

King Fahd University of Petroleum and Minerals
Department of Mathematics & Statistics
Math 405 Learning from Data
Syllabus (Term 201)
Instructor: 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, Basic Probability Theory, Inference, Least-Square Estimation, Maximum Likelihood Estimation, Gradient Descent, 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 machine learning 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.

King Fahd University of Petroleum and Minerals
 Department of Mathematics & Statistics
Math 405: Learning from Data
 Syllabus (Term 201)
 Instructor: Dr. Slim Belhaiza

Grading Policy:

1. Exam I	Material: (1.1-2.4) Date: Place: TBA	15% (60 points)
2. Exam II	Material: (3.1-4.10) Date: Place: TBA	15% (60 points)
3. Final Exam A	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.	
	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.

King Fahd University of Petroleum and Minerals
Department of Mathematics & Statistics
Math 405: Learning from Data
Syllabus (Term 201)
Instructor: Dr. Slim Belhaiza

Week	Dates (2020)	Sec.	Topics
1	Aug. 30 - Sep 3	1.1	Multiplication Ax Using Columns of A
		1.2	Matrix-Matrix Multiplication AB .
		1.3	The Four Fundamental Subspaces
2	Sep. 6 - 10	1.4	Elimination and $A = LU$
		1.5	Orthogonal Matrices and Subspaces
		1.6	Eigenvalues and Eigenvectors
		1.7	Symmetric Positive Definite Matrices
3	Sep. 13 - 17	1.8	Singular Values and Singular Vectors in the SVD
		1.9	Principal Components and the Best Low Rank Matrix
		1.10	Rayleigh Quotients and Generalized Eigenvalues
4	Sep. 20 - 24	1.11	Norms of Vectors and Functions and Matrices
		1.12	Factoring Matrices and Tensors: Positive and Sparse
		2.1	Numerical Linear Algebra
5	Sep. 27 – Oct. 1	2.2	Least Squares
		2.3	Three Bases for the Column Space
		2.4	Randomized Linear Algebra
Exam#1: TBA (1.1- 2.4)			
6	Oct. 4 - 8	3.1	Changes in A^{-1} from Changes in A .
		3.2	Interlacing Eigenvalues and Low Rank Signals
		3.3	Rapidly Decaying Singular Values
		3.4	Split Algorithms for l_1+l_2
7	Oct. 11 – 15	3.5	Compressed Sensing and Matrix Completion
		4.1	Fourier Transforms : Discrete and Continuous
		4.2	Shift Matrices and Circulant Matrices

8	Oct. 18 – 22	4.3	The Kronecker Product $A X B$
		4.4	Sine and Cosine Transforms from Kronecker Sums
		4.5	Toeplitz Matrices and Shift Invariant Filters
9	Oct. 25 – 29	4.6	Graphs and Laplacians and Kirchhoff's Laws
		4.7	Clustering by Spectral Methods and k-means
		4.8	Completing Rank One Matrices
10	Nov. 1 - 5	4.9	The Orthogonal Procrustes Problem
		4.10	Distance Matrices
		5.1	Mean, Variance, and Probability
Exam#2: TBA (3.1- 4.10)			
11	Nov. 8 - 12	5.2	Probability Distributions
		5.3	Moments, Cumulants, and Inequalities of Statistics
		5.4	Covariance Matrices and Joint Probabilities
12	Nov. 15 - 19	5.5	Multivariate Gaussian and Weighted Least Squares
		5.6	Markov Chains
		6.1	Minimum Problems: Convexity and Newton's Method
13	Nov. 22 - 26	6.2	Lagrange Multipliers = Derivatives of the Cost
		6.3	Linear Programming, Game Theory, and Duality
		6.4	Gradient Descent Toward the Minimum
14	Nov. 29 – Dec. 3	6.5	Stochastic Gradient Descent and ADAM
		7.1	The Construction of Deep Neural Networks
		7.2	Convolutional Neural Nets
15	Dec. 10 - 15	7.3	Backpropagation and the Chain Rule
		7.4	Hyperparameters: The Fateful Decisions
		7.5	The World of Machine Learning
Final Exam: TBA			

