ASSIGNMENT – 1 Neural Networks

1. **Using one/ three hidden layers -**

When only one hidden layer is used, validation accuracy begins to decline after the fourth epoch (88.82) while training accuracy continued to rise with every epoch. The training loss decreases with every epoch, whereas the validation loss initially decreased but increased after the fifth epoch, indicating overfitting. When using three hidden layers, validation accuracy

increased for two epochs and then began to fluctuate. Validation accuracy has a peak at fifth Epoch (88.86). From the below Matblot graphs we can see that training loss decreases with every epoch and the training accuracy increases with every epoch. Whereas our validation loss has minimum value at 5 epoch and validation accuracy has peak at 5 Epoch. Ideally, we should stop after 5 epochs. Adding more layers resulted in less accuracy.

*On one hidden layer-*

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*On three hidden layer-*

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1. **Using layers with more hidden units or fewer hidden units: 32 units, 64 units, so on**

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From the below Matblot graphs we can see that training loss decreases with every epoch and the training accuracy increases with every epoch. Whereas our validation loss has minimum value at 2 epochs and validation accuracy has a peak at 2 Epochs. Ideally, we should stop after 2 epochs. Due to underfitting and statistical bias, using a few hidden units will result in high training error and generalization error and because of overfitting and excessive variation, using too many hidden units might result in low training error but high generalization error.

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**Part 3) and 4) Train a new Network using the MSE loss function instead of binary cross entropy and tanh activation**

From the above Matblot graphs we can see that training loss decreases with every epoch and the training accuracy increases with every epoch. Whereas our validation loss has minimum value at 4 epochs and validation accuracy has a peak at 24 Epoch.  Ideally, we should stop after 4 epochs.

If the network features sigmoid or SoftMax nonlinearity, cross-entropy is the best/optimal method to utilize in the output layer, we can use MSE instead if we assume the objective is continuous and regularly distributed and we need to maximize the likelihood of the net output under these assumptions, for this the cross entropy rather than the MSE is a better choice for categorization.

Tanh's validation accuracy fluctuates more than the relu's and the loss of validity is constant in tanh, whereas relu's validation accuracy surged at one point and then began to decline.

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4) Applying Dropout is one of the most effective and most used techniques for neural networks. We have added 50% dropout rate for the first two layers.

Above plot shows clear improvement once dropout regularization technique has been implied validation loss significantly reduced.

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