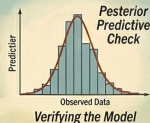


The Weakly Informative Prior.
Guiding without dominating.

A broad distribution designed to regularize the model by covering a reasonable range of plausible parameter values. Strong enough to prevent unrealistic extremes, but weak enough to let the data dictate the precise posterior.



STAT 207: Intermediate Bayesian Statistical Modeling



Verifying the Model



Discovering Truths!



The Path to Convergence



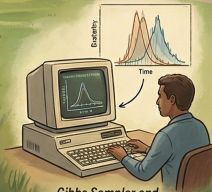
Merge knowledge from multiple sources to update a model



Gathering Observed Data



a telescope to make a confident prediction



Gibbs Sampler and Metropolis-Hastings

run MCMC run

What this course is about

- “Intermediate” Bayesian statistical modeling after “intermediate” Bayesian inference.
 - More statistics: new theory and methods.
 - More modeling: new tasks, analysis scenarios, and computational tools.
 - Less inference from a theoretical perspective, but more inferential tasks driven by analyzing scientific data.
- What we will focus on:
 - Designing and Implementing your own model for inference
 - Being familiar with the workflow of Bayesian modeling
 - Being prepared to work with Bayesian models in research settings
 - Both deep understanding of some key Bayesian concepts, and ‘broad’ understanding of topics from more current(-ish) research
- **The ultimate goal** is to enable you to be comfortable with designing and implementing Bayesian methods to deal with scientific problems

What this course is about

- Real-world research setting: *Here is my dataset, and here is my question, can you help me answer it?*
- Simplified setting of this course: *Here is my dataset, here is the model I believe describes the data, and here is my parameter of interest. Can you help me estimate it?*

What this course is about

Main topics

- We study a somewhat rich collection of models
- Are the models too simple / too complex / inappropriate for the data?
- How to do the computation?
- How to check the results make sense?
- How to summarize the results?

What we do not cover much in lecture, but you will need to think about...

- How to turn the knowledge of the problem into a model?
- Do the model parameters really answer the question?
- Is the question answerable with the data?
- Is the question really the right question to ask?

Bayesian Data Analysis, Third Edition

by A. Gelman, J. B. Carlin, H. S. Stern, D.B. Dunson, A. Vehtari and D. B. Rubin.

PDF available at <http://www.stat.columbia.edu/~gelman/book/>

Other References

- *Bayesian and Frequentist Regression Methods*, by Jon Wakefield
- *Bayesian Ideas and Data Analysis*, by Ronald Christensen, Wesley Johnson, Adam Branscum, and Timothy Hanson
- *Monte Carlo Statistical Methods, Second Edition*, by Christian Robert and George Casella

Evaluation

- *Homework (20%)*: 4 homework sets. Partial solutions will be provided.
- *Take-home quizzes (40%)*: 2 take-home problem sets
 - The take-home exams are data analysis problems that are more open-ended than you would see in FYE take-home.
 - Accordingly, the requirements are less strict. You can use AI tools and off-the-shelf Bayesian computation packages **in these two quizzes**.
 - A short written report is expected. You will be graded based on how well you explain your analysis and results, as well as the quality of the analysis.
 - You will have about four days to complete it.
- *Final Exam (40%)*: In person 90 minutes final in Week 10.

Office hour: Wednesday 10:30 – 11:30 AM on ZOOM

The plan: see Canvas home page.

Pre-requisites

Statistics foundations

- Multivariate calculus and linear algebra.
- Common univariate and multivariate probability distribution and their properties.
- Classical inference. Point estimation, MLE, confidence intervals.
- Bayes theorem. Derivation of posteriors.

Computation

- Familiar with R or Python or other high-level language.
- Able to derive and code MCMC algorithms by hand (see homework 1 for examples).
- Able to perform basic data manipulation and visualization.

Communication

- Familiar with statistical communication and data visualization.
- Familiar with scientific writing.

Good Recreational Bayesian Resources

- Learning Bayesian Statistics Podcast: <https://learnbayesstats.com/>
- Andrew Gelman's blog: <https://statmodeling.stat.columbia.edu/>
- Christian Robert's blog: <https://xianblog.wordpress.com/>
- ISBA Bulletin: <https://bayesian.org/resources/bulletin/>