HW4_Part2_Henry_Romero

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[32]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split, cross_val_score
from sklearn.preprocessing import MinMaxScaler
from sklearn import linear_model
from sklearn.metrics import mean_squared_error, r2_score,␣
 ↪explained_variance_score

# Load dataset
file_path = "~/Downloads/advertising.csv"  # Update to the avertising data set␣
 ↪with 3 variables affecting sales
df = pd.read_csv(file_path)

# Display dataset information
print("Dataset Info:\n", df.info())
print("\nDataset Description:\n", df.describe())
print("\nData Types:\n", df.dtypes)

# Preprocessing Section and handle missing values
print("\nChecking for missing values:\n", df.isnull().sum())
df.dropna(inplace=True)  # Removing rows with missing values (Not needed here)

# Correlation Matrix
corr_matrix = df.corr()
print("\nCorrelation Matrix:\n", corr_matrix)

# Generate Correlation Heatmap
plt.figure(figsize=(6,4))
sns.heatmap(corr_matrix, annot=True, cmap="coolwarm") #Small for a small␣
 ↪dataset with 2 variables
plt.title("Correlation Matrix Heatmap")
plt.show()
```

```
# Normalize Data with the minmax scaler
scaler = MinMaxScaler()
df_scaled = pd.DataFrame(scaler.fit_transform(df), columns=df.columns)

# Split Data
X = df_scaled.iloc[:, :-1]  # Independent variables (TV, Radio, Newspaper)␣
 ↪Everything except the last column
y = df_scaled.iloc[:, -1]   # Dependent variable (Sales) Only last column
print("Mulivalue Variables:",X)
print("Dependent variable:",y.name)
print(y)

# Conduct and Train Linear Regression Model
model = linear_model.LinearRegression()
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42) # 20 percent in training here
model.fit(X_train, y_train)

# Make Predictions
y_pred = model.predict(X_test)
print("Prediction:", y_pred)

# Evaluate Model
mse = mean_squared_error(y_test, y_pred)
r2 = r2_score(y_test, y_pred)
explained_var = explained_variance_score(y_test, y_pred)
cross_val = cross_val_score(model, X, y, cv=5).mean()

print("Mean Squared Error:", mse)
print("R^2 Score:", r2)
print("Explained Variance Score:", explained_var)
print("Cross-Validation Score:", cross_val)


# Plotting graphs
## scatter plot for Predicting Values
plt.figure(figsize=(6,4))
plt.scatter(y_test, y_pred, color='blue', alpha=0.5)
plt.plot([0, 1], [0, 1], linestyle='dashed', color='red')  # Ideal line
plt.xlabel("Actual Values")
plt.ylabel("Predicted Values")
plt.title("Linear Regression: Actual vs. Predicted")
plt.show()


## Bar Chart to illuistrate the importance a variable is to sales by␣
 ↪coefficenient value
```

```python
### Just like the heatmap, TV is what is the most effective in advertising
plt.figure(figsize=(6,4))
coefficients = pd.DataFrame(model.coef_, X.columns, columns=['Coefficient'])
coefficients.plot(kind='bar', legend=False)
plt.title("Feature Importance (Linear Regression Coefficients)")
plt.xlabel("Features")
plt.ylabel("Coefficient Value")
plt.grid(axis="y")
plt.show()
```

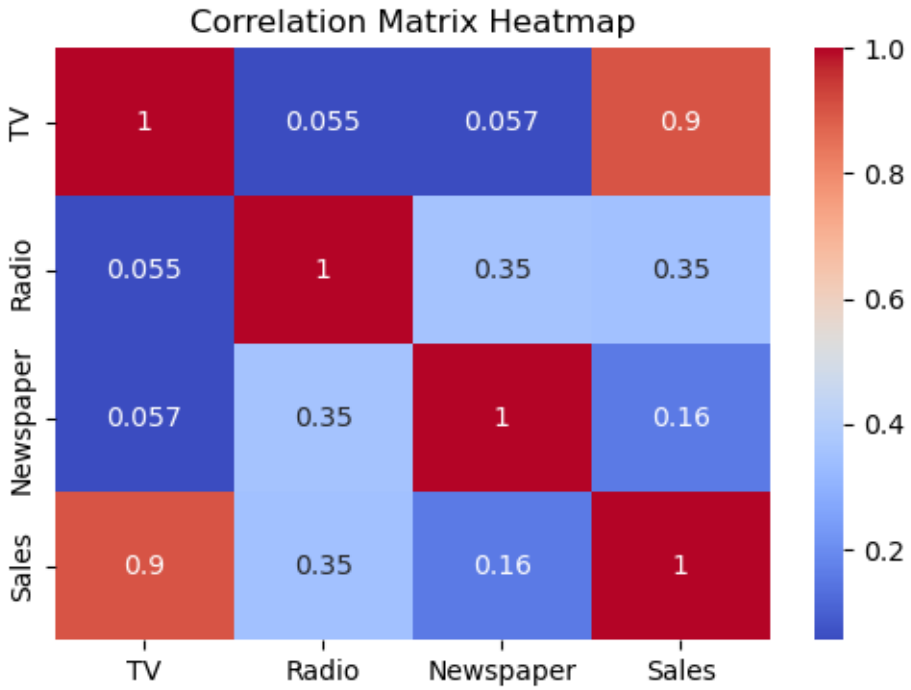
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 200 entries, 0 to 199
Data columns (total 4 columns):
 #   Column     Non-Null Count  Dtype
---  ------     --------------  -----
 0   TV         200 non-null    float64
 1   Radio      200 non-null    float64
 2   Newspaper  200 non-null    float64
 3   Sales      200 non-null    float64
dtypes: float64(4)
memory usage: 6.4 KB
Dataset Info:
 None

Dataset Description:
                TV       Radio   Newspaper       Sales
count  200.000000  200.000000  200.000000  200.000000
mean   147.042500   23.264000   30.554000   15.130500
std     85.854236   14.846809   21.778621    5.283892
min      0.700000    0.000000    0.300000    1.600000
25%     74.375000    9.975000   12.750000   11.000000
50%    149.750000   22.900000   25.750000   16.000000
75%    218.825000   36.525000   45.100000   19.050000
max    296.400000   49.600000  114.000000   27.000000

Data Types:
 TV           float64
Radio        float64
Newspaper    float64
Sales        float64
dtype: object

Checking for missing values:
 TV           0
Radio        0
Newspaper    0
Sales        0
dtype: int64
```

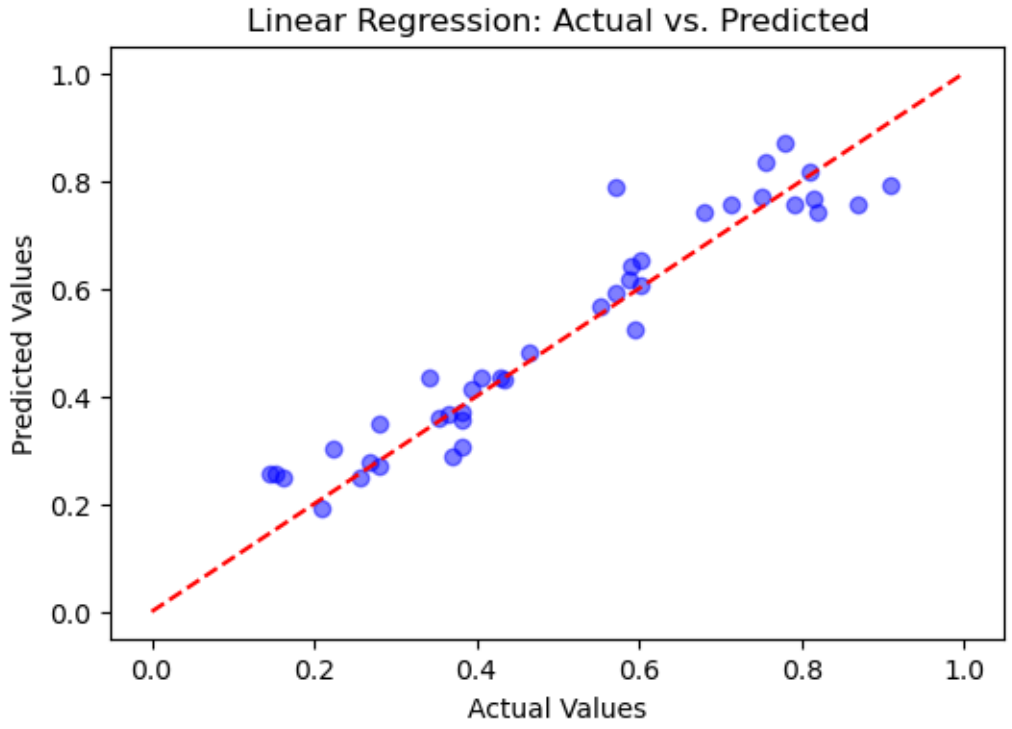
```
Correlation Matrix:
                  TV     Radio  Newspaper     Sales
TV          1.000000  0.054809   0.056648  0.901208
Radio       0.054809  1.000000   0.354104  0.349631
Newspaper   0.056648  0.354104   1.000000  0.157960
Sales       0.901208  0.349631   0.157960  1.000000
```




```
Mulivalue Variables:             TV     Radio  Newspaper
0     0.775786  0.762097   0.605981
1     0.148123  0.792339   0.394019
2     0.055800  0.925403   0.606860
3     0.509976  0.832661   0.511873
4     0.609063  0.217742   0.510994
..         …         …          …
195   0.126818  0.074597   0.118734
196   0.316199  0.098790   0.068602
197   0.596212  0.187500   0.053650
198   0.956713  0.846774   0.579595
199   0.782550  0.173387   0.073879

[200 rows x 3 columns]
Dependent variable: Sales
0      0.807087
1      0.346457
```

```
2      0.409449
3      0.586614
4      0.641732
         …
195    0.236220
196    0.488189
197    0.519685
198    0.940945
199    0.661417
Name: Sales, Length: 200, dtype: float64
Prediction: [0.6076682  0.74054096 0.87102318 0.30207816 0.79065822 0.43186621
 0.76697616 0.27914766 0.61563042 0.59317223 0.28834508 0.27093443
 0.65383907 0.25462627 0.43486259 0.52486725 0.25701362 0.64168369
 0.37042545 0.74324126 0.75615427 0.43302492 0.36634578 0.81844676
 0.30779374 0.2490184  0.75744429 0.48091376 0.36105548 0.2490876
 0.56533361 0.35570506 0.75602048 0.34780873 0.78655414 0.77100964
 0.41449676 0.83502097 0.43346172 0.1915123 ]
Mean Squared Error: 0.0045070322249846405
R^2 Score: 0.9059011844150826
Explained Variance Score: 0.9110403201701543
Cross-Validation Score: 0.8953723525274103
```

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<Figure size 600x400 with 0 Axes>
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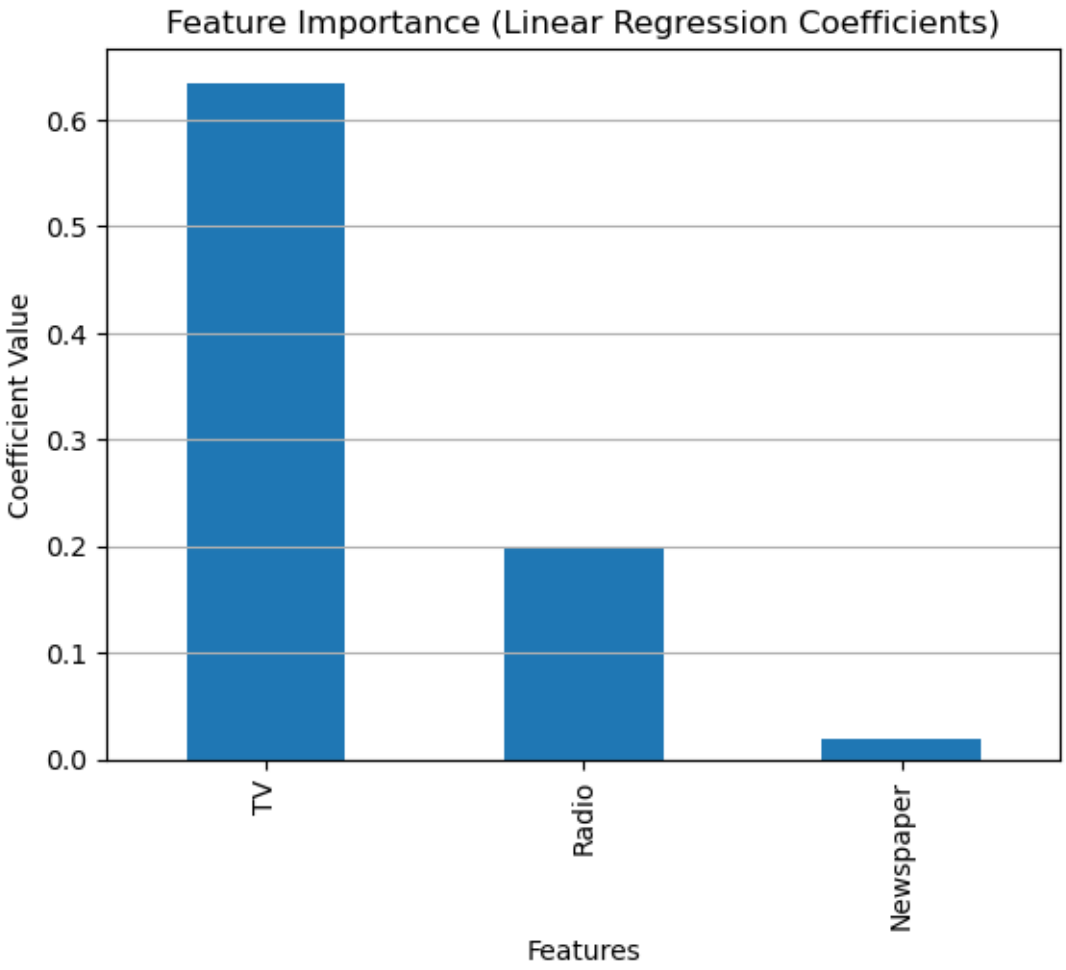
Feature Importance (Linear Regression Coefficients)
Coefficient Value
0.0
0.1
0.2
0.3
0.4
0.5
0.6
TV
Radio
Newspaper
Features