

Instructor: Prof. James M. Murphy

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Office Hours: Tuesday (2:00-3:00 PM, JCC 520F), Friday (3:00-4:30 PM, Zoom)

Zoom Meeting ID: 596 709 6261

Grader: Zixiao Yang

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Office Hours: Monday (9:00-10:00 AM, JCC 5th floor common area, near restrooms)

Course websites:

(1) canvas.tufts.edu

(2) <https://jmurphy.math.tufts.edu/Teaching/Spring2023/MATH123/>

Office Hours: Office hours will be held both in person and remotely on Zoom.

Main Text: Prof. Christoph Borger's slides

Supplemental Textbooks

- G. Strang. "Linear Algebra and Learning from Data."
- C.M. Bishop. "Pattern Recognition and Machine Learning."
- T. Hastie, R. Tibshirani, and J. Friedman. "The Elements of Statistical Learning."

Prerequisites: Multivariable calculus (MATH 42), linear algebra (Math 70 or Math 72), and willingness to work in MATLAB/Python.

Expectations for Participation

- Attendance is required at all lectures.
- Students participate in class by asking and answering questions.

Topics: The course is an introduction to mathematical data science. The course will emphasize theory, in particular linear algebra, graph theory, discrete math, and optimization. We will also program in a high-level programming language (e.g. MATLAB or Python).

Approximate Lecture Schedule ("All of Statistics" Chapters):

January 19: Review of Linear Algebra

January 24: Principal Component Analysis, Part 1

January 26: Principal Component Analysis, Part 2

January 31: Principal Component Analysis, Part 3

February 2: Kernel Principal Component Analysis

February 7: K-Means Clustering

February 9: Hierarchical Clustering

February 14: Density-Based Clustering
February 16: Exam 1
February 21: Spectral Graph Theory and Clustering, Part 1
February 28: Spectral Graph Theory and Clustering, Part 2
March 2: Spectral Graph Theory and Clustering, Part 3
March 7: Spectral Graph Theory and Clustering, Part 4
March 9: Nearest Neighbor Classification
March 14: Linear Support Vector Machines, Part 1
March 16: Linear Support Vector Machines, Part 2
March 28: Optimization for SVM, Part 1
March 30: Optimization for SVM, Part 2
April 4: Midterm 2
April 6: Optimization for SVM, Part 3
April 13: Kernel SVM
April 18: Neural Networks, Review, and Outlook
April 20: Project Presentations, Part 1
April 25: Project Presentations, Part 2
April 27: Project Presentations, Part 3

Exams and Grading: There will be weekly homework and two in-class exams. The course grade will be computed as:

Homework: 25%
Midterm 1: 15/30%
Midterm 2: 15/30%
Final Project: 25%
Participation: 5%

For homework, the best 10/12 homework assignments will be used in computing the final grade. Homework is due at the start of class on the day it's due. For the exams, the lower score counts for 15% of the course grade and the higher score counts for 30% of the course grade.

Exam 1 is February 16. Exam 2 is April 4. Exam 2 is not cumulative.

A final project on a topic in mathematical data science will be the concluding assignment of the course. It is a team project (2-4 members), and consists of two parts:

- A short presentation (15 minutes+5 minutes for questions). The presentations will be held during the last three days of class, April 20, 25, 27.
- A 5-10 page technical write-up on the topic investigated and salient computational results, submitted by midnight on May 1.

The participation grade consists in lecture attendance and participation.

Late Policy: Late homework is not accepted. The policy of using only the best 10/12 assignments provides a contingency option if an assignment cannot be completed in time.

Homework Collaboration: Students are encouraged to collaborate on homework assignments! But, all solutions must write or type their own solutions in their own words. Copying from others verbatim (or approximately verbatim) will result in a 0 on the assignment and disciplinary action.

Learning Objectives:

- Basic Understanding of Higher Mathematics
- Written Communication
- Problem Solving Skills

Academic Support at the StAAR Center:

The StAAR Center (formerly the Academic Resource Center and Student Accessibility Services) offers a variety of resources to all students (both undergraduate and graduate) in the Schools of Arts and Science, Engineering, the SMFA and Fletcher; services are free to all enrolled students. Students may make an appointment to work on any writing-related project or assignment, attend subject tutoring in a variety of disciplines, or meet with an academic coach to hone fundamental academic skills like time management or overcoming procrastination. Students can make an appointment for any of these services by visiting [go.tufts.edu/TutorFinder](https://students.tufts.edu/TutorFinder), or by visiting our website (<https://students.tufts.edu/staar-center>).

Accommodations for Students with Disabilities:

Tufts University values the diversity of our students, staff, and faculty; recognizing the important contribution each student makes to our unique community. Tufts is committed to providing equal access and support to all qualified students through the provision of reasonable accommodations so that each student may fully participate in the Tufts experience. If you have a disability that requires reasonable accommodations, please contact the StAAR Center (formerly Student Accessibility Services) at StaarCenter@tufts.edu or 617-627-4539 to make an appointment with an accessibility representative to determine appropriate accommodations. Please be aware that accommodations cannot be enacted retroactively, making timeliness a critical aspect for their provision.