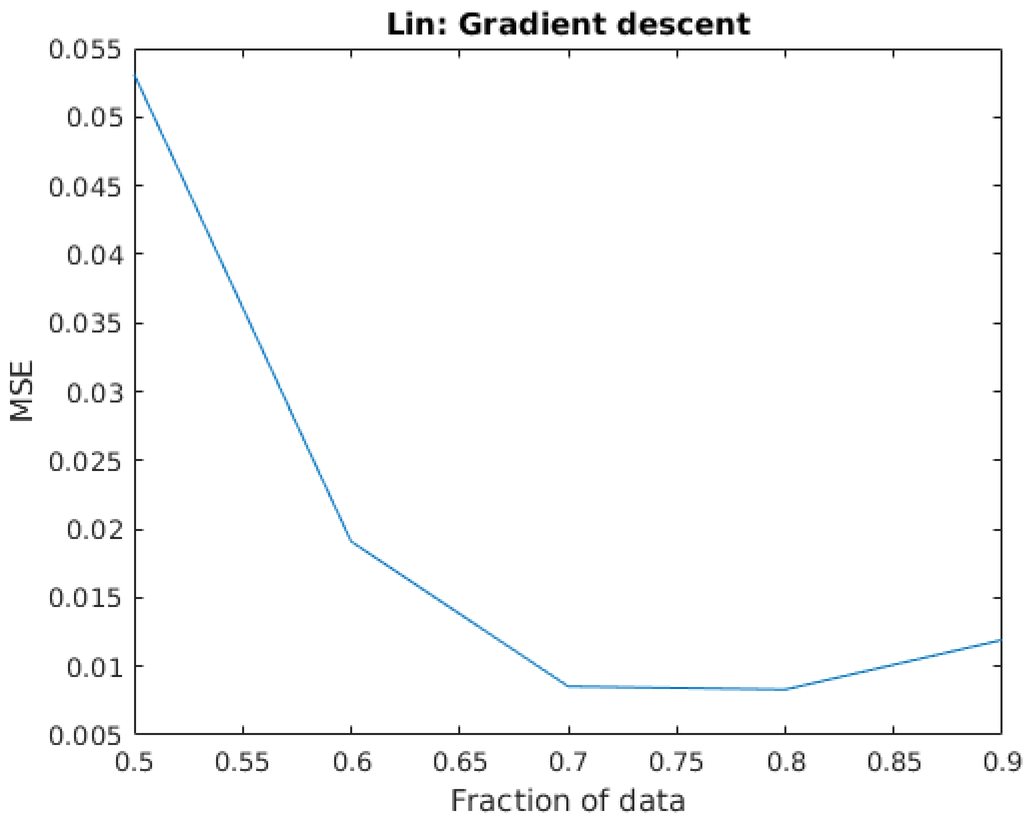
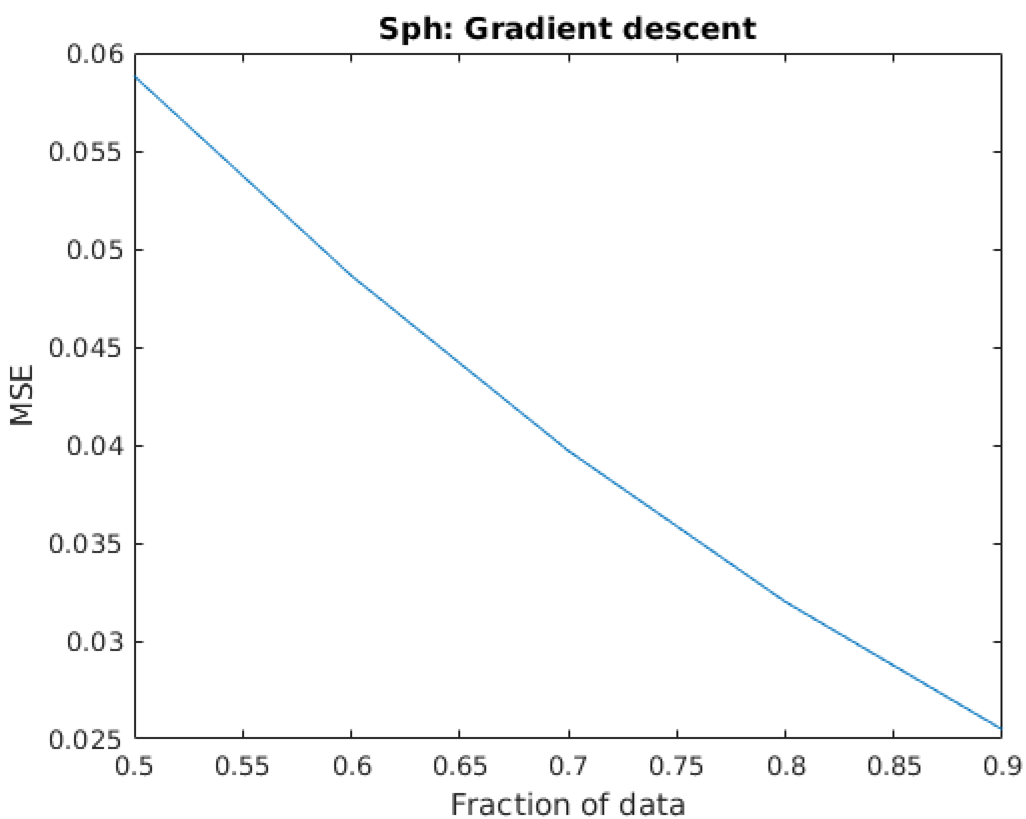
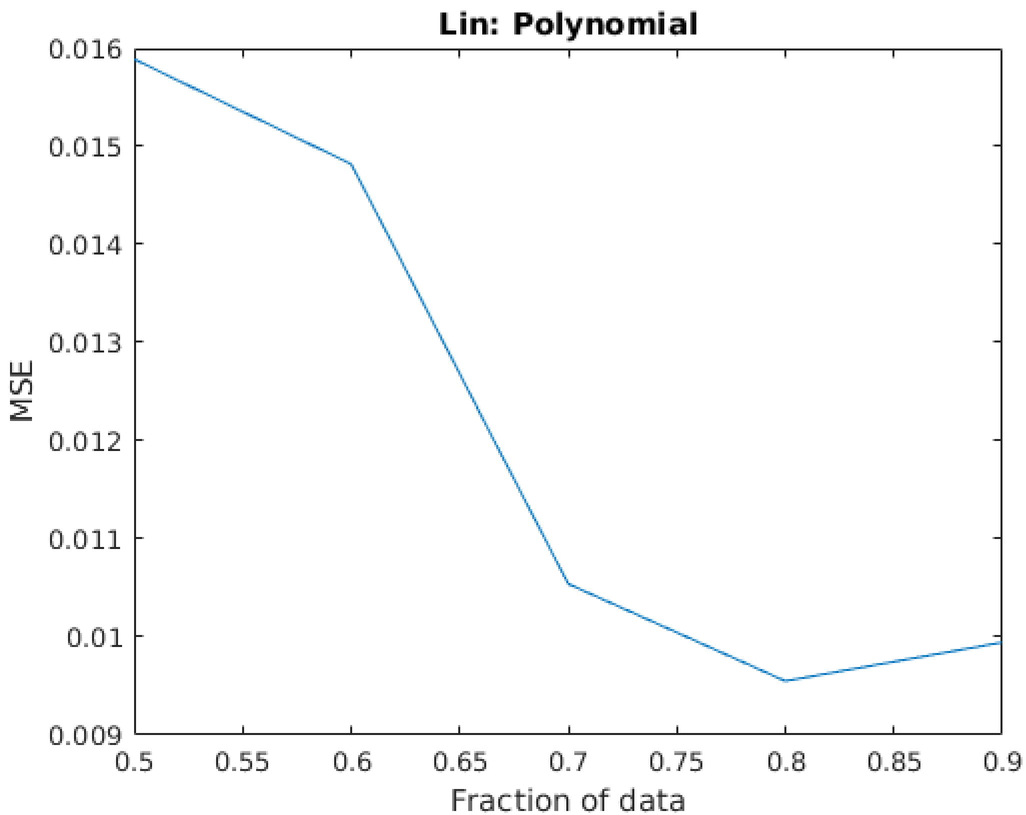
Ans 4. a.

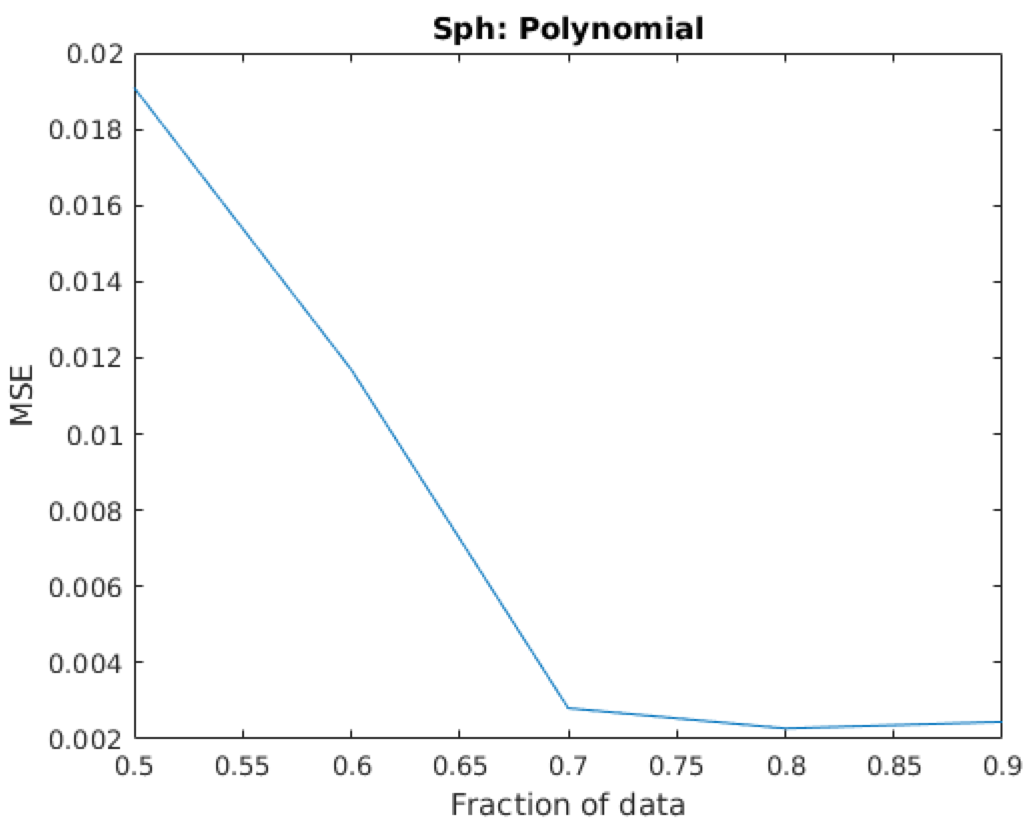

Lin: Gradient descent
0.055
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
MSE
0.5
0.55
0.6
0.65
0.7
0.75
0.8
0.85
0.9
Fraction of data


Sph: Gradient descent
0.06
0.055
0.05
0.045
0.04
0.035
0.03
0.025
MSE
0.5
0.55
0.6
0.65
0.7
0.75
0.8
0.85
0.9
Fraction of data

Ans 4. b.

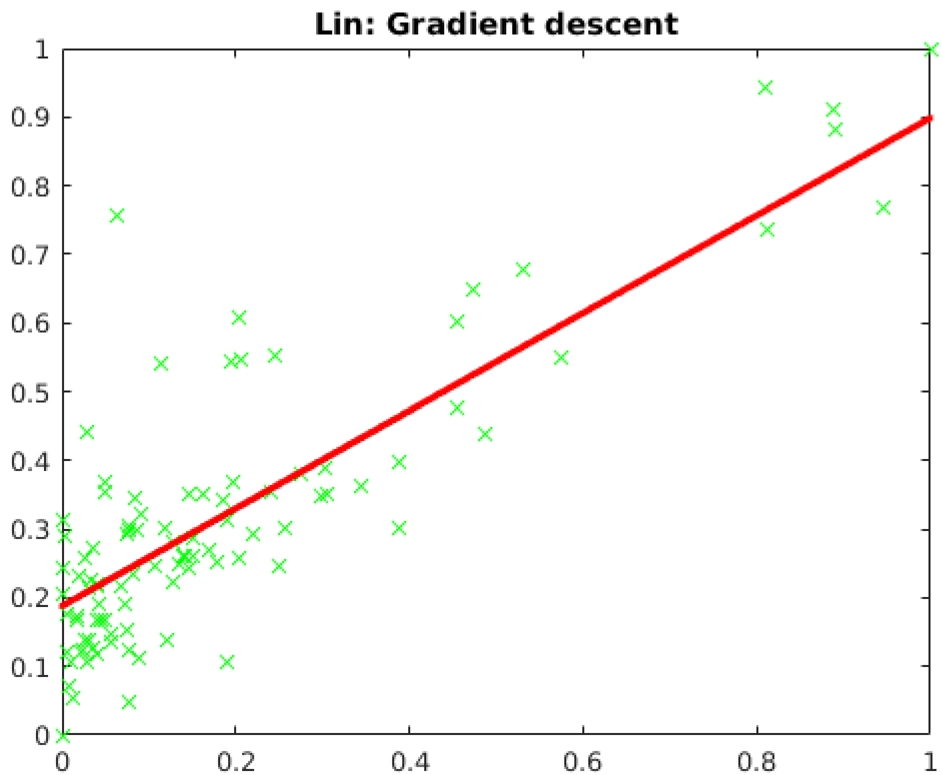


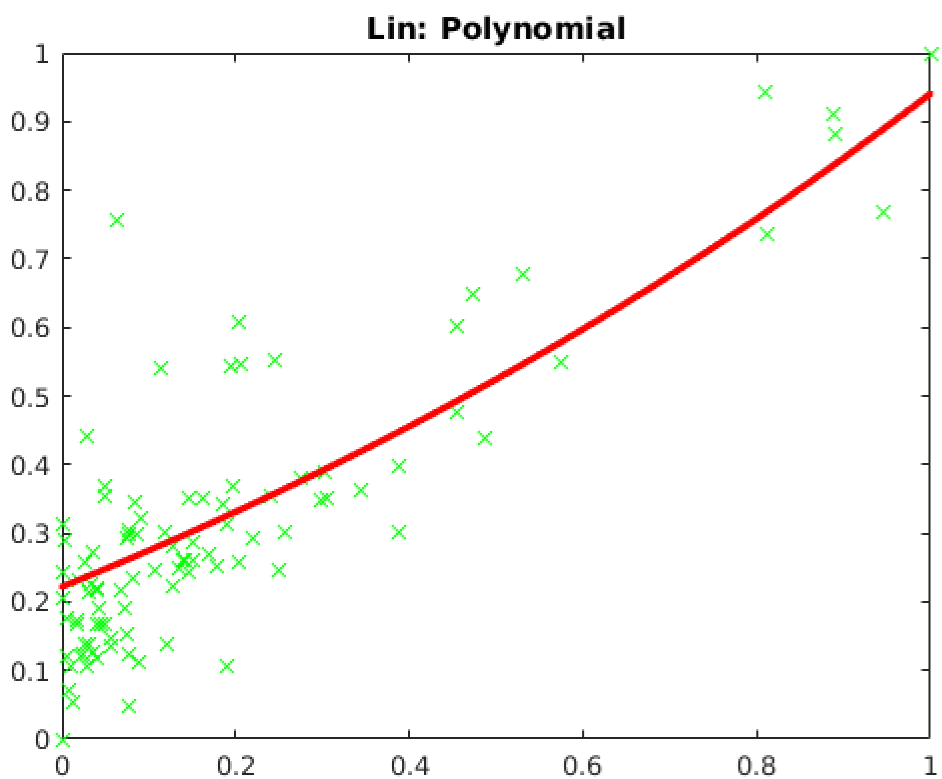
Lin: Polynomial
0.016
0.015
0.014
0.013
0.012
0.011
0.01
0.009
MSE
0.5
0.55
0.6
0.65
0.7
0.75
0.8
0.85
0.9
Fraction of data

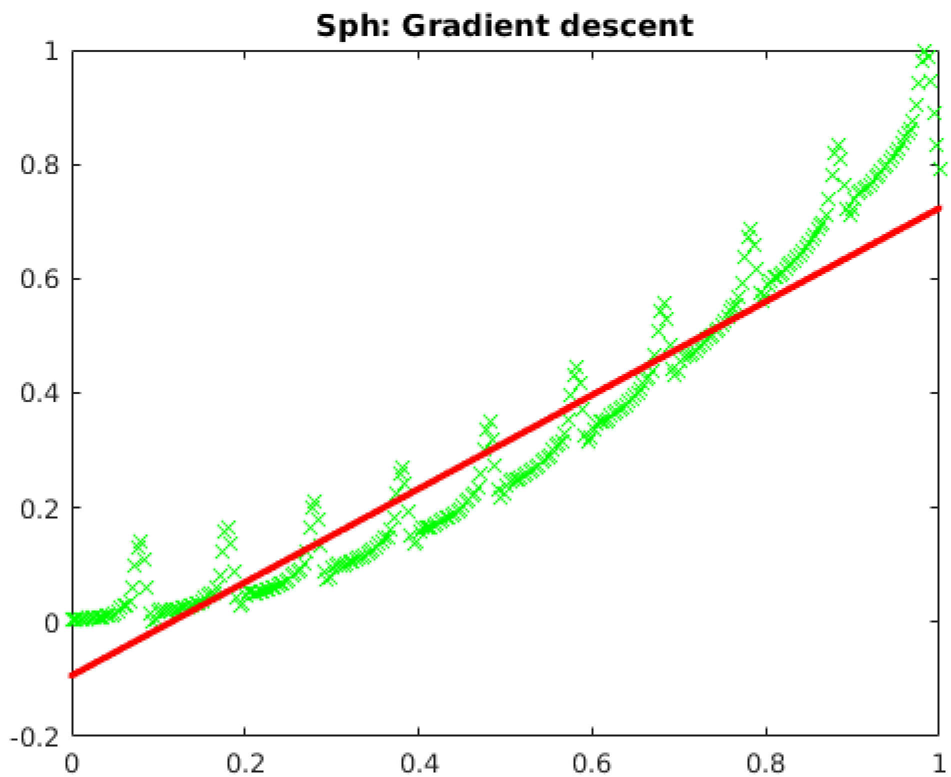



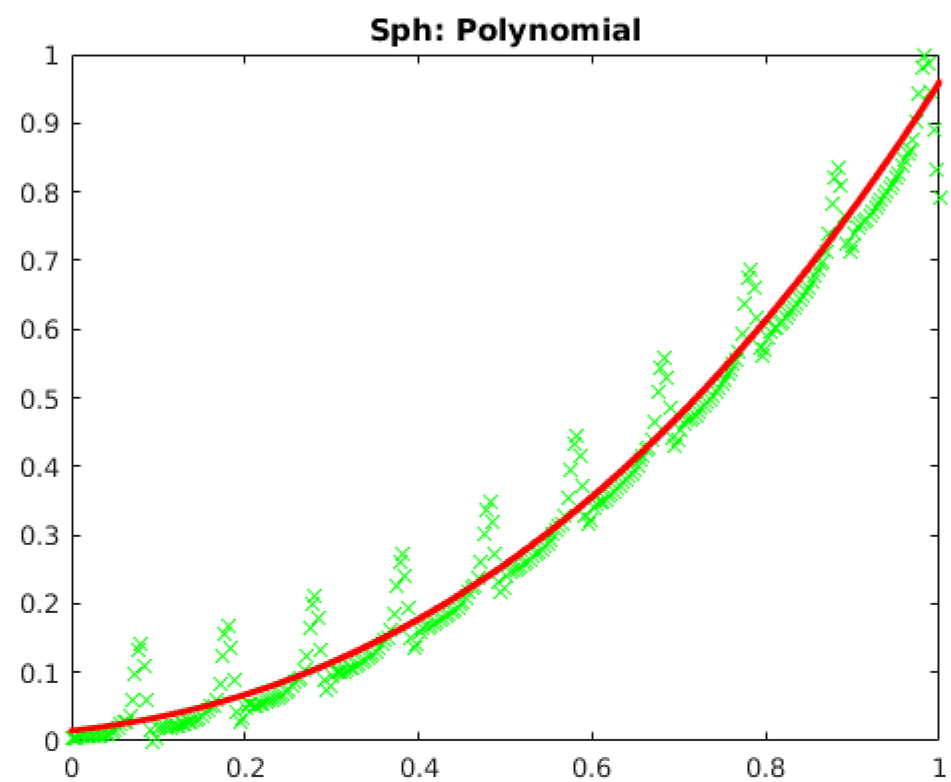
Sph: Polynomial
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
MSE
0.5
0.55
0.6
0.65
0.7
0.75
0.8
0.85
0.9
Fraction of data

Ans 4. c.




Sph: Gradient descent
1
0.8
0.6
0.4
0.2
0
-0.2
0
0.2
0.4
0.6
0.8
1


Sph: Polynomial
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.2
0.4
0.6
0.8
1

Ans 4. d.

Choosing the delta value:

Lin dataset:

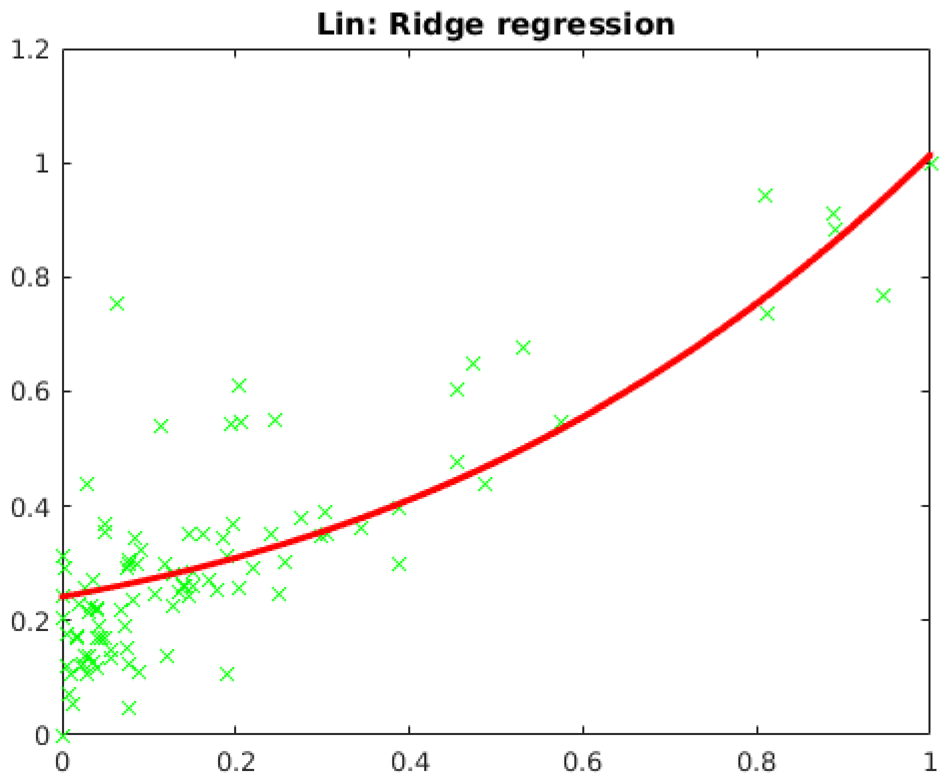
| | 80 % training data + 20 % test data | | | 90 % training data + 10 % test data | | |
|---|---|---|---|---|---|---|
| | Train Error | Test Error | Avg Error | Train Error | Test Error | Avg Error |
| 0.1 | 0.062826 | 0.007193 | 0.035009 | 0.031174 | 0.018482 | 0.024828 |
| 0.5 | 0.050667 | 0.017297 | 0.033982 | 0.149542 | 0.014900 | 0.082221 |
| 1 | 0.346640 | 0.014163 | 0.180401 | 0.185215 | 0.013989 | 0.099602 |
| 10 | 2.208664 | 0.008807 | 1.108736 | 1.922445 | 0.009766 | 0.966106 |
| 50 | 3.498616 | 0.011004 | 1.754810 | 2.168872 | 0.014136 | 1.091504 |

For 90% training example the test error seems to be minimized for delta = 1. It performs not so great compared to delta = 0.1(best avg error) but that is majorly due to poor performance in train error. Therefore, delta = 1

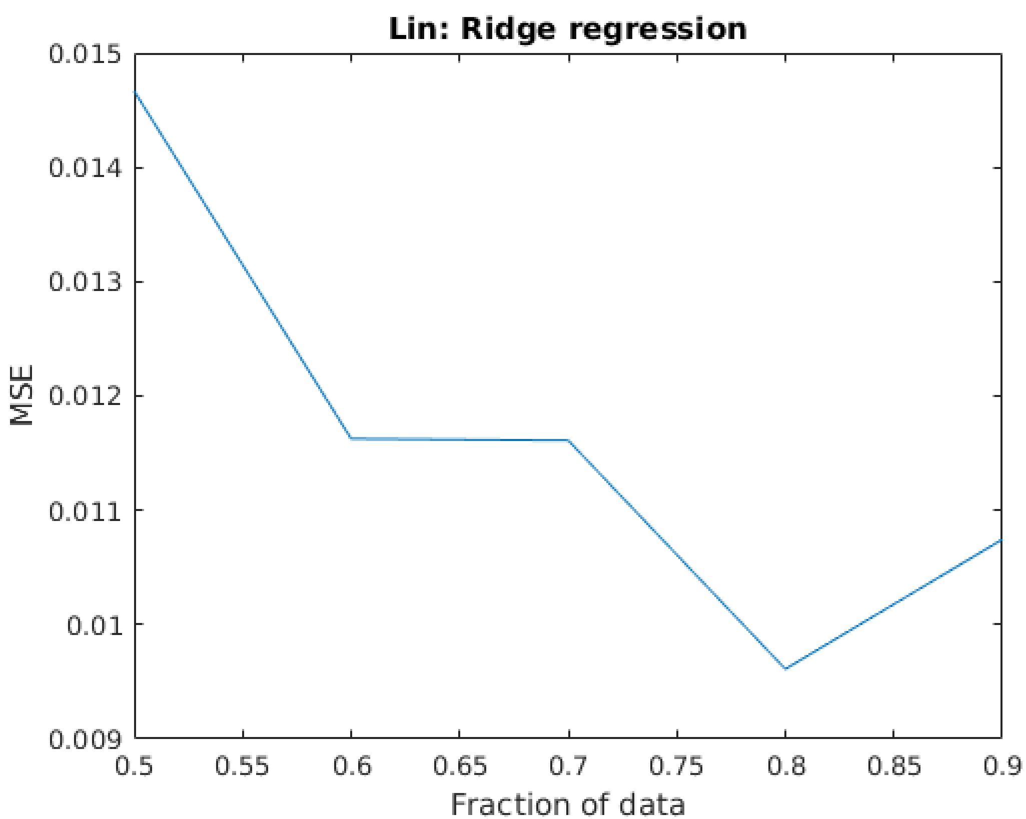
Sph dataset:

| | 80 % training data + 20 % test data | | | 90 % training data + 10 % test data | | |
|---|---|---|---|---|---|---|
| | Train Error | Test Error | Avg Error | Train Error | Test Error | Avg Error |
| 0.1 | 0.030096 | 0.002553 | 0.016325 | 0.031361 | 0.001729 | 0.016545 |
| 0.5 | 0.145685 | 0.005339 | 0.075512 | 0.153389 | 0.001715 | 0.077552 |
| 1 | 0.268837 | 0.003753 | 0.136295 | 0.293244 | 0.002082 | 0.147663 |
| 10 | 2.124107 | 0.024976 | 1.074542 | 2.301376 | 0.006795 | 1.154086 |
| 50 | 2.589090 | 0.020900 | 1.304995 | 13.872964 | 0.406893 | 7.139928 |

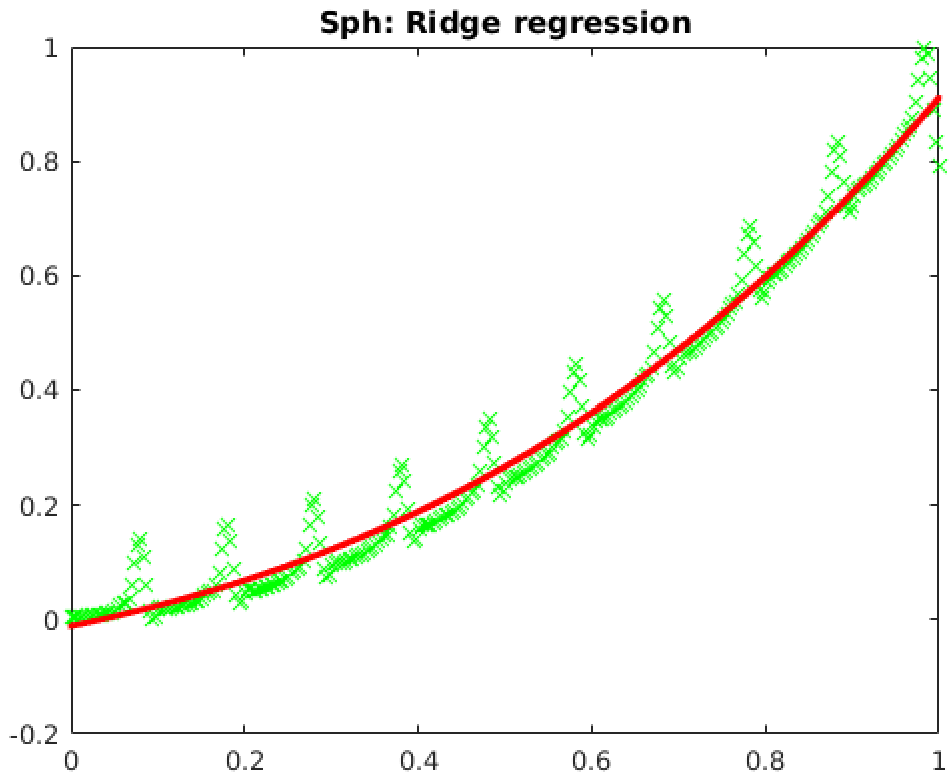
For 90% training example the test error seems to be minimized for delta = 0.5. It performs not so great compared to delta = 0.1(best avg error) but that is majorly due to poor performance in train error. Therefore, delta = 0.5

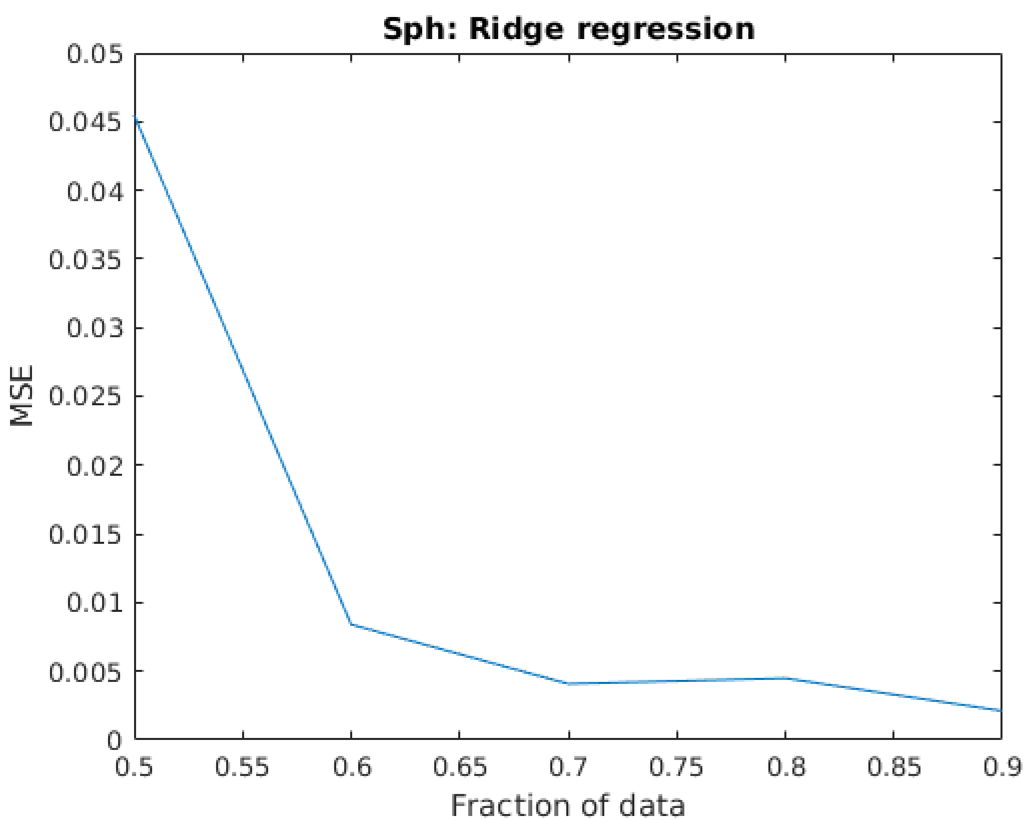


Lin: Ridge regression
1.2
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1

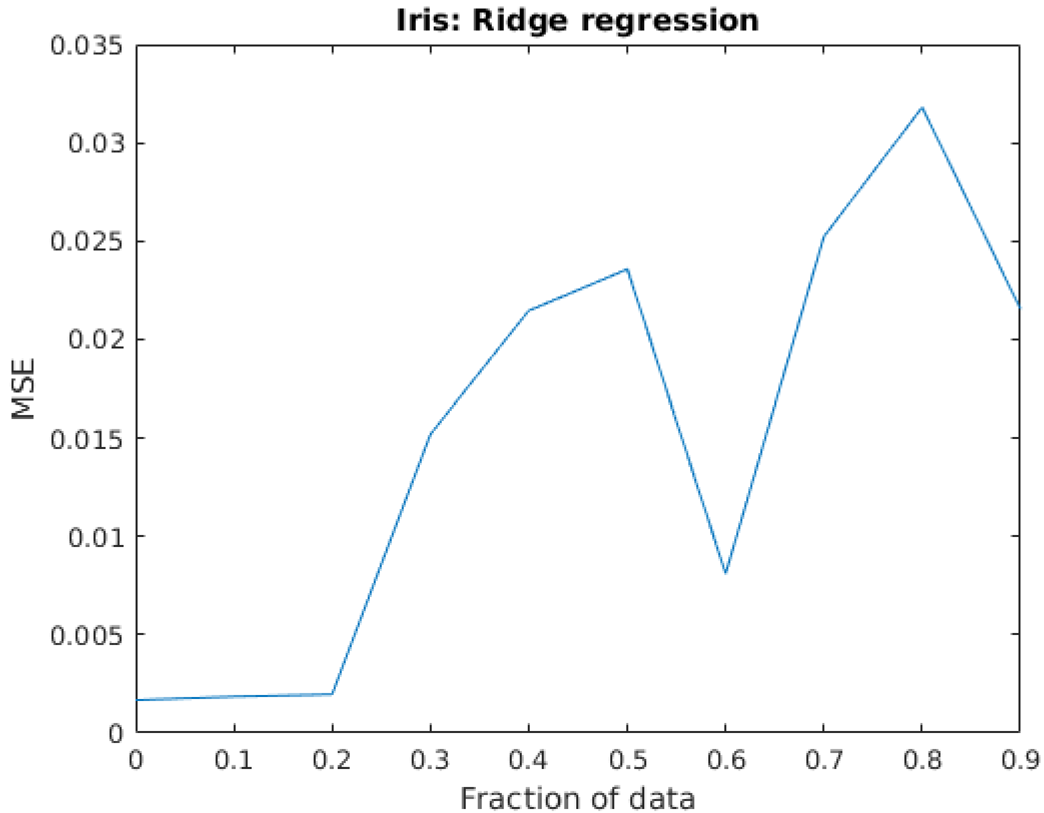



Lin: Ridge regression
0.015
0.014
0.013
0.012
0.011
0.01
0.009
MSE
0.5
0.55
0.6
0.65
0.7
0.75
0.8
0.85
0.9
Fraction of data

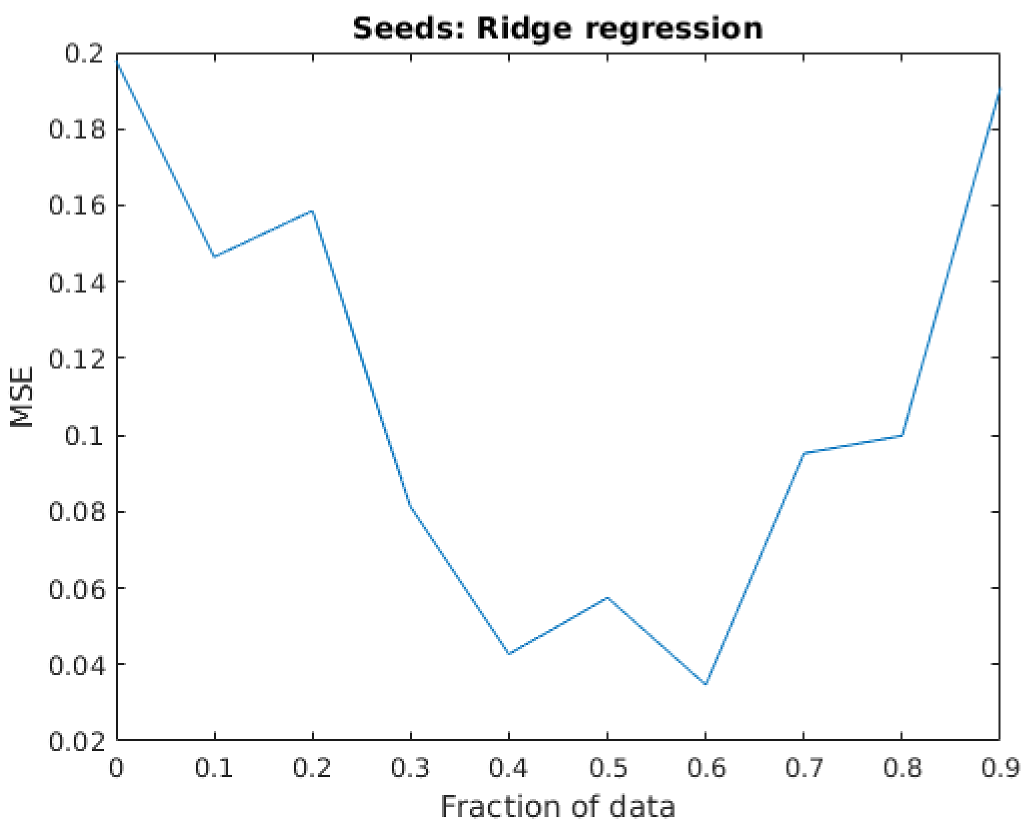

Sph: Ridge regression
1
0.8
0.6
0.4
0.2
0
-0.2
0
0.2
0.4
0.6
0.8
1


Sph: Ridge regression
MSE
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0.5
0.55
0.6
0.65
0.7
0.75
0.8
0.85
0.9
Fraction of data

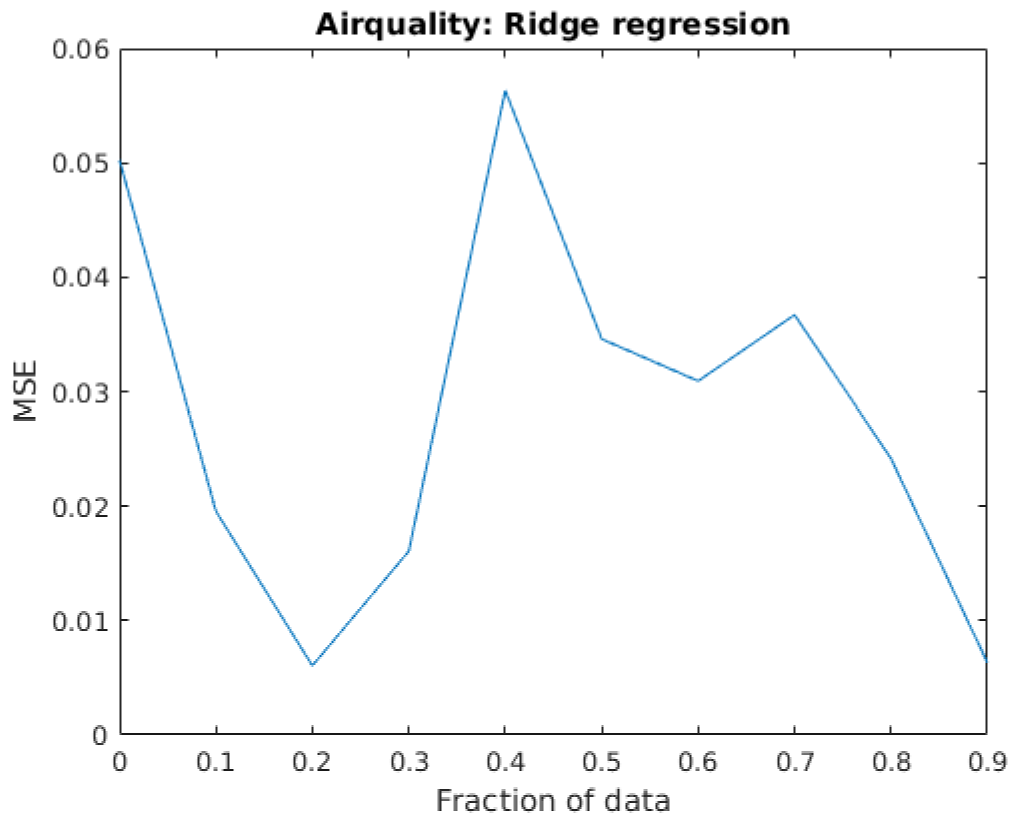
Ans 4. e. Error plots: (Fraction of data represents training data from 'fraction of data' to 'fraction of data'+10% data size)



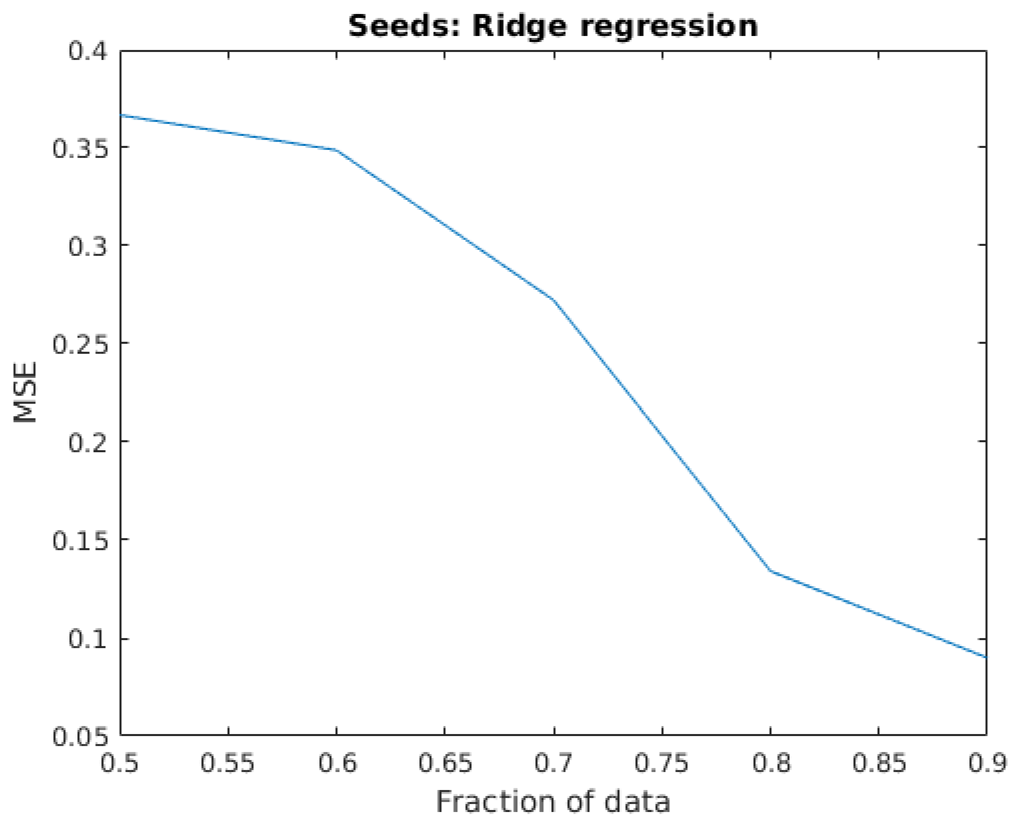

Mean: 0.015237 Std deviation: 0.011118

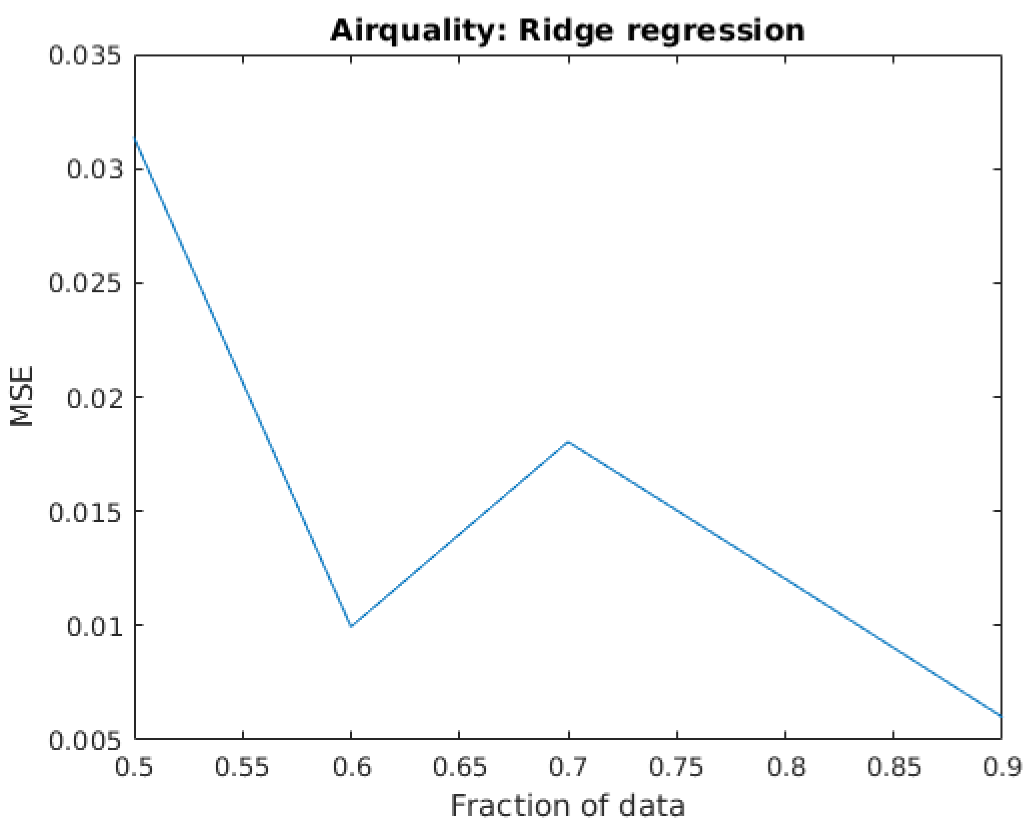


Mean: 0.110497 Std deviation: 0.059651




Mean: 0.028098 Std deviation: 0.017013
MSE vs fraction of data plots:


Seeds: Ridge regression
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
MSE
0.5
0.55
0.6
0.65
0.7
0.75
0.8
0.85
0.9
Fraction of data


Airquality: Ridge regression
0.035
0.03
0.025
0.02
0.015
0.01
0.005
MSE
0.5
0.55
0.6
0.65
0.7
0.75
0.8
0.85
0.9
Fraction of data