Probability Models and Inference
STSCI/BTRY 3080
Spring 2018

Course personnel

INSTRUCTOR

- Dr. James Booth
  Department of Biological Statistics and Computational Biology
  and Department of Statistical Science

- Office: 1172 Comstock Hall

- E-mail: jb383@cornell.edu

- Office Hours: Tuesday, 4:30-5:30PM in 1187 Comstock

TEACHING ASSISTANTS

- Claudiu Dinicu: cd535@cornell.edu

- Yuxuan Zhao: yz2295@cornell.edu

Lecture/Discussion meeting times and places

Lecture (Professor): Phillips Hall 203, M & W, 2:55-4:10 PM.

Discussion 1 (TA): Olin 218, Tuesday, 2:55 - 4:10 PM.

Discussion 2 (TA): Olin 218, Thursday, 2:55 - 4:10 PM.

Prerequisites and textbooks

- Pre/Corequistes: **Introductory Statistics, Multivariable Calculus**, or the equivalent. It is assumed that students have a good command of algebra and calculus, especially differentiation and integration, including multiple integrals; these tools will be used extensively throughout the semester.

- Required textbook: **Probability and Statistics, by Morris H. De-Groot and Mark J. Schervish,** Publisher Addison Wesley; 4th edition, 2011.

Course Objectives

This course provides an introduction to probability and parametric inference. Topics include: random variables, joint and conditional distributions, standard distributions, the central limit theorem, sampling distributions and instances of likelihood-based estimation. The expected learning outcomes are listed below.

1. Students will be able to manipulate random variables and their distributions using differential and integral calculus.

2. Students will be able to recognize, apply and derive properties of standard probability distributions.

3. Students will be exposed to introductory elements of statistical inference, rigorously derived.

Course Outline

We will follow the (*tentative*) outline below. The topics are selected from Chapters 1 - 8 in your textbook. Depending on time, some topics will be covered in more depth and some may be omitted.

Basic Probability (Chapters 1 & 2)

- Sample Spaces
- Events and Probabilities
- Combinatorial Methods and Binomial Coefficients
- Conditional Probabilities and Independent Events
- Bayes' Theorem

Random Variables and Probability Distributions (Chapter 3)

- Random Variables
- Discrete Random Variables
- Continuous Random Variables
- Bivariate Distributions
- Marginal and Conditional Distributions
- Functions of Random Variables

Expectation (Chapter 4)

- Concept of Expected Value of a Random Variable
- Properties of Expectation
- Moments and Variance
- Covariance and Correlation
- Conditional Expectation

Special Distributions (Chapter 5)

- The Bernoulli and Binomial Distributions
- The Poisson Distribution
- The Negative Binomial Distribution
- The Multinomial Distribution
- The Uniform Distribution
- The Gamma and Beta Distributions
- The Normal Distribution
- The Bivariate Normal Distribution

Distribution of the Sample Mean (Chapter 6)

- Mean and Variance
- Chebyshev's and Markov's Inequality
- Law of Large Numbers
- Central Limit Theorem

Estimation and Sampling Distributions (Chapters 7 & 8)

- Random sampling
- Sampling distribution of a statistic
- Chi-squared distribution
- T-distribution
- Confidence intervals

Exam schedule and grading policy

Your grade in this class will be based on the following:

1. **Homeworks.** You will receive 6 problem sets that will account for **20%** of the grade. You are responsible to upload your homework via Blackboard between 8 AM and 7 PM, on each announced due date, after which homework submission automatically closes. Homework solutions will be made available on Blackboard, starting at 7 PM, on the due date. **Since solutions will be posted on the due date, late problem sets will not be accepted.** Note that the homework with the lowest grade will be dropped from the final grade calculation. **Below are the tentative dates for the homework assignments.**

Assignment	Post date	Due date
Homework 1	Friday, Feb.2	Friday, Feb.9
Homework 1	Friday, Feb.9	Friday, Feb.16
Homework 1	Friday, Mar.2	Friday, Mar.9
Homework 1	Friday, Mar.16	Friday, Mar.23
Homework 1	Friday, Apr.13	Friday, Apr.20
Homework 1	Friday, Apr.27	Friday, May.4

2. **Exams.** Two prelims and a final will account for **80%** of the grade. The prelims with lowest/highest grade will receive a weight of 20% and 30%, respectively. The final exam is 30% of the final grade. **Below are the dates of these exams, as well as the** *tentative* **chapters on which they are based.**

Exam	Date	Required material
Prelim 1	**Thursday, Feb.22**	Parts of Chapters 1, 2 & 3
Prelim 2	**Thursday, Mar.29**	Parts of Chapters 3, 4 & 5
Final	**Sunday, May.20**	Parts of Chapters 5, 6, 7 & 8

- The exams are not cumulative, but it is implicitly understood that basic material covered by earlier exams may be needed in later tests. So, for example, some of the material required for Prelim 2 may also be required for the final exam. More details will be given prior to each exam.

- Each exam will be based on: (i) the material covered in class during the period before the exam, including all problems solved in lecture; (ii) all homework problems due prior to the exam; (iii) the material covered in the discussion session.

- I will discuss the general exam outline in class, before each exam. You will have a preparatory discussion session before each exam. It is very important that you attend these lectures and discussion sections!

- If you have **documented medical or religious** reasons for conflicts with exam times, contact me directly, as soon as possible **before** the exams.

Administrative details

This class has a Blackboard site (STSCI 3080 Probability Models & Inference). All materials listed below will be available on-line, at this site. It is entirely your responsibility to download them and/or print them as needed. A brief description of these materials follows.

- This Syllabus should be used as reference throughout the year for exam dates and course policy: **Please consult the syllabus before e-mailing us, it may already contain the answer to your question.**

- I will post my (hand-written) notes from each lecture. **These notes are not meant to replace the textbook. Their role is to help you navigate with ease through new material. It is your responsibility to read both the notes and the corresponding text book chapter(s).**

- The Discussion sessions will be based on fully solved practice exercises that will be posted on-line weekly, prior to each session.

- The homeworks will be posted on the course Blackboard site.

- **The solutions to homeworks will be posted on blackboard immediately after the due time. No homeworks will be accepted after that.**

Academic Integrity

Course materials given in this class are intellectual property belonging to the instructor. Students are not permitted to buy or sell any course materials without the express permission of the instructor. Such unauthorized behavior constitutes academic misconduct. Each student in this course is expected to abide by the Cornell University Code of Academic Integrity. Any work submitted by a student in this course for academic credit will be the student's own work.

University breaks (no lectures/discussion sessions):

No discussion sessions: Thursday, January 25; Thursday, February 22.