6.842 Randomness and Computation January 31, 2022

Course Information
Lecturer: Ronitt Rubinfeld

Lectures: MW 11:00-12:30, Room 5-134.

Instructor: Ronitt Rubinfeld, `ronitt@csail.mit.edu`, G32-698.

Teaching Assistant: Amartya Shankha Biswas, `asbiswas@mit.edu`

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Course Website: `http://people.csail.mit.edu/ronitt/COURSE/S22/index.html`

Course topics The course will consist of a subset of the topics mentioned below. The list is subject to change due to my personal whims, class interest and timing issues. The topics will not be covered in the order given below.

- Some uses of randomness: algorithms (parallel algorithms, small space algorithms for graph connectivity, uniform generation and approximate counting, property testing), probabilistic proofs and constructions of combinatorial objects (e.g., expander graphs, Lovasz Local Lemma, efficient codes, Szemerédi partitions).
- Randomness vs. predictability:
  - Computational learning theory (predictability): learning vs. predictability, learning constant depth circuits, learning decision trees, learning noisy parity functions, weak learning, boosting.
  - Pseudorandomness (unpredictability): pseudorandomness vs. unpredictability, pseudorandom generators (prg's) based on hard problems, derandomization, randomness from weak random sources, randomness extractors, extractors vs. prg's, techniques for recycling randomness, derandomizing space bounded computation, sample spaces with limited independence, deterministic connectivity in logspace.
- Tools: Influence of a variable on a function, random walks on graphs, expander graphs, list decoding, limited independence, Fourier representation of a function, simple additive number theory, Szemerédi regularity lemma.

Course Requirements Homework sets (50%). Scribe notes (15%). Final project (20%). Class participation (15%). As part of class participation, students will be asked to help with grading of assignments and the preparation of solution sets.

Scribe policy The first version of the scribe notes is due *two days* after the lecture. The final version is due *one week* after the lecture. A sample scribe tex file is available on the course website. Both tex and pdf files should be emailed to the course staff.

Homework policy Homeworks should be written in latex and uploaded as a pdf file (instructions for uploading coming soon).

Grading policy Graders will be asked to meet with Shankha to plan rubrics, and to finish grading within a week after the assignment is due. After finishing, the graders should meet with Shankha again to summarize and discuss. Graders are responsible for preparing a correct solution (in latex) including common mistakes and alternative solutions, though they may decide to use one of the submitted solutions (with permission from the student).

Project The course project consists of a brief project proposal, a final project writeup and a final project presentation in class. A project can survey works not covered in the course, or present new research directions. You may work with up to two other partners.

Prerequisites 6.046 or 6.045 or 6.840 (or permission of instructor).