Course Syllabus

ISYE 6739-II

Random Variables – Great Expectations to Bell Curves

Professor: Dr. David Goldsman

Course Description

This second course discusses properties and applications of **random variables**, e.g., how many customers are likely to arrive in the next hour? What is probability that a lightbulb will last more than a year? When you're done with this mini-course, you'll have enough firepower to undertake a wide variety of modeling and analysis problems; and you'll be well-prepared for the upcoming Statistics mini-courses.

Prerequisites

You will be expected to come in knowing a bit of set theory and basic calculus, as well as the material from the first course in this series (A Gentle Introduction to Probability). The prerequisite material is all available for you to access; and in any event, we will try to make the current course as self-contained as possible. In addition, this course will involve a bit of computer programming, so it would be nice to have at least a little experience in something like Excel.

Course Goals

Random Variables – Great Expectations to Bell Curves

- Learn about discrete and continuous probability distributions.
- Study properties of distributions such as the expected value, variance, and moment generating function.
- Get exposure to functions of random variables and how they can be used in computer simulation applications.
- Learn about joint (two-dimensional) random variables and how to extract marginal (one-dimensional) and conditional information from them.
- Study the concepts of independence and correlation.
- Prepare for upcoming courses involving probability and statistics applications.

Grading Policy

- There will be one exam in this course. Test questions are multiple choice or T/F.
- There will be four homework assignments for this course. The HWs often have bonus questions, which you can do to earn a few extra points. Let r = the number of required questions, R = the # of required questions you answer correctly, and B = the number of bonus questions you answer correctly. Then your HW grade will be 100*(R+B)/r.

- You must achieve an overall weighted average of 60% to pass the course.
- Work hard and you will be rewarded – Grading is usually pretty generous.
- But let's be winners, not whiners. We are happy to discuss grades, but please make reasonable requests. 😊
- Grading Breakdown: For this course, the HW counts as 20% and the exam as 80%.

Exam Policy

- The exam covers all the material in the course.

Plagiarism Policy

Plagiarism is considered a serious offense. You are not allowed to copy and paste or submit materials created or published by others, as if you created the materials. All materials submitted and posted must be your own.

Course Materials

- All content and course materials can be accessed online.
- Suggested textbook: D. Goldsman and P. Goldsman, *A First Course in Probability and Statistics* – available for **free** PDF download. $ave $ave $ave!

For an inexpensive hard copy, click the book icon →

Technology/Software Recommendations

- Internet connection (DSL, LAN, or cable connection desirable)
- Adobe Acrobat PDF reader (free download; see https://get.adobe.com/reader/)
- Excel (or equivalent)
- R statistical software (free download; see cran.r-project.org) (or similar statistics packages such as Minitab, JMP, SAS, etc.)
- Bonus software: Any "real", high-level language such as Matlab, Python, etc.

Course Topics and Sample Pacing Schedule

- The table below contains a course topic outline and a SUGGESTED course progression timetable.
- The **SUGGESTED** (but not mandatory) time units are in weeks, so there's one HW/week.
- Note that some topics below are marked as **OPTIONAL**. We have included this material in case you need additional review or would like to delve into a topic further. You will be given extra credit homework on those topics, but you will not be tested on those topics.

	Course Topics
Week 1	**Course II: Random Variables – Great Expectations to Bell Curves** **Module 2: Univariate Random Variables** • Lesson 1: Introduction (§2.1 of text) • Lesson 2: Discrete Random Variables (§2.2) • Lesson 3: Continuous Random Variables (§2.3) • Lesson 4: Cumulative Distribution Functions (§2.4) • Lesson 5: Great Expectations (§2.5.1) • Lesson 6: LOTUS, Moments, and Variance (§2.5.2) **Homework** • Homework 1
Week 2	**Module 2 (cont'd): Univariate Random Variables** • Lesson 7 **[OPTIONAL]:** Approximations to E[$h(X)$] and Var($h(X)$) (§2.5.3) • Lesson 8: Moment Generating Functions (§2.6) • Lesson 9: Some Probability Inequalities (§2.7) • Lesson 10: Functions of a Random Variable (§2.8.1) • Lesson 11: Inverse Transform Theorem (§2.8.2) • Lesson 12 **[OPTIONAL]:** Honors Bonus Results (§2.8.3) **Homework** • Homework 2
Week 3	**Module 3: Bivariate Random Variables** • Lesson 1: Introduction (§§3.1.1–3.1.3) • Lesson 2: Marginal Distributions (§3.1.4) • Lesson 3: Conditional Distributions (§3.2) • Lesson 4: Independent Random Variables (§3.3.1) • Lesson 5: Consequences of Independence (§3.3.2) • Lesson 6: Random Samples (§3.3.3) • Lesson 7: Conditional Expectation (§3.4.1) • Lesson 8: Double Expectation (§3.4.2) • Lesson 9 **[OPTIONAL]:** First-Step Analysis (§3.4.3) **Homework** • Homework 3
Week 4	**Module 3 (cont'd): Bivariate Random Variables** • Lesson 10 **[OPTIONAL]:** Random Sums of Random Variables (§3.4.3) • Lesson 11 **[OPTIONAL]:** Standard Conditioning Argument (§3.4.3) • Lesson 12: Covariance and Correlation (§3.5.1) • Lesson 13: Correlation and Causation (§3.5.2) • Lesson 14: A Couple of Worked Correlation Examples (§3.5.3) • Lesson 15: Some Useful Covariance / Correlation Theorems (§3.5.4)

	• Lesson 16: Moment Generating Functions, Revisited (§3.6) • Lesson 17 **[OPTIONAL]:** Honors Bivariate Functions of Random Variables (§3.7) **Homework** • Homework 4 **Assessments** • **Course II Exam – Study Really Hard!**