ECE 3077: Intro to Probability and Statistics for ECEs
Summer 2016 Syllabus

Summary

ECE 3077 is a foundational course in probability and statistics.

The central theme of the course is the development of mathematical methods for understanding and modeling uncertainty.

Prerequisites

I will assume that you are comfortable with the fundamentals in calculus (calculating integrals, understanding limits, Taylor series expansions, etc) and linear algebra (matrix-vector multiplication, solving systems of equations, dimension, rank, etc). I will also assume basic proficiency in MATLAB\footnote{I prefer you do things in MATLAB, but if you feel strongly about using Python, Julia, R, Octave, or another language, come and see me.} — many of the homework assignments will require you to write MATLAB code.

Instructor

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Teaching Assistant

TBA
Grading

Your grade will be assigned based on the following factors:

- **Homework (15%)** – Lowest score dropped.
- **Computer exercises (10%)** – Lowest score dropped.
- **Quiz 1 (20%)** – Tentatively scheduled for June 7 (in class).
- **Quiz 2 (20%)** – Tentatively scheduled for June 30 (in class).
- **Final exam (30%)** – Scheduled for July 28, 2:50-5:40pm
- **Participation (5%)**

Unauthorized use of any previous semester course materials, such as tests, quizzes, homework, and any other coursework, is prohibited in this course. **Using these materials will be considered a direct violation of the GT Academic Honor Code.** Furthermore, redistributing materials from this semester (e.g., contributing to test banks, CourseHero, or similar sites) is also prohibited. For any questions involving these or any other Academic Honor Code issues, please consult me or [www.honor.gatech.edu](http://www.honor.gatech.edu).

Homework

Homework will be assigned weekly (approximately). Homework will be turned in at the beginning of lecture. **Late homework will get zero credit.**

You are encouraged to discuss the homework with other members of the class. However, everything that you turn in must be your own work. **You must write up the assignments (and accordingly the MATLAB code) by yourself, citing any outside references you use to arrive at your solution. Failure to do so will be considered a violation of the GT Academic Honor Code.**

The homework assignments will be hard; many of them will require significant amounts of time and effort to complete. But this is really where most of the learning takes place. You will get out of the assignments what you put into them. Solving problems in probability and statistics involves a style of thinking which is, at times, as much art as science. This style is best learnt through working examples. Students who complete all of the assignments in full will be rewarded with a deep understanding of the role that probability and statistics can play in both electrical and computer engineering as well as everyday life.

Effectively, homework is worth much more than 15% of your grade. In teaching this and other classes, **I have yet to see a case where a student does not put effort into the homework assignments but does well on the exams.**
Computer exercises

We will spend Friday class periods solving problems together in class. There will be a set of required exercises for each session that must be completed in class using the online platform OpenStax Tutor. The URL for the OpenStax Tutor webpage for this class is openstaxtutor.org/classes/65.

There will be no makeup dates for these problem solving sessions, so you will need to bring your laptop to class each Friday. The exercises are not supposed to be a test, they are meant to help solidify your understanding of the material through low-stakes practice. Each assignments will count equally in computing your overall grade, although some assignments may have more exercises than others. Note that to receive full credit you must complete all exercises and view the solutions after the assignment is due. You have until the end of the semester to view these solutions (although I recommend doing this as soon as possible), but you will receive a 50% penalty on any assignments for which you do not view the feedback.

Tests

The tests (two midterm quizzes and a final exam) will be given on the dates shown above. No make-up tests will be given. If you must miss a test for some grave illness or other reason beyond your control, please send an e-mail immediately to Prof. Davenport. Written official documentation will be required within 3 days. If you are excused from a test, the next test will cover that percentage in your grade (i.e., if you miss Quiz 1, Quiz 2 would be worth 40%; or if you miss Quiz 2, the Final would be worth 50%). Test are closed book, but handwritten notes will be allowed (1 page for quizzes, 3 pages for the final exam). Calculators are also allowed.

Participation

I am excited about teaching this course and want everyone to succeed. However, your learning is ultimately up to you. We have very limited time together this semester, and your active participation in the course makes the best use of that time for both yourself and your fellow students. Thus, a portion of your grade will be based on your active participation in all facets of the class. At a minimum, you should show up on time and be prepared to be engaged. (Yes, it’s easy for me to see when you’re looking at your phone under the table or chatting with friends, even if you’re sitting in the back row.) Equally important is making a good faith effort on the computer exercises and engaging with the course outside of the classroom (e.g., actively engaging with the homework, attending office hours, and/or contributing to the online discussions in Piazza). All of this will factor into your participation grade.

That being said, a student will not pass the class based on attendance, participation or effort alone. Part of my job is to asses whether or not each student has achieved a deep and thorough understanding of the material. If you find that you are studying an extreme amount but still not performing well, I am happy to discuss possible changes to the way you study that may be of benefit.
T-square and Piazza

General course information, lecture notes, homework assignments, course grades, and other supplemental materials will be posted on T-square.

We will also use Piazza to make announcements and for you to post questions about the course, lectures, and homework assignments. All questions that are not personal should be posted here rather than emailed to me so that everyone can benefit from the discussion and you can get quicker feedback than you might get from me alone. Posts I make to Piazza will be considered official announcements that you are expected to be aware of, so please make sure that you check it often and/or receive email notifications. Also, you are encouraged to answer questions for other students on Piazza. Notable Piazza contributors will be rewarded in their participation grade. The Piazza page for this course is located at piazza.com/gatech/fall2015/ece3077

Textbook and other resources

The required text for the course is

- Bertsekas and Tsitsiklis: *Introduction to Probability*
  [http://amzn.to/YRPH3x](http://amzn.to/YRPH3x)

Here are several other books that I can recommend for learning the material in this class. You couldn’t possibly read them all over the next few months, but if you take the time to read any of them you will find it worthwhile.

- Durrett: *Elementary Probability for Applications*  
  [amzn.to/1UNd5YN](http://amzn.to/1UNd5YN)This is an excellent introduction to probability. It is not specifically focused on applications in ECE and is less comprehensive than Bertsekas and Tsitsiklis, but has a great treatment of the material for roughly the first 2/3 of the course.

- Yates: *Probability and Stochastic Processes: A Friendly Introduction for Electrical and Computer Engineers*  
  [amzn.to/13fHKB2](http://amzn.to/13fHKB2)
  
  Yates is very good, especially for ECE majors. This was a candidate for the course’s official text, but its focus on random processes makes it more appropriate for a second course (i.e., ECE 4260, Random Signals and Applications).

- Feller: *An Introduction to Probability Theory and its Applications*  
  Volume 1: [amzn.to/19k00jf](http://amzn.to/19k00jf)  
  Volume 2: [amzn.to/13tXSm9](http://amzn.to/13tXSm9)

  This book is an absolute classic written by one of the greatest probabilists of the 20th century. It was first published in 1950, but the writing style is so clear that it has held up perfectly. This book is a little more advanced mathematically than this course will be, but it is still very accessible. The material covered in Volume 1 is particularly relevant. I cannot recommend it enough as a supplement to the material in this course.
• Hamming: *The Art of Probability*
  [amzn.to/126Zyiu](amzn.to/126Zyiu)
  This book is another classic. Hamming (of the Hamming window, Hamming code, Hamming
distance, etc.) was trained as a mathematician, but spent much of his life at Bell Labs working
with engineers. This book is a little different than Feller in that Hamming takes a strong
position on various philosophical issues related to what probability really is and devotes a fair
bit of discussion to these issues. If you’re interested, this can be fascinating, but even if you’re
not, Hamming does an excellent job of giving lots of examples and trying to develop intuition
for how to approach these problems to find the most elegant (i.e., easiest and fastest) solution.
Chapter 4 is particularly good in this respect.

• Wasserman: *All of Statistics*
  [amzn.to/18G1Dsc](amzn.to/18G1Dsc)
  If you like the material at the end of this course, check this out. Wasserman provides a fairly
concise overview of, well, all of statistics. If you want to go get a job doing something related
to “big data” or “data science,” read this book.

• Mlodinow: *The Drunkard’s Walk: How Randomness Rules our Lives*
  [amzn.to/11zCQoe](amzn.to/11zCQoe)
  An easy read which has interesting tidbits about some of the historical figures in the develop-
ment of probability theory, and modern experiments that show how bad human intuition
is at judging probabilities.

• Bernstein: *Against the Gods: The Remarkable Story of Risk*
  [amzn.to/19kPkxD](amzn.to/19kPkxD)
  This is a fascinating history of the development of probability theory from the 16th century
to the present, with a bit more emphasis on applications in business and finance.

• Taleb: *Fooled by Randomness*
  [amzn.to/15H1O6w](amzn.to/15H1O6w)
  The theme of this book is how terrible humans are in general about understanding the role
randomness plays in our lives (especially in finance).

• Silver: *The Signal and the Noise*
  [amzn.to/17Ygz2i](amzn.to/17Ygz2i)
  Nate Silver got a lot of attention for his accurate predictions in the 2008, 2010, an 2012
elections. This book examines how experts predict uncertain events (i.e., the weather, earth-
quakes, an athlete’s performance, etc.) using probabilistic models.

You may also want to take advantage of some of the following online resources:

• MIT OpenCourseware
  [bit.ly/NA4aLP](bit.ly/NA4aLP)
  This course used the same book, and will match our course pretty closely, at least through the
first few weeks. There are alternative lecture notes, homework assignments (with solutions),
and other materials at the website above.

• Harvard Statistics 110: Probability
  [bit.ly/NhMdxb](bit.ly/NhMdxb)
  Harvard also has a similar course with video lectures available through iTunes.
• Khan Academy lectures on probability

bit.ly/PaBJmu

The Khan Academy has some fantastic (shortish) lectures available for many of the topics in this course. Many of them are centered on working specific problems.

Outline

We will start the course by following the book fairly closely for the first 5 chapters. After that, the material will overlap, but we will be choosing a more customized list of topics. The ordering of subjects in this outline is rough and subject to change.

• Introduction to probability
  – simple probability models, the Kolmogorov axioms, the uniform law
  – independence
  – conditional probability and Bayes rule
  – basic combinatorics

• Discrete random variables
  – probability mass functions (pmfs)
  – expectation, variance, and moments
  – multiple discrete random variables, joint pmfs
  – conditional pmfs
  – example distributions: Bernoulli, Binomial, Geometric, Poisson, etc.
  – entropy and source coding

• Continuous random variables
  – probability distributions and probability density functions (pdfs)
  – expectation, variance, and moments
  – multiple continuous random variables, joint pdfs
  – conditional pdfs
  – example distributions: Uniform, Exponential, Gaussian/Normal, etc.

• Further topics in probability
  – covariance and correlation
  – iterated expectation
  – Bayes rule for random variables
  – functions of random variables
  – generating random numbers
  – the central limit theorem
• Basic statistics
  – sample mean and variance
  – weak law of large numbers
  – confidence intervals, the student-t distribution
  – maximum likelihood estimation
  – hypothesis testing
  – linear regression
  – Bayesian methods

• Further topics as time permits