220962050_Arhaan_Lab04

August 14, 2024

Arhaan Girdhar - 220962050

0.1 Question 1

a. Create a CSV file with sample data.
b. Write a Python function program to: Find the fitted simple linear and polynomial regression equations for the given data.
c. Compare the coefficients obtained from manually intuitive and matrix formulation methods with your program.
d. Plot the scatterplot of the raw data and then another scatterplot with lines pertaining to a linear fit and a quadratic fit overlayed.
e. Compute the error, MSE, and RMSE.

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

[ ]:
```
data = pd.read_csv('Week4Q1.csv')
X = data['Temp'].values
y = data['Yield'].values
```

[ ]:
```
X
```

[ ]:
```
array([ 50,  50,  50,  70,  70,  70,  80,  80,  80,  90,  90,  90, 100,
        100, 100])
```

[ ]:
```
y
```

[ ]:
```
array([3.3, 2.8, 2.9, 2.3, 2.6, 2.1, 2.5, 2.9, 2.4, 3. , 3.1, 2.8, 3.3,
        3.5, 3. ])
```

[ ]:
```
lin_reg = np.vstack([X, np.ones(len(X))]).T
m, c = np.linalg.lstsq(lin_reg, y, rcond=None)[0]
```

[ ]:
```
m
```

[ ]:
```
0.006756756756756736
```

[ ]:
```
c
```

[ ]: 2.3063063063063094

[ ]:
```
mult_reg = np.vstack([X**2, X, np.ones(len(X))]).T
a, b, c_poly = np.linalg.lstsq(mult_reg, y, rcond=None)[0]
```

[ ]:
```
a
```

[ ]: 0.001075601374570447

[ ]:
```
b
```

[ ]: -0.1537113402061856

[ ]:
```
c_poly
```

[ ]: 7.9604810996563575

[ ]:
```
y_pred_linear = m * X + c
y_pred_mult = a * X**2 + b * X + c_poly
mse_linear = np.mean((y - y_pred_linear)**2)
rmse_linear = np.sqrt(mse_linear)
mse_poly = np.mean((y - y_pred_mult)**2)
rmse_poly = np.sqrt(mse_poly)
```

[ ]:
```
mse_linear
```

[ ]: 0.1327087087087O868

[ ]:
```
mse_poly
```

[ ]: 0.04778465063001147

[ ]:
```
rmse_linear
```

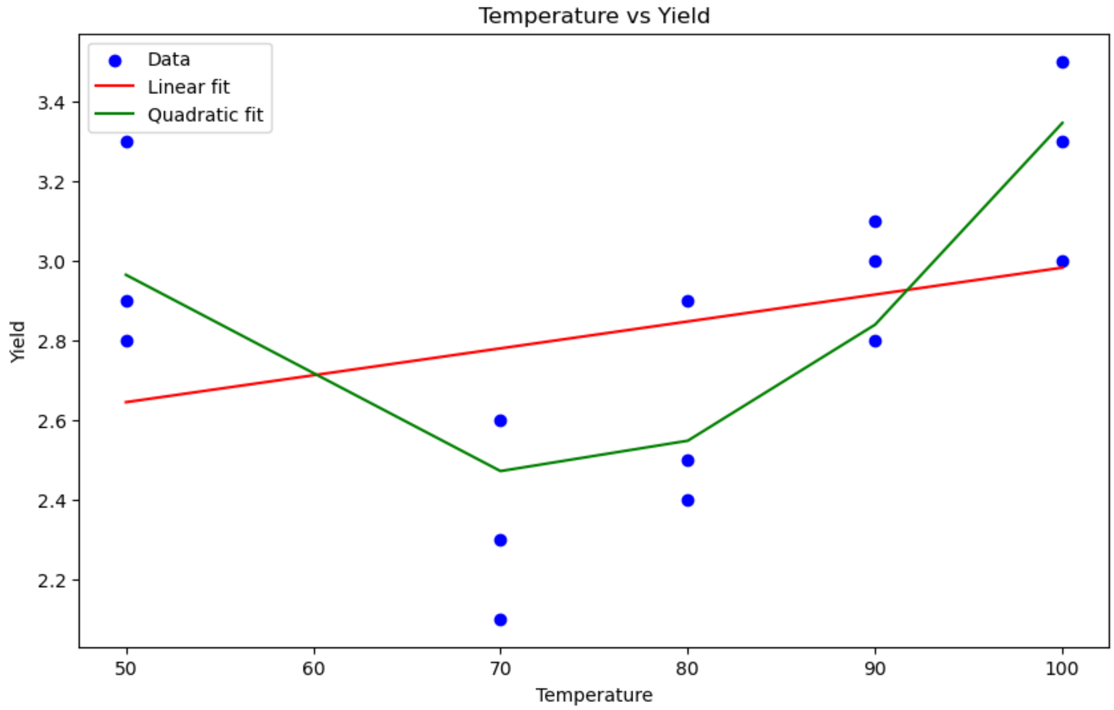
[ ]: 0.3642920651190589

[ ]:
```
rmse_poly
```

[ ]: 0.21859700508015079

[ ]:
```
plt.figure(figsize=(10, 6))
plt.scatter(X, y, color='blue', label='Data')
plt.plot(X, y_pred_linear, color='red', label='Linear fit')
plt.plot(X, y_pred_mult, color='green', label='Quadratic fit')
plt.xlabel('Temperature')
plt.ylabel('Yield')
plt.title('Temperature vs Yield')
plt.legend()
```

```
plt.show()
```



0.2 Question 2

a. Create a CSV file with sample data.
b. Write a Python function program to:
c. Find the fitted multiple linear regression equation for the given data.
d. Compare the coefficients obtained manually using intuitive and matrix formulation methods with your program.
e. Plot the data adorned with the estimated regression equation.
f. Compute the error, MSE, and RMSE.

[ ]:
```
df1 = pd.read_csv('Week4Q2.csv')
df1
```

[ ]:

	Infarc	Area	Group	X2	X3
0	0.119	0.34	3	0	0
1	0.190	0.64	3	0	0
2	0.395	0.76	3	0	0
3	0.469	0.83	3	0	0
4	0.130	0.73	3	0	0
5	0.311	0.82	3	0	0
6	0.418	0.95	3	0	0
7	0.480	1.06	3	0	0

```
8     0.687  1.20      3   0   0
9     0.847  1.47      3   0   0
10    0.062  0.44      1   1   0
11    0.122  0.77      1   1   0
12    0.033  0.90      1   1   0
13    0.102  1.07      1   1   0
14    0.206  1.01      1   1   0
15    0.249  1.03      1   1   0
16    0.220  1.16      1   1   0
17    0.299  1.21      1   1   0
18    0.350  1.20      1   1   0
19    0.350  1.22      1   1   0
20    0.588  0.99      1   1   0
21    0.379  0.77      2   0   1
22    0.149  1.05      2   0   1
23    0.316  1.06      2   0   1
24    0.390  1.02      2   0   1
25    0.429  0.99      2   0   1
26    0.477  0.97      2   0   1
27    0.439  1.12      2   0   1
28    0.446  1.23      2   0   1
29    0.538  1.19      2   0   1
30    0.625  1.22      2   0   1
31    0.974  1.40      2   0   1
```

[ ]:
```
X = df1[['Area', 'Group', 'X2', 'X3']].values
y = df1['Infarc'].values
```

[ ]:
```
X
```

[ ]:
```
array([[0.34, 3.  , 0.  , 0.  ],
       [0.64, 3.  , 0.  , 0.  ],
       [0.76, 3.  , 0.  , 0.  ],
       [0.83, 3.  , 0.  , 0.  ],
       [0.73, 3.  , 0.  , 0.  ],
       [0.82, 3.  , 0.  , 0.  ],
       [0.95, 3.  , 0.  , 0.  ],
       [1.06, 3.  , 0.  , 0.  ],
       [1.2 , 3.  , 0.  , 0.  ],
       [1.47, 3.  , 0.  , 0.  ],
       [0.44, 1.  , 1.  , 0.  ],
       [0.77, 1.  , 1.  , 0.  ],
       [0.9 , 1.  , 1.  , 0.  ],
       [1.07, 1.  , 1.  , 0.  ],
       [1.01, 1.  , 1.  , 0.  ],
       [1.03, 1.  , 1.  , 0.  ],
       [1.16, 1.  , 1.  , 0.  ],
```

```
       [1.21, 1.  , 1.  , 0.  ],
       [1.2 , 1.  , 1.  , 0.  ],
       [1.22, 1.  , 1.  , 0.  ],
       [0.99, 1.  , 1.  , 0.  ],
       [0.77, 2.  , 0.  , 1.  ],
       [1.05, 2.  , 0.  , 1.  ],
       [1.06, 2.  , 0.  , 1.  ],
       [1.02, 2.  , 0.  , 1.  ],
       [0.99, 2.  , 0.  , 1.  ],
       [0.97, 2.  , 0.  , 1.  ],
       [1.12, 2.  , 0.  , 1.  ],
       [1.23, 2.  , 0.  , 1.  ],
       [1.19, 2.  , 0.  , 1.  ],
       [1.22, 2.  , 0.  , 1.  ],
       [1.4 , 2.  , 0.  , 1.  ]])
```

[ ]:
```
y
```

[ ]:
```
array([0.119, 0.19 , 0.395, 0.469, 0.13 , 0.311, 0.418, 0.48 , 0.687,
       0.847, 0.062, 0.122, 0.033, 0.102, 0.206, 0.249, 0.22 , 0.299,
       0.35 , 0.35 , 0.588, 0.379, 0.149, 0.316, 0.39 , 0.429, 0.477,
       0.439, 0.446, 0.538, 0.625, 0.974])
```

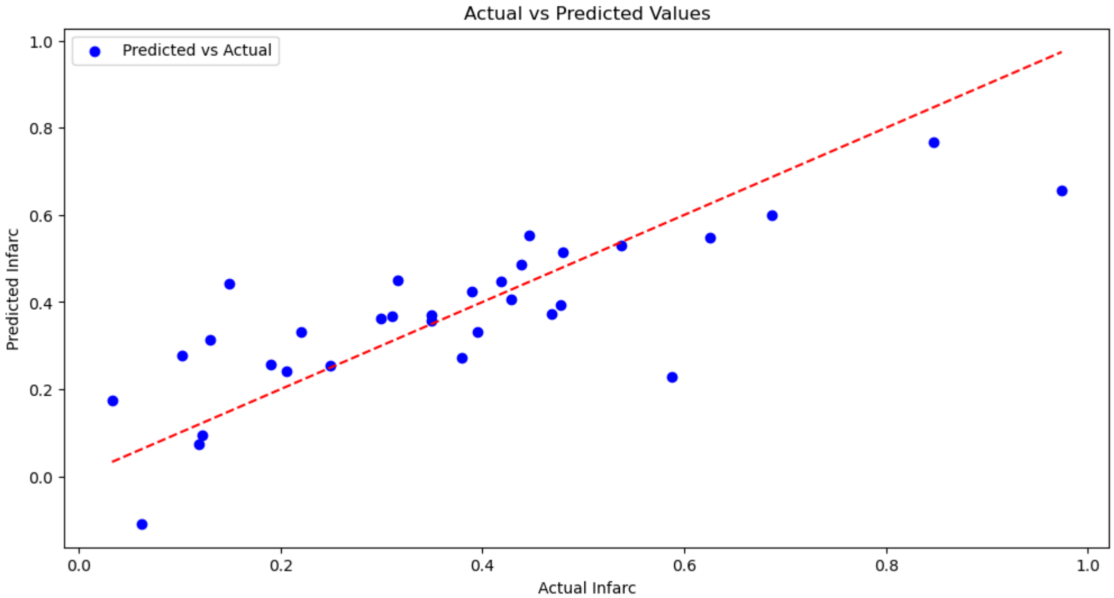
[ ]:
```
X_transpose = X.T
coefficients = np.linalg.inv(X_transpose @ X) @ X_transpose @ y
```

[ ]:
```
coefficients
```

[ ]:
```
array([ 0.61265498, -0.04484546, -0.33317315, -0.11050115])
```

[ ]:
```
y_pred = X @ coefficients
```

[ ]:
```
plt.figure(figsize=(12, 6))
plt.scatter(y, y_pred, color='blue', label='Predicted vs Actual')
plt.xlabel('Actual Infarc')
plt.ylabel('Predicted Infarc')
plt.title('Actual vs Predicted Values')
plt.plot([min(y), max(y)], [min(y), max(y)], color='red', linestyle='--')
plt.legend()
plt.show()
```



[ ]:
```
residuals = y - y_pred
residuals
```

[ ]:
```
array([ 0.04523369, -0.06756281,  0.0639186 ,  0.09503275, -0.18270175,
       -0.0568407 , -0.02948585, -0.0348779 ,  0.08635041,  0.08093356,
        0.17045042,  0.02827428, -0.14037087, -0.17552221, -0.03476291,
       -0.00401601, -0.11266116, -0.06429391, -0.00716736, -0.01942046,
        0.35949019,  0.10744774, -0.29409565, -0.1332222 , -0.034716  ,
        0.02266365,  0.08291675, -0.0469815 , -0.10737355,  0.00913265,
        0.077753  ,  0.31647511])
```

[ ]:
```
mse = np.mean(residuals**2)
mse
```

[ ]:
```
0.0170284226245642
```

[ ]:
```
rmse = np.sqrt(mse)
rmse
```

[ ]:
```
0.13049299837372194
```

[ ]:
```
```