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University of Massachusetts - Amherst
Department of Electrical and Computer Engineering

ECE 597 MS – Math Tools for Data Science
Winter 2020/2021 Syllabus

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DESCRIPTION

Success in the field of data science heavily depends on students' knowledge of many mathematical tools that are not always covered in standard mathematical curriculum. Often, these topics are not covered appropriately in data science courses either due to the time limits. This course aims at filling this void: it covers mathematical tools needed for courses in data science such as machine learning, data mining, neural networks, etc. It motivates the topics by real-word applications and discusses how they can be used in data analytics algorithms.

INSTRUCTOR

Instructor: Prof. Hossein Pishro-Nik, Marcus Hall 215K,
Contact: umasscourse@gmail.com
Please use only the above email address to communicate with the instructor.
Please do NOT use the messaging tool in blackboard.

In-Person Meeting: Appointments are available for students on campus on Wednesdays. Please send a message to the instructor to request a face-to-face meeting.

PREREQUISITES

- Calculus II or equivalent;
- An introductory course in probability and statistics

COURSE FORMAT

The course is offered during 6 weeks. There are video lectures as well as reading materials for each week. Lecture notes associated to the videos are available. There will be HWs every week. The HW assignment usually have two main parts to help students manage the work.

TEXTBOOK

This is a unique course covering materials from a variety of resources. Therefore, the main reading resource will be the posted lecture notes. For each module of the course, a few textbooks are

introduced. These are optional and are meant for students who would like to dig deeper or have access to more practice materials.

GRADING

- Midterm Exam 1: 25%
- Midterm Exam 2: 25%
- Final Exam: 30%
- Homework assignments: 20%

HOMEWORK ASSIGNMENTS

Weekly Assignments:
There will be approximately 6 homework assignments (one every week) that will be posted in Blackboard (log in at https://uma.umassonline.net/webapps/login/). Assignments must be uploaded before due date (usually Friday). Late submissions will **not** be accepted. You can either type the HW solutions or can write them on papers and upload the scanned version. In any case, you need to make sure your work is clearly and neatly presented.

It is encouraged to discuss the problem sets with others, but each student must turn in a unique personal write-up or code implementation. *Homework assignments are preparation for exams*, so do not rely too heavily on other students for help. Homework solution will be posted online after the due deadline.

EXAMS

There will be three exams: two midterm exams and one final exam. Each exam will be available on the Thursday morning of the corresponding week. You have to upload your solutions by Friday night of that week (so you have two-full days to work on the exam). You can choose to type your solutions, or to handwrite them on papers and upload the scanned version. In any case, you need to make sure your work is clearly and neatly presented. Each exam will approximately take 2 hours to finish (this is just a guideline, you can decide to spend as much time as you will during the two-day period). The exams are open book, so you can consult the textbook, notes, etc. during the exam.

Important: For HWs and Exams, make sure to

1. Upload solutions in a **single pdf** file.
2. The name of your file must be "**your last name_your first name_assignment.pdf**"
   For example: **pishro-nik_hossein_exam2.pdf**

Note: Due to the short length of the summer semester, there will be HW assignments every week, including the exam weeks. You need to plan ahead so that you have enough times to allocate to your HW assignments and exams, particularly during the exam weeks.

TENTATIVE TOPICS COVERED (NOT Exactly in this order).

1. Linear Algebra
    a. Vectors and Matrices and basic operations
    b. Vector spaces
    c. Eigenvalues and eigenvectors
    d. Singular value decomposition (SVD) and application to dimensionality reduction
2. Probability and Statistics
    a. Basic probability, conditional probability, Bayes' rule
    b. Random variables and random vectors
    c. Probability bounds
    d. Markov chains
    e. Application to web search algorithms: Link analysis and Page Rank
3. Foundations of Statistical Learning
    a. Basics of statistical learning: models, regression, curse of dimensionality, overfitting, etc.
    b. Optimization and convexity
    c. Gradient descent
    d. Newton's method
4. Classification
    a. Linear discriminant analysis
    b. Logistic Regression
    c. Support vector machines (SVM)
5. Additional methods:
    a. Similarity and distances
    b. Nearest neighbor methods
    c. Decision tress and application of entropy
6. Clustering, Graph Analysis and Algorithms
    a. Clustering algorithms
    b. Social network graphs
    c. Community detection
7. Additional topics
    a. Knowledge driven feature design
    b. Basics of neural networks

ACADEMIC HONESTY POLICY

It is expected that all students will abide by the Academic Honesty Policy, available at the Academic Honesty Office (Ombud's Office), or online at http://www.umass.edu/dean_students/codeofconduct/acadhonesty/. Acts of academic dishonesty

(such as taking or giving answers in an exam, use of extra crib sheets, submitting another person's work as your own, etc.) will result in a grade of F in the course, and possibly additional sanctions including being placed on probation or suspension for a period of time or being dismissed from the University. All students have the right of appeal through the Academic Honesty Board.

ACCOMMODATION POLICY

The University of Massachusetts-Amherst is committed to providing an equal educational opportunity for all students. If you have a documented physical, psychological or learning disability on file with Disability Services (DS), Learning Disability Support Services (LDSS) or Psychological Disabilities Services (PDS), you may be eligible for reasonable academic accommodations to help you succeed in this course. If you have a documented disability that requires an accommodation, **please notify me within the first week of the semester so that we may make appropriate arrangements**.