First Course Handout

EE915 PYTHON-Based Machine Learning Simulation for Wireless Systems

Jul-Sep 2024

E-masters in Communication Systems

Department of Electrical Engineering

Indian Institute of Technology Kanpur

1. Objectives:

The course aims to introduce students to PYTHON-based simulation of modern ML techniques. Students will participate and successfully complete several PYTHON-based projects and case-studies on key ML techniques such as Linear Regression, Logistic Regression, Support Vector Machines, Linear Discriminant Analysis, Principal Component Analysis and others.

2. Prerequisites:

EE902 Advanced ML Techniques for Wireless Technology

Students are also expected to be familiar with basic concepts of

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

3. Course Contents:

S.No	Broad Title	Topics	Number of Lectures
1	Introduction to PYTHON, ML Packages, Principal Component Analysis (PCA)	**Introduction to PYTHON libraries and PCA algorithm** **Project 1: PCA-Based clustering**	4

2	Linear Regression	**Regression applications, Problem formulation and solution** **Project 2: PYTHON-Based Regression**	4
3	Logistic Regression	**Logistic function, Likelihood maximization** **Project 3: PYTHON for Logistic Regression**	4
4	Support Vector Machines	**SVM applications, Maximum margin classifier, Kernel SVM** **Project 4: PYTHON Project for SVC**	4
5	Naïve Bayes	**Discrete feature vectors, Naïve Bayes assumption, Calculation of posterior probabilities** **Project 5: Naïve Bayes Classification using PYTHON**	4
6	Linear Discriminant Analysis	Multivariate Gaussian modeling, Likelihood Ratio test **Project 6: PYTHON-based LDA**	4
7	Decision Tree Classifiers (DTC)	**DTC structure, Mutual Information or Information Gain** **Project 7: Building a Decision Tree Classifier using PYTHON**	4
8	K-Means and Probabilistic Clustering	Unsupervised learning, K-Means procedure **Project 8: Clustering Analysis using PYTHON**	4

4. Special Emphasis:

PYTHON-based simulation of ML techniques

- Linear Regression
- Logistic Regression
- Support Vector Machines (SVM)
- Kernel SVM
- Naïve Bayes
- Principal Component Analysis (PCA)
- Decision Tree Classifiers (DTC)
- Gaussian Discriminant Analysis

5. Live Interaction:

- Sunday 11:00 AM – 12:00 PM via zoom.
- Students can also contact both instructor as well as TAs via e-mail.

6. Evaluation Components & Policies:

	Proposed Weightage
Assignments (Theory)	15%
Quizzes	30%
Final exam	40%
Attendance + Project completion Minimum 80% attendance + project completion Attendance will be considered only if PYTHON project is completed	15%

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 PDF Link

9. Instructor and TA Information

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