Report: Lab 08

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Question 0:
The different loss functions are given as follows:

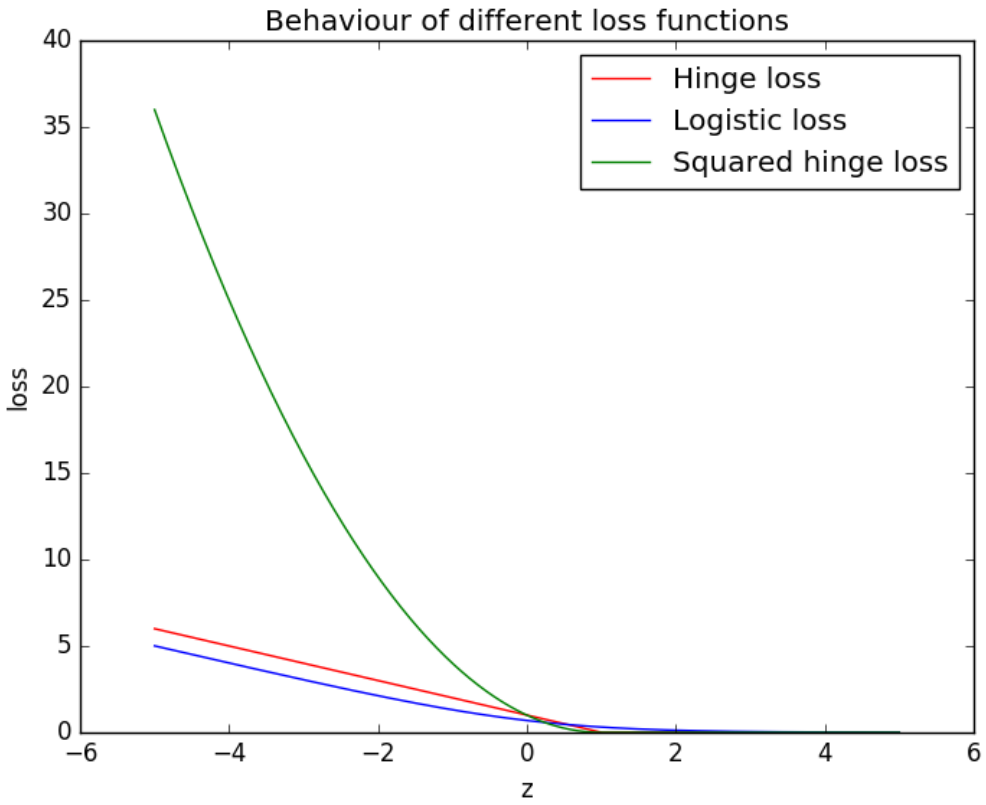

Figure 1: Plot for Different loss functions

Question 1:

The entire code for Question 1 is attached in the file ex1.py

Question 2:

Subpart 1:

An apt choice of $f_i(w)$ is given as:

$$f_i(w) = \frac{\lambda}{2n}||w||_2^2 + \frac{1}{n}L(y_i, w^T x_i)$$

The python modules for subparts 2,3,4,5 can be found in the python file ex2.py
The expression for gradient in subpart 4 is given as:

$$g_i(w) = \frac{\lambda}{n}w_j \qquad , if 1 - y_i w^T x <= 0$$

$$g_i(w) = \frac{\lambda}{n}w_j - \frac{1}{n}y_i x_{ij} \qquad , if 1 - y_i w^T x > 0$$

Subpart 6:

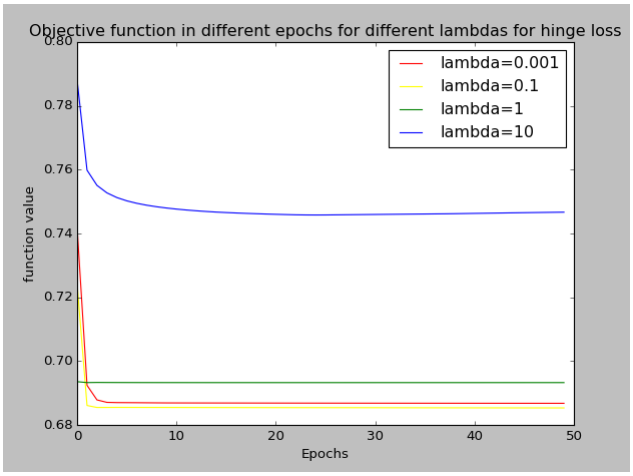

Figure 2: Plot of objective value every 10 epochs

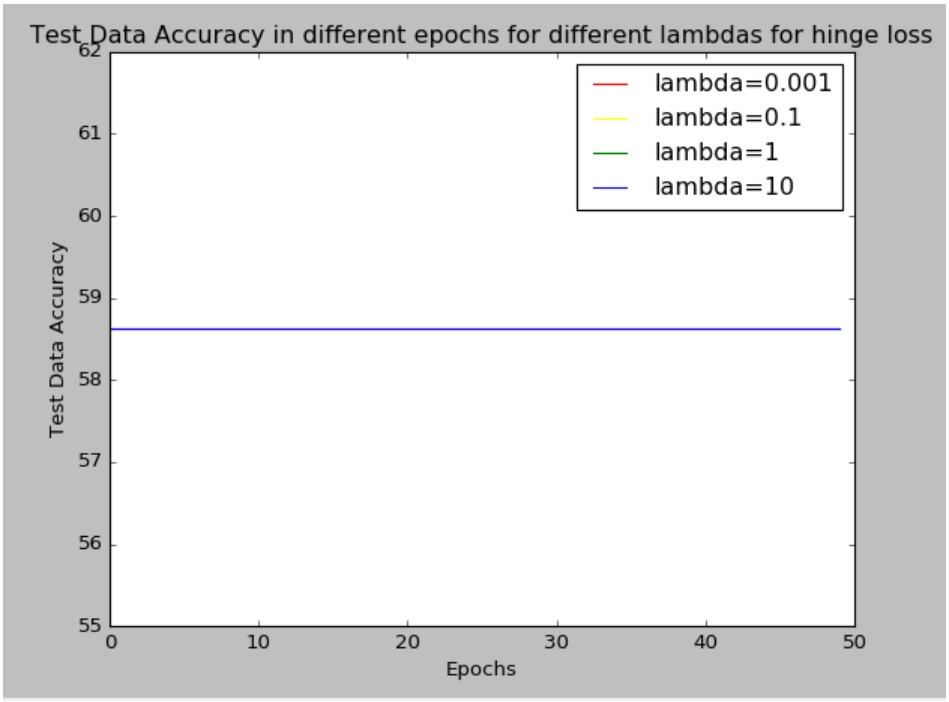

Figure 3: Plot the test set accuracy every 10 epochs

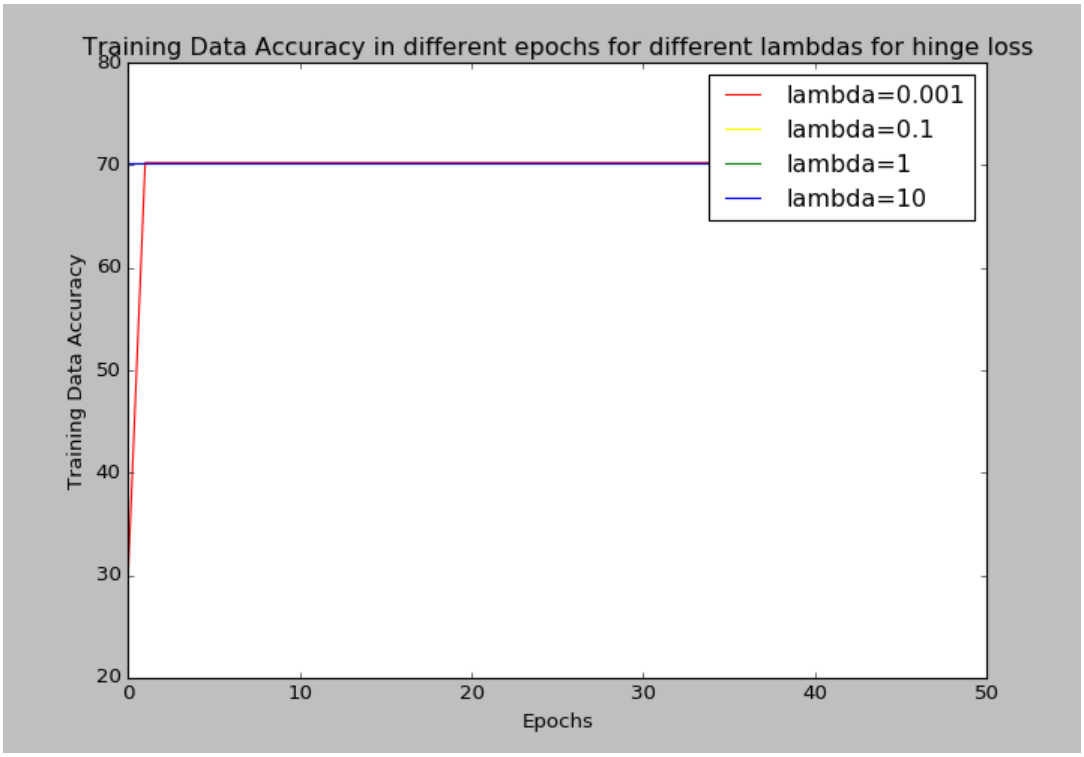

Figure 4: Plot the training set accuracy every 10 epochs

```
Enter the no. of epochs: 500
For lambda= 0.001  train set accuracy is:  68.5950413223  and test set accuracy is:  58.6206896552
For lambda= 0.1  train set accuracy is:  68.5950413223  and test set accuracy is:  58.6206896552
For lambda= 1  train set accuracy is:  68.5950413223  and test set accuracy is:  58.6206896552
For lambda= 10  train set accuracy is:  68.5950413223  and test set accuracy is:  58.6206896552
```

Figure 5: Final test set accuracy and final training set accuracy for different values of λ

The table is given as follows:

λ	Training set Accuracy	Test Set Accuracy
0.001	68.59504	58.6206896
0.1	68.59504	58.6206896
1	68.59504	58.6206896
10	68.59504	58.6206896

The codes for the above 4 parts are attached with the names ex26a.py, ex26b.py, ex26c.py and ex26d.py.

We observe from the plot of "objective value every 10 epochs" that the objective function value has a decreasing trend which makes sense because with each epoch we are finding a better value of w which minimizes the objective function.
We also observe that the test set accuracy remains exactly constant for all epochs and also for all values of λ.
We also observe that the training set accuracy every remains more or less constant for all epochs and for all values of λ except for $\lambda = 0.001$, when the Training set accuracy increased and then remained constant for the rest of the epochs.
It is to be noted that the training set accuracy is higher that testing set accuracy for almost all epochs and all values of λ.
We also observe that the final test accuracy as well as the final training accuracy are same for all values of λ.

Subpart 8:

Logistic loss function:

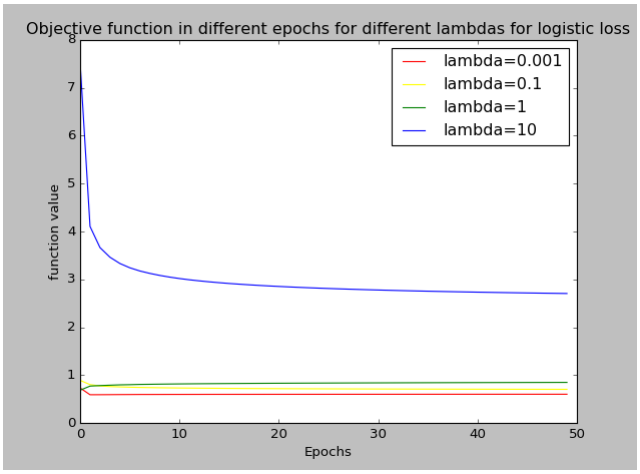

Figure 6: Plot of objective value every 10 epochs

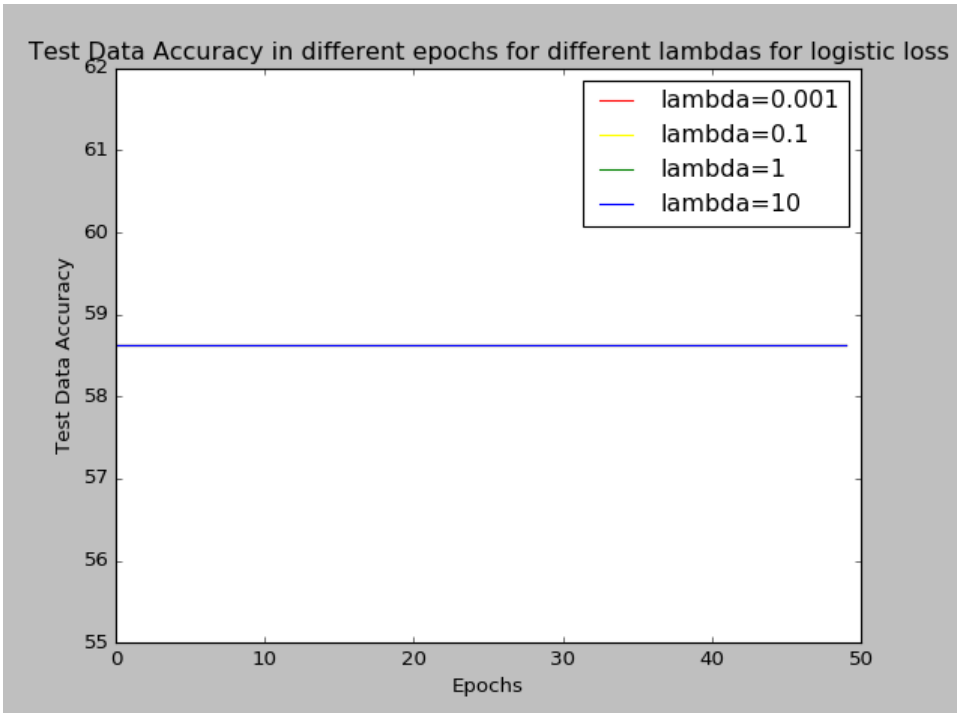

Figure 7: Plot the test set accuracy every 10 epochs

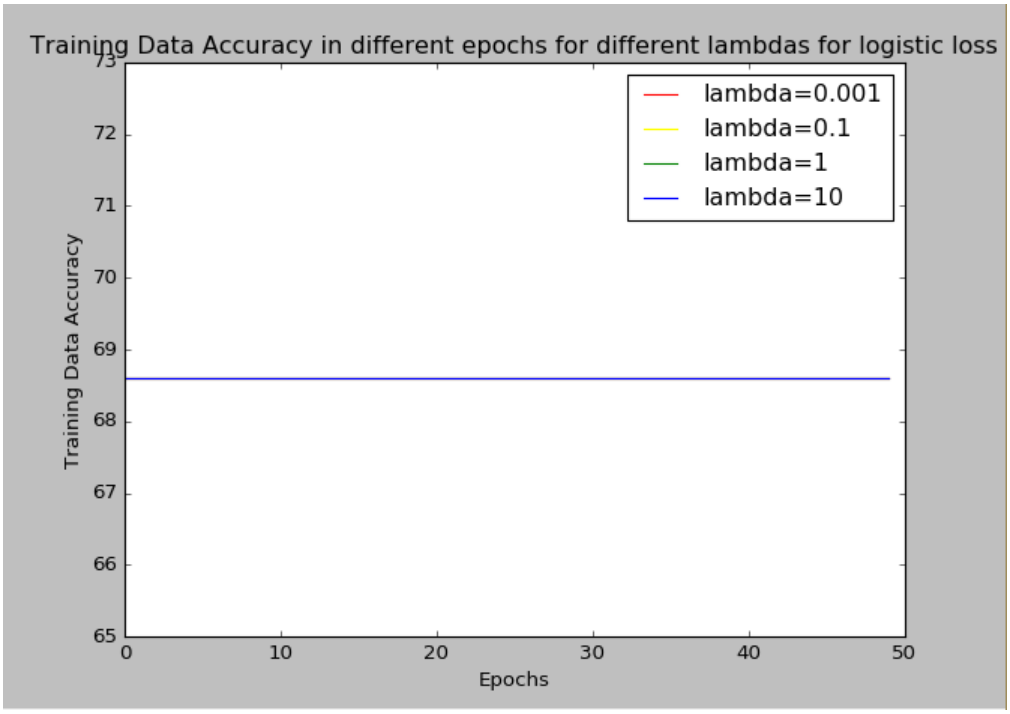

Figure 8: Plot the training set accuracy every 10 epochs

```
Enter the no. of epochs: 500
For lambda= 0.001  train set accuracy is:  66.1157024793  and test set accuracy is:  68.9655172414
For lambda= 0.1  train set accuracy is:  66.1157024793  and test set accuracy is:  68.9655172414
For lambda= 1  train set accuracy is:  66.1157024793  and test set accuracy is:  68.9655172414
For lambda= 10  train set accuracy is:  66.1157024793  and test set accuracy is:  68.9655172414
```

Figure 9: Final test set accuracy and final training set accuracy for different values of λ

The table is given as follows:

λ	Training set Accuracy	Test Set Accuracy
0.001	66.11570	68.965517
0.1	66.11570	68.965517
1	66.11570	68.965517
10	66.11570	68.965517

The codes for the above 4 parts are attached with the names $ex2\_8\_2a.py, ex2\_8\_2b.py, ex2\_8\_2c.py$ and $ex2\_8\_2d.py$.

We observe from the plot of "objective value every 10 epochs" that the objective function value has a decreasing trend in general for all values of λ except when $\lambda = 1$ but then also the increase is very minute. The observed trends makes sense because with each epoch we are finding a better value of w which minimizes the objective function.
We also observe that the test set accuracy remains exactly constant for all epochs and also for all values of λ.
We also observe that the training set accuracy every remains more or less constant for all epochs and for all values of λ except for $\lambda = 0.001$, when the Training set accuracy increased and then remained constant for the rest of the epochs.
It is to be noted that the training set accuracy is higher that testing set accuracy for almost all epochs and all values of λ.
We also observe that the final test accuracy as well as the final training accuracy are same for all values of λ.

Squared Hinge loss function:

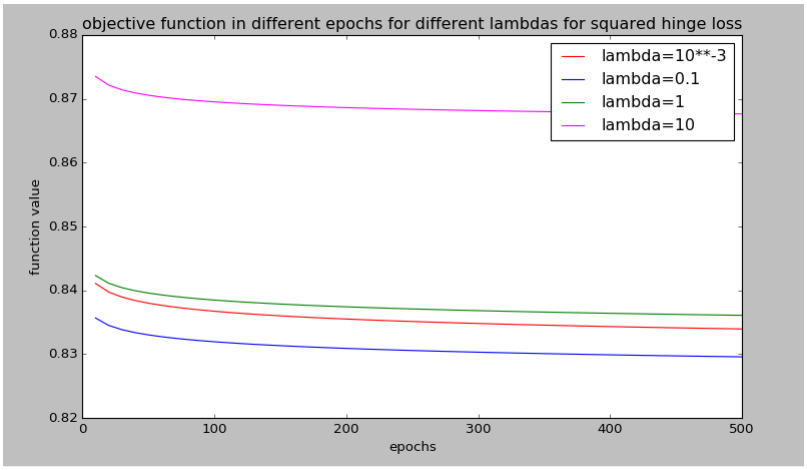

Figure 10: Plot of objective value every 10 epochs

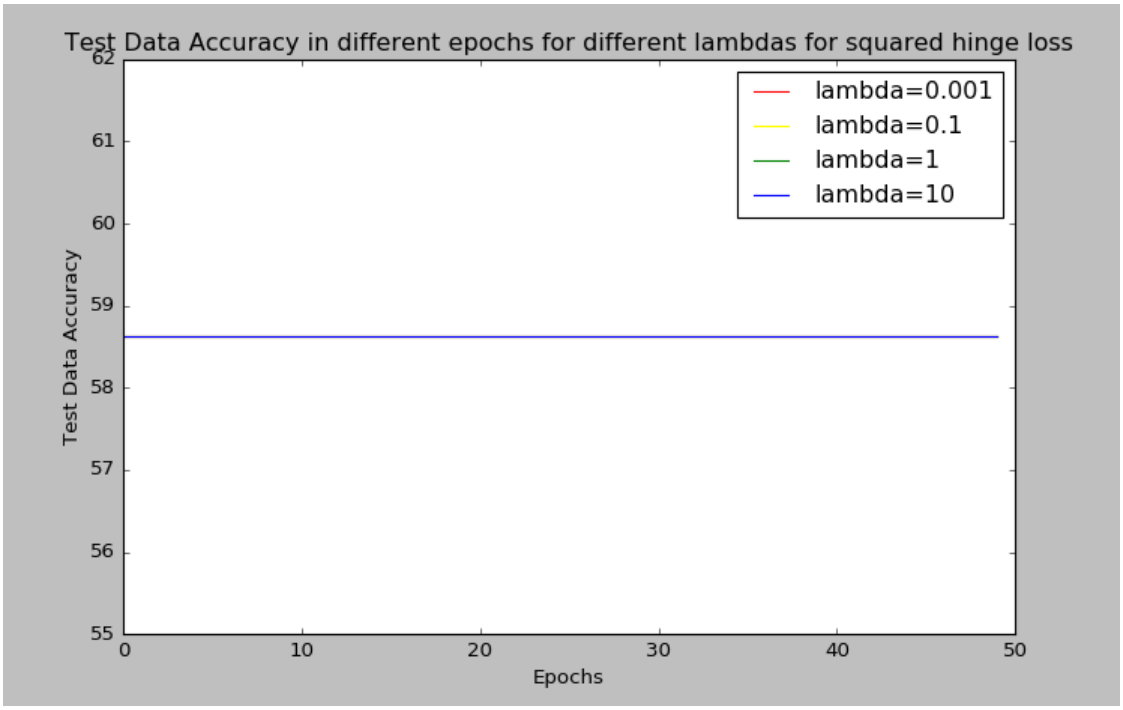

Figure 11: Plot the test set accuracy every 10 epochs

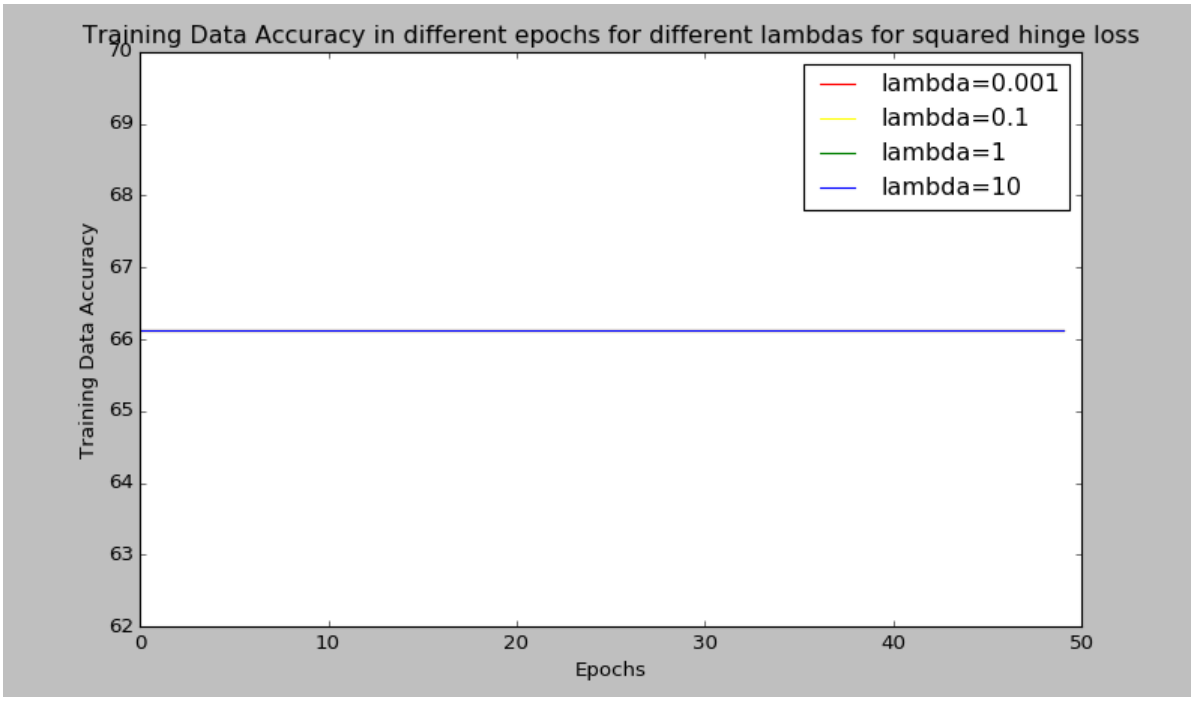

Figure 12: Plot the training set accuracy every 10 epochs

```
Enter the no. of epochs: 500
For lambda= 0.001  train set accuracy is:  66.9421487603  and test set accuracy is:  65.5172413793
For lambda= 0.1  train set accuracy is:  66.9421487603  and test set accuracy is:  65.5172413793
For lambda= 1  train set accuracy is:  66.9421487603  and test set accuracy is:  65.5172413793
For lambda= 10  train set accuracy is:  66.9421487603  and test set accuracy is:  65.5172413793
>>>
```

Figure 13: Final test set accuracy and final training set accuracy for different values of λ

The table is given as follows:

λ	Training set Accuracy	Test Set Accuracy
0.001	66.94214	65.51724
0.1	66.94214	65.51724
1	66.94214	65.51724
10	66.94214	65.51724

The codes for the above 4 parts are attached with the names $ex2\_8\_3a.py, ex2\_8\_3b.py, ex2\_8\_3c.py$ and $ex2\_8\_3d.py$.

We observe from the plot of "objective value every 10 epochs" that the objective function value has a decreasing trend for all values of λ. The observed trends makes sense because with each epoch we are finding a better value of w which minimizes the objective function.
We also observe that the test set accuracy remains exactly constant for all epochs and also for all values of λ.
We also observe that the training set accuracy every remains more or less constant for all epochs and for all values of λ except for $\lambda = 0.001$, when the Training set accuracy increased and then remained constant for the rest of the epochs.
It is to be noted that the training set accuracy is higher that testing set accuracy for almost all epochs and all values of λ.
We also observe that the final test accuracy as well as the final training accuracy are same for all values of λ.

Solution 3:

I tried running the code on the server but was encountering some problems because the dataset was not available on the server. I downloaded it and tried running it on IDLE but then my code is facing "memory issues". Attaching the screenshot below:

The code files are given as : ex3a.py, ex3b.py, ex3c.py and ex3d.py

```
  File "C:\Python27\lib\site-packages\sklearn\datasets\covtype.py", line 98, in fetch_covtype
    Xy = np.genfromtxt(GzipFile(filename=archive_path), delimiter=',')
  File "C:\Python27\lib\site-packages\numpy\lib\npyio.py", line 2149, in genfromtxt
    output = np.array(data, dtype)
MemoryError
>>>
```

Figure 14: Memory Issues