APMA 1650: Statistical Inference I

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Office: 182 George St. #222

Class Hours: Tue/Th, 1:00-2:20pm
Class Room: McMillan 117

Course Description

APMA 1650 is an integrated first course in mathematical statistics. The first half of the course covers probability, and the last half is statistics, integrated with its probabilistic foundation. Specific topics include probability spaces, discrete and continuous random variables, methods for parameter estimation, confidence intervals, and hypothesis testing.

Class format: This is a lecture-based course. The course will consist of one-hour and twenty minute lectures two times per week.

Prerequisites

One year of university-level calculus. At Brown, this corresponds to MATH 0100, MATH 0170, MATH 0180, MATH 0190, MATH 0200, or MATH 0350. A score of 4 or 5 on the AP Calculus BC exam is also sufficient.

Text books

- *Mathematical Statistics with Applications*, 7th Edition,
  by Wackerly, Mendenhall, and Scheaffer, Thomson Brooks/Cole, 2008.

This has been the required textbook in the past for APMA 1650. If you wish to have your own physical copy, the 6th edition (2001) is not significantly different and can usually be found used on amazon.com for less than 20.

Course Policies

General

- All quizzes and exams are closed book and closed notes.
- **There will be NO makeup quizzes or exams** unless you present verifiable proof of the reason for missing the exam.

Homework

- Problem sets will be due on Thursdays at start of class.
- On weeks when there is an exam, there will be no problem set due on Thursday. There are no problem sets due the first week of class.
- Problem sets will be posted at least one week in advance of the due date.
- You are encouraged to work together on assignments, however, **you must write up your own solutions**.
- Late Homeworks will be penalized proportionally to the degree of lateness.

Grading Policy

The grade will count the assessments using the following proportions:

- **30%** of your grade will be determined by **problem sets**.
- **20%** of your grade will be determined by **the 1st midterm exam**.
- **20%** of your grade will be determined by **the 2nd midterm exam**.
- **30%** of your grade will be determined by **the final exam**.

Time Required

Over 14 weeks, students will spend 3 hours per week in class (42 hours). The weekly homeworks are expected to take roughly 6-8 hours each ($\approx$ 84 hours). It is strongly encouraged to read the appropriate sections of the book beforehand. This may take an additional 1-2 hours each week ($\approx$ 20 hours).

Learning Goals

To build a solid undergraduate foundation in probability and statistical theory. To understand the relevance and importance of the theory in solving practical problems in the real world.

Schedule and weekly tentative contents

The schedule is *tentative* and subject to change. The learning goals below should be viewed as the key concepts you should grasp after each week, and also as a study guide before each exam, and at the end of the semester.

Week 01, 09/03 - 09/07: Introduction to Probability (2.1 - 2.5)

- Introduction, Set notation, probability spaces

Week 02, 09/10 - 09/14: Conditional Probability (2.6 - 2.10)

- Counting: permutations, combinations, and multinomials.
- Conditional probability, Independence, Multiplicative & Additive Law, Law of Total Probability, Bayes Law, Tree diagrams.

Week 03, 09/17 - 09/21: Discrete Random Variable (2.11, 3.1 - 3.5, 3.7 - 3.8)

- Random variable (r.v.), Probability distribution of a discrete r.v.
- Expectation, Binomial Distribution, Geometric Distribution, Hypergeometric Distribution, Poisson Distribution.

Week 04, 09/24 - 09/28: Discrete Random Variable (3.3, 3.11), Continuous R.V. (4.1 - 4.3)

- Revisit Expectation, Variance: Deviations from the mean, Indicator r.v.,
- Markov's inequality, Chebyshev's inequality.
- Probability distribution of a continuous r.v., distribution function, probability density function, Expectation.

Week 05, 10/01 - 10/05: Continuous probability distributions (4.4 - 4.7, 4.9 - 4.10)

- Uniform distribution, Normal distribution, Gamma distribution, Beta distribution
- Moment generating function, Markov's inequality, Chebyshev's inequality.

Week 06-07, 10/08 - 10/19: Multivariate probability distributions (5.1 - 5.4)

- Bivariate and Multivariate probability distributions, Marginal and conditional probability distirbutions, Independent Random Variables.
- Midterm 1 (TBA)

Week 08, 10/22 - 10/26: Multivariate probability distributions (5.5 - 5.7, 5.11)

- Expectation and its properties, Covariance and correlation, Conditional Expectation.

Week 09, 10/29 - 11/02: Central Limit Theorem (6.5, 7.1-7.3), Estimation (8.1-8.4)

- Sampling distributions, Central limit theorem, point estimators, Bias, Mean square error (MSE), Error of estimation.

Week 10, 11/05 - 11/09: Estimation (8.5 - 8.9)

- Confidence intervals: Large-sample, small-sample.

Week 11, 11/12 - 11/16: Point Estimators and Methods of Estimation (9.1 - 9.7)

- Properties of Point estimators: Bias, Efficiency, Consistency, Sufficiency
- Method of Moments, Maximum Likelihood (MLE).
- Midterm 2 (TBA).

Week 12, 11/19 - 11/23: Hypothesis Testing (10.1-10.6)

- Hypothesis Testing.

Week 13, 11/26 - 11/30: Hypothesis Testing (10.7-10.10)

- Hypothesis Testing.

Week 14, 12/03 - 12/07: Hypothesis Testing (10.11)

- Likelihood Ratio Tests.

Week 15, 12/10 - 12/14: Final Exam

- 13-DEC-2018, Exam Time: 02:00:00 PM, Exam Group: 10.