# DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING



# NATIONAL INSTITUTE OF TECHNOLOGY PATNA

Ashok Raj Path, PATNA 800 005 (Bihar), India

Phone No.: 0612 – 2372715, 2370419, 2370843, 2371929, 2371930, 2371715

Fax – 0612- 2670631 Website: <u>www.nitp.ac.in</u>

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CSXX2829: Deep Learning Algorithms

L-T-P-Cr: 2-0-2-3

# **Pre-requisites:**

1. Basic knowledge of machine learning.

# **Course Objectives:**

- 1. Students will be able to understand the architecture of neural network.
- 2. Students will be able to learn different optimization techniques.
- 3. Student will be able to know working of deep architectures like convolutional neural network and variants of recurrent neural network.

**Course Outcome:** Upon successful completion of this course, students should be able to:

SI. No.	Course Outcome (CO)	Program Outcome (PO)
1	Explain the fundamental concepts of neural networks, including error functions, activation functions, and optimization algorithms like gradient descent.	PO1
2	Implement and analyze feedback networks like Hopfield networks and Radial Basis Function Networks (RBFNs) for tasks like pattern association and reconstruction.	PO1, PO2, PO3, PO5
3	Apply clustering algorithms using Self-Organizing Feature Maps (SOMs) and understand advanced techniques like Adaptive Resonance Theory (ART) networks.	PO1, PO2, PO3, PO5
4	Design and utilize Convolutional Neural Networks (CNNs) for image processing tasks, including understanding convolutional operations, pooling, and advanced architectures like Dilated CNNs.	PO1, PO2, PO3, PO5, PO6 (Optional)
5	Implement Deep Recurrent Neural Networks (RNNs) with a focus on Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU) architectures, and explore the concept of attention mechanisms.	PO1, PO2, PO3, PO5
6	Develop and train deep unsupervised learning models like Autoencoders and Generative Adversarial Networks (GANs) to understand data representation and generation.	PO1, PO2, PO3, PO5
7	Apply deep learning techniques to solve real-world problems in a chosen domain (e.g., computer vision, natural language processing) through project work or	PO1, PO2, PO3, PO9, PO10, PO12

case studies.

## **UNIT I: Introduction to Neural NetworkLectures: 10**

Brief introduction to neural network. Error Cost Function, Mean-Square Error, Cross-Entropy.Linear vs Non-linear functions:Activation Function – Linear, Sigmoid, Softmax, Relu.

**Optimization**: Gradient Descent Algorithm, Momentum Based Gradient Descent Algorithm and Nesterov Accelerated Gradient Descent Algorithm.

#### UNIT II: Feedback Networks

**Algorithm for Pattern Association/Reconstruction:** Associative memory networks, Hetero Associative Memory neural networks, Auto Associative Memory Networks, Bi-directional Associative memory networks.

Lectures: 12

**Feedback Networks:** Discrete Hopfield Net, Continuous Hopfield Net, Radial Basis Function Networks (RBFN): Training algorithm for an RBFN with fixed Centres.

## **UNITIII: Lectures: 10**

**Cluster Network:** Self-Organizing Feature Map, Plasticity/Stability Problem, Adaptive Resonant Theory (ARTI and ARTII) - Architecture, ARTMAP.

**Dense Embeddings**: word2vec – Skip-gram model, Continuous Bag Of Words (CBOW) Model.

## **UNIT IV:** Lectures: 16

**Convolutional Neural Network**: Architecture, Convolution Operation, Filters, Pooling Operation – Max pooling, Average pooling, Global pooling. Dilated CNN.

**Deep RecurrentNeural Network**: Long Short Term Memory (LSTM) – Architecture. Gated Recurrent Unit (GRU). Attention Mechanism.Recursive Neural Network.

**Deep Unsupervised Learning:**Autoencoders, Variational Autoencoders, Adversarial Generative Networks.

# Reference Book:

- 1) Neural Network by Simon Haykin, Pearson Education/PHI
- 2) Deep Learning, Part II. Goodfellow, I., Bengio, Y., Courville, A., MIT Press, 2016.

## **References:**

1) Learning deep architectures for AI. Bengio, Yoshua. Foundations and trends in Machine Learning 2.1 (2009): 1127.