Errors

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Signaling errors

as a function **author**

Change project to:

[hadcol-test]

Motivation: protect against bad inputs

```
# Or Ctrl/Cmd + Shift + L
devtools::load_all()

df <- data.frame(x = 1, y = 2)

add_col(df, name = "z", value = 3, where = 0)
#> Error in `[.default`(x, lhs) :
#> only 0's may be mixed with
#> negative subscripts
```

Finding where errors occur

```
> add_col(df, name = "z", value = 3, where = 0)
```

```
Error in `[.default`(x, lhs) :
  only 0's may be mixed with negative
subscripts
```

Show Traceback

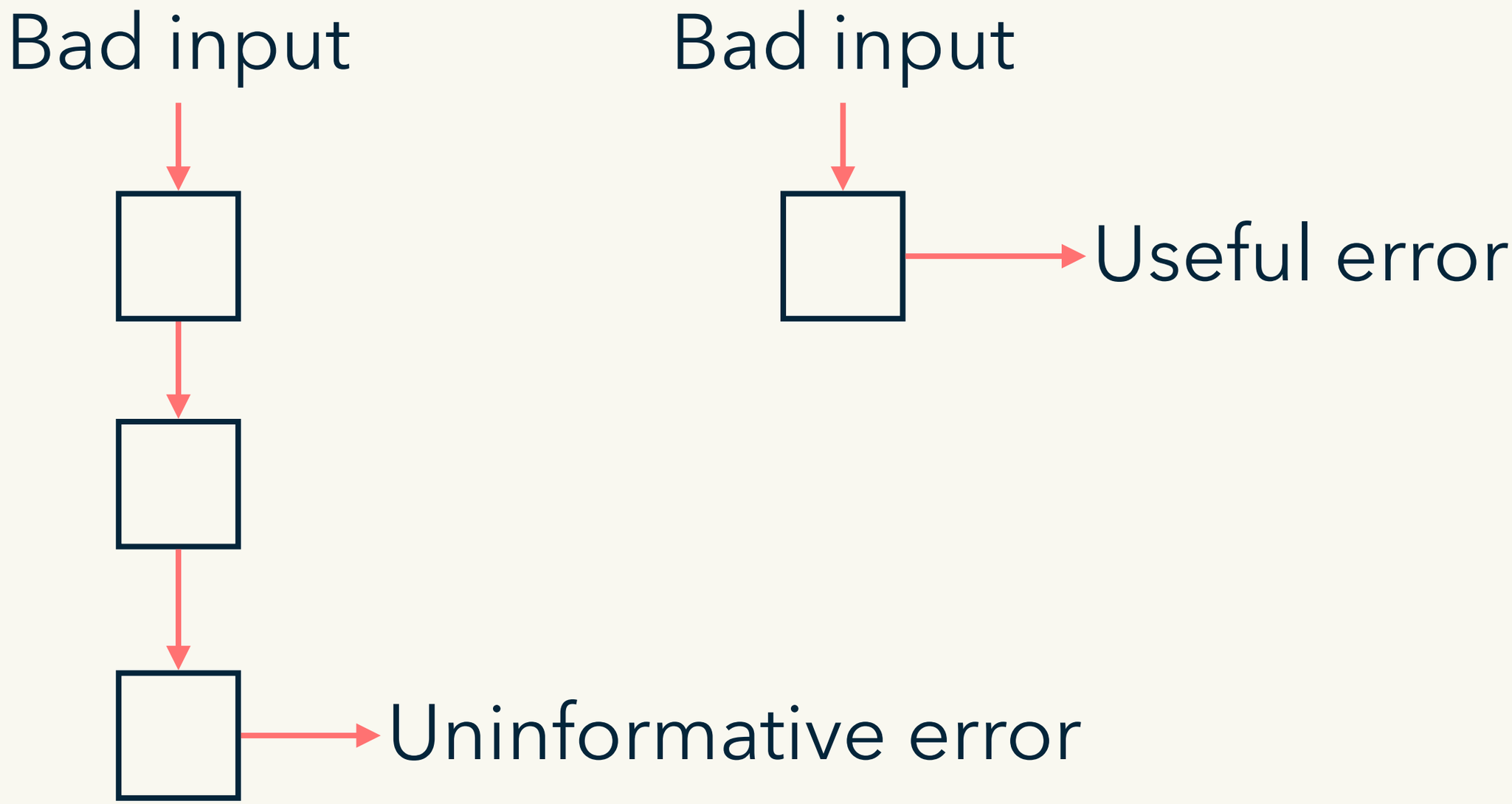
Rerun with Debug

```
 6. NextMethod("[")
 5. `[.data.frame`(x, lhs)
 4. x[lhs]
 3. cbind(x[lhs], y, x[-lhs]) at insert_into.R#8
 2. insert_into(x, df, where = where) at add_col.R#7
 1. add_col(df, name = "z", value = 3, where = 0)
```

```
# Not in RStudio
traceback()
```

Fail fast

For robust code, fail early



Check inputs in insert_into()

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

```
# We need these to return errors
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 could add to insert_into directly

```
insert_into <- function(x, y, where = 1) {
  if (!is.numeric(where) || length(where) != 1) {
    stop("`where` is not a number", call. = FALSE)
  } else if (where == 0 || is.na(where)) {
    stop("`where` must not be 0 or NA", call. = FALSE)
  } else 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])
  }
}
```

But this muddles the intent of insert_into()

Better to have a function responsible for this

```
insert_into <- function(x, y, where = 1) {
  where <- check_where(where)
  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])
  }
}
```

Add protection against bad inputs

1. Decide what should happen with bad inputs
2. Write tests for `check_where()` that reflect #1
3. Write `check_where()`
4. Update `insert_into()` to use `check_where()`

Error message structure

1. **Problem statement**
   (use must or can't)
2. **Error location**
   (where possible)
3. **Hint**
   (if common)

http://style.tidyverse.org/error-messages.html

Your turn

```
# Write down the error message that you think
# each of these lines should generate

check_where(where = 0)
check_where(where = NA)
check_where(where = 1:10)
check_where(where = "a")
```

My results

```
check_where(0)
#> Error: `where` must not be zero or a missing value.
check_where(NA)
#> Error: `where` must not be zero or a missing value.
check_where(1:10)
#> Error: `where` must be a length one numeric vector.
check_where("a")
#> Error: `where` must be a length one numeric vector.
```

Style

- Surround variable names in `...`, and strings in '...'
- Sentence case

Use expect_error() to test for errors

```
# Test will pass if error occurs
expect_error(
  check_where("a")
)
```

```
# Test will pass if error message matches
expect_error(
  check_where("a"),
  "not a number"
)
```

A regular expression

Point of match:

```
expect_error(
  check_were("a")
)
```

```
expect_error(
  check_were("a"),
  "not a number"
)
```

Your turn

Write tests to ensure that `check_where()` only allows valid inputs.

(Where should the tests live? How many tests do you need? How many expectations?)

```
check_where(0)
#> Error: `where` must not be zero or a missing value.
check_where(NA)
#> Error: `where` must not be zero or a missing value.
check_where(1:10)
#> Error: `where` must be a length one numeric vector.
check_where("a")
#> Error: `where` must be a length one numeric vector.
```

My tests

```
# I think should live in tests/testthat/test-insert_into.R
test_that("where must be valid value", {
  expect_error(check_where("a"), "length one numeric vector")
  expect_error(check_where(1:10), "length one numeric vector")

  expect_error(check_where(0), "not be zero or missing")
  expect_error(check_where(NA_real_), "not be zero or missing")
})
```

Signal an error with stop()

```
f <- function(){
  stop(
    "This is an error message.",
    call. = FALSE
  )
}
```

Don't include the call in error message

```
f()
# Error : This is an error message.
```

Check inputs by combining with if()

```
# A general pattern
f <- function(x){
  if (!is.numeric(x)) {
    stop("`x` must be numeric",
         call. = FALSE)
  }
  x
}
f("a")
```

Your turn

Write `check_where()`. It should throw an error if the input is incorrect. I suggest you put in the same file as `insert_into()`.

```
check_where(0)
check_where(NA)
check_where(1:10)
check_where("a")
```

Hint to get started on next slide

Hint: getting started

```
# Start with a skeleton in R/insert_into.R
check_where <- function(x) {

}
```

```
# Make sure you've put the tests in
# tests/testthat/test-insert_into.R
# Check you get four failures with
devtools::test()

# Edit check_where() until it passes tests
```

My answer

```
check_where <- function(x) {
  if (length(x) != 1 || !is.numeric(x)) {
    stop("`where` must be a length one numeric vector.",
      call. = FALSE)
  }
  x <- as.integer(x)

  if (x == 0 || is.na(x)) {
    stop("`where` must not be zero or missing",
      call. = FALSE)
  }
  x
}
```

Other conditions

Errors `stop()`

No way for function to continue, execution must stop.

Warnings `warning()`

Signal that something has gone wrong, but the code has been able to recover and continue. Use sparingly, would an error be safer?

Messages `message()`

Informational only.

use cat() when primary purpose is output

https://adv-r.hadley.nz/conditions.html#signalling-conditions

Handling errors

as a function **user**

Programmer tools

```
tryCatch(
  code,
  error = function(e) {
    # run if error occurs
  }
)
# https://adv-r.hadley.nz/conditions.html

# But today I want to focus on
# data scientist tools
```

Iteration: what happens if there is an error?

```
library(purrr)
input <- list(1:10, sqrt(4), 5, "n")
map(input, log)
#> Error in .Primitive("log")(x, base) :
#>   non-numeric argument to mathematical
#>   function
```

No results.

No idea which element was the problem.

Principle:

Turn side-effects into data

What does safely() do?

```
library(purrr)
input <- list(1:10, sqrt(4), 5, "n")

# This will never fail
map(input, safely(log))

# What does it return when the function
# succeeds? What about when it fails?
```

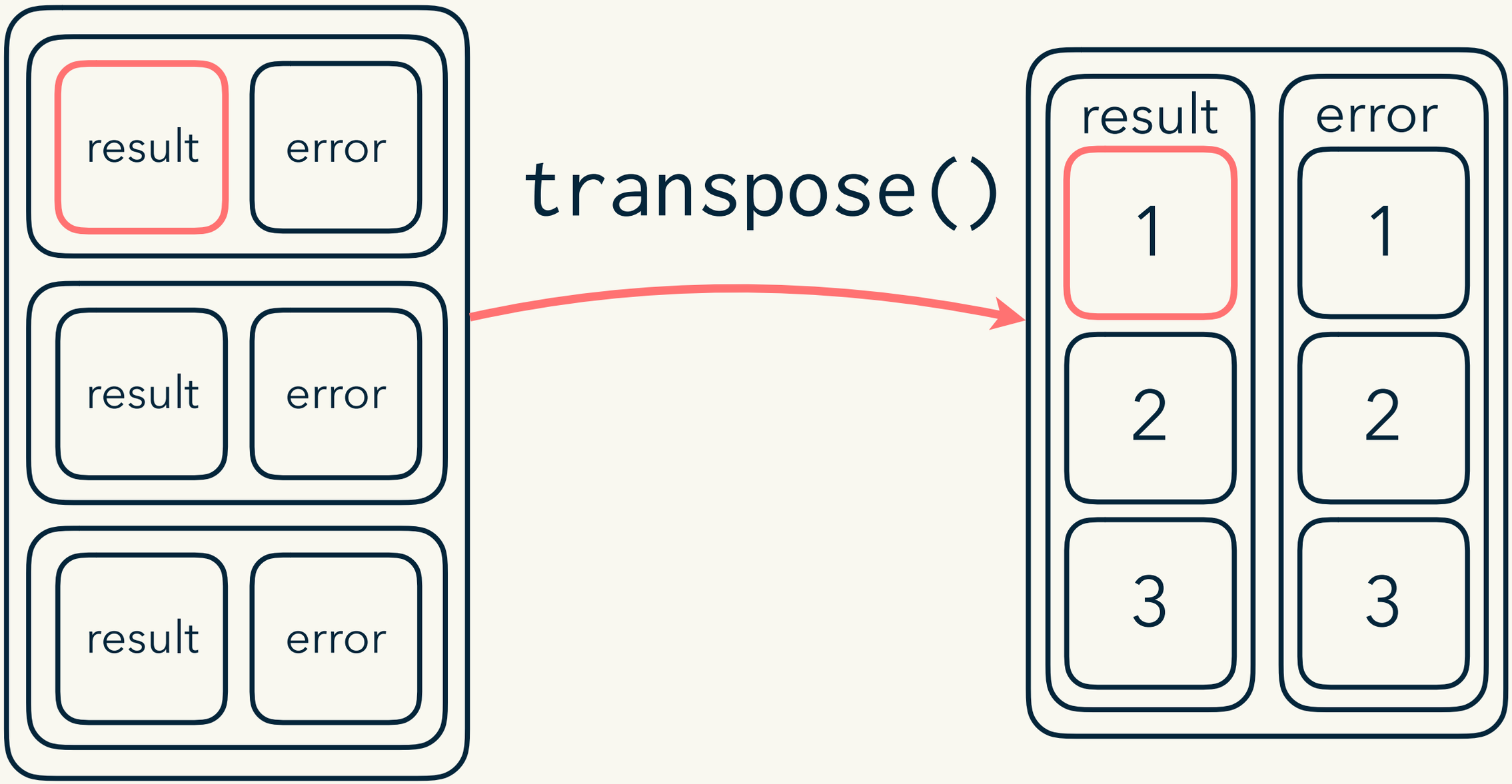
A more realistic example

```
urls <- c(
  "https://google.com",
  "https://en.wikipedia.org",
  "asdfasdasdkfjlda"
)
```

```
# Fails
contents <- urls %>%
  map(readLines, warn = FALSE)

# Always succeeds
contents <- urls %>%
  map(safely(readLines), warn = FALSE)
str(contents)
```

But map() + safely() gives awkward output




```
x[[1]][["result"]]  ⟶  x[["result"]][[1]]
```

Your turn

Apply `transpose()` to `contents` from "A more realistic example" then:

1. Make logical vector that is `TRUE` if download succeeded. (`map_lgl()`)
2. List failed urls
3. Extract successfully retrieved text

Common pattern with safely()

```
contents <- urls %>%
  map(safely(readLines)) %>%
  transpose()

ok <- map_lgl(contents$error, is.null)
# This is suboptimal:
ok <- !map_lgl(contents$result, is.null)

urls[!ok]
contents$result[ok]
```

Functional operators

one or more function(s) as input, a function as output

`safely()`
`possibly()`
`quietly()`
	turn side effects into data

`partial()`	set some arguments
`memoise::memoise()`	add a memory

Think **adverbs:** alter the behaviour of a function