Deep Learning

Course Code: BECCS3C008
Course Title: Deep Learning
Semester: VI
Credits: 03

Rationale

This course provides a comprehensive introduction to deep learning, covering fundamental concepts, practical implementations, and advanced applications. It emphasizes understanding both the underlying mechanics and high-level frameworks. Students will gain hands-on experience by building models from scratch and utilizing modern deep learning algorithms.

Course Outlines

Contents	No. of Lectures
UNIT–I Fundamentals of Deep Learning History of Deep Learning, Difference between machine learning and deep learning, McCulloch Pitts Neuron, Thresholding Logic, Perceptrons, Perceptron Learning Algorithm and Convergence, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons. Feedforward Neural Networks, Representation Power of Feedforward Neural Networks, Autoencoder.	8
UNIT–II Optimizing Deep Learning Training Backpropagation, Gradient Descent (GD), Momentum based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam. Regularization: Bias Variance Tradeoff, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Dropout, Greedy Layerwise Pre-training, Better activation functions, Better weight initialization methods, Batch Normalization.	8
UNIT–III Convolutional Neural Networks (CNNs) Introduction to CNNs – convolution, pooling, Deep CNNs, Different deep CNN architectures: LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing Convolutional Neural Networks, Training a CNNs: weights initialization, batch normalization, hyperparameter optimization.	8
UNIT–IV Recurrent Neural Networks (RNNs) Sequence modeling using Recurrent Neural Network (RNNs), Backpropagation Through Time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, Gated Recurrent Units (GRUs), Long Short-Term Memory (LSTM) Cells, Solving the vanishing gradient problem with LSTMs	8
UNIT–V Generative models Encoder Decoder Models, Generative Adversarial Networks (GANs) Attention Mechanism, Attention over images, Hierarchical Attention, Transformers: Multi-headed Self Attention, Cross Attention	8

Applications of DNN: Application in computer vision, Time series analysis, natural language processing.	

Course objectives & learning outcomes:

Upon successful completion of this course, candidates will be able to:

1. To understand the fundamental concepts of deep learning and its architecture.
2. Design, train and optimize neural networks using advanced techniques.
3. Use regularization and optimization techniques to improve model performance.
4. Implement various deep neural networks such as Convolutional and Recurrent Neural
5. Networks, Transformers etc.
6. Apply deep learning to solve real-world problems and evaluate model results effectively.

Text Books/ Reference books

1. Ian Goodfellow and Yoshua Bengio and Aaron Courville. Deep Learning. An MIT
2. Press book. 2016.
3. Charu C. Aggarwal. Neural Networks and Deep Learning: A Textbook. Springer. 2019.
4. Satish Kumar, Neural Networks - A Class Room Approach, Second Edition, Tata McGraw-
5. Hill, 2013
6. Zhang, A., Lipton, Z. C., Li, M., & Smola, A. J Dive into Deep Learning. 2021.