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Workshop Week-5

```
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```

```
import pandas as pd
import numpy as np
import matplotlib as plt
from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_squared_error, r2_score

dataSet=pd.read_csv("/content/drive/MyDrive/Concept of Ai Technology/student.csv")
headData=dataSet.head()
print("This is the most top data : \n" ,headData,"\n")
```

```
This is the most top data :
    Math  Reading  Writing
0    48       68       63
1    62       81       72
2    79       80       78
3    76       83       79
4    59       64       62
```

+ Code + Text

```
[4] tailData=dataSet.tail()
    print("This is the most button data :\n" ,tailData,"\n" )
```

```
This is the most button data :
      Math  Reading  Writing
995    72       74       70
996    73       86       90
997    89       87       94
998    83       82       78
999    66       66       72
```

```
dataInfo=dataSet.info
print("Basic info of the given dataset:" ,dataInfo,"\n")
```

```
Basic info of the given dataset: <bound method DataFrame.info of      Math  Reading  Writing
0      48       68       63
1      62       81       72
2      79       80       78
3      76       83       79
4      59       64       62
..    ...      ...      ...
995    72       74       70
996    73       86       90
997    89       87       94
998    83       82       78
999    66       66       72

[1000 rows x 3 columns]>
```

```
[6] dataDesc=dataSet.describe()
    print("Description of the given dataset : \n" ,dataDesc,"\n")
```

```
Description of the given dataset :
                Math      Reading      Writing
count  1000.000000  1000.000000  1000.000000
mean     67.290000    69.872000    68.616000
std      15.085008    14.657027    15.241287
min      13.000000    19.000000    14.000000
25%      58.000000    60.750000    58.000000
50%      68.000000    70.000000    69.500000
75%      78.000000    81.000000    79.000000
max     100.000000   100.000000   100.000000
```

```
X = dataSet[['Math', 'Reading']]
Y = dataSet['Writing']

print("Features (X):")
print(X)

print("\nTarget (Y):")
print(Y)
```

```
Features (X):
     Math  Reading
0      48       68
1      62       81
2      79       80
3      76       83
4      59       64
..    ...      ...
995    72       74
996    73       86
997    89       87
998    83       82
999    66       66

[1000 rows x 2 columns]

Target (Y):
0      63
1      72
2      78
3      79
```

```python
X = dataSet[['Math', 'Reading']].to_numpy()
Y_actual = dataSet['Writing'].to_numpy()
X = X.T
d = X.shape[0]
W = np.random.rand(d, 1)
Y_pred = np.dot(W.T, X).T
print("Weight Vector (W):")
print(W)

print("\nFeature Matrix (X):")
print(X)

print("\nPredicted Target Vector (Y):")
print(Y_pred)
print("\nShapes:")
print("W:", W.shape)
print("X:", X.shape)
print("Y (predicted):", Y_pred.shape)
```

```
Weight Vector (W):
[[0.6862043 ]
 [0.74594273]]

Feature Matrix (X):
[[48 62 79 ... 89 83 66]
 [68 81 80 ... 87 82 66]]

Predicted Target Vector (Y):
[[ 83.66191247]
```

```
[ 71.24892128]
[113.76608181]
[ 94.07445388]
[ 66.44549115]
[ 94.13419231]
[ 66.68444488]
[115.85535159]
[107.41102779]
[ 88.55416258]
[ 88.34586573]
[ 99.68356517]
[ 82.01989327]
[110.81296775]
[113.79673869]
[ 91.77688725]
[ 94.37314604]
[114.45228612]
[105.0843796 ]
[106.15809605]
[114.48294299]
[ 99.11683773]
[103.62157569]
[ 72.44211459]
[ 77.75410903]
[ 73.84518006]
[108.90291326]
[102.54785924]
[ 61.64206103]
[114.989932  ]
[110.96152617]
[ 90.85172922]
[ 71.54761343]
```

```python
from sklearn.model_selection import train_test_split
X = dataSet[['Math', 'Reading']].to_numpy()
Y = dataSet['Writing'].to_numpy()
X_train, X_test, Y_train, Y_test = train_test_split(X, Y, test_size=0.2, random_state=42)
print("Training set shapes:")
print("X_train:", X_train.shape, "Y_train:", Y_train.shape)

print("\nTest set shapes:")
print("X_test:", X_test.shape, "Y_test:", Y_test.shape)
```

```
Training set shapes:
X_train: (800, 2) Y_train: (800,)

Test set shapes:
X_test: (200, 2) Y_test: (200,)
```

0s

```python
def cost_function(X, Y, W):
    """
    Parameters:
    - X: Feature Matrix
    - Y: Target Matrix
    - W: Weight Matrix

    Output:
    - cost: Mean Squared Error
    """
    y_pred = np.dot(W.T, X).flatten()
    error = y_pred - Y
    cost = np.mean(error ** 2) / 2

    return cost
```

[11] def cost_function(X, Y, W):

```python
def cost_function(X, Y, W):
    """
    Parameters:
    - X: Feature Matrix
    - Y: Target Matrix
    - W: Weight Matrix

    Output:
    - cost: Mean Squared Error
    """
    y_pred = np.dot(X, W)
    error = y_pred.flatten() - Y
    cost = np.mean(error ** 2) / 2
    return cost

X_test = np.array([[1, 2], [3, 4], [5, 6]])
Y_test = np.array([3, 7, 11])
W_test = np.array([1, 1]).reshape(2, 1)
cost = cost_function(X_test, Y_test, W_test)
print("Cost function output:", cost)
if cost == 0:
    print("Proceed further.")
else:
    print("Something went wrong: Reimplement the cost function.")
```

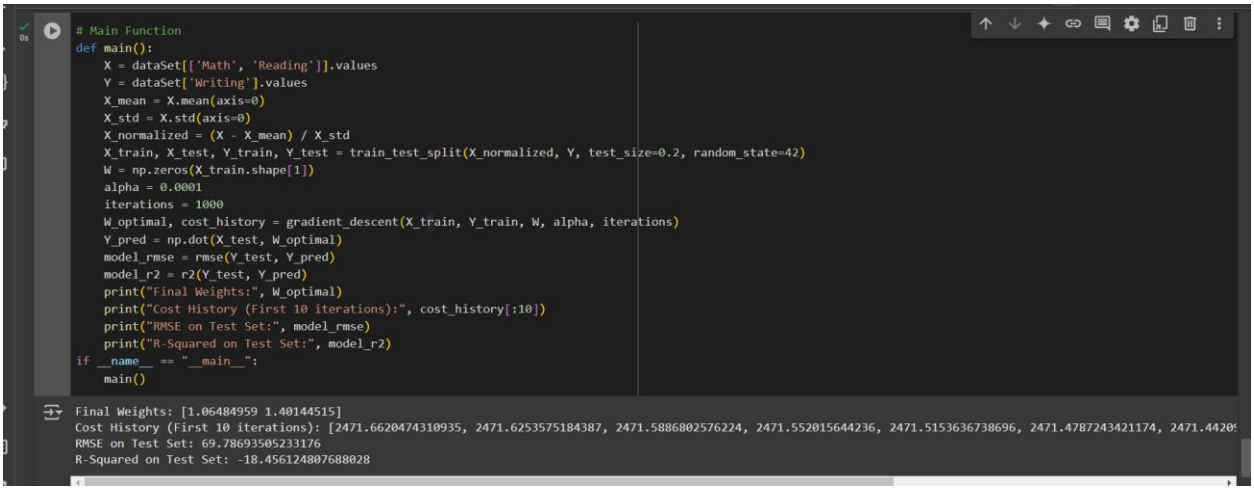
```
Cost function output: 0.0
Proceed further.
```

```python
def gradient_descent(X, Y, W, alpha, iterations):
    """
    Perform gradient descent to optimize the parameters of a linear regression model.

    Parameters:
    - X (numpy.ndarray): Feature matrix (m x n).
    - Y (numpy.ndarray): Target vector (m x 1).
    - W (numpy.ndarray): Initial guess for parameters (n x 1).
    - alpha (float): Learning rate.
    - iterations (int): Number of iterations for gradient descent.

    Returns:
    - W_update (numpy.ndarray): Updated parameters (n x 1).
    - cost_history (list): History of cost values over iterations.
    """
    m = len(Y)
    cost_history = [0] * iterations

    for iteration in range(iterations):
        Y_pred = np.dot(X, W)
        loss = Y_pred - Y
        dw = (1 / m) * np.dot(X.T, loss)
        W = W - alpha * dw
        cost = cost_function(X, Y, W)
        cost_history[iteration] = cost

    return W, cost_history
```

```
[13] np.random.seed(0)
     X = np.random.rand(100, 3)
     Y = np.random.rand(100)
     W = np.random.rand(3)
     alpha = 0.01
     iterations = 1000
     final_params, cost_history = gradient_descent(X, Y, W, alpha, iterations)
     print("Final Parameters:", final_params)
     print("Cost History:", cost_history)

     Final Parameters: [0.20551667 0.54295081 0.10388027]
     Cost History: [0.10711197094660153, 0.10634880599939901, 0.10559826315680616, 0.10486012948320558, 0.1041341956428534, 0.10342025583900626, 0.1027181077540776, 0.102
```

```python
def rmse(Y, Y_pred):
    """
    Calculate the Root Mean Squared Error (RMSE).

    Parameters:
    - Y: Actual target values (1D array).
    - Y_pred: Predicted target values (1D array).

    Returns:
    - rmse: Root Mean Squared Error.
    """
    n = len(Y)
    rmse = np.sqrt(np.sum((Y - Y_pred) ** 2) / n)
    return rmse
```

```python
def r2(Y, Y_pred):
    """
    Calculate the R Squared (coefficient of determination) value.

    Parameters:
    - Y: Actual target values (1D array).
    - Y_pred: Predicted target values (1D array).

    Returns:
    - r2: R Squared value.
    """
    n = len(Y)
    mean_y = np.mean(Y)
    ss_total = np.sum((Y - mean_y) ** 2)
    ss_residual = np.sum((Y - Y_pred) ** 2)
    r2 = 1 - (ss_residual / ss_total)
    return r2
```



```python
# Main Function
def main():
    X = dataSet[['Math', 'Reading']].values
    Y = dataSet['Writing'].values
    X_mean = X.mean(axis=0)
    X_std = X.std(axis=0)
    X_normalized = (X - X_mean) / X_std
    X_train, X_test, Y_train, Y_test = train_test_split(X_normalized, Y, test_size=0.2, random_state=42)
    W = np.zeros(X_train.shape[1])
    alpha = 0.0001
    iterations = 1000
    W_optimal, cost_history = gradient_descent(X_train, Y_train, W, alpha, iterations)
    Y_pred = np.dot(X_test, W_optimal)
    model_rmse = rmse(Y_test, Y_pred)
    model_r2 = r2(Y_test, Y_pred)
    print("Final Weights:", W_optimal)
    print("Cost History (First 10 iterations):", cost_history[:10])
    print("RMSE on Test Set:", model_rmse)
    print("R-Squared on Test Set:", model_r2)
if __name__ == "__main__":
    main()
```

```
Final Weights: [1.06484959 1.40144515]
Cost History (First 10 iterations): [2471.6620474310935, 2471.6253575184387, 2471.5886802576224, 2471.552015644236, 2471.5153636738696, 2471.4787243421174, 2471.4420
RMSE on Test Set: 69.78693505233176
R-Squared on Test Set: -18.456124807688028
```