

Deep Learning Assignment 1

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1 Question 1

Cross Entropy Loss is a natural choice for logistic regression as we get cross entropy loss by maximizing negative log likelihood of bernoulli distribution, cross-entropy loss aligns well the maximum likelihood estimation principle commonly used in statistical modeling.

Cross Entropy Loss penalizes the model heavily for confidently incorrect predictions, encouraging well-calibrated probabilities and reducing confusion in classification tasks.

Cross-entropy loss tends to produce larger gradients compared to MSE, especially when the predicted probability is far from the true label. This is crucial for the optimization process during training. Larger gradients lead to faster convergence, which means the model learns more efficiently and reaches the optimal solution faster.

2 Question 2

Option C - Both

If the activation function is linear for all layers, then the combination of linear activation functions with either cross-entropy (CE) or mean squared error (MSE) loss results in a convex optimization problem.

If the activation function is linear the entire neural network becomes a linear function. Both the Cross-Entropy (CE) and Mean Squared Error (MSE) loss functions are convex when their inputs are linear.

3 Question 3

Here MNIST dataset was used for classification.

The model constructed consist of 1 input layer, 1 output layer and a single hidden layer. The activation function used is relu(Rectified Linear Units). Number of neurons in hidden layer was treated as a hyper-parameter and an optimal value between 60-600 was selected with a step size of 60.

The preprocessing is task and dataset specific which means that differnt methods would be required for different datasets, since we were working on MNIST dataset - all pixel values were normalized between 0-1 and also the image to flattened and was converted into a vector of size $28 \times 28 = 784$.

The code implementation is available on GitHub at the following link: [GITHUB LINK](#)

Code implementation on Google Collab: [COLLAB LINK](#)

4 Question 4

The suitability of a model for a particular dataset depends on various factors such as model complexity, dataset characteristics, and computational resources.

LeNet-5 : It can be used for the SVHN dataset due to its simplicity and efficiency. However, it may not achieve great performance compared to more complex models like VGG or ResNet. It achieves a test accuracy of 47% .

AlexNet : It's deeper architecture requires more computational resources compared to simpler models like LeNet-5. Its test and train score are better than LeNet5, this is because it is a more complex model.

VGG : VGG can be well suited for the SVHN dataset due to its strong performance on image classification tasks and its ability to capture intricate features from the data. However, its deeper architecture may require more computational resources compared to shallower models like LeNet-5. It achieves a test accuracy of 94%. This is because of its deeper structure.

ResNet : ResNet can be highly suitable for the SVHN dataset due to its state-of-the-art performance on image classification tasks and its ability to effectively capture intricate features. However, its deeper architecture may require significant computational resources for training. ResNet 18,50,100 all achieve around 94-95% test accuracy which is similar to VGG. It utilizes residual blocks where each block contains shortcut connections (skip connections) to jump over some layers.

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