Unit testing

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Motivation

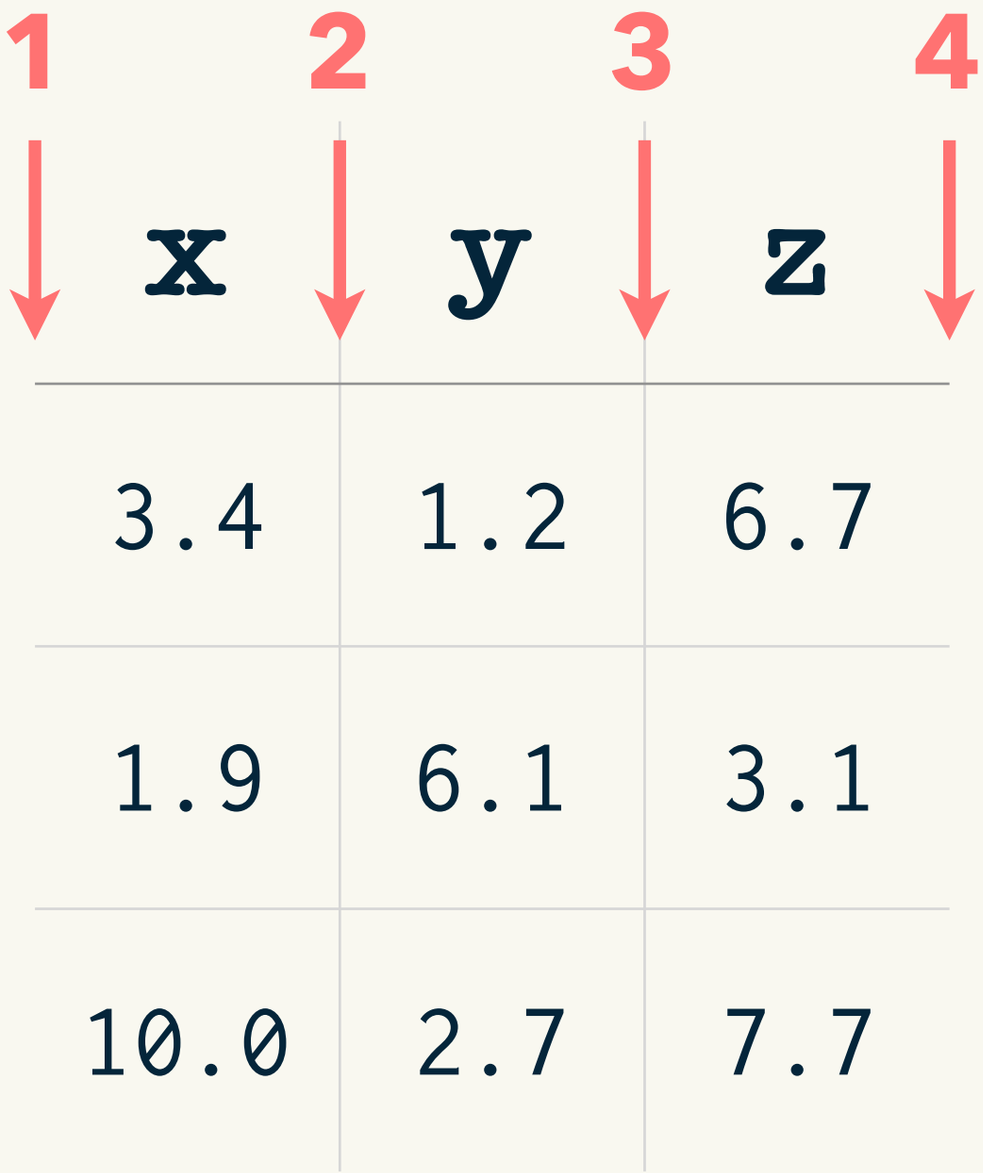
Let's add a column to a data frame

```
# Goal:
# Write a function that allows us to add a
# new column to a data frame at a specified
# position.
```

```
add_col(df, "name", value, where = 1)
add_col(df, "name", value, where = 2)
```

```
# Start simple and try out as we go
```

where =



x	y	z
3.4	1.2	6.7
1.9	6.1	3.1
10.0	2.7	7.7

Start with insert_into()

Works like `cbind()` but can insert anywhere

df1

a	b	c
3	4	5

df2

X	Y
1	2

```
insert_into(
  df1, df2,
  where = 1
)
```

X	Y	a	b	c
1	2	3	4	5

```
insert_into(
  df1, df2,
  where = 2
)
```

a	X	Y	b	c
3	1	2	4	5

Add the columns of `df2` to `df1` at position `where`

What goes in ...?

```
insert_into <- function(x, y, where = 1) {
  if (where == 1) { # first col
    ...
  } else if (where > ncol(x)) { # last col
    ...
  } else {
    ...
  }
}
# Hint: cbind() will be useful
# Add the columns of df2 to df1 at position where
```

My first attempt

```
insert_into <- function(x, y, where = 1) {
  if (where == 1) {
    cbind(x, y)
  } else if (where > ncol(x)) {
    cbind(y, x)
  } else {
    cbind(x[1:where], y, x[where:nrow(x)])
  }
}
```

Actually correct

```
insert_into <- function(x, y, where = 1) {
  if (where == 1) {
    cbind(y, x)
  } else if (where > ncol(x)) {
    cbind(x, y)
  } else {
    lhs <- 1:(where - 1)
    cbind(x[lhs], y, x[-lhs])
  }
}
```

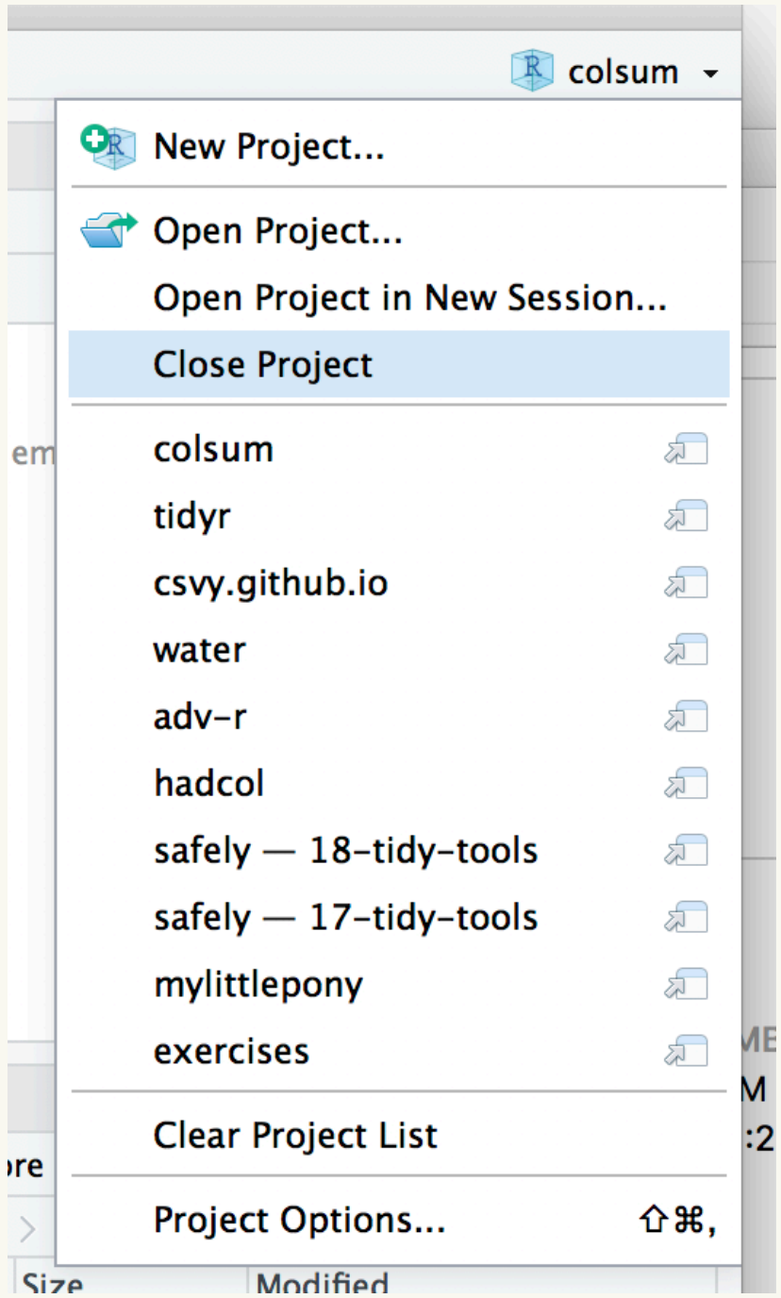
How did I write that code?

```
# Some simple inputs
df1 <- data.frame(a = 3, b = 4, c = 5)
df2 <- data.frame(X = 1, Y = 2)

# Then each time I tweaked it, I re-ran
# these cases
insert_into(df1, df2, where = 1)
insert_into(df1, df2, where = 2)
insert_into(df1, df2, where = 3)
insert_into(df1, df2, where = 4)
```

Where did I write that code?

As well as RStudios associated with a project, you also get one associated with no project



integer {base}

Options

- General
- Code
- Appearance
- Pane Layout
- Packages
- R Markdown
- Sweave
- Spelling
- Git/SVN
- Publishing
- Terminal

Default working directory (when not in a project):

~ Browse...

- [x] Re-use idle sessions for project links
- [ ] Restore most recently opened project at startup
- [x] Restore previously open source documents at startup
- [ ] Restore .RData into workspace at startup

Save workspace to .RData on exit: Never

- [x] Always save history (even when not saving .RData)
- [x] Remove duplicate entries in history
- [ ] Show .Last.value in environment listing
- [ ] Use debug error handler only when my code contains errors
- [ ] Automatically expand tracebacks in error inspector
- [ ] Wrap around when navigating to previous/next tab
- [x] Automatically notify me of updates to RStudio

OK Cancel Apply

as.integer attempts to coerce its argu

Two challenges

Cmd + Enter is error prone

Looking at the outputs of each run is tedious

We need a new workflow!

Cmd + Enter is error prone

Put code in R/ and use devtools::**load_all()**

Looking at the outputs of each run is tedious

Write unit tests and use devtools::**test()**

Testing workflow

http://r-pkgs.had.co.nz/tests.html

First, create a package

```
usethis::create_package("~/Desktop/hadcol")
usethis::use_r("insert_into")


insert_into <- function(x, y, where = 1) {
  if (where == 1) {
    cbind(y, x)
  } else if (where > ncol(x)) {
    cbind(x, y)
  } else {
    lhs <- 1:(where - 1)
    cbind(x[lhs], y, x[-lhs])
  }
}
```

copy + paste this code into insert_into.R

Then, set up testing infrastructure

Key infrastructure

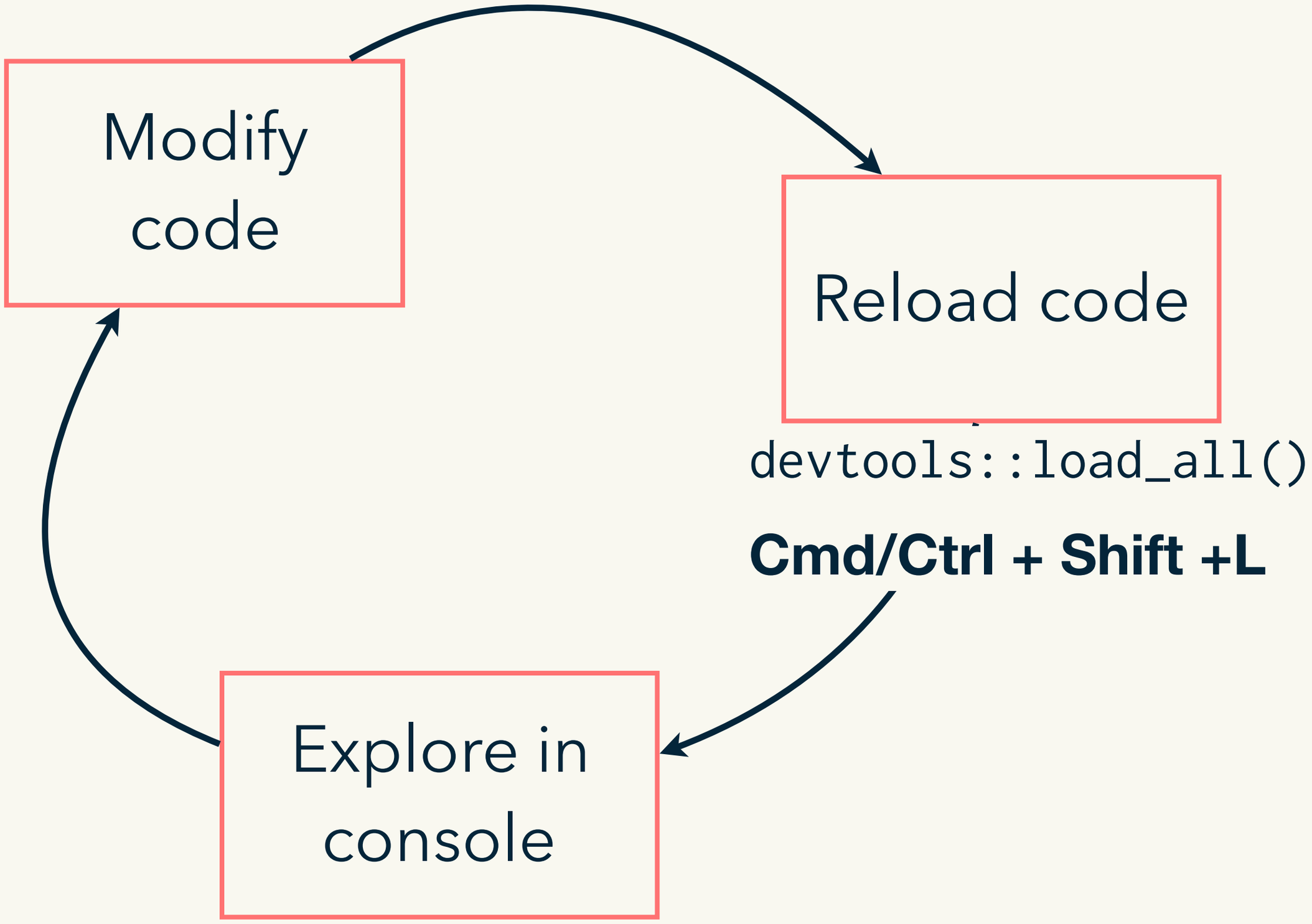
```
usethis::use_test()
✔ Adding 'testthat' to Suggests field
✔ Creating 'tests/testthat/'
✔ Writing 'tests/testthat.R'
✔ Writing 'tests/testthat/test-insert_into.R'
● Modify 'tests/testthat/test-insert_into.R'
```

Creates test file **matching** script file

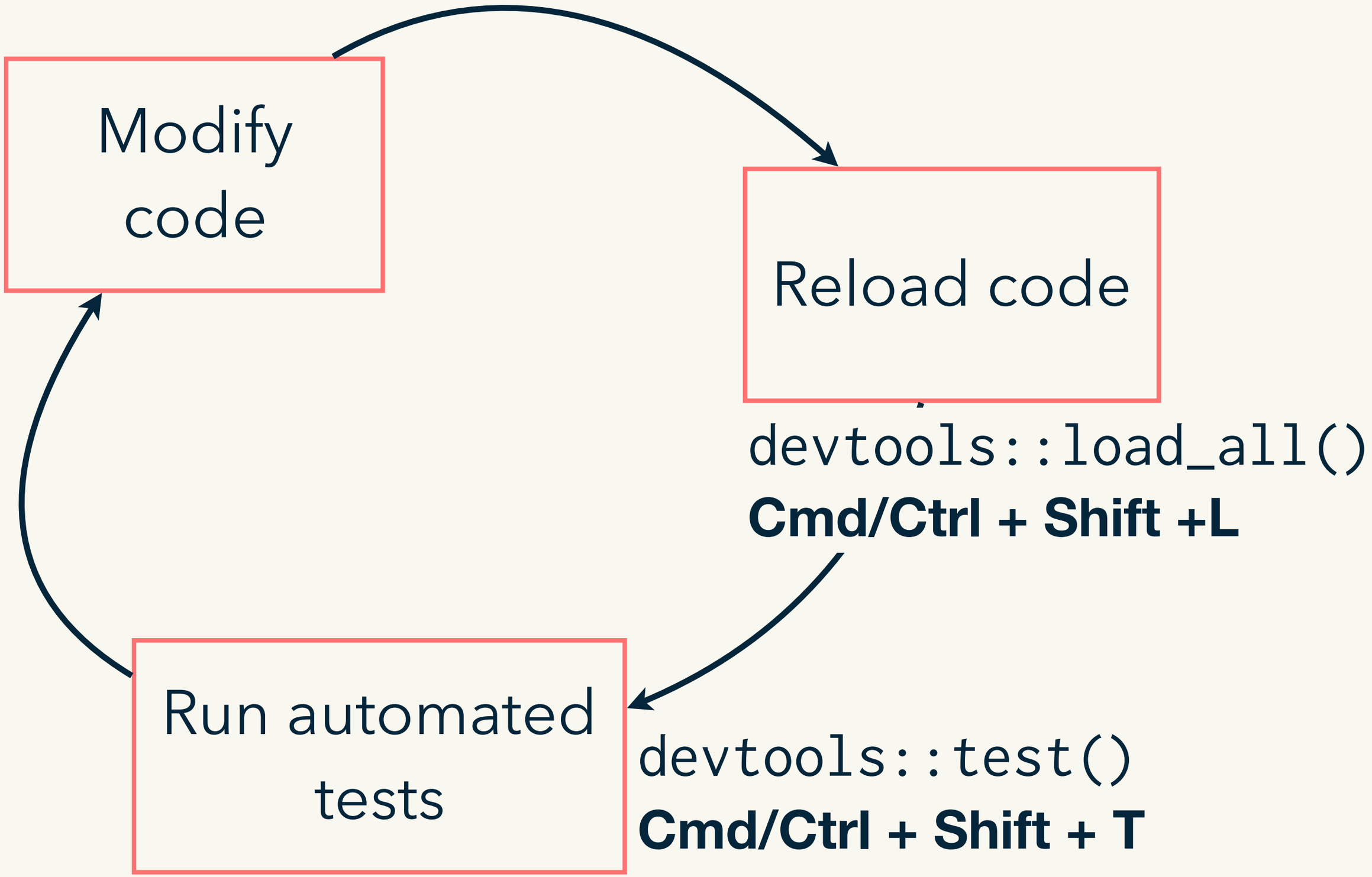
Run tests

```
devtools::test()
# Or Command + Shift + T
```

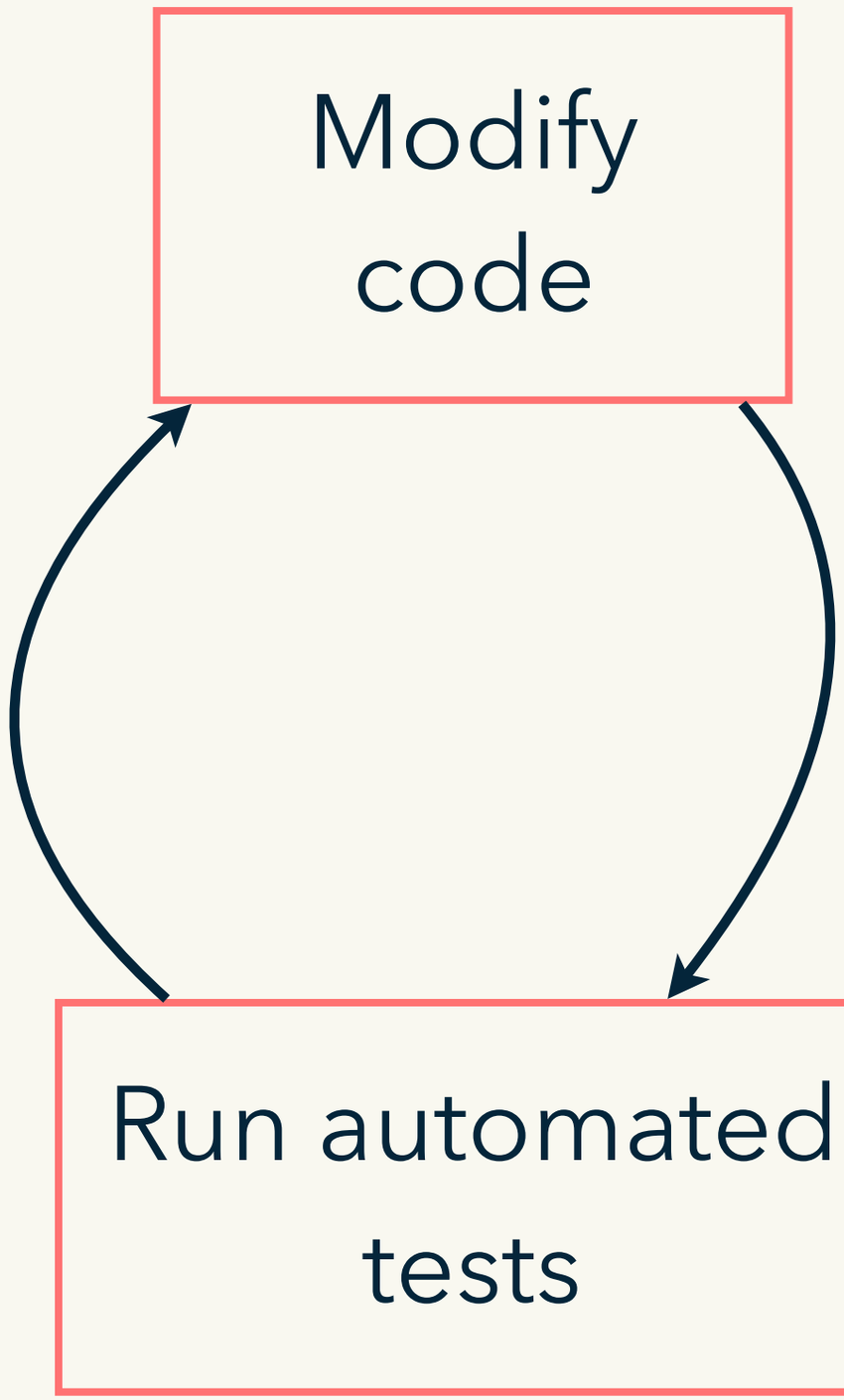
So far we've done this:



Testthat gives a new workflow



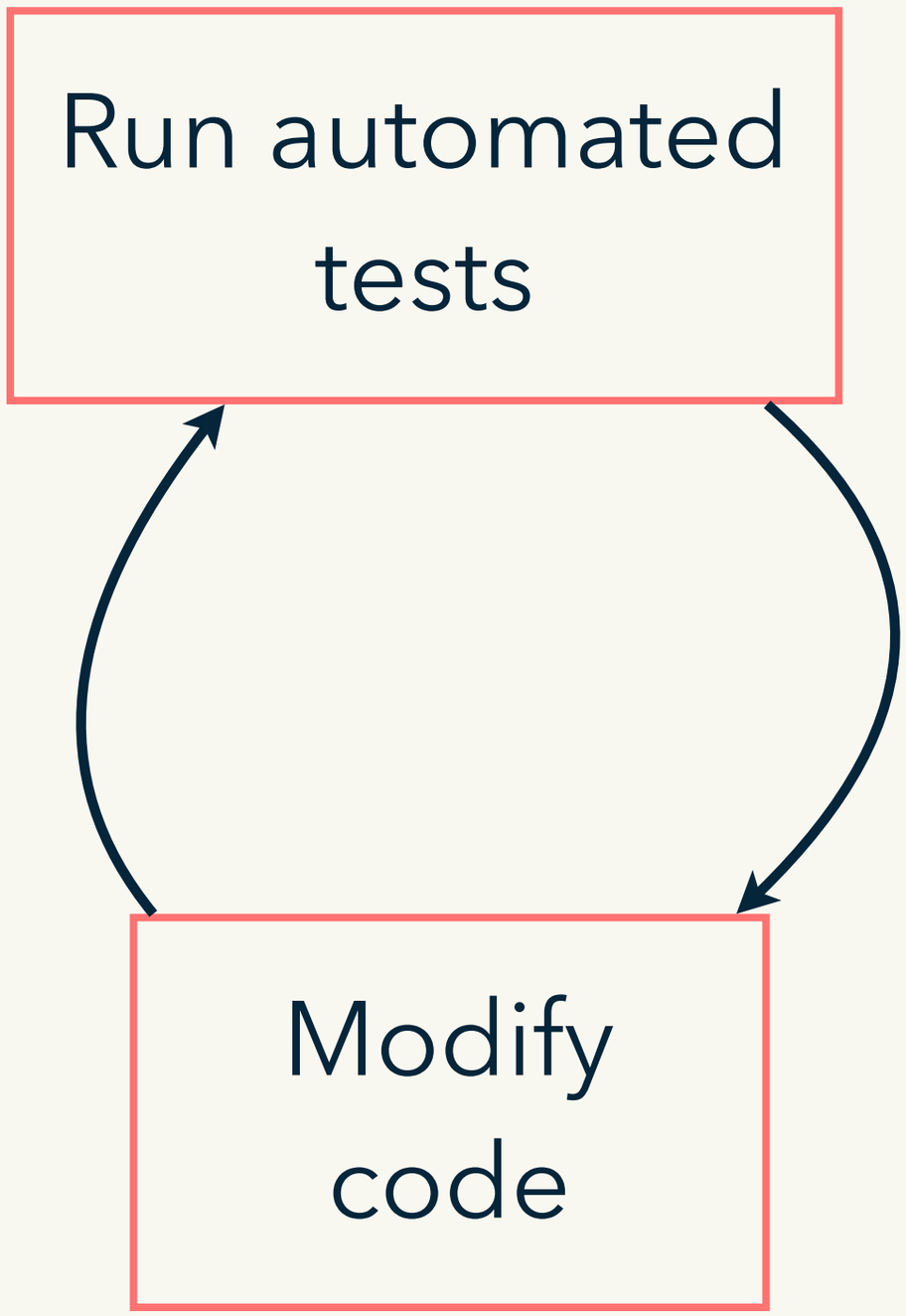
But why reload the code?



`devtools::test()`

Cmd/Ctrl + Shift + T

Or you might start with the tests



`devtools::test()`

Cmd/Ctrl + Shift + T

This is called test driven development (TDD)

Key idea of unit testing is to automate!

Helper function to reduce duplication

```
at_pos <- function(i) {
  insert_into(df1, df2, where = i)
}
```

```
expect_named(at_pos(1), c("X", "Y", "a", "b", "c"))
expect_named(at_pos(2), c("a", "X", "Y", "b", "c"))
expect_named(at_pos(3), c("a", "b", "X", "Y", "c"))
expect_named(at_pos(4), c("a", "b", "c", "X", "Y"))
```

Describes an expected property of the output

Key idea of unit testing is to automate!

```
at_pos <- function(i) {
  insert_into(df1, df2, where = i)
}
```

```
expect_named(at_pos(1), c("X", "Y", "a", "b", "c"))
expect_named(at_pos(2), c("a", "X", "Y", "b", "c"))
expect_named(at_pos(3), c("a", "b", "X", "Y", "c"))
expect_named(at_pos(4), c("a", "b", "c", "X", "Y"))
```

Easy to see the pattern

This automation must follow conventions

```
# In tests/testthat/test-insert_into.R
test_that("can add column
  df1 <- data.frame(a = 3,
  df2 <- data.frame(X = 1, Y = 2)
  at_pos <- function(i) {
    insert_into(df1, df2, where = i)
  }

  expect_named(at_pos(1), c("X", "Y", "a", "b", "c"))
  expect_named(at_pos(2), c("a", "X", "Y", "b", "c"))
  expect_named(at_pos(3), c("a", "b", "X", "Y", "c"))
  expect_named(at_pos(4), c("a", "b", "c", "X", "Y"))
})
```

Important convention

Tests are organised in three layers

One per .R file in R/

One per invariant

Very fine grained

File

Test

Expectation
Expectation
Expectation
Expectation
Expectation

Test

Expectation
Expectation

Test

Expectation

Test

Expectation
Expectation

Practice the workflow

```
usethis::create_package("~/Desktop/hadcol")

usethis::use_r("insert_into")
# Check all is ok with load_all()

usethis::use_test()
# Copy expectations from next next slide

# Run tests with keyboard shortcut
# Confirm that if you break insert_into() the
# tests fail.
```

Expectations

```
# Create file with use_test()
context("test-insert_into")

test_that("can add column at any position", {
  df1 <- data.frame(a = 3, b = 4, c = 5)
  df2 <- data.frame(X = 1, Y = 2)
  at_pos <- function(i) {
    insert_into(df1, df2, where = i)
  }

  expect_named(at_pos(1), c("X", "Y", "a", "b", "c"))
  expect_named(at_pos(2), c("a", "X", "Y", "b", "c"))
  expect_named(at_pos(3), c("a", "b", "X", "Y", "c"))
  expect_named(at_pos(4), c("a", "b", "c", "X", "Y"))
})
```

Other advantages

Writing tests
improves your API

https://unsplash.com/photos/TL5Vy1IM-uA

Improve readability or performance without changing behaviour.

https://unsplash.com/photos/gYBMinOIAUE

When you stop work,
leave a test failing

https://unsplash.com/photos/y02jEX_B0O0

add_col

Next challenge is to implement add_col()

```
df <- data.frame(x = 1)
add_col(df, "y", 2, where = 1)
add_col(df, "y", 2, where = 2)
add_col(df, "x", 2)
```

Most important expectation

```
expect_equal(obj, exp)
```

More at
http://testthat.r-lib.org

Make these tests pass

```
usethis::use_test("add_col")
# Copy this test:
test_that("where controls position", {
  df <- data.frame(x = 1)

  expect_equal(
    add_col(df, "y", 2, where = 1),
    data.frame(y = 2, x = 1)
  )
  expect_equal(
    add_col(df, "y", 2, where = 2),
    data.frame(x = 1, y = 2)
  )
})
# Run tests with keyboard shortcut
# Some hints on next slide
```

Hint: getting started

```
usethis::use_r("add_col")


# In R/add_col.R
# Start by establishing basic form of the
# function and setting up the test case.
add_col <- function(x, name, value, where) {
}

# Make sure that you can Cmd + Shift + T
# and get two test failures before you
# continue

# More hints on the next slide
```

Hint: add_col()

```
# You'll need to use insert_into()

# insert_into() takes two data frames and
# you have a data frame and a vector

# setNames() lets you change the names of
# data frame
```

My solution

```
# Lives in R/add_col.R
add_col <- function(x, name, value, where) {
  df <- setNames(data.frame(value), name)
  insert_into(x, df, where = where)
}
```

Make this test pass

```
# add me to test-add_col.R
test_that("can replace columns", {
  df <- data.frame(x = 1)

  expect_equal(
    add_col(df, "x", 2, where = 2),
    data.frame(x = 2)
  )
})
```

My solution

```
add_col <- function(x, name, value, where) {
  if (name %in% names(x)) {
    x[[name]] <- value
    x
  } else {
    df <- setNames(data.frame(value), name)
    insert_into(x, df, where = where)
  }
}
```

Make this test pass

```
# add me to test-add_col.R
test_that("default where is far right", {
  df <- data.frame(x = 1)

  expect_equal(
    add_col(df, "y", 2),
    data.frame(x = 1, y = 2)
  )
})
```

1	2	3	4
x	y	z	
3.4	1.2	6.7	
1.9	6.1	3.1	
10.0	2.7	7.7	

My solution

```
add_col <- function(x, name, value,
                    where = ncol(x) + 1) {
  if (name %in% names(x)) {
    x[[name]] <- value
    x
  } else {
    df <- setNames(data.frame(value), name)
    insert_into(x, df, where = where)
  }
}
```

What about bad inputs?

```
# We need to test for errors too
df1 <- data.frame(a = 3, b = 4, c = 5)
df2 <- data.frame(X = 1, Y = 2)

insert_into(df1, df2, where = 0)
insert_into(df1, df2, where = NA)
insert_into(df1, df2, where = 1:10)
insert_into(df1, df2, where = "a")
```

We'll return to this tomorrow...

Test coverage

Test coverage shows you what you've tested

```
devtools::test_coverage()
devtools::test_coverage_file()
```