DA-IICT Gandhinagar

MC321—Machine Learning (3-0-2-4)

AY:2024-2025 (Winter)

Course Placement: Machine learning is B.Tech MnC Core course in the 6th semester.

Course Format: It is **3 hours' lecture** and **2 hours' lab** every week.

Instructor: Srimanta Mandal (srimanta_mandal@daiict.ac.in)

Course Objective:

The objective of this course is to introduce different classical techniques for machine learning such that the students can understand the working principle of different techniques. The course shall also help the students to address different real life problems with machine learning techniques. Moreover, the project part of the course is completely devised to encourage student to explore the area of machine learning by research and development.

Pre-requisites:

i) Probability, Random Variable
ii) Linear Algebra
iii) Optimization
iv) Programming (Python—preferable /MATLAB)

Course Content:

1) *Regression* – Linear regression, Convexity and gradient descent algorithm, Maximum likelihood and maximum a posteriori estimation, Polynomial regression and basis functions, Bias, variance, capacity, regularization, overfitting

2) *Classification* – Logistic regression, Softmax, Linear Discriminant Analysis, Quadratic Discriminant Analysis, Decision trees, Boosting, Random forest, K-NN, Support Vector Machine

3) *Resampling, Model Selection and Regularization* – Cross-validation, The Bootstrap, Choosing the optimum model, Ridge regression, The Lasso

4) *Clustering* – K-Means, Gaussian Mixture Model

5) *Dimensionality reduction* – Principal component analysis

6) *Neural Network*- Representation, Forward propagation, Back Propagation

Readings:

1. Machine Learning: A probabilistic Perspective by Kevin Murphy
2. Pattern Recognition and Machine Learning by Christopher Bishop
3. Elements of Statistical Learning by Trevor and Hastie
4. Research Articles (suggested by the instructors)

Assessment Method (Tentative):

- 1st In-semester examination – 20%
- 2nd In-semester examination – 25%
- End-semester examination – 35%
- Lab assignments – 20%

Course Outcomes:

After completion of this course, students should be able to:

- Understand the fundamental machine learning techniques. [P1, P12]
- Analyze a problem, and formulate a model to address the same. [P2, P3, P4]
- Analyze the shortcomings of existing methods, and ponder upon those. [P2, P5]
- Work in a group for a project, and present their work to scientific community [P9, P10].

Mapping of Course Outcomes to Program Outcomes

P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
x	x	x	x	x				x	x		x

Lecture Schedule (Tentative):

Sl. No.	Description		No. of Lectures
1	**Regression**		**10**
	1.1	Linear regression	
	1.2	Convexity and gradient descent algorithm	
	1.3	Maximum likelihood and maximum a posteriori estimation	

	1.4	Polynomial regression and basis functions	
	1.5	Bias, variance, capacity, overfitting, regularization	
2	**Classification**		**14**
	2.1	Logistic Regression	
	2.2	Softmax	
	2.3	Linear Discriminant Analysis	
	2.4	Quadratic Discriminant Analysis	
	2.5	Decision trees, Boosting	
	2.6	Random forest	
	2.7	K-NN	
	2.8	Support Vector machine and Kernel	
3	**Resampling, Model Selection and Regularization**		**6**
	3.1	Cross-validation	
	3.2	The Bootstrap	
	3.3	Optimum model selection	
	3.4	Ridge regression	
	3.5	The Lasso	
4	**Clustering**		**4**
	4.1	K-means	
	4.2	Gaussian Mixture Model	
5	**Dimensionality Reduction**		**3**
	5.1	Principal Component Analysis	
6	**Neural Networks**		**5**
	6.1	Representation	
	6.2	Forward Propagation	
	6.3	Backpropagation	