Probability and Computing

MAT 4953-001 & MAT 5983-003

Syllabus, Spring 2021, University of Texas at San Antonio

Instructor: Alperen A. Ergür
Time & Place: Live zoom session at TR 2:30 - 3:45 pm
Office Hours: Friday 3:00 - 4:00 pm, on zoom
Office: -
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The course syllabus is a general plan for the course;
deviations announced to the class by the instructor may be necessary.

Eligibility: You must have the course prerequisites listed below or equivalents. In case of doubt, consult with the instructor.

Important Dates: (subject to change)
Midterm 1: February 16^{th}
Midterm 2: April 1^{st}
Final Exam: May 6^{th}, 1:00 - 2:50 pm

Grading: Homework: 20 % Midterms: 25% Final Exam: 30%
The final letter grade is determined according to the following scale:

A = 92.1–100% ,	**A**$^-$ = 90–92%	
B$^+$ = 86.1–89.9%,	**B** = 82.1-86% ,	**B**$^-$ = 80-82%
C$^+$ = 76.1–79.9%,	**C** = 70.1-76% ,	**C**$^-$ = 68.1-70%
D = 60-68%,	**F** = 0–59.9%	

Catalog: Expectation of random variables: randomized identity testing, randomized min-cut algorithm. Moments of random variables: Chebyshev and Markov inequalities; sampling estimator for mean. Basic Concentration Inequalities: Chernoff and Hoeffding inequalities; parameter estimation and set balancing. Discrete probabilistic structures and computing: Bucket sort algorithm, Poisson approximation, Lovasz local Lemma, independent set search, satisfiability problems. The Gaussian: Moment Generating Functions, Central Limit Theorem; Johnson-Lindenstrauss dimensionality reduction lemma.

Course Objective: This course has two objectives: to introduce undergraduate level probability theory, and to introduce basic ideas in randomized computation. The course will deliver probability theory content "on demand" i.e. every theoretical concept will be coupled with immediate applications in computation.

- Gain proficiency in probabilistic reasoning
- Understand the basic differences between randomized and deterministic computation (i.e. how being %99 correct can be too much faster than %100 correct)

- Gain basic understanding of probabilistic tools for computing with discrete objects (i.e. how can a dice help you to do computations on graphs, numbers, routes etc..)
- Build background knowledge for further studies in Machine Learning, Data Science, Algorithms, and Discrete Mathematics

Prerequisite: A discrete mathematics course (i.e. CS 3333 or MAT 2313) is helpful, but the main prerequisite is mental fitness. If you have decided that you can't learn probabilistic reasoning or sophisticated algorithmic ideas, talk to me or to your academic advisor (more than likely you are completely wrong on this). Otherwise, please come join me for a little jogging tour in the world of probability and computation.

Textbook Probability and Computing: Randomization and Probabilistic Techniques in Algorithms and Data Analysis by Mitzenmacher and Upfal

Expectations: Being present with your attention in the lectures and gaining proficiency by paying the due respect to HW problems.

Homework policy: I will assign biweekly homeworks. You will need some practice to get used to probabilistic and algorithmic reasoning: HW's will include questions to be graded, and further questions for your practice that are not going to be graded. HW practice will be extremely useful for your success in the exams, so please work on all of the problems.

Course Schedule: The course topics will be covered according to the following plan.

- Elementary Probability: Definitions of events and their probabilities. Algorithmic applications: Randomized identity testing for polynomials (PIT) and a randomized min-cut algorithm (3 Lectures)
- Random variables and Expectation: Bernoulli, Binomial, and Geometric distributions, expectation, conditional expectation. Algorithmic application: Average analysis of Quicksort (5 Lectures)
- Moments of random variables: Markov and Chebyshev's Inequalities, Empirical Mean Estimator (3 Lectures)
- Basic Concentration Inequalities: Chernoff and Hoeffding Inequalities, parameter estimation, set balancing (4 Lectures)
- Basic Structures in Random Discrete Objects: Balls and Bins, Bucket sort algorithm, Poisson Approximation, First Moment Method, Lovasz Local lemma and algorithmic applications (7 Lectures)
- The Gaussian: Normal Distribution, Central Limit theorem, Multivariate Normal Distribution, Johnson-Lindenstrauss Dimensionality Reduction Lemma (5 Lectures)

UTSA Guide to online learning Please take a look at `https://odl.utsa.edu/guide/`

Counseling Services: Counseling Services provides confidential, professional services by staff psychologists, social workers, counselors and psychiatrists to help meet the personal and

developmental needs of currently enrolled students. Services include individual brief therapy for personal and educational concerns, couples/relationship counseling, and group therapy on topics such as college adaptation, relationship concerns, sexual orientation, depression and anxiety. Counseling Services also screens for possible learning disabilities and has limited psychiatric services. Visit Counseling Services at http://utsa.edu/counsel/ or call (210) 458-4140 (Main Campus) or (210) 458-2930 (Downtown Campus).

Student Code of Conduct and Scholastic Dishonesty: The Student Code of Conduct is Section B of the Appendices in the Student Information Bulletin. Scholastic Dishonesty is listed in the Student Code of Conduct (Sec. B of the Appendices) under Sec. 203 http://catalog.utsa.edu/policies/administrativepoliciesandprocedures/studentcodeofconduct/

Students with Disabilities: The University of Texas at San Antonio in compliance with the Americans with Disabilities Act and Section 504 of the Rehabilitation Act provides "reasonable accommodations" to students with disabilities. Only those students who have officially registered with Student Disability Services and requested accommodations for this course will be eligible for disability accommodations. Instructors at UTSA must be provided an official notification of accommodation through Student Disability Services. Information regarding diagnostic criteria and policies for obtaining disability-based academic accommodations can be found at www.utsa.edu/disability or by calling Student Disability Services at (210) 458-4157. Accommodations are not retroactive.

Transitory/Minor Medical Issues: In situations where a student experiences a transitory/minor medical condition (e.g. broken limb, acute illness, minor surgery) that impacts their ability to attend classes, access classes or perform tasks within the classroom over a limited period of time, the student should refer to the class attendance policy in their syllabus.

Supplemental Instruction: Supplemental Instruction offers student-led study groups using collaborative learning for historically difficult classes. Supported courses and schedules can be found on the TRC website. You can call the SI office if you have questions or for more information at (210) 458-7251.

Tutoring Services: Tomás Rivera Center (TRC) may assist in building study skills and tutoring in course content. The TRC has several locations at the Main Campus and is also located at the Downtown Campus. For more information, visit the Tutoring Services web page or call (210) 458-4694 on the Main Campus and (210) 458-2838 on the Downtown Campus.

Academic Success Coaching: The Tomas Rivera Center (TRC) Academic Success Coaching Program offers one-on-one study skills assistance through Academic Coaching. Students meet by appointment with a professional to develop more effective study strategies and techniques that can be used across courses. Group workshops are also offered each semester to help students defeat common academic challenges. Find out more information on the TRC Academic Success Coaching website or call (210) 458-4694.

Sexual Harassment and Sexual Misconduct: UTSA is committed to providing an environment free from all forms of discrimination and sexual harassment, including sexual

misconduct, sexual assault, domestic violence, dating violence, and stalking. If a student has experienced or experiences any of these incidents, know that UTSA has resources to help.

UTSA faculty have the responsibility to create a learning environment that is safe and free from hostility. State and federal law as well as UTSA's Handbook of Operating Procedures (HOP 9.24) require that instructors must report incidents of sexual harassment and sexual misconduct they learn about to the Title IX Coordinator or a Deputy Title IX Coordinator. This means that if a student tells their instructor about a situation (including classroom discussions, written work and/or one-on-one meetings) involving sexual harassment, sexual assault, dating violence, domestic violence, or stalking, the instructor must report it to the EOS/Title IX Office. Although the faculty member must report the situation, the student will still have options about how their case will be handled, including whether or not they wish to pursue a formal complaint. The university's goal is to make sure students are aware of the range of options available to them and have access to the resources they need.

If a student wishes to speak to someone confidentially, they can contact any of the following on-campus resources, who are not required to report the incident to the EOS/Title IX Office: (1) Counseling Services at 210-458-4140; (2) Student Health Services at 210-458-4142; or (3) PEACE Center at 210-458-4077.

The Roadrunner Creed: The University of Texas at San Antonio is a community of scholars, where integrity, excellence, inclusiveness, respect, collaboration, and innovation are fostered.

As a Roadrunner, I will: Uphold the highest standards of academic and personal integrity by practicing and expecting fair and ethical conduct; Respect and accept individual differences, recognizing the inherent dignity of each person; Contribute to campus life and the larger community through my active engagement; and Support the fearless exploration of dreams and ideas in the advancement of ingenuity, creativity, and discovery. Guided by these principles now and forever, I am a Roadrunner!