GMU Department of Mathematical Sciences
Math 493/689: Topics in Mathematics of Data Science
Fall 2019
Syllabus

Instructor:
Prof. Maria Emelianenko
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Office: Room 4454, Exploratory Hall
Office Hours: MW 1:30-2:30pm and by appt

Time and Room:
MW 4:30 pm - 5:45 pm Robinson B228
Course materials, assignments and announcements will be available on Blackboard.

Prerequisite: Basic knowledge of linear algebra, ODEs and probability theory. Familiarity with numerical methods is a plus but not required. Computational skills are good to have.

Textbook: The course does not have any assigned textbook. Lecture notes and supplementary reading materials will be provided. The following references might be useful for certain parts of the course:

1. Steven L. Brunton, J. Nathan Kutz, "Data-driven science and engineering", Cambridge University Press, 2019
2. James Ramsay, Giles Hooker, "Dynamic Data Analysis: modeling data with differential equations", Springer, 2017
3. Ralph C. Smith, "Uncertainty Quantification: theory, implementation and applications", SIAM 2014
4. Sheldon M. Ross, "Introduction to Probability models", 7th edition, Academic Press, 2000

Course Description:
The course will give a brief overview of mathematical methods used in modern data science and predictive analytics applications. MATLAB-based codes will be provided to complement theory. Emphasis will be placed on open research problems.

Tentative schedule:
Weeks 1-2: SVD, PCA, random matrix theory, Fourier and wavelet transforms
Weeks 3-4: Sparsity, compressed sensing, K-means, spectral clustering
Weeks 5-6: Graphs and diffusion maps, entropy, information theory
Weeks 6-7: Approximation algorithms, Max-Cut
Weeks 8-9: Data-driven dynamical systems, stochastic methods, Bayesian methods, MCMC
Weeks 10-11: Uncertainty propagation in linear and nonlinear models, confidence and prediction intervals, polynomial chaos expansions
Weeks 12-14: Group testing, error-correcting codes, additional topics and open problems

Grading policy:
Your grade in this course will depend entirely on several graded projects, each containing an analytical and computational part. 2-3 projects will be given during the course of the semester and oral presentations will be scheduled. Groups of up to 3 people are allowed to work on each assignment, and group members are allowed to switch groups between assignments with instructor's approval.

Academic Policies
All GMU policies regarding ethics and honorable behavior apply to this course. If you are a student with a disability and you need academic accommodations, please see me and contact the Office of Disability Resources at 703/993-2474. All academic accommodations must be arranged through that office.