Probability Theory

Spring 2021

Instructor:	Burleigh Charlton	**Time:**	T,Th 14:00 – 17:00
Email:	bccharlt@ucsc.edu	**Place:**	Remote

Course Pages:

1. https://people.ucsc.edu/~bccharlt/
2. ttps://canvas.ucsc.edu/courses/69420

Office Hours:

Monday: 16:00 - 17:30
Wednesday: 13:00 - 14:30
Thursday: 12:00 - 13:30

I will always stay after class to answer questions and will schedule office hours via appt.

Main References: This is a restricted list of various interesting and useful books that will be touched during the course. You need to consult them occasionally.

(a) "Theory of Statistics" by Schervish
Requires Measure theory and advanced knowledge, for the more advanced students

(b) "Foundations of the Theory of Probability" by Kolmogorov
Original Axiomization of probability theory. A few pages from the introduction may be used in a history tangent or as a conversation in office horus.

(c) "Probability and Statistics" Degroot and Schervish
Full solutions guide and very comprehensive. I may take problems from this book or assign them.

Objectives:

- *(Goal 1)* Ability to compare different schools of probabilistic thought primarily between a Frequentist and a Bayesian perspective including their relative advantages in certain scenarios.
- *(Goal 2)* Defend the typical axioms of probability and apply them to general problems.
- *(Goal 3)* Relate ideas of independence to probability and justify connections.
- *(Goal 4)* Examine information of a given problem and transform the given facts into mathematical language
- *(Goal 5)* Apply concepts of the class and previous work to solve new problems. Specifically applying Bayes Rule to find information of an unknown when given an observation and a prior rate.
- *(Goal 6)* Generation of CDFs, PMFs, and MGFs from given data, and interpreting them to understand data.

- *(Goal 7)* Understanding of problem solving philosophy and general strategies in the face of uncertainty. The ability to draw conclusions of the validity of a given study or news article by observing the data.

Prerequisites: A basic understanding of calculus, linear algebra, algorithms, and statistics is assumed. An undergraduate-level understanding of probability, graph theory, and abstract algebra will allow for exploration and optional challenge problem.

Course Outline:

Week 1:Thinking Conditionally
Week 2:Law of Total Probability and Bayes Rule
Week 3:Random variables and distributions
Week 4:Moments and MGFs
Week 5:General Strategies for advanced Problem solving
Week 6:Week based on class interest
Week 7:PDFs CDFs
Week 8:LLN and Central Limit Thm
Week 9:Multivariate Distributions
Week 10:Markov Chains

Grading Policy:

- For all answers in this class suppose that the grader is sitting there with you and you're having a brief discussion with her/him on each question; that is, write down in a few sentences what you would say to someone to support your position. The right answer with no reasoning to support it, or the wrong reasoning, is insufficient and will not get full credit. The wrong answer arrived at with a good effort will receive partial credit. Leaving a problem or a part of a problem blank will get no credit.
- Every point in this class is worth the same. All points are earned on quizzes and take home tests.

Important Dates:

Quiz #1 ..... Jan 21st
THT #1 ..... Jan 28th
Quiz #2 ..... Feb 11th
THT #2 ..... Feb 18th
Quiz #2 ..... Mar 4th
THT #3 ..... Mar 19th

Class Policy:

- I will be thoroughly introducing the problems in sections and answering specific questions about the exam in detail during office hours.
- Regular attendance is essential and expected.
- Questions are actively encouraged, this material is difficult and I have left some space in the schedule for lectures to not be 100% efficient. I would rather finish behind schedule with great comprehension than ahead of schedule with only half the class.

Academic Honesty: All work in this class is to be entirely your own efforts; do not collaborate with anyone or get help from anyone but me. The intent is that the course lecture notes and readings should be

sufficient to provide you with all the guidance you need to solve the problems posed in exams but you may use other written materials (e.g., the web, journal articles, and books other than those already mentioned in the readings), **provided that you cite your sources thoroughly and accurately**. Lack of knowledge of the academic honesty policy is not a reasonable explanation for a violation.

Other Resources:

(a) 3b1b Bayesian Series
https://www.youtube.com/watch?v=lG4VkPoG3ko
https://www.youtube.com/watch?v=HZGCoVF3YvM
https://www.youtube.com/watch?v=8idr1WZ1A7Q

(b) A Cheatsheet for the important formulae in this class
https://people.ucsc.edu/~bccharlt/stats131/probability_cheatsheet.pdf

(c) An alternative explanation to Bayesian reasoning
https://www.lesswrong.com/posts/CMt3ijXYuCynhPWXa/bayes-theorem-illustrated-my-way

- ACE Tutoring Sessions https://ace.science.ucsc.edu/