Machine Learning - CS60050

Assignment 1 Report

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Part 1

Here the dataset was generated and split as mentioned. The training was done for 10000 iterations. The learned values for the dataset are:

The learned coefficients for degree 1 polynomial are:
[0.9994631 -2.01035175]

The learned coefficients for degree 2 polynomial are:
[0.54234662 0.73382011 -2.64969007]

The learned coefficients for degree 3 polynomial are:
[0.55187438 0.5306924 -2.06275565 -0.4168198]

The learned coefficients for degree 4 polynomial are:
[0.59232666 0.55804174 -2.43600353 -1.00160293 1.06125497]

The learned coefficients for degree 5 polynomial are:
[0.59443006 0.7709194 -2.69742484 -1.5947037   0.27436018 1.6993383]

The learned coefficients for degree 6 polynomial are:
[0.57416426 0.99491693 -2.78230333 -1.95932032 -0.28627278 1.01486888
  1.79932064]

The learned coefficients for degree 7 polynomial are:
[0.54858465 1.16389353 -2.76573891 -2.13617937 -0.62182511 0.56603595
  1.27648203 1.6193209]

The learned coefficients for degree 8 polynomial are:
[0.52634407 1.27088129 -2.71031296 -2.19962495 -0.79944889 0.29866132
  0.94508302 1.24584199 1.32613613]

The learned coefficients for degree 9 polynomial are:
[0.51016592 1.32925502 -2.65037507 -2.20576819 -0.88137412 0.15183669
  0.74877281 1.01463378 1.07231834 1.01249275]

Part 2

Here the dataset and the learned polynomials were visualized using matplotlib library and a graph showing test and train error vs degree of polynomial was plotted.
The training was done for 10000 iterations and dataset size was 10. The learned values for the dataset are:

The learned coefficients for degree 1 polynomial are:
[0.8864805 -1.77551567]

The learned coefficients for degree 2 polynomial are:
[0.50776042 1.82631691 -5.08586969]

The learned coefficients for degree 3 polynomial are:
[0.42569175 1.68003687 -2.53145235 -3.23625779]

The learned coefficients for degree 4 polynomial are:
[0.42804954 1.3567949 -1.81907174 -2.25066668 -1.85469013]

The learned coefficients for degree 5 polynomial are:
[0.43168406 1.22452723 -1.63754149 -1.93392303 -1.51283162 -1.04104527]

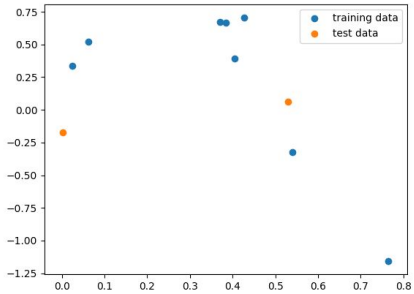
The learned coefficients for degree 6 polynomial are:
[0.43734603 1.14973086 -1.56902393 -1.81154046 -1.38359307 -0.92403128
 -0.58129865]

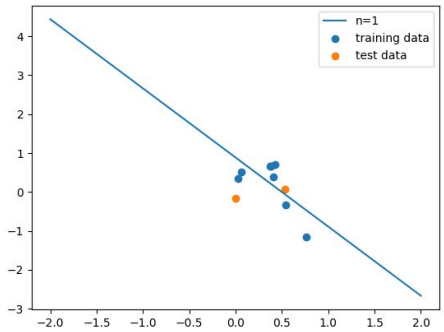
The learned coefficients for degree 7 polynomial are:
[0.44094507 1.11431954 -1.54555857 -1.76338042 -1.33051279 -0.87478947
 -0.53904252 -0.32096483]

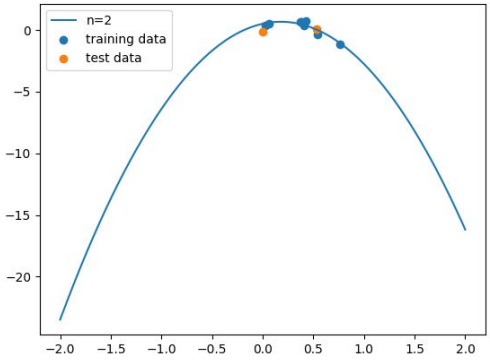
The learned coefficients for degree 8 polynomial are:
[0.4431131   1.09721239 -1.53758591 -1.74368137 -1.30773804 -0.8531114
 -0.52013547 -0.30524173 -0.17501938]

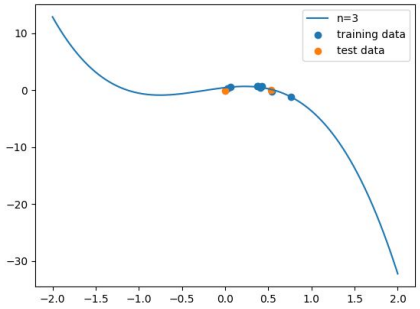
The learned coefficients for degree 9 polynomial are:
[0.44439604 1.08872018 -1.5350452 -1.73538585 -1.2976074 -0.84320068
 -0.51134669 -0.29785329 -0.16900439 -0.09410941]

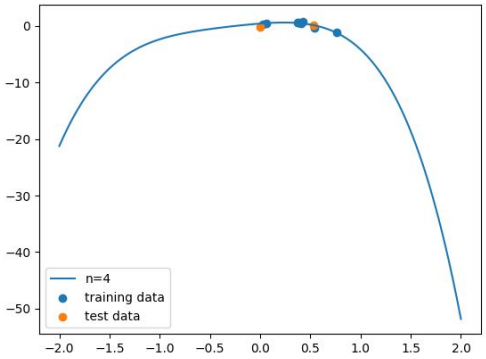
Plots:

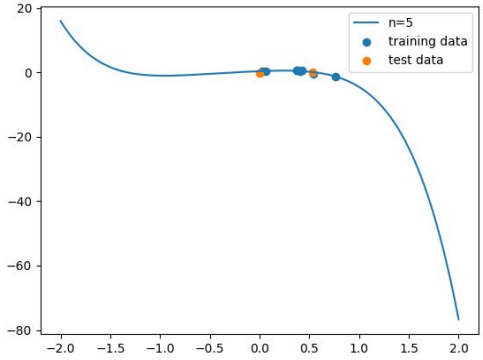

training data
test data

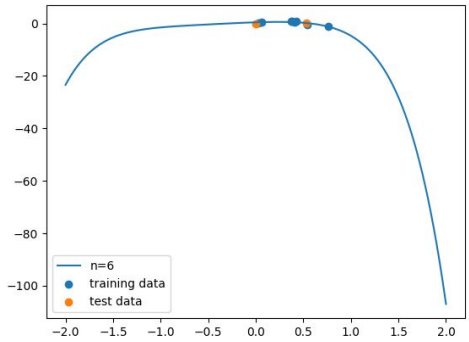

n=1
training data
test data

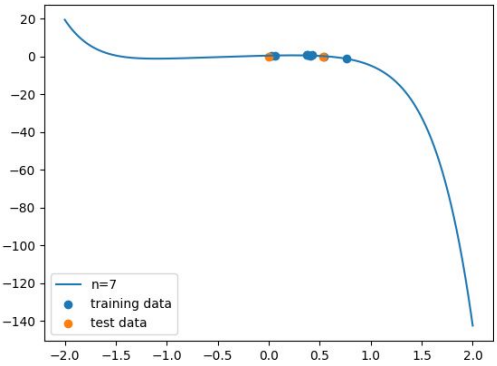

n=2
training data
test data

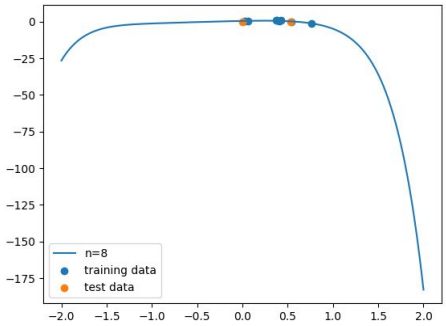

n=3
training data
test data

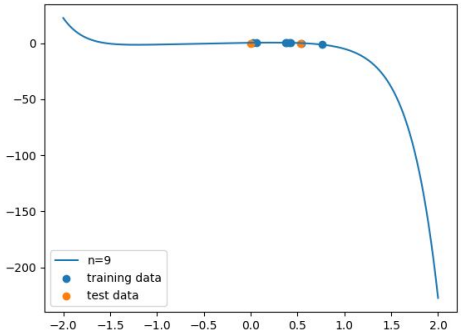

n=4
training data
test data

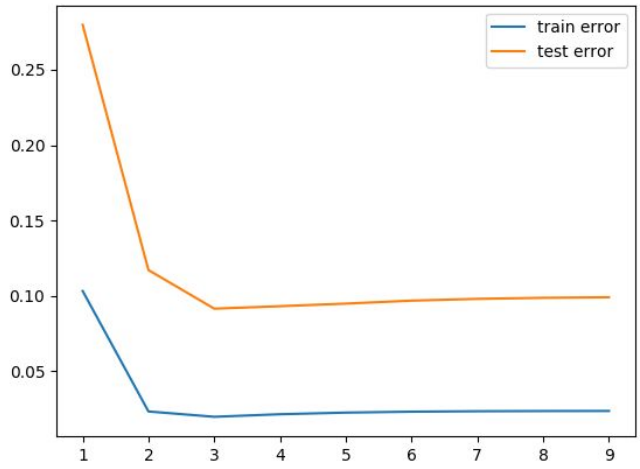

n=5
training data
test data











On analysing the above graph we can see that n = 3 is suitable for the dataset generated as the error is minimized at n = 3. The error value then increases till n = 9 due to

overfitting. This is so because as we can see that the dataset generated roughly resembles a cubic-like plot.

Part 3

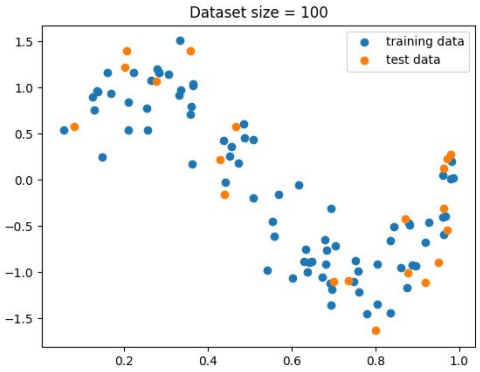
Here the experiment was repeated for datasets of sizes 100, 1000 and 1000. Plots of the datasets and the fitted polynomial were generated for each dataset size.
The number of iterations were 10000 and the polynomial taken was of degree 5.

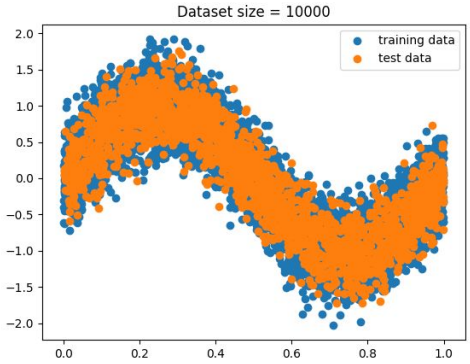
Learned coefficient for dataset of 100 size:
[1.55008067 -1.95188071 -2.93711472 -1.13424204 1.19823305 3.23059499]

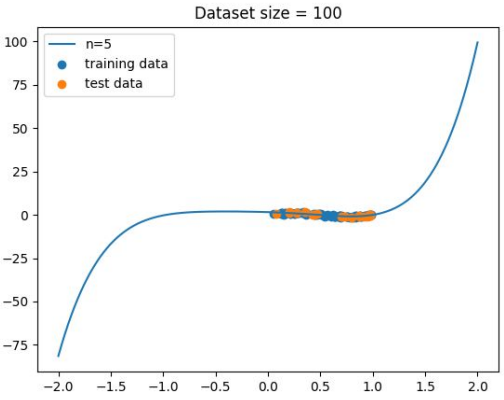
Learned coefficient for dataset of 1000 size
[0.89407006 -0.19060305 -3.19166764 -1.56023972 0.88558171 2.98642787]

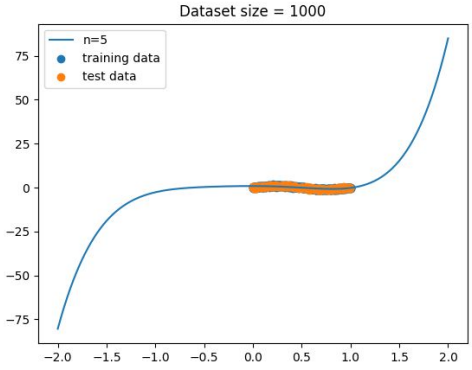
Learned coefficient for dataset of 10000 size
[0.87647388 -0.15800059 -3.26851218 -1.5866947   0.90750751 3.05153863]

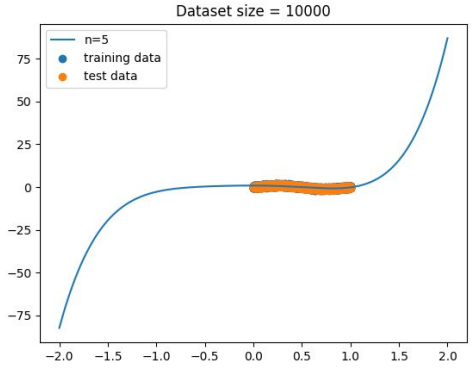
Plots








Dataset size = 1000
n=5
training data
test data
75
50
25
0
−25
−50
−75
−2.0
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0


Dataset size = 10000
n=5
training data
test data
75
50
25
0
−25
−50
−75
−2.0
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0


Error vs Dataset Size
training error
test error
0.105
0.100
0.095
0.090
0.085
0.080
0.075
0.070
0
2000
4000
6000
8000
10000

Part 4

Here two different cost functions were implemented, mean absolute error and fourth power error. Plots for the RMSE errors vs learning rates were then plotted.
The number of iterations were 500 and the curve was of degree 5

The learned values for the dataset are:

The coefficients for MSE:

The learned coefficients for learning rate 0.025 are:
[0.69850808 -0.70521735 -1.10413104 -0.2480759 0.23087479 0.14359983]

The learned coefficients for learning rate 0.05 are:
[0.81811065 -1.07353431 -1.10915777 -0.25586925 0.33341551 0.45514393]

The learned coefficients for learning rate 0.1 are:
[0.91059211 -1.14407491 -1.64608102 -0.12952831 0.11990506 1.27718013]

The learned coefficients for learning rate 0.2 are:
[0.95822137 -1.10020464 -1.78469546 -0.99924938 0.49027376 2.01414073]

The learned coefficients for learning rate 0.5 are:
[0.85704014 -0.13394459 -3.18879809 -1.42605446 0.66844721 2.95715401]

The coefficients for MAE:

The learned coefficients for learning rate 0.025 are:
[0.73262928 -0.84594864 -0.78933165 -0.8084757 -0.32555641 0.99586568]

The learned coefficients for learning rate 0.05 are:
[1.02301884 -1.52878113 -1.44980234 -0.18213733 0.45938885 1.01254093]

The learned coefficients for learning rate 0.1 are:
[1.09845629 -1.51491617 -1.93479509 -0.31952929 0.81273744 1.41785368]

The learned coefficients for learning rate 0.2 are:
[1.14494882 -1.80246188 -1.47014853 -0.48640232 0.2835827 1.95217291]

The learned coefficients for learning rate 0.5 are:
[1.01292394 -1.45225319 -1.52731811 -0.64941083 1.03478565 0.94063404]

The coefficients for Power 4:

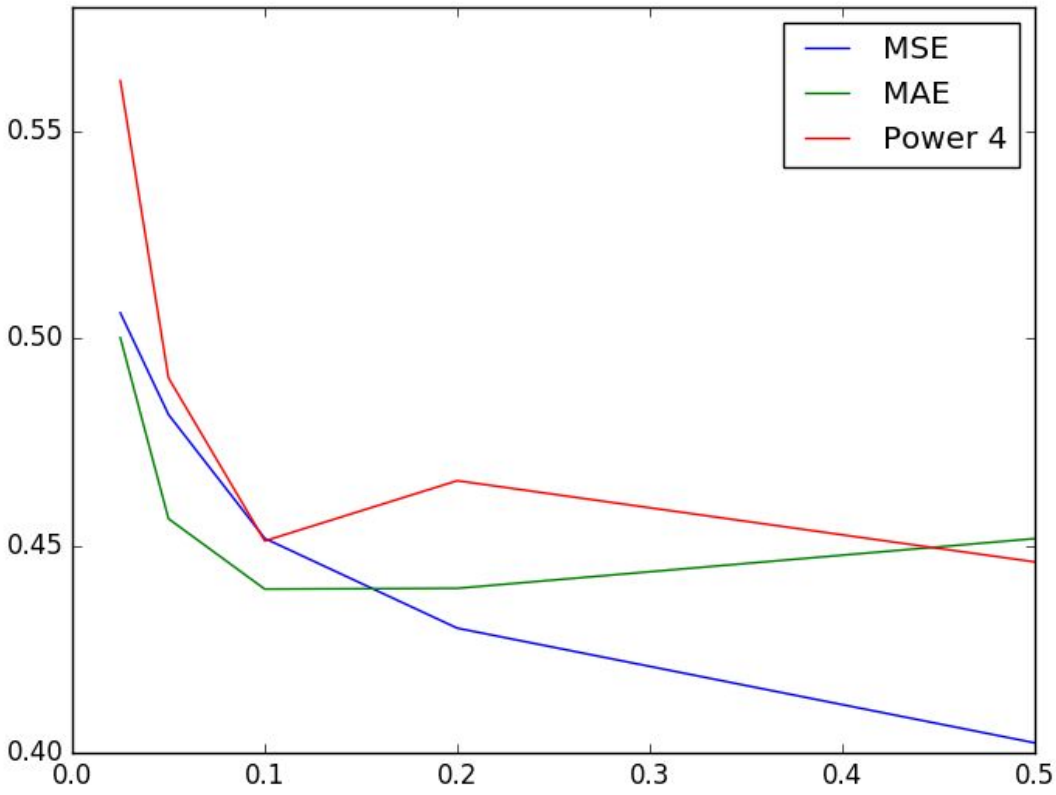
The learned coefficients for learning rate 0.025 are:
[-0.20608794 0.27213708 0.37014445 0.54751565 -0.15112504 0.5864917]

The learned coefficients for learning rate 0.05 are:
[-0.02264466 0.4995612 -0.05917496 0.21372465 0.27451838 -0.07770602]

The learned coefficients for learning rate 0.1 are:
[0.10605941 -0.18161337 0.26470056 0.25829366 0.2903092   0.01967871]

The learned coefficients for learning rate 0.2 are:
[-0.10003781 -0.3289311   0.29243808 0.48167659 0.04266961 0.54957895]

The learned coefficients for learning rate 0.5 are:
[-0.24258713 0.17788301 0.07655786 0.53941262 -0.28884171 0.21081934]



The learning rate of 0.5 should be preferred as it gives least value of RMS error