PROB 140

Probability for Data Science

Spring 2022

WEEK 10 STUDY GUIDE

The Big Picture

The normal and gamma families are heavily used in modeling. We study these, along with a generating function that helps understand them better

- We start by establishing some properties of the standard normal that we have taken for granted without proof. We notice connections with gamma distributions. By simulation, we notice key properties of sums: sums of independent normals are normal, and sums of independent gammas (with the same rate) are gamma.
- The two most important branches of the gamma family have integer or half-integer shape parameters.
- The *moment generating function* (mgf) is more powerful than probability generating functions for dealing with sums. This helps us establish the properties of normal and gamma families that we observed by simulation, and indicates why the CLT is true.
- The mgf and *Chernoff's bound* improves on the tail bounds of Markov and Chebyshev.

Week At a Glance

Mon 3/28	Tue 3/29	Wed 3/30	Thu 3/31	Fri 4/1
	Lecture	Sections: **Quiz 2**	Lecture	Sections
HW 9 Party 9am to noon **HW 9 Due** HW 10 (due Mon 4/4)				
Lab 4B Due Lab 5A (Due Mon 4/4)				Lab 5A Party 3pm to 5pm
Study for the quiz; skim Section 18.2	Study for the quiz	Work through Section 18.2; skim Section 19.1	Work through Chapter 19	Work through Chapter 19

Reading, Practice, and Live Sessions

Book	Topic	Lectures: Prof. A.	Sections: GSIs	Optional Additional Practice
Ch 18	**Normal and gamma families** - 18.1 establishes the normal density, mean, and variance, and in the process discovers an important fact about sums of squares of standard normals. You *have* to know the results even if you don't follow some of the proofs. - 18.2 observes by simulation that sums of independent normals are normal, and uses this in exercises - 18.3 observes by simulation that sums of independent gammas with the same rate are gamma, and studies one major branch of the gamma family - 18.4 studies the other major branch	Tuesday 3/29 - Fundamental properties of the standard normal - The gamma family and its relation to squares of centered normals	Wednesday 3/30 - **Quiz 2** - Ch 18 Ex 2, 4	Ch 18 - Ex 1, 3, 5, 8
Ch 19	**Moment generating functions** The first two sections parallel the start of Ch 14 on the pgf - 19.1 has a formula for the density of a sum, but it's often intractable - 19.2-3 define the mgf and examine its uses including a sort-of proof of the CLT - 19.4 uses the mgf to develop a new tail bound	Thursday 3/31 - Convolution formula for the density of a sum - Moment generating functions: definition, main uses, Chernoff's bound	Friday 4/1 - Ch 18 Ex 4, again - Ch 19 Ex 3, 2	Ch 19 - Ex 1, 7