Math 385
Accelerated Mathematics for MMSS: Probability and Statistics
Fall 2014

Course:

Lecture: MW 9:30–10.50, Harris Hall L07
Discussion: F 9:30–10.50, Harris Hall L07

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Course Description: This course is part of the MMSS second year core curriculum. It provides an introduction to probability and statistics, and it serves as the first quarter of the MMSS statistics and econometrics sequence. The first part of this course will cover the structure of probability theory, which is the foundation of statistics, and provide many examples of the use of probabilistic reasoning. It will then move to a discussion of the most commonly encountered probability distributions, both discrete and continuous. We will then consider random sampling from a population, and the distributions of some sample statistics. From there we will move to the problem of estimation -the process of using data (in the best possible way) to learn about the value of the unknown parameters of a model. Finally, we will discuss hypothesis testing - the use of data to confirm or reject hypotheses that we have formed about the relationship among (economic) variables.

Text: The required text for this course is by Morris DeGroot and Mark Schervish, *Probability and Statistics*, 3rd edition (or 4th edition), Addison Wesley, 2001. This book provides a good description of the basic theory and it contains many illustrative examples. The level of the exposition is similar to that of the class lectures, although the text also contains more advanced material. An alternative textbook is the one by John A. Rice, *Mathematical Statistics and Data Analysis*, 3rd edition, Duxbury Press, 2006. This book is more concise and includes shorter discussions of every topic than the other book. Both are excellent books and I recommend that you follow **only one** of the books.

Problem Sets: There will be weekly problem sets. Almost all of the questions will be drawn from DeGroot & Schervish and Rice. Problem sets *must* be submitted in class on their due dates. Late problem sets will **not** be accepted. You may want to work in groups on problem sets, but each student must turn in their own answers. If you miss class you can take a picture (or scan) of your solutions and send them by email to me or the TA.

Exams and Grading: There will be a midterm exam and a final. The midterm will be an in-class exam, on **Wednesday, October 22**. The final is scheduled for **Thursday, December 11 from 3PM to 5PM**. The weighting scheme for the final grade will be:

Problem Sets:	20%
Midterm Exam:	35%
Final Exam:	45%

The exam will be open book and open notes, but no electronic devices may be used. Any student who misses the midterm or final without a good reason will receive no credit for the exam. Medical reasons require written confirmation from the University health services or your doctor. Non-medical reasons require a written excuse from official of the University (e.g., an official from the WCAS Dean's Office). A makeup for the midterm or final will be permitted only if there is a good reason for missing the exam. Suspicion of academic dishonesty will be referred immediately to the Dean's Office.

Any student with a documented disability needing accommodations is requested to speak directly to the Office of Services for Students with Disabilities (SSD) and the instructor as early as possible in the quarter. All discussions will remain confidential.

Discussions: The TA will work on problems that will help you prepare for the current homework and the exam. The TA session will not consist on solving past problem sets.

How to succeed in this course: The best way to learn the material is by doing the problems. Moreover, each new concept builds on the previous material, and it is difficult to catch up if you fall behind. It is not a good idea to learn the subject by cramming at the end of the course. I recommend the following steps to make this class a walk in the park:

- Review the lecture notes after class every week. Avoid getting behind.
- Identify the topics of the lecture in your book and use the book as reference.
- Approach the problem sets as follows: (a) read the problems early on, (b) for every question identify what topic/property/theorem seems relevant (even if you are not sure how to use such property), (c) review the corresponding topic/property/theorem in your notes/book, (d) attempt to solve the problem, (e) discuss your attempt with peers/study group. **Remember:** you should always work on the problem sets with your **notes/book open** and use the homework as an excuse to **review the material while solving the problems**. There is little value in getting the right answers without reviewing.

Course Outline

1. Introduction to Probability (2 Lectures: Sept. 24 & 29)
    - Sample Space
    - Events and Probability
    - Combinatorial Method and Binomial Coefficient
2. Conditional Probability (1 Lecture: Oct. 1)
    - Conditional Probability
    - Independent Events
    - Bayes' Theorem
3. Random variables (2 Lectures: Oct. 6 & 8)
    - Random Variables
    - Probability Distributions
    - Discrete and Continuous Random Variables
    - Joint Distributions
    - Marginal and Conditional Distributions
4. Expectations and Moments (2 Lectures: Oct. 13 & 15)
    - Expectations: Definition and Properties
    - Variance
    - Covariance and Correlation
    - Conditional Expectation
    - Moment Generating Function
5. Common Families of Distributions (1 Lecture: Oct. 20)
    - Discrete: Bernoulli, Binomial and Poisson Distributions
    - Continuous: Uniform, Gamma, Exponential and Normal Distributions
    - Bivariate Normal Distribution
6. Limit Theorems: LLN and CLT (1 Lecture: Oct. 27)
    - Inequalities: Markov and Chebyshev
    - The sample mean and sample variance
    - Convergence in Probability and the Law of Large Numbers
    - Convergence in Distribution and the Central Limit Theorem

7. Point Estimation (2 Lectures: Oct. 29 & Nov. 3)
    - Method of Moments Estimators (MME)
    - Maximum Likelihood Estimators (MLE)
8. Sampling Distributions (1 Lecture: Nov. 5)
    - The Chi-Square Distribution
    - the t-Distribution
    - Sampling Distributions in the Normal Case
    - Asymptotic Distributions
9. Properties of Estimators (2 Lectures: Nov. 10 & 12)
    - Exact Properties of Estimators
    - Asymptotic Properties of Estimators
    - Asymptotic Properties of MLE
    - Fisher Information and Efficiency
10. Statistical Inference (4 Lectures: Nov. 17, 19, 24 & 26)
    - Hypothesis Testing
    - Null and Alternatives
    - Critical Region and Test Statistics
    - The power function and types of errors
    - The p-value
    - Confidence Intervals
    - Inference for MME
    - Inference for MLE