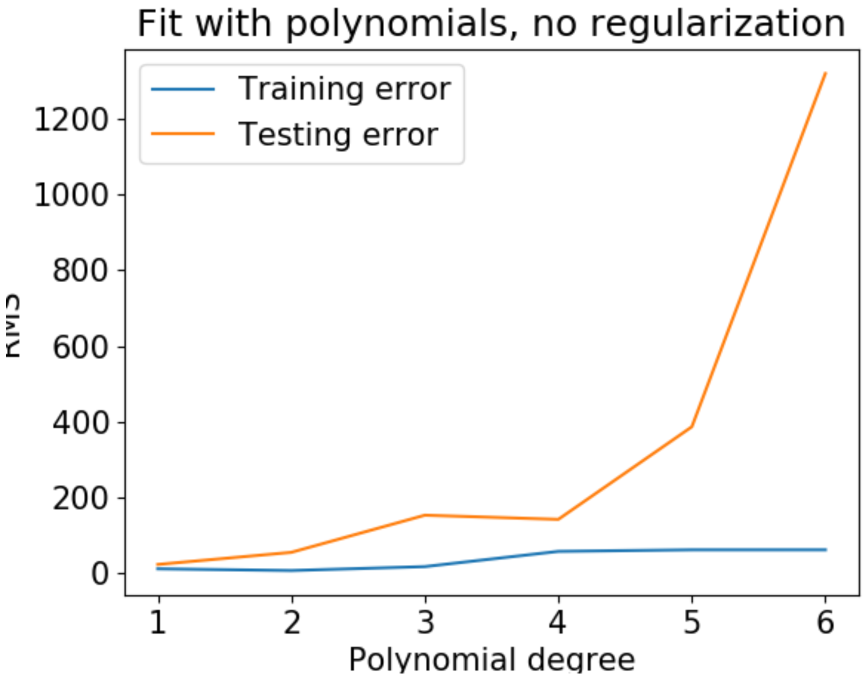
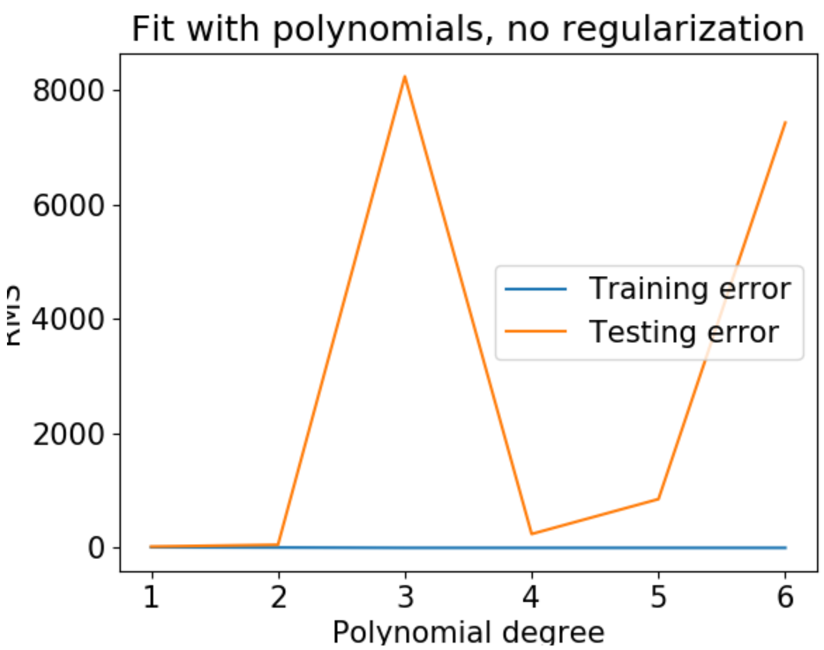
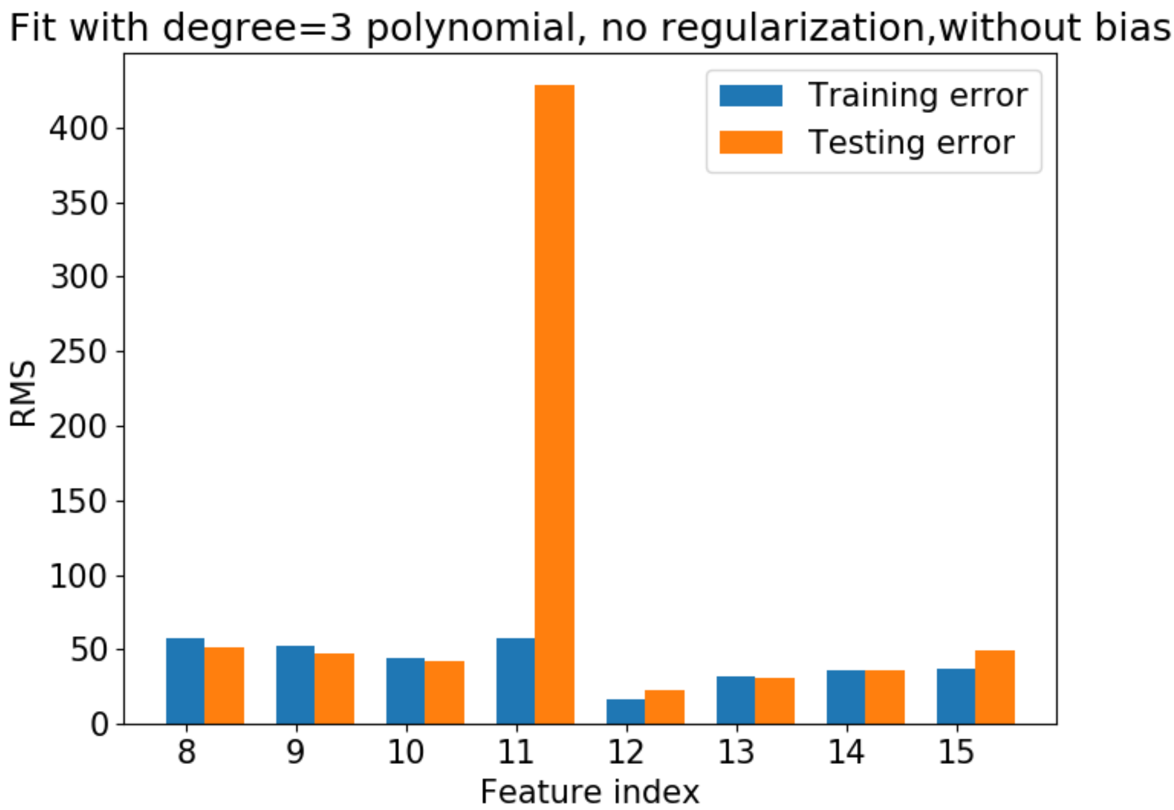
5.2
1)

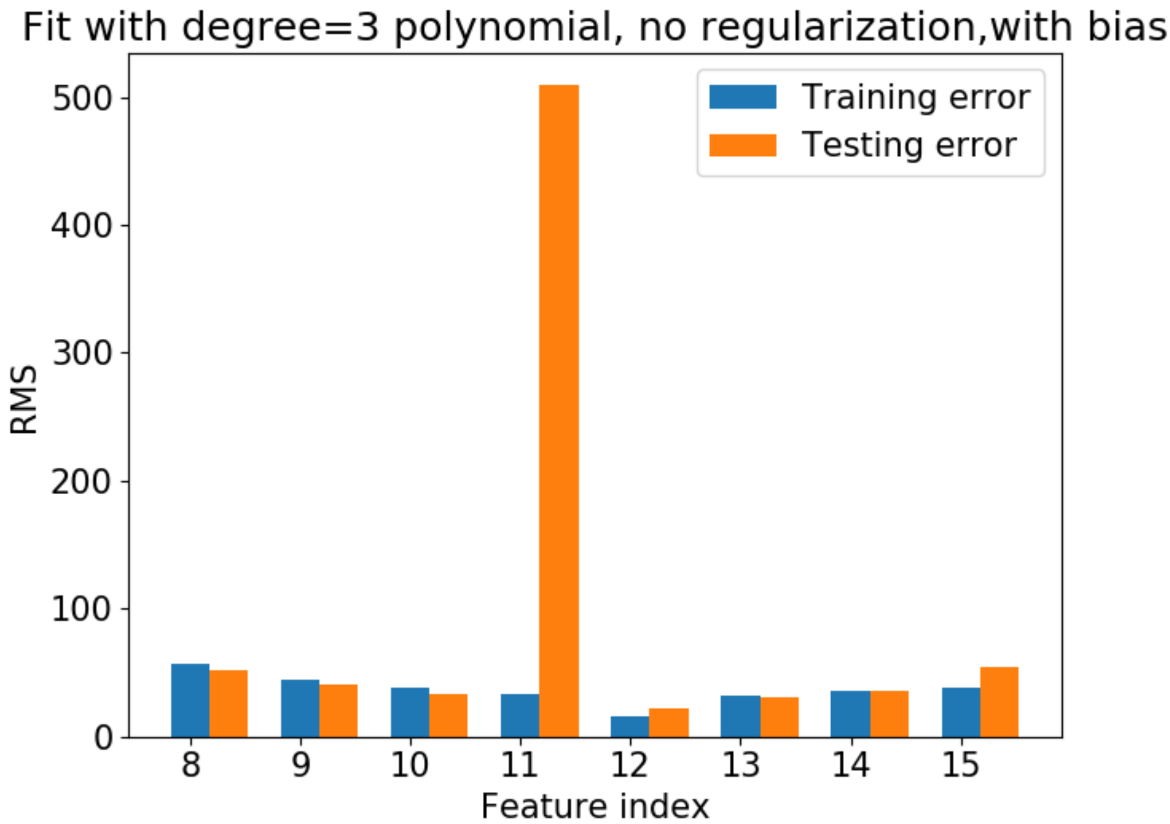


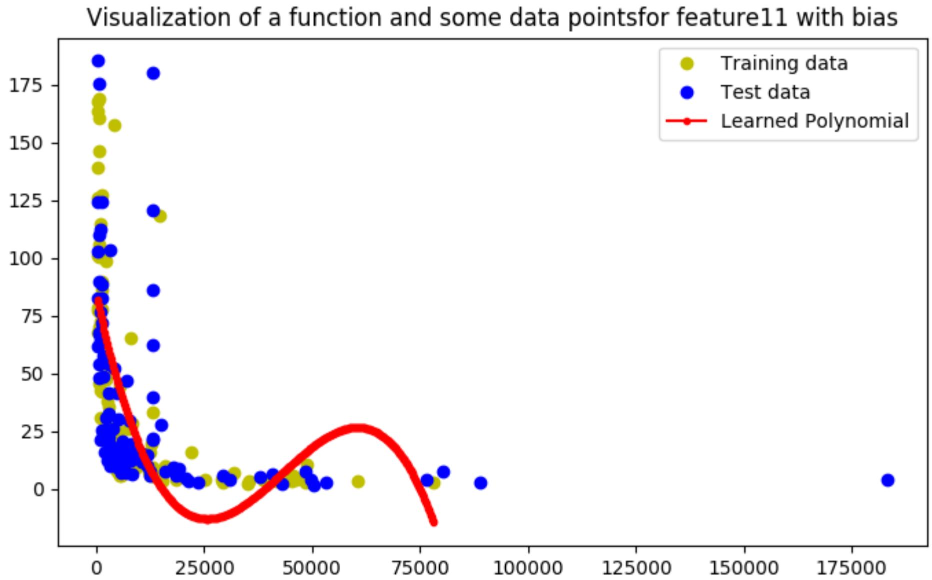
There are two things wrong here. The first one is usually as polynomial degree increases the training error will decrease since higher degree usually fits the data better. After we apply the normalization on input features this problem is solved. The reason is that we may have some features whose orders of magnitudes are larger than others, and they may dominate the objective function and make the estimator unable to learn from other features correctly as expected.
Another problem is as orders of degree increase, the model is being more over-fitted. This problem can be solved with regularized regression which we will do in 5.4.



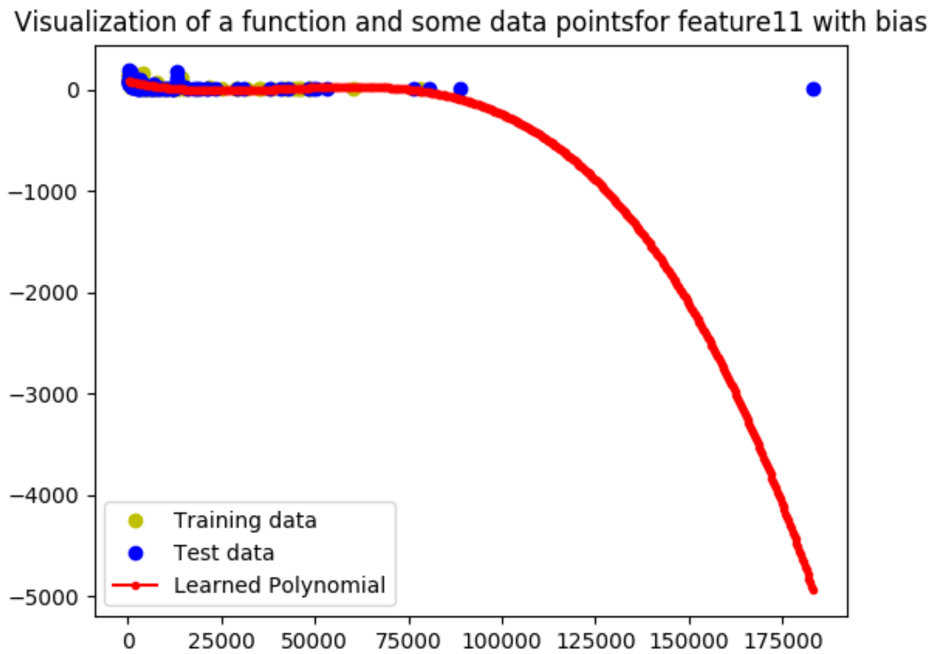
2)

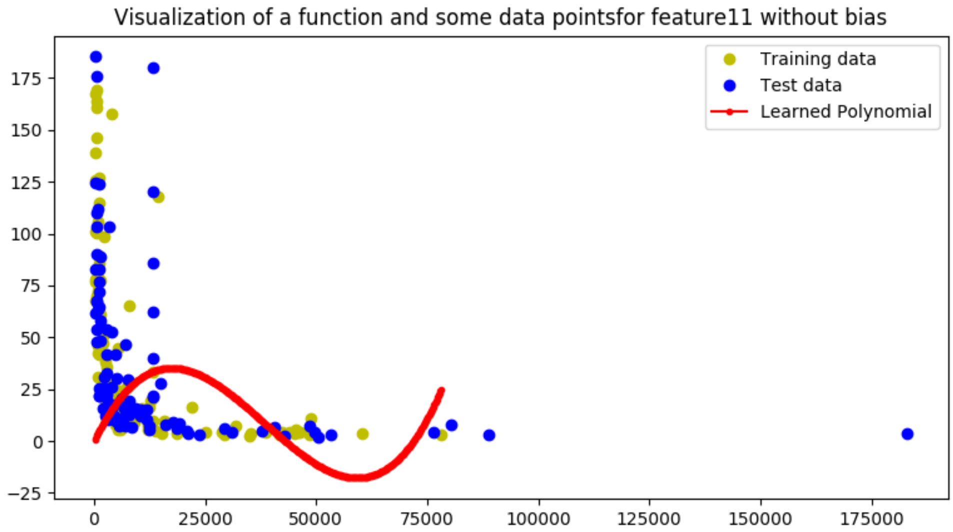

Fit with degree=3 polynomial, no regularization,without bias
Training error
Testing error
RMS
0
50
100
150
200
250
300
350
400
8
9
10
11
12
13
14
15
Feature index

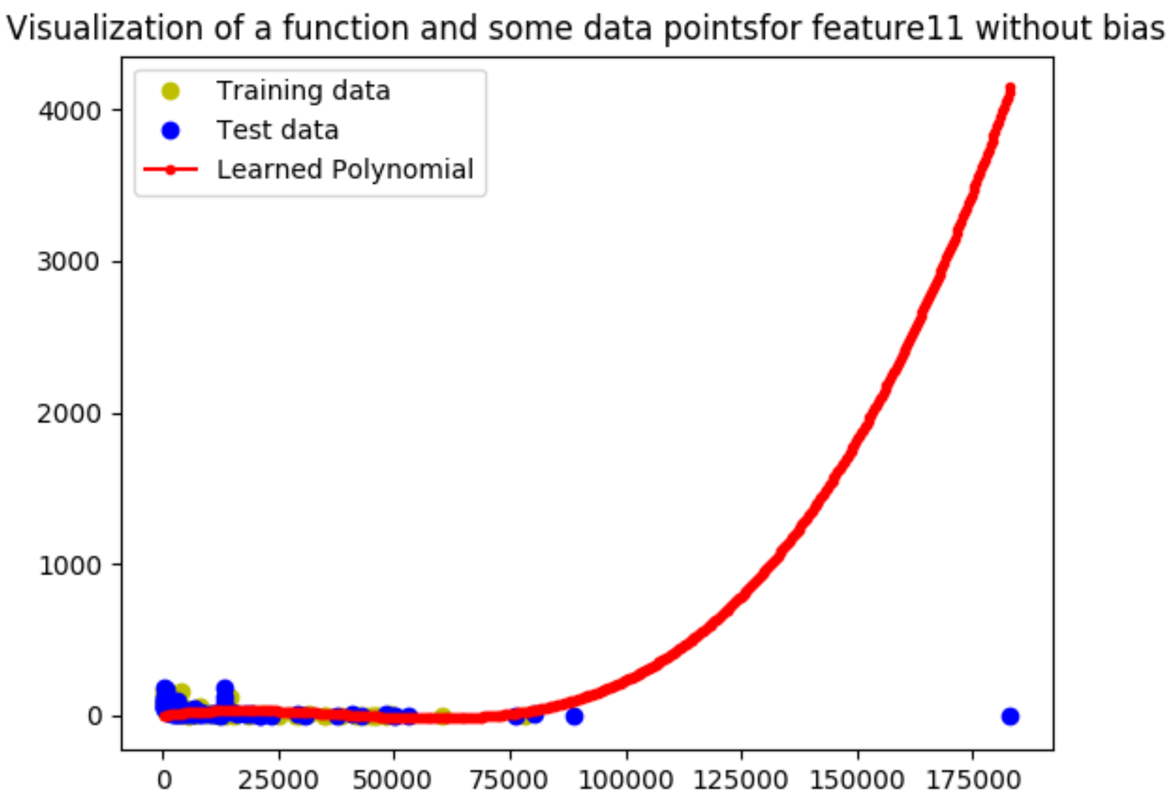

Fit with degree=3 polynomial, no regularization,with bias
Training error
Testing error
RMS
0
100
200
300
400
500
8
9
10
11
12
13
14
15
Feature index



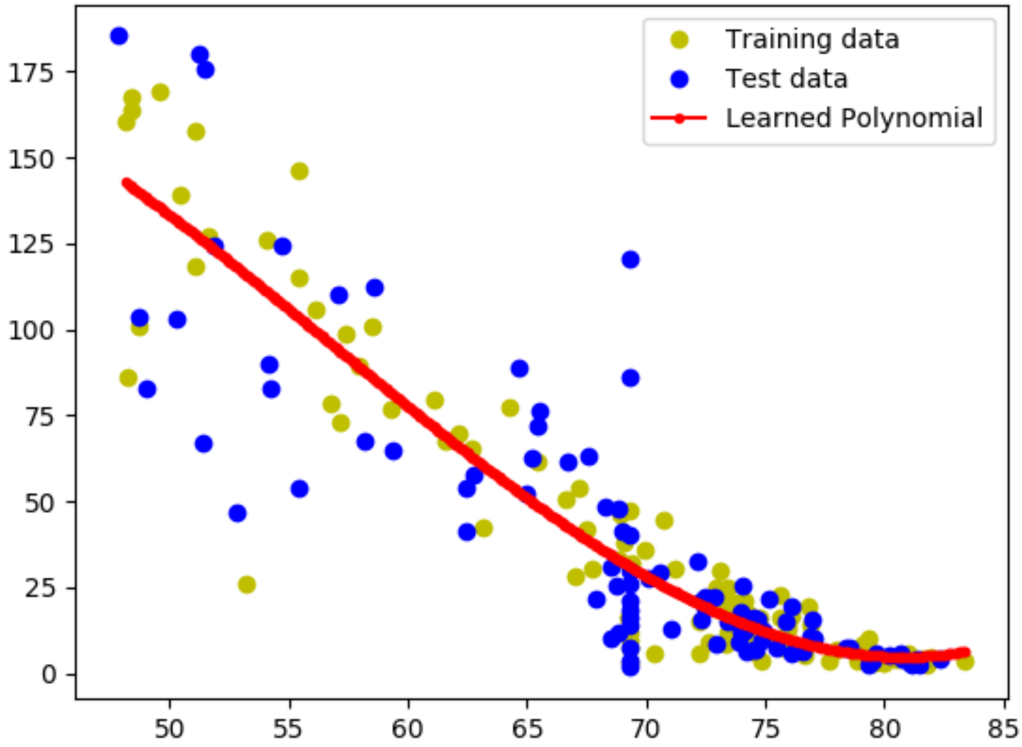
Since there is an outlier so we need to use a larger scale.



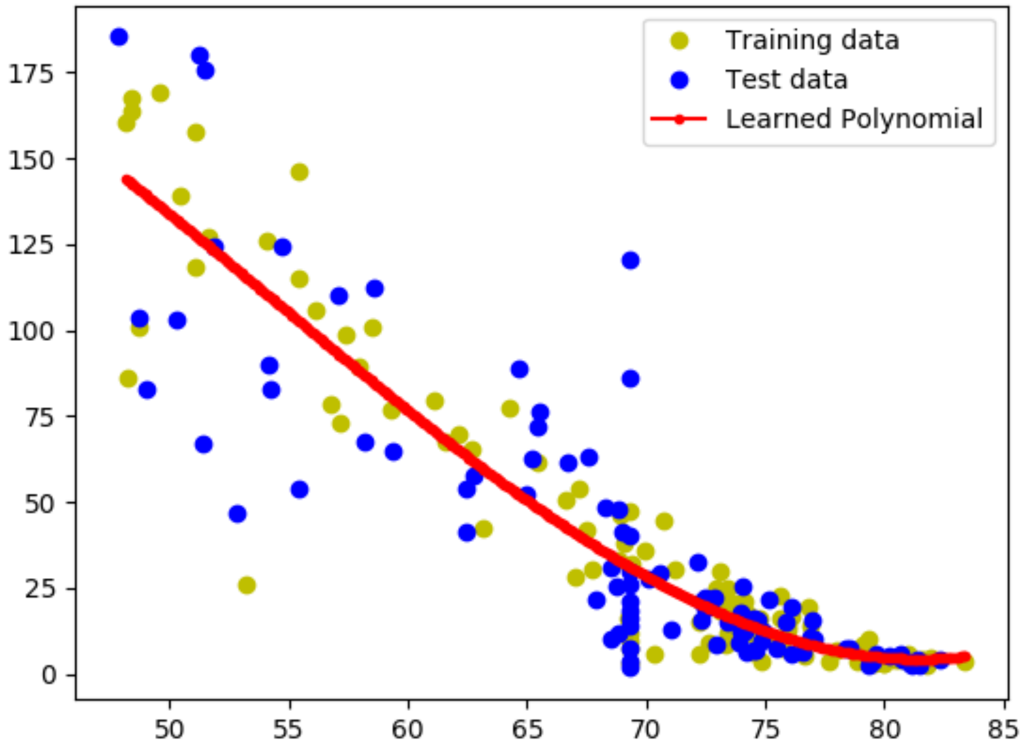

Visualization of a function and some data pointsfor feature11 without bias
Training data
Test data
Learned Polynomial
175
150
125
100
75
50
25
0
−25
0
25000
50000
75000
100000
125000
150000
175000


Visualization of a function and some data pointsfor feature11 without bias
Training data
Test data
Learned Polynomial
4000
3000
2000
1000
0
0
25000
50000
75000
100000
125000
150000
175000

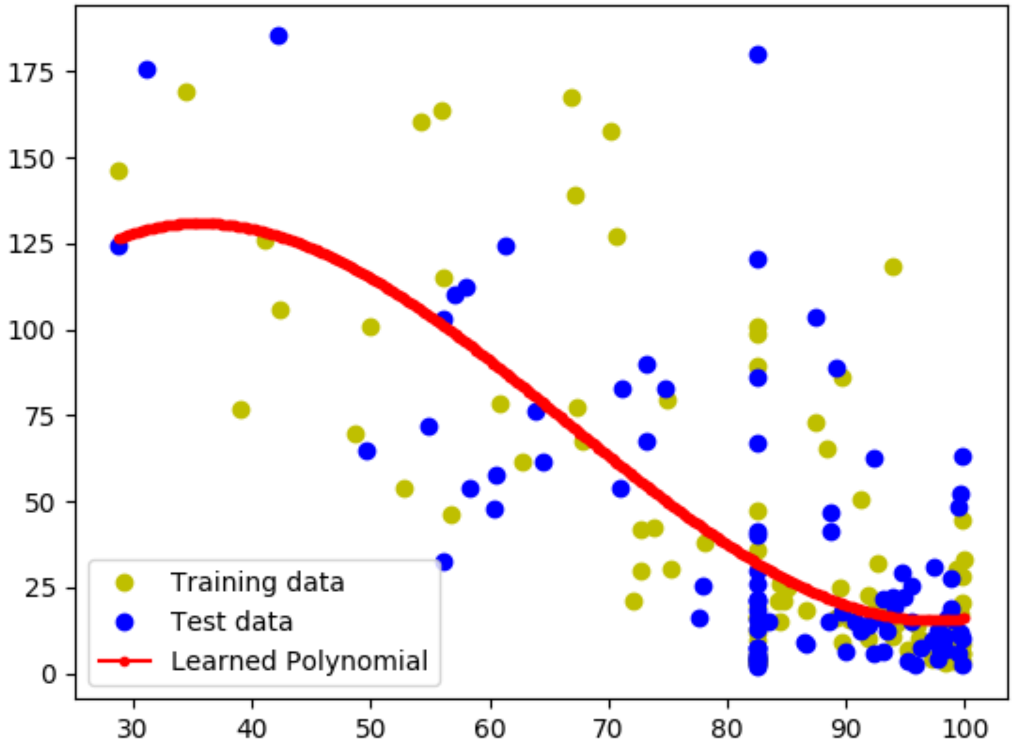
Visualization of a function and some data pointsfor feature12 with bias



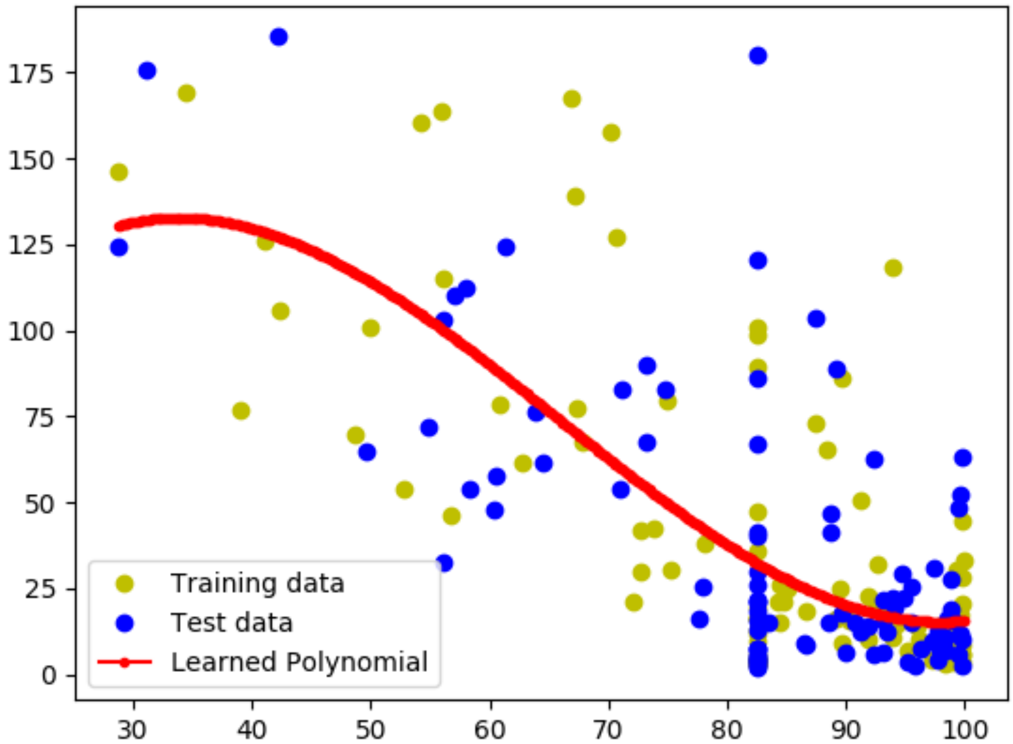
Visualization of a function and some data pointsfor feature12 without bias



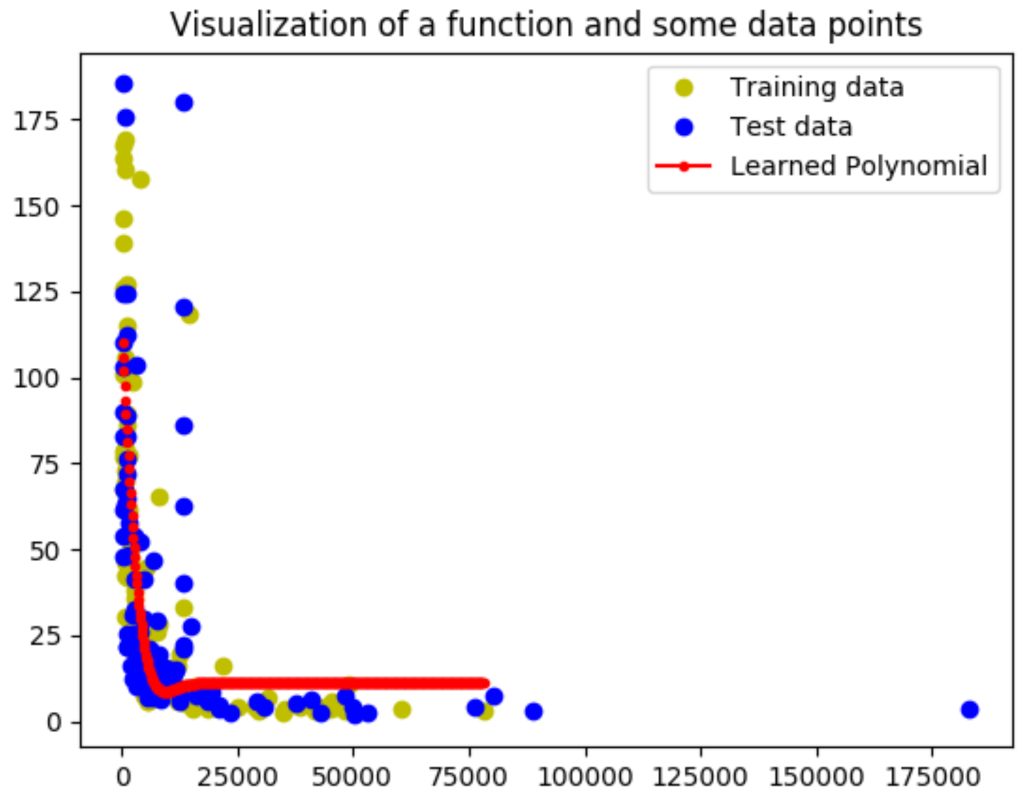
Visualization of a function and some data pointsfor feature13 with bias



Visualization of a function and some data pointsfor feature13 without bias

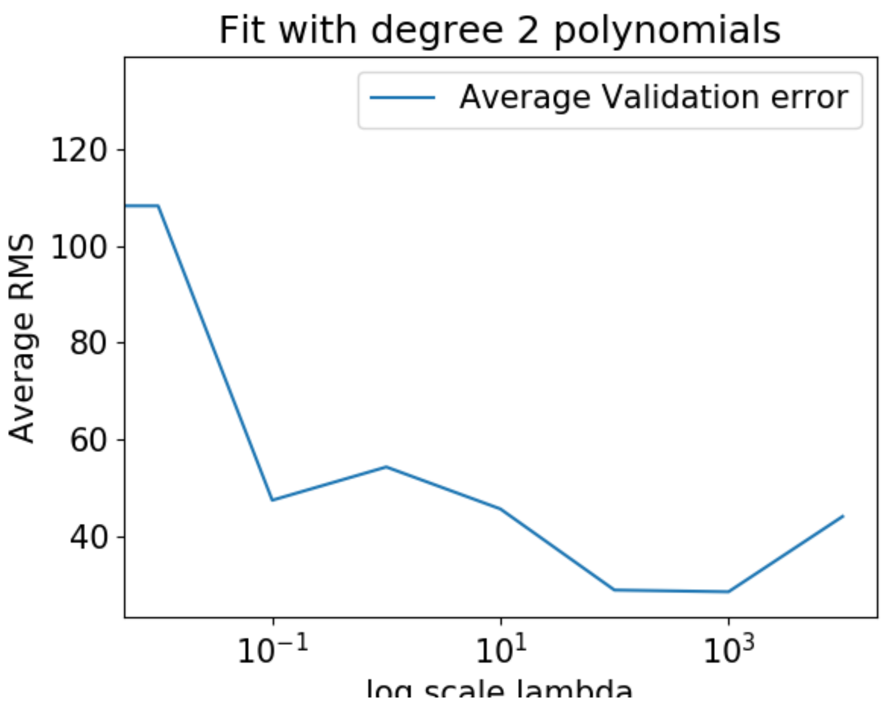


5.3



training error: [[28.45793776]]
testing error: [[33.8067249]]

5.4



the errors for lambda 0 to 1000 are :

lambda=0	134.08724800120225
lambda=0.01	108.33938137863713
lambda=0.1	47.42014676680511
lambda=1	54.30153018685256
lambda=10	45.61747891270658
lambda=100	28.827211650792474
lambda=1000	28.46922327978877
lambda=10000	44.06076704806573

Lambda=1000 yields the lowest average validation error so we will choose lambda=1000