Welcome, Bienvenue, Willkommen, ??

WRITING EFFICIENT R CODE

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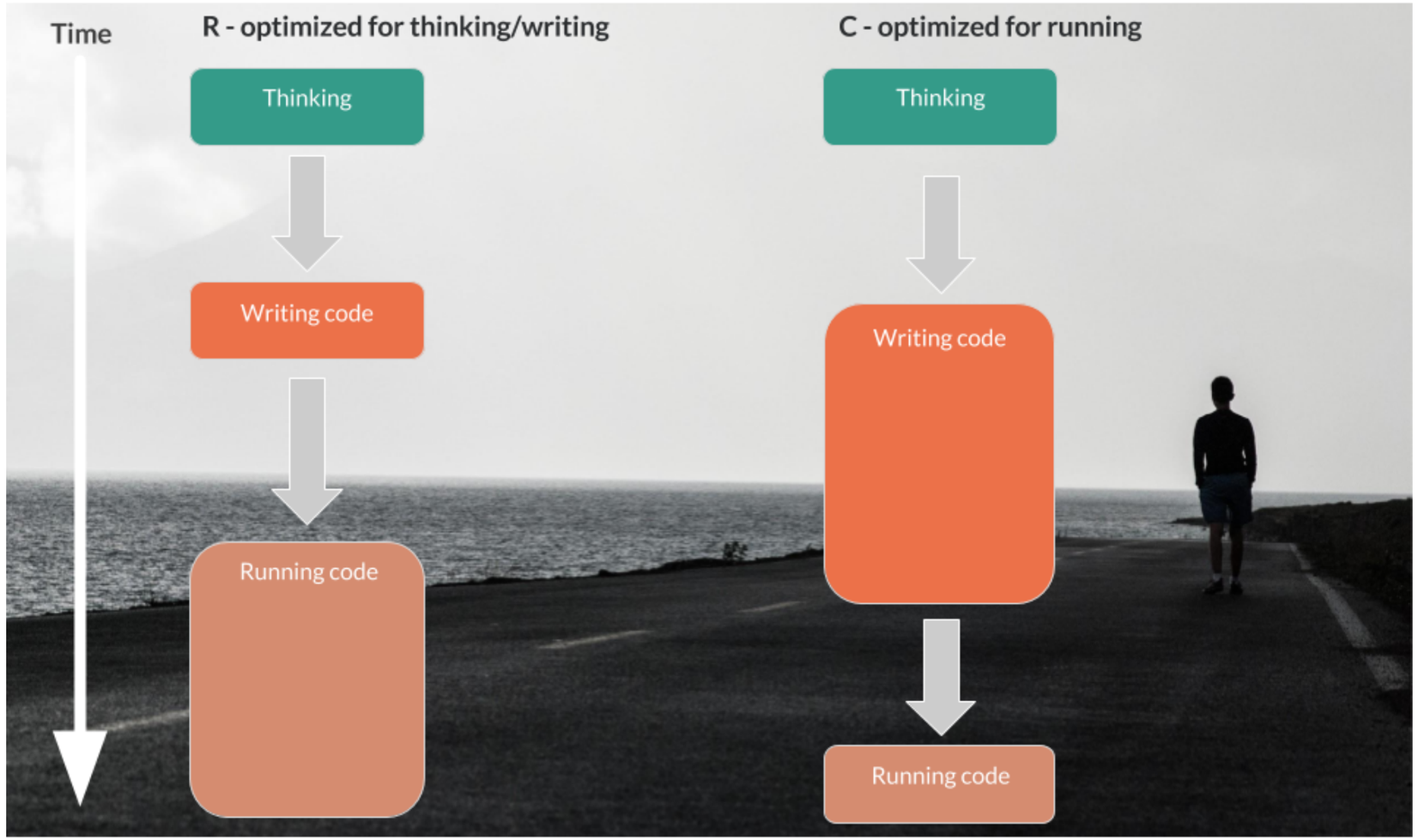
datacamp


MOTS


Time
R - optimized for thinking/writing
Thinking
Writing code
Running code
C - optimized for running
Thinking
Writing code
Running code

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

My code is slow!

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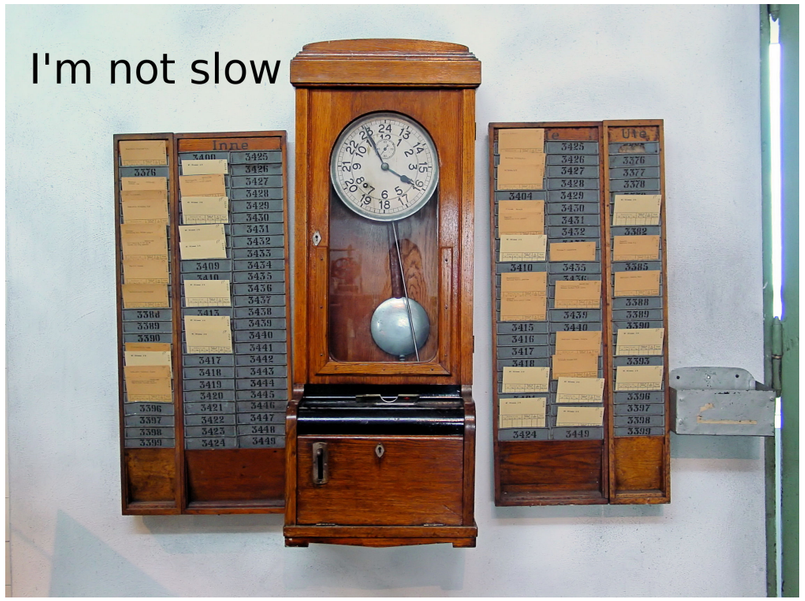
Is my code really slow?



- 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

$$1, 2, 3, \ldots, n$$

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 to code 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	$1.60/0.060 = 26.7$

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
```

How good is your machine?

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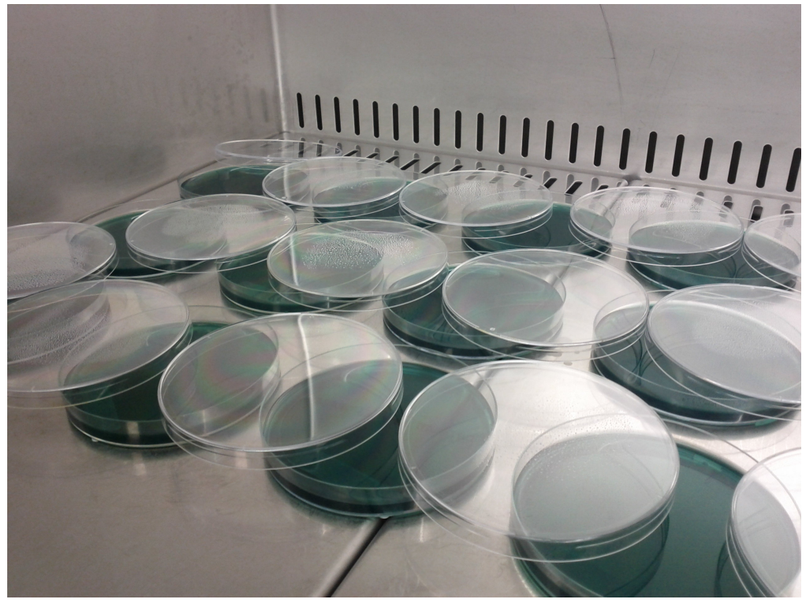
Experiments!

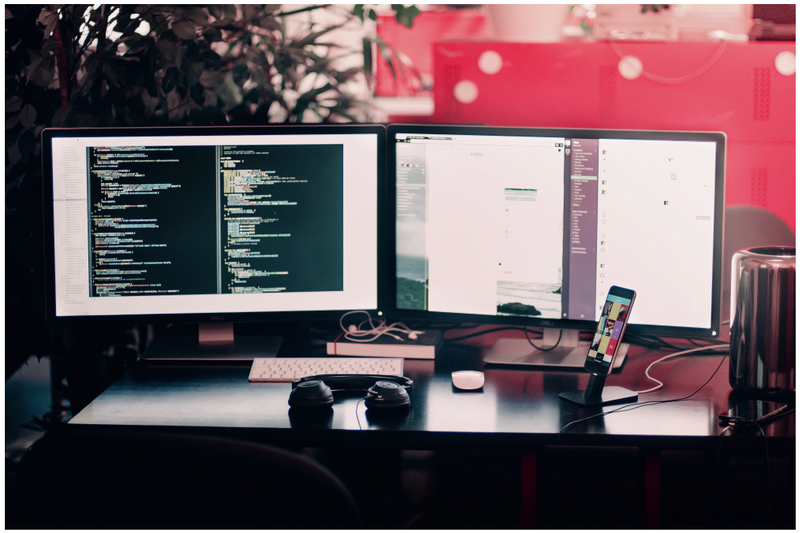


Cost of experiment:

- 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)
```