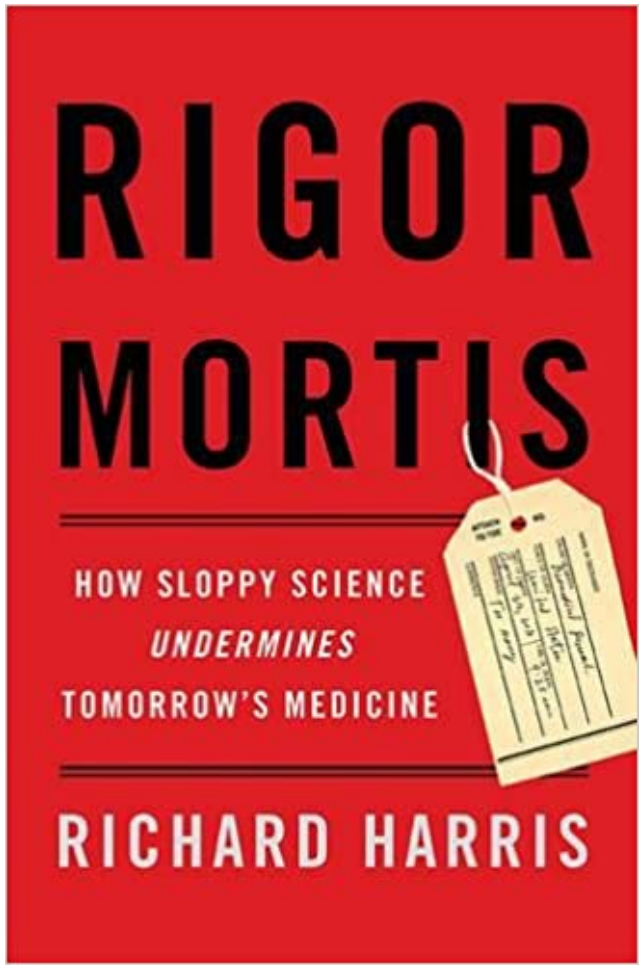
PSYCH 260

Speed lab

2021-12-07 15:46:56

Today's topic

- Measuring the speed of nervous system conduction
- And, a tiny lesson in open, transparent, reproducible data science


RIGOR MORTIS
HOW SLOPPY SCIENCE
UNDERMINES
TOMORROW'S MEDICINE
RICHARD HARRIS

Question

- How fast does the nervous system conduct information?
- Some prior evidence. Spring 2017 data
    - Proprioception vs. touch
- Why do we care?

Prediction

We predict that the speed of conduction will be …

Scheme

- Speed (s) = Distance (d)/Time (t), then $t = d/s$
- Chain of participants to make distance larger
  - If typical person ~ 1.5 m, then
  - at $s = 30$ m/s, $t = d/s \rightarrow 1.5/30$ = 0.05 secs.

Condition 1 (ankle)

- Squeeze (pull on) ankle
- `ankle_shoulder + shoulder_brain + brain_decide + brain_shoulder + shoulder_hand`

Condition 2 (shoulder)

- Squeeze (pull on) shoulder
- `shoulder_brain` + `brain_decide` + `brain_shoulder` + `shoulder_hand`
- Condition 1 - Condition 2
- `ankle_shoulder` + ~~`shoulder_brain`~~ + ~~`brain_decide`~~ + ~~`brain_shoulder`~~ + ~~`shoulder_hand`~~

Measure

- sum(`ankle_shoulder`) for all participants -> Distance
- mean(time(Condition 1)) - mean(time(Condition 2)) -> Time
- Speed = Distance/Time

Materials

- Stop watch
- Tape measure
- Paracord (for social distancing)

Decisions

- Same hand or dominant?
- Alternate ankle/shoulder or one condition before the other?
- How many trials?
    - Fixed number?
    - When reach asymptote?

Data files

- Data file with body measurements
  - participant, ankleshoulder (cm)
- Data file with reaction times
  - trial {1…n}, condition {ankle, shoulder}, time (s)

```
# Load R packages
suppressPackageStartupMessages(library("googledrive"))
suppressPackageStartupMessages(library("magrittr"))
suppressPackageStartupMessages(library("dplyr"))
suppressPackageStartupMessages(library("ggplot2"))
```

Download data as CSV

```
googledrive::drive_download(file = 'psych-260-2021-fall-distance', path = 'csv/psych-260-2021-f

googledrive::drive_download(file = 'psych-260-2021-fall-time', path = 'csv/psych-260-2021-fall-
```

Reimport data

```
distance_all <-readr::read_csv("csv/psych-260-2021-fall-distance.csv")
```

```
## New names:
## * `` -> ...3
```

```
## Rows: 24 Columns: 4
```

```
## ── Column specification ────────────────────────────────
## Delimiter: ","
## dbl (2): participant.id, ankleshoulder
## lgl (2): ...3, comment
```

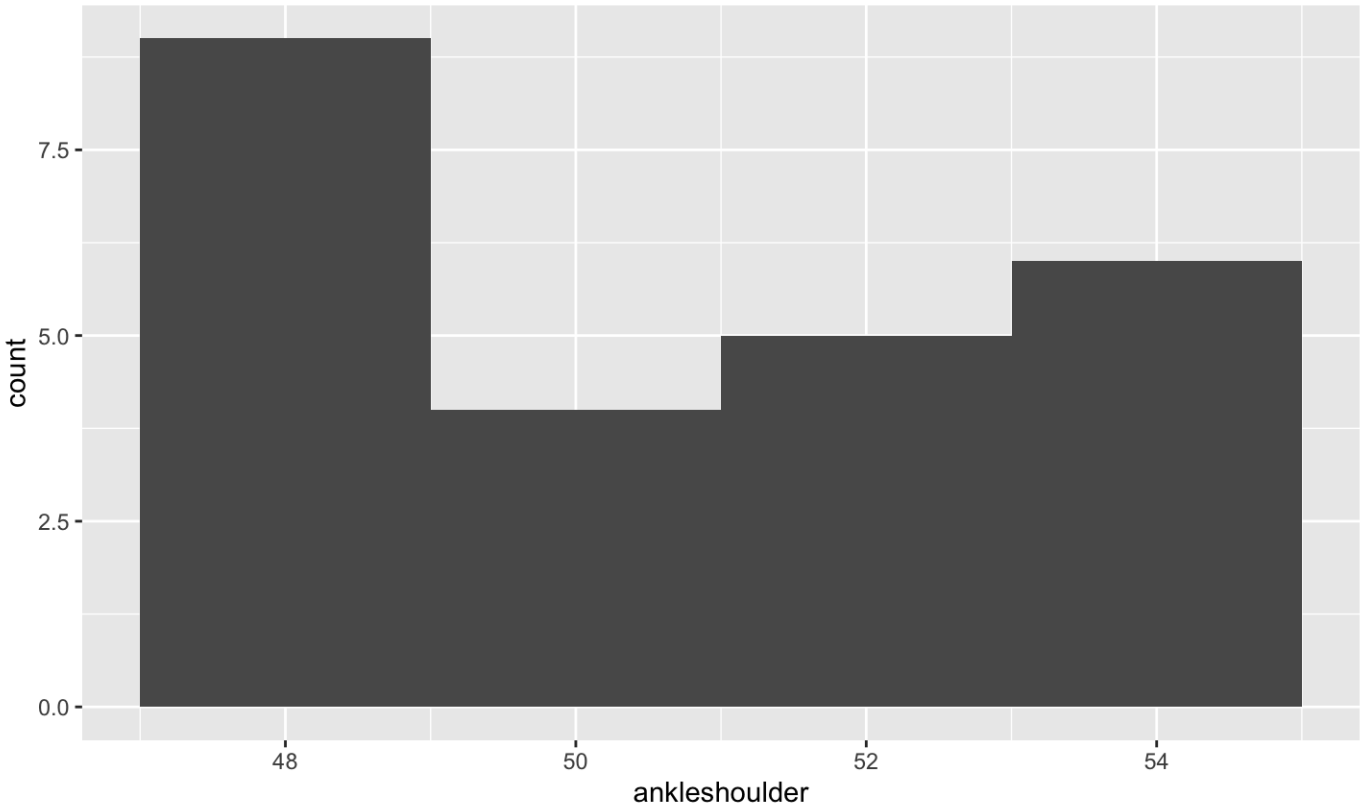
```
##
## ℹ Use `spec()` to retrieve the full column specification for this data.
## ℹ Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
distance <- distance_all %>%
  select(participant.id, ankleshoulder)

time <- readr::read_csv("csv/psych-260-2021-fall-time.csv")
```

```
## Rows: 10 Columns: 3
```

Measuring distance

```
dist.hist <- ggplot(data = distance, aes(x=ankleshoulder)) +
  geom_histogram(bins = 5)
```


7.5
5.0
2.5
0.0
count
48
50
52
54
ankleshoulder

Sum distance

```
with(distance, summary(ankleshoulder))
```

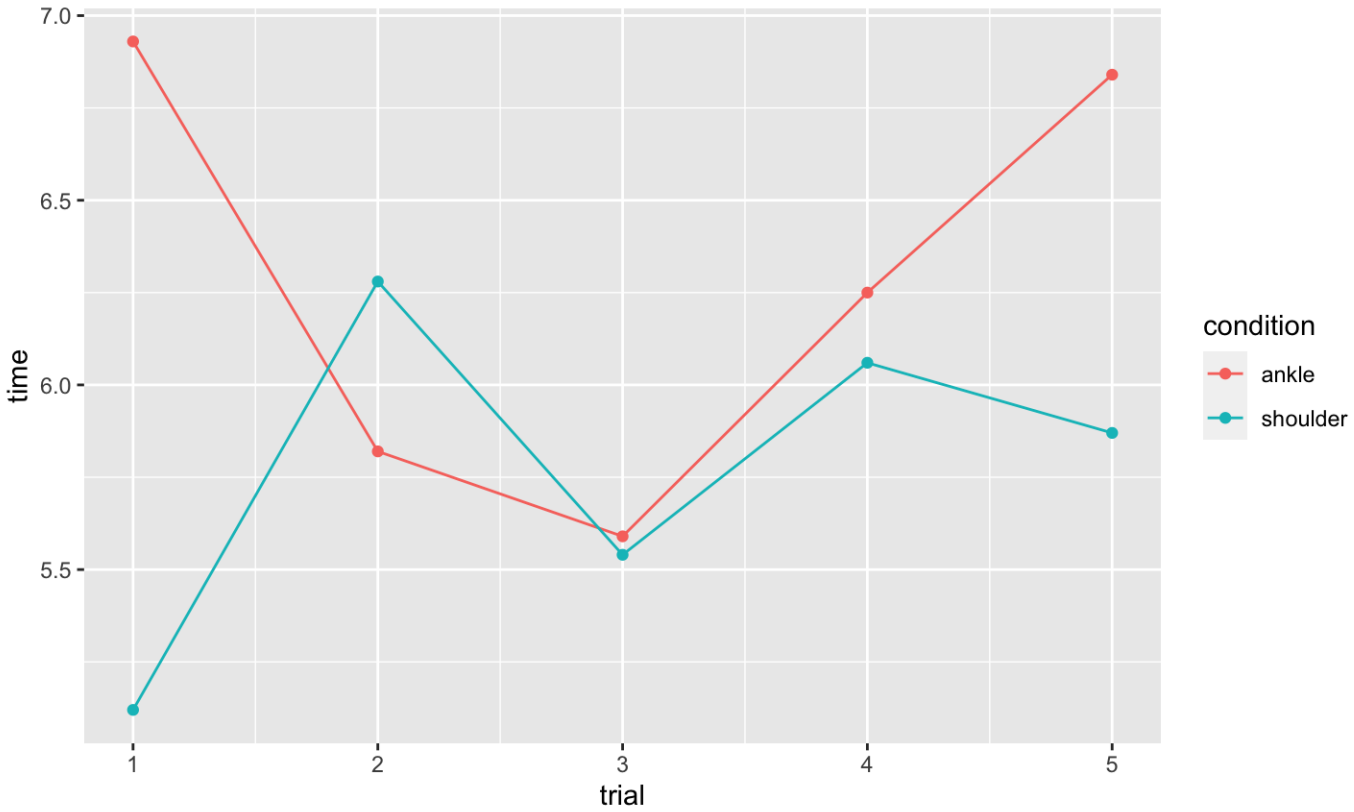
```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   47.00   48.75   50.38   50.78   53.06   55.00
```

```
# Calculate sum
dist.sum = with(distance, sum(ankleshoulder, na.rm = TRUE))
```

The total distance is 1218.75 cm.

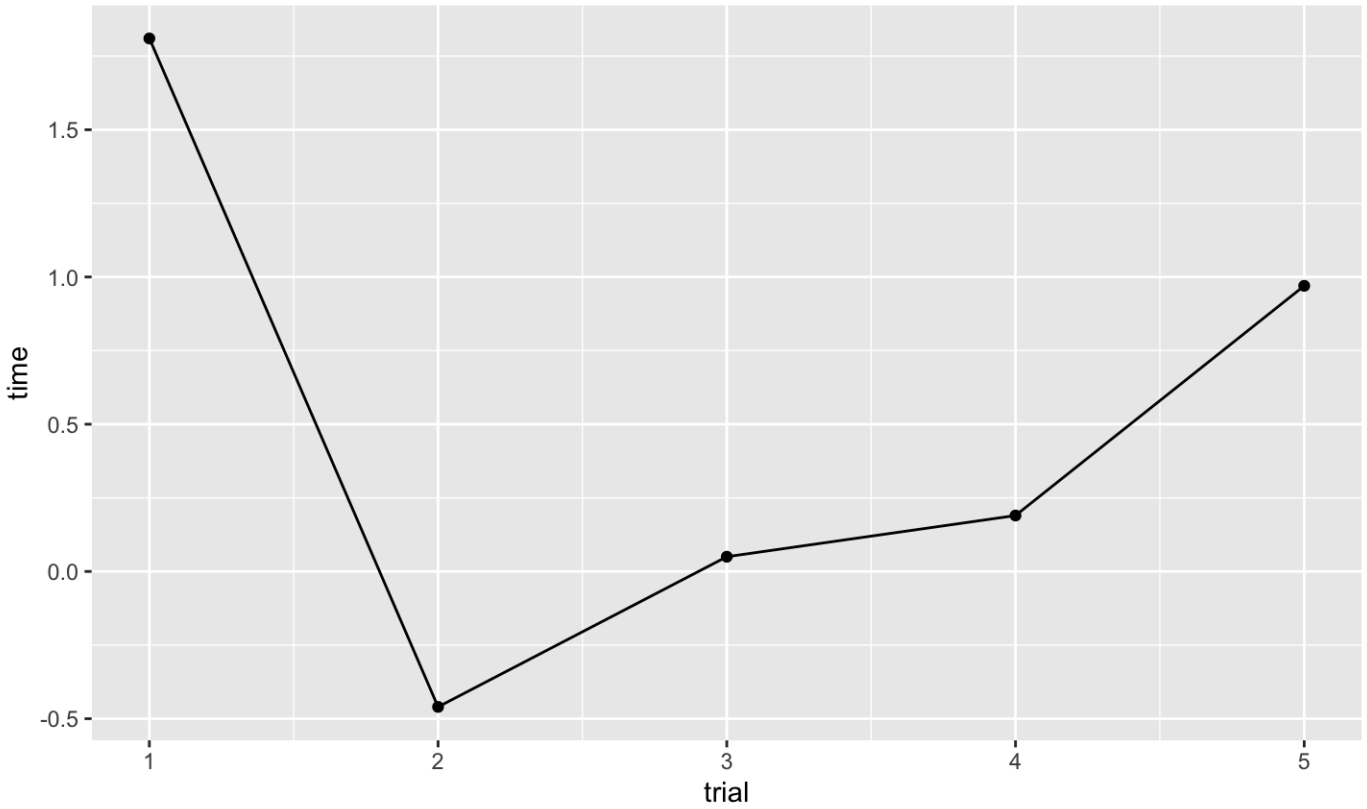
Measuring time

```
# Plot data
time.plot = ggplot(data = time, aes(x=trial, y=time, color=condition)) +
  geom_point() +
  geom_line()
```


7.0
6.5
6.0
5.5
time
1
2
3
4
5
trial
condition
ankle
shoulder

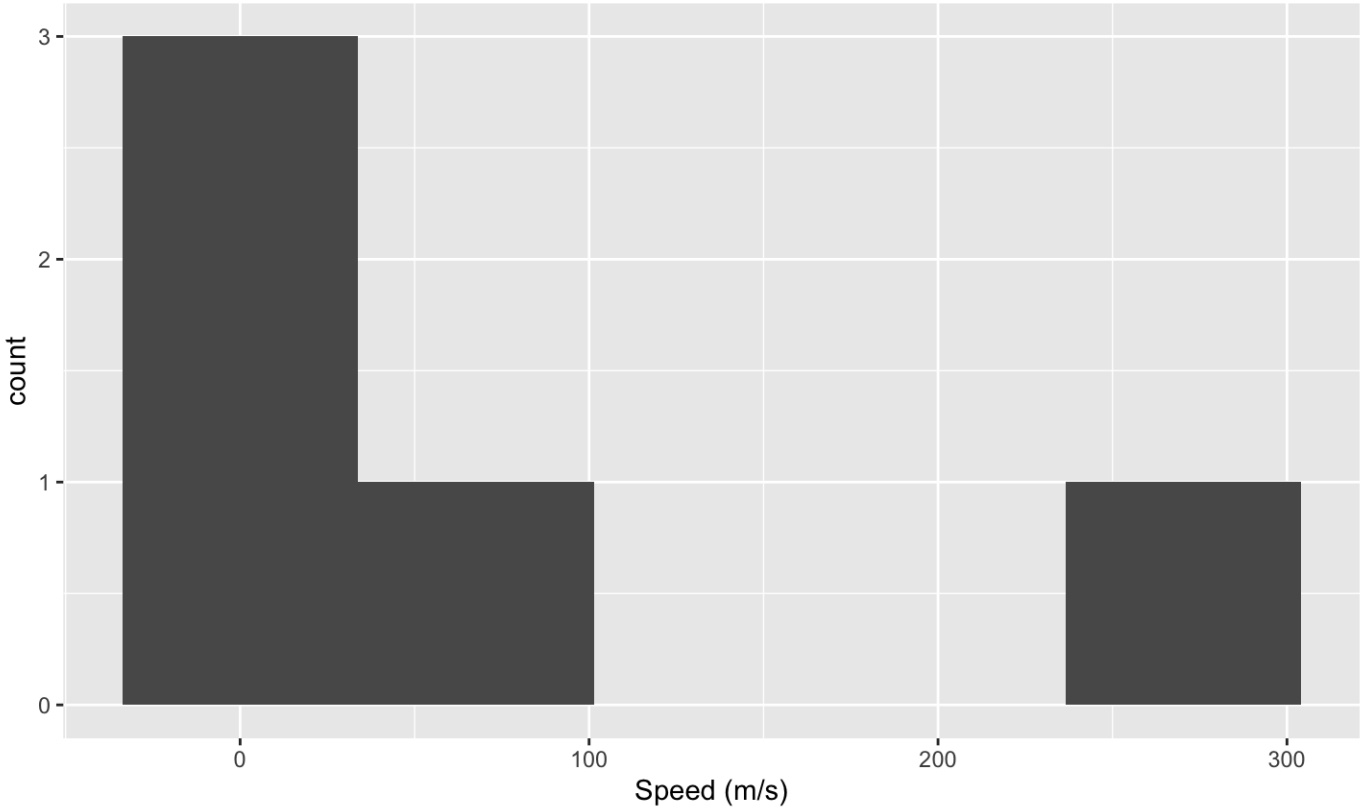
Calculate time difference

```
time %>%
  filter(condition == "ankle") ->
  ankle.times

time %>%
  filter(condition == "shoulder") ->
  shoulder.times

time.diff <- tibble(trial=unique(time$trial),
                    time=ankle.times$time - shoulder.times$time)

time.diff.plot = ggplot(data = time.diff, aes(x=trial, y=time)) +
  geom_point() +
  geom_line()
```


1.5
1.0
0.5
0.0
-0.5
time
1
2
3
4
5
trial

Calculating speed

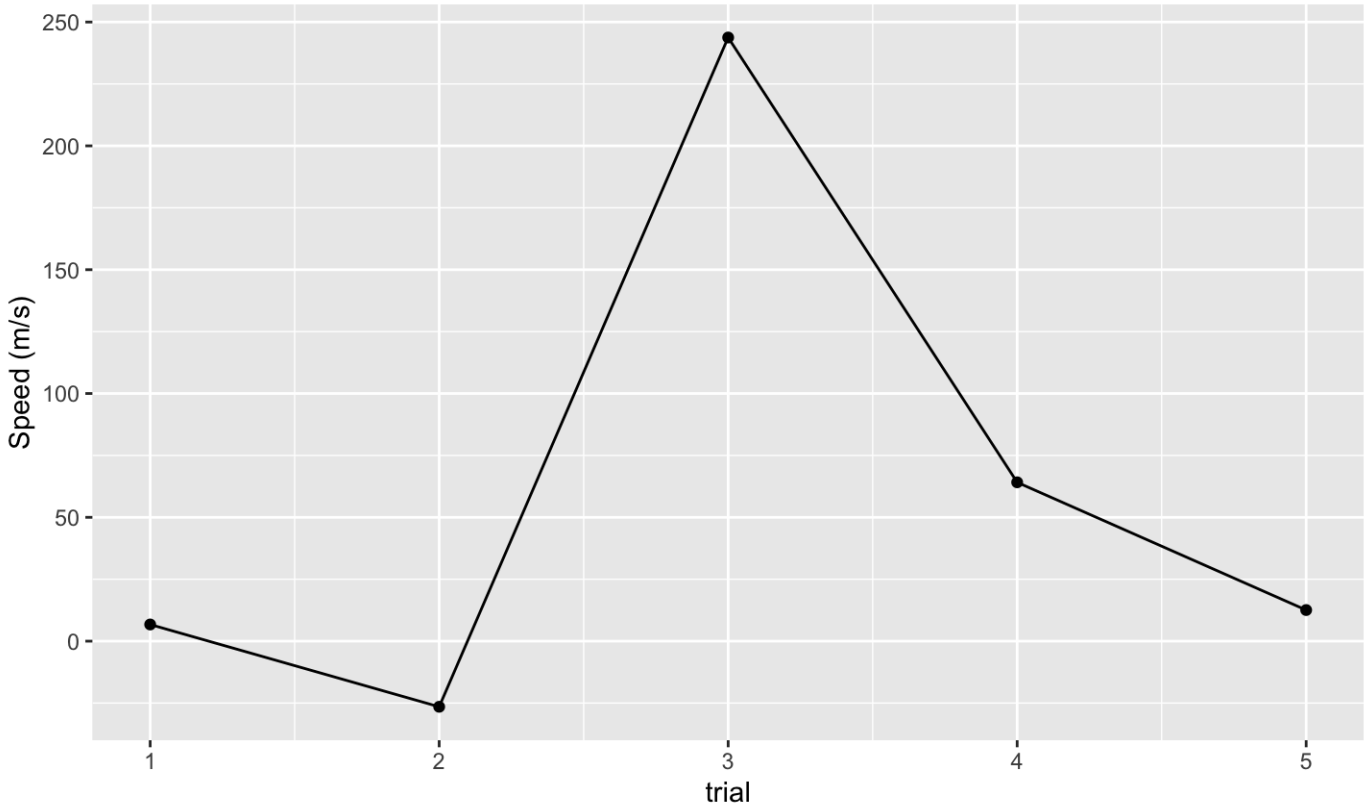
```
cm_to_m <- 1/100
time.diff$speed <- (dist.sum)*(cm_to_m)/time.diff$time

speed.hist <- ggplot(data = time.diff, aes(x=speed)) +
  geom_histogram(bins = 5) +
  xlab("Speed (m/s)")
```


3
2
1
0
count
0
100
200
300
Speed (m/s)

Plot time series of speeds

```
speed.plot <- ggplot(data = time.diff, aes(x=trial, y=speed)) +
  geom_point() +
  geom_line() +
  ylab("Speed (m/s)")
```

```
speed.plot
```



Summarizing findings

- We tested the mean speed of neural propagation in a sample of n=24 college-age adults.
- The mean speed of neural propagation over 5 trials was 60.139606 m/s with a range of [-26.4945652, 243.75] m/s.
- These findings **are/are not** generally in accord with values we would expect from the literature.

Limitations

How to replicate/extend

Contributors

Resources

This document was prepared in RStudio 1.4.717 on 2021-12-07 15:47:01.

```
sessionInfo()
```

```
## R version 4.1.0 (2021-05-18)
## Platform: x86_64-apple-darwin17.0 (64-bit)
## Running under: macOS Big Sur 11.6.1
##
## Matrix products: default
## LAPACK: /Library/Frameworks/R.framework/Versions/4.1/Resources/lib/libRlapack.dylib
##
## locale:
## [1] en_US.UTF-8/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets
## [6] methods   base
##
## other attached packages:
## [1] ggplot2_3.3.5     dplyr_1.0.7
## [3] magrittr_2.0.1    googledrive_2.0.0
##
## loaded via a namespace (and not attached):
##  [1] tidyselect_1.1.1 xfun_0.27        bslib_0.3.1
##  [4] purrr_0.3.4      gargle_1.2.0     colorspace_2.0-2
##  [7] vctrs_0.3.8      generics_0.1.1   htmltools_0.5.2
## [10] yaml_2.2.1       utf8_1.2.2       rlang_0.4.12
## [13] jquerylib_0.1.4  later_1.3.0      pillar_1.6.4
## [16] glue_1.4.2       withr_2.4.2      DBI_1.1.1
## [19] bit64_4.0.5      lifecycle_1.0.1  stringr_1.4.0
## [22] munsell_0.5.0    pagedown_0.15    gtable_0.3.0
## [25] websocket_1.4.1  evaluate_0.14    labeling_0.4.2
## [28] knitr_1.36       tzdb_0.2.0       fastmap_1.1.0
```