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Indian Institute of Technology Kanpur
Proposal for a New Course

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1. Course No: CHE 6XX

2. Course Title: Applied Machine learning for Chemical Engineers

3. Per Week Lectures: <u>3</u> (L), Tutorial: <u>0</u> (T), Laboratory: <u>0</u> (P), Additional Hours[0-2]: <u>0</u> (A),
   Credits (3-0-0-0)   Duration of Course: Full semester

4. Proposing Department: Department of Chemical Engineering

   Other Departments/IDPs which may be interested in the proposed course: ME, AE, MSE

   Other faculty members interested in teaching the proposed course: Harshwardhan H. Katkar

5. Proposing Instructor(s): Indranil Saha Dalal

6. Course Description:

   A) Objectives: The course will attempt to introduce the essential concepts and tools of Machine learning with an emphasis on applications. Frequent computer assignments will further enforce practical learning of the same and show possible usage in engineering, particularly chemical engineering, applications.

   B) Contents (preferably in the form of 5 to 10 broad titles):
      <u>Lecture-wise break-up (considering the duration of each lecture is 50 minutes)</u>

S. No.	Broad Title	Topics	No. of Lectures
1.	Introduction	Introduction to Machine learning and basics of python programming	3
2.	Optimization tools	Zero order, first and second order optimization techniques	7
3.	Linear learning	Linear regression, least squares and least absolute deviations, multi-output regression	5
4.	Linear two-class classification	Logistic regression: Cross Entropy and Softmax cost, Perceptron, Support Vector Machines	8
5.	Linear Multi-Class classification	One-versus-all multi-class classification, Multi-class Perceptron	4
6.	Linear Unsupervised learning	Spanning sets, orthonormality, projections, Principal component Analysis, Recommender systems, K-means clustering, Matrix Factorization problems	6
7.	Non-linear learning	Non-linear regression, non-linear two-class classification, non-linear multi-class classification, non-linear unsupervised learning	4
8.	Fully-connected Neural Networks	Basics of Neural Networks	3

   C) Recommended pre-requisites, if any (examples: a- PSO201A,or b- PSO201A or equivalent): Basic UG-level programming and numerical methods knowledge

D) Short summary for including in the Courses of Study Booklet:
   Optimization Tools, Linear learning methods, Linear classification methods, Linear unsupervised learning, Non-linear learning, Neural networks

7. Recommended text/reference books:
   A) Jeremy Watt, Reza Bohrani, Aggelos K. Kastaggelos, Machine Learning Refined 2nd Ed., Cambridge University Press, 2020.

8. Any other remarks:
   A) Most of the homework assignments will involve computer programming by the students. Assignments will be given every week.

Dated: 12/7/2024   Proposer: Indranil Saha Dalal

Dated: DPGC Convener:

The course is approved / not approved

Chairman, SUGC

Dated: 27/09/2022