Birla Institute of Technology & Science, Pilani
Hyderabad Campus

SECOND SEMESTER 2022-2023
COURSE HANDOUT (PART-II)

Date: 16/01/2023

In addition to Part-I (General Handout for all courses appended to the timetable), this portion gives further specific details regarding the course.

Course Code : ME F321
Name of the Course : Data Mining in Mechanical Sciences
Instructor-In-Charge : Dr. Kundan Kumar Singh

Scope and Objective of the Course: The primary focus of this course is on application of data mining methods in mechanical sciences and engineering. Following are the detailed objectives of this course:

- Understanding the fundamental of data mining.
- Building mathematical foundation for data mining.
- Knowledge of data capturing to minimize the information losses.
- Understanding of patterns in data, data classification and clustering.
- Knowledge of application of identified patterns in data in fields like in-process monitoring, machine monitoring, defect analysis, machine and maintenance scheduling etc.
- Understanding of different prediction methods based on the data processing.
- Understand the difference between artificial intelligence, machine learning and deep learning.
- Knowledge of which data mining methods should be used for what type of data.
- Understanding the concept of big data in manufacturing and how to handle it.

Text Books

[1] Bhatia, P., 2019. Data mining and data warehousing: principles and practical techniques. Cmbridge University Press.

[2] Zaki, M.J. and Meira Jr, W., 2020. Data Mining and Machine Learning: Fundamental Concepts and Algorithms. Cambridge University Press

Reference Books

[3] Kantardzic, Mehmed. Data mining: concepts, models, methods, and algorithms. John Wiley & Sons, 2011.

[4] Hand, David J. "Data mining: statistics and more?" The American Statistician 52, no. 2, 1998.

[5] Maimon, Oded Z., and Lior Rokach. Data mining with decision trees: theory and applications. Vol. 81. World scientific, 2014.

Course Contents

Lecture No.	Learning Objectives	Topic to be covered	Chapter in the text book
1-2	Understanding the objectives of data mining	Why data analysis? Importance of data analysis, Data analysis to data mining, Definition of data mining, Objectives of data mining, Analogy of data mining with concept of mechanical science, Steps in data mining/Data mining process, Concept of data warehouses, Why data mining fails?	Class notes and [3]-1
3-4	Measuring the data and changing the form of raw data (Data preprocessing)	Data measurement (Sampling method) Structure/ representation of data Temporal and spatial data Different types of data; Numeric and categorical data Dimensionality of data., Mean, variance, data normalization methods, data smoothing methods.	Class notes and [4]-2
5-6	Statistical analysis and outlier detection	Point estimation, central limit theory, Regression methods, logistical regression, Density and proximity based outlier detection, clustering based method.	Class notes and [5]-8, [4]-6
7-10	Feature identification/extraction methods	Supervised and unsupervised feature, Architecture for feature subset selection, Principle component analysis for feature selection, relief algorithm, ranking score, entropy method, Chimerge technique for feature discretization	Class notes and [5]-13, [4]-6
11-15	Different clustering algorithms and its applications	Objective of clustering, methods for similarity measure, Agglomerative hierarchical clustering, partitional and incremental clustering, DBSCAN algorithm, clustering validity.	Class notes and [3]-9, [4]-9
16-22	Different classification algorithms and its application	General approach for classification problem, accuracy and error rate, Decision tree, design of decision tree, algorithm for decision tree, K nearest neighbors.	Class notes and [4]-10, [4]-4

23-26	Prediction from data; machine learning methods	Learning machine, types of learning methods; supervised and unsupervised learning, statistical learning theory, Support vector machine algorithm, Neural networks; ANN, RNN etc. Deep learning methods.	Class notes and [3]-6,7
27-28	Case studies	Different case studies for application of machine learning in mechanical system, design and manufacturing.	Class notes, Journal papers

List of Experiments*

Week	Experiment No.	Experiment details
1	E1	Basics of python, installing python and setting up python environment; how python works?
2	E2	Getting started with python programming; running code, input, processing and output, running a script
3	E3	Data loading and preprocessing with pandas, data processing with NumPy, Creating NumPy arrays
4	E4	Writing control loop, programming for if and if-elase statements, Design and functions
5	E5	Binary classification and multilabel classification, linear regression, logistical regression
6	E6	The data pipeline, principle component analysis Kernel PCA, outlier detection binary classification
7	E7	Feature selection, univariant selection, recursive elimination
8	E8	K-nearest neighbors, Clustering using python DBSCAN in python
9	E9	Programming for decision tree and entropy analysis, different examples
10	E10	SVM for classification, SVM for regression, tuning SVM
11	E11	Neural network programming
12	E12	ANN and deep learning using Keras, different case studies using Keras.

*All experiments will be conducted using Python.

Evaluation Scheme and Schedule

Component	Duration	Weightage(%)	Date & Time	Nature of Component
Mid Sem. Test	90 Min.	20	18/03 4.00 - 5.30PM	Close Book
Quiz	–	10	To be announced in class	Close Book
Project/case study	–	15	–	Open Book
Laboratory	-	20	To be announced.	Open Book
Comprehension examination	3 Hrs.	35	20/05 AN	Close Book

VI. Chamber Consultation Hour: To be announced in the class

VII. Notices concerning the course: All notices concerning the course will be displayed on the CMS notice board.

VIII. Make-up Policy: Make-up will be permitted only in genuine cases with prior permission.

NOTE: The border cases in final grading will be decided based on mainly classroom attendance and attentiveness in the classroom.

Academic Honesty and Integrity Policy:

Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Instructor-In-Charge
ME F321