Lahore University of Management Sciences

EE 514/CS 535 Machine Learning

Spring 2020-21

Instructor	Zubair Khalid
Room No.	SBASSE 9-251
Office Hours	TBA
Email	zubair.khalid@lums.edu.pk
Telephone	042 3560 8477
Secretary/TA	Rabeeya Hamid, TBA, TBA
TA Office Hours	TBA
Course URL (if any)	https://www.zubairkhalid.org/ee514_2020.html

Course Teaching Methodology (Please mention following details in plain text)

- Teaching Methodology: We will follow hybrid (synchronous/asynchronous approach) for content delivery. Assessment includes timed Quizzes on LMS, Homeworks/Assignments and take-home (timed) Exams.
- Lecture details: Recorded lectures would be made available over the course YouTube channel or LMS. We will have one recitation/tutorial almost every week during the regular time slot.

Course basics				
Credit Hours	3 hours			
Lecture(s)	Nbr of Lec(s) Per Week	2	Duration	75 minutes
Recitation/Lab (per week)	Nbr of Lec(s) Per Week		Duration	
Tutorial (per week)	Nbr of Lec(s) Per Week	1 (optional)	Duration	50 minutes

Course distribution	
Elective	This is an elective course.
Open for Student Category	Juniors, seniors and graduates.
Close for Student Category	Please see prerequisites below.

Course description

Machine learning (ML) studies the design and development of algorithms that learn from the data and improve their performance through experience. ML refers to a set of methods and that help computers to learn, optimize and adapt on their own. ML has been employed to devise algorithms for diverse applications including object detection or identification in computer vision, sentiment analysis of speaker or writer, detection of disease and planning of therapy in healthcare, product recommendation in e-commerce, learning strategies for playing games, recommending movies to customers, speech recognition systems, fraudulent transaction detection or loan application approval in banking sector, to name a few.

This course provides a thorough introduction to the theoretical foundations and practical applications of ML. We will learn fundamental algorithms in supervised learning and unsupervised learning. We will not only learn how to use ML methods and algorithms but will also try to explain the underlying theory building on mathematical foundations. While reviewing the several problems and algorithms to carry out classification, regression, clustering, dimensionality reduction, we will focus on the core fundamentals which unifies all the algorithms. The theory discussed in class will be tested in assignments, quizzes and exams.

Course prerequisites

- Undergrads (Seniors/Juniors) must have passed:
  - An Ugrad/Grad course in Probability (MATH230 (Probability) OR DISC203 (Probability & Statistics) OR CS501 (Applied Probability))
  - And, a programming course (CS200/EE201 (Intro. to Programming))
  - And, a course on Linear Algebra (MATH120 (LA with Diff. Equations))
- Grads are strongly advised to brush up their programming skills and take CS501 (Applied Probability), may be in parallel with ML
- All students must possess strong programming skills and proficiency in algorithm implementation in JAVA/C/Python/MATLAB

Course objectives

Lahore University of Management Sciences

The goal of this course is to get the students excited about Machine Learning and to enable them to:

- To provide a thorough introduction to ML methods
- To build mathematical foundations of ML and provide an appreciation for its applications
- To provide experience in the implementation and evaluation of ML algorithms
- To develop research interest in the theory and application of ML

Learning outcomes

By the end of the course, students should be able to:

- Understand and recognize a machine learning problem
- Formulate and execute solutions to the machine learning problems
- Understand the core theoretical concepts serve as foundations of ML algorithms
- Understand the trade-offs among model complexity, data size, and model performance for different algorithms
- Apply and interpret information theoretic and probabilistic machine learning methods on real-world datasets

Grading Breakup and Policy (remote)

Online timed quizzes (1-2 per week):	20%
Project:	10%
Programming Assignments or homework(s)/	25%
Mid examination:	20%
Final examination:	25%

Examination detail

Midterm Exam	Yes/No:	Yes
	Duration:	2 hours
	Exam Specifications:	Timed (take-home) exam
Final Exam	Yes/No:	Yes
	Duration:	2.5 – 3 hours
	Exam Specifications:	Timed (take-home) exam.

Textbook(s)/Supplementary Readings

Textbooks

- Pattern Recognition and Machine Learning, Christopher M. Bishop – CB
- Machine Learning: a Probabilistic Perspective, Kevin Murphy – KM
- Machine Learning, Tom Mitchell – TM
- The Elements of Statistical Learning: Data mining, Inference, and Prediction, by Hastie, Tibshirani, Friedman – HTF
- Information Theory, Inference, and Learning Algorithms, David Mackay – DM

Assessed Course Learning Outcomes

EE 514/ CS 535	By the end of the course, students should be able to:
CLO1:	Understand and recognize a machine learning problem
CLO2:	Formulate and execute solutions to the machine learning problems
CLO3:	Understand the core theoretical concepts serve as foundations of ML algorithms
CLO4:	Understand the trade-offs among model complexity, data size, and model performance for different algorithms
CLO5:	Apply and interpret information theoretic and probabilistic machine learning methods on real-world datasets

Relation to EE Program Outcomes

EE-514/CS 535 CLOs	Related PLOs	Levels of Learning	Teaching Methods	CLO Attainment checked in
CLO1	PLO1	Cog-1		
CLO2	PLO2	Cog-2		
CLO3	PLO1	Cog-1		
CLO4	PLO4	Cog-4		
CLO5	PLO2	Cog-3		

Lahore University of Management Sciences

Course Overview			
Week No.	Book Chapter	Topic	Related CLOs & Additional Remarks
1-14		- Introduction - Regression - ML Pipeline - Classification - Statistical Decision Theory - Linear Regression - Non-linear Regression - Bias-variance tradeoff - Linear Classification - Indicator Regression - Dimensionality Reduction, PCA, LDA - Naive Bayes - Logistic Regression - Perceptron - SVM - Decision Trees - Bagging, boosting, stacking - Neural Networks, Backpropagation - Training Deep Neural Networks - Convolutional neural networks intro - Recurrent Neural Networks - ML and MAP Estimation Theory - Bayesian Learning and Bayesian Linear Regression - Kernel Methods and Gaussian Process - K-means Clustering - Computational Learning Theory (Time Permitting)	

Prepared and Revised by:	**Zubair Khalid**
Revision Date:	**29-12-2020**