Deep Learning | Assignment 3 Report | Classification of MNIST Using Pytorch

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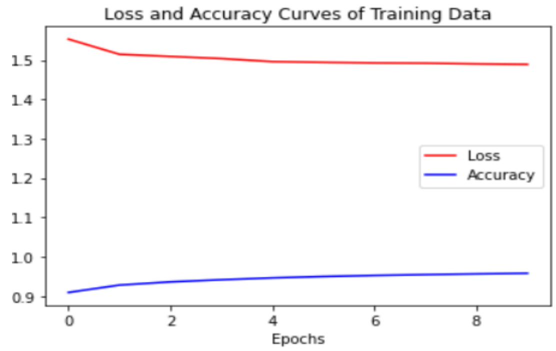
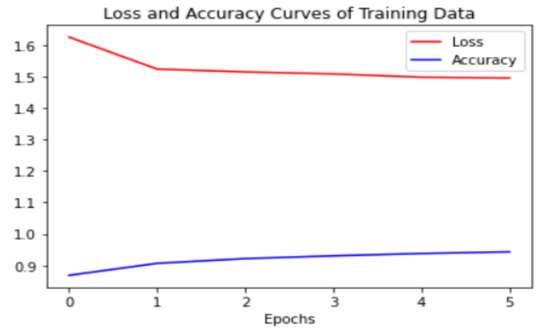
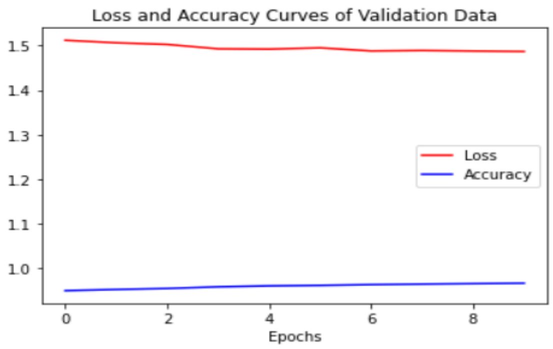
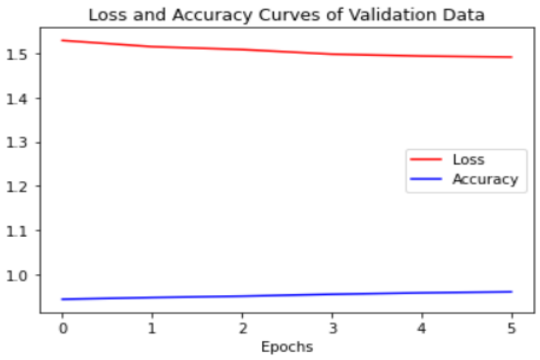
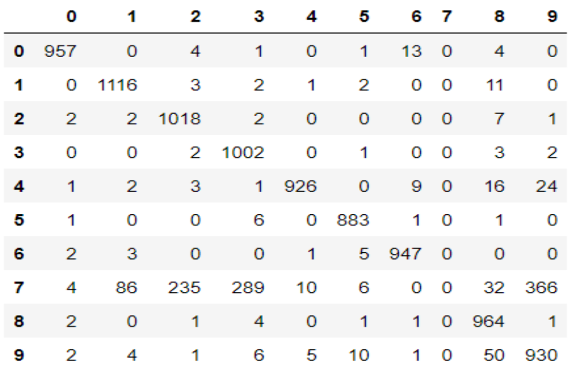
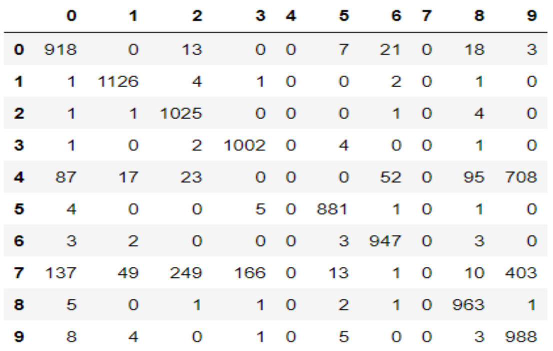
Compare results of simple convolution block base architecture vs mobilenet block based architecture and report results with reasoning.

METRICS	Architecture 1 with MobileNet Blocks	Architecture 2 Standard Convolution Block without MobileNet Blocks
Training Accuracy	0.9578	0.9431
Loss Accuracy Curve of Training Set		
Validation Accuracy	0.9657	0.9606
Loss Accuracy Curve of Validation Set		
Test Accuracy	0.8743000000000001	0.785
Recall	0.8771143140838301	0.7858181027056627

Confusion Matrix



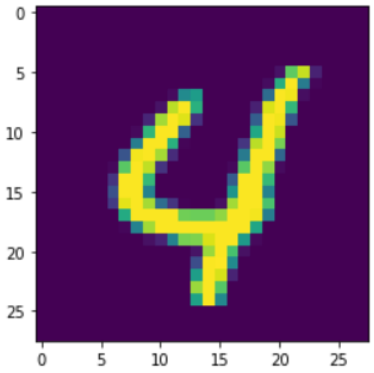
	0	1	2	3	4	5	6	7	8	9
0	957	0	4	1	0	1	13	0	4	0
1	0	1116	3	2	1	2	0	0	11	0
2	2	2	1018	2	0	0	0	0	7	1
3	0	0	2	1002	0	1	0	0	3	2
4	1	2	3	1	926	0	9	0	16	24
5	1	0	0	6	0	883	1	0	1	0
6	2	3	0	0	1	5	947	0	0	0
7	4	86	235	289	10	6	0	0	32	366
8	2	0	1	4	0	1	1	0	964	1
9	2	4	1	6	5	10	1	0	50	930



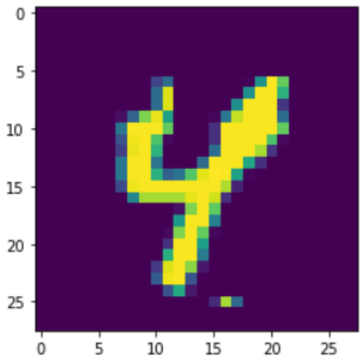
	0	1	2	3	4	5	6	7	8	9
0	918	0	13	0	0	7	21	0	18	3
1	1	1126	4	1	0	0	2	0	1	0
2	1	1	1025	0	0	0	1	0	4	0
3	1	0	2	1002	0	4	0	0	1	0
4	87	17	23	0	0	0	52	0	95	708
5	4	0	0	5	0	881	1	0	1	0
6	3	2	0	0	0	3	947	0	3	0
7	137	49	249	166	0	13	1	0	10	403
8	5	0	1	1	0	2	1	0	963	1
9	8	4	0	1	0	5	0	0	3	988

Figures along with labels for correct predictions and wrong ones.

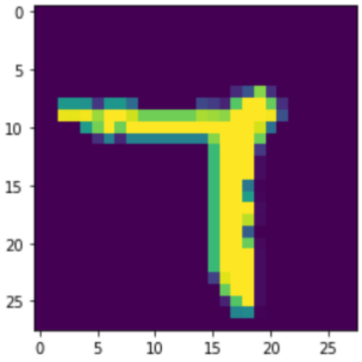
a. Architecture 1 with MobileNet Blocks



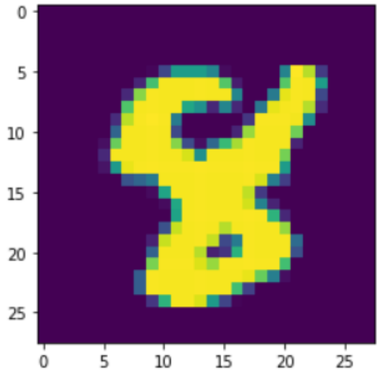
```
Predicted: 9
Ground Truth: 4
```



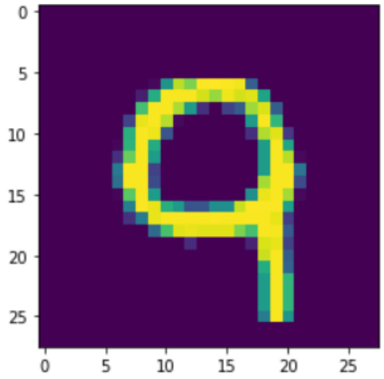
```
Predicted: 8
Ground Truth: 4
```



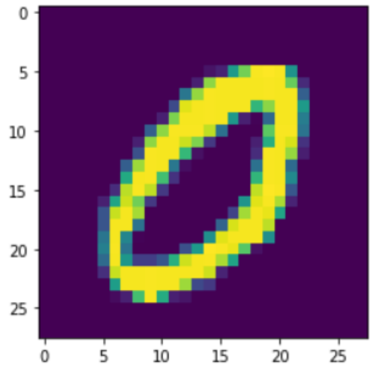
```
Predicted: 3
Ground Truth: 7
```



```
Predicted: 8
Ground Truth: 8
```

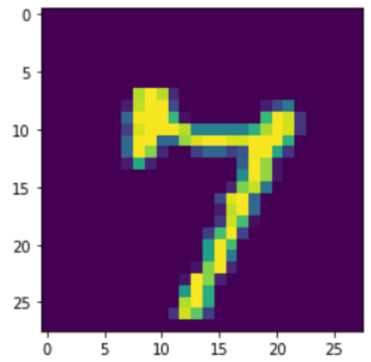


```
Predicted: 9
Ground Truth: 9
```

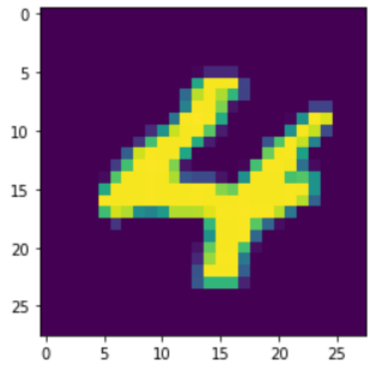


```
Predicted: 0
Ground Truth: 0
```

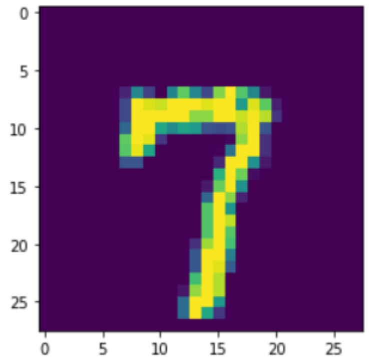
b. **Architecture 2 Standard Convolution Block without MobileNet Blocks.**



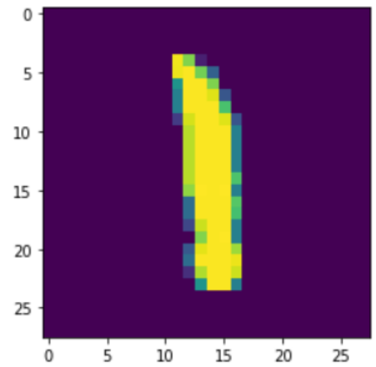
```
Predicted: 9
Ground Truth: 7
```



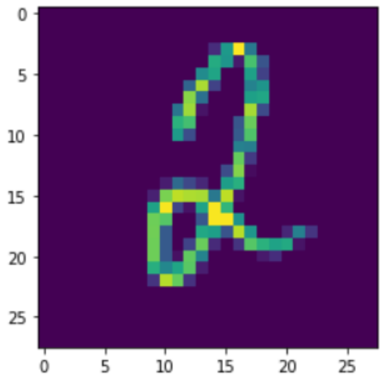
```
Predicted: 9
Ground Truth: 4
```



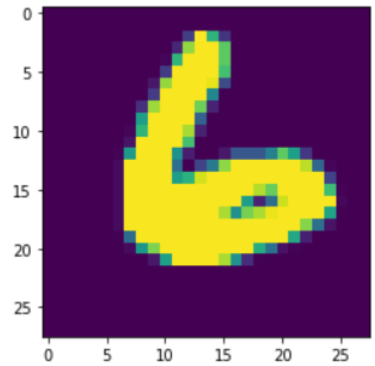
```
Predicted: 9
Ground Truth: 7
```



```
Predicted: 1
Ground Truth: 1
```



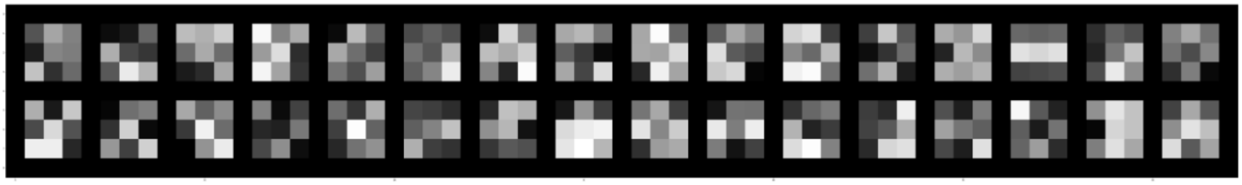
```
Predicted: 2
Ground Truth: 2
```



```
Predicted: 6
Ground Truth: 6
```

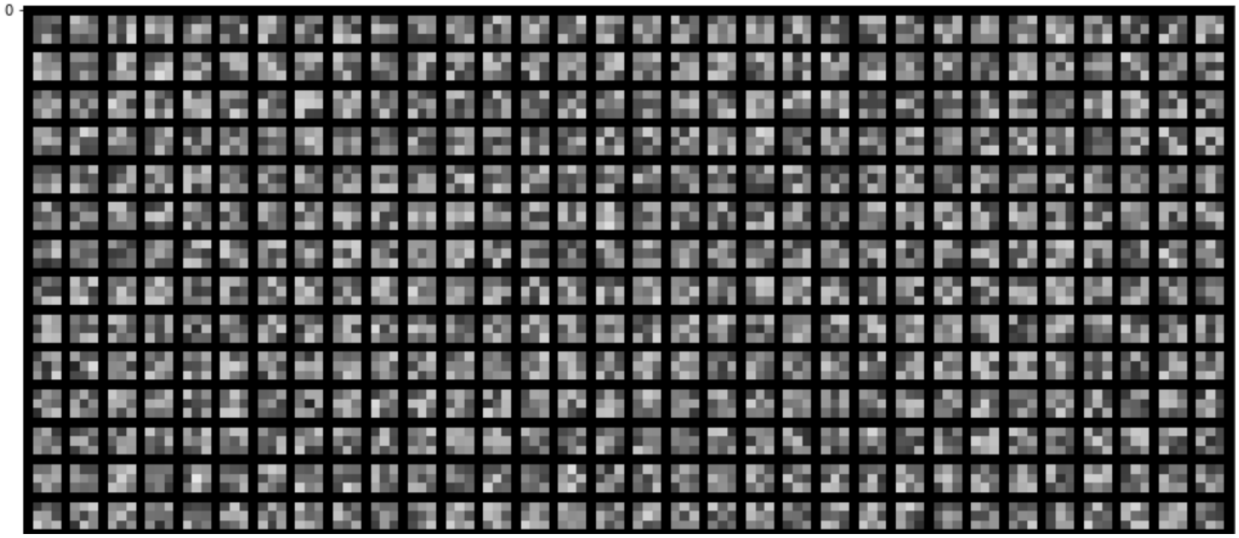
Plot learned filters of your last convolution layer using matplotlib.

a. **Architecture 2 Standard Convolution Block without MobileNet Blocks.**
First convolutional layer's learned filters:

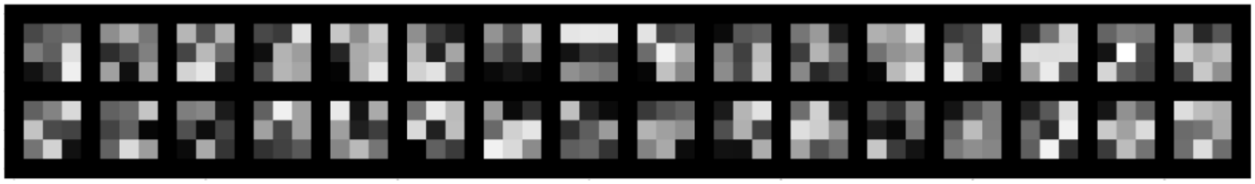


`

Last convolutional layer's learned Filters:
[Posting a snippet as the filters size is too big for a screenshot]

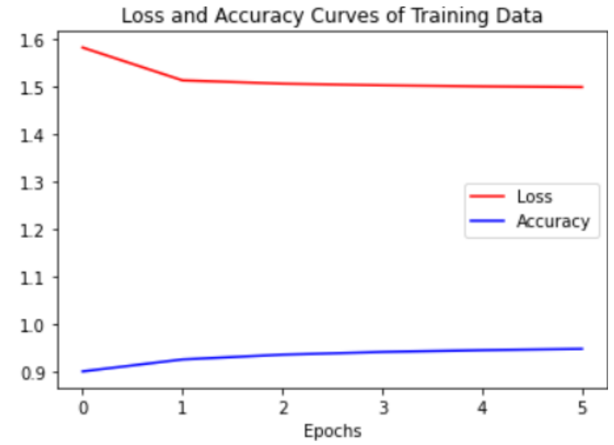
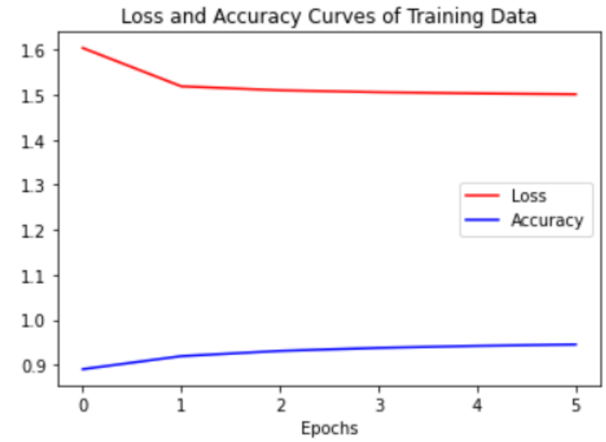
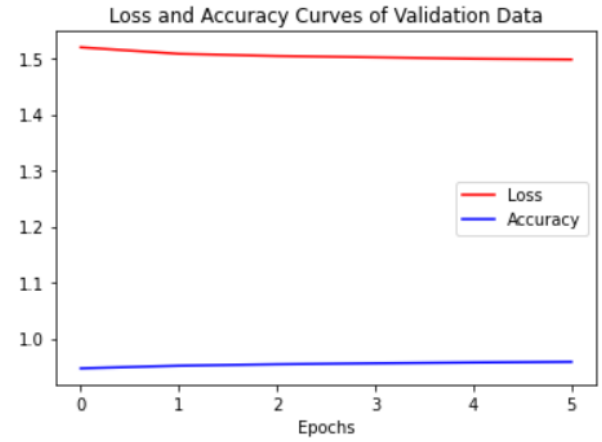
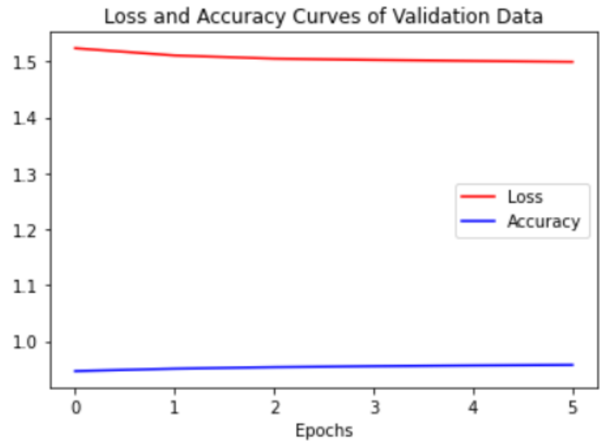


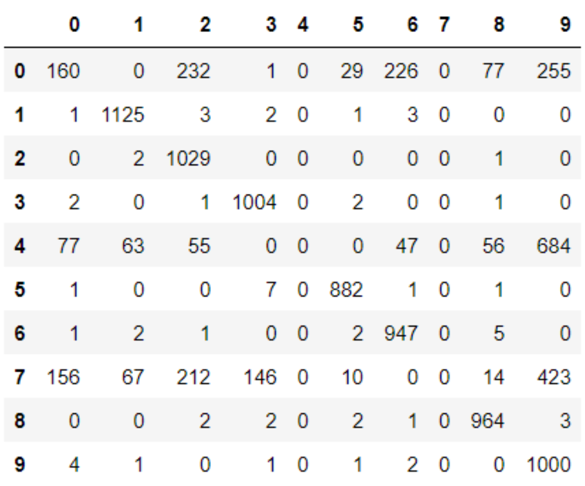
b. **Architecture 1 with MobileNet Blocks**
First convolutional layer's learned filters:



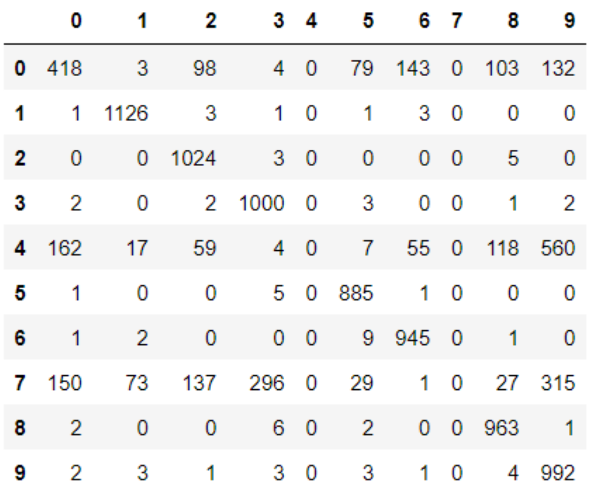
Last convolutional layer's learned filters:
[Posting a snippet as the filters size is too big for a screenshot]

Use no of different conv block and mobileNet block and compare its accuracy

1 convBlock 3 mobileNetBlocks	3 convBlocks 1 mobileNetBlock
TRAINING ACCURACY: 0.9484	TRAINING ACCURACY: 0.9452
	
VALIDATION ACCURACY: 0.9584	VALIDATION ACCURACY: 0.9576
	
RECALL: 0.710372748265324	RECALL: 0.7351388698526621
TEST ACCURACY 0.7111000000000002	TEST ACCURACY 0.7353

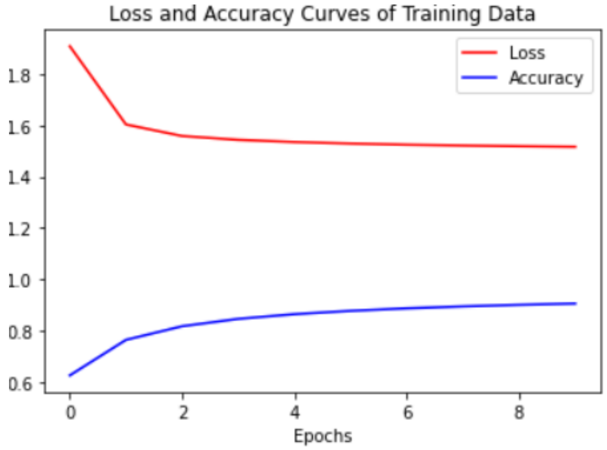
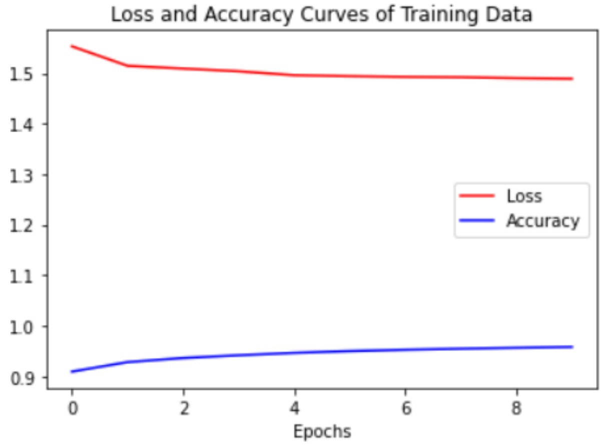


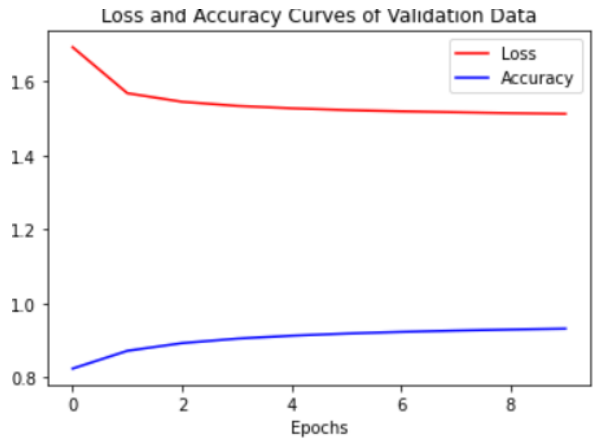
	0	1	2	3	4	5	6	7	8	9
0	160	0	232	1	0	29	226	0	77	255
1	1	1125	3	2	0	1	3	0	0	0
2	0	2	1029	0	0	0	0	0	1	0
3	2	0	1	1004	0	2	0	0	1	0
4	77	63	55	0	0	0	47	0	56	684
5	1	0	0	7	0	882	1	0	1	0
6	1	2	1	0	0	2	947	0	5	0
7	156	67	212	146	0	10	0	0	14	423
8	0	0	2	2	0	2	1	0	964	3
9	4	1	0	1	0	1	2	0	0	1000



	0	1	2	3	4	5	6	7	8	9
0	418	3	98	4	0	79	143	0	103	132
1	1	1126	3	1	0	1	3	0	0	0
2	0	0	1024	3	0	0	0	0	5	0
3	2	0	2	1000	0	3	0	0	1	2
4	162	17	59	4	0	7	55	0	118	560
5	1	0	0	5	0	885	1	0	0	0
6	1	2	0	0	0	9	945	0	1	0
7	150	73	137	296	0	29	1	0	27	315
8	2	0	0	6	0	2	0	0	963	1
9	2	3	1	3	0	3	1	0	4	992

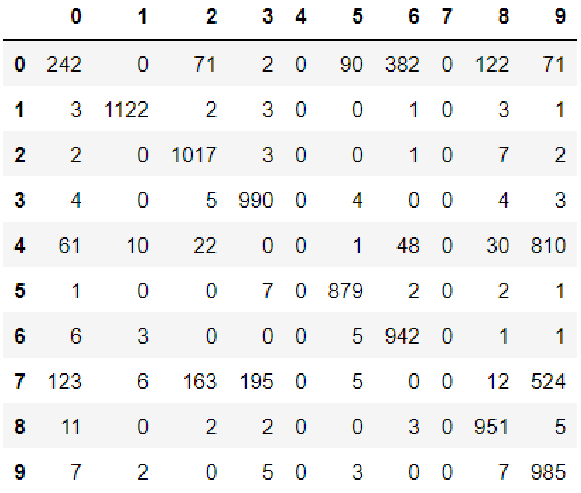
Report the accuracy by changing loss functions, batch size, learning rate, epochs, and the ratio of training and testing data, etc.

Epochs = 10, Optimizer= SGD, lr= 0.001, 80 to 20 ratio of train to test	**Epochs = 10, Optimizer= ADAM, lr= 0.001, 80 to 20 ratio of train to test**
TRAINING ACCURACY: 0.9052	TRAINING ACCURACY: 0.9578
Loss and Accuracy Curves of Training Data  	Loss and Accuracy Curves of Training Data 
VALIDATION ACCURACY: 0.9315	VALIDATION ACCURACY: 0.9657

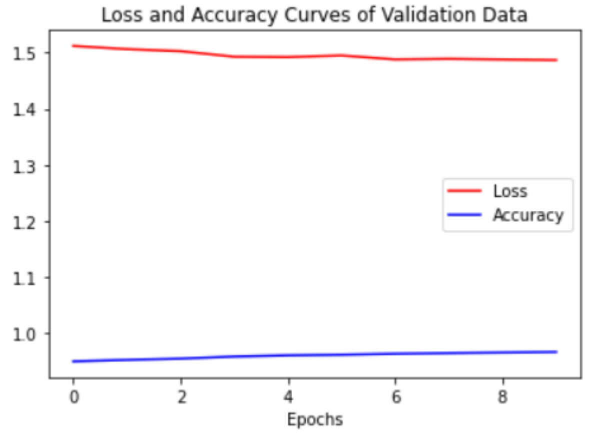


RECALL: 0.7122472824989527

TEST ACCURACY 0.7128000000000001

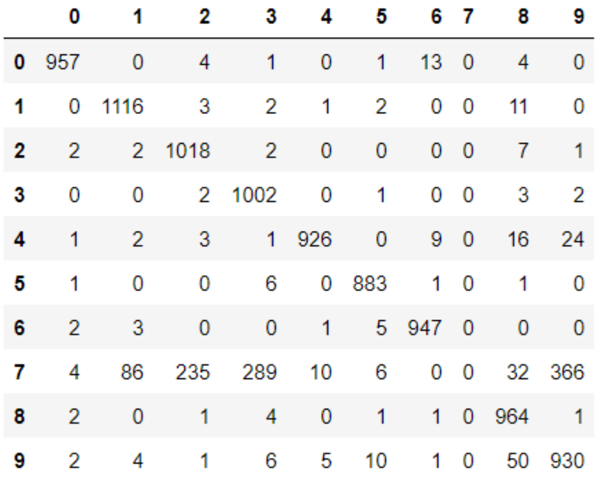


	0	1	2	3	4	5	6	7	8	9
0	242	0	71	2	0	90	382	0	122	71
1	3	1122	2	3	0	0	1	0	3	1
2	2	0	1017	3	0	0	1	0	7	2
3	4	0	5	990	0	4	0	0	4	3
4	61	10	22	0	0	1	48	0	30	810
5	1	0	0	7	0	879	2	0	2	1
6	6	3	0	0	0	5	942	0	1	1
7	123	6	163	195	0	5	0	0	12	524
8	11	0	2	2	0	0	3	0	951	5
9	7	2	0	5	0	3	0	0	7	985



RECALL: 0.8771143140838301

TEST ACCURACY 0.8743000000000001



	0	1	2	3	4	5	6	7	8	9
0	957	0	4	1	0	1	13	0	4	0
1	0	1116	3	2	1	2	0	0	11	0
2	2	2	1018	2	0	0	0	0	7	1
3	0	0	2	1002	0	1	0	0	3	2
4	1	2	3	1	926	0	9	0	16	24
5	1	0	0	6	0	883	1	0	1	0
6	2	3	0	0	1	5	947	0	0	0
7	4	86	235	289	10	6	0	0	32	366
8	2	0	1	4	0	1	1	0	964	1
9	2	4	1	6	5	10	1	0	50	930

Conclusion:

MobileNet architecture is much more efficient than standard convolution neural networks in terms of parameters and hence the cost. Introducing mobile net blocks slightly decreases the accuracy as the network has less complexity due to reduced number of weights. Overall, in terms of accuracy the difference is very minimal, but the network size reduces significantly.