Machine Learning -II (PCCS5010T)

Teaching Scheme
Lectures : 03 Hrs./week
Credits : 03

Examination Scheme
Term Test : 15 Marks
Teacher Assessment : 20 Marks
End Sem Exam : 65 Marks
Total Marks : 100 Marks

Prerequisite: Linear Algebra, Calculus, Probability, Statistics and Machine Learning Basics.

Course Objectives:

1. To introduce students with the fundamental concepts of artificial neural network and different learning algorithms: supervised and unsupervised neural networks.
2. Develop in-depth understanding of the key techniques in designing Deep Network, Explainable AI and GAN.
3. To expose Deep Network based methods to solve real world complex problems.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze different neural network architectures and their learning algorithms.	L4	Analyze
CO2	Implement deep network training and design concepts.	L5	Evaluate
CO3	Build solution using appropriate neural network models.	L3, L6	Apply, Create
CO4	Illustrate performance of deep learning models using Explainable AI.	L2	Understand

Course Contents

Unit-I Introduction to Artificial Neural Learning — 04 Hrs.

History of Deep Learning, Fundamental concepts of biological Neural Networks, Important terminologies of ANN: Activation functions: weights, bias, threshold, learning rate, momentum factor; McCulloch Pitts Neuron: Theory and Architecture; Linear separability; Hebb Network: Theory and Algorithm.

Unit-II Supervised Learning Networks — 10 Hrs.

Perceptron: Representational power of Perceptron, The Perceptron Training Rule, Gradient Descent and Delta Rule; Multilayer Networks: A differentiable Threshold Unit, Representational Power of Feedforward Networks; Backpropagation Algorithm: Convergence and local minima, Hypothesis space search and Inductive Bias, Generalization, overfitting and stopping criteria. Regularization for Deep Learning: Parameter Norm Penalties, Dataset Augmentation, Noise Robustness, Early Stooping, Sparse Representation, Dropout. Optimization for Training Deep Models: Challenges in Neural network Optimization, Basic Algorithms, Parameter Initialization Strategies.

Unit-III Convolutional Networks — 06 Hrs.

The Convolution Operation, sparse interactions, parameter sharing, Pooling, Convolution and Pooling as an Infinity Strong Prior, Variants of Basic Convolution Function, Efficient Convolution Algorithms.

Unit-IV Sequence Modelling — 06 Hrs.

Recurrent Neural Networks (RNN), Bidirectional RNNs, Deep recurrent Networks, Recursive Neural Networks, The challenges of Long-Term Dependencies, Echo State Networks, Leaky Units, The Long Short-Term Memory.

Unit-V Unsupervised Learning Networks — 10 Hrs.

Kohonen Self-Organizing Feature Maps – architecture, training algorithm, Kohonen Self-Organizing Motor Map.

Autoencoders: Linear Factor Methods such as Probabilistic PCA and Factor Analysis, Independent Component Analysis, Sparse Coding; Undercomplete Autoencoders, Regularized Autoencoders, Stochastic Encoders and Decoders, Denoising Autoencoders, Contractive Autoencoders, Applications of Autoencoders. **Generative Adversarial Networks:** Generative Vs Discriminative Modeling, Probabilistic Generative Model, Generative Adversarial Networks (GAN), GAN challenges: Oscillation Loss, Mode Collapse, Uninformative Loss, Hyperparameters, Tackling GAN challenges, Wasser- GAN, Cycle GAN, Neural Style Transfer.

Unit-VI Explainable AI 06 Hrs.

Explaining and Interpreting, From black box to white box models, SHAP (Shapley Additive Explanation) and LIME (Local Interpretable Model-agnostic Explanation).

Text Books:

1. Simon Haykin, "Neural Networks and Learning Machines", Pearson Prentice Hall, 3rd Edition, 2010.
2. S. N. Sivanandam and S. N. Deepa, "Introduction to Soft Computing", 3rd Edition, Wiley India Publications, 2018.
3. David Foster, "Generative Deep Learning", O'Reilly Media, 2019.
4. Denis Rothman, "Hands-On Explainable AI (XAI) with Python", Packt, 2020.

Reference Books:

1. Ian Goodfellow and Yoshua Bengio and Aaron Courville, "Deep Learning", An MIT Press, 2016.
2. François Chollet, "Deep Learning with Python", Manning Publication, 2017.
3. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner's Approach", O'Reilly Publication, 2017.
4. Andrew W. Trask, Grokking, "Deep Learning", Manning Publication, 2019.
5. John D. Kelleher, "Deep Learning", MIT Press Essential Knowledge series, 2019.

Web Links:

1. Learning Rule: http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/explist.php
2. ANN Virtual Lab: http://cse22-iiith.vlabs.ac.in/List%20of%20experiments.html
3. Deep Learning: https://vlab.spit.ac.in/ai/#/experiments
4. NPTEL Course: Deep Learning Part 1: https://onlinecourses.nptel.ac.in/noc19_cs85/preview

Evaluation Scheme:

Theory :

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of semester.

Continuous Assessment (B):

1. Two term tests of 15 marks each will be conducted during the semester.
2. Best of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper based on the entire syllabus, summing up to 65 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Machine Learning -II Laboratory (PCCS5010L)

Practical Scheme
Practical : 02 Hrs./week
Credit : 01

Examination Scheme
Teacher Assessment : 25 Marks
End Sem Exam : 25 Marks
Total : 50 Marks

Course Objectives:

1. Monitor and evaluate the deep learning models using different techniques.
2. Building SNN, RNN and explainable AI with real world data.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Build solution using appropriate neural network models.	L4	Analyze
CO2	To expose Deep Network based methods to solve real world complex problems.	L5	Evaluate
CO3	Illustrate performance of deep learning models using Explainable AI.	L2	Understand

List of Laboratory Experiments

Suggested List of Experiments:

1. Implement Boolean gates using perceptron.
2. Implement backpropagation algorithm from scratch.
3. Monitoring and evaluating deep learning models using Tensorflow and Keras.
4. Evaluate and analyze Prediction performance using appropriate optimizers for deep learning models.
5. Implement Sentiment analysis on text dataset to evaluate customer reviews.
6. Building CNN models for image categorization.
7. Document classification using RNN models.
8. Outlier detection in time series dataset using RNN.
9. Anomaly detection using Self-Organizing Network.
10. Compare the performance of PCA and Autoencoders on a given dataset.
11. Build Generative adversarial model for fake (news/image/audio/video) prediction.
12. Build Explainable AI to improve human decision-making using a two-choice classification experiment with real-world data.

Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.

Evaluation Scheme:

Laboratory:

Continuous Assessment (A):

Laboratory work will be based on PCCS5010T with at least 10 experiments from the above list to be incorporated. The distribution of marks for term work shall be as follows:

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Subject Specific Lab Assignment/Case Study: 10 Marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

End Semester Examination (C):

Oral/ Practical examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.