King Fahd University of Petroleum and Minerals
Department of Mathematics & Statistics

Math 405 Learning from Data

Syllabus (Term 211)
Dr. Slim Belhaiza

Title: Math 405 Learning from Data

Credit: 3-0-3

Textbook: Linear Algebra and Learning from Data, by Prof. Gilbert Strang, WELLESLEY- CAMBRIDGE PRESS, 2018.

Description: Basic vector and matrix operations, Factorizations, Least-Square Estimation, Matrix Completion, Special Matrices, Fourier Transforms, Linear Regression and Neural Networks.

Learning Outcome: Upon successful completion of this course, a student should be able to:

1. Describe linear algebra and statistics fundamental to many data science algorithms.
2. Apply linear algebra concepts to probability and statistics.
3. Apply linear algebra to optimization problems.
4. Use linear algebra and statistics in selected machine learning algorithms.

Main objectives :

1. Introduce topics from linear algebra, statistics, and optimization related to data science.
2. Discuss selected applications in Regression and Neural Networks using numerical software, toolboxes, and libraries.

Grading Policy:

1. Exam I	**Material:** (1.1-1.12) **Date**: **Place:**	15% (60 points)
2. Exam II	**Material:** (2.1-4.8) **Date**: **Place: TBA**	15% (60 points)
3. Final Exam	**Material:** (Comprehensive) **Date**: **Place: TBA**	25% (100 points)
4. Class Work	**i) Homeworks:** .	15% (60 points)
	iii) Class Activities: It is based on quizzes, class tests, or other class activities determined by the instructor.	15% (60 points)
	iii) Term Project & Presentation: Term project to be announced.	15% (60 points)

Exam Questions: The questions of the common exams are based on the examples, homework problems, recitation problems and the exercises of the textbook.

Missing Exam I or Exam II: No makeup exam will be given under any circumstance. When a student misses Exam I or Exam II for a legitimate reason (such as medical emergencies), his grade for this exam will be determined based on the existing formula, which depends on his performance in the non-missing exam and in the final exam.

Attendance: Attendance is a University Requirement. A DN grade will be awarded to any student who accumulates 9 unexcused absences (lecture and recitation).

Academic Integrity: All KFUPM policies regarding ethics apply to this course.

Week	Dates (2021)	Sec.	Topics
1	Aug. 29 - Sep 2	1.1	Multiplication Ax Using Columns of A
		1.2	Matrix-Matrix Multiplication AB.
2	Sep. 5 - 9	1.3	The Four Fundamental Subspaces
		1.4	Elimination and $A = LU$
3	Sep. 12 - 16	1.5	Orthogonal Matrices and Subspaces
		1.6	Eigenvalues and Eigenvectors
4	Sep. 19 - 23	1.7	Symmetric Positive Definite Matrices
		1.8	Singular Values and Singular Vectors in the SVD
5	Sep. 26 – Sep. 30	1.9	Principal Components and the Best Low Rank Matrix
		1.10	Rayleigh Quotients and Generalized Eigenvalues
6	Oct. 3 - 7	1.12	Factoring Matrices and Tensors: Positive and Sparse
		2.1	Numerical Linear Algebra
7		2.2	Least Squares
		2.2	Least Squares (Continue)
8		2.3	Three Bases for the Column Space
		3.1	Changes in A^{-1} from Changes in A.
9		3.2	Interlacing Eigenvalues and Low Rank Signals
		3.4	Split Algorithms
10		3.5	Compressed Sensing and Matrix Completion
		4.1	Fourier Transforms
11		4.2	Shift and Circulant Matrices
		4.3	The Kronecker Product
13		4.4	Toeplitz Matrices & Shift Invariant Filters
		4.7	Clustering by Spectral Methods and K-Means
14			Time Series
		7.1	Construction of Neural Networks
15			**Review & Pace Adjustment**
Final Exam: TBA			