**CMPE 543 Randomized Algorithms (Fall 2019)**

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| **Instructor:** | Prof. Dr. Doğu Arifler<br>Phone: 630-1192, e-mail: dogu.arifler@emu.edu.tr |
| **Office Hours:** | TBA |
| **Textbook:** | M. Mitzenmacher and E. Upfal, *Probability and Computing: Randomization and Probabilistic Techniques in Algorithms and Data Analysis*, 2nd ed., Cambridge University Press, 2017. |
| **Prerequisite:** | No official prerequisite. However, you **must** have background in elementary probability theory (at the level of MATH 322) and analysis of algorithms (at the level of CMPE 371). |

Randomness is widely used in modern computer science and engineering. Randomized algorithms make random choices during their execution and are often faster and/or simpler than deterministic algorithms. However, randomized algorithms come with a small probability of error and it is important to bound this error probability.This course is intended to introduce tools and techniques that are used to design and analyze efficient randomized algorithms. Another important aim of the course is to teach key probabilistic ideas to computer engineering students who will pursue advanced studies in areas that involve probabilistic analysis techniques. Recently, probabilistic methods have become central to computing with the growing importance of network modeling, big data analysis, machine learning, and data mining.

**Catalog Description:** Fundamental tools of probabilistic analysis and applications of these tools to understand the behaviors of random processes and algorithms in modern computer science and engineering. Topics include moments and deviations, bounds, random graphs, the probabilistic method, Markov chains and random walks, entropy, the Monte Carlo method, coupling of Markov chains, martingales, pairwise independence and universal hashing.

**Important Dates:** Midterm: 4 November 2019, Final: 23 December 2019.

**Grading Policy:** Midterm 30%, Final 40%, Assignments 30%.

**Make-Up Policy:** Only one **comprehensive** make-up examination will be given for a missed midterm or final **only under exceptional/extenuating circumstances** (e.g., hospitalization, loss of a close relative, etc.). In these cases, students must submit a petition with related official reports to me within the next three working days following the missed exam. Note that minor ailments are not considered as exceptional/extenuating circumstances. Eligibility to take the make-up exam will be **subject to my final approval**.

**Academic Dishonesty:** Any conduct that attempts to gain unfair academic advantage is considered academic dishonesty. Copying assignments, cheating during exams, substituting for another person are some examples of academic dishonesty. Cases of academic dishonesty **will not** be tolerated and will be punished according to EMU's disciplinary policies.

**Tentative outline:** Below is a tentative outline for this course. I reserve the right to adjust the pace and topics of the class as the semester progresses.

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| **Week 1** | Introduction, events and probability |
| **Week 2** | Applications: verifying polynomial identities and matrix multiplication |
| **Week 3** | Random variables and expectation |
| **Week 4** | Bernoulli, Binomial, and Geometric random variables |
| **Week 5** | Coupon collector's problem, randomized Quicksort |
| **Week 6** | Moments and deviations, Markov's and Chebyshev's inequalities |
| **Week 7** | Chernoff and Hoeffding bounds, parameter estimation, set balancing |
| **Weeks 8–9** | Midterms |
| **Week 10** | Balls, bins, and random graphs, the birthday paradox |
| **Week 11** | The Poisson distribution, the Poisson approximation |
| **Week 12** | Hashing: chain hashing, bit strings, Bloom filters |
| **Week 13** | The probabilistic method, Lovasz Local Lemma |
| **Week 14** | Markov Chains, the Monte Carlo Method (if time permits) |

**Additional references for probability theory and algorithms:**

- D. Bertsekas and J. Tsitsiklis, *Introduction to Probability*, 2nd ed., Athena Scientific, 2008.
- S. M. Ross, *Probability Models for Computer Science*, Academic Press, 2001.
- T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, *Introduction to Algorithms*, 3rd ed., MIT Press, 2009.