Savitribai Phule Pune University

Board of Studies - Mechanical and Automobile Engineering

Undergraduate Program – Final Year Automation and Robotics (2019 pattern)

402543: Artificial Neural Network and Deep Learning

Teaching Scheme		Credits		Examination Scheme	
Theory	02 Hr/week	**Theory**	2	**End-Semester**	50 Marks
Practical	02 Hr/week	**Practical**	1	**Practical**	50 Marks

Prerequisites: Artificial Intelligence and Statistics

Course Objectives:

1. To provide students with a basic understanding of the fundamentals and applications of artificial neural networks
2. To identify the learning algorithms and to know the issues of various feed-forward and feedback neural networks.
3. To Understand the basic concepts of Associative Learning and pattern classification.
4. To solve real-world problems using the concept of Artificial Neural Networks.

Course Outcomes:

On completion of the course the learner will be able to;

CO1: UNDERSTAND the basic features of neural systems and be able to build the neural model.

CO2: PERFORM the training of neural networks using various learning rules.

CO3: GRASPING the use of Associative Learning Neural Network

CO4: DESCRIBE the concept of Competitive Neural Networks

CO5: IMPLEMENT the concept of Convolutional Neural Networks and its models

CO6: USE a new tool /tools to solve a wide variety of real-world problems

Course Contents

Unit 1	**Introduction to Artificial Neural Networks**

Introduction to ANN, History of Neural Networks, Structure and working of Biological Neural Networks, Neural net architecture, Topology of neural network architecture, Features, Characteristics, Types, Activation functions, Models of neuron-Mc Culloch & Pitts model, Perceptron, Adaline model, Basic learning laws, Applications of neural networks, Comparison of BNN and ANN.

Unit 2	**Learning Algorithms**

Learning and Memory, Learning Algorithms, Numbers of hidden nodes, Error Correction and Gradient Decent Rules, Perceptron Learning Algorithms, Supervised Learning Backpropagation, Multilayered Network Architectures, Backpropagation Learning Algorithm, Feed forward and feedback neural networks, example and applications.

Unit3	**Associative Learning**

Introduction, Associative Learning, Hopfield network, Error Performance in Hopfield networks, simulated annealing, Boltzmann machine and Boltzmann learning, State transition diagram and false minima problem, stochastic update, simulated annealing. Basic functional units of ANN for pattern recognition tasks: Pattern association, pattern classification and pattern mapping tasks.

Unit 4	**Competitive learning Neural Network**

Components of CL network, Pattern clustering and feature mapping network, ART networks,

Features of ART models, character recognition using ART network. Self-Organization Maps (SOM): Two Basic Feature Mapping Models, Self-Organization Map, SOM Algorithm, Properties of Feature Map, Computer Simulations, Learning Vector Quantization, Adaptive Pattern Classification

Unit 5	**Convolution Neural Network**

Building blocks of CNNs, Architectures, convolution/pooling layers, Padding, Strided convolutions, Convolutions over volumes, SoftMax regression, Deep Learning frameworks, Training and testing on different distributions, Bias and Variance with mismatched data distributions, Transfer learning, multi-task learning, end-to-end deep learning, Introduction to CNN models: LeNet – 5, AlexNet, VGG – 16, Residual Networks

Unit 6	**Applications of ANN**

Pattern classification – Recognition of Olympic games symbols, Recognition of printed Characters. Neocognitron – Recognition of handwritten characters. NET Talk: to convert English text to speech. Recognition of consonant vowel (CV) segments, texture classification and segmentation

Books and other resources

Text Books:

2. Neural Networks a Comprehensive Foundations, Simon Haykin, PHI edition.
3. Laurene Fausett: Fundamentals of Neural Networks: Architectures, Algorithms & Apps, Pearson, 2004.
4. An introduction to neural networks, Gurney, Kevin, CRC press.

References Books:

1. Artificial Neural Networks - B. Vegnanarayana Prentice Hall of India P Ltd ,2005
2. Neural Networks in Computer Inteligance- Li Min Fu, MC GRAW HILL EDUCATION, 2003
3. Neural Networks -James A Freeman David M S Kapura, Pearson Education, 2004.
4. Introduction to Artificial Neural Systems- Jacek M. Zurada, JAICO Publishing House Ed.,2006.

Web References:

1.https://www.pdfdrive.com/neural-networks-a-comprehensive-foundationpdf-e18774300.html
2.https://www.pdfdrive.com/elements-of-artificial-neural-networks-e17103719.html
3.https://www.pdfdrive.com/neural-networks-methodology-and-applications-e38107895.html

MOOC Courses:

1.https://nptel.ac.in/courses/117105084
2. https://www.coursera.org/projects/predicting-weather-artificial-neural-networks

Guidelines for Laboratory Conduction

- The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic.
- The assignment framing policy needs to address the average students and be inclusive of an element to attract and promote the intelligent students.
- The instructor may set multiple sets of assignments and distribute among batches of students. It is appreciated if the assignments are based on real world problems/applications.
- Encourage students for appropriate use of Hungarian notation, proper indentation and comments.
- Use of open-source software is to be encouraged. In addition to these, instructor may assign one real life application in the form of a mini-project based on the concepts learned. Instructor may also set one assignment or mini-project that is suitable to respective branch

beyond the scope of syllabus.

- Set of suggested assignment list is provided in groups- A and B. Each student must perform at least 10 assignments and one mini project (at least 6 from group A and 4 from group B). Group A and B assignments should be implemented in Python without using built-in methods for major functionality of assignment. Operating System recommended:- 64-bit Open source Linux or its derivative Programming tools recommended: - Open Source Python, Programming tool like Jupyter Notebook, Pycharm, Spyder, Tensorflow.

Term Work

The student shall complete the following activity as a Term Work:

Group A (Any 6)

1. Write a Python program to plot a few activation functions that are being used in neural networks.
2. Generate ANDNOT function using McCulloch-Pitts neural net by a python program.
3. Write a Python Program using Perceptron Neural Network recognize even and odd numbers. Given numbers are in ASCII from 0 to 9
4. With a suitable example demonstrate the perceptron learning law with its decision regions using Python the output in graphical form.
5. Write a python Program for Bidirectional Associative Memory with two pairs of vectors.
6. Write a python program to recognize the number 0, 1, 2, 39. A 5 * 3 matrix forms the numbers. For any valid point it is taken as 1 and invalid point it is taken as 0. The net has to be trained to recognize all the numbers and when the test data is given, the network has to recognize the particular numbers
7. Implement Artificial Neural Network training process in Python by using Forward Propagation, Back Propagation.
8. Create a Neural network architecture from scratch in Python and use it to do multi-class classification on any data.
   Parameters to be considered while creating the neural network from scratch are specified as:
   (1) No of hidden layers: 1 or more
   (2) No. of neurons in hidden layer: 100
   (3) Non-linearity in the layer: Relu
   (4) Use more than 1 neuron in the output layer. Use a suitable threshold value
   Use appropriate Optimization algorithm

Group B (Any 4)

1. Write a python program to show Back Propagation Network for XOR function with Binary Input and Output
2. Write a python program to illustrate ART neural network.
3. Write a python program in python program for creating a Back Propagation Feed-forward neural network
4. Write a python program to design a Hopfield Network which stores 4 vectors
5. Write Python program to implement CNN object detection. Discuss numerous performance evaluation metrics for evaluating the object detecting algorithms' performance.

Mini Project

Car Object Detection using (ConvNet/CNN) Neural Network
Car Object Data: Data Source – https://www.kaggle.com/datasets/sshikamaru/car-object-detection
The dataset contains images of cars in all views.
Training Images – Set of 1000 files
Use Tensor flow, Keras & Residual Network resNet50
Constructs comparative outputs for various Optimisation algorithms and finds out good accuracy.

OR

Mini Project to implement CNN object detection on any data. Discuss numerous performance evaluation metrics for evaluating the object detecting algorithms' performance, Take outputs as a comparative results of algorithms.