Power Simulation for Logistic Regression

Last modified: 2025-03-02

Overview

- ► Large effects from subtle manipulations?
 - ▶ Decision biases from two-hand tapping
- ► Power simulation for logistic regression
- Exercises

Refresher: Framing

Tversky and Kahneman (1981)

"Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed" (p. 453)

If Program A is adopted **200** people will be **saved** [109]

If Program B is adopted there is 1/3 probability that **600** people will be **saved**, and 2/3 probability that **no people** will be **saved** [43]

If Program C is adopted **400** people will **die** [34]

If Program D is adopted there is 1/3 probability that **nobody** will **die**, and 2/3 probability that **600** people will **die** [121]

▶ Odds ratio (OR) = 9.0

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Decision biases from two-hand tapping

► McElroy and Seta (2004), *n* = 48

"a behavioral task of finger tapping was used to induce asymmetrical activation of the respective hemispheres ... Framing effects were found when the right hemisphere was selectively activated whereas they were not observed when the left hemisphere was selectively activated" (p. 572)

	right-hand tapping			left-hand tapping			ratio of odds	5
	safe	risky		safe	risky		ratios (ROR)	
gain	8	4		12	1			
loss	7	4		3	9			
OR		1.1			36		31.5	

▶ Our replication (see Gelman, 2020), n = 332

gain	52	31	56	27	
loss	26	57	30	53	
OR		3.7		3.7	1.0

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Power simulation

Let us go through the general steps

- 1. Specify the model including the effect of interest
- 2. Generate observations from the model
- 3. Test H₀
- 4. Repeat

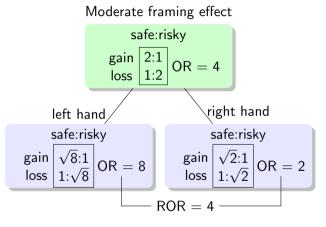
1. Specify model

Logit model with interaction

$$\log \frac{p}{1-p} = \beta_0 + \beta_1 \cdot \text{left hand} + \beta_2 \cdot \text{gain} + \beta_3 \cdot (\text{left hand} \times \text{gain})$$

- Suggest a minimum relevant effect
 - ▶ We can look at the original framing effect study and its many replications
 - ► Former study by McElroy and Seta (2003) found ROR = 3.4 for similar manipulation
 - Other studies investigating influencing factors (with RORs \approx 2–3, e.g., foreign language effect, Costa et al., 2014; Wickelmaier, 2015)
- ▶ Underlying distribution: $X \sim Binom(n, p)$

1. Specify model



Translating into parameters

- $\exp(\beta_0) = \frac{1}{\sqrt{2}}$ odds in reference categories: right and loss
- $\exp(\beta_1) = \frac{1}{2}$ OR of switching to left hand
- $\exp(\beta_2) = 2$ OR of switching to gain frame

$$\log \frac{p}{1-p} = \beta_0 + \beta_1 \cdot \text{left hand} + \beta_2 \cdot \text{gain} + \beta_3 \cdot (\text{left hand} \times \text{gain})$$

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2. Generate observations

► Calculate logits for the model

```
dat <- read.table(header = TRUE, text = "</pre>
  hand frame
     r gain
     r loss
     l gain
     l loss")
                                                           # ref. cat.
dat$hand <- factor(dat$hand, levels = c("r", "l"))</pre>
                                                                   right
dat$frame <- factor(dat$frame, levels = c("loss", "gain")) #</pre>
                                                                   loss
expbeta \leftarrow c(1/sqrt(2), 1/2, 2, 4) # ROR = 4, linear on logit scale
logit <- model.matrix(~ hand * frame, dat) %*% log(expbeta)</pre>
```

2. Generate observations

Simulate data from binomial distribution

3. Test H₀

Fit null model to your generated observations, H_0 : $\beta_3 = 0$ m1 <- glm(cbind(y, n/4 - y) ~ hand + frame, binomial, dat)

▶ Fit interaction model to your generated observations, H_1 : $\beta_3 \neq 0$ m2 <- glm(cbind(y, n/4 - y) ~ hand * frame, binomial, dat) ## ROR estimate = 5.9

Perform a likelihood ratio test of the interaction

4. Repeat

- ▶ Do previous steps repeatedly
 - Calculate the proportion of significant tests (= power)
 - Adjust n to reach the preset power criterion

References

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