Question 1

-----------------------------------------------------

Question 1(a):

[[0.49241486 0.75239824 0.67606395]

[0.50275673 0.37619258 0.00279037]

[0.80117437 0.48985495 0.57285682]

[0.40931682 0.56693066 0.04106205]]

-----------------------------------------------------

Question 1(b):

[[0.43579684]

[0.60612126]

[0.17501898]

[0.84358646]]

-----------------------------------------------------

Question 1(c):

[[0.49241486 0.75239824 0.67606395 0.50275673 0.37619258 0.00279037]

[0.80117437 0.48985495 0.57285682 0.40931682 0.56693066 0.04106205]]

-----------------------------------------------------

Question 1(d):

[[0.9282117 1.18819508 1.11186079]

[1.10887799 0.98231384 0.60891163]

[0.97619335 0.66487393 0.7478758 ]

[1.25290328 1.41051712 0.88464851]]

-----------------------------------------------------

Question 1(e):

[0.43579684 0.60612126 0.17501898 0.84358646]

-----------------------------------------------------

Question 1(f):

[[0.43579684 0.75239824 0.67606395]

[0.60612126 0.37619258 0.00279037]

[0.17501898 0.48985495 0.57285682]

[0.84358646 0.56693066 0.04106205]]

-----------------------------------------------------

Question 1(g):

[[1.11186079 0.75239824 0.67606395]

[0.60891163 0.37619258 0.00279037]

[0.7478758 0.48985495 0.57285682]

[0.88464851 0.56693066 0.04106205]]

-----------------------------------------------------

Question 1(h):

[[1.11186079 0.75239824]

[0.60891163 0.37619258]

[0.7478758 0.48985495]

[0.88464851 0.56693066]]

-----------------------------------------------------

Question 1(i):

[0.60891163 0.37619258 0.00279037]

[0.88464851 0.56693066 0.04106205]

-----------------------------------------------------

Question 1(j):

[3.35329674 2.18537643 1.29277319]

-----------------------------------------------------

Question 1(k):

[1.11186079 0.60891163 0.7478758 0.88464851]

-----------------------------------------------------

Question 1(l):

0.5692871962413104

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Question 1(m):

[[ 0.21207001 -0.56897905 -0.7829352 ]

[ -0.99216426 -1.95530818 -11.76316258]

[ -0.58103673 -1.4272919 -1.11423895]

[ -0.24512974 -1.13503655 -6.38534173]]

-----------------------------------------------------

Question 1(n):

[[1.73078967]

[1.11990004]

[0.43121804]]

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Question 2 a)

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Question 2 b)

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Question 2 c) N=200

0.00139498710632 seconds for Cube1 using numpy

13.2935760021 seconds for Cube2 using loops

Magnitude of the difference is3.5652192309498787e-10

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Question 2 c) N=2000

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Question 4

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Best Fitting Function:

Optimal value of M = 8

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Optimal value of w = [[ -61.53882763]

[-10549.5556656 ]

[ 4063.78680234]

[ 16096.66588129]

[ -6484.81659136]

[ 1311.64720066]

[ 9698.18002229]

[-13217.21905889]

[ -776.23779436]]

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Training Error of Optimal Value of M and w :2.18847416521

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Testing Error of Optimal Value of M and w :7.12818038225

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Training error is indeed less than test error.

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Question 5

Best Fitting Function:

Optimal value of alpha = 0.01

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Optimal value of w = [-54.00925081 6.86609108 2.13415301 15.60406784 8.4904623

14.11255525 6.71531265 15.41208278 10.05519171 -1.05068362

5.83225073 16.41405537 18.42321933 18.46844516 5.19156131

2.34580555]

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Training Error of Optimal Value of alpha and w :3.8656997219

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Validation Error of Optimal Value of alpha and w :6.0118079848

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Testing Error of Optimal Value of alpha and w : 10.2899664701

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The errors are indeed training error < validation error < test error

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Question 6

Mean of training Errors: 14.7400278752

Mean of Validation Errors: 22.6200288501

Mean Validation Error is indeed greater than the mean training error

Optimal value of alpha: 0.01

Optimal value of w: [ 0. 9.84997665 2.88387482 12.84162448 7.77670626 8.52412807

10.31588447 12.70522616 4.64092524 -1.08416118 6.27918074 10.86074865

17.48942947 17.895359 5.29632983 3.05619382]

Testing Error: 2340.78470317

Training Error: 2420.35600705

Mean Validation Error: 92.9771469652

Question 7

Optimal w:[-54.00923223 6.86608902 2.13415233 15.60406712 8.49046416

14.11254968 6.71531101 15.41208098 10.05518514 -1.05068938

5.83223619 16.41404581 18.42321599 18.46844225 5.19156209

2.34580498]

Training error: 3.8657004454924415

Test Error: 10.289966675669232

w2: [-54.00925081 6.86609108 2.13415301 15.60406784 8.4904623

14.11255525 6.71531265 15.41208278 10.05519171 -1.05068362

5.83225073 16.41405537 18.42321933 18.46844516 5.19156131

2.34580555]

Manitude of the difference: 7.90621829969e-10

Learning Rate: 0.01

Value of alpha: 0.01

Process finished with exit code 0