Assessing Bridge Conditions in New York State: The Impact of Age, Municipality, and Structural Deficiencies*

My subtitle if needed

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First sentence. Second sentence. Third sentence. Fourth sentence.

Table of contents

*Code and data are available at: https://github.com/Jiaqi-Xing/NYS_Bridge_Condition_Analysis.

1 Introduction

Overview paragraph

Estimand paragraph

Results paragraph

Why it matters paragraph

Telegraphing paragraph: The remainder of this paper is structured as follows. Section 2….

2 Data

2.1 Overview

We use the statistical programming language R (R Core Team 2023)…. Our data (Toronto Shelter & Support Services 2024)…. Following Alexander (2023), we consider…

The dataset, titled New_York_Bridges_2016(**2016data?**), was orignaly posted by(**NYS?**), collected by (**2016data?**). Original website now are with newly updated data in 2020. This data contains detailed information about bridges in New York State. The raw dataset has 17502 rows and 13 columns, capturing structural, geographical, and condition-related aspects of 17502 bridges. After cleaning the data, we keep 4 variables for analysis, whith response variable "Condition" and three predictor variables, "AgeAtInspection"(numeric), "Located_Municipality"(categorical) and "Owner_Goup"(categorical).

A similar dataset, New York Bridges 2020(**2020data?**), was considered but not used because its key variable for condition is binary (indicating whether the bridge is in poor condition or not). While this binary variable might be useful for certain analyses, it does not provide the granularity needed to fully understand bridge conditions or to assess the relationships between explanatory variables and condition scores. The 2016 dataset, by contrast, includes a numeric measure of condition, allowing for a more nuanced analysis.

2.2 Measurement

In New York State, bridge inspectors from the State Department of Transportation (NYSDOT) conduct evaluations of non-toll bridges every two years to ensure their safety and structural integrity. Their assessments are performed on a span-by-span basis, meaning that each section of the bridge between its supporting points is inspected individually. For every bridge, inspectors examine up to 47 structural elements, including 25 span-specific components such as the deck, beams, and supports. Each component is assigned a condition score, ranging from 1 (severely deficient) to 7 (new or excellent condition), which reflects its structural health at the time of inspection. Inspectors also note any defects, such as cracks, corrosion, or wear, and document associated quantities, such as the length, area, or number of affected elements, to capture the extent of the damage.

In addition to these detailed evaluations, inspectors assign federal ratings based on the overall average condition of a bridge's major components. These federal ratings correspond to the values of the **Condition** variable used in our paper and analysis. Bridges with condition scores below 5 are classified as being in "poor" condition and are further categorized as either Structurally Deficient (SD) or Functionally Obsolete (FO). All findings from these assessments are recorded in inspection reports, providing essential data to guide maintenance, rehabilitation, or replacement efforts.

2.3 Outcome variables

Add graphs, tables and text. Use sub-sub-headings for each outcome variable or update the subheading to be singular.

Some of our data is of penguins (Figure 1), from Horst, Hill, and Gorman (2020).

Talk more about it.

And also planes (**?@fig-planes**). (You can change the height and width, but don't worry about doing that until you have finished every other aspect of the paper - Quarto will try to make it look nice and the defaults usually work well once you have enough text.)

Talk way more about it.

2.4 Predictor variables

Add graphs, tables and text.

Use sub-sub-headings for each outcome variable and feel free to combine a few into one if they go together naturally.

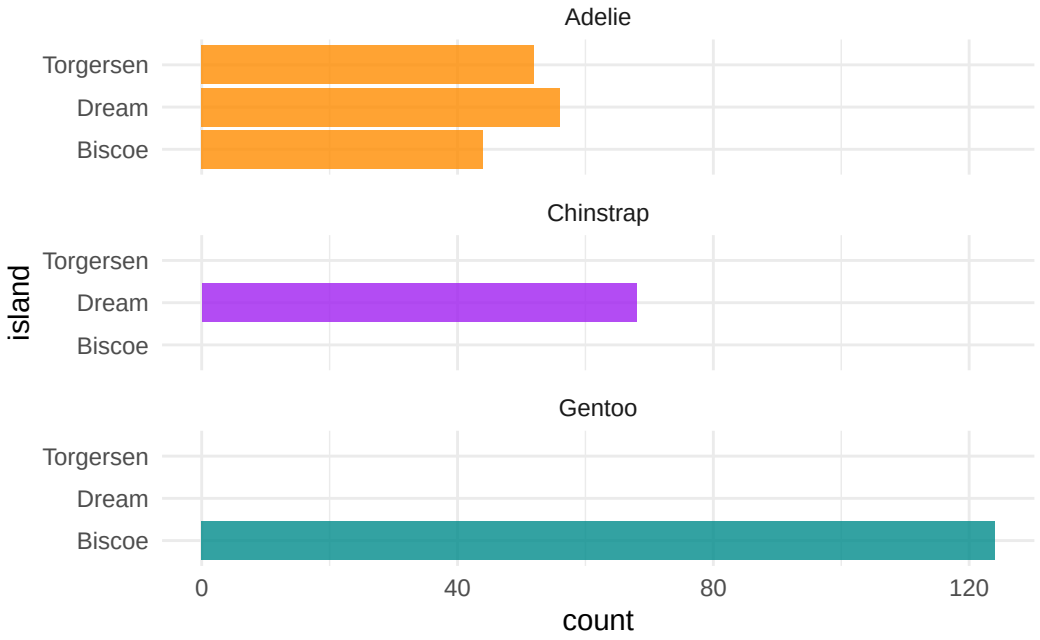

Figure 1: Bills of penguins

3 Model

The goal of our modelling strategy is twofold. Firstly,...

Here we briefly describe the Bayesian analysis model used to investigate... Background details and diagnostics are included in Appendix B.

3.1 Model set-up

Define y_i as the number of seconds that the plane remained aloft. Then β_i is the wing width and γ_i is the wing length, both measured in millimeters.

$$y_i|\mu_i, \sigma \sim \text{Normal}(\mu_i, \sigma) \tag{1}$$
$$\mu_i = \alpha + \beta_i + \gamma_i \tag{2}$$
$$\alpha \sim \text{Normal}(0, 2.5) \tag{3}$$
$$\beta \sim \text{Normal}(0, 2.5) \tag{4}$$
$$\gamma \sim \text{Normal}(0, 2.5) \tag{5}$$
$$\sigma \sim \text{Exponential}(1) \tag{6}$$

We run the model in R (R Core Team 2023) using the `rstanarm` package of Goodrich et al. (2022). We use the default priors from `rstanarm`.

3.1.1 Model justification

We expect a positive relationship between the size of the wings and time spent aloft. In particular...

We can use maths by including latex between dollar signs, for instance θ.

4 Results

Our results are summarized in Table **??**.

5 Discussion

5.1 First discussion point

If my paper were 10 pages, then should be be at least 2.5 pages. The discussion is a chance to show off what you know and what you learnt from all this.

5.2 Second discussion point

Please don't use these as sub-heading labels - change them to be what your point actually is.

5.3 Third discussion point

5.4 Weaknesses and next steps

Weaknesses and next steps should also be included.

Appendix

A Additional data details

B Model details

B.1 Posterior predictive check

In **?@fig-ppcheckandposteriorvsprior-1** we implement a posterior predictive check. This shows…

In **?@fig-ppcheckandposteriorvsprior-2** we compare the posterior with the prior. This shows…

Examining how the model fits, and is affected
by, the data

B.2 Diagnostics

?@fig-stanareyouokay-1 is a trace plot. It shows… This suggests…

?@fig-stanareyouokay-2 is a Rhat plot. It shows… This suggests…

Checking the convergence of the MCMC algo-
rithm

References

Alexander, Rohan. 2023. *Telling Stories with Data*. Chapman; Hall/CRC. https://tellingstorieswithdata.com/.

Goodrich, Ben, Jonah Gabry, Imad Ali, and Sam Brilleman. 2022. "rstanarm: Bayesian applied regression modeling via Stan." https://mc-stan.org/rstanarm/.

Horst, Allison Marie, Alison Presmanes Hill, and Kristen B Gorman. 2020. *palmerpenguins: Palmer Archipelago (Antarctica) penguin data*. https://doi.org/10.5281/zenodo.3960218.

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