DATA 140

Probability for Data Science

Fall 2024

WEEK 11 STUDY GUIDE

The Big Picture

After two main applications of the mgf, we move to estimation from the frequentist and Bayesian perspectives
- We use the moment generating function to indicate why the CLT is true.
- The mgf and *Chernoff's bound* improves on the tail bounds of Markov and Chebyshev.
- In the frequentist world, a parameter is a fixed but possibly unknown number. The method of *maximum likelihood* identifies the parameter that makes the data most likely.
- In the Bayesian world, the data scientist's degree of uncertainty about unknown quantities is described by probability distributions. Unknown parameters are therefore random variables, and inference consists of updating our distribution of the parameter based on the observed data. For these calculations we need some basic methods for conditioning on continuous variables.
- Our main example is inference for the unknown p of a coin. Independence is affected by the randomization of the parameter.
- If the prior is uniform, the MAP estimate (the mode of the posterior) is the same as the maximum likelihood estimate with which the week started.

Week At a Glance

Mon 11/4	Tue 11/5	Wed 11/6	Thu 11/7	Fri 11/8
	Lecture	**No section**	Lecture	Mega Section
HW 10 due at 12 noon	HW 11 (**Due 9AM Tue 11/12**)			HW 11 Party 2 PM to 5 PM
	Lab 7A (**Due 9AM Tue 11/12**)		Lab 7A Party 2PM to 5PM	
Midterm 2	Election night. If you want to work on 140, then work through Ch 19.	Work through Ch 19, especially 19.4.1 through 19.4.6	Work through Section 20.1	Work through Chapter 20; work through any remaining parts of Chapter 19

Reading, Practice, and Class Meetings

Book	Topic	Lectures: Prof. A.	Sections: TAs	Optional Additional Practice
Ch 19	**More uses of the mgf** - 19.3 examines uses of the mgf including a sort-of proof of the CLT - 19.4 uses the mgf to develop a new tail bound	Tuesday 11/5 - Maximum likelihood - Random parameters: conditioning and independence	Wednesday 11/6 **Sections will not be held.** Instead, we will provide video walkthroughs of Ch 19 Ex 2, 3.	Ch 19 - Ex 1
Ch 20	**Approaches to inference** - 20.1 is about the method of maximum likelihood - 20.2 introduces conditioning on a continuous variable, and shows once again that randomizing a parameter affects dependence and independence (you saw this earlier with Poissonization) - 20.3 formalizes the concepts of prior and posterior distributions of parameters, and compares the MAP estimate and the MLE	Thursday 11/7 - Maximum likelihood - Random parameters: conditioning and independence	Friday 11/8 - Ch 20 Ex 1, 4, 6	Ch 20 - Ex 2, 5