

Welcome, Bienvenue, Willkommen, ??

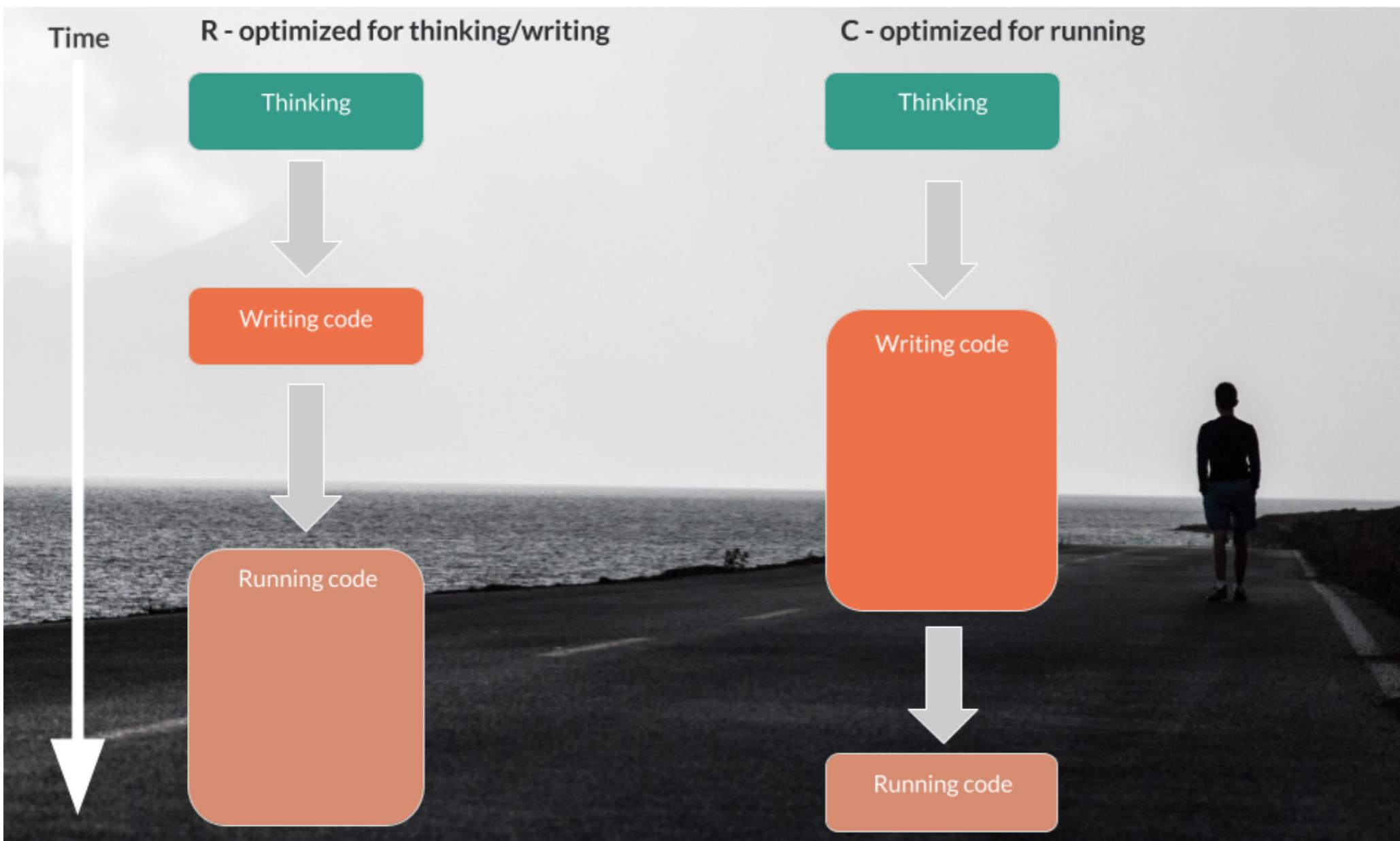
WRITING EFFICIENT R CODE



Colin Gillespie

Jumping Rivers & Newcastle University





A typical R workflow

```
# Load  
data_set <- read.csv("dataset.csv")  
  
# Plot  
plot(data_set$x, data_set$y)  
  
# Model  
lm(y ~ x, data = data_set)
```

When to optimize

Premature optimization is the root of all evil

Popularized by Donald Knuth

R version

- **v2.0** Lazy loading; fast loading of data with minimal expense of system memory.
 - **v2.13** Speeding up functions with the byte compiler
 - **v3.0** Support for large vectors
- Main releases every *April*
 - e.g. 3.0, 3.1, 3.2
- Smaller bug fixes throughout the year
 - e.g. 3.3.0, 3.3.1, 3.3.2

Let's practice!

WRITING EFFICIENT R CODE

My code is slow!

WRITING EFFICIENT R CODE



Colin Gillespie

Jumping Rivers & Newcastle University

Is my code really slow?



I'm not slow

- 1 second?
- 1 minute?
- 1 hour?

Is my code really slow?

Benchmarking

1. We construct a function around the feature we wish to benchmark
2. We time the function under different scenarios, e.g. data set

Example: Sequence of numbers

1, 2, 3, ..., n

Option 1

1:n

Option 2

seq(1, n)

Option 3

seq(1, n, by = 1)

Function wrapping

```
colon <- function(n) 1:n  
colon(5)
```

```
1 2 3 4 5
```

```
seq_default <- function(n) seq(1, n)  
seq_by <- function(n) seq(1, n, by = 1)
```

Timing with system.time()

```
system.time(colon(1e8))
```

```
# user system elapsed
# 0.032 0.028 0.060
```

```
system.time(seq_default(1e8))
```

```
# user system elapsed
# 0.060 0.028 0.086
```

```
system.time(seq_by(1e8))
```

```
# user system elapsed
# 1.088 0.520 1.600
```

- **user** time is the CPU time charged for the execution of user instructions.
 - **system** time is the CPU time charged for execution by the system on behalf of the calling process.
 - **elapsed** time is approximately the sum of user and system, this is the number we typically care about.

Storing the result

The trouble with

```
system.time(colon(1e8))
```

is we haven't stored the result.
We need to rerun the code to store
the result

```
res <- colon(1e8)
```

The <- operator performs both:

- Argument passing
- Object assignment

```
system.time(res <- colon(1e8))
```

The = operator performs **one**
of:

- Argument passing
- object assignment

```
# Raises an error
system.time(res = colon(1e8))
```

Relative time

Method	Absolute time (secs)	Relative time
colon(n)	0.060	$0.060/0.060 = 1.00$
seq_default(n)	0.086	$0.086/0.060 = 1.40$
seq_by(n)	1.607	$1.607/0.060 = 26.7$

Microbenchmark package

- Compares functions
 - Each function is run multiple times

```
library("microbenchmark")
n <- 1e8
microbenchmark(colon(n),
+                 seq_default(n),
+                 seq_by(n),
+                 times = 10) # Run each function 10 times
```

```
# Unit: milliseconds
#      expr   min    lq    mean   median    uq    max   neval cld
# colon(n)  59 130  220     202  341  391    10     a
# seq_default(n)  94 204  290     337  348  383    10     a
# seq_by(n) 1945 2044 2260    2275 2359 2787    10     b
```

Let's practice!

WRITING EFFICIENT R CODE

How good is your machine?

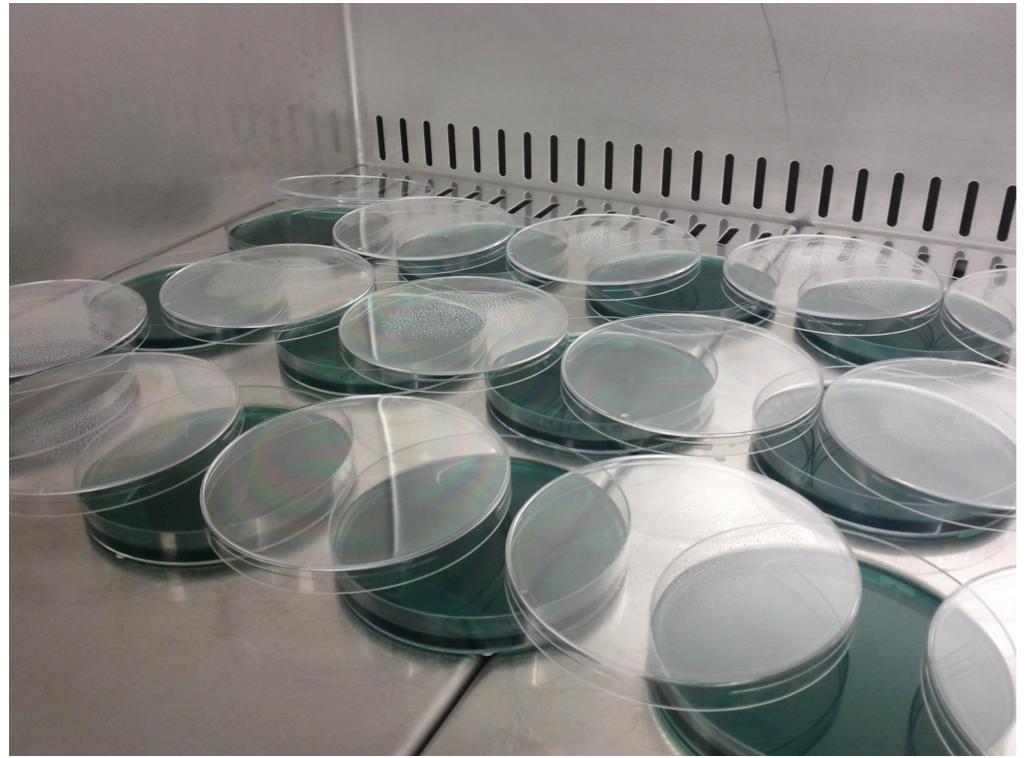
WRITING EFFICIENT R CODE



Colin Gillespie

Jumping Rivers & Newcastle University

Experiments!

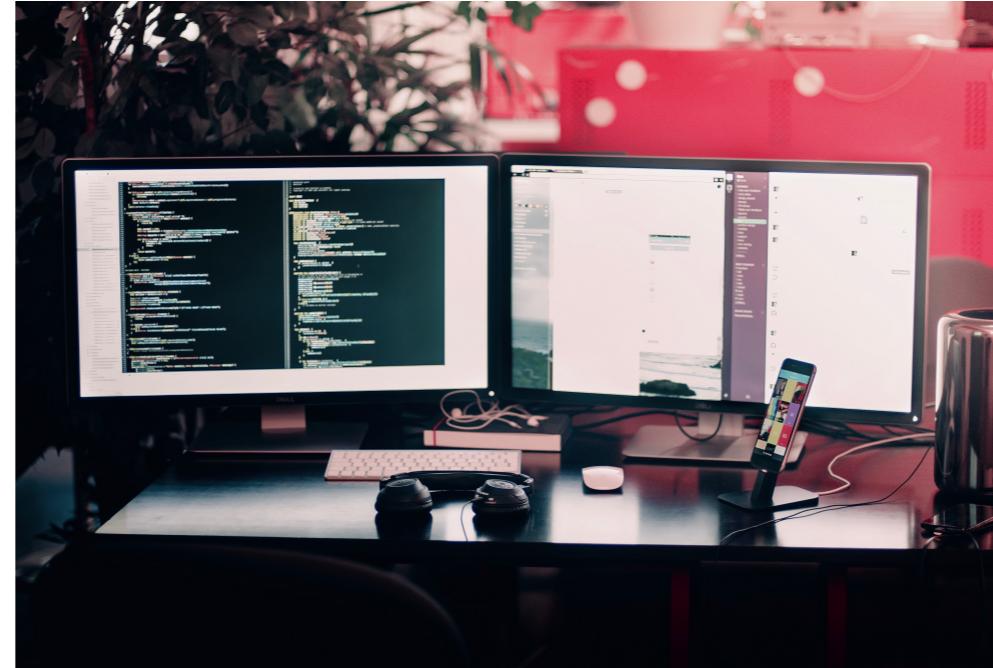


Cost of experiment:

- Experimental equipment
- Researcher time

Not cheap!

To buy, or not to buy...



To buy, or not to buy...

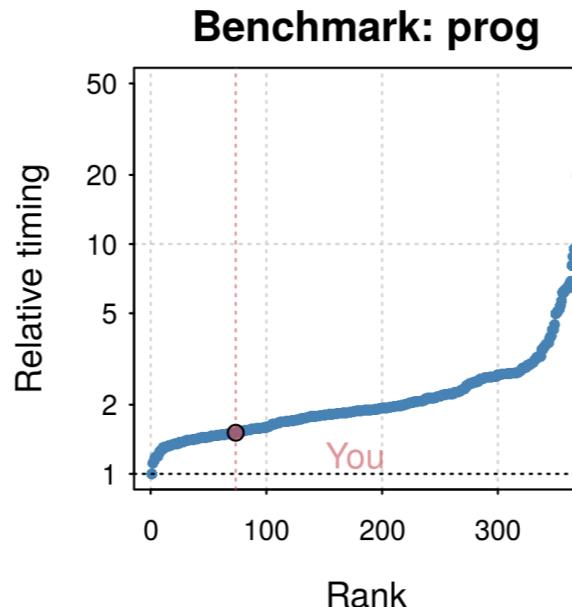
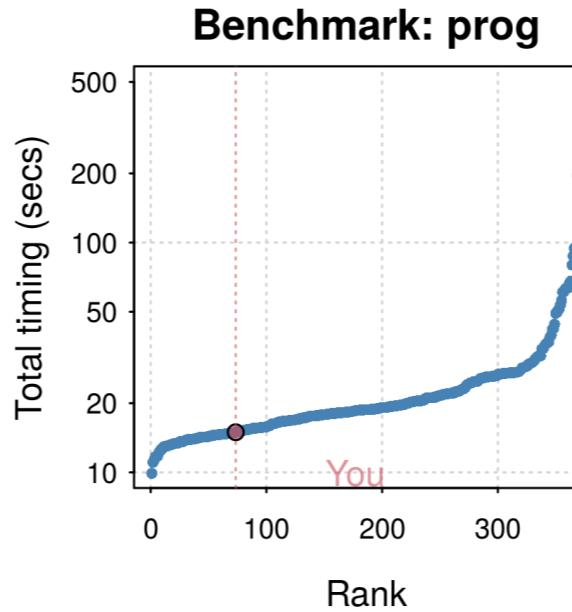
- Analysis takes twenty minutes on your current machine
 - Ten minutes to run on a new machine
 - Your time is charged at \$100 per hour
 - Run sixty analyses to pay back the cost of a \$1000 machine

The benchmarkme package

```
install.packages("benchmarkme")
library("benchmarkme")
# Run each benchmark 3 times
res <- benchmark_std(runs = 3)
plot(res)
```

My machine is ranked 75th out
400 machines

```
upload_results(res)
```



Let's practice!

WRITING EFFICIENT R CODE