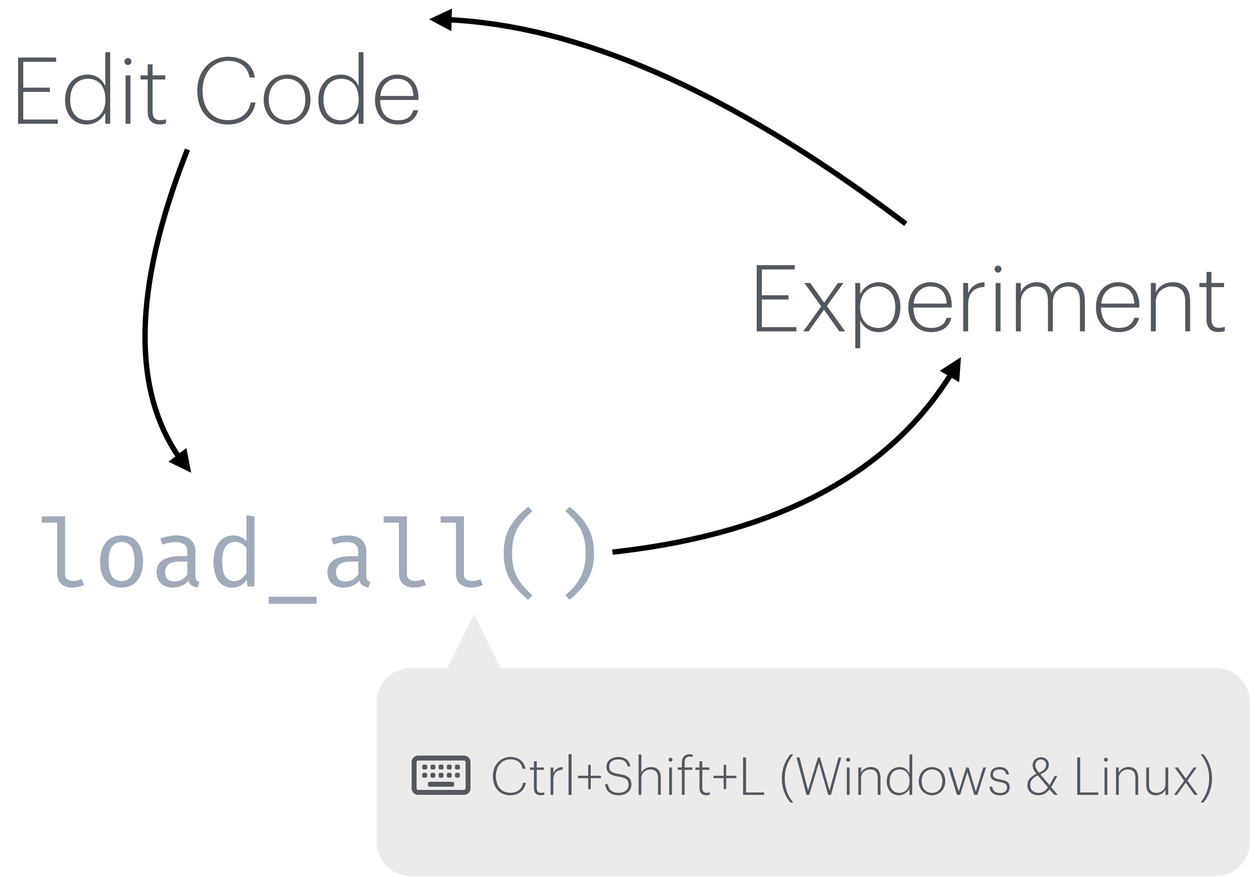
- `check()`

Review: workflow



Testing

Current workflow



Automated Testing

Benefits

- Fewer bugs
- Better code structure
- Call to action when fixing bugs
- Robust (future-proof) code

use_testthat()

Set up formal testing of your package*

```
use_testthat()

#> ✔ 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.
```

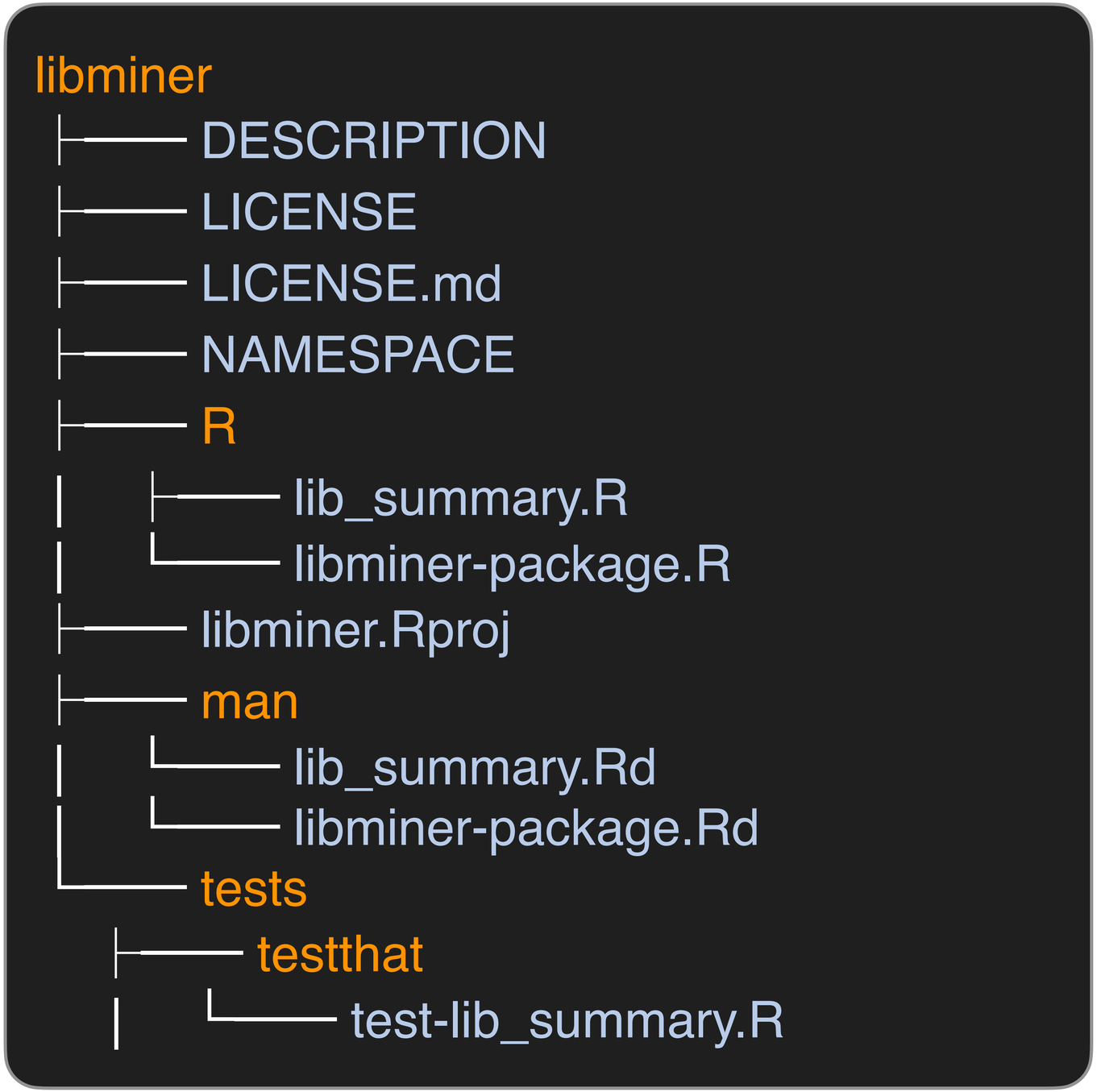
*Sorry, you still have to write the tests

use_test()

```
use_test('my-fun.R')*

#> ✔ Writing 'tests/testthat/test-my-fun.R'
#> • Edit 'tests/testthat/test-my-fun.R'
```

*Omit file name when 'R/my-fun.R' is active file

File structure



`use_test()` + `use_r()` vibe with file pairs

`R/a.R`	`tests/testthat/test-a.R`
`R/b.R`	`tests/testthat/test-b.R`
`R/c.R`	`tests/testthat/test-c.R`

Test structure

```
testthat("description of what you're testing", {
  expect_equal([function output], [expected output])
})
```

- **File:** one or more related tests
- **Test:** test_that("...")
  - Tests a unit of functionality (hence unit tests)
  - Contains one or more expectations
- **Expectation:** expect_*(…)
  - Tests a specific computation and compares it to an expected value

Expectations

- **Objects**
  - expect_equal(), expect_type(), expect_s3_class() , ...
- **Vectors**
  - expect_length(), expect_lt(), expect_gte(), expect_true(), expect_contains(), ...
- **Side-effects**
  - expect_error(), expect_silent(), expect_no_warning(), expect_output(), ...
- **Snapshots**
  - expect_snapshot(), expect_snapshot_value(), ...

test()

- Runs all tests in your test suite

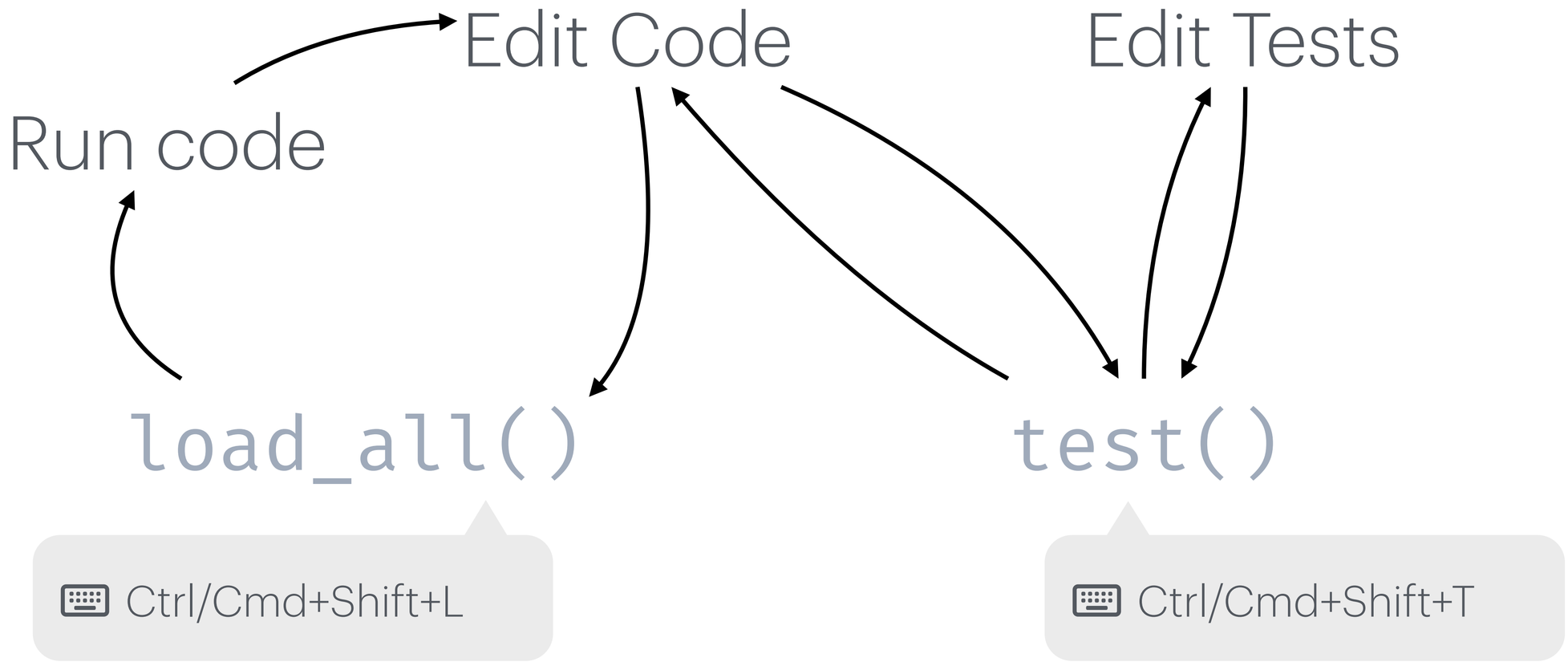
```
test()

#> ℹ Testing
#> ✔ | F W S  OK | Context
#>
#> ⋮ |         0 |
#> ✔ |         1 |
#>
#> ═══ Results
```

⌨ Ctrl+Shift+T (Windows & Linux)

Your Turn

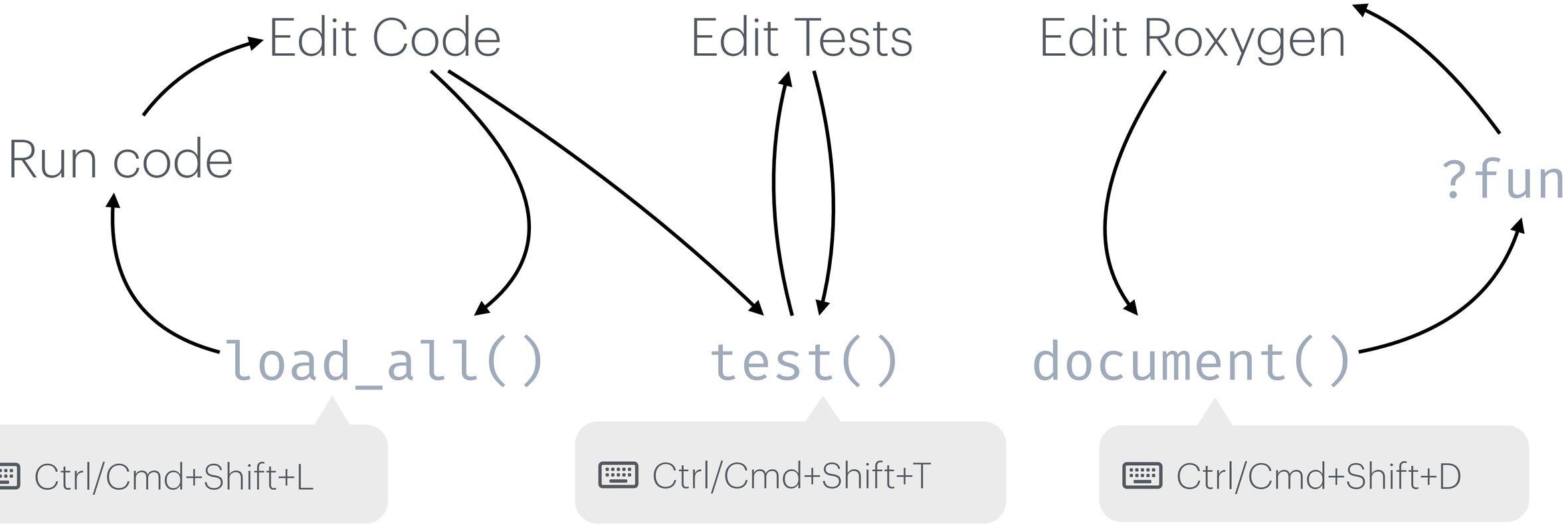
Updated workflow

Code + testing



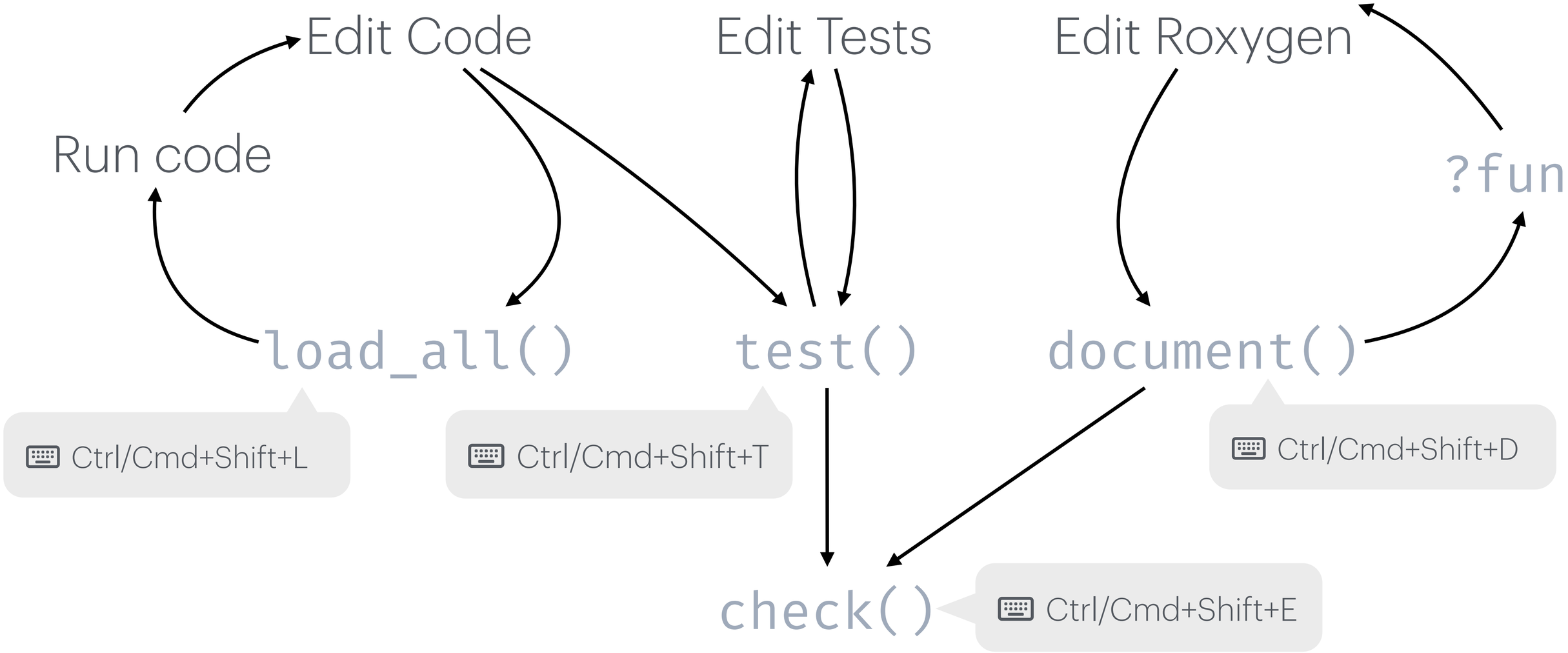
Workflow

Code + testing + documentation



Workflow

Code + testing + documentation + check



check()
Commit your changes
Push to GitHub

testthat workflow patterns

`load_all()`

- testthat's workflow is designed around `load_all()`
- Makes entire package namespace available
- Attaches testthat
- Sources `tests/testthat/helper.R`

Functions that help with testing

Workflow: micro-iteration, interactive experimentation

- tweak the `foofy()` function and re-load it with `load_all()`
  - also attaches testthat and sources any test helpers

- interactively explore and refine expectations
  `expect_equal(foofy( ... ), EXPECTED_FOOFY_OUTPUT)`

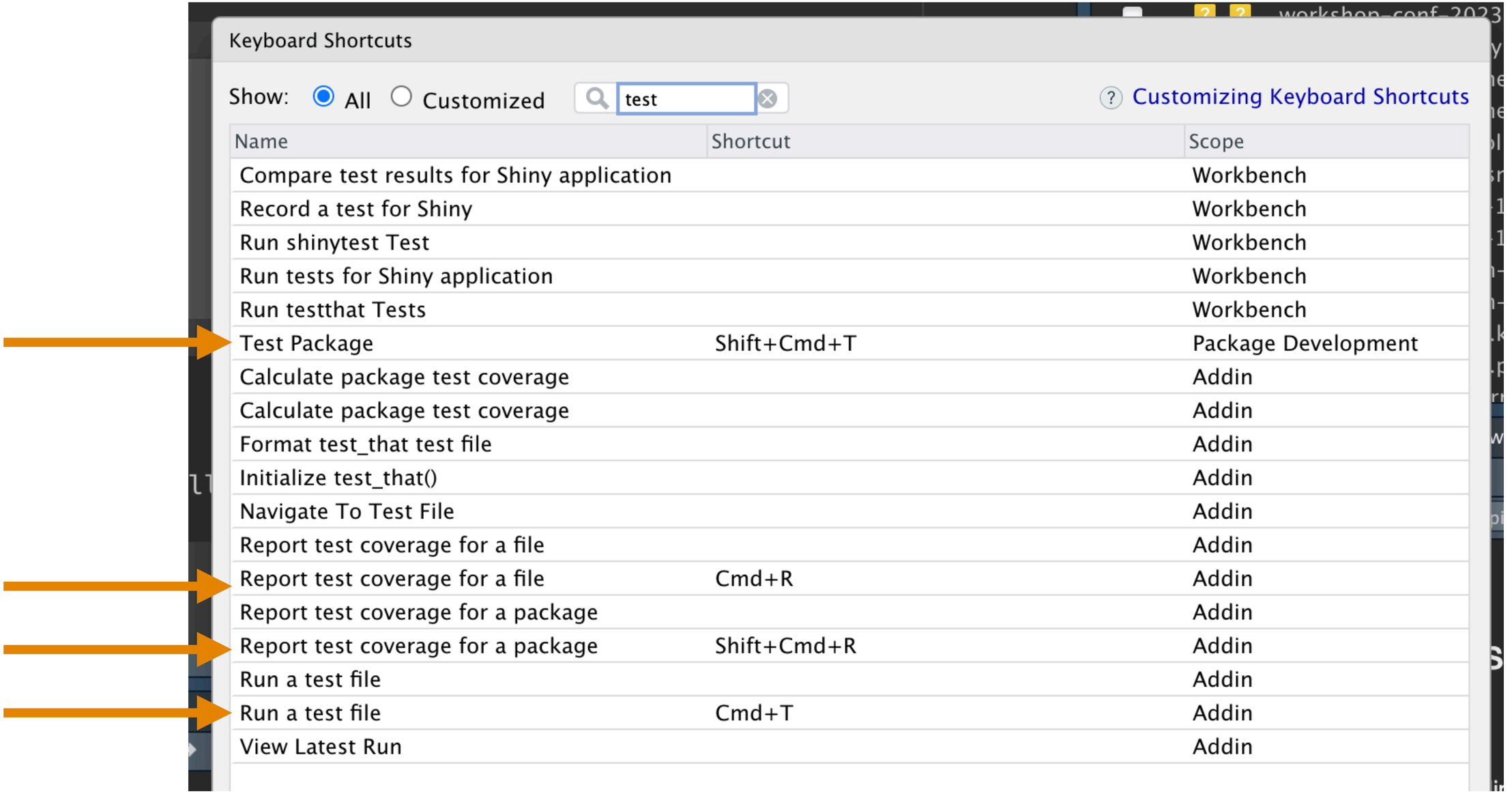
- and tests
  `test_that("foofy does good things", { ... })`

Workflow: mezzo-iteration, whole test file

```
test_file("tests/testthat/test-foofy.R")
```

- In RStudio, with test or R file focused
  ```
  test_active_file()
  test_coverage_active_file()
  ```

*Consider binding these to Cmd + T, Cmd + R


Keyboard Shortcuts
Show: All Customized test
Customizing Keyboard Shortcuts
Name Shortcut Scope
Compare test results for Shiny application Workbench
Record a test for Shiny Workbench
Run shinytest Test Workbench
Run tests for Shiny application Workbench
Run testthat Tests Workbench
Test Package Shift+Cmd+T Package Development
Calculate package test coverage Addin
Calculate package test coverage Addin
Format test_that test file Addin
Initialize test_that() Addin
Navigate To Test File Addin
Report test coverage for a file Addin
Report test coverage for a file Cmd+R Addin
Report test coverage for a package Addin
Report test coverage for a package Shift+Cmd+R Addin
Run a test file Addin
Run a test file Cmd+T Addin
View Latest Run Addin

Workflow: macro-iteration, all files

`test()` Ctrl/Cmd+Shift+T

`test_coverage()` Ctrl/Cmd+Shift+R

`check()` Ctrl/Cmd+Shift+E

Your Turn

Test suite design principles

- A test should be self-sufficient and self-contained.
- The interactive workflow is important.
- Obvious >>> DRY
- Don't let a nonstandard workflow "leak".

Test smell: top-level code that's outside `test_that()`

```
dat <- data.frame(x = c("a", "b", "c"), y = c(1, 2, 3))

skip_if(today_is_a_monday())

test_that("foofy() does this", {
  expect_equal(foofy(dat), ...)
})

dat2 <- data.frame(x = c("x", "y", "z"), y = c(4, 5, 6))

skip_on_os("windows")

test_that("foofy2() does that", {
  expect_snapshot(foofy2(dat, dat2)
})
```

Deodorizing the previous example

```
test_that("foofy() does this", {
  skip_if(today_is_a_monday())

  dat ← data.frame(x = c("a", "b", "c"), y = c(1, 2, 3))

  expect_equal(foofy(dat), ...)
})

test_that("foofy() does that", {
  skip_if(today_is_a_monday())
  skip_on_os("windows")

  dat ← data.frame(x = c("a", "b", "c"), y = c(1, 2, 3))
  dat2 ← data.frame(x = c("x", "y", "z"), y = c(4, 5, 6))

  expect_s3_class(foofy(dat, dat2), "data.frame")
})
```

Move file-scope logic to a narrower scope (as done here) or a broader scope (test setup and/or test helpers).

It's OK to repeat yourself!

Leave the world the way you found it

```
circumference <- function(r) {2 * pi * r}

test_that("calculations work", {
  withr::local_options(digits = 3)
  expect_equal(circumference(r = 8), 50.3))
})
```

withr's `local_*()` functions are super useful for making changes that are scoped to a single `test_that()`.

Things to avoid in your tests

```
library(somedependency)
```

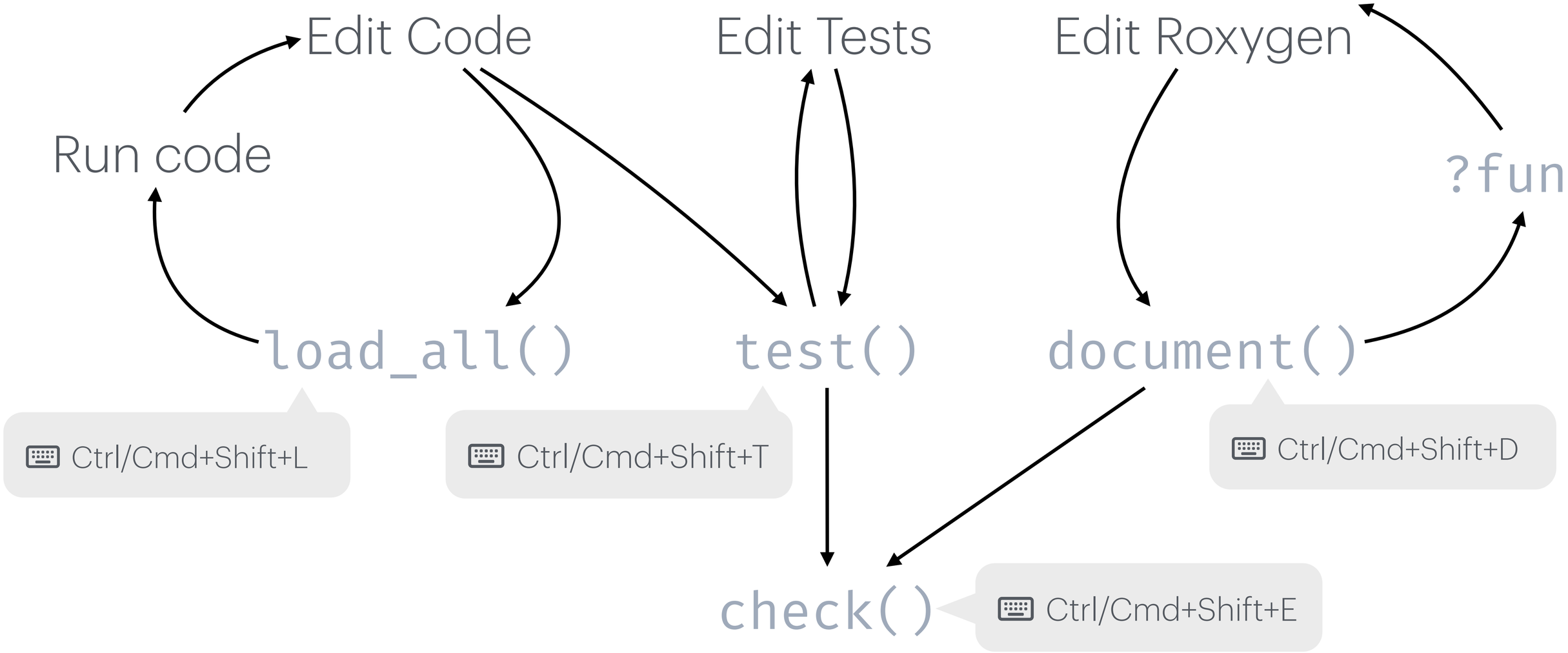
Please no! Access functions from your dependencies, in your tests, exactly as you do below R/.

```
source("stuff-thats-handy-for-your-tests.R")
```

Please no! Unexported helper functions and test helper files are a better mechanism for this.

Workflow

Code + testing + documentation + check



Dependencies

Use functions from another package inside your package

use_package()

Add a dependency

- Use functions from another package inside your package
- Dependencies must be declared
  - Even from included packages (stats::sd(), tools::file_ext() etc.)
- Never call library(pkg) in code below R/!

```
use_package("fs")
#> ✔ Adding 'fs' to Imports field in DESCRIPTION
#> • Refer to functions with `fs::fun()`
```

Listing dependencies in DESCRIPTION

Three options

- Depends:
  - Ensures the package is installed with your package
  - *Attaches the package when yours is attached*
  - Rarely needed or recommended
- Imports:
  - Ensures the package is installed with your package
  - Most common location for dependencies
- Suggests:
  - Does not ensure installation automatically
  - Packages required for development (running tests, building vignettes, etc).
  - Rarely used functionality (especially if the dependency is difficult to install)

devtools DESCRIPTION file:

https://github.com/r-lib/devtools/blob/main/DESCRIPTION

Imports: DESCRIPTION vs NAMESPACE

DESCRIPTION

- Lists packages that your package requires
- Ensures required packages are ***installed*** during package installation
- ***Does not*** import that package into your package's namespace
- Add via use_package() (or manually)

NAMESPACE

- ***Imports*** R objects from another package into your package's namespace
- **import** == Available to be used internally by your package
- Don't edit manually - use roxygen tags:

```
#' @importFrom pkg fun
#' @import pkg
```

3 ways to use functions from another package

1 - Call function with namespace qualifier

1. Add package to DESCRIPTION file in Imports
2. Call function like package::fun()

☑ Most common and recommended pattern

DESCRIPTION

```
Imports:
    purrr
```

R/my-fun.R

```
#' @export
myfun <- function(x) {
   purrr::map(x, mean)
}
```

NAMESPACE

```
export(myfun)
```

3 ways to use functions from another package

2 - Import just the functions you want to use via @importFrom tag:

1. Add package to DESCRIPTION file in Imports
2. Use @importFrom roxygen tags
3. Call function like fun()

DESCRIPTION

```
Imports:
    purrr
```

R/my-fun.R

```
#' @importFrom purrr map
#' @export
myfun <- function(x) {
   map(x, mean)
}
```

NAMESPACE

```
importFrom(purrr, map)
export(myfun)
```

document()

3 ways to use functions from another package

3 - Import the entire package via @import roxygen tag:

1. Add package to DESCRIPTION file in Imports
2. Use @import roxygen tag
3. Call functions like fun()

DESCRIPTION

```
Imports:
    purrr
```

R/my-fun.R

```
#' @import purrr
#' @export
myfun <- function(x) {
   y <- map(x, mean)
   reduce(y, `+`)
}
```

NAMESPACE

```
import(purrr)
export(myfun)
```

3 ways to use functions from another package

1. package::fun()
2. Import just the functions you want to use via @importFrom roxygen tag:

```
#' @importFrom pkg fun1 fun2
```

Adds to `NAMESPACE`:

```
importFrom(pkg, fun1)
importFrom(pkg, fun2)
```

*Shortcut: `usethis::use_import_from("pkg", "function")`

3. Import the entire package with @import:

```
#' @import pkg
```

Adds to `NAMESPACE`:

```
import(pkg)
```

Use your new dependency

Write a function using a function from the dependent package

- use_package("fs")
- Write/edit function using dependency: pkg::fn()
- Edit roxygen comments
- document()
  - Writes man/*.Rd files & regenerates NAMESPACE
- Update tests

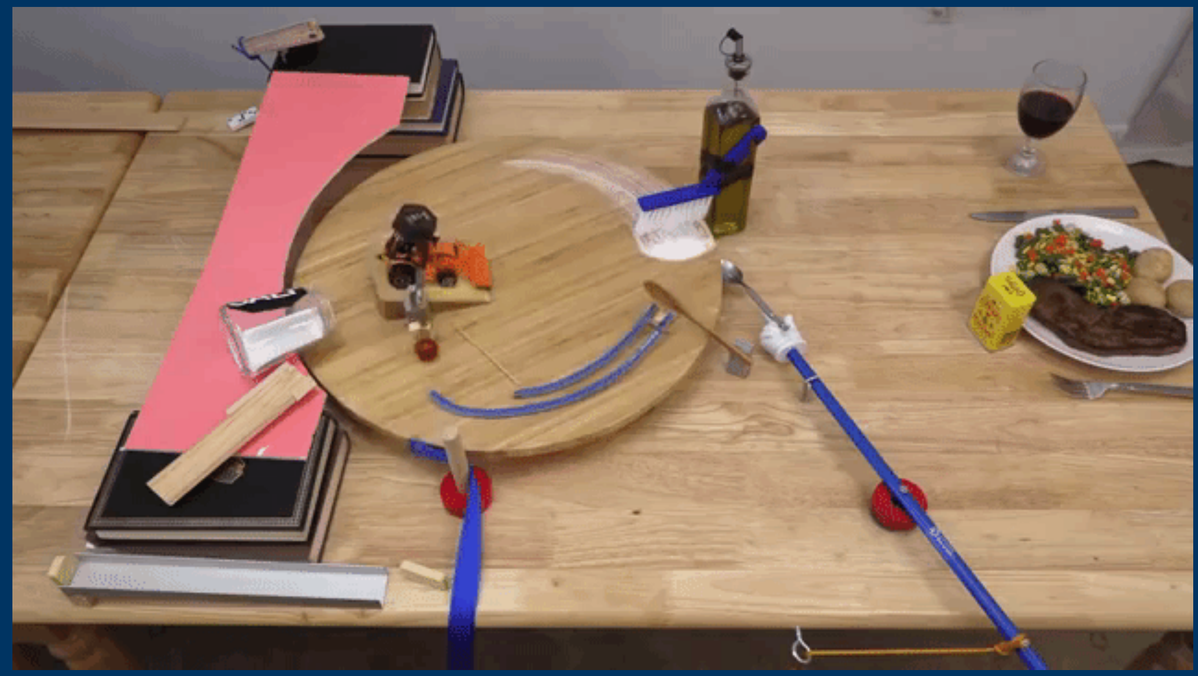
Let’s add one more

use_import_from("pkg", "function")

- See:
  - DESCRIPTION
  - R/mypackage-packge.R (remember use_package_doc()?)
  - NAMESPACE
- Write/edit function using dependency: fn()
- *test()

check()
Commit your changes
Push to GitHub

Continuous Integration



use_github_action()

github.com/r-lib/actions

- "check-standard": Runs R CMD check when you push
- "test-coverage": Compute test coverage and report at codecov.io
    - (Requires an account and API key)
- "pr-commands": Enables automatic documentation and styling of code via special PR comments
- And more…

https://github.com/r-lib/actions/tree/v2-branch/examples

Break Time!

Design Principles

Review: functions

Run once

- `create_package()`
- `use_git()`
- `use_mit_license()`
- `use_testthat()`
- `use_readme_rmd()`

Run periodically

- `use_r()`
- `use_test()`
- `use_package()`
- `rename_files()`
- `build_readme()`
- `use_github_action()`

Run frequently

- `load_all()`

- `document()`

- `test()`

- `check()`

Learning Objectives

- At the end of this section you will be able to:
  - Understand core principles about **function design**
  - Apply the **DRY principle** to avoid redundancy and improve maintainability in your R code
  - Design functions with **default arguments, input validation, and helper functions** for greater clarity and flexibility
  - Enhance **code readability and consistency** by following structured style guidelines and effective naming conventions

Why Design?

Focus on core principles to make R code cleaner and easier to manage

Tidyverse guiding design principles

- Programming is a task performed by **humans**
- Reduce your cognitive load with the **consistent** design (as much as possible)
- Make your functions and systems **composable**
- Think about others who are not like us to create an **inclusive** space

```
cor(1:10, 2:11, "pairwise.complete.obs", “spearman")


cor(1:10, 2:11, use = "pairwise.complete.obs", method = "spearman")
```

Naming things

Some general guidelines

- Use verbs to ascribe as action
- Use consistent style
- Use singular (because English is weird)
- Consider short prefixes to unify package functions
- Don’t be afraid to be verbose

```
## bad
gse(date = “1977-05-25”)
## good
get_salmon_escapement(date = “1977-05-25”)
```

Pure functions versus Side effects

- A pure function:
  - produces the same output for the same input, with no impact on other parts of the program
  - only change is what is returned
  - Easier to test and maintain
- Function with side effects
  - A function that interacts with the outside environment

Pure functions

```
add ← function(x, y) {
  x + y
}
add(2, 3)
#> [1] 5
```

Functions with Side effects

```
library(readr)
read_csv(readr_example("mtcars.csv"))
#> # A tibble: 32 × 11
#>       mpg   cyl  disp    hp  drat    wt  qsec    vs    am  gear  carb
#>     <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
#>  1  21        6  160    110  3.9   2.62  16.5     0     1     4     4
#>  2  21        6  160    110  3.9   2.88  17.0     0     1     4     4
#>  3  22.8      4  108     93  3.85  2.32  18.6     1     1     4     1
#>  4  21.4      6  258    110  3.08  3.22  19.4     1     0     3     1
#>  5  18.7      8  360    175  3.15  3.44  17.0     0     0     3     2
#>  6  18.1      6  225    105  2.76  3.46  20.2     1     0     3     1
#>  7  14.3      8  360    245  3.21  3.57  15.8     0     0     3     4
```

The DRY Principle: Don’t Repeat Yourself

What is DRY?

- Minimize redundancy by centralizing logic

- Benefits
  - Consistency
  - Easier debugging
  - Maintenance

The DRY Principle: Don’t Repeat Yourself

Identifying Redundant Code

- Signs of redundant code
  - Repeated data transformations
  - Hardcoded values

- Think MODULAR

- Look for patterns

The DRY Principle: Don’t Repeat Yourself

Refactor to use functions

```r
# Without DRY
se_age ← sd(df$age) / sqrt(length(df$age))
se_income ← sd(df$income) / sqrt(length(df$income))

# With DRY
se ← function(x) sd(x) / sqrt(length(x))

# Now we can reuse the function for any column
se_age ← se(df$age)
se_income ← se(df$income)
```

Helper Functions

- Breaking (**decompose**) up Large Functions
  - Limitations of lengthy, complex functions
  - How small, focused functions increase readability and testing ease
- Can make help to DRY but also has value to itself
- When and How to Use Helper Functions
  - Define helper functions to handle subtasks within a larger function

Helper Functions

Example

```
sum_of_squares ← function(a, b) {
  (a * a) + (b * b)
}

sum_of_squares(3, 5)
#> [1] 34
```

Helper Functions

Example

```
square ← function(x) {
  x * x
}

sum_of_squares ← function(a, b) {
  square(a) + square(b)
}
sum_of_squares(3, 5)
#> [1] 34
```

Helper Functions

libminer

```r
lib_summary ← function(sizes = FALSE) {
  pkgs ← utils::installed.packages()
  pkg_tbl ← table(pkgs[, "LibPath"])
  pkg_df ← as.data.frame(pkg_tbl, stringsAsFactors = FALSE)
  names(pkg_df) ← c("Library", "n_packages")

  if (sizes) {
    pkg_df$lib_size ← map_dbl(
      pkg_df$Library,
      ~ sum(fs::file_size(fs::dir_ls(.x, recurse = TRUE))),
    )
  }
  pkg_df
}
```

check()
Commit your changes
Push to GitHub

Arguments

- What Are Function Arguments?
  - Values passed to a function that specify how it should operate
  - Allow customization and flexibility in function behaviour
- Types of Arguments
  - Required arguments: Must be provided when the function is called
  - Default arguments: Have preset values; can be overridden
  - Variable arguments: Use ... to accept a flexible number of inputs

Default Argument Values

- Why Use Default Arguments?
  - Adds flexibility by setting typical values that simplify function calls.
  - Allow functions to handle common cases without needing all arguments specified every time.
  - Useful in cases where arguments have default values that cover frequent use-cases

Arguments

Refactor to use functions

```
greet ← function(name, greeting = "Hello") {
  paste(greeting, name)
}


# Usage
greet(name = "Andy")
#> [1] "Hello Andy"
greet(name = "Andy", greeting = "Hi")
#> [1] "Hi Andy"
```

Default Argument Values

Setting Defaults

- Use defaults for parameters that often remain the same, making it easier to call the function without redundant inputs.
- Avoid defaults that might hide potential issues (e.g., setting a default that could lead to silent errors if overlooked).
- Document defaults clearly, so it’s clear what will happen if arguments are left unspecified.

```
  #' @param name a person's name.
  #' @param greeting the greeting you wish to choose. defaults to
"Hello"
```

Input Checking and Validation

Why Input Checking Matters

- Prevents Unexpected Errors: Ensures that the function receives valid inputs, reducing the likelihood of errors.
- Improves Code Robustness: Increases confidence in code behaviour
- Helps make failures intentional by catching errors early in the process, making debugging easier by validating assumptions

Tools for Input Checking

- Packages: assertthat, check, validate
- Built-in functions: stop, is.numeric, is.character

Input Checking and Validation

An example

```
calculate_area ← function(length, width) {
  area ← length * width
  area)
}
calculate_area(4, 2)
#> [1] 8
```

Input Checking and Validation

An example - bad inputs!

```
calculate_area(-5, 2)
#> [1] -10
calculate_area('5', 2)
#> Error in length * width: non-numeric argument to binary operator
```

Input Checking and Validation

An example - bad inputs!

```
calculate_area ← function(length, width) {
  if (length ⩽ 0 || width ⩽ 0) {
    stop("Length and width must be positive numbers.", call. = FALSE)
  }
  area ← length * width
  area
}
calculate_area(-5, 2)
#> Error: Length and width must be positive numbers.
```

Input Checking and Validation

An example - bad inputs!

```
calculate_area('5', 2)
#> Error in length * width: non-numeric argument to binary operator
```

Quickly back to helper functions

```
validate_inputs ← function(length, width) {
  if (length ⩽ 0 || width ⩽ 0) {
    stop("Length and width must be positive numbers.", call. = FALSE)
  }
  if (!is.numeric(length) || !is.numeric(width)) {
    stop("Length and width must be a number.", call. = FALSE)
  }
}
```

Quickly back to helper functions

```
calculate_area ← function(length, width) {
  validate_inputs(length, width)
  area ← length * width
  area
}
calculate_area(-5, 2)
#> Error: Length and width must be positive numbers.
calculate_area('5', 2)
#> Error: Length and width must be a number.
```

Your Turn

libminer::Input Checking and Validation

```
lib_summary ← function(sizes = FALSE) {
  pkg_df ← lib()
  pkg_df ← table(pkg_df$LibPath)
  names(pkg_df) ← c("Library", "n_packages")

  if (sizes) {
    pkg_df ← calculate_sizes(pkg_df)
  }
  pkg_df
}
```

Code Style of Readability

Why should you care about code readability?

Facilitates Teamwork

- Clear and consistent code makes it easier for team members to understand each other's work, enhancing collaboration.

Enhances Maintainability

- Readable code simplifies debugging and updates, making it easier to maintain and extend functionality.

Reduces cognitive load

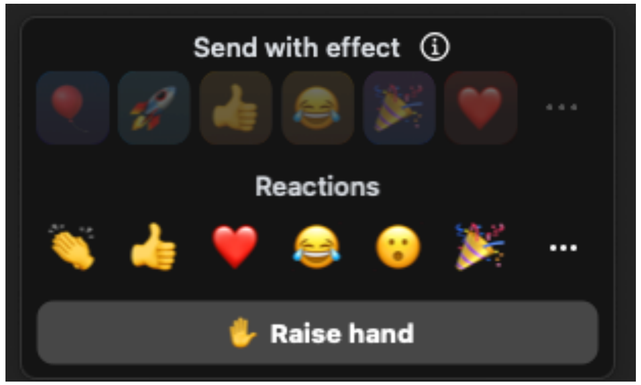
- Well-structured code reduces the time spent reading and understanding code, allowing developers to focus on problem-solving.

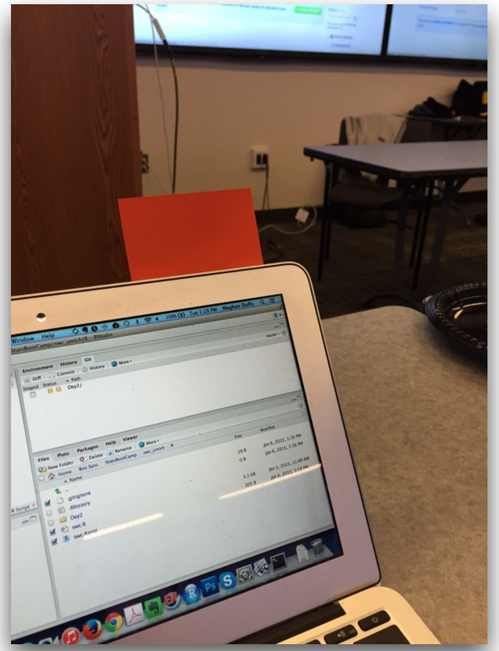
Day two complete!

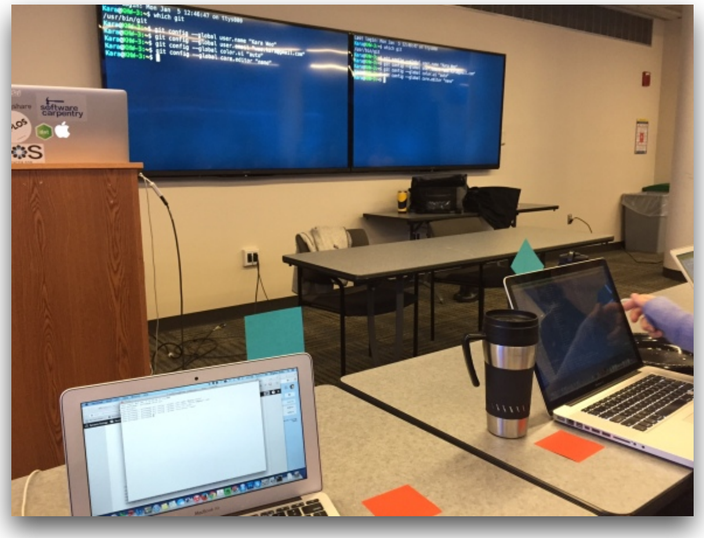
Welcome back to day three

Sticky Notes

I’m stuck, please send help







I’m good, let’s move on

Day 3: Schedule and Learning Objectives

2024-11-06		
08:00 - 09:20	Website Creation & Using the Tidyverse in Your Package	80 min
09:20 - 09:35	Break	15 min
09:35 - 10:55	Using the Tidyverse in Your Package part 2	80 min
10:55 - 11:10	Break	15 min
11:10 - 12:30	Communicating with your Users & Distribution & General Discussion	80 min

Website Creation and Long Form Documentation

Why make a website?

- Professional Documentation
  - Offers a polished interface that enhances the credibility of your package.
- Improved Accessibility
  - Makes documentation easily accessible online, allowing potential users to quickly find information, tutorials, and examples.
- Enhanced Discoverability
  - Increases visibility of your package, helping users easily learn about its features and functionalities.
- It’s easy!

use_pkgdown_github_pages()

pkgdown.r-lib.org/

- Automatically creates a website using pkgdown:
  - Function documentation
  - Dataset documentation
  - Vignettes (and articles)
  - README and NEWS
- Sets up a GitHub Action to deploy on GitHub Pages

Your Turn

Vignettes

Long-form documentation

- `use_vignette()` is a good way to initiate a vignette
- `use_article()` initiates a article that only exists in the pkgdown website
- Today these functions create an `.Rmd` document
- pkgdown just gained experimental support for Quarto (`.qmd`) and usethis will adapt soon
- A vignette or article focuses on how to solve a target problem, versus documenting a specific function

Vignettes

Long-form documentation

- Vignettes can only use packages you formally depend on, i.e. they appear in `Imports` or `Suggests`
- Help topics live as `.Rd` files in a source package, but there's no equivalent for rendered vignettes
  - Creates some inherent awkwardness in vignette workflow
- Similar to examples, `R CMD check` treats vignettes like big, weird tests.
  - Creates tension between showing realistic usage and ensuring the code can be evaluated, 100% of the time and quickly.
  - Challenges: wrapping an external service, long-running code, etc.

Eval chunk option

- `eval` chunk option controls whether code is evaluated
- Similar to `@examplesIf`, you can call a function to determine if it's safe to evaluate a chunk

- `eval = requireNamespace("somedependency")`
- `eval = !identical(Sys.getenv("SOME_THING_YOU_NEED"), "")`
- `eval = file.exists("credentials-you-need")`

- You can use `eval` local to individual chunks or set it globally in a setup chunk.

```{r setup, include = FALSE}
can_decrypt <- gargle:::secret_can_decrypt("googlesheets4")
knitr::opts_chunk$set(
  collapse = TRUE,
  comment = "#>",
  error = TRUE,
  eval = can_decrypt
)
```

```{r eval = !can_decrypt, echo = FALSE, comment = NA}
message("No token available. Code chunks will not be evaluated.")
```

```{r index-auth, include = FALSE}
googlesheets4:::gs4_auth_docs()
```

Using the tidyverse in your package

Learning Objectives

- At the end of this section you will be able to:
  - build functions that call tidyverse functions, using bare-name arguments:
    - designed for interactive use, i.e. like dplyr::filter()
  - understand terms: **data masking**, **tidy select**, **dynamic dots**

Tidy Evaluation

Motivation

- Tidy eval (and non-standard evaluation generally in R) exists so that we can refer to data columns directly using bare names.
  - `dplyr::filter(mtcars, cyl == 4)`

  vs

  - `mtcars[mtcars$cyl == 4, ]`

- It makes things easier if you are working interactively (it allows *indirection*).
- It makes things more interesting if you are writing functions.

Welcome to *more interesting*.

Families of Tidy-eval Functions

- **data-masking:** compute on values within a dataset:

```
mtcars |>
   dplyr::mutate(wt_kg = wt * 1000 / 2.2)
```

- **tidy-select:** specify columns within a dataset

```
mtcars |>
   dplyr::select(starts_with("w"))
```

Families of Tidy-eval Functions

- **data-masking:** evaluate variables in context of data frame:

`arrange()`, `count()`, `filter()`, `group_by()`, `mutate()`, and `summarize()`

- **tidy-select:** specify columns within a data frame

`across()`, `relocate()`, `rename()`, `select()`, and `pull()`

Data Masking

Two types of variables

- `mtcars`, `starwars` - datasets, variables available in the environment
  - **environment-variables**

- `cyl`, `mpg`, `homeworld`, and `species` - columns in datasets, variables available in data
  - **data-variables**

Data Masking

Evaluate variables in the context of a data frame

```
starwars[starwars$homeworld == "Naboo" & starwars$species == "Human", ]

starwars |>
  filter(homeworld == "Naboo", species == "Human")

mtcars |>
  group_by(cyl) |>
  summarise(n = n(), mpg = mean(mpg))
```

Data Masking

Identify env-variables vs data-variables

```
starwars[starwars$homeworld == "Naboo" & starwars$species == "Human", ]

starwars |>
  filter(homeworld == "Naboo", species == “Human")

mtcars |>
  group_by(cyl) |>
  summarise(n = n(), mpg = mean(mpg))
```

Programming with data variables

```
var_summary <- function(data, var) {
  data |>
    summarise(
      min = min(var),
      max = max(var)
    )
}
```

```
mtcars |>
  group_by(cyl) |>
  var_summary(mpg)
#> Error in `summarise()`:
#> ℹ In argument: `min = min(var)`.
#> ℹ In group 1: `cyl = 4`.
#> Caused by error:
#> ! object 'mpg' not found
```

Programming with data variables

{{ embrace }} data variables as function arguments

```
var_summary <- function(data, var) {
  data |>
    summarise(
      min = min({{ var }}),
      max = max({{ var }})
    )
}
```

```
mtcars |>
  group_by(cyl) |>
  var_summary(mpg)
#> # A tibble: 3 × 3
#>     cyl   min   max
#>   <dbl> <dbl> <dbl>
#> 1     4  21.4  33.9
#> 2     6  17.8  21.4
#> 3     8  10.4  19.2
```

Programming with data variables

Use `.data$[[]]` for function arguments passed as characters

```
var_summary <- function(data, var) {
  data |>
    summarise(
      min = min(.data[[var]]),
      max = max(.data[[var]])
    )
}
```

```
mtcars |>
  group_by(cyl) |>
  var_summary("mpg")
#> # A tibble: 3 × 3
#>     cyl   min   max
#>   <dbl> <dbl> <dbl>
#> 1     4  21.4  33.9
#> 2     6  17.8  21.4
#> 3     8  10.4  19.2
```

Programming with data variables

Use `.data$` pronoun for variables you know about

```
big_cars_summary <- function(var) {
  mtcars |>
    filter(.data$cyl >= 6) |>
    group_by(.data$cyl) |>
    summarise(
      n = n(),
      mean = mean({{ var }}),
    )
}
```

```
big_cars_summary(disp)
#> # A tibble: 2 × 3
#>     cyl     n  mean
#>   <dbl> <int> <dbl>
#> 1     6     7  183.
#> 2     8    14  353.
```

Write a function that summarizes one or more variables in `starwars` by any grouping variable

```
library(dplyr)
head(starwars)
#> # A tibble: 6 × 14
#>   name      height  mass hair_color skin_color eye_color birth_year sex   gender
#>   <chr>      <int> <dbl> <chr>      <chr>      <chr>           <dbl> <chr> <chr>
#> 1 Luke Sky…    172    77 blond      fair       blue             19   male  mascu…
#> 2 C-3PO        167    75 <NA>       gold       yellow          112   none  mascu…
#> 3 R2-D2         96    32 <NA>       white, bl… red              33   none  mascu…
#> 4 Darth Va…    202   136 none       white      yellow           41.9 male  mascu…
#> 5 Leia Org…    150    49 brown      light      brown            19   fema… femin…
#> 6 Owen Lars    178   120 brown, gr… light      blue             52   male  mascu…
#> # ℹ 5 more variables: homeworld <chr>, species <chr>, films <list>,
#> #   vehicles <list>, starships <list>
```

* Do this in a file that is not inside `R/`
* Add path to `.Rbuildignore`

Write a function that summarizes one or more variables in `starwars` by any grouping variable

```
height_sum <- function(data, group_var) {
  data |>
    dplyr::group_by({{ group_var }}) |>
    dplyr::summarise(
      n = dplyr::n(),
      mean_height = mean(.data$height)
    )
}

height_sum(starwars, hair_color)
```

Modify that function to take > 1 grouping variables

- Hint: '...' can get passed through unaltered.

Modify that function to take > 1 grouping variables

```
height_sum <- function(data, ...) {
  data |>
    dplyr::group_by(...) |>
    dplyr::summarise(
      n = dplyr::n(),
      mean_height = mean(.data$height)
    )
}

height_sum(starwars, hair_color, eye_color)
```

Data Masking - Summary

- dplyr: `arrange()`, `filter()`, `group_by()`, `mutate()`, and `summarise();`
- ggplot2: `aes()`

- Data-variable is passed as a **function argument** x:
  - `arrange(df, {{ x }})`
- You (as developer) know the **data-variable** is x:
  - `arrange(df, .data$x)`
- Name of data-variable is a **character string** in an **env-variable** x:
  - `arrange(df, .data[[x]])`

- Remember `...` can be passed through - no special treatment required.

Name injection with dynamic dots

Dynamically create new variable names

- Generate names programmatically by using `:=` instead of `=`
- Two ways:
  - From a variable containing a string using `{glue}` syntax
  - From a data variable using `{{embrace}}` syntax

- To use in your package:

```
usethis::use_import_from("rlang", ":=")
```

Name injection with dynamic dots

Dynamically create new variable names

```
var_summary <- function(data, var, new_col_name) {
  data |>
    summarise(
      “{new_col_name}" := min({{ var }})
    )
}
```

```
mtcars |>
  group_by(cyl) |>
  var_summary(mpg, new_col_name = "min_mpg")
#> # A tibble: 3 × 2
#>     cyl min_mpg
#>   <dbl>   <dbl>
#> 1     4    21.4
#> 2     6    17.8
#> 3     8    10.4
```

Name injection with dynamic dots

Dynamically create new variable names

```
var_summary <- function(data, var) {
  data |>
    summarise(
      "{{var}}_min" := min({{ var }})
    )
}
```

```
mtcars |>
  group_by(cyl) |>
  var_summary(mpg)
#> # A tibble: 3 × 2
#>     cyl mpg_min
#>   <dbl>   <dbl>
#> 1     4    21.4
#> 2     6    17.8
#> 3     8    10.4
```

Write a function that summarizes `starwars`, and dynamically creates new column names

```
library(dplyr)
head(starwars)
#> # A tibble: 6 × 14
#>   name      height  mass hair_color skin_color eye_color birth_year sex   gender
#>   <chr>      <int> <dbl> <chr>      <chr>      <chr>           <dbl> <chr> <chr>
#> 1 Luke Sky…    172    77 blond      fair       blue             19   male  mascu…
#> 2 C-3PO        167    75 <NA>       gold       yellow          112   none  mascu…
#> 3 R2-D2         96    32 <NA>       white, bl… red              33   none  mascu…
#> 4 Darth Va…    202   136 none       white      yellow           41.9 male  mascu…
#> 5 Leia Org…    150    49 brown      light      brown            19   fema… femin…
#> 6 Owen Lars    178   120 brown, gr… light      blue             52   male  mascu…
#> # ℹ 5 more variables: homeworld <chr>, species <chr>, films <list>,
#> #   vehicles <list>, starships <list>
```

* Do this in a file that is not inside `R/`
* Add path to `.Rbuildignore`

Write a function that summarizes `starwars`, and dynamically creates new column names

```
dynamic_sum <- function(data, group_var, sum_var) {
  data |>
    dplyr::group_by({{ group_var }}) |>
    dplyr::summarise(
      n = dplyr::n(),
      "mean_{{sum_var}}" := mean({{ sum_var }})
    )
}

dynamic_sum(starwars, hair_color, mass)
```

Tidy Selection

Select columns in a data frame

- Using bare names, or tidyselect helpers:
  - `select(df, 1)`: selects the first column
  - `select(df, last_col())` selects the last column.
  - `select(df, c(a, b, c))` selects columns `a`, `b`, and `c`.
  - `select(df, starts_with("a"))` selects all columns whose name starts with “`a`”
  - `select(df, ends_with("z"))` selects all columns whose name ends with “`z`”.
  - `select(df, where(is.numeric))` selects all numeric columns.
- Using character vectors:
  - `select(df, all_of(c("a", "b", "c"))` strictly selects all specified
  - `select(df, any_of(c("a", "b", "c"))` selects specified columns if they exist

`dplyr::across()`

- Used inside *data-masking* verbs, e.g., `summarize()`
- Specify:
  - Which columns to consider, using *tidy-select*
  - What functions to apply, if any

```
mtcars |>
  dplyr::group_by(cyl) |>
  dplyr::summarise(
    dplyr::across(c("mpg", "disp"), mean)
  )
#> # A tibble: 3 × 3
#>     cyl   mpg  disp
#>   <dbl> <dbl> <dbl>
#> 1     4  26.7  105.
#> 2     6  19.7  183.
#> 3     8  15.1  353.
```

all_of(); any_of()

- Used to disambiguate external vector (env-var) of column names
- `all_of()` is strict

```
cols <- c("mpg", "disp", "xyz")
mtcars |>
  dplyr::group_by(cyl) |>
  dplyr::summarise(
    dplyr::across(dplyr::all_of(cols), mean)
  )
#> Error in `dplyr::summarise()`:
#> ℹ In argument: `dplyr::across(dplyr::all_of(cols), mean)`.
#> ! Can't subset elements that don't exist.
#> ✖ Element `xyz` doesn't exist.
```

all_of(); any_of()

- Used to disambiguate external vector (env-var) of column names
- `any_of()` is permissive

```
cols <- c("mpg", "disp", "xyz")
mtcars |>
  dplyr::group_by(cyl) |>
  dplyr::summarise(
    dplyr::across(dplyr::any_of(cols), mean)
  )
#> # A tibble: 3 × 3
#>     cyl   mpg  disp
#>   <dbl> <dbl> <dbl>
#> 1     4  26.7  105.
#> 2     6  19.7  183.
#> 3     8  15.1  353.
```

Tidyversify libminer

- Use:
  - tidyverse functions
  - Data Masking with `{{ }}`
  - Data Masking with `.data`
  - `...`
  - `across()` and `any_of()`
- Update tests
- Update documentation

Break Time!

Communicating with your user

Signaling Conditions

Three conditions

- **Errors**
  - most severe
  - no way for a function to continue and execution must stop.
- **Warnings**
  - in between errors and message
  - something has gone wrong or is unexpected but the function has executed
- **Messages**
  - mildest
  - Inform users that some action has been performed on their behalf.

Signaling Conditions

Three conditions

- **Errors**
  - `stop("You provided an invalid input")`
- **Warnings**
  - `warning("Unknown value converted to NA")`
- **Messages**
  - `message("Reticulating splines… this may take a while")`

Conditions are better than `cat()`

- They inherently indicate the severity of the message
- They can be handled in special ways with things like `try()`, `tryCatch()`, etc.
- Warnings and messages can silenced by users:

```
chatty <- function() {
  message("Hello there!")
  warning("You have been warned!")
}

chatty()
#> Hello there!
#> Warning in chatty(): You have been warned!

suppressMessages(chatty())
#> Warning in chatty(): You have been warned!

suppressWarnings(chatty())
#> Hello there!
```

beautiful command line interfaces

With the {cli} package

- Build a CLI using semantic elements: headings, bullet lists, etc.
- All cli text can contain interpreted string literals, via the glue package.
- Support for pluralization and list concatenation.
- Inline text formatting.
- Text wrapping.
- Theming via a CSS-like language.
- Progress bars from R and C code.
- Emit conditions -- messages, warnings, and errors -- with rich text formatting.

usethis's UI is built with cli

Character vector of lines.

Names control the type of bullet.

```
> ui_bullets(c(
+   "v" = "A great success!",
+   "_" = "Something you need to do.",
+   "x" = "Bad news.",
+   "i" = "The more you know.",
+   " " = "I'm just here for the indentation.",
+   "No indentation at all. Not used much in usethis."
+ ))
✔ A great success!
☐ Something you need to do.
✖ Bad news.
ℹ The more you know.
  I'm just here for the indentation.
No indentation at all. Not used much in usethis.
```

cli's greatest hits

- Single line alerts:
  - `cli_alert_success()`, `cli_alert_danger()`, `cli_alert_info()`, `cli_alert_warning()`

- Multi-line bullet lists:
  - `cli_bullets()`

- Conditions with all the cli (+ rlang) goodness
  - `cli_inform()`, alternative for `message()` or `rlang::inform()`
  - `cli_warn()`, alternative for `warning()` or `rlang::warn()`
  - `cli_abort()`, alternative for `stop()` or `rlang::abort()`

* All cli outputs are `message` conditions and can be handled as such

Interpolation

Code inside curly braces is evaluated, a la the glue package.

```
> pkgs <- "pkg1"
> cli_text("Will install the {pkgs} package")
Will install the pkg1 package
```

Pluralization

```
> nfiles <- 0; cli_text("Found {nfiles} file{?s}")
Found 0 files
> nfiles <- 1; cli_text("Found {nfiles} file{?s}")
Found 1 file
> nfiles <- 2; cli_text("Found {nfiles} file{?s}")
Found 2 files
```

Pluralization and concatenation

```
> pkgs <- "pkg1"
> cli_text("Will install the {pkgs} package{?s}")
Will install the pkg1 package

> pkgs <- c("pkg1", "pkg2", "pkg3")
> cli_text("Will install the {pkgs} package{?s}")
Will install the pkg1, pkg2, and pkg3 packages
```

Inline text formatting

"{.thm text}"

```
cli_bullets(c(
  "*" = "{.emph Emphasized} text",
  "*" = "{.strong Strong} importance",
  "*" = "A piece of code: {.code sum(a) / length(a)}",
  "*" = "A package name: {.pkg cli}",
  "*" = "A function name: {.fn cli_text}",
  "*" = "A keyboard key: press {.kbd ENTER}",
  "*" = "A file name: {.file /usr/bin/env}",
  "*" = "An email address: {.email bugs.bunny@acme.com}",
  "*" = "A URL: {.url https://acme.com}",
  "*" = "An environment variable: {.envvar R_LIBS}",
  "*" = "Some {.field field}"
))
```

- *Emphasized* text
- **Strong** importance
- A piece of code: `sum(a) / length(a)`
- A package name: cli
- A function name: `cli_text()`
- A keyboard key: press [ENTER]
- A file name: /usr/bin/env
- An email address: bugs.bunny@acme.com
- A URL: <https://acme.com>
- An environment variable: `R_LIBS`
- Some field

Help topic links

```
> cli_text("Try out the {.fun cli::cli_abort} function")
Try out the `cli::cli_abort()` function
```

The function is styled as a function (backticks and parentheses).

Click on it to open the help topic.

File hyperlinks

```
> cli_text("A file name: {.file DESCRIPTION}")
A file name: DESCRIPTION.
```

In RStudio and Positron, this link will open DESCRIPTION (assuming we're in a package, of course).

URLs

```
> cli_text(
    "See the cli homepage at {.url https://cli.r-lib.org} for details"
)
See the cli homepage at <https://cli.r-lib.org> for details.
```

A clickable hyperlink with no custom link text.

Hyperlinks

Markdown-style hyperlinks

```
> cli_text(
    "See the {.href [cli homepage](https://cli.r-lib.org)} for details"
)
See the cli homepage for details.
```

A clickable hyperlink with custom link text.

Formatting plus interpolation

Use double curly braces

```
> cli_url <- "https://cli.r-lib.org"
> cli_text(
  "See the cli homepage at {.url {cli_url}} for details"
)
See the cli homepage at <https://cli.r-lib.org> for details.
```

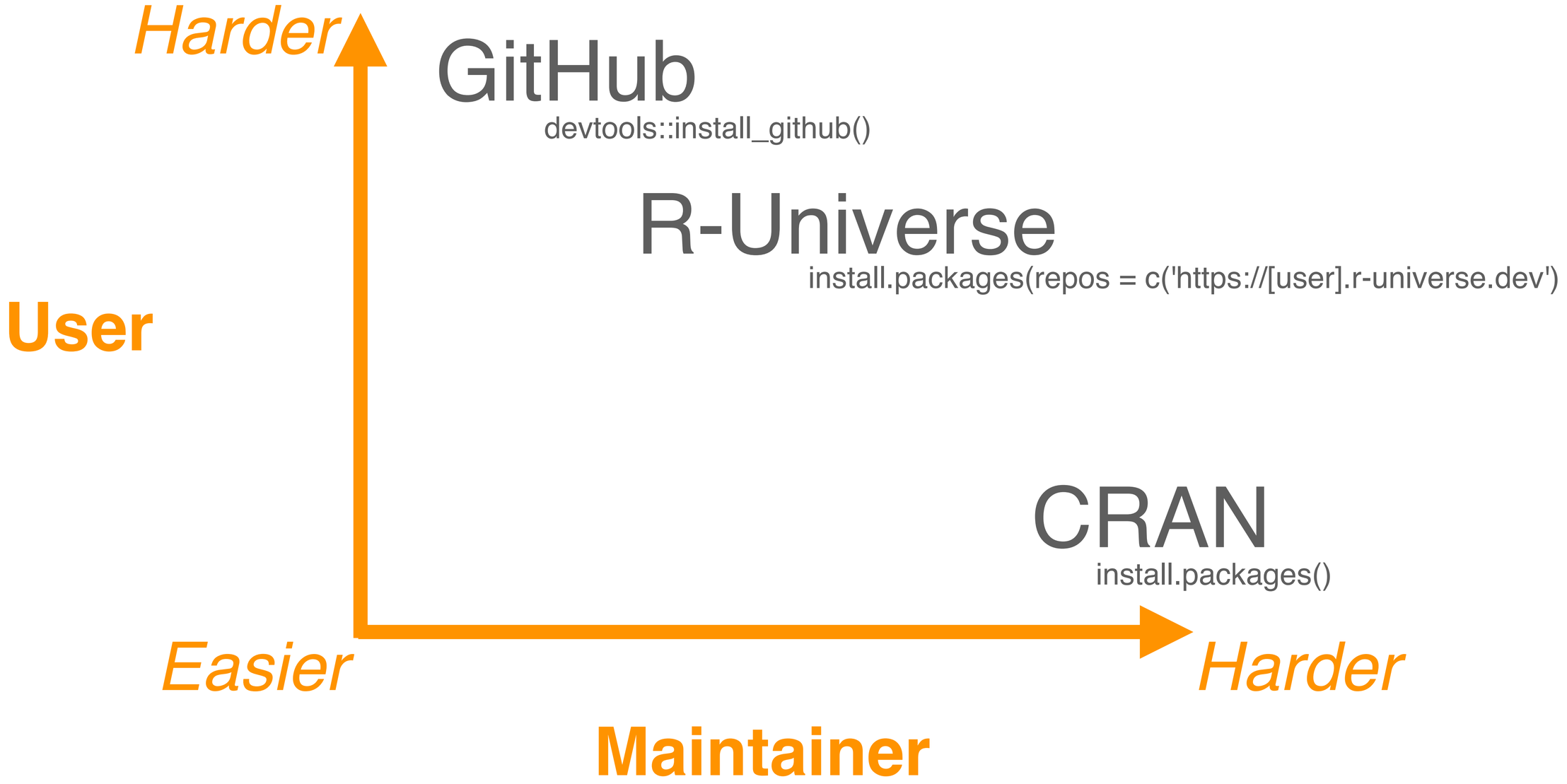
Your turn! Some prompts

- Choose a package: libminer or one of your own
- Study the existing user interface (which functions are used?).
- Incrementally convert the UI-providing functions (e.g. `message()` or `stop()`) to its cli equivalent.
- Add some more bling
- Look at the cli documentation, especially:
  - cli's articles: https://cli.r-lib.org/articles/index.html
  - Help topics in the "Introduction" section here: https://cli.r-lib.org/reference/index.html

Break Time!

Sharing your Package

Package Distribution



Releasing your package to CRAN

Releasing to CRAN

TLDR:

- `release()`
  - Runs through an additional list of checks
  - Builds package bundle and submits to CRAN

use_news_md()

Adds a NEWS.md file to your package

- Tracks version numbers
- Tracks user-facing changes between versions

use_cran_comments()

Comments that go along with your submission

```
## R CMD check results

0 errors | 0 warnings | 1 note

* This is a new release.
```

- Most times don’t need more than this
- Note if you are fixing failures seen in CRAN checks
- Note reverse dependency checks
- If your submission was rejected, note that it is a resubmission and say how you have addressed the issues

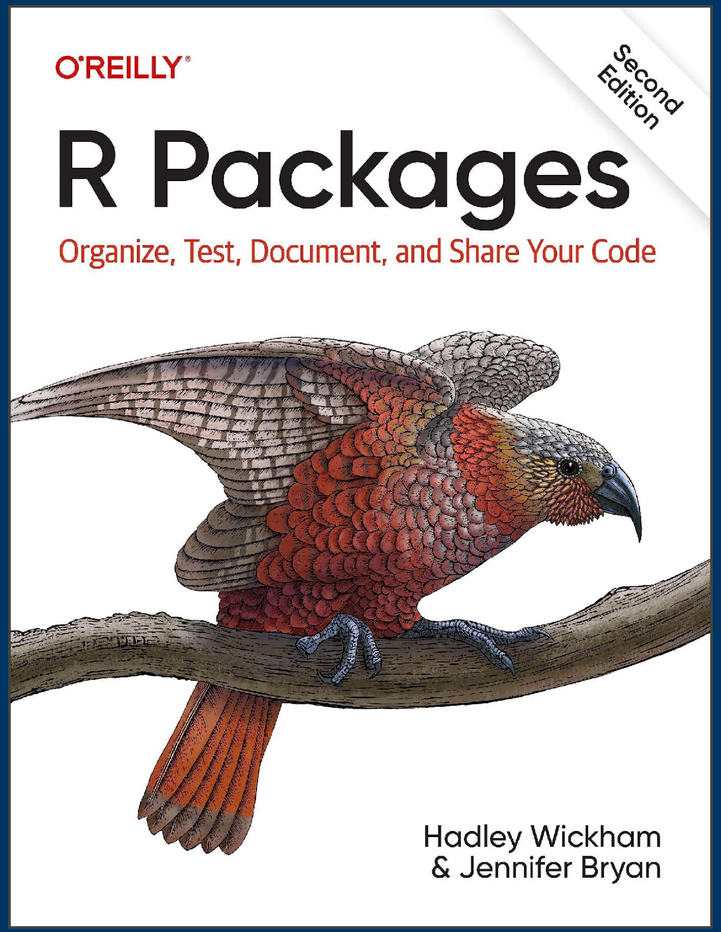
*There is always one NOTE with initial submission

DFO Package Discussion

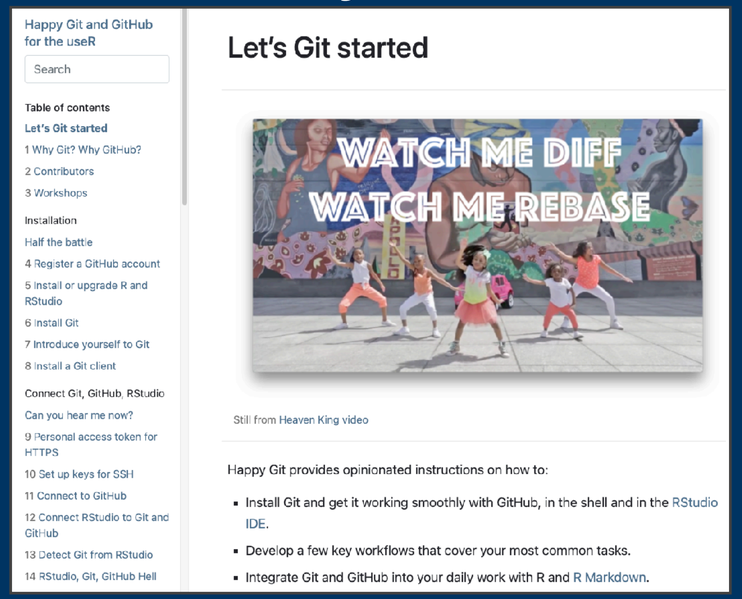
Thank You!

Resources

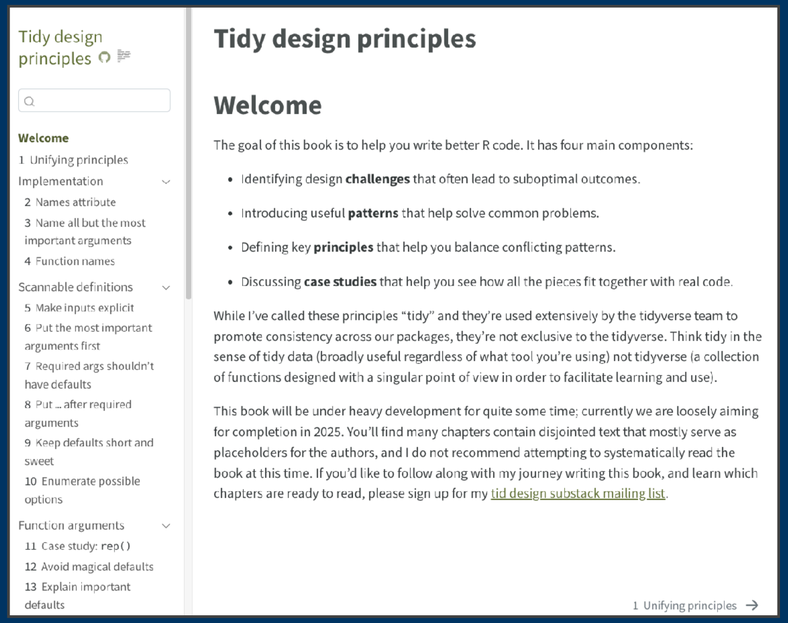
https://community.rstudio.com/c/package-development



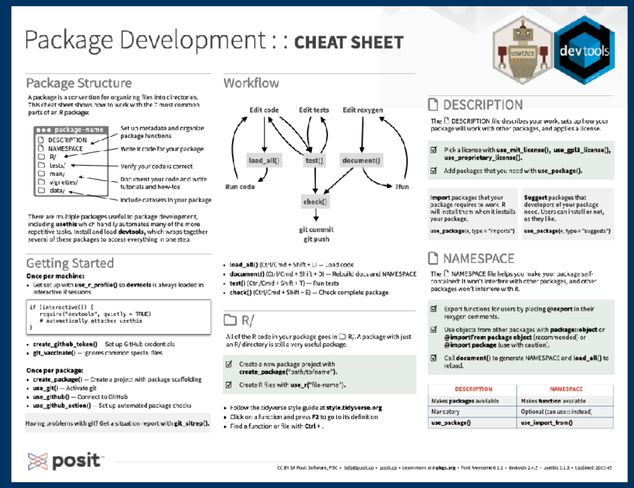
r-pkgs.org



happygitwithr.com



design.tidyverse.org
tidydesign.substack.com



posit.co/resources/cheatsheets/

Attribution

- https://github.com/posit-conf-2024/pkg-dev
- https://cli.r-lib.org/articles/index.html
- https://adv-r.hadley.nz/conditions.html
- https://rstudio-conf-2022.github.io/build-tidy-tools/
- https://dplyr.tidyverse.org/articles/programming.html
- https://design.tidyverse.org/

Course Materials

https://andyteucher.ca/pkg-dev-dfo-2024-11

Survey

Your feedback is crucial! Please complete the post-workshop survey! 🙏

Data from the survey informs curriculum and format decisions for future workshops, and we really appreciate you taking the time to provide it.