Lahore University of Management Sciences

EE 212 – Mathematical Foundations for Machine Learning and Data Science

Summer II 2020

Course Description and Topics
Machine Learning and Data Science are being used these days in a variety of applications including, but not limited to, forecasting in economics and finance, predicting anomalies or signal analysis in engineering, identification of speaker in acoustics, detection of cosmic bubbles in astrophysics and diagnosis in medical imaging. While machine learning and data science have enabled many success stories, and tools are readily available to analyse data or design machine learning systems, the strong mathematical foundations in these areas are of significant importance to understand, review, analyse and evaluate the technical details of the machine learning systems and data science algorithms that are usually abstracted away from the user. This course focuses on the mathematical foundations that are essential to build an intuitive understanding of the concepts related to Machine Learning and Data Science. Topics covered are - Linear Algebra: vectors and matrices, vector spaces, system of linear equations, eigen-value decomposition, singular value decomposition, regression, least-squares, regularization - Calculus: Multivariate calculus and differentials for optimization, gradient descent - Probability: probability axioms, Bayes rule, random variable, probability distributions - Statistics: descriptive stats, inferential stats, statistical tests - Introduction to Neural Networks: single and multi-layer perceptron(s), feedforward and feedback networks - Application to machine learning and data science: principal component analysis (PCA), time series forecasting, clustering etc - Hands-on exercises: Implementation of the exercises will be carried out in MATLAB or Python

Course Basics	
Instructor	Zubair Khalid
Room No.	9-251 (Zubair)
Office Hours	TBA
Email	zubair.khalid@lums.edu.pk
Telephone	8477
Secretary/TA	TBA
TA Office Hours	TBA
Course URL (if any)	https://www.zubairkhalid.org/ee212_2020.html

Credit Hours	3
Lectures/Sessions	Per Week Schedule: 1 session (120 minutes): Content Delivery 1 session (120 minutes): Content Delivery + Practice Problems 1 session (120 minutes): Content Delivery + Practice Problems 1 session (120 minutes): Lab exercise 4-5 modules - prerecorded (20-25 minutes each)

Lahore University of Management Sciences

Course Distribution	
Elective	Open
Open for Student Category	BS/MS/Ph.D.

COURSE PREREQUISITE(S)	
•	None

Grading Breakup and Policy (Tentative)
• Assignments, 20 % • Programming Assignments, 10 % • Quizzes, 10 % • Mid-Exam, 20 % • Mid-Viva, 10 % • Final Exam, 20 % • Final Viva, 10 %

Textbook(s)/Supplementary Readings
Books: • S.Boyd and L. Vandenberghe. **Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares.** Cambridge University Press, 2019 • M. P. Deisenroth, A. A. Faisal and Cheng Soon Ong. **Mathematics for Machine Learning**. Cambridge University Press, 2019 • G. Strang. **Introduction to Linear Algebra.** 2016 Class notes will be provided to supplement these readings