Department of Artificial Intelligence and Data Science

IV Year VIII Semester

8AIDS4-01: Deep Learning

Note: Each assignment of Maximum Marks 10.All question carries equal marks.

ASSIGNMENT-I

Q.1 Explain the fundamental differences between supervised, unsupervised, and reinforcement learning algorithms. Provide examples of tasks that each type of algorithm is well-suited for, and discuss the challenges associated with training and evaluation.	BLT-2	CO-1
Q.2 Describe the concept of maximum likelihood estimation (MLE) and its importance in statistical modeling. Provide a step-by-step explanation of how MLE is used to estimate the parameters of a statistical model. Discuss potential limitations or assumptions of MLE.	BLT-3	CO-1
Q.3 Outline the key steps involved in building a machine learning algorithm from scratch. Discuss the importance of data preprocessing, feature selection, model selection, and evaluation metrics. Provide examples of popular machine learning algorithms and their applications.	BLT-2	CO-1
Q.4 Explain the architecture and functioning of a Multilayer Perceptron (MLP) neural network. Describe the back-propagation algorithm and how it is used to train MLPs. Discuss common variants of back-propagation, such as stochastic gradient descent (SGD), and their advantages and disadvantages.	BLT-3	CO-1
Q.5 Define the curse of dimensionality and discuss its implications for machine learning algorithms. Explain how deep feed forward networks address the curse of dimensionality by learning hierarchical representations of data. Provide examples of deep feed forward network architectures and their applications in real-world scenarios.	BLT-2	CO-1

ASSIGNMENT-II

Q.1. Define machine learning and deep learning. Explain the difference between the two approaches and provide examples of applications for each. Briefly describe the primary characteristics of representation learning and list three common activation functions used in neural networks.	BLT-2	CO-2
Q.2. Compare and contrast the concepts of width and depth in neural networks. Provide examples of how adjusting the width and depth of a network can impact its performance and computational complexity. Explain the advantages and disadvantages of using Rectified Linear Unit (ReLU), Leaky ReLU (LReLU), and Exponential ReLU (ELU) activation functions in neural networks.	BLT-3	CO-2
Q.3. Design a simple neural network architecture for image classification using either TensorFlow or PyTorch. Specify the number of layers, the activation functions, and any regularization techniques you would use. Train the model on a small dataset and evaluate its performance using appropriate metrics.	BLT-5	CO-2
Q.4 Compare the training processes of unsupervised neural networks, such as restricted Boltzmann machines (RBMs) and autoencoders. Discuss how these methods learn representations of data without labeled examples and analyze the strengths and weaknesses of each approach.	BLT-2	CO-2
Q.5 Critically evaluate three recent deep learning applications in areas such as computer vision, natural language processing, or healthcare. Discuss the challenges faced in each application, the performance of the proposed models, and the potential ethical implications.	BLT-1	CO-2

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ASSIGNMENT-III

Q.1 Describe the architectural components of convolutional neural networks (CNNs) and explain the motivation behind their design. Discuss how CNNs are inspired by the visual cortex of the human brain and how this influences their effectiveness in tasks such as image recognition.	BLT-1	CO-3
Q.2 Explain the concept of layers and filters in CNNs and how they contribute to feature extraction and hierarchical learning. Discuss the importance of parameter sharing in reducing the number of trainable parameters in CNNs and its impact on model efficiency and generalization. Provide a detailed example illustrating how convolutional and pooling layers operate on input data.	BLT-1	CO-3
Q.3 Discuss the importance of regularization in preventing overfitting in CNNs and improving their generalization performance. Compare and contrast different regularization techniques, such as dropout, L1 and L2 regularization, and data augmentation..	BLT-1	CO-3
Q.4 Provide an in-depth overview of the ResNet and AlexNet architectures, including their key design principles, such as residual connections and multiple pathways. Discuss the innovations introduced by each architecture and how they have contributed to advancements in deep learning research.	BLT-2	CO-3
Q.5 Provide an in-depth overview of the ResNet and AlexNet architectures, including their key design principles, such as residual connections and multiple pathways. Discuss the innovations introduced by each architecture and how they have contributed to advancements in deep learning research.	BLT-4	CO-3

ASSIGNMENT-IV

Q.1 Explain the architecture and functioning of Recurrent Neural Networks (RNNs), focusing on their ability to handle sequential data. Discuss the challenges associated with training RNNs, such as the vanishing gradient problem, and explain how techniques like Backpropagation Through Time (BPTT) address these challenges. Provide examples of real-world applications where RNNs have been successfully applied.	BLT-1	CO-4
Q.2 Describe the concept of Bidirectional RNNs and how they leverage information from both past and future time steps to make predictions. Explain the architecture of Encoder-Decoder sequence-to-sequence models and their applications in tasks such as machine translation and speech recognition. Discuss the training process of Encoder-Decoder architectures and the role of attention mechanisms.	BLT-2	CO-4
Q.3 Explain the internal mechanisms of LSTM units, including gates and memory cells, and how they enable LSTMs to learn and retain information over long sequences. Provide examples of tasks where LSTMs have outperformed other recurrent architectures.	BLT-1	CO-4
Q.4 Describe the specific challenges and requirements of each task and how RNN-based models are adapted or extended to address them. Analyze the performance and limitations of these models in real-world scenarios.	BLT-2	CO-4
Q.5 Investigate case studies in classification, regression, and deep networks, highlighting the diversity of applications and domains where deep learning techniques are applied. Choose specific examples from areas such as healthcare, finance, or autonomous vehicles, and discuss the architecture, training process, and performance metrics of the deep learning models used.	BLT-4	CO-4

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ASSIGNMENT-V

Q.1 Define an under complete auto encoder and explain its architecture and training process. Discuss how under complete auto encoders learn to compress input data into a lower-dimensional latent space representation.	BLT-1	CO-5
Q.2 Describe the concept of regularization in auto encoders and explain how it helps prevent over fitting and improve the generalization performance of the model. Discuss common regularization techniques used in auto encoders, such as L1 and L2 regularization, dropout, and sparsity constraints.	BLT-1	CO-5
Q.3 Explore the idea of stochastic encoders and decoders in auto encoder architectures and their role in generating diverse output representations. Explain how variational auto encoders (VAEs) leverage stochasticity to model the underlying probability distribution of the data.	BLT-2	CO-5
Q.4 Define a contractive auto encoder and discuss its distinctive feature of enforcing a contractive penalty term during training. Explain how contractive auto encoders learn to capture the local structure of the input data and maintain similarity relationships in the latent space. Provide examples of applications where contractive auto encoders have been used for semi-supervised learning and representation learning.	BLT-2	CO-5
Q.5 Conduct a comparative analysis of under complete, regularized, stochastic, and contractive auto encoders. Discuss the strengths, weaknesses, and trade-offs of each variant in terms of reconstruction quality, computational complexity, and applicability to different types of data.	BLT-3	CO-5

*BLT: BLT shows the **Bloom's taxonomy** levels