[AISII
assignment-I]

Roll no. MT2021130

(i) ⇒ closed form:

$$f(x, y, z) = x^2 + yz + 1$$

Here, $\frac{\partial f}{\partial x} = 2x$, $\frac{\partial f}{\partial y} = z$, $\frac{\partial f}{\partial z} = y$

equating each equation to 0;

$$2x = 0 \Rightarrow x = 0$$
$$y = 0 \Rightarrow y = 0$$
$$z = 0 \Rightarrow z = 0$$

So, ans $= (x, y, z) = (0, 0, 0)$

(ii) ⇒ gradient descent:

$$f(x, y, z) = x^2 + yz + 1$$

learning rate $\alpha = 0.1$

$$(x_{init}, y_{init}, z_{init}) = (2, 1, 1)$$

no. of iteration = 3

Here,

$$\frac{\partial f}{\partial x} = 2x, \quad \frac{\partial f}{\partial y} = z, \quad \frac{\partial f}{\partial z} = y$$

itr 1

Here $(x_0, y_0, z_0) = (2,1,1)$

$$\left(\frac{\partial f}{\partial x}\right)_{(2,1,1)} = 4 \quad \left(\frac{\partial f}{\partial y}\right)_{(2,1,1)} = 1 \quad \left(\frac{\partial f}{\partial z}\right)_{(2,1,1)} = 1$$

$$x_1 = x - \alpha \left(\frac{\partial f}{\partial x}\right)_{(x_0, y_0, z_0)}$$

$$= 2 - (0.1)(4)$$

$$= 1.6$$

Similarly, $y_1 = 1 - (0.1)(1) = 0.9$

$z_1 = 1 - (0.1)(1) = 0.9$

itr 2

Here, $(x_1, y_1, z_1) = (1.6, 0.9, 0.9)$

So, $\left(\frac{\partial f}{\partial x}\right)_{(x_1, y_1, z_1)} = 3.2 \quad \left(\frac{\partial f}{\partial y}\right) = 0.9 \quad \left(\frac{\partial f}{\partial z}\right) = 0.9$

So, $x_2 = \overset{1.6}{\cancel{}} - (0.1)(3.2) = 1.28$

$y_2 = 0.9 - (0.1)(0.9) = 0.810$

$z_2 = 0.9 - (0.1)(0.9) = 0.81$

itr 3

Here $(x_2, y_2, z_2) = (1.28, 0.81, 0.81)$

So, $\left(\frac{\partial f}{\partial x}\right)_{(x_2,y_2,z_2)} = 2.56$ $\left(\frac{\partial f}{\partial y}\right)_{(x_2,y_2,z_2)} = 0.81$ $\left(\frac{\partial f}{\partial z}\right)_{(x_2,y_2,z_2)} = 0.81$

$x_3 = 1.28 - (0.1)(2.56) = 1.024$

$y_3 = 0.81 - (0.1)(0.81) = 0.729$

$z_3 = 0.81 - (0.1)(0.81) = 0.729$

So, after 3 itr

$(x, y, z) = (1.024, 0.729, 0.729)$

Q-3

(a) since, there are two input variables x_1, x_2: dataspace will be a 3 dimensional plot depending on data points.

(b) if we consider $y = f(x_1, x_2)$ scenario ~~for modal space~~ then hypothesis y for model ~~space~~ will be,

$$h_\theta(x_1, x_2) = y = \theta_1 + \theta_2 x_1 + \theta_3 x_2 \quad \text{①}$$

Cost function

$$J(\theta_1, \theta_2, \theta_3) = \sum_{i=1}^{m} (h_\theta(x_1, x_2) - y^i)^2 \quad \text{②}$$

So, from above. Cost function we can conclude that model space will be in ~~4~~ 3D space with discrete points.

ⓒ as described ~~ea~~ in question 3ⓑ's equation 1,

We need to calculate 3 parameters $\theta_1, \theta_2, \theta_3$ ~~for model spa~~ to create a model.

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[1]
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

Gradient descent with 3 variables

f(x, y, z) = x^2 + yz + 1

α = 0.1

Initialy, (x, y, z) = (2, 1, 1)

[2]
```
def three_dimensional_loss(x, y, z):
    return x**2 + y*z + 1
```

[3]
```
def three_dimensional_loss_gradient(x, y, z):
    '''
    partially derivating f(x,y,z) w.r.t  x,y and z
    '''
    return (2*x, z, y)
```

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[4]
```
x_init, y_init, z_init = 2, 1, 1
```

[5]
```
learning_rate = 0.1
num_iters = 2000
```

[6]
```
x, y, z = x_init, y_init, z_init
costs = []
for _ in range(3):
    cost = three_dimensional_loss(x, y, z)
    costs.append(cost)
    dx, dy, dz = three_dimensional_loss_gradient(x, y, z)
    x = x - learning_rate*dx
    y = y - learning_rate*dy
    z = z - learning_rate*dz
```

[7]
```
plt.plot(costs)
plt.xlabel("Iteration")
plt.ylabel("Cost")
```

```
Text(0, 0.5, 'Cost')
```

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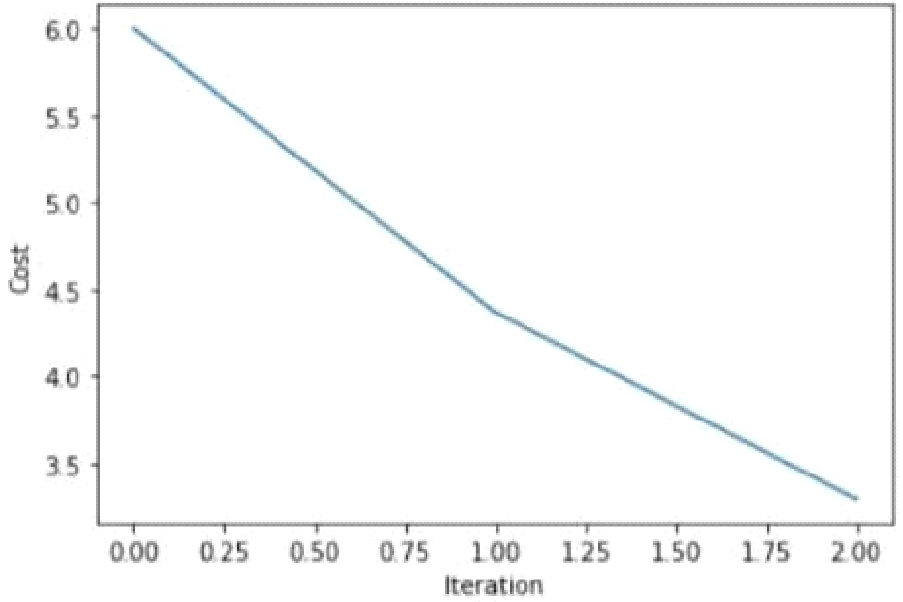
[6]
```
    y = y - learning_rate*dy
    z = z - learning_rate*dz
```

[7]
```
plt.plot(costs)
plt.xlabel("Iteration")
plt.ylabel("Cost")
```

```
Text(0, 0.5, 'Cost')
```



[8]
```
(x, y, z)
```

```
(1.024, 0.7290000000000001, 0.7290000000000001)
```

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