Bayesian Statistics: The Foundation of Scientific Inference — Syllabus

Fall 2024, Deep Springs College, **Prof. Brian Hill**

Overview

There are two types of inferential statistics that are widely used: frequentist and Bayesian. Frequentist inference is an oversimplification, and it sometimes gives obviously wrong results. However, frequentist inference remains the dominant way that statistics is learned and applied to experimental data to make claims because it is somewhat easier to learn. We will begin with the unassailable basics which underly both frequentist and Bayesian statistics. The basics common to both are known as "descriptive statistics." After covering descriptive statistics, we can spend some time on frequentist inference, including the derivation of the linear regression formulae. Then we will graduate to Bayesian statistics. We will conclude with Monte Carlo methods.

Prerequisite / Joining the Class

I will use mathematics that is commonly known as either Algebra 2 or Algebra 3-4 (depending on whether a school numbers its math classes by the year or the semester). We will need to develop and use some calculus to do statistics, and I will go slowly and assume you have never seen any calculus.

Texts

We are going to use three texts. In order, the three texts we will use are:

- Hugh Young, **Statistical Treatment of Experimental Data** (this is a compact classic that will be of use no matter what additional statistics you do or don't ever use)
- Therese Donovan and Ruth Mickey, **Bayesian Statistics for Beginners** (this is the book we will use the most — it is at a good level for our purposes)
- W.R. Gilks, S. Richardson, David Spiegelhalter, eds., **Markov Chain Monte Carlo in Practice** (the first two chapters of this collection will conclude our course and serve as a bridge from the illlustrative but simple Monte Carlo applications in Chapters 13-16 of Donovan and Mickey to realistic and impactful epidemiological applications)

Grading

- 45% assignments
- 15% (45% total) for each of three exams, dates to be determined, but coming at about the 5th, 9th, and 14th week of classes
- 10% preparation for class and leadership of course

Problem Sets / Handouts / Being Neat and Organized

There will be at least one problem set every week, and ideally more if I can produce one for every class. There will also be handouts, problem set solutions, exams, and exam solutions. To be organized, locate a three-ring binder and a three-ring hole punch, and file everything chronologically. Reverse-chronological is actually the most convenient, because you always open your binder to what you are currently working on. Problem sets should be *neat* and on standard 8 1/2 x 11 paper. Multi-page problem sets should be stapled. The nicest technical work is facilitated by engineering pads, such as these **Roaring Spring Engineering Pads at Amazon** (which are pretty expensive unless you buy by the case), and done with a mechanical pencil, a ruler, and an eraser at hand.

Absences (and late work)

The College's policies on absences (and late work) are applicable. Refer to the Deep Springs Handbook.