

# Assignment 2 Report

## Group Members:

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The MNIST dataset contains 60,000 training examples of which 10,000 examples were used for testing.

To overcome the problem of over-fitting, regularization can be applied to avoid complexity in the neural network even if it leads to a less accurate learning rule.

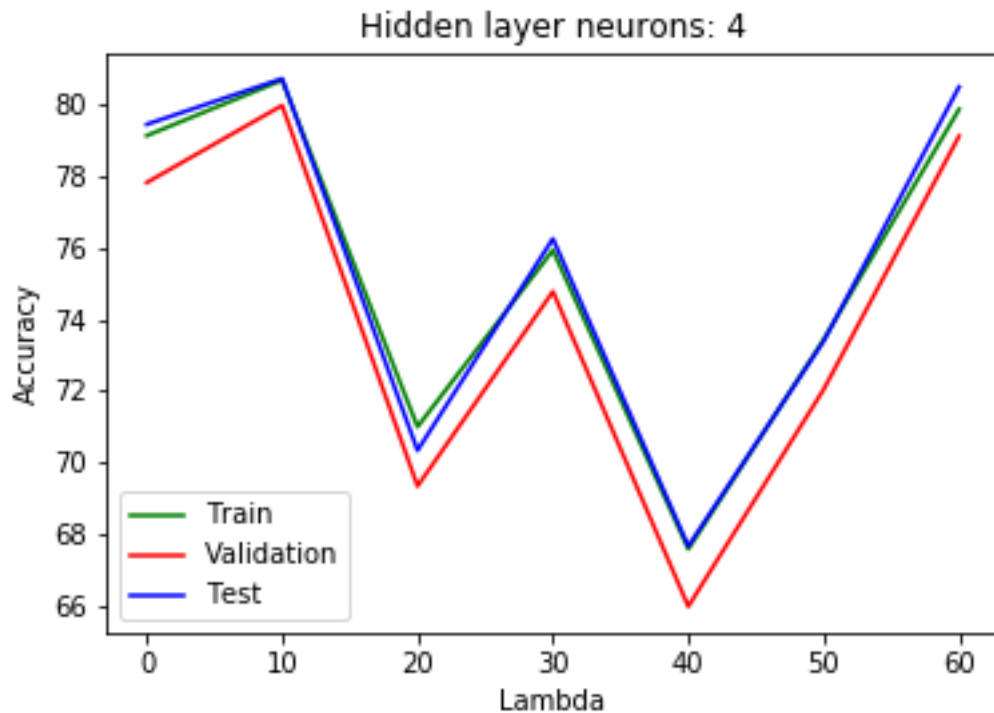
The results obtained were as follows:

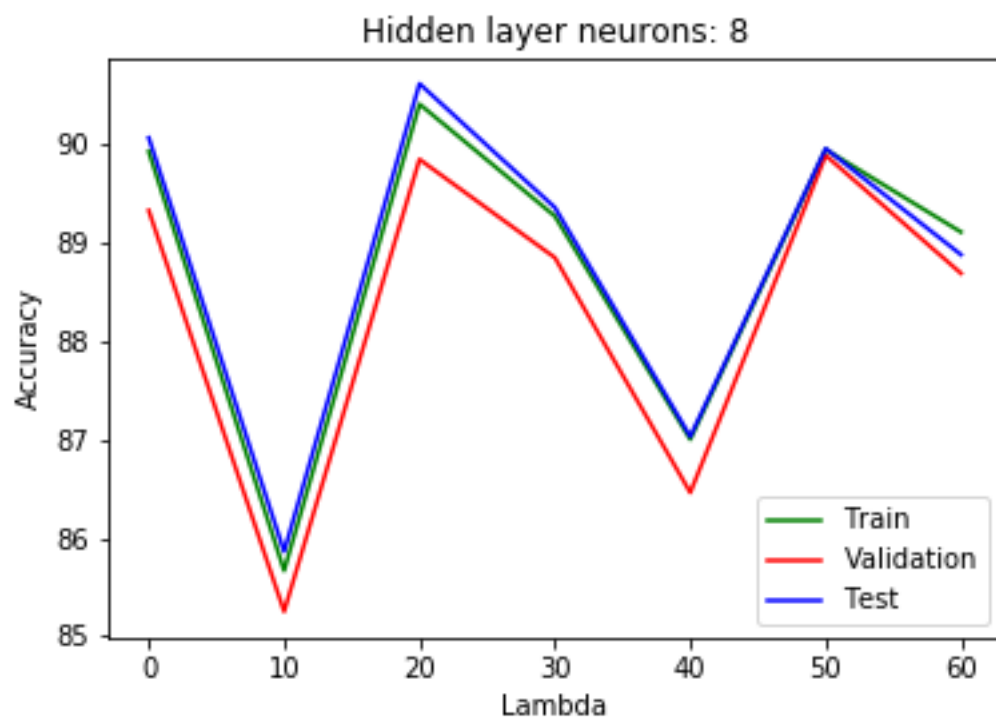
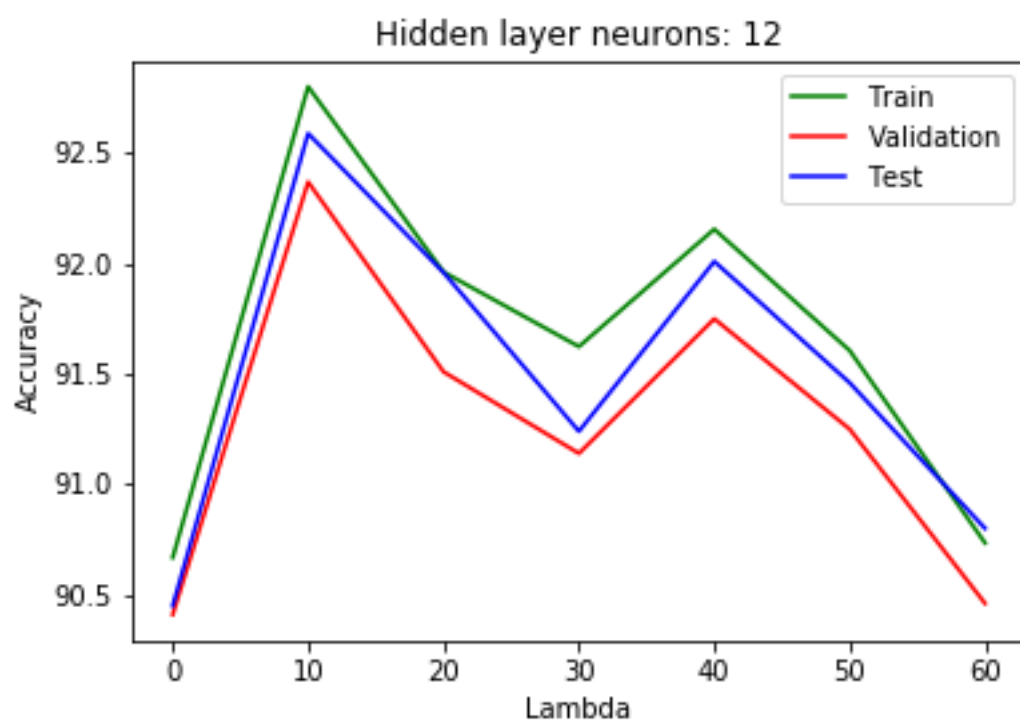
Neurons	Lambda	Training Accuracy	Validation Accuracy	Test Accuracy	Execution Time
4	0	79.144	77.83	79.46	36.735395
4	10	80.696	79.99	80.74	36.353194
4	20	70.992	69.33	70.33	33.438556
4	30	75.936	74.78	76.26	40.492816
4	40	67.564	65.96	67.65	33.417834
4	50	73.436	72.04	73.39	35.181007
4	60	79.884	79.13	80.51	41.77168
8	0	89.93	89.33	90.07	55.227985
8	10	85.666	85.25	85.86	53.286098
8	20	90.412	89.85	90.62	50.133207
8	30	89.272	88.85	89.36	50.045499
8	40	87	86.46	87.03	48.942037
8	50	89.95	89.89	89.96	55.216143
8	60	89.11	88.69	88.88	52.554599
12	0	90.668	90.41	90.45	56.295632
12	10	92.802	92.37	92.59	67.338038
12	20	91.962	91.51	91.96	74.071944
12	30	91.624	91.14	91.24	76.728945
12	40	92.156	91.75	92.01	61.500176
12	50	91.606	91.25	91.46	74.40139

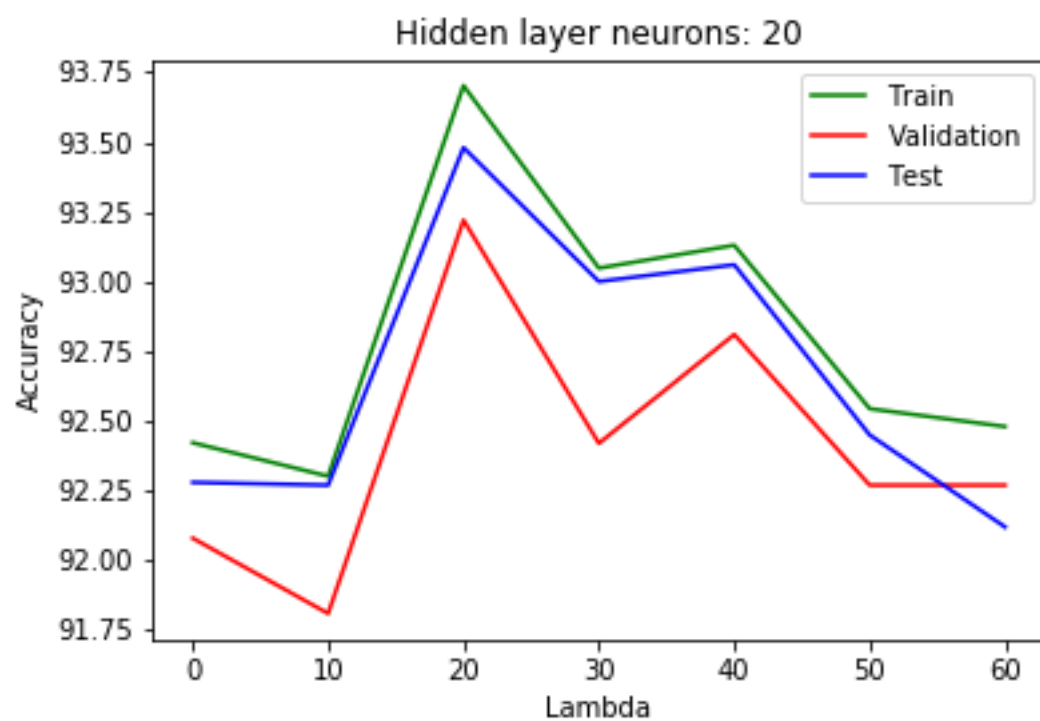
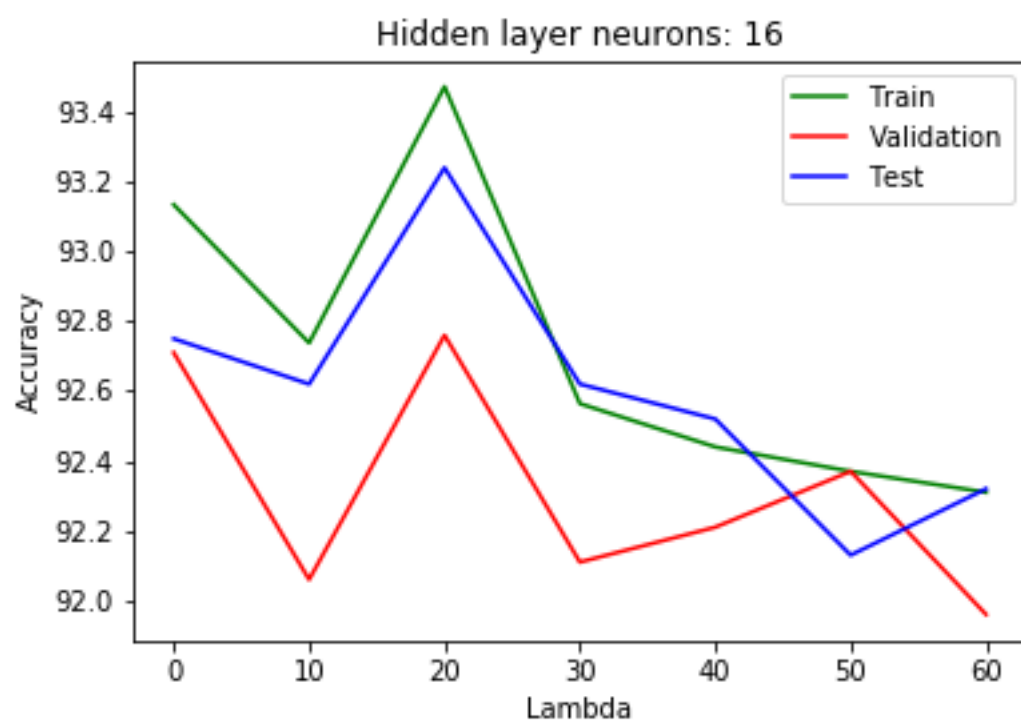
12	60	90.734	90.46	90.8	71.814382
16	0	93.134	92.71	92.75	48.514163
16	10	92.738	92.06	92.62	54.721375
16	20	93.472	92.76	93.24	78.116074
16	30	92.564	92.11	92.62	60.418555
16	40	92.44	92.21	92.52	46.311029
16	50	92.37	92.37	92.13	45.692616
16	60	92.31	91.96	92.32	44.359222
20	0	92.422	92.08	92.28	49.879307
20	10	92.302	91.81	92.27	49.695451
20	20	93.702	93.22	93.48	48.384475
20	30	93.048	92.42	93	48.744077
20	40	93.13	92.81	93.06	48.855366
20	50	92.544	92.27	92.45	50.318161
20	60	92.48	92.27	92.12	49.558784

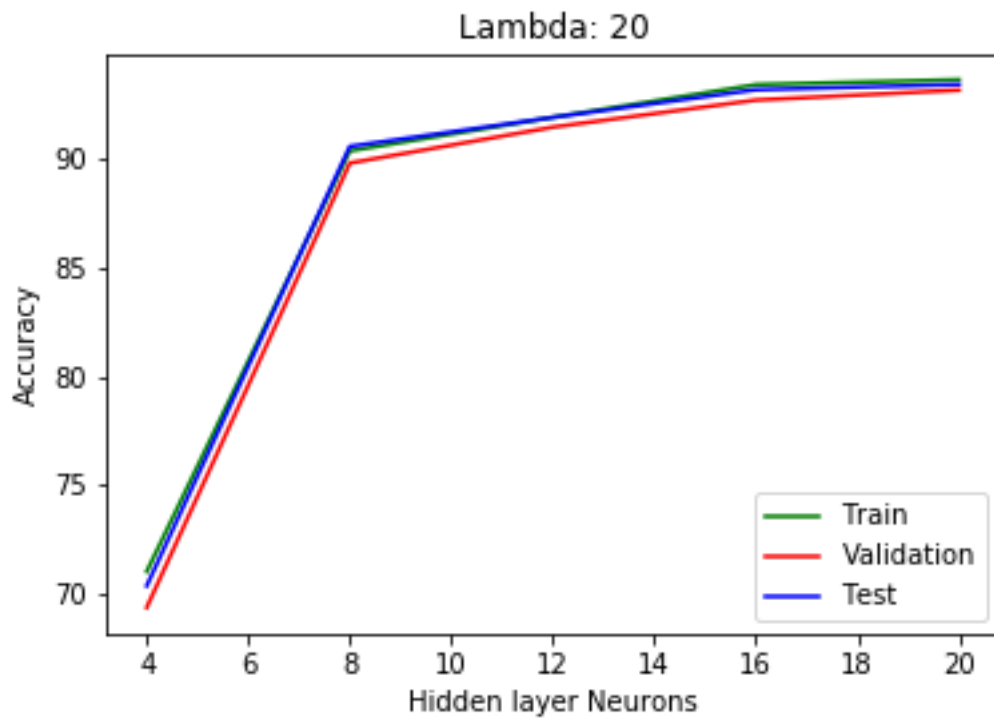
Thus, maximum accuracy for validation is obtained when we have **20 neurons and  $\lambda = 20$**  as hyper-parameters based on validation data accuracy.

The graphs comparing accuracy against lambda for different number of neurons are as follows:









**Accuracy and training time for hand-written digit test data:**

Iterations	Test Accuracy	Time (MM:SS)
Before Optimization	18.6%	00:00
1	17.2%	00:00
100	67%	00:90
1000	93.5%	03:80
10,000	98.6%	28:14

## **Accuracy of classification method on CelebA dataset**

The accuracy of deep Neural Network for CelebA data for training, validation and test data were as follows:

**Number of hidden neurons: 256**

**Lambda: 20**

**Iterations: 50**

<b>Data Type</b>	<b>Accuracy</b>
Training	84.97%
Validation	83.60%
Test	85.04%

For deep neural network, the accuracy obtained for different number of hidden layers was as follows:

**Learning rate: 0.001**

**Training epoch: 100**

**Batch size: 100**

**Number of hidden neurons at each layer: 256**

<b>Number of Hidden Layers</b>	<b>Accuracy</b>
3	81.39%
5	81.98%
7	84.14%