Power Simulations in R

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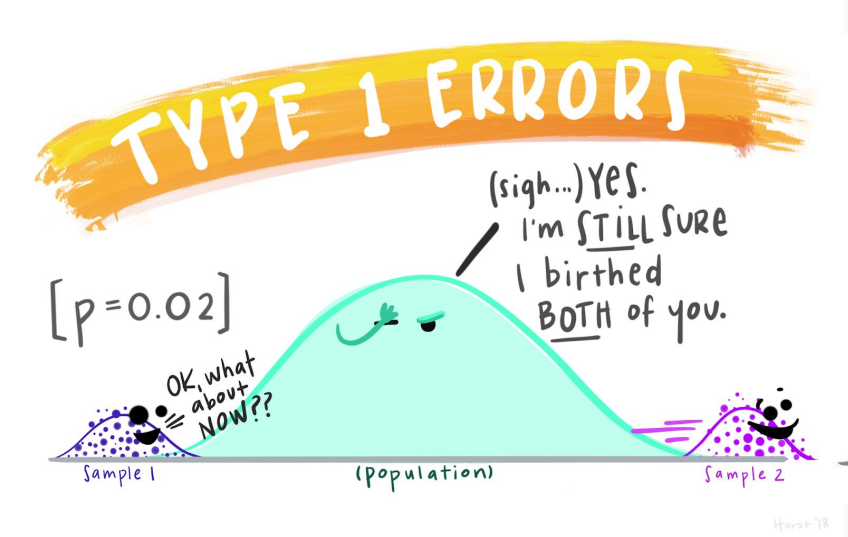
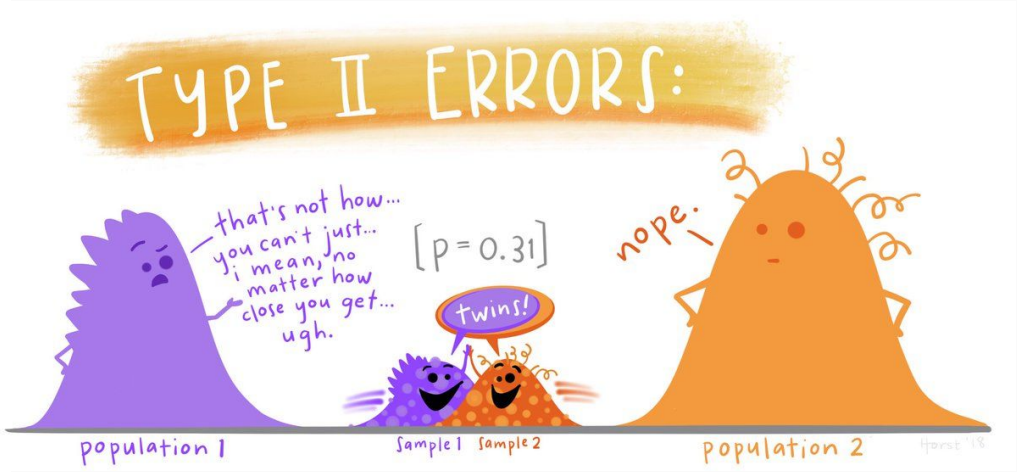
August 13, 2019

A Review of Statistical Decisions

	Reject null	Accept null
Null hypothesis is true	Type I Error	**Correct Decision**
Null hypothesis is false	**Correct Decision; POWER**	Type II Error

A Review of Statistical Decisions





Illustrations by Allison Horst. Twitter: @allison_horst

A Review of Statistical Decisions

- **Power:** Probability we reject the null hypothesis when it is false
  - EX: A jury finds a person who commited a crime “guilty”
- When designing a study we want to maximize our certainty of detecting a true alternative hypothesis while minimizing our risk of making a Type I error
  - Type I error: probability of rejecting the null hypothesis when it is true
  - EX: determining an innocent person to be guilty

Basic components of power

- Type I error (alpha)
- Type II error (beta) -> Power = 1-beta
- Sample size (n)
- Effect size (delta)
    - This is referring to the difference between the two (or more) groups of interest
    - Often called the treatment effect or minimally relevant clinical difference

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Grants often require us (statisticians) to justify a sample size for a study to have “80% power and 5% type I error rate”

Basic components of power

- If we fix our Type I error at 5% and our power at 80%, then our parameters left to vary to meet these criteria are:
  - Increasing our sample size (n)
  - Increase the minimum treatment effect size we think it is reasonable to power our study to detect
- Depending on the disease, study design, funding, etc. one of these parameters may already be fixed

Methods for Calculating Power

- Deriving equations by hand
- Statistical packages which implement equations behind-the-scenes
- Simulating the data and subsequent analysis yourself!

The Basic Power Simulation Process

1. Generate fake data under the alternative hypothesis
2. Run your statistical model
3. Determine whether your model rejects the null hypothesis at alpha of .05
    a. In other words, was your p-value < .05?
    b. Save this result
4. Repeat many times
5. # of times you rejected the null hypothesis / total simulations = power

Let's look at some code examples...

Takeaways

- These are very simple model examples, but can be expanded to determine the power of much more complicated analyses
  - Complex models or assumptions
  - Study design questions from investigators
- Simulations are a great way to improve our understanding of methods and their nuances before we tackle real data