Introductory lecture

Statistical Inference (AMS132)
What this course is …

So far (AMS131):

What is the number of heads in 6 tosses of a fair coin?

Now (AMS132):

If 3 heads out of 6 tosses, what is the probability of head?
What this course is …

• An inference course:
  • Estimation: what is the value (or a reasonable set of values) for the parameter?
  • Testing: is the value of the parameter consistent with some theory?

• A melting pot of ideas: there is NOT one single correct procedure!!!!!
Estimation

• How does the lifetime of an electronic component behave?
• What is the trend in global temperature?
• What is the volatility (variability) in the S&P500?
Prediction

- What will the sea temperature be in 30 years?
- What will the value of the S&P500 be tomorrow?
- In some cases, it is hard to see the difference between estimation and prediction (see the lifetime example in the previous slide).
In the People v. Collins case, a purse was snatched from an elderly person in a Los Angeles suburb. A couple seen running from the scene were described as a black man with a beard and a mustache and a blond girl with hair in a ponytail. Witnesses said they drove off in a partly yellow car. Malcolm and Janet Collins were arrested. He was black and though clean shaven when arrested had evidence of recently having had a beard and a mustache. She was blond and usually wore her hair in a ponytail. They drove a partly yellow Lincoln. What would you argue if you were the accuser? What if you were the defense?

Reproduced from Grinstead, C. M. and Snell, J. L. Introduction to Probability (2nd Revised Edition), American Mathematical Association
Some extra info …

- Man with mustache  1/4
- Girls with blond hair  1/3
- Girl with ponytail  1/10
- Black man with beard  1/10
- Interracial couple in a car  1/1,000
- Partly yellow car  1/10
- Total (assuming indep.)  1/12,000,000
Discovering the Higgs bosom

• Let $X$ be the rate of energy emission.

$$X \sim \text{Poisson}(\theta + \lambda)$$

• Is $\lambda > 0$?

• If so, what is the value of $\lambda \Rightarrow$ Mass of Higgs bosom.
What this course is NOT …

• A modeling course
  • We will take the likelihood (and priors) for granted.
  • No model criticism.

• A course on any specific class of models (although we will frequently use Gaussian distributions).

• A course in computational tools.
Structure of the course

• Review of basic probability: establish common language.
• Point estimation techniques: MOM, MLE, Bayes.
• Interval estimation.
• Brief detour through prediction, both frequentist and Bayesian.
• Hypothesis testing.
The big picture

• Why so many different approaches?
  • Philosophical.
  • Practical.
• When do they give similar results? (and when they don’t).
• Reporting results and deriving conclusions, specially the jargon.