

SYLLABUS — MATH 689 (?) — Fall 2022

High Dimensional Probability and Applications, Texas A&M University

Credits 3. 3 Lecture Hours.

Instructor: Grigoris Paouris

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Office: Blocker 525J

Office hours : TBA

Lectures: TBA

Course Homepage: <http://www.math.tamu.edu/~grigoris/teachingpaouris.html>
Common Course Homepage: <https://www.math.tamu.edu/courses/math689/>

Textbook: *Roman Vershynin*: “High Dimensional Probability. An Introduction with Applications in Data Science”, Cambridge Cambridge University Press, Cambridge Series in Statistical and Probabilistic Mathematics

To reduce the spread of Covid and to ensure a uniform testing environment for all students, all in-class exams will be done electronically and proctored online over Zoom. In order to do this, the following technical requirements are needed:

- Appropriate hardware (laptop or desktop computer, a second device such as a mobile phone, high-speed internet connection)
- Appropriate software (PDF reader, Zoom on phone and computer, the latest update on an internet browser-Chrome or Firefox are recommended)

Course description: High dimensional Probability investigates the behavior of high dimensional random objects, such as random vectors, random matrices with the emphasis upon quantifying the role of the dimension.

In this course, some of the basic techniques required for applications in Data Sciences will be presented. In particular, the basic theory of concentration of measure, random projection methods and dimension reduction, stochastic processes including chaining as well as combinatorial tools such as the VC dimension.

Applications on statistical learning theory, compressed sensing, approximation algorithms, and estimation in high dimensions will be presented.

Prerequisites: MATH 606 or similar or approval of instructor.

Learning Outcomes: Students will learn how to use basic tools in High dimensional probability such as concentration of measure, bounds on Gaussian processes, techniques from random matrix theory, complexity parameters, entropy, combinatorial entropy and applications to learning, and algorithms.

Material Covered: The course will consist of the following material from the required text.

Week 1: Concentration of Sums of Independent Random variables.

Week 2-3 – Concentration in High Dimensions:

Week 4 – Grothendieck’s inequality and applications to MAX-CUT and Semidefinite Programming

Week 5 – Random matrices: Spectrum, estimates and Covariance approximation

Week 6-7 – Concentration on Random Matrices: Matrix Bernstein’s inequality and improvements. Applications.

Week 7-8 – Concentration due to ti isoperimetry, Log-Sobolev inequality, Johnson-Lindenstrauss Lemma and applications.

Week 9-10 – Random Proccess: Gaussian Complexity, Chaining, Talagrand’s Majorizing Measure Theorem.

Week 10-11 – Chevet’ inequality, Deviation for Random Matrices and Applications.

Week 12-13-14 – Sparse recovery, RIP property, Dvoretzky’s theorem.

Grading Policy : Students grades will be determined by performance on homework assignments, and projects.

Homework: Homework assignments will be posted on Instructors web-page.

Important Dates:

TBA

Zoom Etiquette When joining class remotely via ZOOM, please join with your audio off. When you have a question during class you may (1) use the "CHAT to everyone" feature to type your question, (2) use the "raise your hand" feature and wait for me to call on you, or (3) unmute yourself, politely interrupt me, and I will pause and give you time to ask your question. It is important the students joining remotely are involved in the class discussion.

Make-up policy: Make-up exams will only be allowed in the case of an excused absence as defined by TAMU Student Rule 7. In this case, appropriate documentation of the absence must be provided to the instructor. Wherever possible, students should inform the instructor before an absence. Consistent with TAMU Student Rule 7, students are required to notify an instructor by the end of the next working day after missing an assignment or exam. Otherwise, they forfeit their rights to a make-up.

Academic integrity: Students in this course are allowed to discuss suggested homework problems and solutions. However, students are not permitted to copy homework solutions from another student. Students are not permitted to discuss any aspect of an exam until all students have completed the exam. The penalties for violating this policy will range from an F on an assignment or exam to failing the course. Always abide by the Aggie Code of Honor: “An Aggie does not lie, cheat or steal, or tolerate those who do.” For further information regarding academic integrity, please visit .

Americans with Disabilities Act (ADA): The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil

rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information, please visit <https://disability.tamu.edu/>.

Copyright Policy: It is not allowed to record the lectures without authorized by the Instructor. See <https://disability.tamu.edu/facultyguide/classroom/recording-lectures/> for more information.

Title IX and Statement on Limits to Confidentiality. Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking. With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see University Rule 08.01.01.M1): (*) The incident is reasonably believed to be discrimination or harassment. (*) The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University. Mandatory Reporters must file a report regardless of how the information comes to their attention ? including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, you will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University?s goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need. Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with Counseling and Psychological Services (CAPS). Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University's Title IX webpage.

Statement on Mental Health and Wellness Texas A&M University recognizes that mental health and wellness are critical factors that influence a student?s academic success and overall wellbeing. Students are encouraged to engage in proper self-care by utilizing the resources and services available from Counseling and Psychological Services (CAPS). Students who need someone to talk to can call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at suicidepreventionlifeline.org.

Campus Safety Measures: COVID-19 To promote public safety and protect students, faculty, and staff during the coronavirus pandemic, Texas A&M Univer-

sity has adopted policies and practices for the Fall 2020 academic term to limit virus transmission. Students must observe the following practices while participating in face-to-face courses and course-related activities (office hours, help sessions, transitioning to and between classes, study spaces, academic services, etc.):

- **Self-monitoring** Students should follow CDC recommendations for self-monitoring. Students who have a fever or exhibit symptoms of COVID-19 should participate in class remotely and should not participate in face-to-face instruction. Face Coverings?Face coverings (cloth face covering, surgical mask, etc.) must be properly worn in all non-private spaces including classrooms, teaching laboratories, common spaces such as lobbies and hallways, public study spaces, libraries, academic resource and support offices, and outdoor spaces where 6 feet of physical distancing is difficult to reliably maintain. Description of face coverings and additional guidance are provided in the Face Covering policy and Frequently Asked Questions (FAQ) available on the Provost website.
- **Physical Distancing** Physical distancing must be maintained between students, instructors, and others in course and course-related activities.
- **Classroom Ingress/Egress** Students must follow marked pathways for entering and exiting classrooms and other teaching spaces. Leave classrooms promptly after course activities have concluded. Do not congregate in hallways and maintain 6-foot physical distancing when waiting to enter classrooms and other instructional spaces.
- **Face to Face classes** To attend a face-to-face class, students must wear a face covering (or a face shield if they have an exemption letter). If a student refuses to wear a face covering, the instructor should ask the student to leave and join the class remotely. If the student does not leave the class, the faculty member should report that student to the Student Conduct office for sanctions. Additionally, the faculty member may choose to teach that day's class remotely for all students.

Personal Illness and Quarantine Students required to quarantine must participate in courses and course-related activities remotely and must not attend face-to-face course activities. Students should notify their instructors of the quarantine requirement. Students under quarantine are expected to participate in courses and complete graded work unless they have symptoms that are too severe to participate in course activities. Students experiencing personal injury or illness that is too severe for the student to attend class qualify for an excused absence (See Student Rule 7, Section 7.2.2.) To receive an excused absence, students must comply with the documentation and notification guidelines outlined in Student Rule 7. While Student Rule 7, Section 7.3.2.1, indicates a medical confirmation note from the student's medical provider is preferred, for Fall 2020 only, students may use the Explanatory Statement for Absence from Class form in lieu of a medical confirmation. Students must submit the Explanatory Statement for Absence from Class within two business days after the last date of absence.