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CSE 4309 – 001 Machine Learning
Assignment 3

Task – 1

- **For degree = 1, lambda = 0**

  w0=-6.3872
  w1=0.0276
  w2=0.0432
  w3=0.0126
  w4=0.0176
  w5=0.0080
  w6=-0.0058
  w7=-0.0081
  w8=0.0714
  w9=-0.0153
  w10=-0.0190
  w11=0.0117
  w12=0.0222
  w13=-0.0018
  w14=-0.0013
  w15=0.0091
  w16=0.0382
  ID= 3498, output= 3.8514, target value = 4.0000, squared error = 0.0221

- **For degree = 2, lambda = 0**

  w0=-7.5608
  w1=0.0223
  w2=0.0001
  w3=0.0352
  w4=0.0000
  w5=0.0049
  w6=-0.0000
  w7=-0.0299
  w8=0.0002
  w9=0.0327
  w10=-0.0001
  w11=0.0694
  w12=-0.0004
  w13=0.0079
  w14=-0.0002
  w15=0.0596
  w16=-0.0003
  w17=-0.0184

w18=-0.0000
w19=0.0093
w20=0.0002
w21=0.0162
w22=-0.0000
w23=0.0398
w24=-0.0002
w25=-0.0041
w26=0.0001
w27=0.0538
w28=-0.0007
w29=-0.0149
w30=0.0002
w31=0.1215
w32=-0.0007
ID= 3498, output= 3.6074, target value = 4.0000, squared error = 0.1542

- **For degree = 1, lambda = 1**

w0=-6.2611
w1=0.0275
w2=0.0428
w3=0.0126
w4=0.0172
w5=0.0078
w6=-0.0059
w7=-0.0081
w8=0.0713
w9=-0.0154
w10=-0.0191
w11=0.0116
w12=0.0221
w13=-0.0018
w14=-0.0017
w15=0.0090
w16=0.0383
ID= 3498, output= 3.8528, target value = 4.0000, squared error = 0.0217

- **For degree = 2, lambda = 1**

w0=-7.0384
w1=0.0219
w2=0.0001
w3=0.0310
w4=0.0001

w5=0.0043
w6=-0.0000
w7=-0.0345
w8=0.0002
w9=0.0315
w10=-0.0001
w11=0.0678
w12=-0.0004
w13=0.0077
w14=-0.0002
w15=0.0574
w16=-0.0003
w17=-0.0192
w18=-0.0000
w19=0.0091
w20=0.0002
w21=0.0156
w22=-0.0000
w23=0.0401
w24=-0.0002
w25=-0.0050
w26=0.0001
w27=0.0536
w28=-0.0007
w29=-0.0155
w30=0.0002
w31=0.1208
w32=-0.0007
ID= 3498, output= 3.6001, target value = 4.0000, squared error = 0.1599

Task – 2

The value of w in the limit where lambda approaches positive infinity, w approaches to 0. This is because to find w, the formula is-

$$\boldsymbol{w} = (\lambda \mathrm{I} + \Phi^T \Phi)^{-1} \Phi^T \mathbf{t}$$

Since, $\lambda \mathrm{I} + \Phi^T$ would go to infinity if lambda is infinity, then the inverse of that expression will give us the inverse of infinity, which goes to 0. Therefore, w will be [0 0].

Task – 3

1. f(x) = 3.1x + 4.2

$x_1 = 5.3$, $t_1 = 9.6$
$x_2 = 7.1$, $t_2 = 4.2$
$x_3 = 6.4$, $t_3 = 2.2$

$f(x_1) = 20.63$, $t_1 = 9.6$
$(t_n – f(x))^2 = (9.6 – 20.63)^2 = 121.6609$

$f(x_2) = 26.21$, $t_2 = 4.2$
$(t_n – f(x))^2 = 484.4401$

$f(x_3) = 24.04$, $t_3 = 2.2$
$(t_n – f(x))^2 = 476.9856$

Sum of all = 1083.0866
$E_d(w)$ = ½ (sum of all) = 541.5433

$$E_D(\boldsymbol{w}) = \frac{1}{2}\sum_{n=1}^{N}[(t_n - \boldsymbol{w}^T\varphi(x_n))^2]$$

2. f(x) = 2.4x - 1.5

$x_1 = 5.3$, $t_1 = 9.6$
$x_2 = 7.1$, $t_2 = 4.2$
$x_3 = 6.4$, $t_3 = 2.2$

f(x1) = 11.22, t1 = 9.6
$(t_n – f(x))^2 = (9.6 – 11.22)^2 = 2.6244$

f(x2) = 15.54, t2 = 4.2
$(t_n – f(x))^2 = 128.5956$

F(x3) = 13.86, t3 = 2.2
$(t_n – f(x))^2 = 135.9556$

Sum of all = 267.1756
$E_d(w)$ = ½ (sum of all) = 133.5878

f(x) = 2.4x – 1.5 is a better solution because it results in a lower $E_d(w)$ value from the above calculation and minimized the $E_d(w)$ values. Since the square of error is minimized, f(x) = 2.4x – 1.5 will result in the least variation from the actual line.