

Texas A&M University, Department of Mathematics, Spring 2022
MATH 664 — Topics in Mathematical Data Science *

TR 09:35-10:50, Blocker Building, Room 121 (Lectures)
W 09:10-10:00, Blocker Building, Room 129 (Lab)

Instructor: Simon Foucart, 502D Blocker Building, foucart@tamu.edu

Office hours: Tu 11–11:30, W 10–11, Th 9–9:30, and by appointment

Textbook: *Mathematical Pictures at a Data Science Exhibition*, by Foucart. CUP (to appear).

Course Description: Compulsory lectures and an optional, highly-recommended lab (computational illustrations for the lectures, mostly in Python). The following topics will be covered:

- Machine Learning: general concepts, VC dimension, binary classification, support vector machines, reproducing kernel Hilbert spaces, regression and regularization, clustering, dimension reduction;
- Optimal Recovery: fundamental results, approximability models, optimal observations, tractability and curse of dimensionality;
- Compressive Sensing: sparse recovery, optimality, low-rank recovery, one-bit sensing, group testing;
- Optimization: basic results, linear programming, semidefinite programming, duality, nonconvex optimization;
- Neural Networks: general concepts, expressiveness of shallow networks, the advantages of depth, training by back-propagation.

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

Grading: Based on homework and class participation.

Homework: Homework is an integral part of the course. In particular, it will contain some programming exercises chosen to illustrate the concepts and techniques expected to be mastered. 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.

*this syllabus is a general plan for the course; deviations announced in class may be necessary

Tentative schedule:

Week 01	Chapters 1 and 2
Week 02	Appendix B and Chapter 3
Week 03	Chapter 4 and Appendix C
Week 04	Chapters 5 and 6
Week 05	Chapters 7 and 8
Week 06	Chapters 9 and 10
Week 07	Chapter 11 and 12
Week 08	Appendix A and Chapter 14
Week 09	Chapters 15 and 17
Week 10	Chapters 18 and 19
Week 11	Chapters 20 and 21
Week 12	Chapter 23 and Appendix E
Week 13	Chapters 24 and 25
Week 14	Chapters 26 and 27

Attendance Policy: Attendance is not compulsory, but regular attendance is expected — it is in fact essential if you want to do well in the course. Classes to be missed due to religious holidays must be communicated to me during the first week. You are required to arrive on time and stay the length of the class. If you do not attend a class, you are responsible for any announcement made, any material covered, and any additional topic introduced during this class. Office hours cannot be used for this purpose.

Electronic Etiquette: Cell phones must absolutely be put on silent mode, left closed, and put away. If you have a family emergency and need to take a call during class, I shall be notified in advance so that a special arrangement can be made.

Academic Honesty: *“An Aggie does not lie, cheat, or steal or tolerate those who do.”*
See <http://aggiehonor.tamu.edu> for more information.

Americans with Disabilities: 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, currently located in the Disability Services building at the Student Services at White Creek complex on west campus or call 979-845-1637. For additional information, visit <http://disability.tamu.edu>.