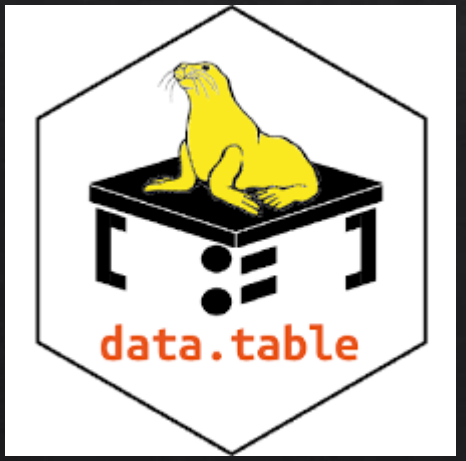
Introduction to data.table

Fast data handling and concise syntax in R



Jorrit Mesman
University of Geneva / Uppsala University
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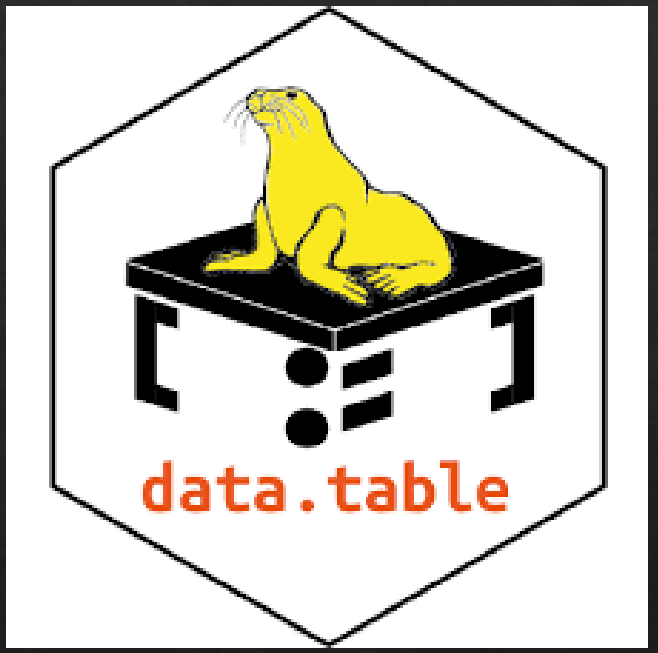
Workshop Outline

- Introductory presentation (20 min.)
  - What is data.table and why should you use it?
- Questions (5 min.)
- Walkthrough script – Part 1 (20 min.)
- Break (10 min.)
- Walkthrough script – Part 2 (20 min.)
- Questions & Try it out yourself! (15 min.)

What is data.table?

- CRAN R package
  - Main developer: Matt Dowle
  - First release: 2006
  - Active development
- Extension to data.frame
- Fast data handling
  - Main focus of the package
  - Reading, writing, selecting, joining, etc.
- Consistent and concise syntax



Website: https://rdatatable.gitlab.io/data.table/
Twitter: @MattDowle, #rdatatable

Why this workshop?

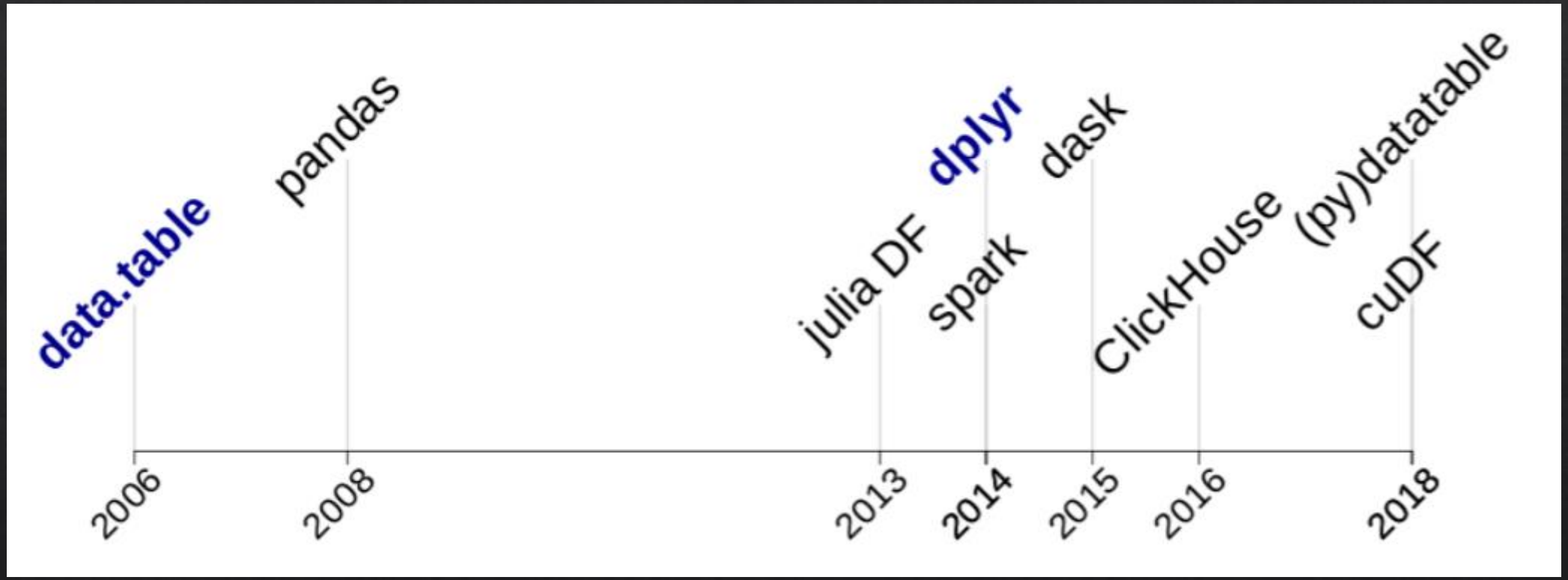
- One of the main packages in R, but little advertised
- Can help you write clearer code and faster scripts
- Faster data handling is particularly useful for GLEONites!
  - High-frequency data and long-term datasets
  - Modelling
  - Global analyses

Performance of data.table

- It is often said that R is slow
- Whether speed is relevant depends on the size of your data and how often you will call your function
  - Single use:
    - Small datasets (<10MB), speed is not so important
    - Large datasets (hundreds of MB), speed matters a lot
  - Repeated analyses:
    - Even small improvements in performance can save you hours

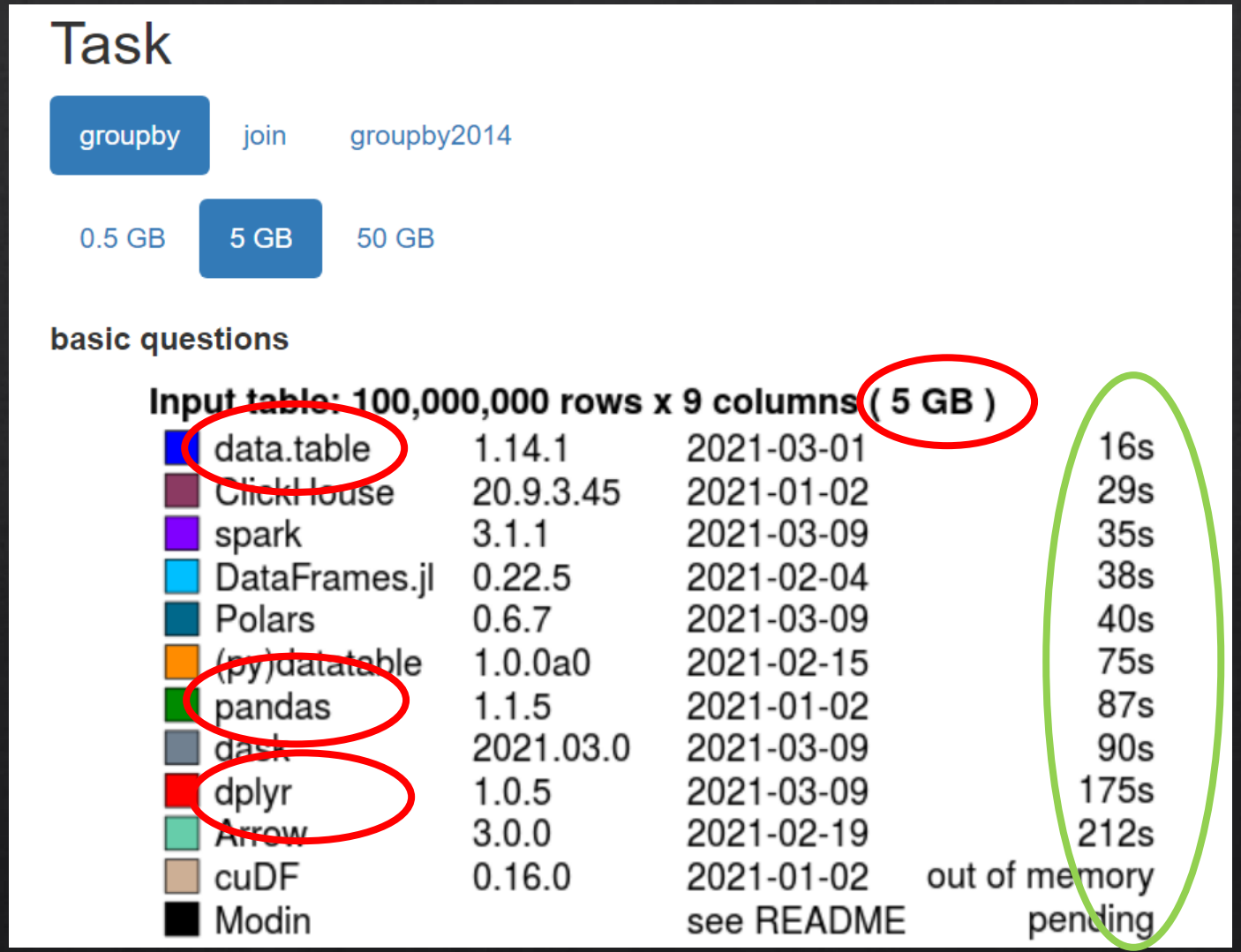
Indication of file sizes:
13 years of water temperature data, text format, 12 distinct depths
- Hourly: 11 MB
- 10 minutes: 85 MB
- 2 minutes: 387 MB

Performance of data.table



Source: Jan Gorecki, 2019

Performance of data.table



Data.table can be multiple factors faster than alternatives, even those in other languages!

https://h2oai.github.io/db-benchmark/, 2021-03-15

Performance of data.table

groupby | join | groupby2014

0.5 GB | 5 GB | 50 GB

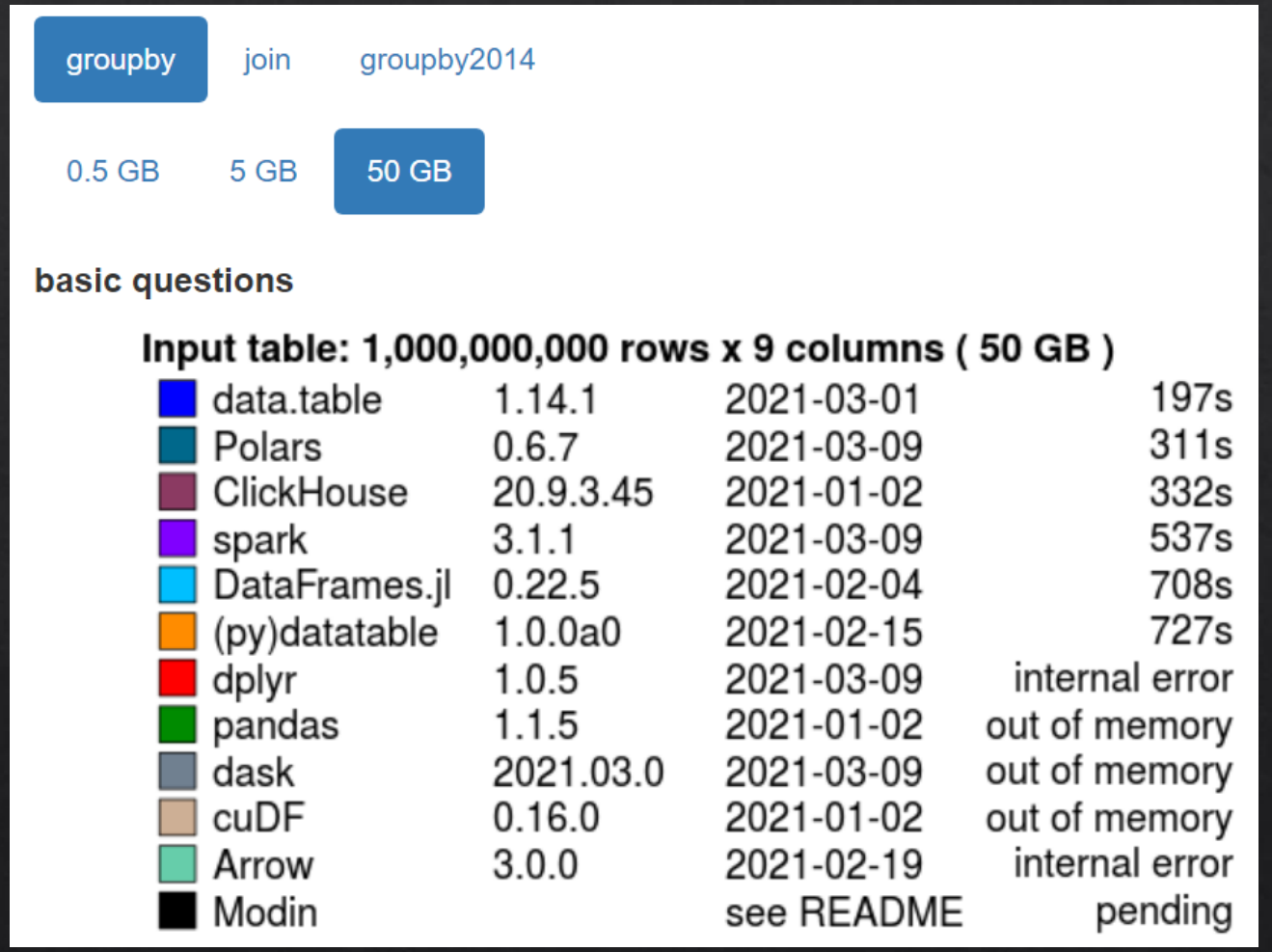
basic questions

Input table: 10,000,000 rows x 7 columns (0.4 GB)

cuDF	0.16.0	2021-01-02	2s
Polars	0.6.7	2021-03-09	6s
data.table	1.14.1	2021-03-01	8s
ClickHouse	20.9.3.45	2021-01-02	22s
dplyr	1.0.5	2021-03-09	29s
spark	3.1.1	2021-03-09	41s
pandas	1.1.5	2021-01-02	56s
DataFrames.jl	0.22.5	2021-02-04	129s
(py)datatable	1.0.0a0	2021-02-15	195s
dask	2021.03.0	2021-03-09	938s
Arrow	3.0.0	2021-02-19	not yet implemented
Modin		see README	pending

https://h2oai.github.io/db-benchmark/, 2021-03-15

Performance of data.table



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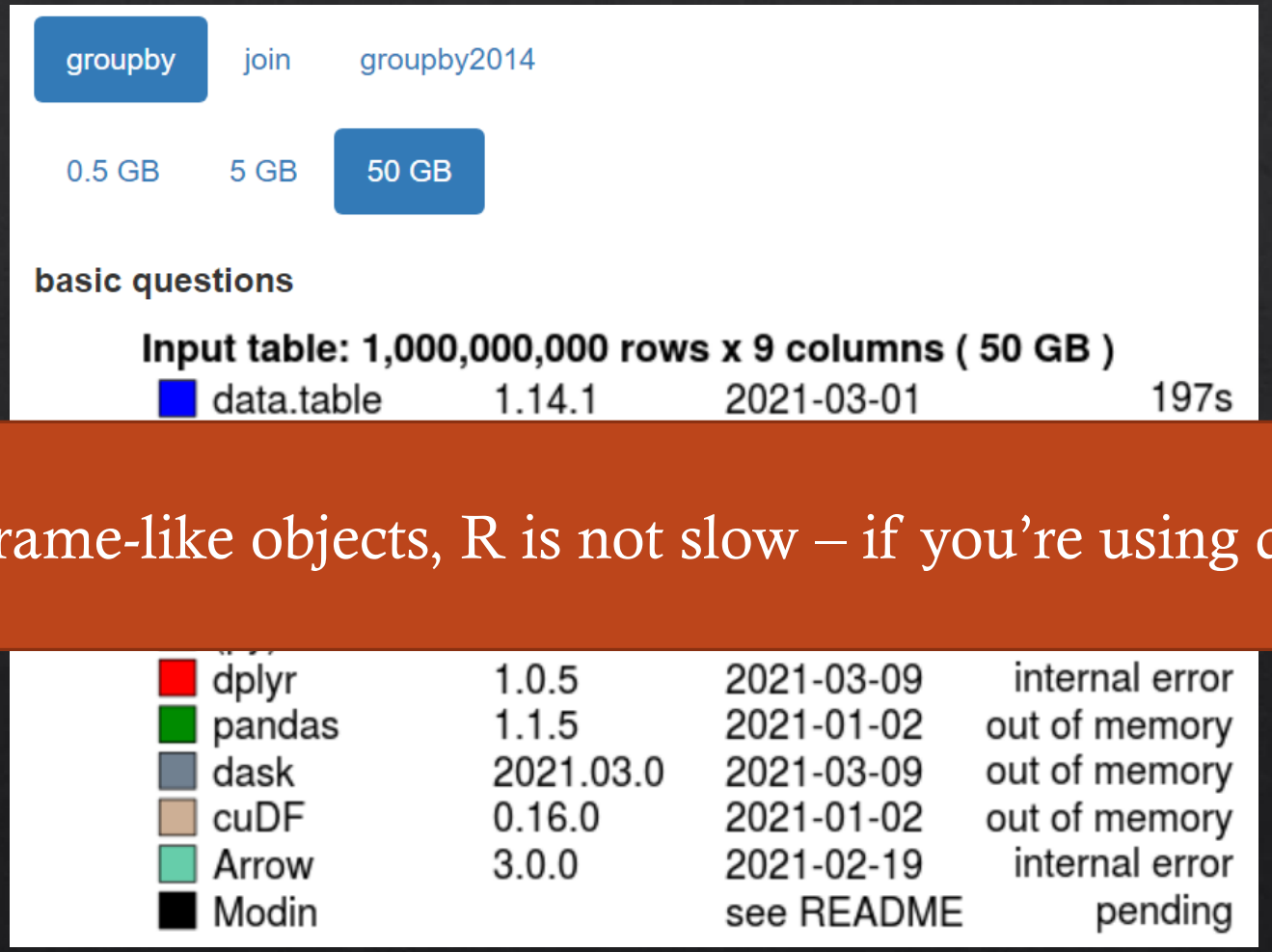
Performance of data.table



for data.frame-like objects, R is not slow – if you're using data.table!

https://h2oai.github.io/db-benchmark/, 2021-03-15

What makes data.table so fast?

- Speed has been the main focus of data.table during its whole development
- Efficient algorithms (C code)
- Internal structure of data.tables
- Less in-memory copying
- Low-level multi-threading

- When using data.table, most of this will happen internally, so you can code “normally” and still achieve a high efficiency

Not just fast, a clear syntax as well!

- Data.table has a syntax that is different from base R
- “Come for the performance, stay for the syntax” – Elio Campitelli, R blogger
- Concise
- Consistent
- DT[i, j, by]
  - i: what rows
  - j: what to do
  - by: by what groups
- More on this in the walkthrough…

Not just fast, a clear syntax as well!

- Tidyverse also offers an alternative syntax to base R
  - Verbose
  - Verbs as functions
  - Pipes
- Data.table
  - More alike query languages such as SQL
  - Closer to base-R
- Which one is “better” ultimately comes down to preference, but to get optimal performance, you’ll have to use at least some of the data.table syntax
- dtplyr package (https://cran.r-project.org/web/packages/dtplyr/index.html)

Short comparison syntax of data.table and tidyverse

Tidyverse	data.table

DF %>%
  group_by(z) %>%
  summarise(sum(y))
ans <- DF %>%
  group_by(z) %>%
  mutate(y = cumsum(y))
	DT[, sum(y), by = z]
	
	DT[, y := cumsum(y), by = z]

DF %>%
  filter(x>2) %>%
  group_by(z) %>%
  summarise(sum(y))
ans <- DF %>%
  group_by(z) %>%
  mutate(y = replace(y,
  which(x > 2),
  cumsum(y)))
	DT[x > 2, sum(y), by = z]
	
	DT[x > 2, y := cumsum(y), by = z]

https://stackoverflow.com/questions/21435339

Short comparison syntax of data.table and tidyverse

Tidyverse

```
diamondsDF %>%
  filter(cut != "Fair") %>%
  group_by(cut) %>%
  summarize(
    AvgPrice = mean(price),
    MedianPrice = as.numeric(median(price)),
    Count = n()
  ) %>%
  arrange(desc(Count))
```

data.table

```
diamondsDT[
  cut != "Fair",
  .(AvgPrice = mean(price),
    MedianPrice = as.numeric(median(price)),
    Count = .N
  ),
  by = cut
][
  order(-Count)
]
```

https://stackoverflow.com/questions/21435339

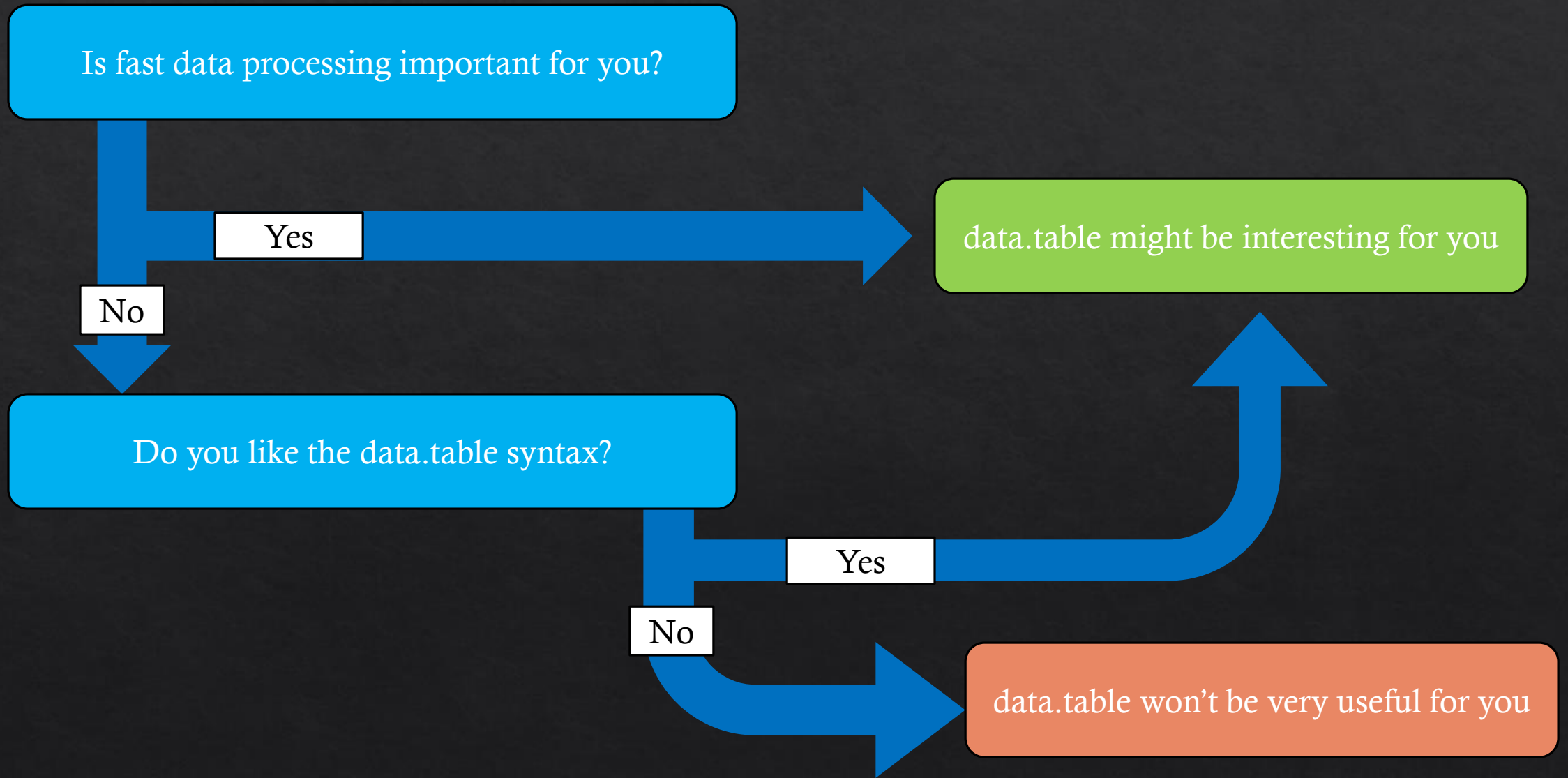
But combinations are possible!

data.table with pipes

```
library(magrittr)
library(ggplot2)
temperature %>%
   .[level == 1000] %>%
   .[, mean(air), by = .(lat, lon)] %>%
   .[lat > 0] %>%
   ggplot(aes(lon, lat)) +
   geom_raster(aes(fill = V1), interpolate = TRUE)
```

https://eliocamp.github.io/codigo-r/en/2019/07/why-i-love-data-table/

Should you use data.table?



In summary

- data.table is very fast on especially large datasets
  - Significantly faster than many alternatives
  - File size needs to be large to notice difference
- Consistent and concise syntax
  - We'll learn how to work with this during the walkthrough

- To the hands-on part!