CSCI 1550 Probability and Computing II:  
Randomized Algorithms and Probabilistic Analysis

Lectures: Tuesdays and Thursdays, 2:30 - 3:50 pm.

Instructor: Prof. Upfal (CIT 319) - eli@cs.brown.edu

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

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

Prerequisites: CS 145, AM 165 or equivalent.

Description:  
Probability, randomness, and statistics play a key role in modern computer science. From the highly theoretical notion probabilistic theorem proving, to the very practical applications of cryptography and web search, sophisticated probabilistic techniques have been developed in the last two decades for a broad range of challenging computing applications.

This course introduces the basic techniques used in the design of randomized algorithms and in probabilistic analysis of algorithms, as well as more advanced techniques and recent applications. The course covers the basic probability theory required for working with these techniques, and demonstrates their use in various computing applications.
Textbook:
The textbook for the course is Probability and Computing: Randomized Algorithms and Probabilistic Analysis by Michael Mitzenmacher and Eli Upfal.

Assignments:
Weekly assignments (problem sets) are the major part of the class works. All assignments will be posted on the course website. Assignments will be handed in class, according to the instructions on the assignment.

Assignments must be typeset in LaTeX or written in a VERY clear handwriting. Answers must be concise and mathematically correct. No late homework will be accepted without prior authorization from the instructor.

Grading:
- 40% homework.
- 20% midterm (a non-collaborative homework set).
- 40% take home final.

Collaboration policy:
Problem sets (except the midterm and final) are collaborative. You may discuss the problems with other students to get a general idea of how to solve them. However, the answers you turn in must be your own, not written in a group.

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 SEAS (https://www.brown.edu/campus-life/support/accessibility-services/). We will do whatever we can to support accommodations recommended by SEAS.
Please review the Brown University Academic Code:


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.

Syllabus:

- Weeks 1-3: Review of discrete probability spaces,
  - Events, Expectation, Variance, Chebyshev Inequality
  - Simple randomized algorithms analysis (polynomial identity, min-cut algorithm, median algorithm)
  - Naïve Bayesian classifier
- Week 3-4: Basic concentration bounds (Chernoff and Hoeffding)
  - Applications: Set balancing, network packet routing, …
- Week 5: The occupancy problem
  - Hashing and random graphs
- Week 6: The Probabilistic Method – explicit constructions
- Week 7: Martingales and concentration bounds
- Week 8 - 10: Foundations of Machine Learning – Sample Complexity
  - PAC learning
  - VC-dimension
  - Rademacher complexity
- Week 11: Markov Chains and the Monte Carlo method
- Week 12-13: Rapidly mixing chains and the coupling method