**CSEAI : DEEP LEARNING**

**Credits: 4 Teaching Scheme Theory: 2 Hours/Week**

**Tutorial: 1 Hours/Week**

**Lab: 2 Hours/Week**

**Course Prerequisites:**

Linear algebra, probability theory and statistics,Artificial Neural Network , Computer vision.

**Course Objectives:**

**1.To explore data preprocessing methods, including feature selection and dimensionality reduction techniques like PCA and LDA.**

**2. To Apply various supervised learning algorithms, including linear and kernel-based models.**

**3.To evaluate classification methods and their applications in solving problems.**

**4. To understand the importance of deep learning and is variants**

**5. To understand the basics of Recurrent neural network models of NN**

**6. To build deep nets with applications to solve real world problem**

**Course Relevance:**

In today’s data-driven landscape, machine learning and deep learning are critical for addressing complex industry challenges and driving innovation. As businesses increasingly rely on data analytics for decision-making, machine learning offers essential tools for predictive modeling, customer insights, and operational efficiency. Deep learning, with its ability to analyze vast amounts of unstructured data, is revolutionizing sectors such as healthcare through improved diagnostics, finance through algorithmic trading, and autonomous systems via enhanced perception and decision-making capabilities. This course prepares students to meet the growing demand for expertise in these technologies, equipping them with the skills to develop intelligent solutions that can transform industries and improve overall productivity.

**Section 1: Topics/Contents**

**Unit-I : Introduction Machine Learning [4 Hours]**

Motivation and role of machine learning in computer science and problem solving,Machine Learning Workflow,Introduce paradigms of Learning,Data Preprocessing and Feature Engineering,Feature Selection and Extraction Techniques,**Dimensionality Reduction Algorithms** : Principal Component Analysis (PCA),Linear Discriminant Analysis (LDA)

**Unit-II: Supervised Learning Algorithms [6 Hours]**

**Linear Models :** Linear Regression **:** Simple Linear Regression,Multiple Linear Regression , Polynomial Linear Regression, **Evaluation Metrics:** MAE, RMSE, R2,MSE,Logistic Regression,Ridge and Lasso Regression.

**Kernel Based Algorithms:** Support Vector Machine (SVM)- Linear Support Vector Machines, Linear Classification, Kernel based classification,**Probability-Based Algorithms :** Naive Bayes’ Classifiers, Multinomial Naïve Bayes, and Gaussian Naive Bayes.

**Unit-III : Supervised Learning : Classification [4 Hours]**

K-nearest neighbor classifier,Decision Tree, **Ensemble Learning**: Bagging, Boosting, Random Forest, Adaboost, **Evaluation Metrics and Score**: Accuracy, Precision, Recall, Fscore, Cross-validation, Micro-Average Precision and Recall, Micro-Average F-score, Macro-Average Precision and Recall,Macro-Average F-score.

**Section 2:** **Topics/Contents**

**Unit-IV: Introduction to Deep Learning [5 Hours]**

Introduction, Evolution of AI, Machine Learning vs Deep Learning, Deep Learning types, Stages in ML/DL project, Applications of Deep Learning, Introduction to DL Frameworks Keras, PyTorch, Caffe, Shogun.**Basic Tensor Operations**: Creating, manipulating, and visualizing tensors. **Building a Neural Network**: Step-by-step implementation using Keras and PyTorch.

**Unit-V: Convolution Neural Network**

CNN architecture overview, Building blocks of Convolutional Network-Convolution, activation functions (ReLU), pooling, fully connected layers.Padding, Strides, Typical Settings, the Fully Connected Layers **Advanced Architectures:** LeNet-5, AlexNet, VGG-16, ResNet.

**Training and Optimization:** Training strategies, regularization, transfer learning.

Implementation of neural network for a case study,case study: Real time applications

**Unit-VI: Recurrent Neural Networks(RNN) [5 Hours]**

Sequence modeling: Recurrent nets RNN architecture, bidirectional RNNs, Challenges in training RNNs,Long Short Term Memory (LSTM) ,Vanishing and exploding gradient problem, Auto encoders, **Applications of RNNs**: Language modeling, speech recognition, machine translation.

**List of Practical :**

1. Perform PCA in dimension reduction of numerical data
2. Pre-process the data through standardization.
3. Perform PCA to reduce dimension.
4. Construct the scree plot.
5. Data visualization in lower dimensional representation.
6. Implement Simple and Multiple Linear Regression to predict continuous variables.
7. Perform data preprocessing (handle missing values, feature scaling).
8. Fit a **Simple Linear Regression** model on a dataset (e.g., predicting house prices).
9. Extend to **Multiple Linear Regression** with multiple features.
10. Evaluate models using **MSE**, **RMSE**, and **R² Score**.
11. Visualize the regression line and predictions.
12. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions. Python ML library classes can be used for this problem.
13. Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
14. Learn Decision trees for regression and classification problem

a. Split the data set into training and test sets.

b. Build the decision tree

c. Check model performances on training and test data sets.

d. Apply cost complexity pruning to overcome overfitting problem

e. Apply Random Forest algorithm to overcome overfitting problem.

f. Apply Ada-boost ensemble method on Decision stumps.

1. Build a Multiclass classifier using the CNN model. Use MNIST or any other suitable dataset.

a. Perform Data Pre-processing

b. Define Model and perform training

c. Evaluate Results using confusion matrix

1. Convolutional neural network (CNN) Use any dataset of plant disease and design a plant disease detection system using CNN.
2. Use MNIST Fashion Dataset and create a classifier to classify fashion clothing into categories. Using CNN
3. Implementation of RNN model for Stock Price Prediction
4. Using LSTM for prediction of future weather of cities in Python
5. Implement a basic **RNN** for handling sequential data.
6. Build an **RNN** for a time-series prediction task.
7. Train on sequential data (e.g., stock prices).
8. Evaluate the model using **MSE** or **RMSE** for regression tasks.
9. Visualize predictions vs actual values over time.

12. Design an object detection model using deep neural networks for simple objects.

1. Select appropriate dataset and perform data pre-processing
2. Define architecture in terms of layers
3. Evaluate Model performance Label the object with appropriate text.

13. Train a CNN model using data augmentation to improve generalization.

1. Apply data augmentation techniques like rotation, zooming, and flipping.
2. Train the CNN on augmented data and compare performance with the original model.
3. Plot training and validation accuracy for both models.

**List of Seminar Topics:**

1. Explainable AI (XAI): Making Machine Learning Models Transparent

2. Reinforcement Learning in Autonomous Systems

3. Federated Learning: Collaborative Learning Without Centralized Data

4. Classification of skin cancer with deep neural networks

5. Self-Supervised Learning: Closing the Gap Between Supervised and Unsupervised Learning

6.Convolutional Neural Networks (CNNs) in Image Processing

7. Accelerating Deep Network Training by Reducing Internal Covariate Shift

8. Deep learning applications for predicting pharmacological properties of drugs

9. GAN (Generalized Adversarial network)

10. Auto encoders

11. LSTM

**List of Course Group Discussion Topics:**

1. Supervised vs. Unsupervised Learning: When to Use Which Approach?

2. The Role of Data Quality in Machine Learning: Can Good Data Outperform Advanced Algorithms?

3. Reinforcement Learning vs. Traditional Machine Learning

4. Hyperparameter tuning: Is there a rule of thumb?

5. Deep Learning vs. Traditional Machine Learning

6 Which cost function: Least squared error or binary cross entropy?

7. Convolutional Neural Networks (CNNs) vs. Recurrent Neural Networks (RNNs): Strengths and Weaknesses

8. Need of hundred classifiers to solve real world classification problem

9. Which optimization: Batch gradient descent of stochastic gradient descent

10. Data Privacy in the Age of AI: Machine Learning and Deep Learning in Sensitive Domains

11. The Role of Data Augmentation in Enhancing Deep Learning Models

**List of Design based Home Assignments:**

**Design:**

1. Design a Machine Learning Model for Predicting Housing Prices
2. Development of control system for fruit classification based on convolutional neural networks
3. Classifying movie review using deep learning
4. Sentiment analysis of the demonetization of economy 2016 India
5. Predicting Students Performance in Final Examination
6. Design an LSTM for Machine Translation

**Case Study:**

1. Credit Risk Scoring for Banking

2.Churn Prediction for Telecom Industry

3. Convolutional Neural Networks for Visual Recognition

4. Deep Learning for Natural Language Processing

5. Scalable object detection using deep neural networks

**Blog**

1. Brain tumor segmentation with deep neural networks

2. Region-based convolutional networks for accurate object detection and

segmentation

3. Human pose estimation via deep neural networks

4. Content Based Image Retrieval

5. Visual Perception with Deep Learning

6. Music genre classification system

**Surveys:**

1. Machine translation using deep learning - survey

2. Shaping future of radiology using deep learning

3. Training Recurrent Neural Networks

4. Text generation with LSTM

5. Deep learning applications in Biomedicine

**Assessment Scheme:** Ensures 360 degree assessment and covers all aspects of Bloom's Taxonomy.

**Laboratory Continuous Assessment:** 100 Marks converted to 10 Marks

**Course Project:** End Semester Examination: 100 Marks converted to 20 Marks

**Lab Examoination:** End Semester Examination (Written): 100 Marks converted to 50 Marks

**Comprehensive Viva Voce:** End Semester Examination: 100 Marks converted to 20 Marks

**Text Books:**

1. T. Mitchell, “Machine Learning”, McGraw-Hill, 1997.
2. Anup Kumar Srivastava, Soft Computing, Alpha Science International limited. 2009.
3. Goodfellow, I., Bengio, Y., and Courville, A., Deeep Learning, MIT Press, 2016.
4. C., M., Pattern Recognition and Machine Learning, Springer, 2006.

**Reference Books:**

1. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.

2. Golub, G.,H., and Van Loan,C.,F., Matrix Computations, JHU Press,2013.

3. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.

4. Richard S. Sutton and Andrew G. Barto, “Reinforcement Learning: An Introduction”

by SethWeidman, “Deep Learning from Scratch: Building with Python from First Principles”O’Reily

5. Francois Duval, “Deep Learning for Beginners, Practical Guide with Python and

Tensorflow”

**MOOCs Links and additional reading material:**

1. www.nptelvideos.in

2. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cs11

3. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cs50

4.https://www.my-mooc.com/en/categorie/deep-learning

**Course Outcomes:**

The student will be able to –

**1) Understand the role of machine learning, data preprocessing techniques, including feature selection, PCA, and LDA, to improve model performance.**

**2) Apply linear models such as Linear Regression and Logistic Regression, and kernel-based models such as SVM for classification tasks.**

**3) Apply ensemble techniques like Bagging and Boosting, and classification algorithms such as KNN and Decision Trees to solve classification problems.**

**3) Compare different classification models in terms of accuracy and computational efficiency in various real-world applications.**

**4) Apply a basic convolutional neural network using a deep learning framework**

**5) Evaluate the performance of CNN models and analyze the benefits of transfer learning using pretrained models in specific applications.**

**6) Analyze the strengths and weaknesses of RNNs in handling long-term dependencies in sequence modeling tasks.**

**CO-PO Map:**

| **CO** | **Program Outcomes (PO)** | | | | | | | | | | | | **PSO** | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |  |
| CO1 | 3 | 3 | 3 | 2 | 3 | 1 |  | 1 | 1 | 1 |  | 2 |  | 3 | 3 |  |
| CO2 | 3 | 3 | 3 | 2 | 3 | 2 |  | 1 | 1 | 1 |  | 2 |  | 3 | 3 |  |
| CO3 | 2 | 3 | 3 | 3 | 3 | 2 |  | 1 | 1 | 1 |  | 2 |  | 3 | 3 |  |
| CO4 | 3 | 3 | 3 | 3 | 3 | 2 |  | 1 | 1 | 1 |  | 2 |  | 3 | 3 |  |
| CO5 | 3 | 3 | 3 | 3 | 3 | 2 |  | 1 | 1 | 1 |  | 2 |  | 3 | 3 |  |
| CO6 | 3 | 3 | 3 | 3 | 3 | 2 |  | 1 | 1 | 1 |  | 2 |  | 3 | 3 |  |
| **Average** | **3** | **3** | **3** | **2.66** | **3** | **1.83** |  | **1** | **1** | **1** |  | **2** |  | **3.0** | **3.0** |  |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**CO Attainment levels:**

Co1 - Level 3

Co2 - Level 3

Co3 - Level 4

Co4 - Level 5

Co5 - Level 5

Co6 - Level 2

**Future Course Mapping:**

Advanced course on Deep learning including Autoencoders and Boltzmann machines, Reinforcement Learning etc

**Job Mapping:**

Deep learning engineer, Data Scientist and Algorithm Architect with industries in domains Healthcare, Industrials & Energy, Automobiles, Finance & Insurance, Human Resources, Agriculture, Cybersecurity, Ad & Marketing, Media and Entertainment, Government, Defence, Data Analytics