Northeastern University

DS 5020
Introduction to Linear Algebra and Probability for Data Science

Fall 2018

Course Syllabus

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Office Hours and location: Thursdays at 4:00-6:00 pm; Dana Building - Room 309

Textbook: Introduction to Linear Algebra, 5th edition by Gilbert Strang
ISBN: 978-09802327-7-6
Textbook webpage: http://math.mit.edu/~gs/linearalgebra/
(Additional material available on the textbook webpage)

Additional read: Probability, Random Variables and Stochastic Processes, 4th edition by Papoulis and Pillai ISBN: 978-0071226615

Grading:			
	Homework :	9 Assignments	40%
	Midterm 1:	In Class	30%
	Midterm 2:	In Class	30%

Syllabus

Matrix operations, trace of a matrix, norms, linear independence and ranks, inverse of a matrix, orthogonal matrices, range and null-space of a matrix, the determinant of a matrix, positive semidefinite matrices, eigenvalues, and eigenvectors, vector spaces, singular value decomposition, random variables, frequency distributions, measures of central tendency, measures of dispersion, moments of a distribution, discrete and continuous probability distributions, chain rule, Bayes' rule, correlation theory, basic sampling.

Grading:

40% Homework assignments: Nine homework (HW) problem sets will be assigned during the term. You should try to complete and hand in your solutions by the due dates given on the tentative calendar. The solutions will be posted on Blackboard 3-4 days after the due date. You are encouraged to seek assistance on a given problem that you couldn't solve after an earnest effort. Discussion about HW problems among students is also encouraged (Discussions panel on Blackboard could be used for this purpose) but every student must independently write and submit their own solutions. Your lowest HW grade will be replaced with highest earnable points from a HW assignment if you submit a proof of TRACE participation and completion.

Homework late submission policy: There is a cumulative 7 days late submission grace period for homework assignments, meaning you are allowed to submit your homework assignments 7 days after the due date in total. (Example: your submissions would be graded out of full credit if you submit 2 in time, and the remaining 7 one day after the due date. Or similarly if you submit 6 in time and 3 two days after the due date, given that the solutions haven't been posted on blackboard yet.)

30% Midterm Exam 1: There will be an in class exam on first half of the course in the mid-half of the course (Oct 25 th 2018 -tentatively).

30% Midterm Exam 2: There will be an in class exam on second half of the course during the final week.

TRACE Participation:

Every student is expected to complete the Teacher Rating and Course Evaluation (TRACE) for this course at the end of the semester.

Statement on Academic Integrity:

A commitment to the principles of academic integrity is essential to the mission of Northeastern University. The Academic Integrity Policy can be found in the undergraduate student handbook (pages 38-41), or from the Office of Student Conduct & Conflict Resolution (OSCCR) http://www.northeastern.edu/osccr/academic-integrity-policy/. I encourage you to familiarize yourself with it. If a student violates this policy in any way, I reserve the right to impose a sanction of failure on the assignment/assessment or failure in the course. If you have questions about appropriate citations, please ask.

Final Remarks:

In order to do well in this course, it is important that you keep up-to-date with each lecture. For this, you should study on a daily basis. This includes review of the lecture, reading relevant material on the textbook, and solving practice problems. I strongly encourage you to actively use the office hours and Blackboard Discussion panel to seek help from me, and from your classmates on the course topics, HW assignments, and any other course related issues.

Tentative Lecture Schedule

Lecture	Topics
1.	Introduction Vectors Linear combinations Dot product Matrices
2.	Linear equations Elimination of variables Matrix operations Inverse of a matrix Factorization of a matrix Transpose of a matrix
3.	Vector spaces Linear independence, rank and dimension Column and null space of a matrix Four subspaces
4.	Orthogonality Orthogonal projection Least squares approximation Orthonormal bases and Gram-Schmidt Determinant of a matrix
5.	Eigenvalues and eigenvectors, Diagonal and Jordan Forms Symmetric and positive definite matrices
6.	Singular value decomposition (SVD) Norms of vectors and matrices
7.	Special matrices Linear transformations Applications

--------- MIDTERM EXAM 1 ----------

8. Set theory
   Counting and combinatorics
   Probability theory

9. Random variables (RVs)
   Probability density function (PDF)
   Cumulative distribution function (CDF)
   Functions of a RV
   Mean, variance and moments of a RV

10. Two random variables
    Joint PDFs
    Conditional PDFs
    Chain rule and Bayes' rule

11. Graphs and Networks
    Linear Programming
    Fourier series
    Weighted least squares (WLS)

12. Students suggested topics
    -Or-
    Principal component analysis
    Independent component analysis
    Neural networks
    Elements of machine learning and data science

--------- MIDTERM EXAM 2 ---------