

Introduction to R Markdown/Quarto for Reproducibility

Birds Canada Science Hour 2023

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Analysis and Data Tools for Science



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Preamble

Online workshops can be challenging

Consider keeping your video on (if possible)

- Kids? Pets? Spouses? No problem
- But ultimately, you need be comfortable! (and you absolutely have the right to privacy)

Interrupt me!

- Generally keep yourself muted but un-mute anytime to ask questions

Ask Questions!

- Group trouble-shooting is really valuable
- If you have a problem, others may also (or may have it in the future)

Screen-sharing

- I may ask you to share your screen with the group (feel free to decline)
- For privacy, close your email etc. Or just share your RStudio window

Introductions

This is me and my creatures



This is my garden



What about you?

- Name
- Background (Role, Area of study, etc.)
- Familiarity with R or Programming
- Creatures (furry, feathery, scaley, green or otherwise)?

Getting Started

Today we're learning to create static HTML reports from R code
(but can also create websites, pdfs, 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/chorus.csv")
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 3.4.1      ✓ purrr  1.0.1
✓ tibble  3.2.1      ✓ dplyr  1.1.1
✓ tidyr   1.3.0      ✓ stringr 1.5.0
✓ readr   2.1.4      ✓ forcats 1.0.0

— 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
5     0.835    95      3
6    -1.85      0     70
7    -1.85     25     44
8     3.05      0    122
```


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

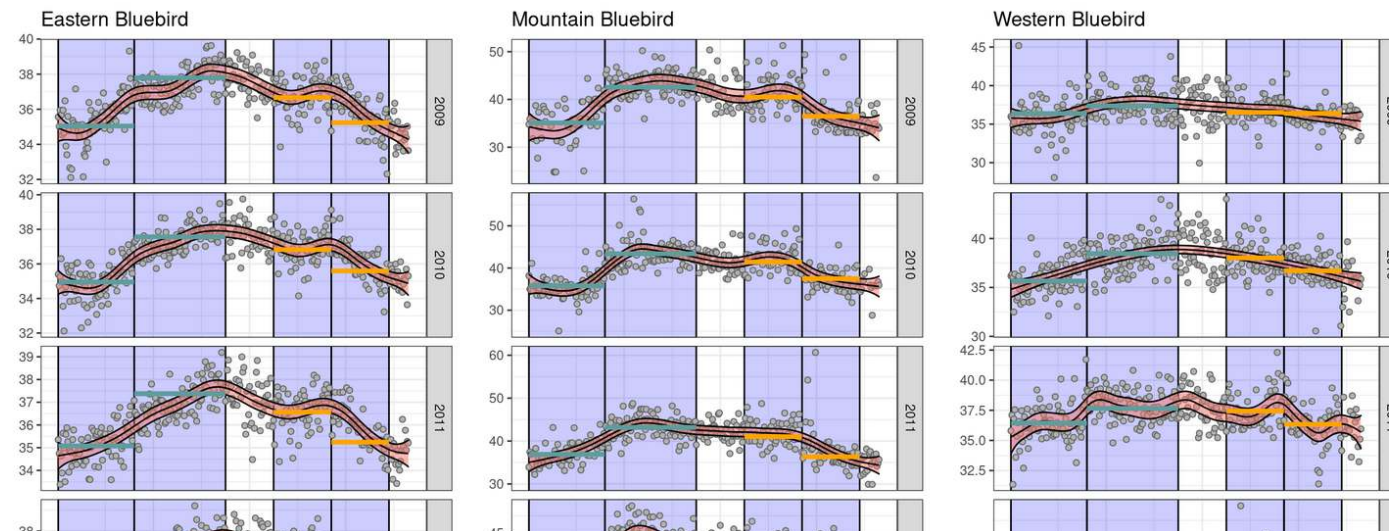
Reproducible

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...

Not 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/steffilazerte/NRI_
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. R code fences (define code *chunks*)
3. Markdown
4. YAML *chunk* options

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

Quick start

- File > New Project
- 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?
R Markdown? Markdown? Quarto? YAML 😱

Terminology

R & RStudio

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



R



R Studio

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

R Markdown, Quarto, knitr, and Pandoc

- R Markdown (`.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



R Markdown vs. Quarto

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

Terminology

YAML, HTML, CSS/SCSS

- **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 `
` for a line **break**
- **CSS** is a language for *styling* websites
 - Can be used to apply custom styles to documents
 - **SCSS** is CSS with superpowers

Some options

Document level options - YAML block

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

- `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! R Markdown has similar ones, but they may be slightly different. E.g., `format: html_document` in R Markdown.

Some options

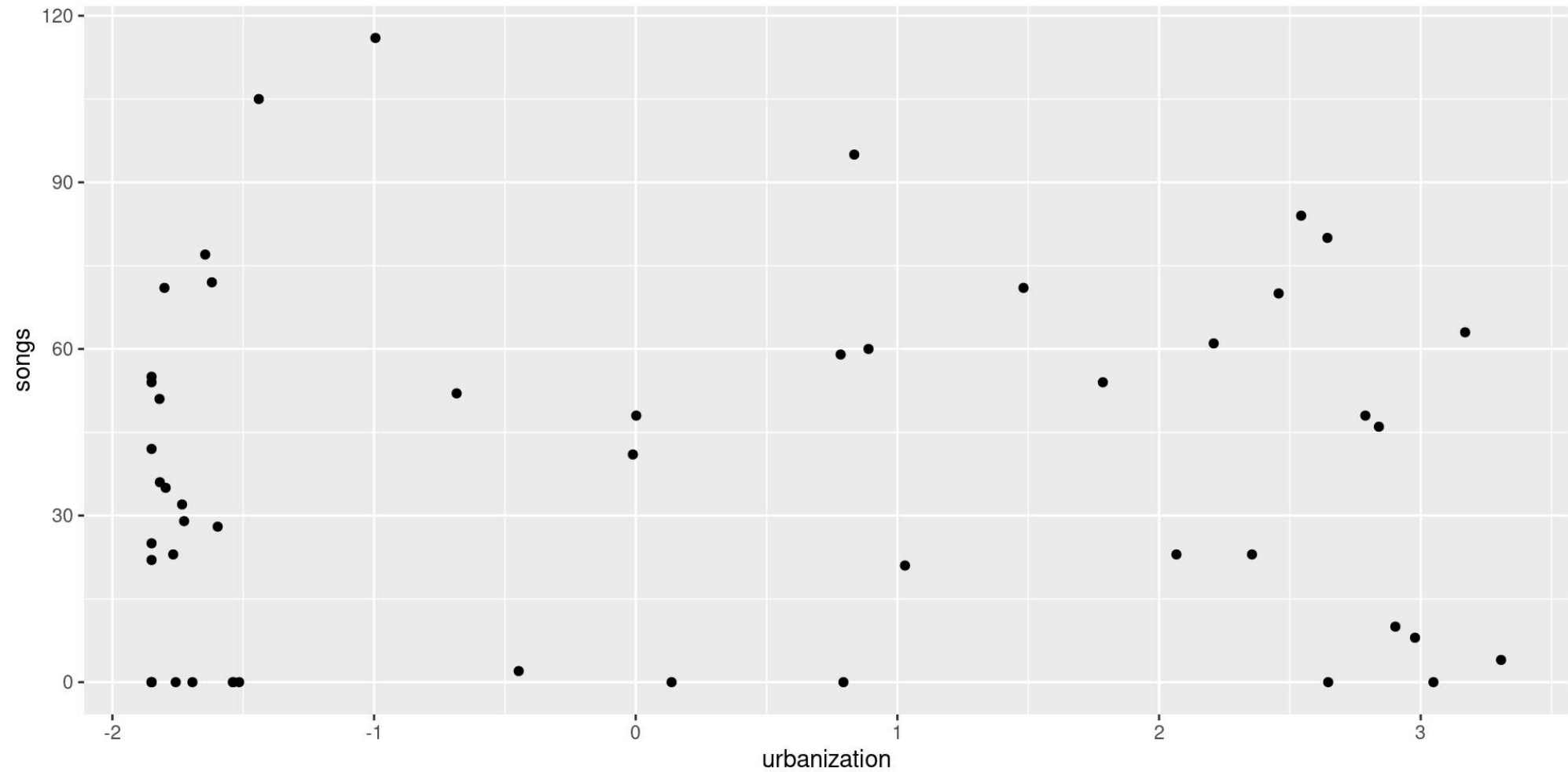
Chunk level options - YAML notation

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

# Cite the Packages!

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

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
- Use ````${r}```` and ````${}```` to define code blocks

## Spinning (Knit button)

`.R` → `.md` → HTML

- Easier to code
- Use `#'` to define markdown
- Use `#+` to define chunk options
  - Use Rmarkdown option style
  - i.e., `error=FALSE` not `error: false`

# Rendering vs. Spinning

## Rendering (Render/Knit button)

```
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_73")
my_data
```

This is what it looks like

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

Or render with:

```
1 quarto::quarto_render(
2 input = "example.qmd",
3 output_file = paste0("example_", Sys.Date(), ".html"))
```

## Spinning (Knit button)

```
1 #' ## Setup
2 #' This is my **great** study.... I used these packages:
3
4 library(tidyverse)
5
6 #' ## Loading data
7 #' These are the datasets I used
8
9 my_data <- read_csv("https://raw.githubusercontent.com/steffilazerte/NRI_73")
10 my_data
11
12 #' This is what it looks like
13
14 #+ fig-width = 6
15 ggplot(data = my_data, aes(x = urbanization, y = songs)) +
16 geom_point()
```

Or spin/render with:

```
1 knitr::spin("example_spin.R", knit = FALSE)
2 quarto::quarto_render(
3 input = "example_spin.Rmd",
4 output_file = paste0("example_spin_", Sys.Date(), ".html"))
```

# 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 > R Markdown Cheat Sheet
- RStudio > Help > Cheat Sheets > R Markdown Reference Guide

## Examples

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

**Thank you!**

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