

# Introduction to Rmarkdown/Quarto for Reproducibility

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Steffi LaZerte



# Getting Started

# Introduction

Today learning to create static HTML reports from R code  
(but can also create websites, and presentations–like this one!)

## Why?

- Keep track of your code *and* results
- Share your work
- Ensure reproducibility
- Be nice to your future self (*What did I do again? What were the results?*)

Okay, what kind of report?

# For example...

```
## Setup
```

This is my **\*\*great\*\*** study.... I used these packages:

```
```{r}
```

```
library(tidyverse)
```

```
```
```

```
## Loading data
```

These are the datasets I used

```
```{r}
```

```
my_data <- read_csv("https://raw.githubusercontent.com/steffilazerte/NRI_7350/main/data/  
my_data
```

```
```
```

This is what it looks like

```
```{r}
```

```
#| fig.width = 6
```

```
ggplot(data = my_data, aes(x = urbanization, y = songs)) +  
  geom_point()
```

```
```
```

# Becomes...

## Setup

This is my **great** study.... I used these packages:

```
1 library(tidyverse)
```

```
— Attaching packages — tidyverse 1.3.2 —
✓ ggplot2 3.3.6      ✓ purrr 0.3.4
✓ tibble 3.1.7       ✓ dplyr 1.0.9
✓ tidyr 1.2.0        ✓ stringr 1.4.0
✓ readr 2.1.2        ✓ forcats 0.5.1
— Conflicts — tidyverse_conflicts() —
✗ dplyr::filter() masks stats::filter()
✗ dplyr::lag() masks stats::lag()
```

## Loading data

These are the datasets I used

```
1 my_data <- read_csv("https://raw.githubusercontent.com/steffilazerte/NRI_7350/main/data/chorus.csv")
2 my_data
```

```
# A tibble: 51 × 3
  urbanization songs calls
      <dbl> <dbl> <dbl>
1      0.794     0  136
2      0.890    60   12
3     -1.85    55   66
4     -1.85    22  115
```

# For another example...

```
### Visual of Thresholds Calculations
```

```
> - Pink ribbon = 99% Confidence interval of latitudes predicted from GAM  
> - Black lines in the ribbon are the upper and lower limit, the middle  
line is the predicted latitude (from GAM model)  
> - Transparent blue rectangles indicate the date ranges used to establish  
the latitudes just after and just before migration.  
> - Blue horizontal lines represents the latitude threshold for spring  
migration (begin/end)  
> - Orange horizontal lines represents the latitude threshold for fall  
migration (begin/end)
```

```
```{r}  
#| fig.asp: 1  
#| fig.width: 15  
wrap_plots(g) + plot_layout(guides = "collect", nrow = 1)  
```
```

*(Plus a bunch of other options)*

# Becomes...

## Setup

Load Data

Estimate Dates

Background

1. Defining the threshold latitude
2. Segmented Regression

Calculate Latitudinal Thresholds

Visual of Thresholds Calculations

Getting Dates from Thresholds

Plot Migration Dates

By year

Save Data

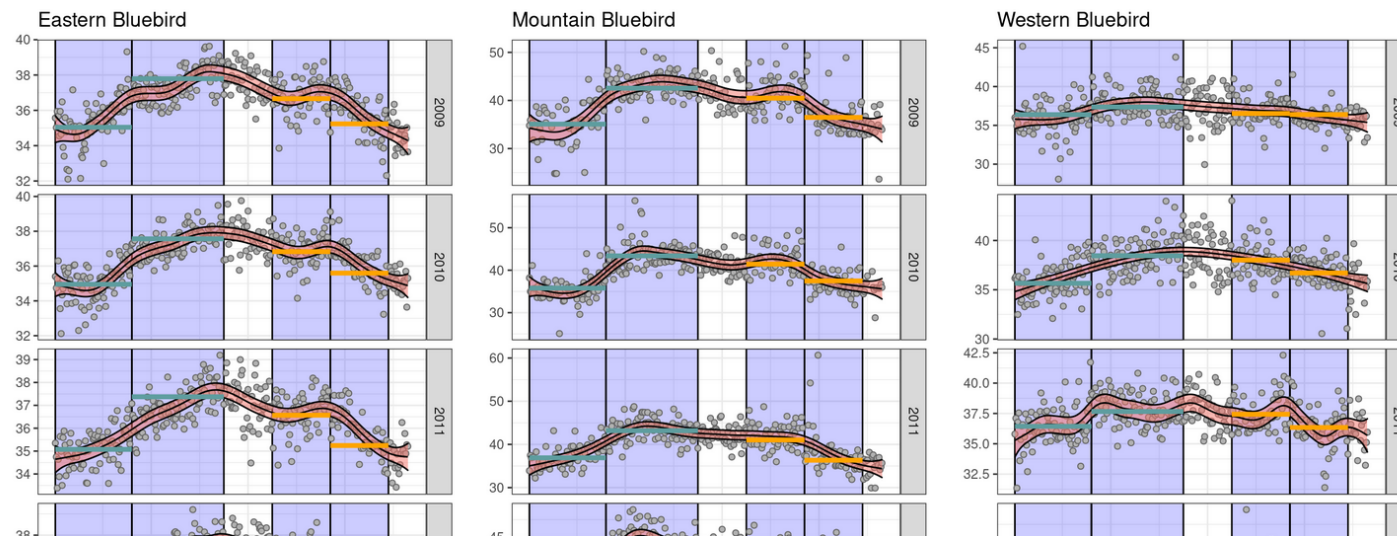
Reproducible

Session Info

## Visual of Thresholds Calculations

- Pink ribbon = 99% Confidence interval of latitudes predicted from GAM
- Black lines in the ribbon are the upper and lower limit, the middle line is the predicted latitude (from GAM model)
- Transparent blue rectangles indicate the date ranges used to establish the latitudes just after and just before migration.
- Blue horizontal lines represents the latitude threshold for spring migration (begin/end)
- Orange horizontal lines represents the latitude threshold for fall migration (begin/end)

```
wrap_plots(g) + plot_layout(guides = "collect", nrow = 1)
```



# Wait a minute...

That doesn't look like an R Script...

```
## Setup
This is my **great** study.... I used these packages:

```{r}
library(tidyverse)
```

## Loading data
These are the datasets I used

```{r}
my_data <- read_csv("https://raw.githubusercontent.com/steffilaze
my_data
```

This is what it looks like

```{r}
#| fig.width = 6
ggplot(data = my_data, aes(x = urbanization, y = songs)) +
  geom_point()
```
```

## Four things going on...

1. R code
2. Markdown
3. R code fences (define code *chunks*)
4. YAML *chunk* options

This is actually not an **.R** script...  
it's an **Rmarkdown ( .Rmd )** or  
**Quarto ( .qmd )** document!



# Quick start

- File > New File > Quarto Document (or R Markdown, if you prefer)
- Add details, click “Create”
- Click “Render” button in the top panel (Quarto)
  - or “Knit” button (R Markdown)

Demo

# Your turn

Using this RStudio template, add in some code from your own scripts and render it.

Keep it relatively simple for now 😊

What just happened? What are all these things?  
Rmarkdown? Markdown? Quarto?

# Terminology

## R & RStudio

- Both are programs
- R is the programming language/envrionment
- RStudio is an IDE (integrated development environment)

# Terminology

## Markdown

- A text markup language
- Files are `.md`

For example, the following...

```
1  ### My heading
2
3  **Hi!** This is in italics
4
5  A [link] (https://cran.r-project.org/) to R
```

Becomes...

**My heading**

**Hi!** This is in *italics*

A [link](https://cran.r-project.org/) to R

# Terminology

## RMarkdown, Quarto, knitr, and Pandoc

- RMarkdown( **. Rmd** ) and Quarto ( **. qmd** ) files are a *mix* of Markdown *and* R code
- **knitr** is an R package which evaluates R code and returns the output as a Markdown file
- **Pandoc** is a separate (independent) program that converts Markdown to a variety of formats



### Rmarkdown vs. Quarto

Quarto ( **. qmd** ) is the *next generation* of Rmarkdown ( **. Rmd** ). You can still use Rmarkdown (it's not going anywhere), but Quarto is much newer and more powerful.

# Terminology

## YAML, HTML, CSS

- **YAML** is a language for specifying metadata
  - Used for specifying document options and *chunk* options
- **HTML** is a language for making websites
  - Can be used directly in `.qmd/ .Rmd` files if you plan to output to HTML
  - E.g., can use `<br>` for a line **break**
- **CSS** is a language for *styling* websites
  - Can be used to apply custom styles to documents

# Some options

## Document level options - YAML block

```
1 ---
2 title: "My great analysis"
3 format:
4   html:
5     code-fold: true
6 date: today
7 toc: true
8 ---
```

- `date: today` to include today's date
- `toc: true` to include a table of contents
- `code-fold: true` to hide code (with option to show)

**Note:** These are Quarto options! RMarkdown has similar ones, but they may be slightly different. E.g., `format: html_document` in RMarkdown.

# Some options

## Chunk level options - YAML notation

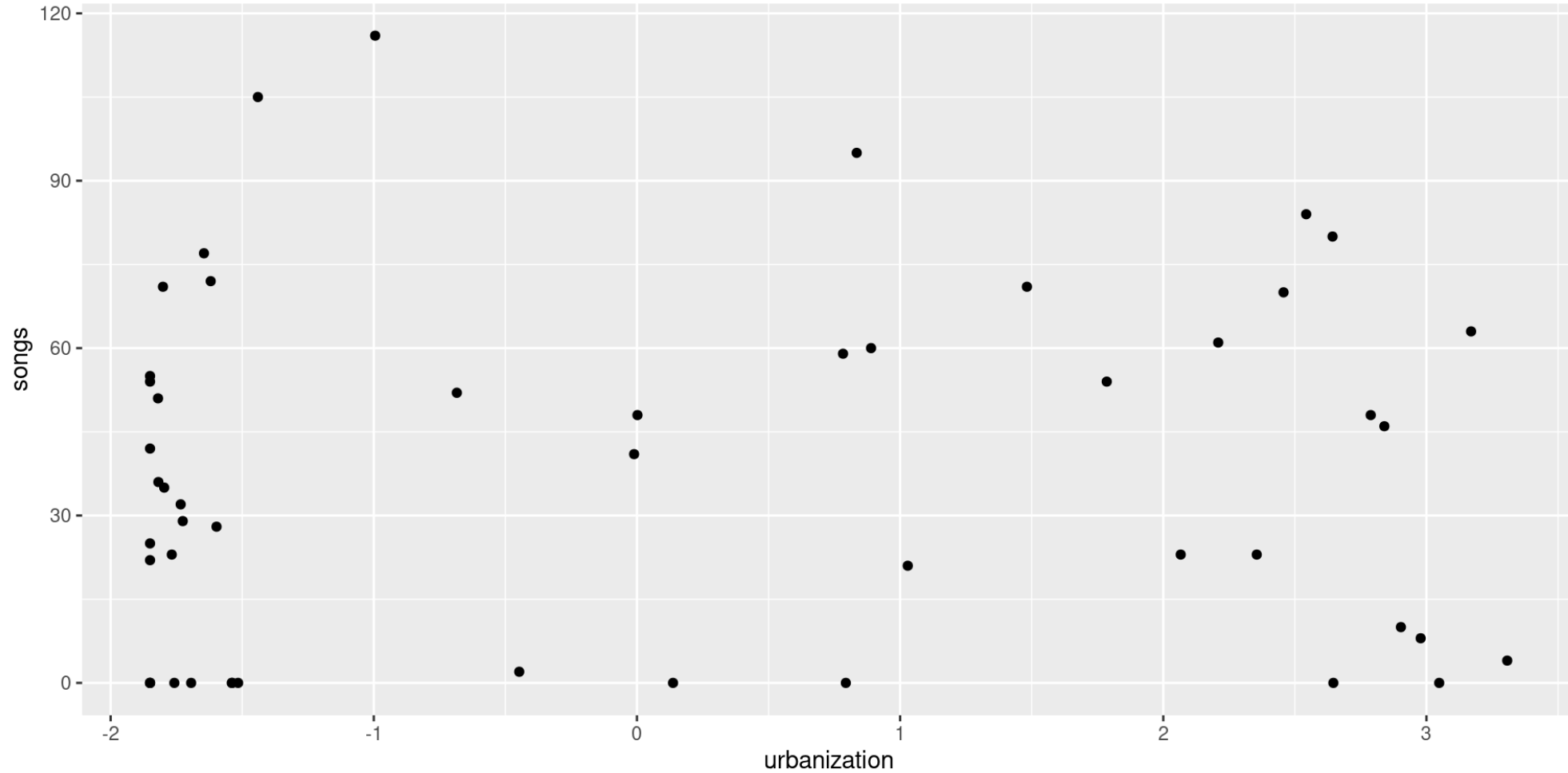
```
```\r}\n#| fig.width: 10\n#| fig.asp: 0.5\n#| fig.alt: |\n#|   A scatterplot in black and white showing degree of\n#|   urbanization on the x-axis and number of songs on\n#|   the y-axis with no appreciable pattern in the data.\n#| fig.cap: |\n#|   The relationship between urbanization and the number\n#|   of songs in mountain chickadee dawn choruses.\n\nggplot(data = my_data, aes(x = urbanization, y = songs)) +\n  geom_point()\n```\n
```

- `fig.width` width of figure in inches
- `fig.asp` aspect of the figure (1 = square) (i.e. height = width \* aspect)
- `fig.alt` **Accessibility** Alt text for screen readers helping those who can't see the figure (should be descriptive, not the same as a caption)
- `fig.cap` Figure caption



# Gives...

```
1 ggplot(data = my_data, aes(x = urbanization, y = songs)) +  
2   geom_point()
```



The relationship between urbanization and the number of songs in mountain chickadee dawn choruses.

# Enhancing Reproducibility

- Make your publication figures in reports
- Date your reports (`my_analysis_2022-09-08.html`)
- Include info on packages used (because you're going to `cite` them... right? **RIGHT?**)
  - `devtools::session_info()`
  - `report::report_packages()`
  - `report::cite_packages()`
- Embed data directly (for smaller datasets) using `DT` package

```
1 DT::datatable(mtcars, extensions = 'Buttons',  
2               options = list(dom = 'Bfrtip', buttons = c('csv', 'excel')))
```

And seriously, `cite` the packages 😁

# Your turn

Use the more advanced `template` (`example.qmd`) to create a reproducible report of your analysis.

Consider the options we learned about. Anything you'd like to add?

**Some final thoughts**

# Rendering vs. Spinning

## Rendering (Render/Knit button)

`.Rmd/.qmd` → `.md` → HTML

- Good for lots of text
- Better option control

## Spinning (Knit button)

`.R` → `.md` → HTML

- Easier to code

Quarto notation (slightly different from Rmarkdown) *only* for `.qmd` documents so far

# Relative locations

If you use nested folders in your work, you'll want to use the [here](#) package to ensure all the file locations are consistent

```
1 library(here)
2 library(tidyverse)
3
4 my_data <- read_csv(here("Data/my_data.csv"))
```

# Resources

## Online References

- [Quarto Documentation](#)
- [Openscapes' Quarto Tutorial](#)
- [RStudio's Welcome to Quarto Workshop!](#) (video)
- [We don't talk about Quarto](#) (blog post)
- [A Quarto tip a day](#) (blog)
- [R Markdown Documentation](#)
- [R Markdown: The Definitive Guide](#) (online book)
- RStudio > Help > Markdown Quick Reference
- RStudio > Help > Cheat Sheets > Rmarkdown Cheat Sheet
- RStudio > Help > Cheat Sheets > Rmarkdown Reference Guide

## Examples

- [This presentation](#)
- [Quarto Gallery](#)
- [R Markdown Gallery](#)