TEXAS A&M UNIVERSITY

Course Syllabus

Course Information

Course Number:	MATH 680
Course Title:	Topics in Mathematical Data Science
Section:	601
Lecture time:	MWF 11:30am-12:20pm
Lecture location:	Blocker 122
Lab time:	T 5:30pm-6:20pm
Lab location:	Blocker 122
Credit Hours:	3

Instructor Details

Instructor:	Simon Foucart
Office:	Blocker 502D
Phone:	None
E-Mail:	foucart@tamu.edu
Office Hours:	T 4:30pm-5:15pm, W 10:30am-11:15am, and by appointment.

Course Description

A rigorous introduction to several subfields of Data Science, namely: 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.