VRIJE UNIVERSITEIT BRUSSEL

Using Open Science to create reproducible research

VUB Ethics week

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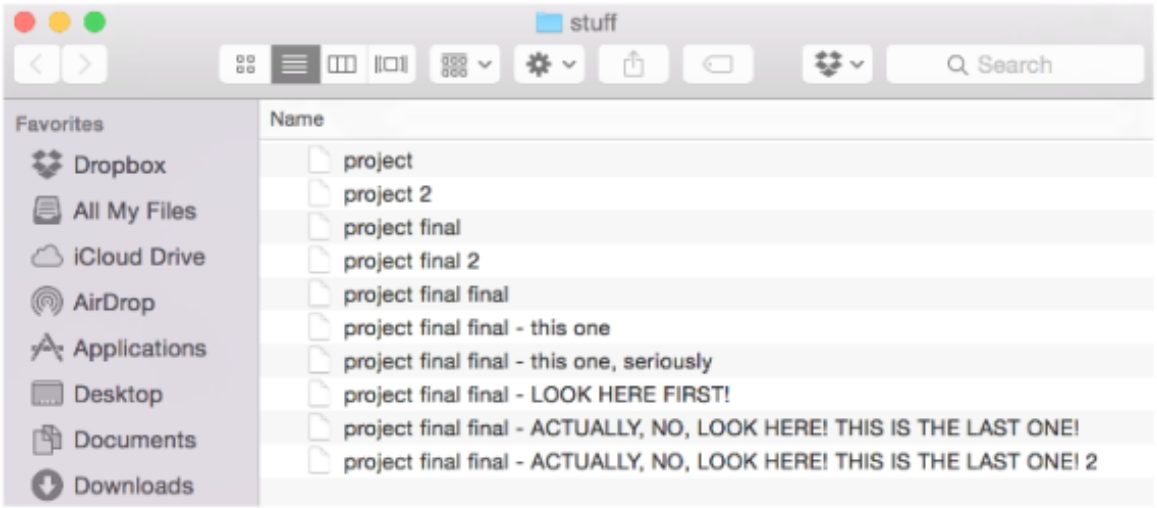
09/12/2022

Materials

- All materials can be downloaded from Github: https://github.com/timvantilborgh/VUB-ethics-week
- Direct link to slides: https://timvantilborgh.github.io/VUB-ethics-week/slides.html#/title-slide


Trying to understand your code from last year
%>%
purrr
rmarkdown
test that
ggplot2
tidyverse
lubri
stringr
forcats
usethis
rsample
tibble
dplyr
parsnip


stuff
Search
Favorites
Dropbox
All My Files
iCloud Drive
AirDrop
Applications
Desktop
Documents
Downloads
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project
project 2
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project final final
project final final - this one
project final final - this one, seriously
project final final - LOOK HERE FIRST!
project final final - ACTUALLY, NO, LOOK HERE! THIS IS THE LAST ONE!
project final final - ACTUALLY, NO, LOOK HERE! THIS IS THE LAST ONE! 2

What is reproducible research?

> Research is reproducible when others can reproduce the results of a scientific study given only the original data, code, and documentation [1]

1. Alston, J. M., & Rick, J. A. (2021). A beginner's guide to Conducting reproducible research. *Bulletin of the Ecological Society of America, 102*(2), 1-14

How does it fit into open science?

> "Open Science" is an umbrella term used to refer to the concepts of openness, transparency, rigour, **reproducibility**, replicability, and accumulation of knowledge, which are considered fundamental features of science [1]

1. Crüwell, S., van Doorn, J., Etz, A., Makel, M. C., Moshontz, H., Niebaum, J. C., … & Schulte-Mecklenbeck, M. (2019). Seven Easy Steps to Open Science: An Annotated Reading List. Zeitschrift für Psychologie, 227(4), 237-248

Reproducability vs Replicability

		Data	
		Same	Different
Analysis	Same	Reproducible	Replicable
	Different	Robust	Generalisable

Source: https://the-turing-way.netlify.app/reproducible-research/overview/overview-definitions.html

To what extent is it a problem?

- Random sample of 250 psychology articles published between 2014 and 2017 [1]
  - Research materials availability: 14%
  - Protocol availability: 0%
  - Data availability: 2%
  - Analysis-script availability: 1%

1. Hardwicke, T. E., Thibault, R. T., Kosie, J. E., Wallach, J. D., Kidwell, M. C., & Ioannidis, J. P. (2022). Estimating the prevalence of transparency and reproducibility-related research practices in psychology (2014–2017). *Perspectives on Psychological Science, 17*(1), 239-251

To what extent is it a problem?

- 232 key statistical claims from 46 published articles tested using the raw data and following the methods section closely [1]:
  - 70% of claims could be successfully reproduced
  - 7% of claims were no longer statistically significant

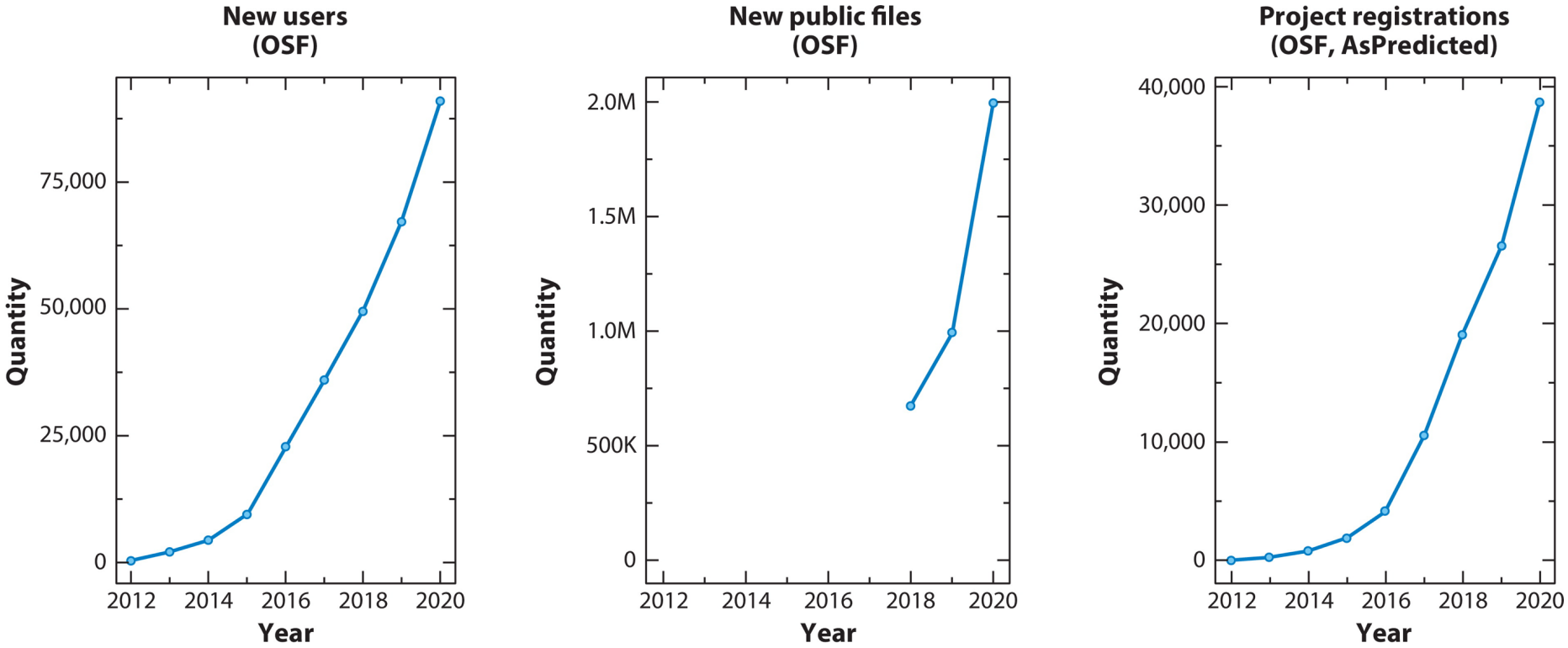
1. Artner, R., Verliefde, T., Steegen, S., Gomes, S., Traets, F., Tuerlinckx, F., & Vanpaemel, W. (2021). The reproducibility of statistical results in psychological research: An investigation using unpublished raw data. *Psychological Methods, 26*(5), 527

To what extent is it a problem?

- These problems are not limited to psychology
  - Economics: problems in 29 out of 67 articles [1]
  - Genetics: problems in 10 out of 18 articles [2]
  - Political science: problems in 20 out of 24 articles [3]

1. Chang, A., & Li, P. (2015). *Is economics research replicable? sixty published articles from thirteen journals say 'usually not'*. Board of Governors of the Federal Reserve System Finance and Economics.
2. Ioannidis, J. P., Allison, D. B., Ball, C. A., Coulibaly, I., Cui, X., Culhane, A. C., Falchi, M., Furlanello, C., Game, L., Jurman, G., Mangion, J., Mehta, T., Nitzberg, M., Page, G. P., Petretto, E., & van Noort, V. (2009). Repeatability of published microarray gene expression analyses. *Nature Genetics, 41*(2), 149–155.
3. Eubank, N. (2016). Lessons from a decade of replications at the quarterly journal of political science. *Political Science & Politics, 49*(2), 273–276.

To what extent is it a problem?

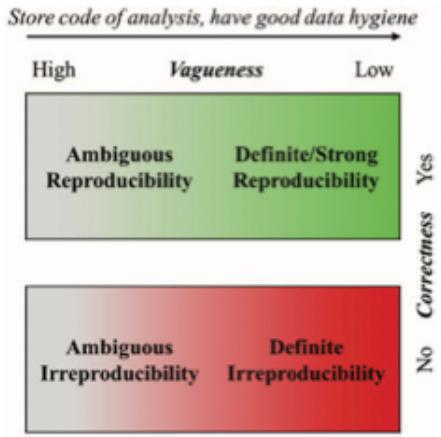


Nosek BA, et al. 2022
Annu. Rev. Psychol. 73:719–48

Nosek, B. A., Hardwicke, T. E., Moshontz, H., Allard, A., Corker, K. S., Dreber, A., ... & Vazire, S. (2022). Replicability, robustness, and reproducibility in psychological science. *Annual review of psychology, 73*, 719-748.

How can we make our research reproducible?

- Open materials allow us to test reproducability [1]

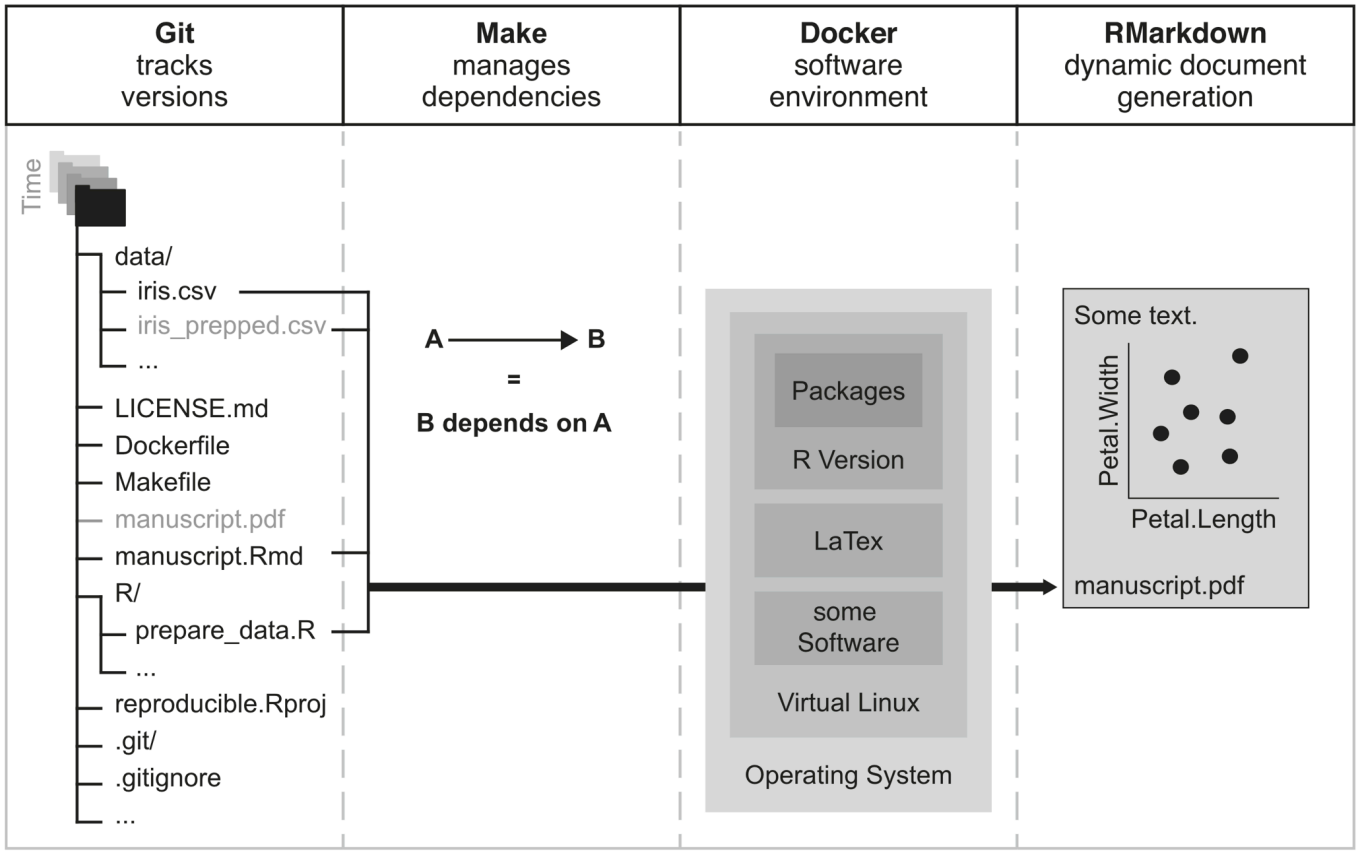


1. Artner, R., Verliefde, T., Steegen, S., Gomes, S., Traets, F., Tuerlinckx, F., & Vanpaemel, W. (2021). The reproducibility of statistical results in psychological research: An investigation using unpublished raw data. *Psychological Methods, 26*(5), 527

How can we make our research reproducible?

- Share data
- Share analysis scripts
- Use and share lab notebooks
- Reproducible workflow with **dynamic documents**

Reproducible workflow



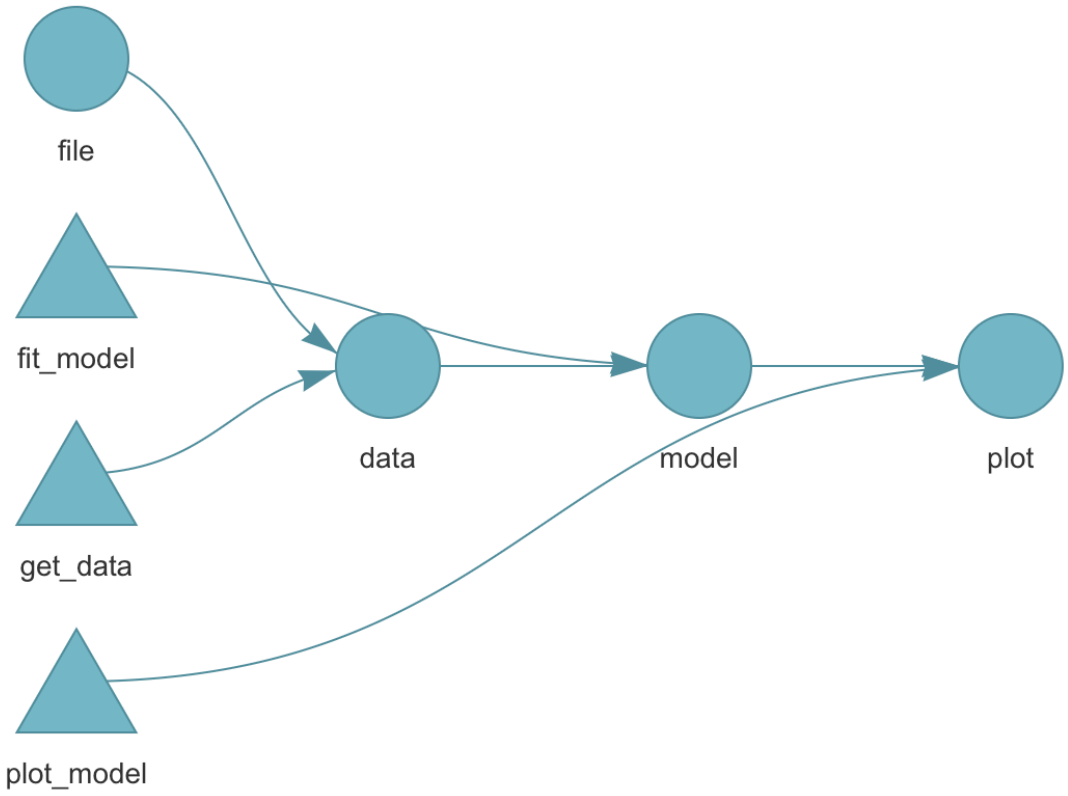
Peikert, A., & Brandmeier, A. M. (2021). A reproducible data analysis workflow with R markdown, Git, Make, and Docker. *Quantitative and Computational Methods in Behavioral Sciences*, 1-27.

Version control

- Track changes to files
- Ability to recall specific versions of files or revert entire project to a past state
- Tools: GitHub, Gitlab
- Ability to collaborate and share files

Dependency management

- In what sequence should files be executed?
- Tools: Make, Targets, Drake



Dynamic document generation

````
### Dynamic Document Demonstration

```{r setup, echo=FALSE}
library("knitr")
library("papaja")
```

This is a simple analysis of the `sleep` dataset (Student, 1908) taken from
`help(t.test)`.

```{r t-test}
data("sleep")
result <- t.test(extra ~ group, data = sleep, paired = TRUE)
```

The difference in means of hours slept between the groups
was `r ifelse(result$p.value >= .05, "**not**", "")`
significantly different from zero (`r apa_print.htest(result)$full_result`).
````

Dynamic Document Demonstration

This is a simple analysis of the `sleep` dataset (Student, 1908) taken from `help(t.test)`.

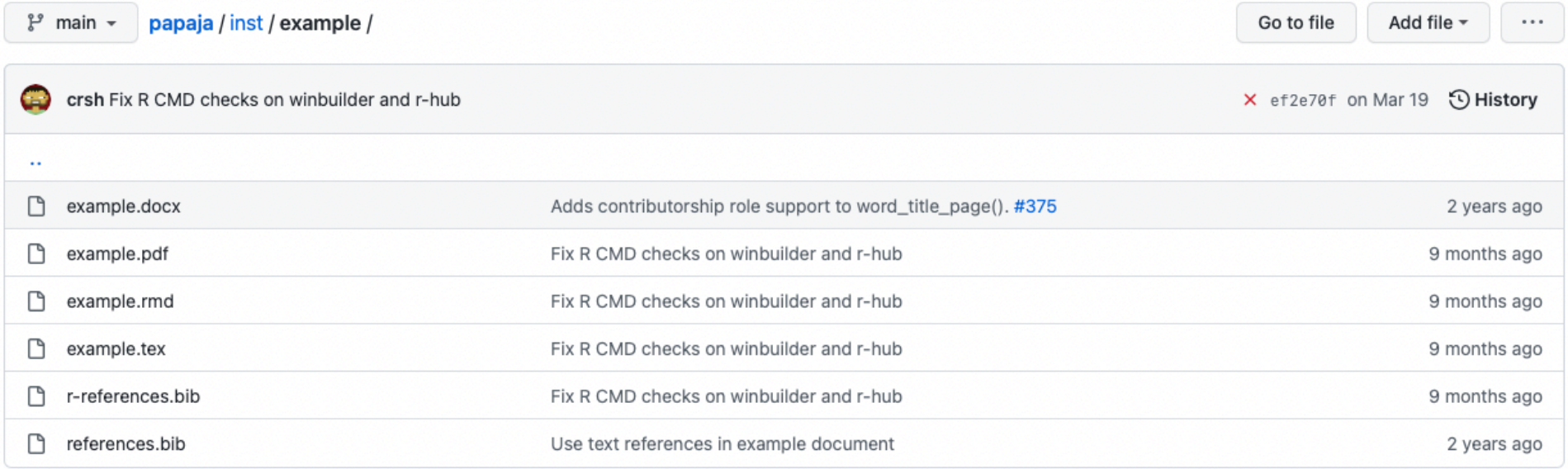
```
data("sleep")
result <- t.test(extra ~ group, data = sleep, paired = TRUE)
```

The difference in means of hours slept between the groups was significantly different from zero ($M_d = -1.58$, 95% CI $[-2.46, -0.70]$, $t(9) = -4.06$, $p = .003$).

Peikert, A., & Brandmeier, A. M. (2021). A reproducible data analysis workflow with R markdown, Git, Make, and Docker. *Quantitative and Computational Methods in Behavioral Sciences*, 1-27.

Dynamic document generation: Papaja

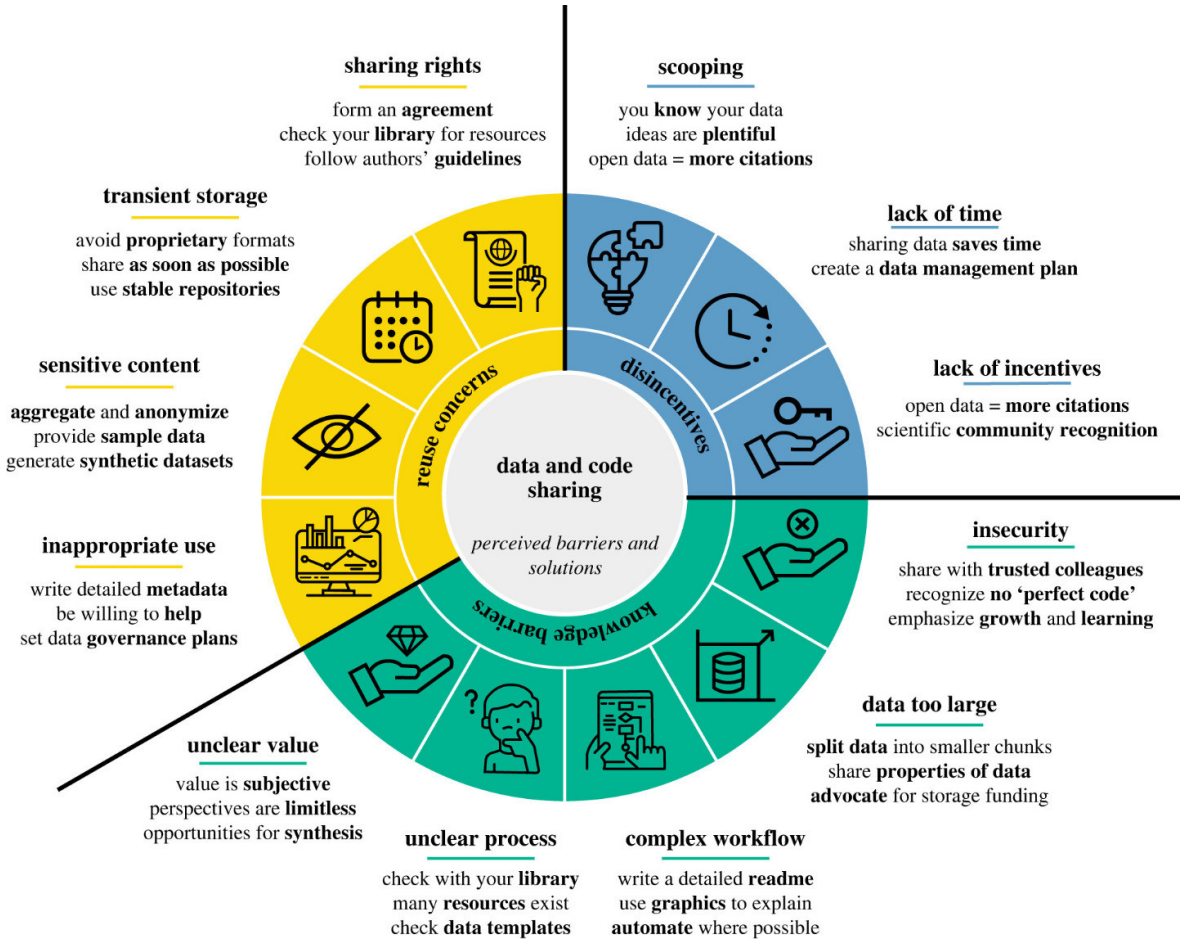
https://github.com/crsh/papaja/tree/main/inst/example



Containerization

- Software, R packages, operating systems are commonly updated
- Code may no longer run due to updates
- Tools: Docker, renv, liftR, holepunch
- Encapsulate, share, and re-create computational environment
- Save versions of R packages, R, operating systems, etcetera

So why aren't we all doing this?

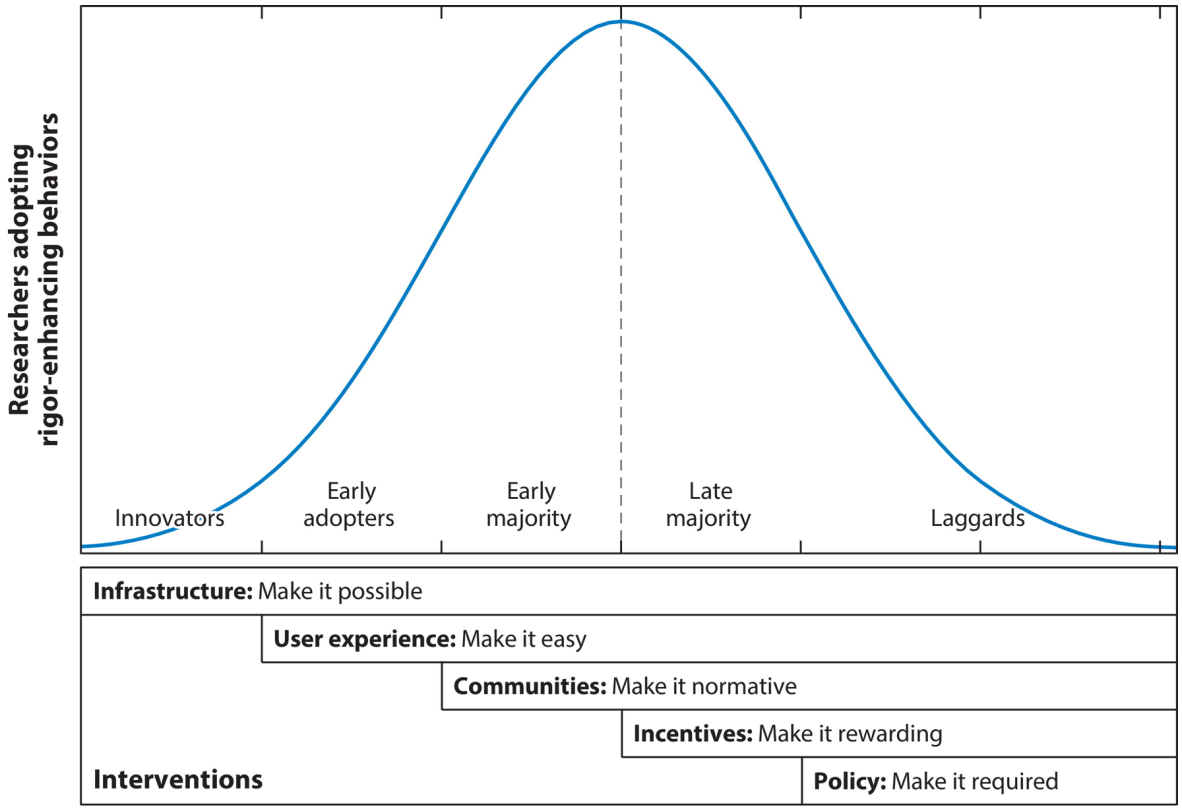


Gomes, D. G., Pottier, P., Crystal-Ornelas, R., Hudgins, E. J., Foroughirad, V., Sánchez-Reyes, L. L., … & Gaynor, K. M. (2022). Why don't we share data and code? Perceived barriers and benefits to public archiving practices. *Proceedings of the Royal Society B, 289*(1987), 20221113.

Limitations

- Collaboration can be difficult when co-authors are not familiar with tools (redoc package!)
- Conversion to pdf works better than conversion to word (Quarto solves this problem)
- There are situations where a simple word document is easier than an Rmarkdown or Quarto file
- There is a learning curve; we should train people early on in their research career!

Conclusion



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Thank you

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