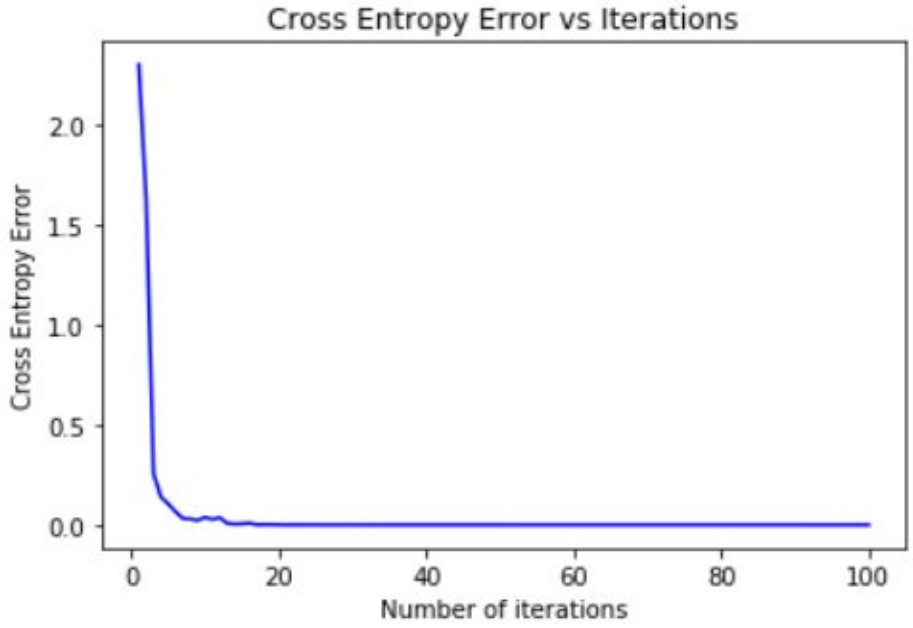
ML Assignment 3

Question 1

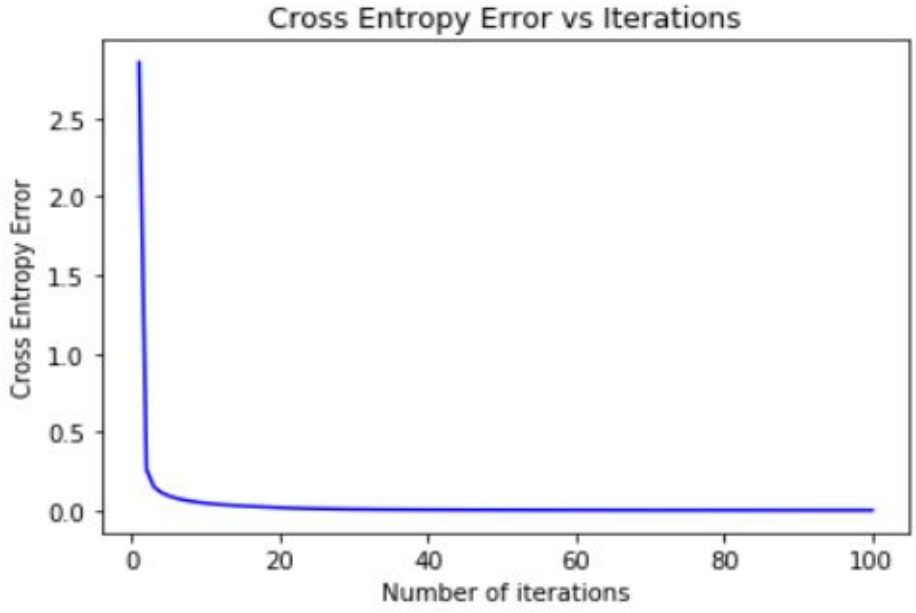
1.1.1

Accuracy of ReLU on implemented Neural Net: 98.06



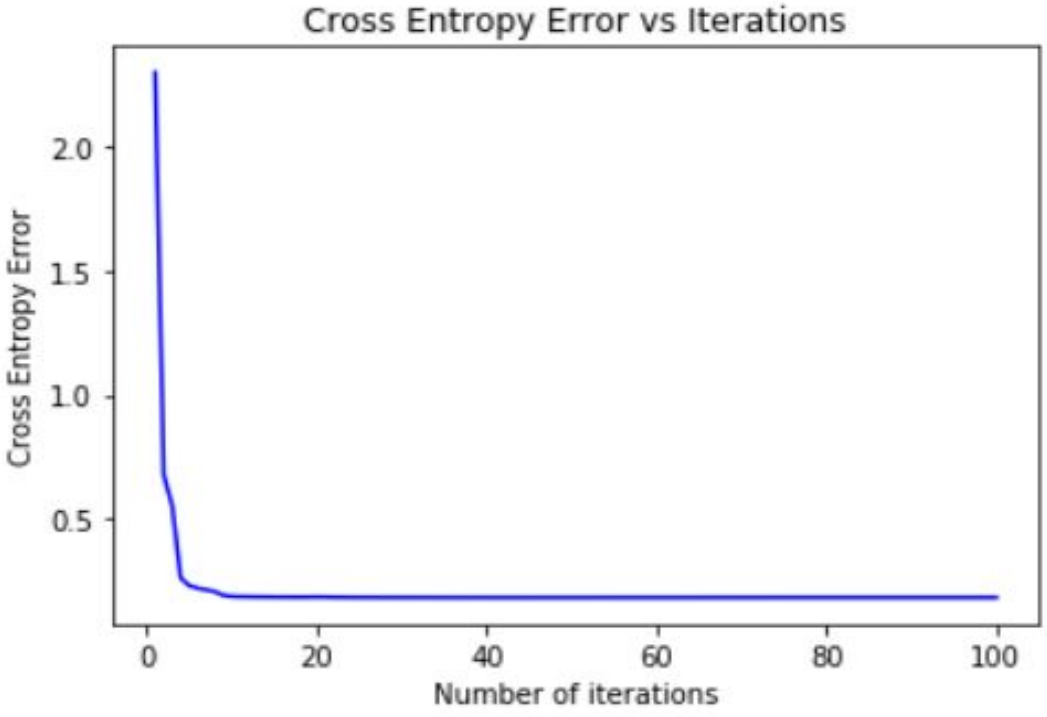
1.1.2

Accuracy of Sigmoid on implemented Neural Net: 97.94



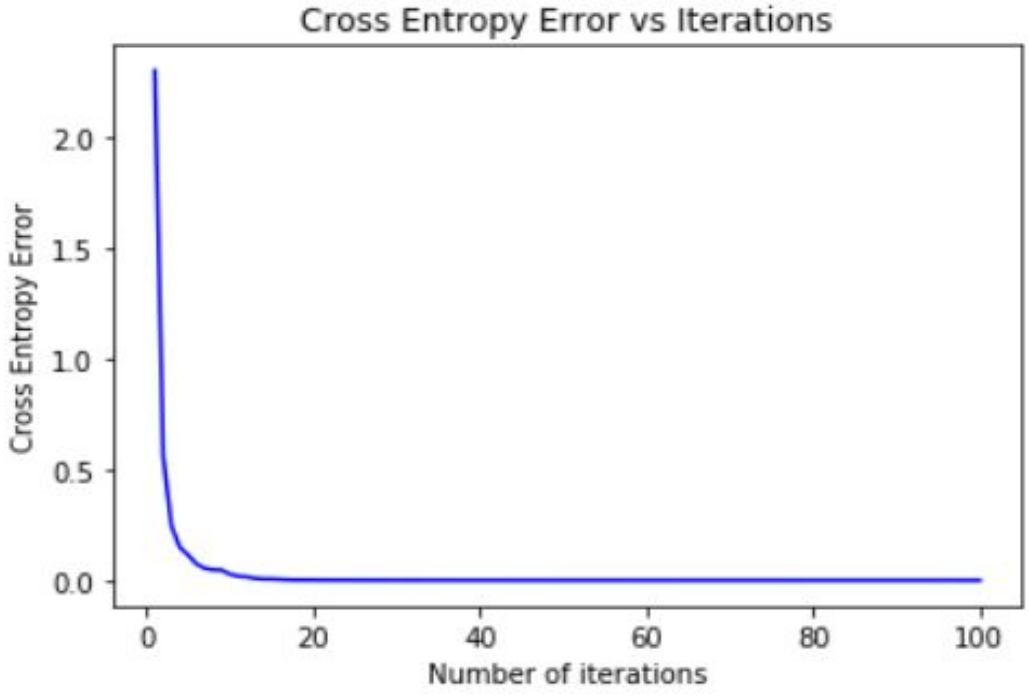
1.1.3

Accuracy of Linear on implemented Neural Net: 90.31



1.1.4

Accuracy of tanh on implemented Neural Net: 97.96



1.2

Accuracy of ReLU on inbuilt Neural Net: 97.88
Accuracy of Sigmoid on inbuilt Neural Net: 97.22
Accuracy of Linear on inbuilt Neural Net: 92.08
Accuracy of tanh on inbuilt Neural Net: 97.19

The difference between accuracies of implemented MLP and sklearn's MLP is not much. sklearn's MLP performs quite better as compared to implemented MLP.

Question 2

2.1.1

Accuracy on Train Set: 81.94493865966797
Accuracy on Test Set: 86.11997985839844

Accuracy on Train Set: 87.71170043945312
Accuracy on Test Set: 87.5300064086914

Accuracy on Train Set: 88.876708984375
Accuracy on Test Set: 88.57002258300781

Accuracy on Train Set: 89.59341430664062
Accuracy on Test Set: 88.72998809814453

Accuracy on Train Set: 90.17842102050781
Accuracy on Test Set: 88.62998962402344

Accuracy on Train Set: 90.4217300415039
Accuracy on Test Set: 88.77999114990234

Accuracy on Train Set: 90.80677032470703
Accuracy on Test Set: 89.6100082397461

Accuracy on Train Set: 91.05675506591797

Accuracy on Test Set: 89.0899887084961

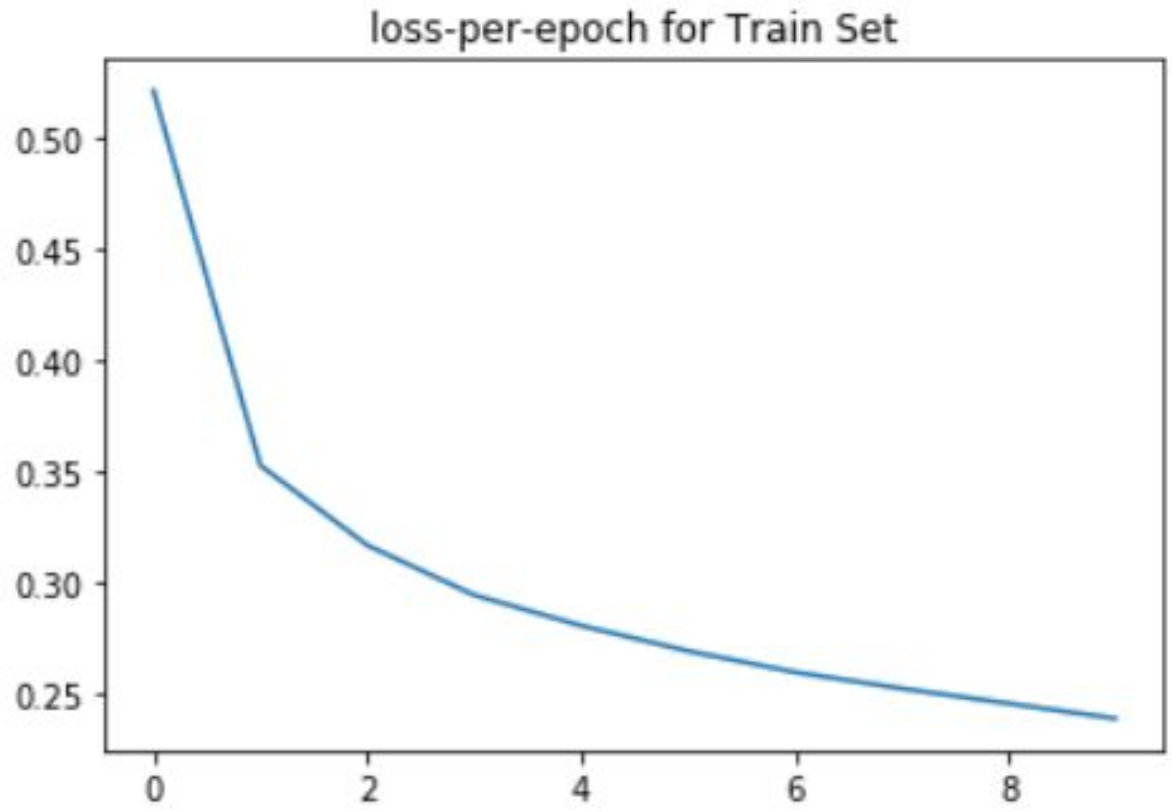
Accuracy on Train Set: 91.2267837524414
Accuracy on Test Set: 89.98002624511719

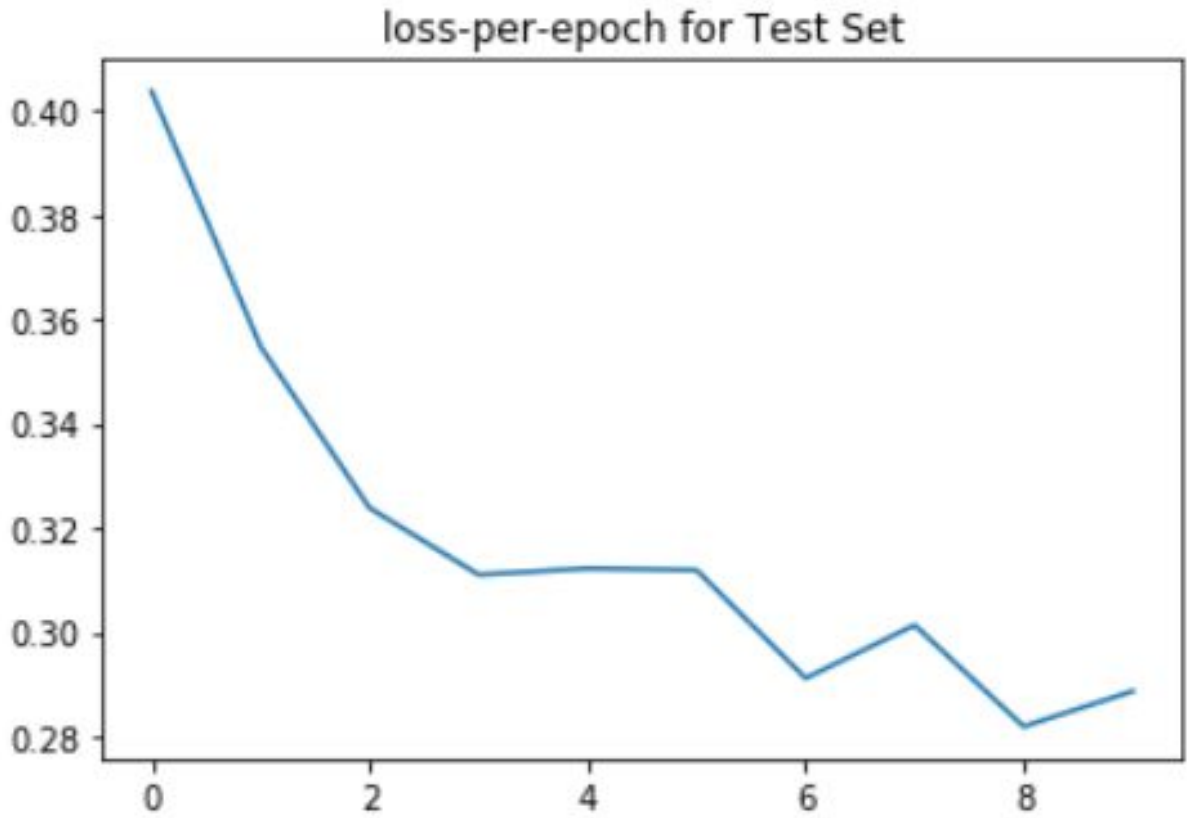
Accuracy on Train Set: 91.47005462646484
Accuracy on Test Set: 89.88999938964844

For SVM, we have considered “RBF” kernel with gamma= “scale” and, probability= “True”.
For CNN, we have considered a total of 4 layers: Convolutional, ReLU, Max-Pooling and Fully connected Layers.

- Conv2d(1,20,kernel_size=(3,3),stride=1)
- MaxPool2d(kernel_size=(3,3),stride=2))
- self.fc_layer=nn.Linear(12*12*20,10)

2.1.2





2.2.1

Accuracy of SVM Kernelized CNN on testing Set: 90.47

Accuracy of SVM Kernelized CNN on training Set: 92.71666666666666

2.2.2

Confusion Matrix of Test set:

```
[[888,   0,  12,  22,   6,   0,  63,   0,   9,   0],
 [  2, 970,   1,  17,   5,   0,   4,   0,   1,   0],
 [ 14,   0, 849,  10,  65,   0,  61,   0,   1,   0],
 [ 18,   5,   8, 929,  21,   0,  19,   0,   0,   0],
 [  2,   1,  48,  29, 872,   0,  47,   0,   1,   0],
 [  0,   0,   0,   1,   0, 977,   0,  15,   0,   7],
 [144,   3,  68,  26,  72,   0, 678,   0,   9,   0],
 [  0,   0,   0,   0,   0,   9,   0, 970,   0,  21],
 [  1,   1,   1,   4,   2,   1,   8,   4, 978,   0],
 [  1,   0,   0,   0,   0,   5,   0,  30,   0, 964]]
```

Confusion Matrix of train set:

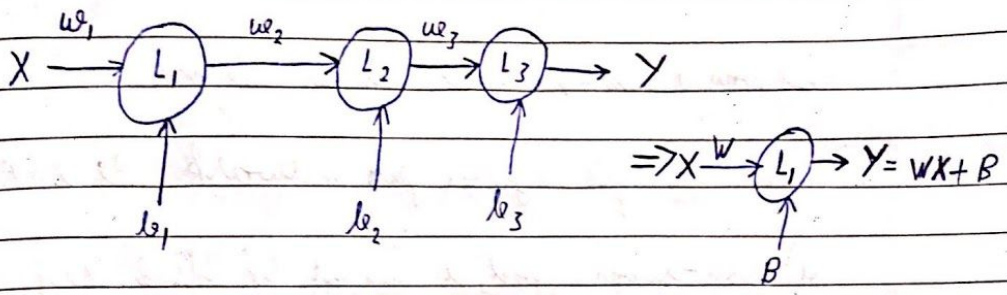
```
[[5367,    3,   70,  103,   13,    0,  427,    0,   17,    0],
 [   5, 5921,    2,   59,    4,    0,    6,    0,    3,    0],
 [  87,    2, 5217,   38,  370,    0,  281,    0,    5,    0],
 [  91,   11,   19, 5647,  130,    0,   97,    0,    5,    0],
 [   7,    7,  259,  137, 5311,    0,  274,    0,    5,    0],
 [   0,    0,    0,    0,    0, 5918,    0,   53,    6,   23],
 [ 639,    5,  356,  112,  320,    1, 4544,    0,   23,    0],
 [   0,    0,    0,    0,    0,   32,    0, 5864,    6,   98],
 [  10,    4,    6,    9,   12,    6,   24,    5, 5923,    1],
 [   0,    0,    0,    0,    1,   12,    0,  126,    1, 5860]]
```

2.3

From the accuracy reports and loss-per-epoch plots, we can clearly see that the accuracy of kernelized SVM is quite good as compared to Convolutional Neural Network. This is because of the fact that the convolutional neural network has already done the job if feature extraction and SVM simply classified the images.

Question 3

Ans.3)



$$Y = w_3\left[w_2\left(w_1 x + b_1\right) + b_2\right] + b_3$$

~~$Y = WX + B$, where $W = w_2$~~

$$Y = \underbrace{(w_1 w_2 w_3)}_{W} X + \underbrace{\left[w_2 w_3 b_1 + b_2 w_3 + b_3\right]}_{B}$$

So, $Y = WX + B$ — (1)

Both, W and B are linear.

No, neural network with linear activation function, of arbitrary depth be used to solve non linear problem (XOR problem).

Because (1) will behave as a single-layered perceptron no matter how many layers are there.

P.T.O.

Question 4

This way a multiple layer Neural Network will decompose into a single layered network. As XOR is a non-linear model, it can not be solved using a linear activation function.

Ans.4) Convolutional Neural Networks are better than neural networks because they (CNN) are more robust. A small translation or rotation will not affect CNN. But it will affect the simple Neural Network. Traditional NN ignores the local features in the image. They are also better because of sparse connectivity => Parameter sharing.

There are 4 major components of a CNN →

(A) Convolutional layer.

(B) ReLU Layer.

(C) Pooling Layer.

(D) Fully connected layer.

Each layer has it's own functionality, needs and advantage over other layers.

(A) Convolutional Layer – Performs convolution operation b/w feature vectors and the Kernel or mask. This layer is important because it is only based on local patterns to maintain a small number of network parameters.

(B) Rectified Linear Unit – It is an activation layer. This layer is important because it propagate gradient without reducing their magnitudes (unlike other activation fx^n). This layer is helpful in a network with multiple layers.

(C) Pooling Layer – It subSamples the features of the previous layer. It basically does down sampling of the features. This is useful in order to reduce the complexity of the network as it captures more complex patterns. There can be a max-Pooling, min-Pooling etc, depending upon the problem.

(D) Fully connected Layer – These are usually last layer in a CNN. Their output is feed into the Softmax layer, where higest value is selected as the final decision.

Question 5