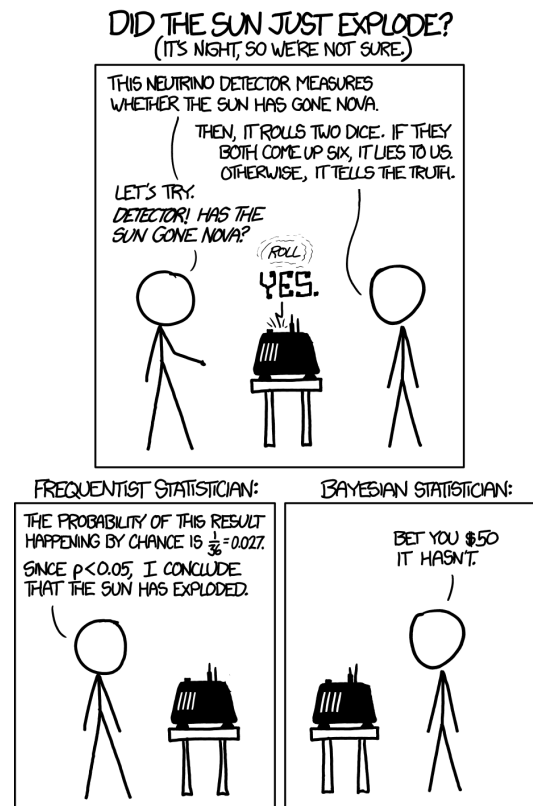


POLS 8500: BAYESIAN DATA ANALYSIS

Maymester 2021

Professor: Joe Ornstein
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Website: [Perusall](#)

Time: M-F 11:00am – 1:45pm
Place: 101D Baldwin Hall



The dominant statistical paradigm in social science today is frequentist Null Hypothesis Significance Testing (NHST). You're probably aware of this paradigm. Probably because I taught it to you in your first semester as a graduate student. It's the idea that uncertainty comes from *sampling error*, and that we can quantify that uncertainty with a p-value — the probability that our result is just the product of a weird sample drawn from the population.

But there are other sources of uncertainty that we might care about too. Bayesian statistics is how you incorporate those sources of uncertainty into a data analysis, build on prior knowledge, and ultimately, create more satisfying and coherent models of the world. Bayesianism isn't for everyone, but if one of the following three statements describes you, it might be for you:

1. You're still not sure how you feel about Bayesianism. You literally just learned about it by reading the previous paragraph. You feel like statistics is hard enough without adding conjugate priors and Markov Chain Monte Carlos and WAICs and whatever the heck else we're learning about in this class. After this summer, you'll probably go back to being a frequentist. But taking this class will help you become a *better frequentist*, by giving you an outside perspective on the statistical tools you use.

2. You don't want to participate in the Bayesian vs. frequentist fight. You just have some data you want to analyze, and there are some types of data – e.g. data with a hierarchical structure or lots of missing values – for which Bayesian data analysis comes in handy. You're not going to “convert to Bayesianism”. You're not a religious person, at least not when it comes to statistical paradigms. You're a statistical mercenary, or perhaps a data science ninja, willing to use whatever tools are appropriate to your dataset and research question. This class will give you those tools, and teach you how to use them responsibly.
3. You know, deep down, that something is rotten at the core of modern statistical practice. You've known it for a while, but you haven't quite had the language to describe it. It's just there, a splinter in your mind, telling you that everything you've been taught is a pleasant lie designed to launder the irreducible chaos of our universe into tidy journal articles with cute little stars that say “It's okay. $p < 0.05$.” This class will finally open your eyes to the truth, you Platonic cave baby. And you're never going back.

Course Structure

Over the next three weeks, we will work through Richard McElreath's delightful textbook [Statistical Rethinking](#). Three hours a day of Bayesian data analysis is a lot, so to minimize the amount of time you need to spend outside of class, we will divide our class time between hands-on exercises, marking up the textbook in [Perusall](#), and discussion. Because pandemic, the course will be offered in a hybrid-synchronous format. I'll be in Baldwin Room 101D. You're welcome to join me, but if doing so is discomfoting, you may also attend class via Zoom.

You will want to bring a laptop equipped with R and RStudio to class every day. If you don't already have that software installed, don't worry. We'll handle all the installation headaches on the first day.

Assignments & Grading

You will be expected to actively read and mark up the textbook on Perusall (50% of your grade). Each day in class we will work on practice problems, and you will submit individual responses to those exercises as a knitted R report (checked for completion, 50% of your grade).

Office Hours

Since we're meeting every day, I won't set aside formal office hours, but I will be available immediately before and after class if you want to chat.

Tentative Course Outline

Moltke the Elder writes that no battle plan survives contact with the enemy. The same is true for syllabi. The following outline gives my rough estimate of how quickly we'll work through the material, but we will adjust as necessary.

Day 1: Getting Started

Setting up R and RStudio, R Bootcamp, Basic Programming, Meditations on Golem Engineering

Day 2: The Basic Ingredients

Marbles, Models, Parallel Universes, Priors, Posteriors, Globe Tossing

Day 3: Sampling From Posteriors

Bayes Theorem, Vampires, Summarizing Distributions from Samples

Day 4: Linear Models

*Why Normal Distributions Are Normal, How To Describe Your Model, How To **quap** Your Model*

Day 5: More Linear Models

Posterior Predictive Distributions, Polynomials, Cherry Blossoms

Day 6: Causal Inference

DAGs, Spurious Associations, Residuals, Multiple Regression, Handling Categorical Variables, Waffle Houses

Day 7: More Causal Inference

Why You Shouldn't Just Throw Every Variable Into Your Model, Causal Salads, Multicollinearity, Post-Treatment Bias, Collider Bias

Day 8: Interactions

Conditional Associations, An Actual Political Science Application, But Also Manatees

Day 9: MCMC

Markov Chains, Monte Carlos, and Markov Chain Monte Carlo

Day 10: Generalized Linear Models

Entropy, Logistic Regression, The Exponential Family

Day 11: Count Models

Binomial Regression, Poisson Regression, Survival Models

Day 12: More Count Models

Whatever We Didn't Finish Yesterday, Hopefully Some Mixture Models

Day 13: Multilevel Models

Pooling, Partial Pooling, Tadpoles

Day 14: Missing Data

Measurement Error, Bayesian Imputation

Day 15: Bonus Day*Catch Up and Wrap Up***Mental Health and Wellness Resources**

- If you or someone you know needs assistance, you are encouraged to contact Student Care and Outreach in the Division of Student Affairs at 706-542-7774 or visit <https://sco.uga.edu>. They will help you navigate any difficult circumstances you may be facing by connecting you with the appropriate resources or services.
- UGA has several resources for a student seeking [mental health services](#) or [crisis support](#).
- If you need help managing stress anxiety, relationships, etc., please visit [BeWellUGA](#) for a list of FREE workshops, classes, mentoring, and health coaching led by licensed clinicians and health educators in the University Health Center.
- Additional resources can be accessed through the UGA App.