MS&E 120: Probabilistic Analysis

This is a fast-paced, fundamental course designed to develop an understanding of uncertain phenomena using the theory of probability. The course objective is to provide students with conceptual and intuitive insights into probabilistic reasoning and the ability to understand and solve real world problems.

Intended Audience

For students seeking an introduction to probability theory and applications, this course is designed to develop their intuition and model building skills. You should acquire Ways of Thinking in Formal Reasoning (intuitively understand a number of fundamental probabilistic reasoning concepts based on a mathematical foundation) and Applied Quantitative Reasoning (solve real world problems under uncertainty by structuring them, building models, and analyzing those models). This course also satisfies the Distributional Breadth GER in Engineering and Applied Science. It is intended for undergraduate students and should be taken for five units. 

Graduate students in MS&E should enroll in a similar but separate course, MS&E 220.

Course Summary

Concepts and tools for the analysis of problems under uncertainty, focusing on structuring, model building, and analysis. Examples from legal, social, medical, and physical problems. Topics include axioms of probability, probability trees, belief networks, random variables, distributions, conditioning, inference, expectation, change of variables, and limit theorems.

Prerequisite: CME 100 (or MATH 51).

Course Staff

Professor: Ross D, Shachter, Huang 337, shachter@stanford.edu, 650-353-7456

   office hours: Mondays, Wednesdays, before class, 8:45-9:30, in 420-041

   For other times, please email Prof. Shachter for an appointment

Staff Support: Rosalind Morf, Huang 339A, rozm@stanford.edu, 723-4173

Teaching Assistants: Christopher Weyant, cweyan@stanford.edu, Huang 212P

   Ruoxuan Xiong, rxiong@stanford.edu, Huang 314M

   office hours: to be determined and posted on course website

Schedule

Lectures and Review: Mondays, Wednesdays, and Fridays, 9:30-11:20, 420-041

Homework Review: Sundays, 7-9pm, Thornton 110 starting Oct 1

   Attendance at lectures and review is required, in that you are responsible for any course material and concepts presented there, and quizzes given there. Lecture notes will be posted in advance but they are intended to enhance your experience in lecture, not to substitute for it.

Course Website

The course web site is accessed via http://msande120.stanford.edu/.
Required Textbook
The required textbook for the course is Sheldon Ross, *A First Course in Probability*, Pearson, 2014 (Ninth Edition). It is on reserve in the Engineering Library, and it is possible to use the eighth edition instead.

Prerequisites
Students should have a working knowledge of calculus at the level of CME 100, including some multivariate integration. Please come to office hours if you need help with the math.

Accommodations
We will do our best to accommodate students who need special arrangements. We may ask you to work with appropriate University officials so we can make accommodations, and to let us know of your need as soon as possible.

Honor Code
The Honor Code is taken seriously at Stanford University and we expect it to be respectfully observed by the course staff and students. Simply put, it places the responsibility for ensuring honest behavior on the students rather than the course staff, and violations should not be tolerated. The midterm and final examinations are strictly individual work and you are not permitted to consult on them with others. You can consult with others on the homework assignments but you must acknowledge their assistance.

Please contact Prof. Shachter if you have any questions about the Honor Code or the requirements for any assignment.

Grades
Course grades will be based on weekly Homework assignments, bi-weekly Friday quizzes, and a Final Examination, with the following weights, and with borderline decisions affected by class participation:

- 10% Homework, worst one dropped
- 40% Friday quizzes, worst one dropped
- 50% Final Examination

There is no predetermined distribution of grades but here is the distribution from last year’s class:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>A+</td>
<td>4%</td>
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<tr>
<td>A</td>
<td>28%</td>
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<tr>
<td>A-</td>
<td>25%</td>
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<tr>
<td>B+</td>
<td>15%</td>
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<tr>
<td>B</td>
<td>14%</td>
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<tr>
<td>B-</td>
<td>7%</td>
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<td>C+</td>
<td>4%</td>
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<tr>
<td>C</td>
<td>0%</td>
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<tr>
<td>C-</td>
<td>2%</td>
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Examinations
There will be bi-weekly quizzes at the Friday review sessions.

There will be a **Final Examination 8:30-11:30am on Tuesday, December 12.**

They will all be open-book and open-notes, and in locations to be determined.

If you are using an e-book, please check out an earlier edition of the textbook from the library if you want to reference it as electronic devices may not be used.

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**All students are responsible for ensuring that they can attend the quizzes and final exam. If you need special arrangements, please let us know as soon as possible.**
Homework

Solving the homework problems is the best way to learn the material and prepare for the examinations. You should submit your completed and partial solutions to the assigned problems, and the worst homework grade will not count. Come see us, early and often, if you have questions. Homework is due at the start of class on Mondays (or before class in the submission kiosk on the Terrace level of Huang). It is important to stay current with the course material and not fall behind. We cannot help you unless you help yourself first. Therefore, we will penalize late homework.

You are welcome to work with others to master the principles and approaches used to solve homework problems (but not on the quizzes and final exam), although the work you turn in should be your own. Copying the work of others would provide you no educational value and would violate the spirit of the Honor Code. In the spirit of academic integrity and the Honor Code, you must acknowledge all of the people and materials you have consulted, including course staff and handouts, in preparing your submissions.

Assignment Problems from the Text, Ninth Edition

Homework 1 Chapter 1 Problems 3, 7, 8, 12, 13, 14, 15, 19, 21, 22
Theoretical Exercises 2, 3
Chapter 2 Problems 1, 3, 9, 13; Theoretical Exercises 6

Homework 2 Chapter 2 Problems 12, 15, 21, 43, 44, 45, 52, 56; Theoretical Exercises 15
Chapter 3 Problems 2, 15, 17, 20, 22, 25, 28, 39, 44, 49, 52

Homework 3 Chapter 3 Problems 53, 55, 59, 60, 66; Theoretical Exercises 11, 28
Chapter 4 Problems 2, 23, 29, 31; Theoretical Exercises 7

Homework 4 Chapter 4 Problems 32, 38, 43, 48, 52, 58, 60; Theoretical Exercises 2, 27
Chapter 5 Problems 1, 10; Theoretical Exercises 7, 29

Homework 5 Chapter 5 Problems 15, 18, 20, 24, 28, 29, 32, 34, 35, 39, 40
Theoretical Exercises 13, 14, 16, 17, 31
Chapter 6 Problems 2, 3, 4, 61

Homework 6 Chapter 6 Problems 10, 12, 16, 19, 20, 23, 30, 43, 56, 57
Theoretical Exercises 8, 9, 14, 22

Homework 7 Chapter 7 Problems 5, 7, 10, 11, 12, 18, 22; Theoretical Exercises 10
Plus additional problems, not from the textbook

Homework 8 Chapter 7 Problems 30, 33, 34, 36, 41, 42, 45, 53, 56, 65
Theoretical Exercises 15, 19

Homework 9 Chapter 7 Problems 75; Theoretical Exercises 48, 52
Chapter 8 Problems 1, 2, 3, 4, 10, 11, 13, 14, 15; Theoretical Exercises 8
## Tentative Course Schedule

The text section numbers cited refer to the course textbook. 
*If the schedule changes, an updated schedule will be posted on the course web site.*

<table>
<thead>
<tr>
<th>Dates</th>
<th>Lecture and Review Topics</th>
<th>Text Sections</th>
<th>Assignments Due next Monday class</th>
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</thead>
<tbody>
<tr>
<td>Sept 25-29</td>
<td>Combinatorics, Axioms</td>
<td>1.1-2.4</td>
<td>Homework 1</td>
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<tr>
<td>Oct 2-6</td>
<td>Axioms, Conditioning</td>
<td>2.5-3.3</td>
<td>Homework 2</td>
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<td><strong>Friday quiz</strong></td>
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<tr>
<td>Oct 9-13</td>
<td>Conditioning, Discrete Random Variables</td>
<td>3.4-4.5</td>
<td>Homework 3</td>
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<tr>
<td>Oct 16-20</td>
<td>Discrete RVs, Continuous RVs</td>
<td>4.6-5.3</td>
<td>Homework 4</td>
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<tr>
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<td><strong>Friday quiz</strong></td>
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<tr>
<td>Oct 23-27</td>
<td>Continuous RVs, Dependent RVs</td>
<td>5.4-6.1, 6.8</td>
<td>Homework 5</td>
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<tr>
<td>Oct 30-Nov 3</td>
<td>Dependent Random Variables</td>
<td>6.2-6.7</td>
<td>Homework 6</td>
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<td></td>
<td><strong>Friday quiz</strong></td>
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<tr>
<td>Nov 6-10</td>
<td>Belief Networks, Expectation</td>
<td>7.1-7.3</td>
<td>Homework 7</td>
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<tr>
<td>Nov 13-17</td>
<td>Expectation</td>
<td>7.4-7.6</td>
<td>Homework 8</td>
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<td></td>
<td><strong>Friday quiz</strong></td>
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<tr>
<td>Nov 20-24</td>
<td><em>Thanksgiving Holiday</em></td>
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<tr>
<td>Nov 27-Dec 1</td>
<td>Expectation, Bounds, Limit Theorems</td>
<td>7.7, 8.1-8.5</td>
<td>Homework 9</td>
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<td><strong>Friday quiz</strong></td>
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<tr>
<td>Dec 4-8</td>
<td>Course Review</td>
<td>9.1</td>
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<tr>
<td>Tue, Dec 12</td>
<td><strong>Final Examination, 8:30-11:30am</strong></td>
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