First Course Handout

EE902 Advanced ML Techniques for Wireless Technology
Jan-Mar 2024
Department of Electrical Engineering
Indian Institute of Technology Kanpur

1. Objectives:

This course will cover advanced Machine Learning (ML) algorithms for Wireless Communication. A variety of Machine Learning tools such as the Linear Regression, Logistic Regression, Support Vector Machines, Discriminant Analysis, and several others will be studied followed by their rigorous analysis. Another important aspect of the program is to study data pre-processing techniques such as Principal Component Analysis for feature selection. Furthermore, other schemes will also be discussed for clustering, such as K-means, Probabilistic Clustering, Naïve Bayes and Decision Tree Classifiers. It is also intended to cover algorithms from modern Probabilistic Inference, Online Learning and Probabilistic Graphical Models to comprehensive analyze their performance. These will involve concepts such as Likelihood Maximization, Bayesian Learning, and Independent Component Analysis.

2. Prerequisites:

Students are expected to be familiar with basic concepts of

- Probability, Random Variables
- Linear Algebra, Properties of Matrices etc.
- Calculus, differentiation, integration

3. Course Contents:

S.No	Broad Title	Topics	Number of Lectures
1	Linear Regression	Regression applications, Nomenclature, Problem formulation and solution, Online learning	4
2	Logistic Regression	Logistic function, Parametric modeling, Likelihood maximization, Online learning for parameter estimation	
3	Support Vector Machines	SVM applications, parallel hyperplanes, Maximum margin classifier, Soft classifier	4
4	Linear Discriminant Analysis	Multivariate Gaussian modeling, Likelihood Ratio test, Discriminant function	4
5	Naïve Bayes	Discrete feature vectors, Naïve Bayes assumption, Calculation of posterior probabilities, Laplacian smoothing	4
6	Decision Tree Classifiers (DTC)	DTC structure, choice of best attribute, Concept of Entropy, Mutual Information or Information Gain	4
7	K-Means and Probabilistic Clustering	Unsupervised learning, K-Means procedure, EM Algorithm, Soft clustering	4
8	Dual SVM, Probabilistic Graphical Models	Dual SVM, Kernel SVM, Bayesian networks, Factorization of PDF, Bayesian inference over graphs	4

4. Special Emphasis:

- Linear Regression, Logistic Regression
- Support Vector Machines,
- Naïve Bayes,
- Linear Discriminant Analysis,
- Decision tree classifiers,
- Clustering algorithms

5. Live Interaction:

- Sunday 12:30 – 1:30 PM via zoom.
- Students can also contact both instructor as well as TAs via e-mail.

6. Evaluation Components & Policies:

	Proposed Weightage
Assignments (Theory)	20%
Quizzes	30%
End-Sem	40%
Attendance Minimum 80% attendance	10%

Best 3 out of four quizzes
Best 6 out of 8 assignments

7. Course Policies: Attendance, Honesty Practices, Withdrawal (within the limits of DOAA Guidelines)

Attendance Policy: Minimum 80% attendance is required to score the 10% marks specified for attendance. Attendance will be recorded in every session.

All participants MUST keep their video feed ON during the live interaction to monitor attendance and participation.

Students are expected to observe a **personal code of honesty** in submission of assignment solutions, quizzes and exams. This will be based on honor code. 25% marks will be deducted for plagiarism or copying.

8. Books & References: Properly Formatted along with listing of possible internet sources.

Text Book	
Pattern Recognition and Machine Learning	Chris Bishop, Springer, 2006

9. Instructor and TA Information

Instructor	
Prof. Aditya K. Jagannatham	ACES 205D
Arun Kumar Chair Professor	Electrical Engineering Department
Electrical Engineering	IIT Kanpur
	Kanpur 208016
	e-mail: adityaj@iitk.ac.in
Course TAs	
Meesam Jafri	meesam@iitk.ac.in

10. Assignment format
- One assignment every week. Total 8 assignments
- Number of questions in each assignment: 10
- Question format: Multiple choice objective questions with four given options and only one correct option
- One mark per question
- NO negative marking

11. Quiz format
- One quiz every 2 weeks. Total 4 quizzes
- Number of questions in each quiz: 10
- Question format: Multiple choice objective questions with four given options and only one correct option
- One mark per question
- NO negative marking
- Quiz 1 – Based on Assignments 1/2
- Quiz 2 – Based on Assignments 3/4
- Quiz 3 – Based on Assignments 5/6
- Quiz 4 – Based on Assignments 7/8
- Duration 30-45 min.

12. Final exam format
- Total questions in Final: 40
- Question format: Multiple choice objective questions with four given options and only one correct option

- One mark per question
- NO negative marking
- Closed-book exam
- Duration is 3 hours
- **Question Paper PATTERN**
  - 8 questions: Recall type (Purely formula), one from each week Assignments/ Quizzes
  - 16 questions: Seen, Directly from Assignments/ Quizzes, two from each week
  - 16 questions: Unseen, Roughly 2 from every week based on Assignment/ Quiz questions