CSCI 1550/2540 Probabilistic Methods in Computing Science

Instructor: Prof. Upfal (CIT 319) – Eli_Upfal@Brown.edu

Description:

CSCI 1550/2540 is a course on the mathematics that motivates, formulates, and explains many of the great successes of computing, including statistical machine learning, Monte Carlo methods, and modern cryptography. Probability, randomness, and statistics play a key role in these and almost any other modern computer science application. This course introduces the novel mathematical and computation methods that were developed at the interplay of probability and computing. *The course focuses on mathematical models, theorems, and proofs, and leaves implementation and experiments to other courses.*

Syllabus:

- Randomized algorithms and probabilistic analysis:
  - Identity testing, min-cut algorithm, …
- Large deviation bounds:
  - Chernoff and Hoeffding's bounds
  - sub-Gaussian distributions
- The occupancy problem:
  - hashing and random graphs
  - the Poisson approximation
- Martingales
  - Definition and applications
  - Azuma-Hoeffding's concentration bound
- Uniform convergence - the fundamental theorem of machine learning:
  - VC-dimension,
  - covering number and chaining
  - Rademacher complexity.
- Dimension reduction and the Johnson-Lindenstrauss theorem,
- Monte Carlo methods
  - Monte Carlo Markov Chains.
  - Rapidly mixing chains and the coupling method

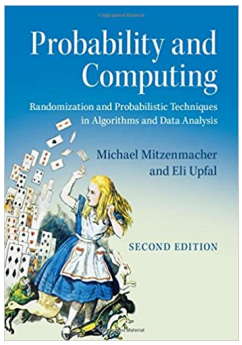
Website: http://cs.brown.edu/courses/cs155/home.html

Check website for instructor's and TA's office hours, locations, and other practical information.

Course staff email: cs155tas@cs.brown.edu

Prerequisites: No formal Prerequisites. Basic understanding of probability theory, mathematical maturity, and interest in rigorous computer science are needed to benefit from this course.

Textbook:
The textbook for the course is Probability and Computing: Randomized Algorithms and Probabilistic Analysis (second edition by Michael Mitzenmacher and Eli Upfal:



Course Work and Grading:

For 1550 credit: 80% homework assignments, 20% projects reviews.

For 1550 credit as a capstone course: 60% homework assignments, 30% project, 10% projects reviews.

For 2540 credit: 40% homework assignments, 50% project, 10% projects reviews.

Assignments:

4-5 assignments (problem sets) are a major part of the class work. All assignments will be posted on the course website and submitted online. Assignments must be typeset in Latex or written in a VERY clear handwriting. Answers must be concise and mathematically correct. Some of the assignments will be solved in class.

Assignments submitted by their deadline will be graded and returned with corrections. Assignments submitted after their deadline and before the next assignments' deadline will be graded, but not retuned with corrections. No assignment will be accepted after that time to allow for posting of the assignments' solutions.

Assignments collaboration policy:

All but the last problem set can be submitted by groups of 1-3 students. Each group submits one write-up, and all members of the group will receive the same grade on that assignment. You may not discuss the problems with students outside your group.

The last problem set must be done individually with no discussion and/or collaboration with other students.

In preparing the assignments you are allowed to use the textbook, the course slides, the discussions on the course's Edstem, and help from the TA's. Any other source must be disclosed in the submission.

Project (for capstone and/or 2000 level credit):

Submit a 6-8 page research project (with possible appendices) on any application of probabilistic method in CS, and give a 15-minute presentation on your project in class. A project can be done by 1 or 2 students. Two students who submit a joint project will receive the same grade on their project.

Students who choose to prepare projects will interact with the instructor and the TA's on preparing their project throughout the course.

Project reviews:

Depending on the total number of projects you will be asked to submit short reviews for all, or some of the projects.

Time Requirements: Total time spent in and out of class for this course is estimated at ~180 hours. Students will spend 3 hours in class each week (a total of 39 hours).

Although specific out-of-class time investments may vary for individual students, a reasonable estimate to support this course's learning outcomes is 140 -150 total out-of class hours, or on average, 10 hours weekly over a 13-week term, in reviewing class material and answering the weekly problem sets, and 10-20 hours working on the take home final.

Accommodations: If you feel you have physical, psychological, or learning disabilities that could affect your performance in the course, we urge you to contact SAS (https://www.brown.edu/campus-life/support/accessibility-services/). We will do whatever we can to support accommodations recommended by SAS.

Please review the Brown University Academic Code:

http://www.brown.edu/academics/college/degree/sites/brown.edu.academics.college.degree/file s/uploads/Academic-Code.pdf

Violations of the Academic Code will lead to strict disciplinary action as outlined in the Code. Misunderstanding of the Code will not be accepted as an excuse for dishonest work.