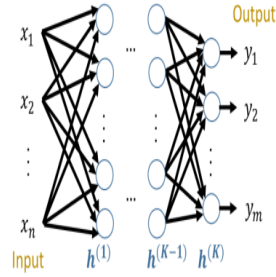


Neural Network HW2B

I. BACKPROPAGATION

Algorithm – Backpropagation for MLP

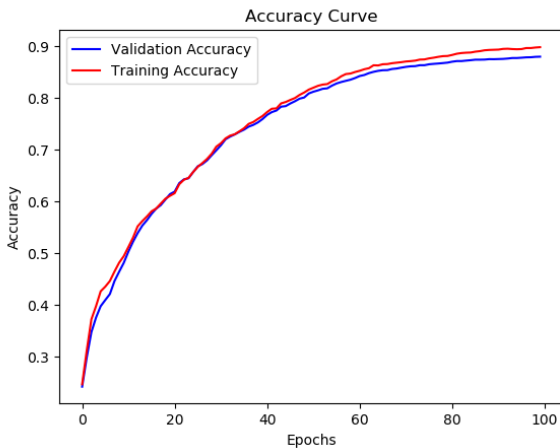
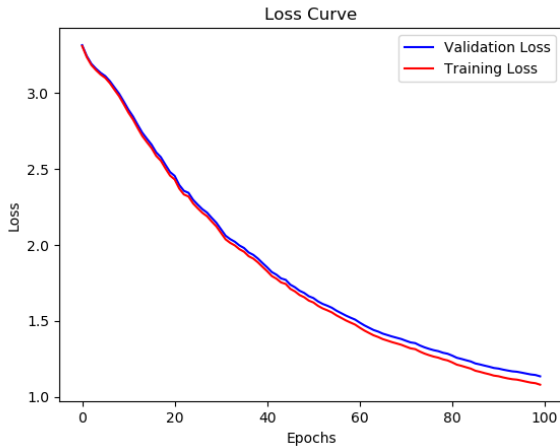
- 1 Run Forward Propagation
- 2 $G \leftarrow \nabla_{\hat{y}} L_y(\hat{y})$
- 3 **for** $k = K$ down to 1 **do**
- 4 $G \leftarrow \nabla_{a^{(k)}} L = G \odot g'(a^{(k)})$
- 5 $\nabla_{b^{(k)}} L = G + \lambda \cdot \nabla_{b^{(k)}} \Omega(\theta)$
- 6 $\nabla_{W^{(k)}} L = h^{(k-1)} \cdot G^T + \lambda \cdot \nabla_{W^{(k)}} \Omega(\theta)$
- 7 $G \leftarrow \nabla_{h^{(k-1)}} L = W^{(k)} \cdot G$
- 8 **end for**



This algorithm was used for implementing backpropagation provided.

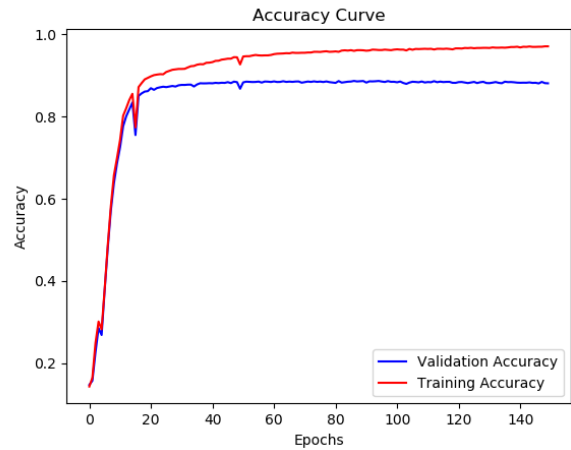
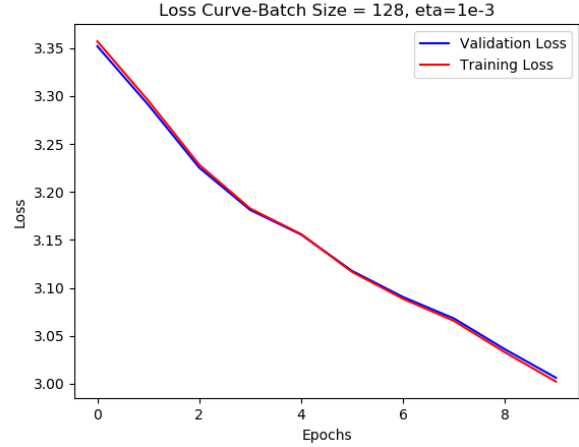
II. HYPERPARAMETERS

A. Using Original Code



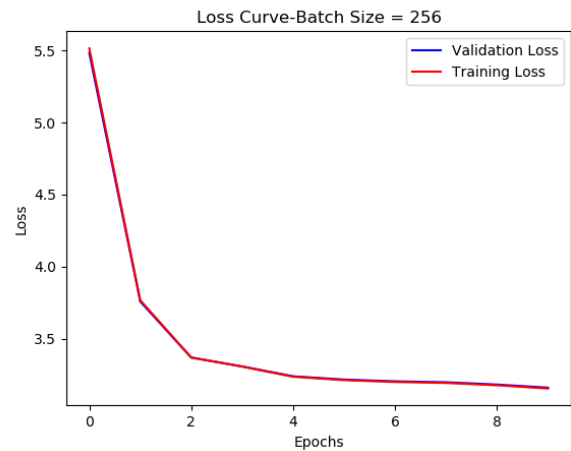
First, using 3 layers NN, with one 20 units, batch size of 128, learning rate of 1e-3.

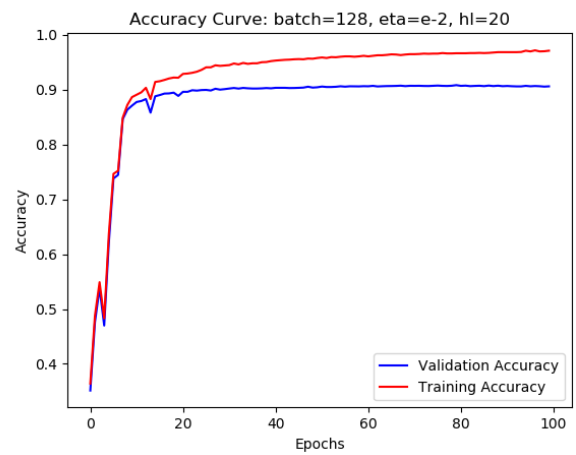
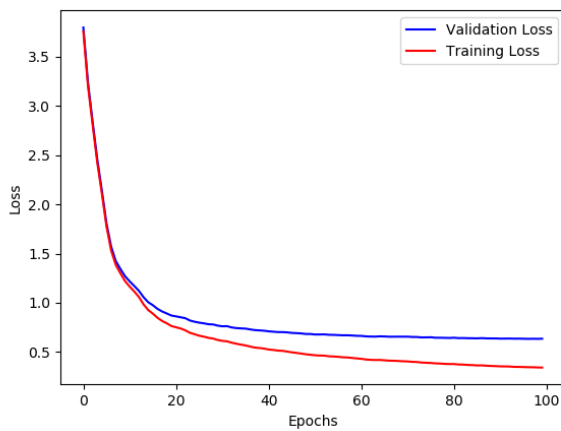
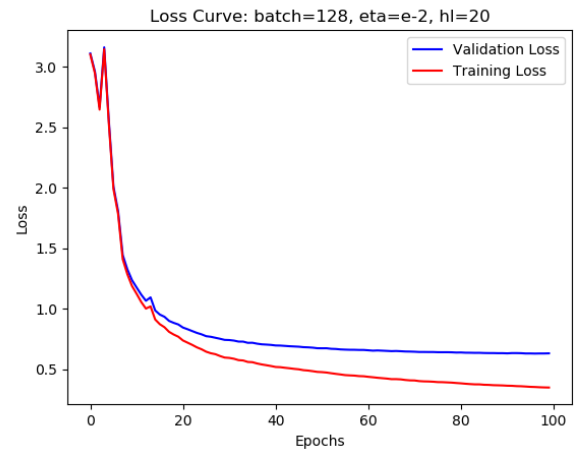
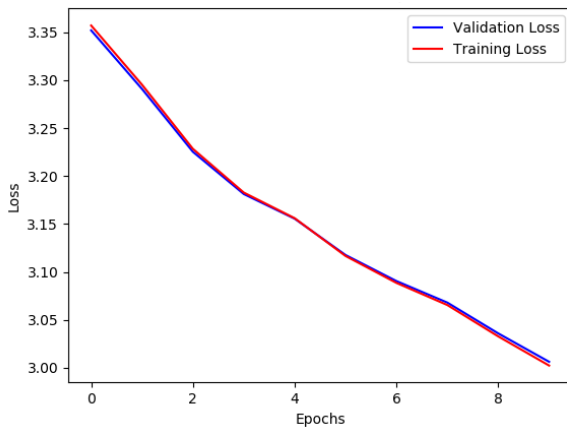
B. Changing Learning Rate eta:



Using eta = 1e-2 improves performance of the NN.

C. Batch Size

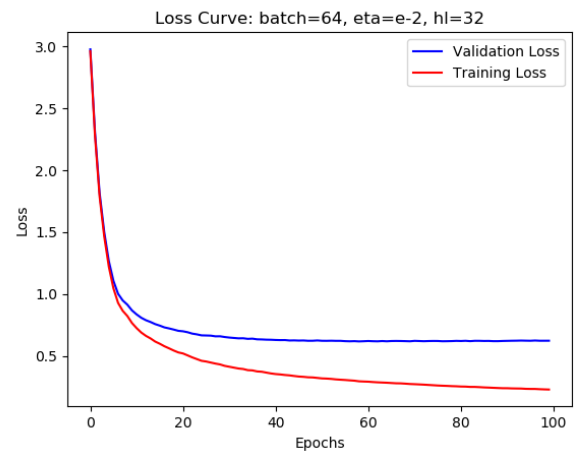


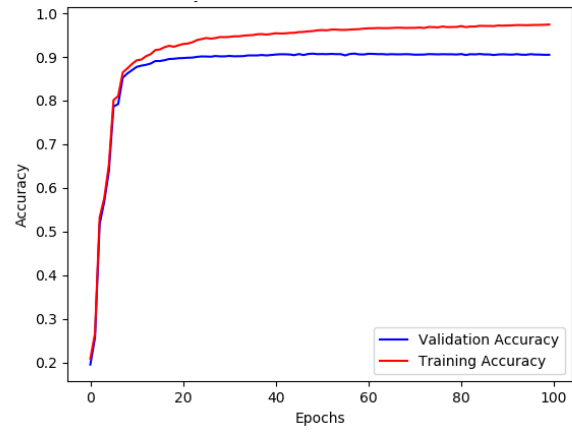
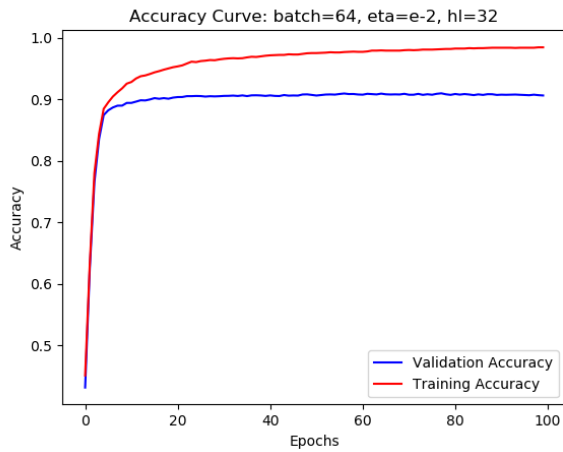


We can see that I get pretty good accuracy for batch size of 64 against 128 & 256.

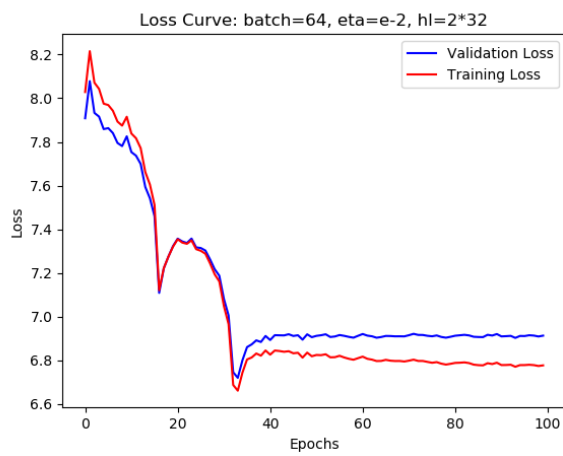
D. Neurons in hidden layer

Changing neuron number for hidden layer doesn't seem to improve a lot of in terms of performance. But neurons for 32 gives smooth graph without any spikes.





Also, increasing hidden layers did not improve efficiency at all, it was even worst.



```
Anaconda Prompt (Anacondas)
[Validation accuracy]: 9069 / 10000
Epoch 96 training complete
[training loss]: 0.23297026004224305
[training accuracy]: 2951 / 3000
[Validation loss]: 0.6245956557377634
[Validation accuracy]: 9065 / 10000
Epoch 97 training complete
[training loss]: 0.23094403607217312
[training accuracy]: 2951 / 3000
[Validation loss]: 0.6227130196434834
[Validation accuracy]: 9074 / 10000
Epoch 98 training complete
[training loss]: 0.22949476836315622
[training accuracy]: 2953 / 3000
[Validation loss]: 0.6228260463097305
[Validation accuracy]: 9066 / 10000
Epoch 99 training complete
[training loss]: 0.22830109976627333
[training accuracy]: 2953 / 3000
[Validation loss]: 0.6229528245169873
[Validation accuracy]: 9061 / 10000
Testing: 9030/10000
PLOTING
```

III. CONCLUSION

Finally a NN with batch size of 64, learning rate of $1e-2$ and neurons in hidden layer of 32 was chosen which gave accuracy of 90.30 % on test set.

