Bayesian Insights into Aerial Bombing Strategies: An Ordered Logistic Regression Analysis of WWII Target Prioritization Against Germany*

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

1 Introduction

You can and should cross-reference sections and sub-sections. We use R Core Team (2023) and Wickham et al. (2019).

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

2 Data

Some of our data is of penguins (**?@fig-bills**), 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.)

*Code and data are available at: https://github.com/yunzhaol/aerial_bomb_priority.git.

Table 1: 2022 CES (Cooperative Election Study) Data (Cultural)

```
# analysis_data |>
#   ggplot(aes(x = width, y = length)) +
#   geom_point(alpha = 0.8) +
#   theme_minimal() +
#   labs(x = "Wing width (mm)",
#        y = "Wing length (mm)")
```

Talk way more about it.

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`.

The Bayesian model for analyzing the prioritization of aerial bombing targets during WWII is formulated as follows:

Let (y_i) be the ordered target priority level for each bombing mission, which can take values from {1, 2, 3, 4}, representing the levels from 'target of last resort' to 'primary target'.

The likelihood of (y_i) given the predictor variables is modeled by an ordered logistic regression:

Table 2: Explanatory models of flight time based on wing width and wing length

[logit(_i^{(k)}) = _k - (_0 + _1 ×tgt_industry_i + _2 ×country_flying_mission_i + _3 ×total_tons_i + _4 ×ac_attacking_i)]

where - (_i^{(k)}) is the probability of (y_i) being at least level (k), - (_k) are the cutpoints between the categories of target priority (with (K-1) cutpoints for (K) categories), - (tgt_industry_i) is the industry type of the target, - (country_flying_mission_i) represents the country conducting the bombing mission, - (total_tons_i) is the amount of bombs dropped in tons, - (ac_attacking_i) is the number of aircraft involved in the mission.

Priors for the model parameters are set as follows: - (_0, _1, _2, _3, _4 Normal(0, 2.5)), - Cutpoints (_k) are ordered with priors (_k Normal(0, 2.5)) ensuring (_1 < 2 < …< {K-1}).

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 2.

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

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

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.

R Core Team. 2023. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.

Wickham, Hadley, Mara Averick, Jennifer Bryan, Winston Chang, Lucy D'Agostino McGowan, Romain François, Garrett Grolemund, et al. 2019. "Welcome to the tidyverse." *Journal of Open Source Software* 4 (43): 1686. https://doi.org/10.21105/joss.01686.