APMA 1690: Computational Probability and Statistics

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Office Hour. Wednesday 3:00-6:00. Room 108, 170 Hope Street.

Class Time/Location. MWF 11:00-11:50pm in Barus & Holley 168.

Course Website. Everything will be on Canvas. All course materials, including course announcements, lecture notes, assignments and solutions, and additional reading materials will be posted on course Canvas website (canvas.brown.edu). Links to Zoom and Gradescope are in Canvas as well. All recordings, if any, can be found under the "Media Library" tab.

Prerequisite. Calculus based undergraduate probability, such as APMA 1650 or MATH 1610, is required. No prior computer programming experience is required.

Course Description. Probability and statistics are increasingly computational fields. Students will be exposed to several topics that use computers to solve challenging problems in probability and statistics. They will also use computers to develop intuitions about classical analytic results in probability and statistics. We will cover topics such as pseudorandom number generator, stochastic approximation (simulation), random walk, Markov chains and MCMC, graphical models, and dimension reduction.

Course Objective. Students completing AMPA 1690 successfully should be able to:

1. basic understanding how randomness can be emulated by deterministic computer algorithms;
2. acquire a technical and computational tool box that can be applied to future work on probability and statistics;
3. build a solid foundation for future study of advanced computational probability and statistics;
4. build intuition and think independently for large scale stochastic models.

Textbooks. No textbook is required. A full set of lecture notes will be posted on Canvas website. I will also post a preprint of a textbook that the lecture notes are based on.

Tentative Overall Grade Allocation. There will be two in-class midterm exam and one final exam. Overall grade will be based on:

Final Grade = homework (55%) + midterms (10%+10%) + final exam (25%)

Tentative Class Schedule. Please be aware that this is very tentative. Course advancement, especially the timing of the two midterms may change drastically.

Week	Topics Covered
1	Overview of class, review of probability, random variables
2	Various kinds of distributions, review of linear algebra notation.
3	Simulating randomness, pseudorandom number generator (PRNG).
4	Law of large numbers, hypothesis testing for evaluating PRNG.
5	transforming randomness, inverse CDF method, rejection sampling .
6	**1st Midtem**. Stochastic approximation, Monte Carlo simulation
7	Importance sampling, central limit theorem, convolution
8	Random walk, recurrence, exit probabilities, Markov chain
9	Recurrence, stationary distribution, convergence
10	Markov Chain Monte Carlo (MCMC), Metropolis-Hastings, Gibbs
11	**2nd midterm**. Graphical models, Gibbs random fields
12	conditioning/marginalizing, exact computation, dynamic programming.
13	Bayes Net, directed acyclic graph, moral graph
14	Dimension reduction, principal component analysis

Credit Hours. Total time spent in and out of class for this course is estimated at 182 hours. Over the 14 weeks of this course, students will spend 3 hours in class each week (42 hours in total). Although specific out-of-class time investments may vary for individual students, a reasonable estimate to support this courses learning outcomes is on average, 10 hours weekly over a 14-week term (140 hours in total). Out-of-class preparation will regularly include about 3 hours per week of reading and 7 hours of working on assignments.

Attendance and Participation. Students are strongly encouraged to participate lectures and office hours. It is probably the most efficient way to learn course materials.

Assignments. Weekly assignments will be posted on Canvas. Late submissions of any assignment will not be accepted, except under documented emergency circumstances. Students are encouraged to discuss the assignment problems in groups. But each student must compose and write his/her own solutions.

Exams. There will be two midterm exams and a final exam. Requests for extensions on exams will be considered only if accompanied by a written memo from a Dean or from Health Services.

Students with Disabilities. Brown University is committed to full inclusion of all students. Please inform me early in the term if you have a disability or other conditions that might require accommodations or modification of any of these course procedures. You may speak with me after class or during office hours. For more information, please contact Student and Employee Accessibility Services at 401-863-9588 or SEAS@brown.edu.

Students in need of short-term academic advice or support can contact one of the deans in the Dean of the College office.

Academic Integrability. Plagiarism and cheating are serious offenses and are more harmful to you, the student, than to the university. Please refer to the Brown University Academic and Student Conduct Codes for details regarding Brown Universitys policy on academic integrity and penalties for violating the academic code.