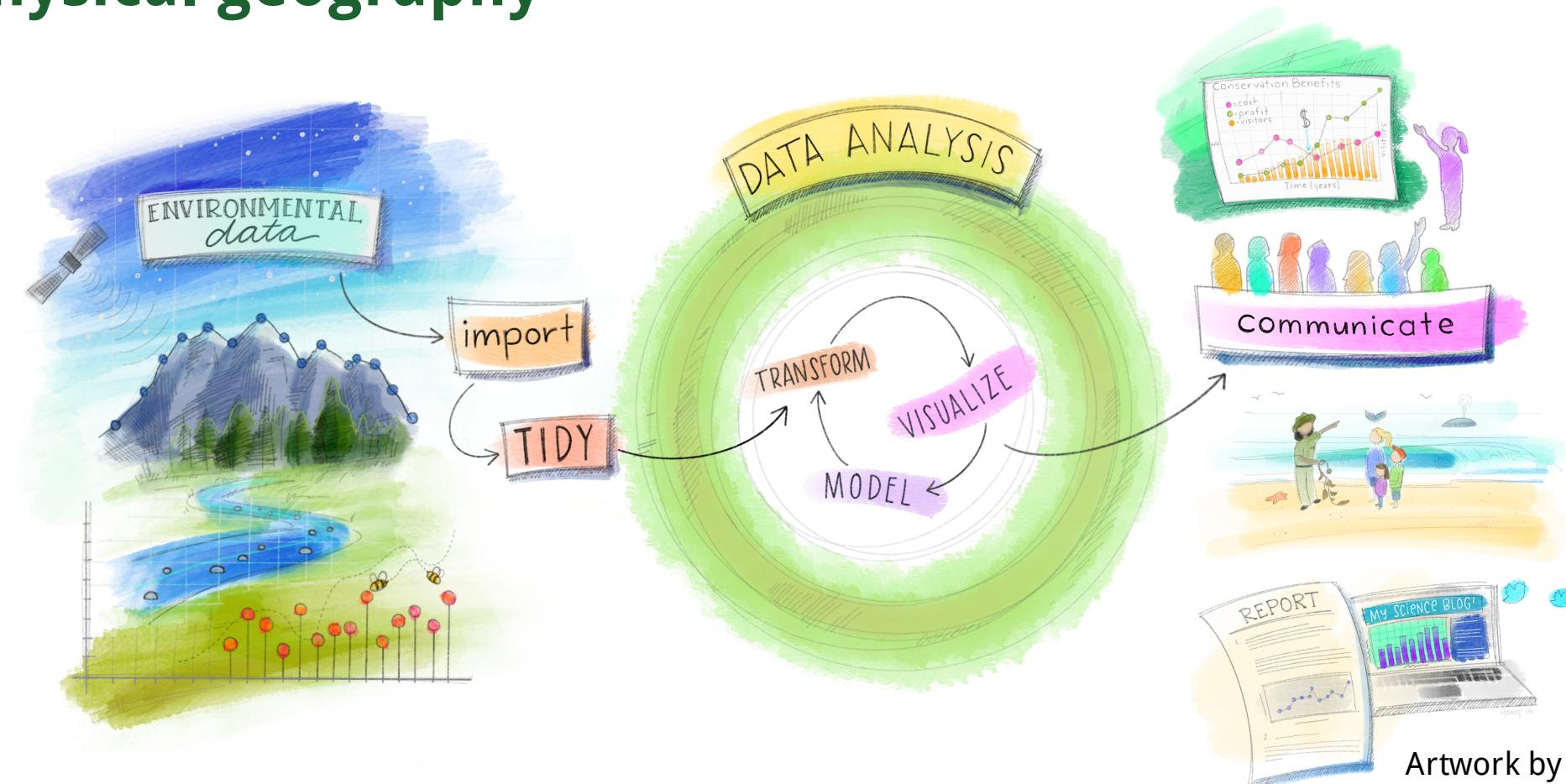


PCAG 2021

Importance of reproducible data analysis in physical geography



Alex Koiter & Steffi LaZerte

Updated from Golemund & Wickham's classis R4DS schematic, envisioned by Dr. Julia Lowndes for her 2019 useR! keynote talk

Artwork by [Allison Horst](#)

Introduction

Reproducibility

- The data analysis can be successfully reproduced

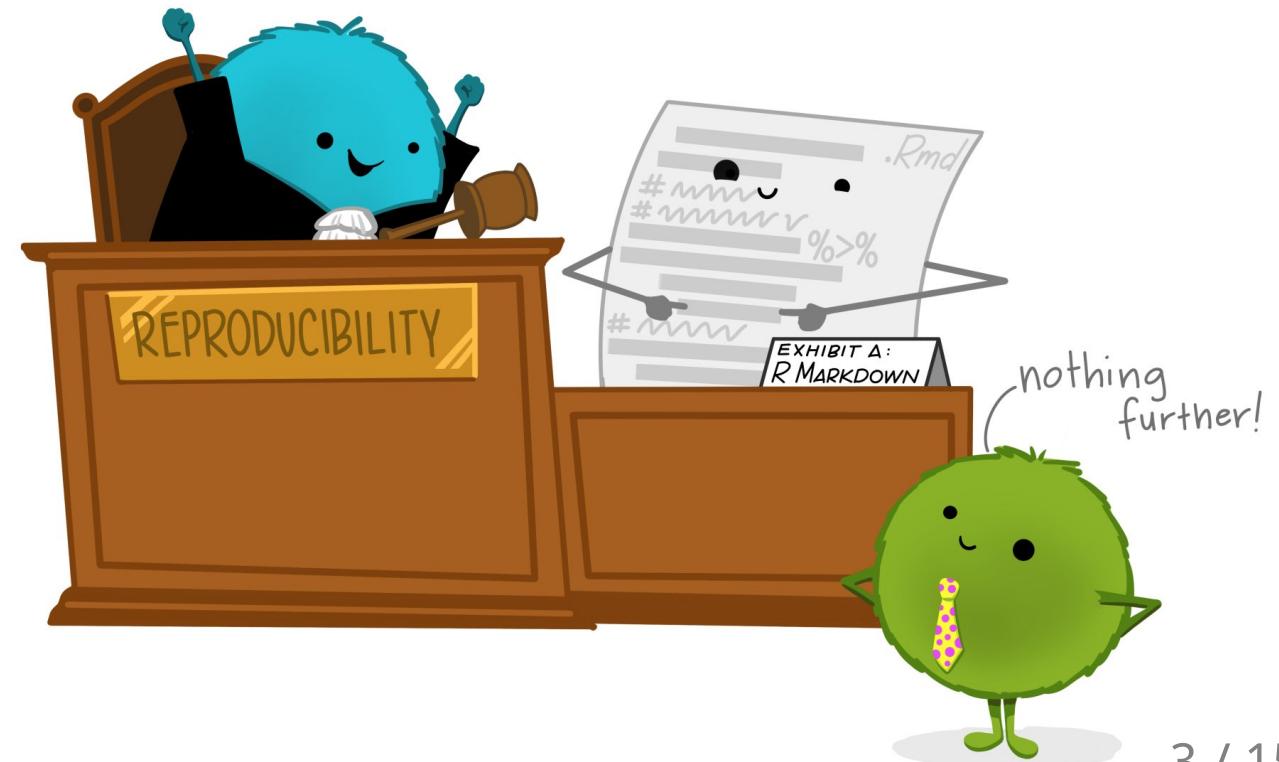
Replicability

- A separate investigator conducted an independent study and came to the same conclusion as the original study

Reproducibility

- Less about ensuring the correctness of the results
- More about being transparent and understanding exactly what was done
 - This is especially important in large and complex datasets

A study can be reproducible
and still be wrong



Computational reproducibility

Important because:

- Allows us to evaluate the data, analyses, and models on which conclusions are drawn
- Allows you to revisit your own work (e.g., incorporate a suggestion)

It is difficult to reproduce because:

- Data is not made available
- Method sections of papers often do not provide enough detail
- Use of graphical programs (clicks and drop down menus)
- Not making code available (R, Python, MATLAB)

Working with large data sets

Data acquisition

- Documenting getting/downloading/importing data sets
 - Always maintain the original data (unmodified)

Working with large data sets

Data munging/wrangling

1. Formatting
2. Merging
3. Quality assurance
 - NA's
 - 0's
 - Detection limits
 - Outliers
 - Typos/errors



Need to document every change you make

Easy with small data sets with and simple structure

Working with large data sets

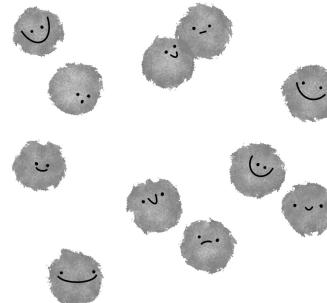
Data analysis

- Analysis/figures
 - Data used
 - Analysis used (trial and error)
 - Parameters
 - Diagnostics
 - Figure creation process
 - Software versions

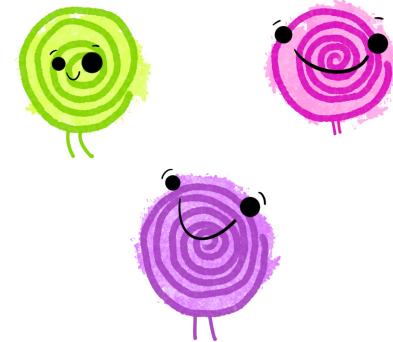
Hard to write papers if you
don't keep track of this!

k-means clustering

OBSERVATIONS



cluster CENTROIDS



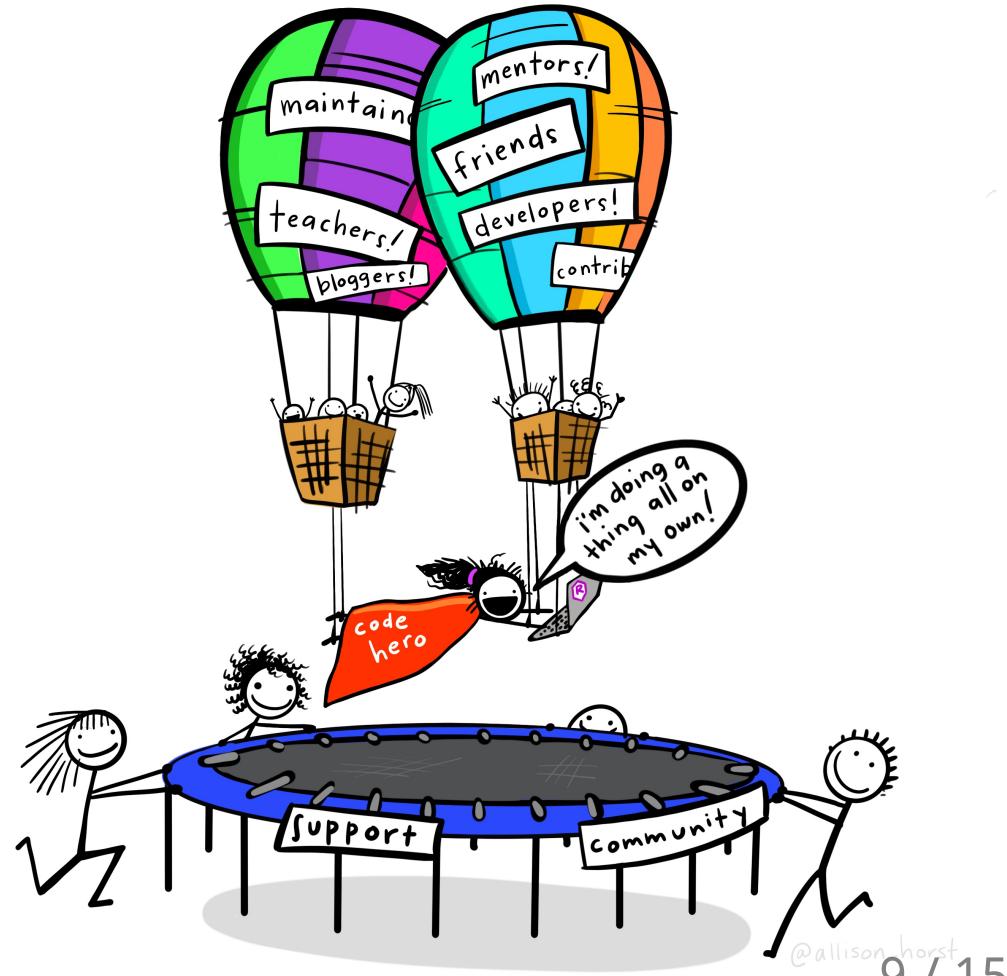
@allison_horst

Why is this not practiced?

- Don't know how
- Too busy
- It's internal work
- Worried about being copied
- Rigged the data

Why is this not practiced?

- Don't know how - **learn! lots of support and tools**
- Too busy - **often faster in the long run**
- It's internal work - **often a need to share**
- Worried about being copied - **in practice low risk**
- Rigged the data - **you have bigger problems**



How can you achieve this?

Keeping track

- Extensive notes
 - What, when, with what
- Programmatically
 - Scripts, R, Python, MATLAB, etc.
- Version control
 - git, [GitHub](#), [GitLab](#)

The screenshot shows the rOpenSci website's "About us" page. The header features the rOpenSci logo and navigation links for About, Blog, Packages, Community, and Resources. The main content area has a light blue background with a white hexagonal pattern. The title "About us" is centered in bold black font. Below it, a paragraph explains the organization's mission: "rOpenSci fosters a culture that values **open** and **reproducible** research using **shared** data and reusable software".

Sharing

- Open Science!
 - [Open Science Framework](#) (OSF)
- Journal Supplementary materials

<https://ropensci.org>

What do we use?

R

- Statistical programming language
- Free and open source

Want to learn?

- rOpenSci organization
- R for Data Science online book
- RStudio Primers interactive online exercises
- Attend classes or workshops
 - Like one of Steffi's Introduction to R workshops
(shameless self-promotion)



Artwork by Allison Horst

What do we use?

git & GitHub

- **git** is a version control system
 - keeps tracks of changes
- **GitHub** is an online home for git projects
 - allows collaboration and sharing
- like R, tricky to learn, but oh so powerful!

Want to learn?

- Happy Git with R online book

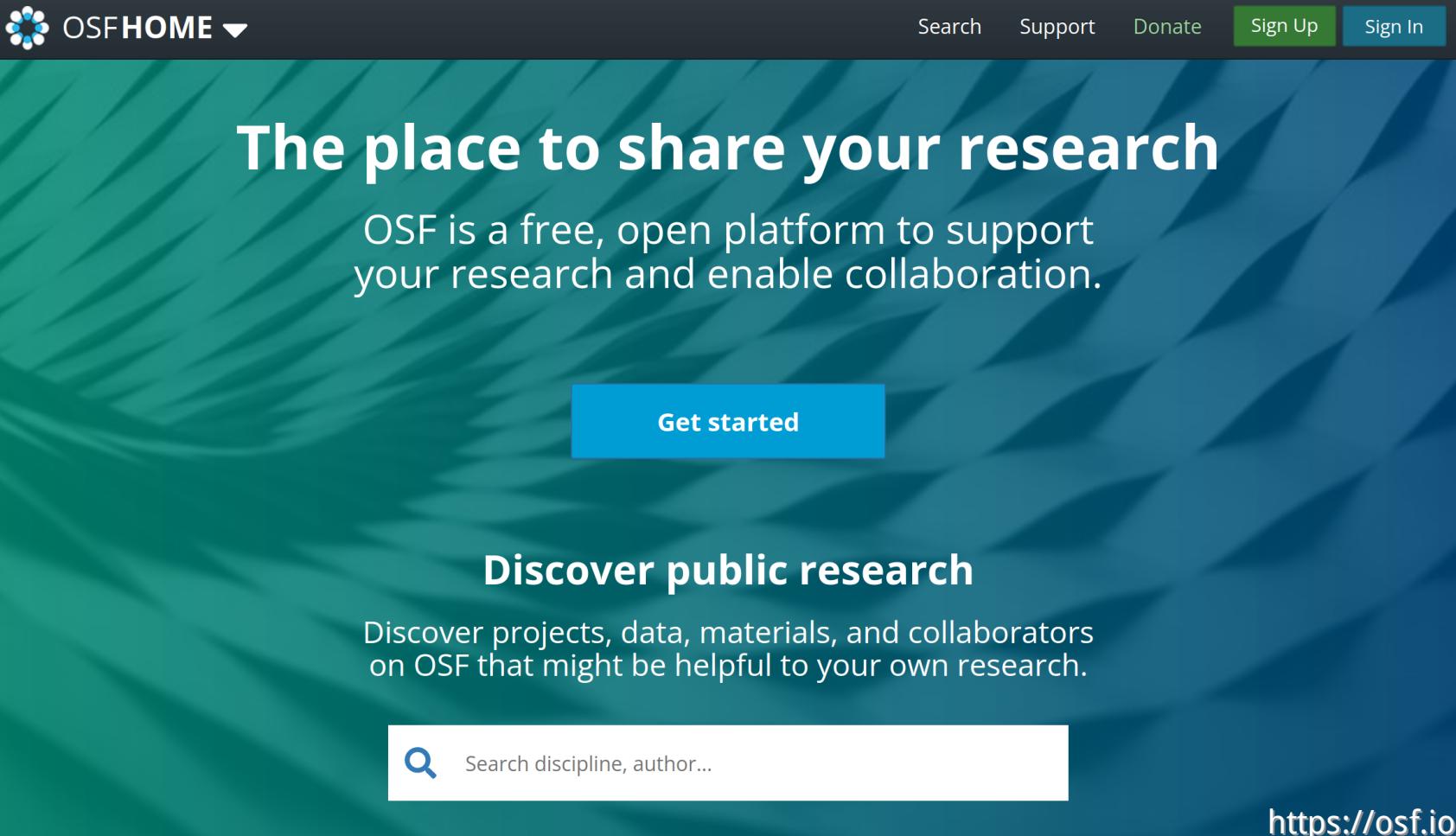
The screenshot shows a GitHub repository page for 'alex-koiter / presentations'. The repository is public. The 'Code' tab is selected. The commit history shows an initial commit by 'alex-koiter' labeled 'Initial commit' from 'yesterday'. Below it, there are nine other commits, each corresponding to a file or folder in the repository: 'Reproducibility_files/header-attrs-2.7', 'figs', 'RUNME.R', 'Repro.Rproj', 'Reproducibility.Rmd', 'Reproducibility.html', 'macros.js', and 'styles.css', all committed 'yesterday'. The commit times are aligned with the creation of the presentation files.

File/Folder	Commit Time
Initial commit	yesterday
Reproducibility_files/header-attrs-2.7	yesterday
figs	yesterday
RUNME.R	yesterday
Repro.Rproj	yesterday
Reproducibility.Rmd	yesterday
Reproducibility.html	yesterday
macros.js	yesterday
styles.css	yesterday

This presentation is on [GitHub!](#)
(and is reproducible and open)

What do we use?

Open Science Framework



The screenshot shows the homepage of the Open Science Framework (OSF). At the top, there is a dark navigation bar with the OSF logo, "OSF HOME ▾", and links for "Search", "Support", "Donate", "Sign Up" (in a green button), and "Sign In". The main background is a teal gradient with a faint image of overlapping leaves. The central text reads "The place to share your research" in large white font, followed by a description: "OSF is a free, open platform to support your research and enable collaboration." Below this is a blue "Get started" button. Further down, there is another section titled "Discover public research" with the subtext: "Discover projects, data, materials, and collaborators on OSF that might be helpful to your own research." At the bottom left is a search bar with a magnifying glass icon and the placeholder text "Search discipline, author...". The URL "https://osf.io" is at the bottom right.

OSFHOME ▾

Search Support Donate Sign Up Sign In

The place to share your research

OSF is a free, open platform to support your research and enable collaboration.

Get started

Discover public research

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<https://osf.io>

What do we use?

Open Science Framework

- Can integrate with GitHub, Dropbox, Zotero, etc.
- Use as Dropbox-like storage and sharing
 - Drag and drop!
- Make parts private or public
- Create DOIs for referencing in publications

Great way to get your feet wet!

The screenshot shows the OSFHOME interface. At the top, there's a navigation bar with links for R Scripts, Files, Wiki, Analytics, Registrations, Contributors, Add-ons, and Settings. The 'R Scripts' tab is active. Below the navigation bar, the project title 'Shifts in North American bluebird migration / R Scripts' is displayed. Project details include: Contributors: Stefanie LaZerte, Matthew Reudink, Jared Sonnleitner; Date created: 2021-05-04 12:35 PM | Last Updated: 2021-09-24 02:39 PM; Identifier: DOI 10.17605/OSF.IO/RZ6KQ; Category: Analysis; Description: Data preparation and analysis scripts; License: GNU General Public License (GPL) 3.0. There are sections for 'Wiki' and 'Files'. The 'Wiki' section contains the placeholder text 'Add important information, links, or images here to describe your project.' The 'Files' section has a message 'Click on a storage provider or drag and drop to upload'. A file list table shows one item: 'R Scripts' (modified 2021-05-04 12:36 PM), which is a folder containing '01_setup.R' and '02_initial_data_hex.R' (both modified 2021-05-04 12:36 PM). A search bar labeled 'Filter' and a help icon are also visible.

Making science stronger

- Peer review is difficult if we don't know how things were done
- Mistakes happen
 - Can only be fixed if found
 - This is not a sign of weakness - hiding or not learning from them is
- Reducing the need to reinvent the wheel for similar projects/analysis
 - Easier to build upon previous work
- Accessibility

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Thank you!

 @Alex_Koiter |  alex-koiter |  alexkoiter.ca

 @steffilazerte |  steffilazerte |  steffilazerte.ca

Slides: <https://github.com/alex-koiter/presentations> (PDF)

Created with the R package [xaringan](#), using [remark.js](#), [knitr](#), and [R Markdown](#)

Icons from [Ionicons](#); Compiled on 2021-09-24



Dr. Steffi LaZerte
Analysis and Data Tools for Science

