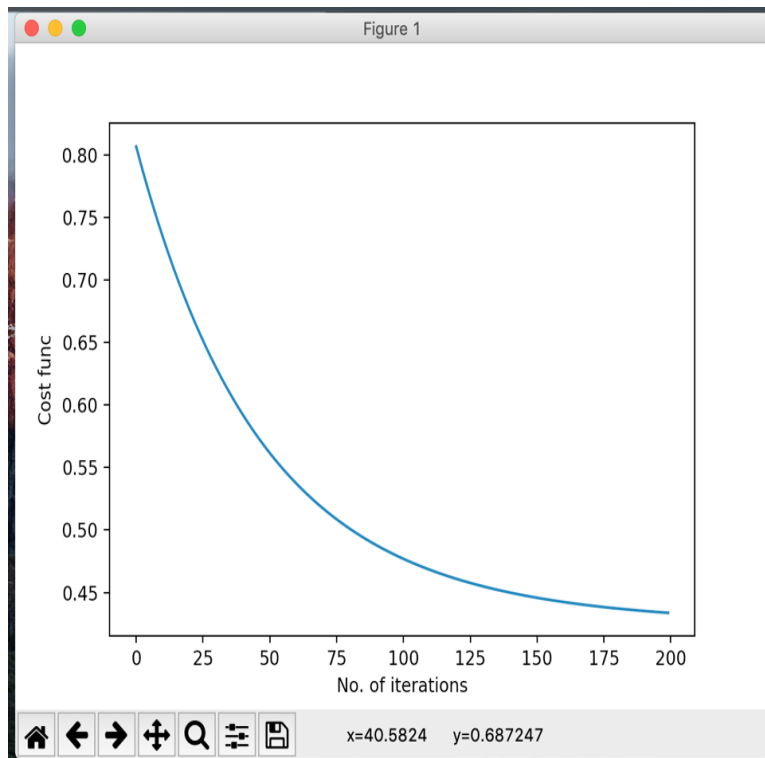


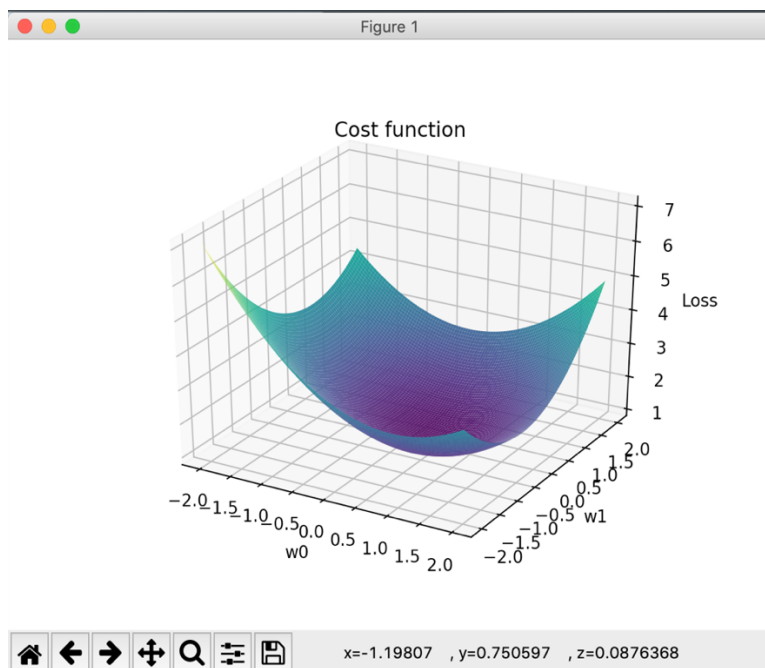
Question 1

Batch gradient descent

Costs vs Iterations



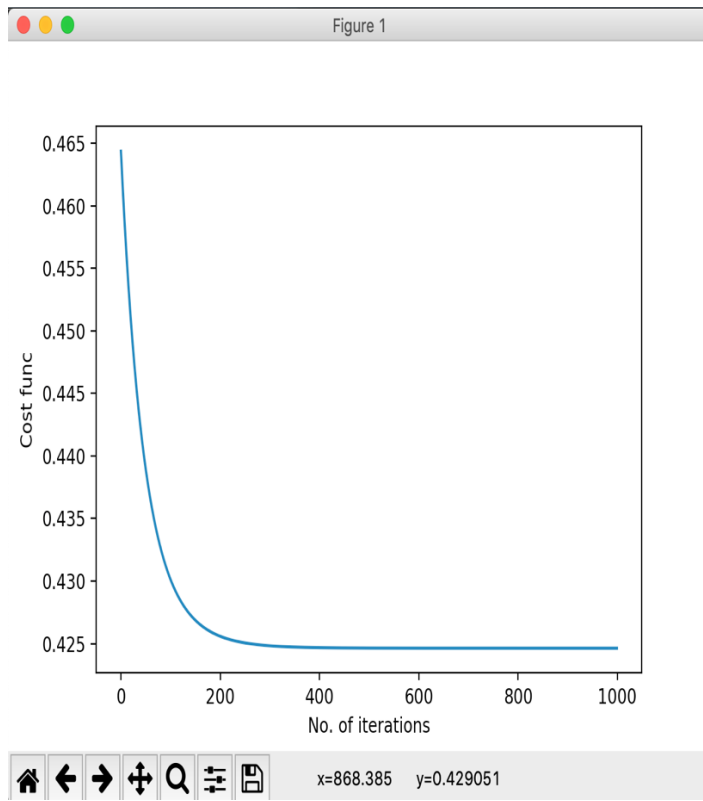
Costs vs weights



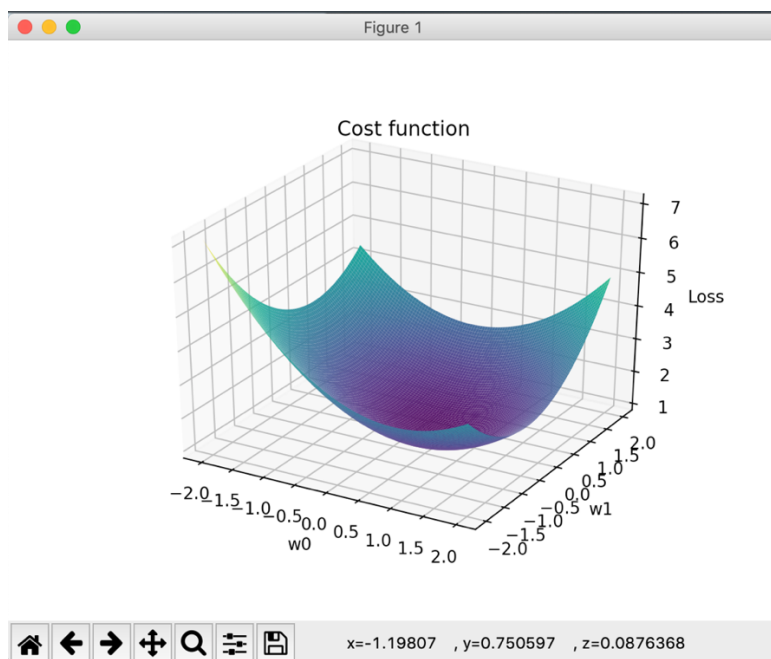
Question 2

Stochastic gradient descent

Cost vs Iterations

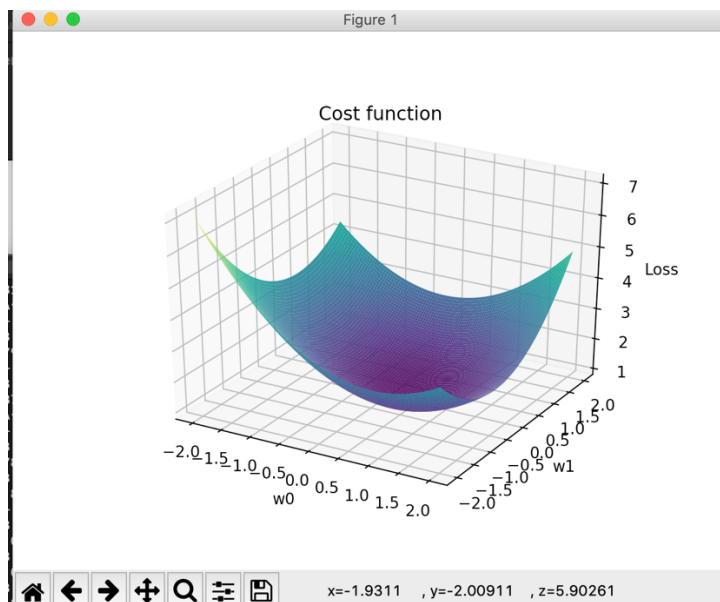
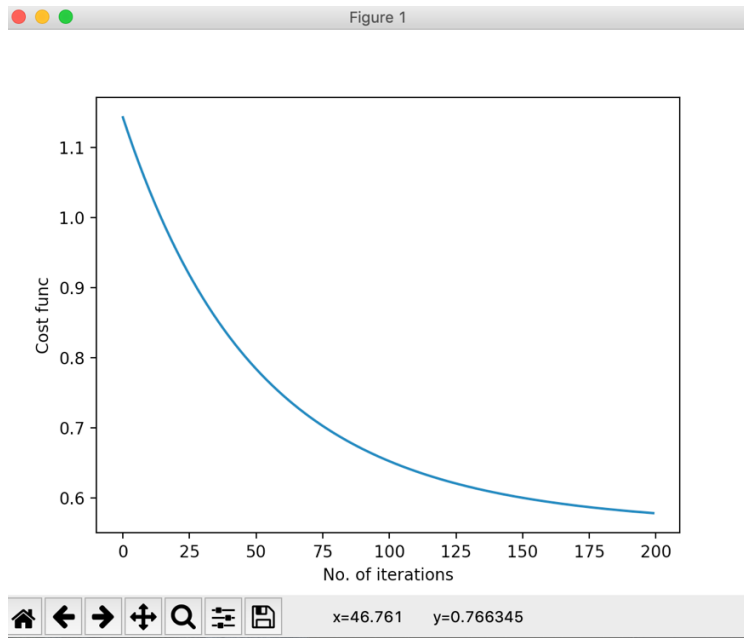


Cost vs weights

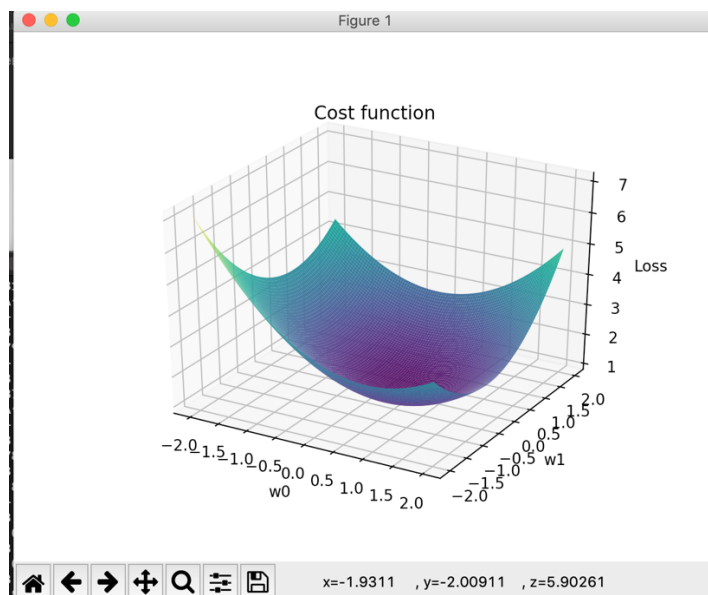
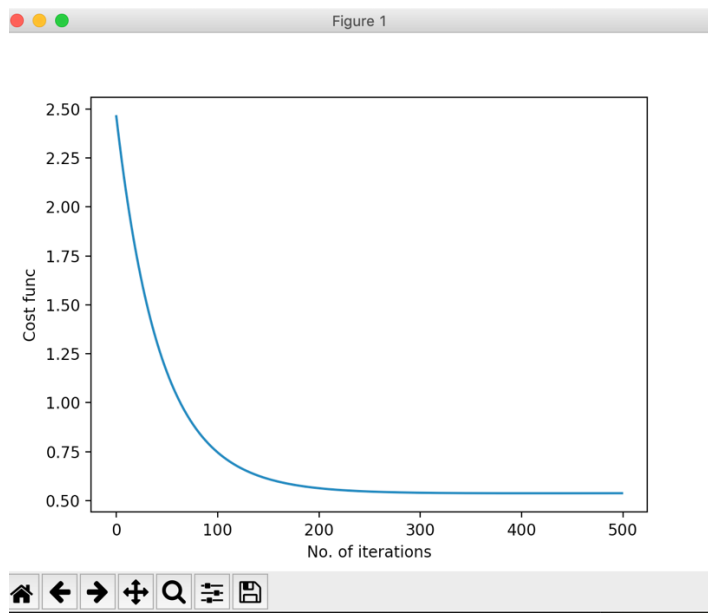


Question 3

Batch ridge regression



Stochastic ridge regression



Question 4

Vectorized linear regression

Batch gradient descent

```
Weights via Gradient Descent: [0.08900052 0.34532509 0.05496967]
Weights via solving for minima using Vectorization Method: [0.0879781 0.34648207 0.05439986]
```

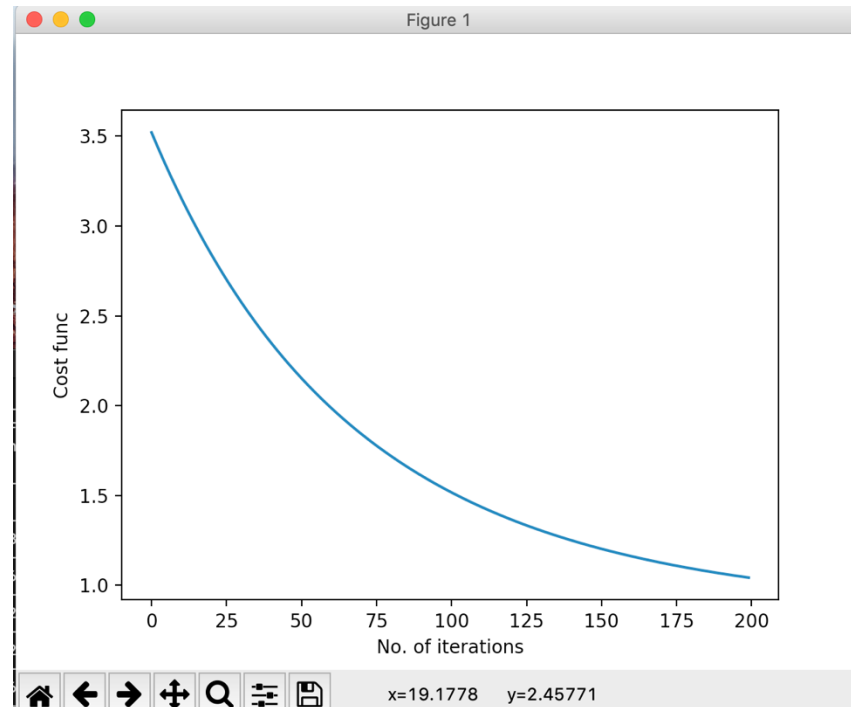
Stochastic gradient descent

```
Weights via Gradient Descent: [0.10942123 0.3236033 0.06647908]
Weights via solving for minima using Vectorized Method: [0.0879781 0.34648207 0.05439986]
Deviation along each axis is [0.02144313 0.02287876 0.01207922]
```

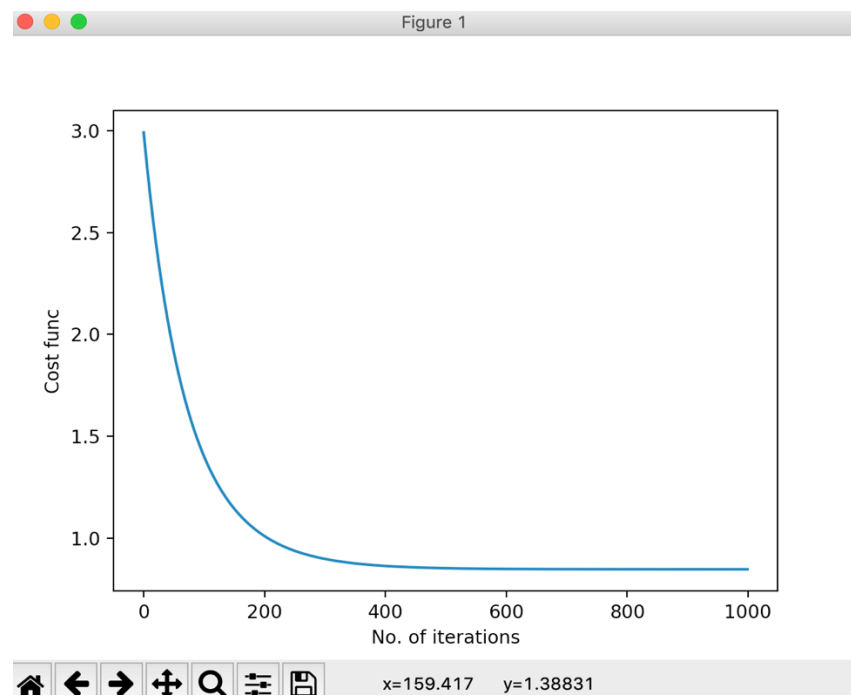
Question 5

Least Angle Regression

Batch

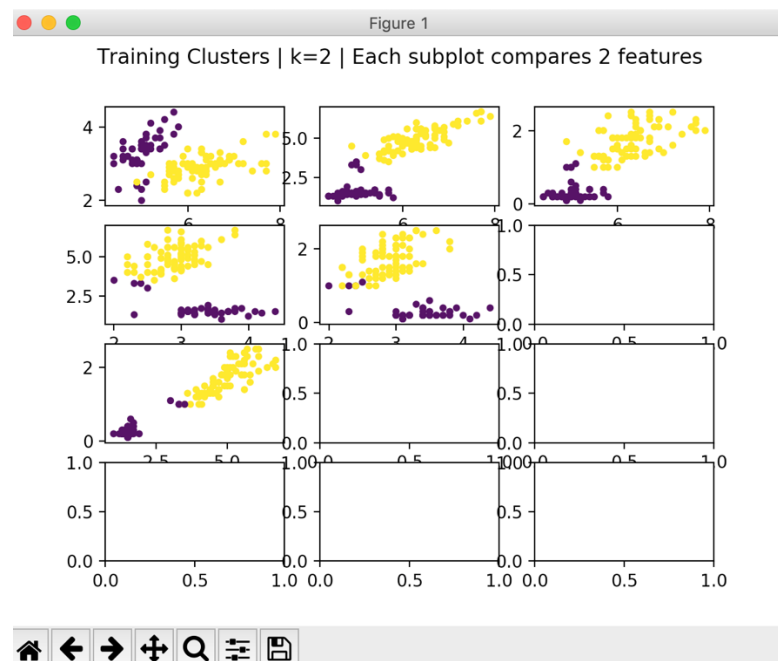


Stochastic gradient descent

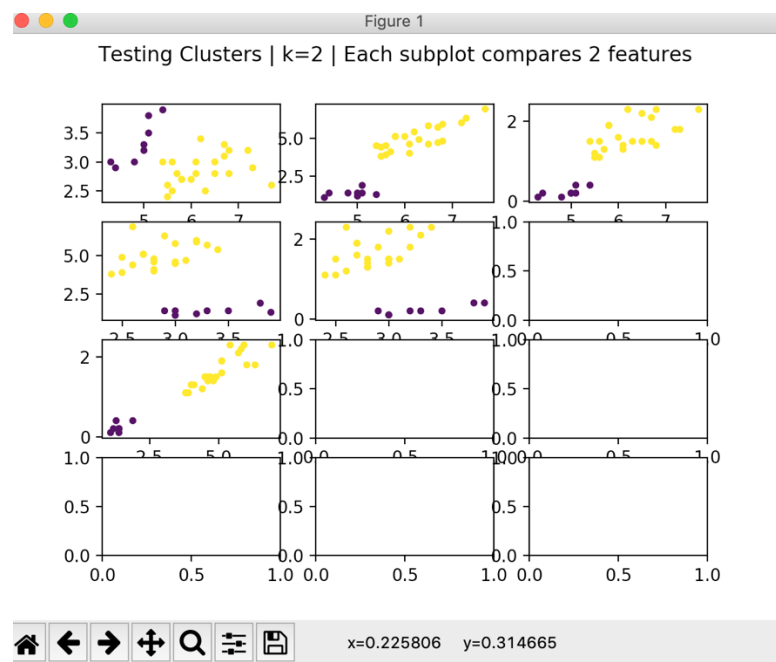


Question 6

Training data



Testing data



Question 7

Sensitivity, accuracy and specificity = 1

```
True Positives: 19
False Positives: 0
True Negatives: 21
False Negatives: 0
The sensitivity is 1.0
The specificity is 1.0
The overall accuracy is 1.0
```

Question 8

One vs One

```
The accuracy for class 1 is 100%
The accuracy for class 2 is 81%
The accuracy for class 3 is 90%
Out of 60 test cases, 54 were predicted correctly, so the overall accuracy of the model is 90.0%
```

One vs all

```
The accuracy for class 1 is 96%
The accuracy for class 2 is 71%
The accuracy for class 3 is 91%
Out of 60 test cases, 53 were predicted correctly, so the overall accuracy of the model is 88%
```

Question 9

Multiclass logistic regression(5 fold)

```
The accuracy for class 1 is 96%
The accuracy for class 2 is 71%
The accuracy for class 3 is 91%
Out of 60 test cases, 53 were predicted correctly, so the overall accuracy of the model is 88%
[(py3) Parths-MacBook-Air:A1 parthanand$ python Q9.py
Accuracy using Fold 1 is 86.67%
Accuracy using Fold 2 is 80.0%
Accuracy using Fold 3 is 90.0%
Accuracy using Fold 4 is 76.67%
Accuracy using Fold 5 is 83.33%
Average accuracy with K-Fold cross validation is 83.33 %
```


Question 10

Likelihood Ratio Test

Specificity, sensitivity = 1

```
19 0 21 0
True Positives: 19
False Positives: 0
True Negatives: 21
False Negatives: 0
The sensitivity is 1.0
The specificity is 1.0
The overall accuracy is 1.0
```

Question 11

Maximum a posteriori(MAP)

Accuracy – 96%

```
The accuracy for class 1 is 100%
The accuracy for class 2 is 92%
The accuracy for class 3 is 94%
Out of 45 test cases, 43 were predicted correctly, so the overall accuracy of the model is 96%
```

Question 12

Maximum Likelihood(ML)

Accuracy = 96%

```
The accuracy for class 1 is 100%
The accuracy for class 2 is 88%
The accuracy for class 3 is 100%
Out of 45 test cases, 43 were predicted correctly, so the overall accuracy of the model is 96%
```

Question 13

This assignment was a good introduction to the foundations of Machine Learning. Through this assignment, we learnt about the different algorithms and their implementation. This assignment also helped in understanding the importance of analyzing data and also distributions. It also helped me in learning how to use Python libraries such as Numpy and Matplotlib which are the fundamentals of Machine Learning using Python. With the help of graphs, we could analyze how the parameters are updated, and objective functions are plotted. The assignment problems helped me sharpen my concepts, data visualization techniques and improve my coding practices.