

**CSE 4/574 INTRODUCTION TO MACHINE LEARNING
ASSIGNMENT 2**

TEAMMATES

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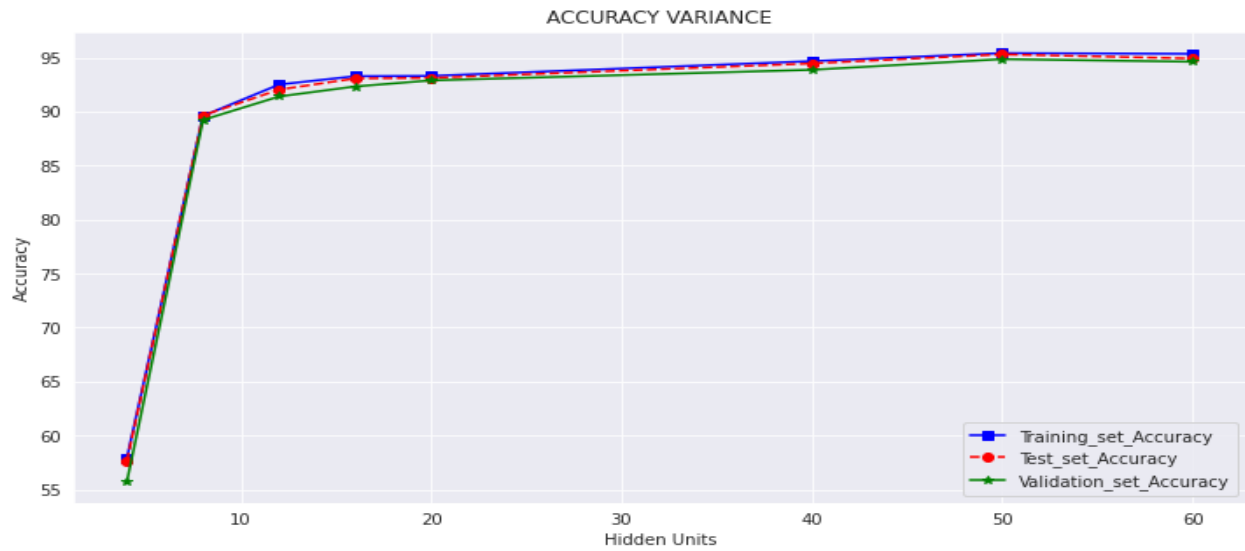
PART -1 : CHOOSING THE HYPER PARAMETER FOR NEURAL NETWORK

For this we first need to find the optimal number of hidden units and lambda

1) We find the optimal number of hidden units by keeping lambda constant. We set lambda to 0 and calculate the value for different hidden units. The values obtained are shown in the table below

Hidden unit values	Training set accuracy	Test set accuracy	Validation set accuracy
4	57.92	57.67	55.75
8	89.594	89.64	89.22
12	92.50	92.03	91.39
16	93.268	93.06	92.32
20	93.296	93.11	92.88
40	94.66	94.45	93.86
50	95.406	95.29	94.85
60	95.342	94.91	94.61

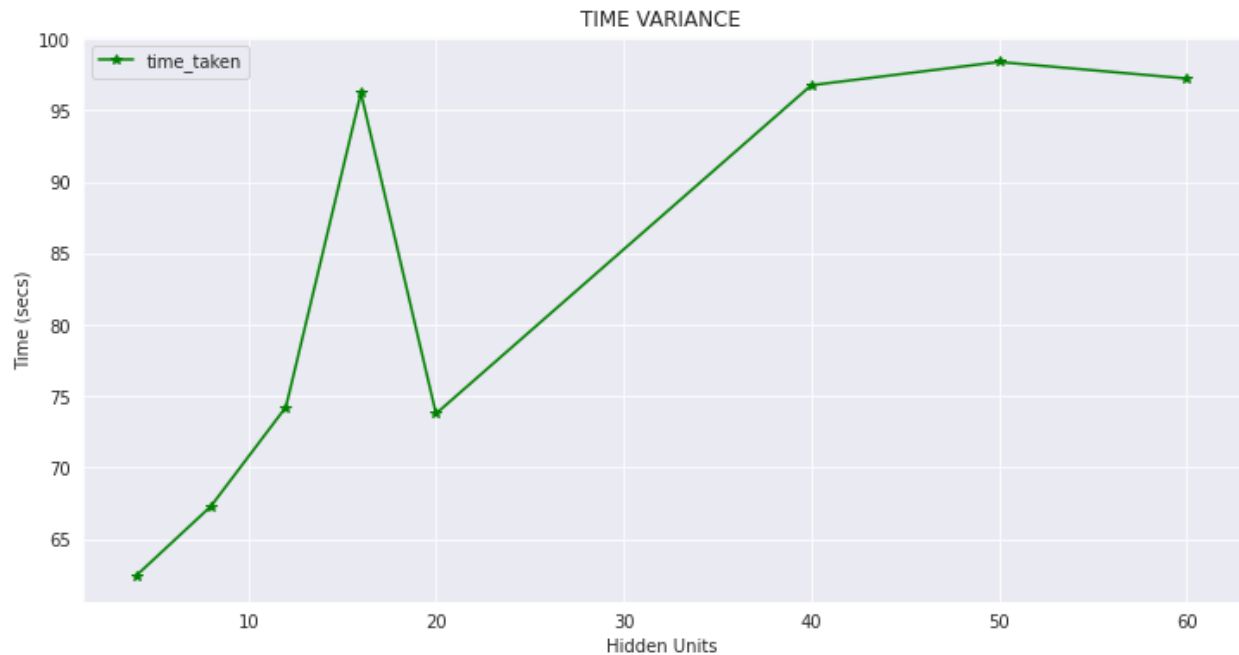
The graphs are shown below



TIME VARIANCE ESTIMATION

Hidden Unit	Time
4	62.4
8	67.28
12	74.23
16	96.22
20	73.77
40	96.76
50	98.39
60	97.23

GRAPHS:



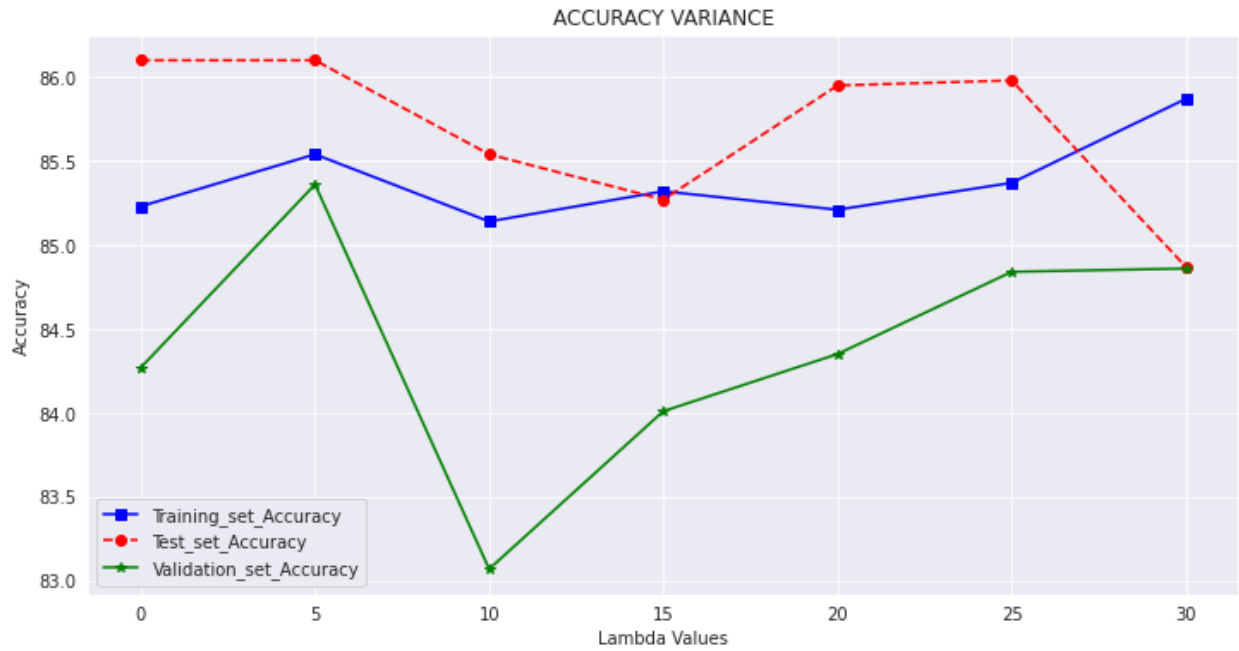
OBSERVATIONS:

The accuracy peaked at the value of 50 and then decreased when we varied the hidden unit values. When it comes to time, the value peaked around 15 and then decreased at 20 and started increasing again. But since we are looking at accuracy, we set the value to 50 where it is at the maximum.

2) We find the optimal number of lambda by keeping hidden units constant. We set the hidden unit to a constant value and calculate the value for different lambda. The values obtained are shown in the table below

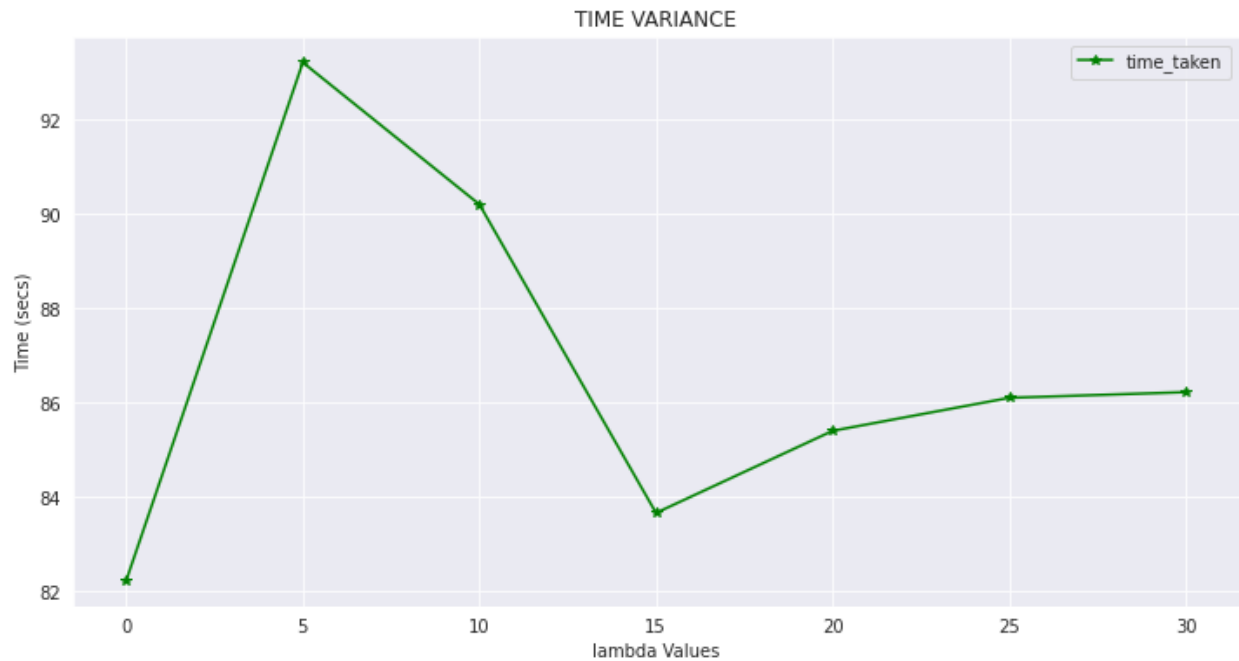
Lambda	Training set	Test Set	Validation set
0	85.23	86.10	84.27
5	85.73	86.10	85.36
10	85.14	85.54	83.07
15	85.32	85.27	84.01
20	85.21	85.95	84.35
25	85.37	85.98	84.84
30	85.20	84.87	84.86

GRAPHS:



TIME VARIANCE:

Lambda	Time
0	82.23
5	93.21
10	90.2
15	83.66
20	85.40
25	86.10
30	86.22



OBSERVATIONS:

Here, we can observe that we obtain maximum accuracy at 5 which later decreases according to the Accuracy graph. Hence, we take lambda value as 5.

Hyper -Parameters	Optimal Value
Hidden Unit	50
Lambda	5
Accuracy	Training Set - 95.40% Validation Set - 94.85% Test Set - 95.29%
Time (In Secs)	98.39

PART-2: COMPARING THE RESULTS OF NEURAL NETWORK WITH ONE HIDDEN LAYER AND DEEP NEURAL NETWORK ON THE CELEBA DATASET

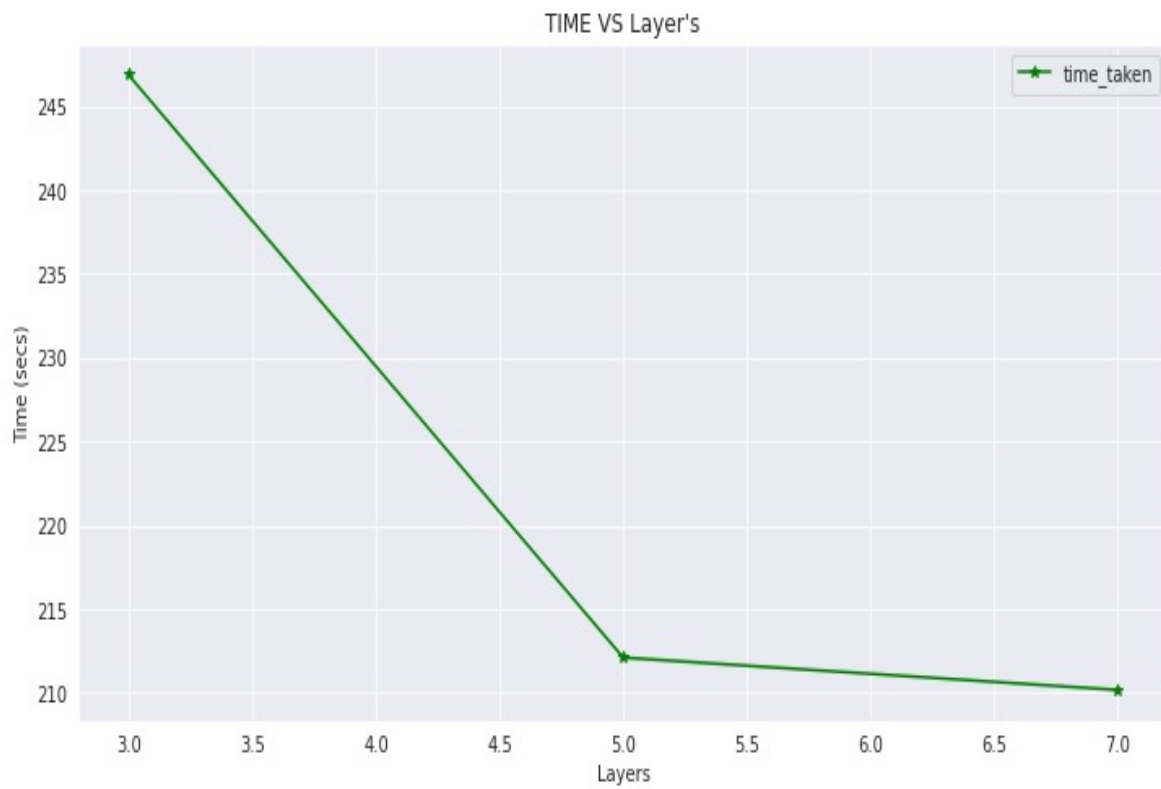
Here, we compare the results of our Neural Network with one hidden layer and deep neural network on CelebA dataset.

Facennscript observations :

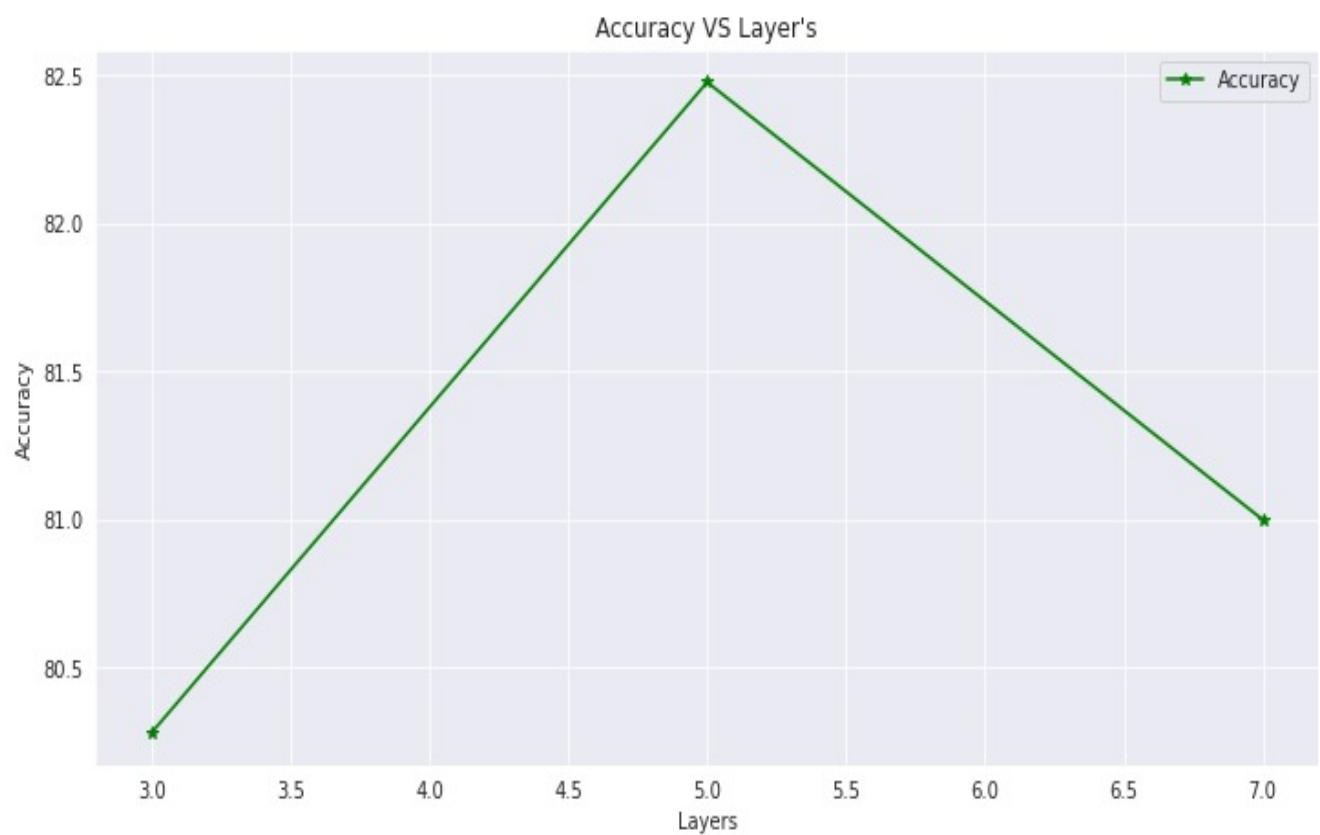
Hyper -Parameters	Optimal Value	Default Value
Hidden Unit	50	256
Lambda	5	10
Accuracy	Training Set - 85.6373459716% Validation Set - 86.10332965% Test Set - 85.3692781476%	Training Set - 85.0521327014218% Validation Set - 84.91557223264% Test Set - 85.29535957607873%
Time (In Secs)	107.39	183.65132400603034

Deepnnscrip observations:

Layers	Accuracy
3	80.28009
5	82.4754
7	80.999243



Layers	Time
3	246.87697
5	212.11057
7	210.1787352



PART-3: CONVOLUTIONAL NEURAL NETWORK

The various parameters obtained are as follows:

The accuracy for test error is 98.7% and Average loss is 0.038312.

Time usage: 0:08:12

The output obtained is as shown below

Test Error:

Accuracy: 10.9%, Avg loss: 2.301893

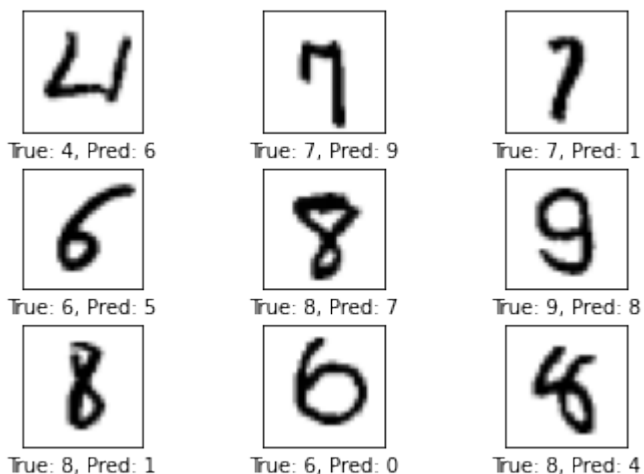
```
loss: 2.311470 [ 0/60000]
loss: 1.484645 [ 6400/60000]
loss: 0.504568 [12800/60000]
loss: 0.325455 [19200/60000]
loss: 0.213629 [25600/60000]
loss: 0.331575 [32000/60000]
loss: 0.279465 [38400/60000]
loss: 0.384017 [44800/60000]
loss: 0.257857 [51200/60000]
loss: 0.331744 [57600/60000]
```

Time usage: 0:00:53

Test Error:

Accuracy: 93.6%, Avg loss: 0.208808

Example errors:



The confusion matrix obtained is as shown below

Confusion Matrix:

```
[ [ 960      0      1      3      0      3      5      3      5      0]
  [    0 1119      3      2      0      0      3      0      8      0]
  [    9      2  944     22     10      1      8     12     22     2]
  [    1      5     12  949      0     10      0     10     15     8]
  [    1      5      3      1  927      0      8      2      2    33]
  [    7      4      3     24      5  817      8      2     18     4]
  [   15      6      2      0     11     17  902      1      4      0]
  [    2     13     25      4      4      1      0   931      4     44]
  [    7      8      6     20     14     13      5      7   879     15]
  [   11      7      5      9     17      4      0     16      7   933] ]
```

GRAPH:

