

Course Information

Course Number:	MATH 680
Course Title:	Topics in Mathematical Data Science
Section:	601
Lecture time:	MWF 9:10-10:00am
Lecture location:	Blocker 110
Lab time:	R 8:25-9:15am
Lab location:	Blocker 129
Credit Hours:	3

Instructor Details

Instructor:	Simon Foucart
Office:	Blocker 502D
Phone:	None
E-Mail:	foucart@tamu.edu
Office Hours:	T 8:30-9:20am, W 8:30-9:00am, R: 11:00-11:30am, and by appointment.

Course Description

A rigorous introduction to several subfields of Data Science: machine learning; optimal recovery; compressive sensing; optimization; neural networks.

Course Prerequisites

MATH 323, MATH 409, and MATH 411, or equivalent; approval of instructor.

Special Course Designation

None.

Course Learning Outcomes

At the end of this course, students will have

- understood the basic principles of machine learning and acquired a working knowledge of VC dimension, binary classification, support vector machines, reproducing kernel Hilbert spaces, regression and regularization, clustering, and dimension reduction;
- understood the basic principles of optimal recovery and acquired a working knowledge of the fundamental results, approximability models, optimal observations, and the curse of dimensionality;
- understood the basic principles of compressive sensing and acquired a working knowledge of sparse recovery, optimality, low-rank recovery, one-bit sensing, and group testing;
- understood the basic principles of optimization and acquired a working knowledge of linear programming, semidefinite programming, duality, and nonconvex optimization;
- understood the basic principles of Neural Networks and acquired a working knowledge of the general concepts, the expressiveness of shallow networks, the advantages of depth, and training by backpropagation.

Textbook and/or Resource Materials

“Mathematical Pictures at a Data Science Exhibition”, by S. Foucart. Cambridge University Press.

Grading Policy

- Grades will be assigned on the scale A, B, C, D, F (without + or – modifiers).
- The following minimum grade is guaranteed, given the following score:
A:100%-90%, B:89%-80%, C:79%-65%, D:65%-50%, F: 49%-0%.
- The grade is based on the following items:
 - Homework (90%). Homework problems will be assigned weekly, some of which will be graded. The graded problems will be collected at the beginning of class on the due date. Late homework will not be accepted. You are encouraged to come and see me during my office hours to obtain some help on particular questions, provided you made a genuine attempt to solve them.
 - Class participation (10%). Although not recorded, regular attendance is expected—it is essential to do well in the course.

Late Work Policy

The graded homework assignments will be collected at the beginning of class on the due date. Late assignments will not be accepted.

Work submitted by a student as makeup work for an excused absence is not considered late work and is exempted from the late work policy. See also [Student Rule 7](#) for attendance and excused absence policies.

Course Schedule

The course is delivered over the span of 15 weeks. The following weekly schedule is preliminary, with possible deviation at the instructor's discretion.

1. Introduction to statistical learning theory, Vapnik—Chervonenkis dimension
2. Review of probability theory, binary classification
3. Support vector machines, review of functional analysis
4. Reproducing kernel Hilbert spaces, regression and regularization
5. Clustering, dimension reduction
6. Introduction to optimal recovery, approximability models
7. Choice of observations, curse of dimensionality
8. High-dimensional geometry, introduction to compressive sensing
9. Sample complexity of sparse recovery, one-bit compressive sensing
10. Group testing, introduction to convex optimization
11. Linear programming, duality theory
12. Nonconvex optimization, review of approximation theory
13. Introduction to neural networks, expressiveness of shallow networks
14. Advantages of depth, training of neural networks
15. Additional Topics

University Policies

Own device policy

As a result of the changing landscape in higher education, Texas A&M University now requires students to have access to an appropriate computer to complement course instruction. Exact requirements can be found [here](#).

Attendance Policy

The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments.

Please refer to [Student Rule 7](#) in its entirety for information about excused absences, including definitions, and related documentation and timelines.

Makeup Work Policy

Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student's grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor.

Please refer to [Student Rule 7](#) in its entirety for information about makeup work, including definitions, and related documentation and timelines.

Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor" ([Student Rule 7, Section 7.4.1](#)).

"The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence" ([Student Rule 7, Section 7.4.2](#)).

Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See [Student Rule 24](#).)

Academic Integrity Statement and Policy

"An Aggie does not lie, cheat or steal, or tolerate those who do."

"Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one's work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case" ([Section 20.1.2.3, Student Rule 20](#)).

You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at aggiehonor.tamu.edu.

Americans with Disabilities Act (ADA) Policy

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact the Disability Resources office on your campus (resources listed below). Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

Disability Resources is located in the Student Services Building or at (979) 845-1637 or visit disability.tamu.edu.

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, a person who is subjected to the alleged conduct 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 healthy self-care by utilizing available resources and services on your campus

Students who need someone to talk to can contact Counseling & Psychological Services (CAPS) or 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.