TASK-1 AM3004-1 NEURAL NETWORK AND DEEP LEARNING

1. Comparative Study of Optimizers in Avoiding Overfitting

Objective:

Train a deep neural network using different optimization techniques (SGD, AdaGrad, Adam) and compare their performance in terms of overfitting.

Steps:

1. Use a dataset prone to overfitting (e.g., small image datasets like MNIST or custom datasets with limited samples).
2. Train the neural network using three different optimizers: Stochastic Gradient Descent (SGD), AdaGrad, and Adam.
3. Monitor the training loss, validation loss, and validation accuracy across epochs.
4. Implement regularization techniques like L2 regularization or dropout in each case.
5. Analyze the impact of each optimizer on overfitting by comparing the training vs. validation performance.

Expected Outcome:

- A detailed analysis of how different optimizers handle overfitting and regularization techniques.
- Plots comparing training/validation loss and accuracy for each optimizer, with and without regularization.

2. Implementation and Analysis of Gradient Clipping in Deep Neural Networks

Objective:

- Implement a deep neural network to solve a classification problem (e.g., CIFAR-10 dataset).
- Train the network without gradient clipping and observe the impact of the exploding gradient problem.
- Then, enable gradient clipping during training and analyze its effect on the training stability, convergence rate, and accuracy.

Steps:

1. Build a deep neural network using a popular framework like TensorFlow or PyTorch.
2. Train the model without gradient clipping and monitor the gradient values, loss, and accuracy across epochs.
3. Enable gradient clipping (e.g., clipping gradients at a maximum value of 1.0) and re-train the model.
4. Compare the training performance (loss, accuracy, gradient magnitude) between both experiments.

Expected Outcome:

- Demonstrate the role of gradient clipping in stabilizing training, especially for deeper networks.
- Provide visualizations of gradient magnitudes and training metrics (loss and accuracy) before and after applying gradient clipping.