# ASSIGNMENT-2 REPORT

All the data was initially normalized and new features were generated according to the degree of the polynomial to be fit. An N-th degree polynomial has $^{N+1}C_2$ coefficients.

Learning rate: (1e-6)
Stopping criteria: (E-E′ ≤ 5e-2)
Maximum iterations: 50000
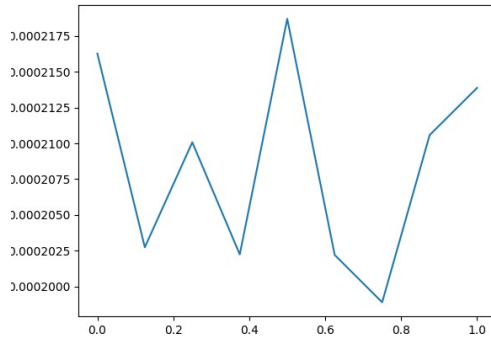
## Gradient Descent:

| DEG | TRAIN ERR | AVG TEST ERR | R2 ERROR | RMSE | WEIGHTS(np.random.randn()) |
|-----|-----------|--------------|----------|------|----------------------------|
| 1 | 2504.969060 | 0.0082859983 | 2.5010214167 | 0.1287322 | [ 0.20848472  0.09536773 -0.09982884] |
| 2 | 2416.236659 | 0.008031471 | 6.212487647 | 0.1267396 | [ 0.1423993   0.52602894 -0.47462574 -0.17928082 -0.03033481  0.13114884] |
| 3 | 2243.467785 | 0.007348374 | 12.65263576 | 0.1212301 | [ 0.22956625 -0.13999825  1.79395354 -2.04201335 -0.53483783 -1.52421099 1.46343568  1.93033192  0.42746262 -1.5781994 ] |
| 4 | 2165.918867 | 0.007224321 | 15.68624651 | 0.1202025 | [ 0.20091943 -0.00290968  1.27206105 -0.40164413 -1.72933962 -0.21291626 -1.98774206  1.08462712  1.66735796 0.57902535  0.02645383  0.27884248 1.56978226 -0.93956409 -1.40090874] |
| 5 | 2124.145589 | 0.00695314 | 17.6060985 | 0.1179249 | [ 0.17442318  0.00980305  1.31990218 -0.28355097 -1.4693503  -0.94444191 0.08125487 -1.98970689  0.69908159 1.32451212  1.63676402 -0.2194968 -0.29283898  0.28029615  0.39492675 1.56601267 -0.10389244 -0.71290387 0.67861609 -1.26979099 -0.87991535] |
| 6 | 2110.53817 | 0.00695059 | 17.77905469 | 0.1179032 | [ 0.17048744 -0.08962674  1.50332933 -0.02050638 -1.53132001 -1.52887083 -0.15819974  0.19751607 -1.95866819 0.57652114  0.99373625  1.036232 1.56734689 -0.37704709 -0.29113032 0.29275535  0.31045194  0.60387746 1.19626403  0.06177757 -0.36096084 -0.31454571  0.73898155 -0.59345753 -0.86432248 -0.03954899 -0.88730104 -0.15256575] |

From the above data:
- As higher degree polynomials are fit to the data, the training error decreases while the R2 error increases, indicating some overfitting.
- Over fit: degree 6 polynomial
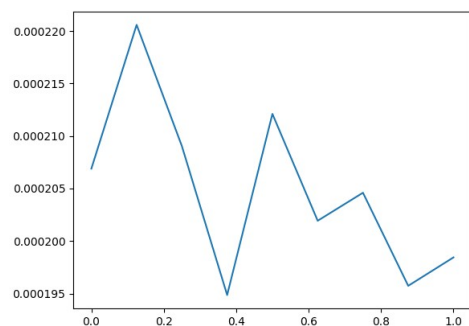- Best fit: degree 4 polynomial

## With L1 Regularization:

| DEG | AVG TEST ERR | R2 ERROR | RMSE | REG. COEFF. | WEIGHTS |
|-----|--------------|----------|------|-------------|---------|
| 6 | 0.005767541 | 15.3936219 | 0.10740150 | 0.750 | [ 0.22443079  0.06434552  0.4484087  0.16840746 -0.59062736 -0.63748462 -0.07625614 -0.27774885 -0.62978988 -0.15228207  0.43046438  0.32790992  0.02454909  0.15110341  0.44225115  0.25862018  0.36611453  0.25219859  0.32065097  0.42464265 -0.31452865  0.16880308  0.02215062 -0.42213197 -0.56118908  0.07997544 -0.1897593  -0.43929934] |



## With L2 Regularization:

| DEG | AVG TEST ERR | R2 ERROR | RMSE | REG. COEFF. | WEIGHTS |
|-----|--------------|----------|------|-------------|---------|
| 6 | 0.005751591 | 15.6276033 | 0.10725289 | 0.375 | [ 0.20728141  0.14860611  0.36461565 -0.11724464  0.02500055 -0.89191597 -0.13662495 -0.15469831 -1.070759  0.60531285 -0.140598   -0.0379052  0.67714743  0.03974865  0.6409446  0.54029996 -0.01648629 -0.045534  0.05002187  0.47055362  0.07705204 -0.03744093  0.30591422  0.02213287 -0.71178604 -0.31446844 -0.49900394 -0.19813366] |



- ■ After regularization, not much change in weights is seen, as they are already quite low.
- ■ It is observed that the RMSE error approaches that of degree 4 after regularization.