In [48]:
```python
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np
sns.set_theme(color_codes = True)
```

In [49]:
```python
df = pd.read_csv('car_data.csv')
df.head()
```

Out[49]:

	Weight	Horsepower	Number of cylinders	Mileage
0	3123.620357	54.714378	7	-15.987429
1	4852.142919	145.461562	7	-20.027300
2	4195.981825	97.153397	6	-12.446144
3	3795.975453	126.285604	4	-2.016606
4	2468.055921	186.134971	7	-11.190111

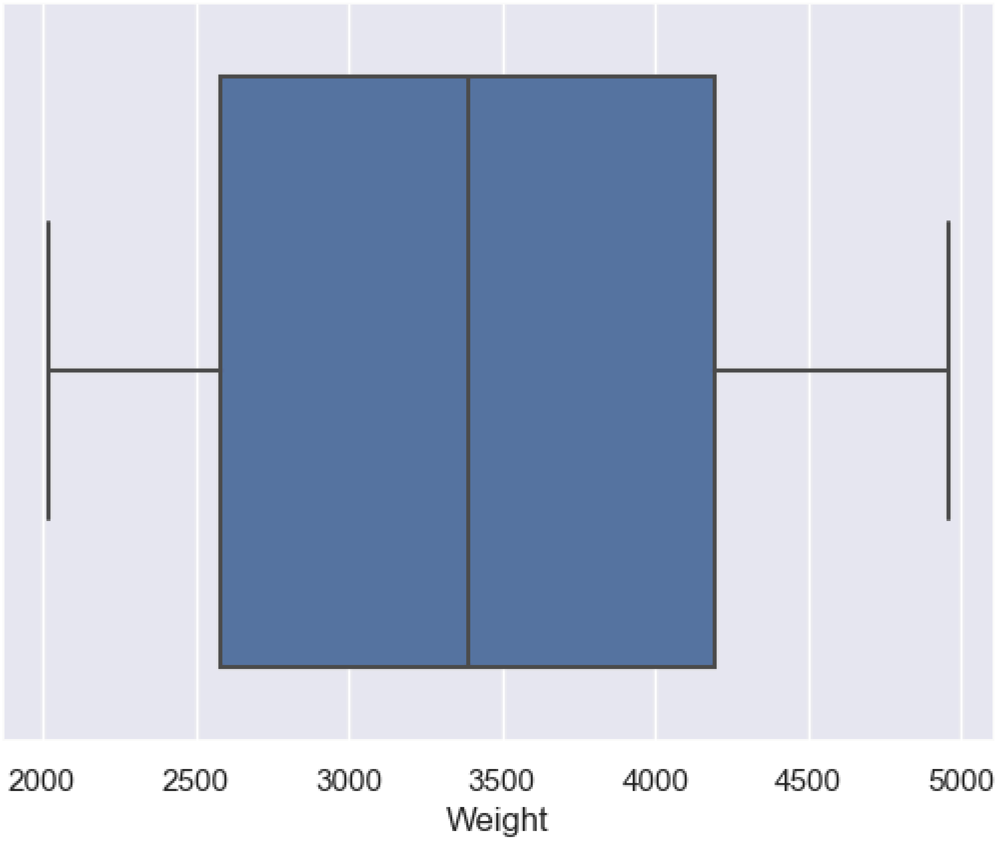
In [50]:
```python
df.isnull().sum()
```

Out[50]:
```
Weight                 0
Horsepower             0
Number of cylinders    0
Mileage                0
dtype: int64
```

In [52]:
```python
sns.boxplot(x=df["Weight"])
```

```
C:\Users\sjkar\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is deprecated and will be removed in a future version. Use isin
stance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
```

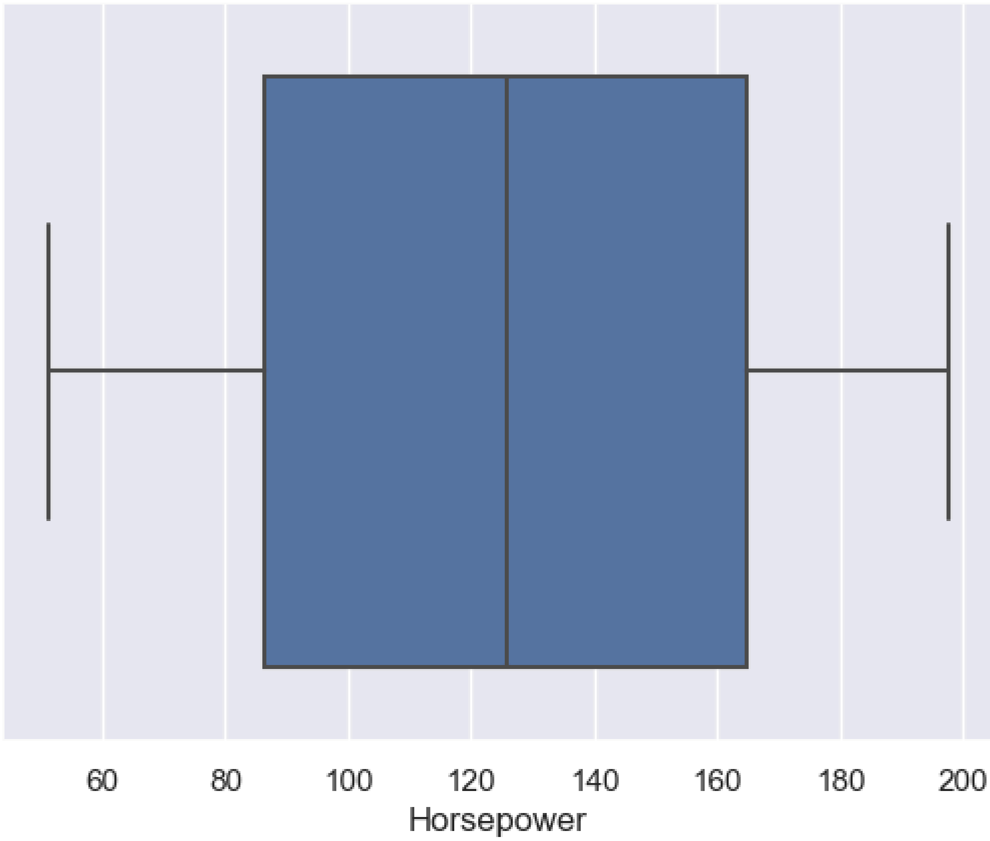
Out[52]:
```
<Axes: xlabel='Weight'>
```



In [53]:
```
sns.boxplot(x=df["Horsepower"])
```

```
C:\Users\sjkar\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: is_categorical_dtype is deprecated and will be removed in a future version. Use isin
stance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
```

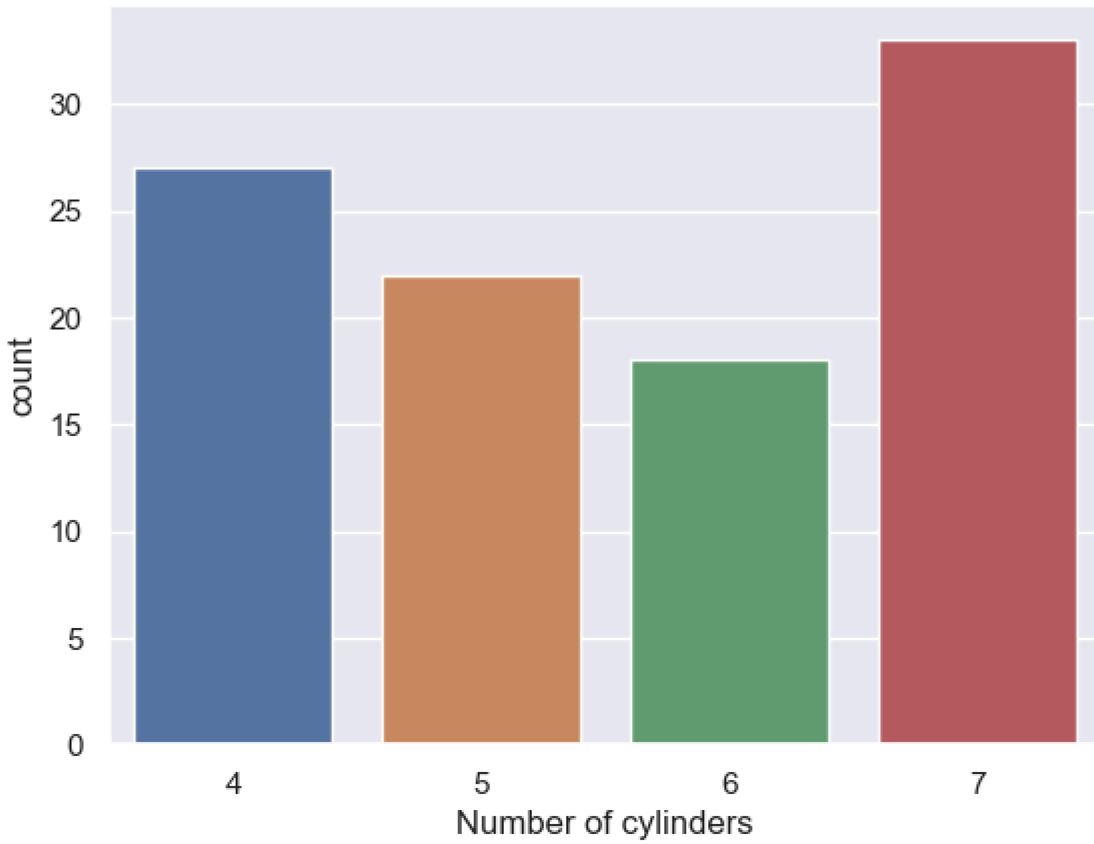
Out[53]:
```
<Axes: xlabel='Horsepower'>
```



In [54]:
```
sns.countplot(data=df, x='Number of cylinders')
```

```
C:\Users\sjkar\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: 
is_categorical_dtype is deprecated and will be removed in a future version. Use isin
stance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
C:\Users\sjkar\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: 
is_categorical_dtype is deprecated and will be removed in a future version. Use isin
stance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
C:\Users\sjkar\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning: 
is_categorical_dtype is deprecated and will be removed in a future version. Use isin
stance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
```

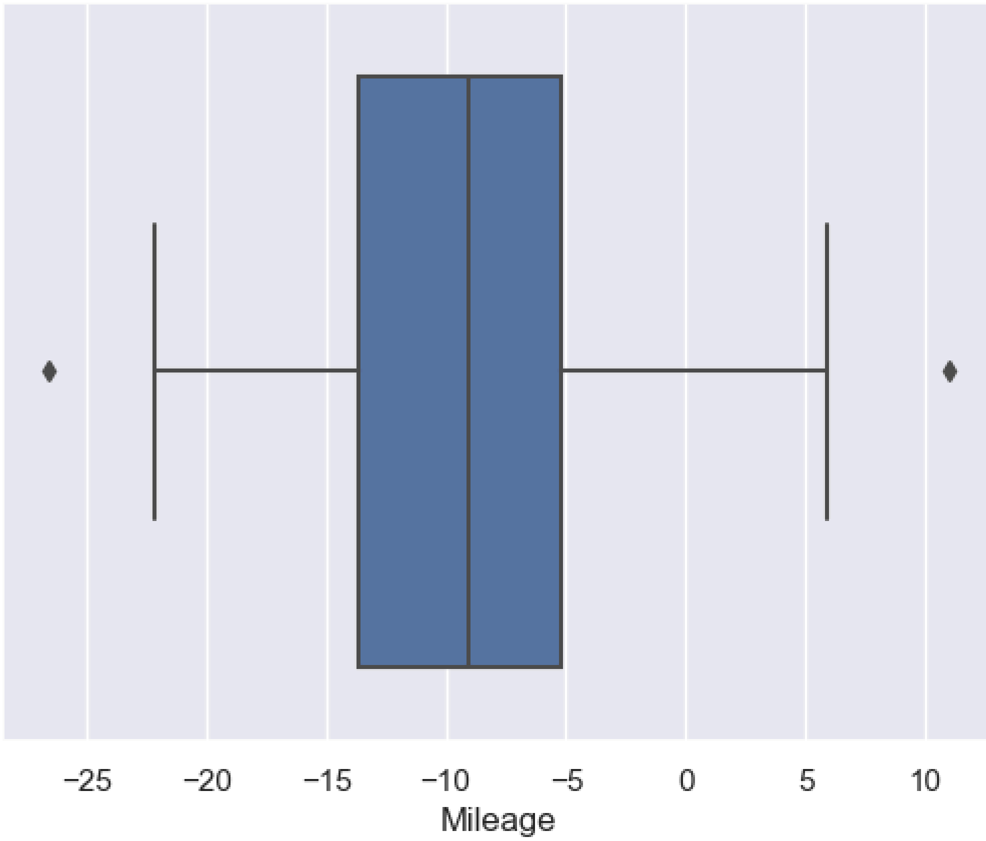
Out[54]:
```
<Axes: xlabel='Number of cylinders', ylabel='count'>
```



In [55]:
```
sns.boxplot(x=df["Mileage"])
```

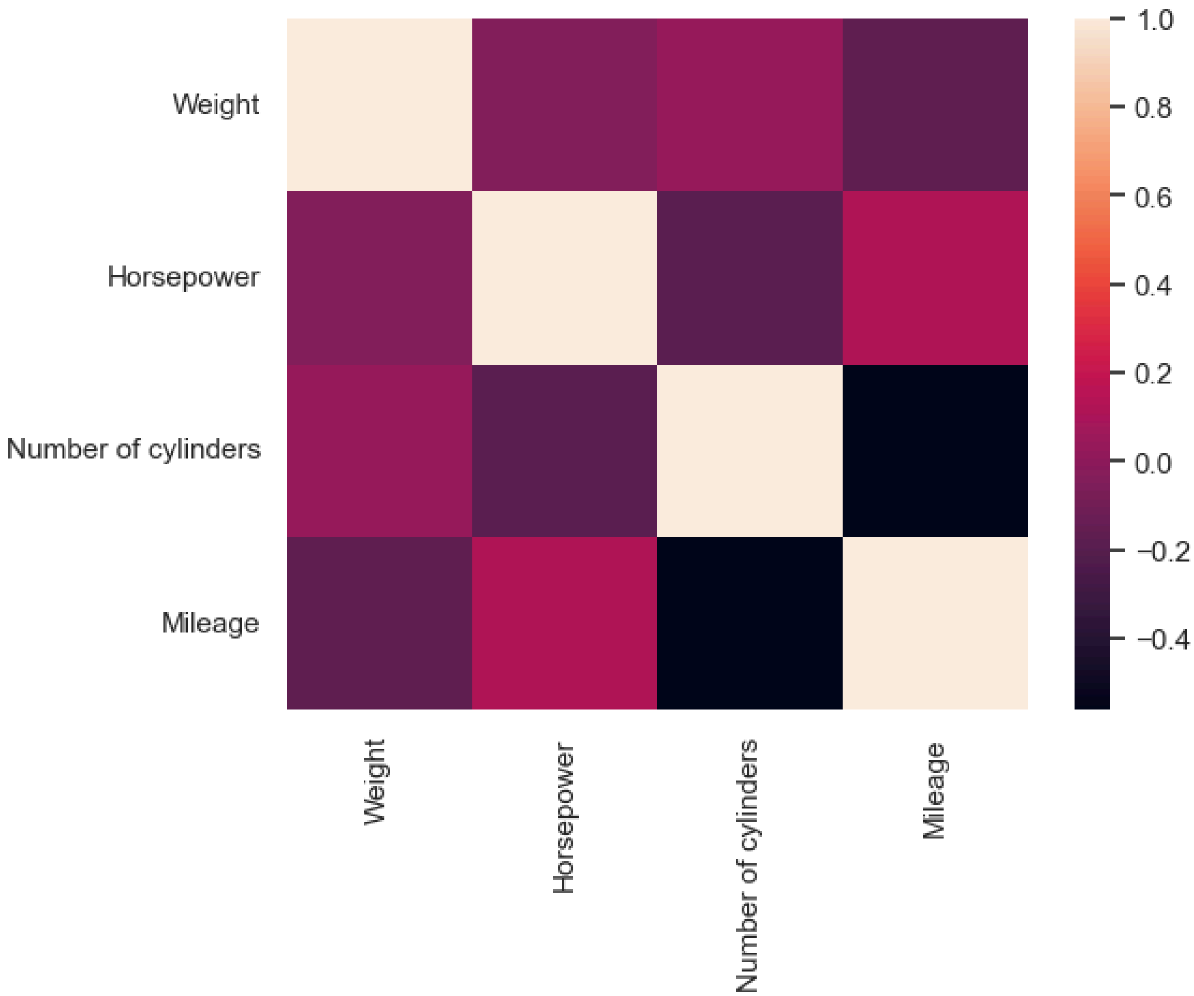
```
C:\Users\sjkar\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1498: FutureWarning:
is_categorical_dtype is deprecated and will be removed in a future version. Use isin
stance(dtype, CategoricalDtype) instead
  if pd.api.types.is_categorical_dtype(vector):
```

Out[55]:
```
<Axes: xlabel='Mileage'>
```



In [56]:
```
sns.heatmap(df.corr(), fmt='.2g')
```

Out[56]:
```
<Axes: >
```



Normalizing

In [57]:
```
df_norm = (df - df.mean()) / df.std()
df_norm.head()
```

Out[57]:

	Weight	Horsepower	Number of cylinders	Mileage
0	-0.321493	-1.591213	1.183599	-1.031539
1	1.615296	0.472785	1.183599	-1.652898
2	0.880076	-0.625959	0.355907	-0.486866
3	0.431873	0.036638	-1.299476	1.117266
4	-1.056045	1.397881	1.183599	-0.293680

In [58]:
```
X = df_norm.drop('Mileage', axis=1)
y = df_norm['Mileage']
```

In [59]:
```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_sta
```

Implementing Linear Regresion(Using Gradient Descent)

In [60]:
```
def hypothesis(X, theta):
    return np.dot(X, theta)
```

In [61]:
```
# Function to calculate the cost (mean squared error)
def cost_function(X, y, theta):
    m = len(y)
    predictions = hypothesis(X, theta)
    cost = (1 / (2 * m)) * np.sum(np.square(predictions - y))
    return cost
```

In [62]:
```
# Function to perform batch gradient descent
def gradient_descent(X, y, theta, learning_rate, iterations):
    m = len(y)
    cost_history = np.zeros(iterations)
    for i in range(iterations):
        predictions = hypothesis(X, theta)
        error = predictions - y
        gradient = (1 / m) * np.dot(X.T, error)
        theta -= learning_rate * gradient
        cost_history[i] = cost_function(X, y, theta)
    return theta, cost_history
```

In [63]:
```
theta = np.zeros(4)
learning_rate = 0.01
iterations = 1000
```

In [64]:
```
# Adding bias column
X_train = np.c_[np.ones(X_train.shape[0]), X_train]
```

In [65]:
```
theta_final, cost_history = gradient_descent(X_train, y_train, theta, learning_rate
```

In [66]:
```
# Calculate RMSE on training set
predictions_train = hypothesis(X_train, theta_final)
rmse_train = np.sqrt(np.mean(np.square(predictions_train - y_train)))
print("RMSE on training set:", rmse_train)
```

```
RMSE on training set: 0.8609909358636338
```

In [67]:
```
# Adding bias column
X_test = np.c_[np.ones(X_test.shape[0]), X_test]
```

In [68]:
```
# Calculate RMSE on testing set
predictions_test = hypothesis(X_test, theta_final)
rmse_test = np.sqrt(np.mean(np.square(predictions_test - y_test)))
print("RMSE on testing set:", rmse_test)
```

```
RMSE on testing set: 0.5654652566917723
```

In [69]:
```
new_data_point = np.array([1, 3000, 150, 6])
```

In [70]:
```
mean_weight = df['Weight'].mean()
std_weight = df['Weight'].std()

mean_horsepower = df['Horsepower'].mean()
std_horsepower = df['Horsepower'].std()

mean_cylinders = df['Number of cylinders'].mean()
std_cylinders = df['Number of cylinders'].std()
```

Predicting for a New DataPoint

In [71]:
```
new_dp = np.array([1, (new_data_point[1] - mean_weight) / std_weight,
                   (new_data_point[2] - mean_horsepower) / std_horsepower,
                   (new_data_point[3] - mean_cylinders) / std_cylinders])
```

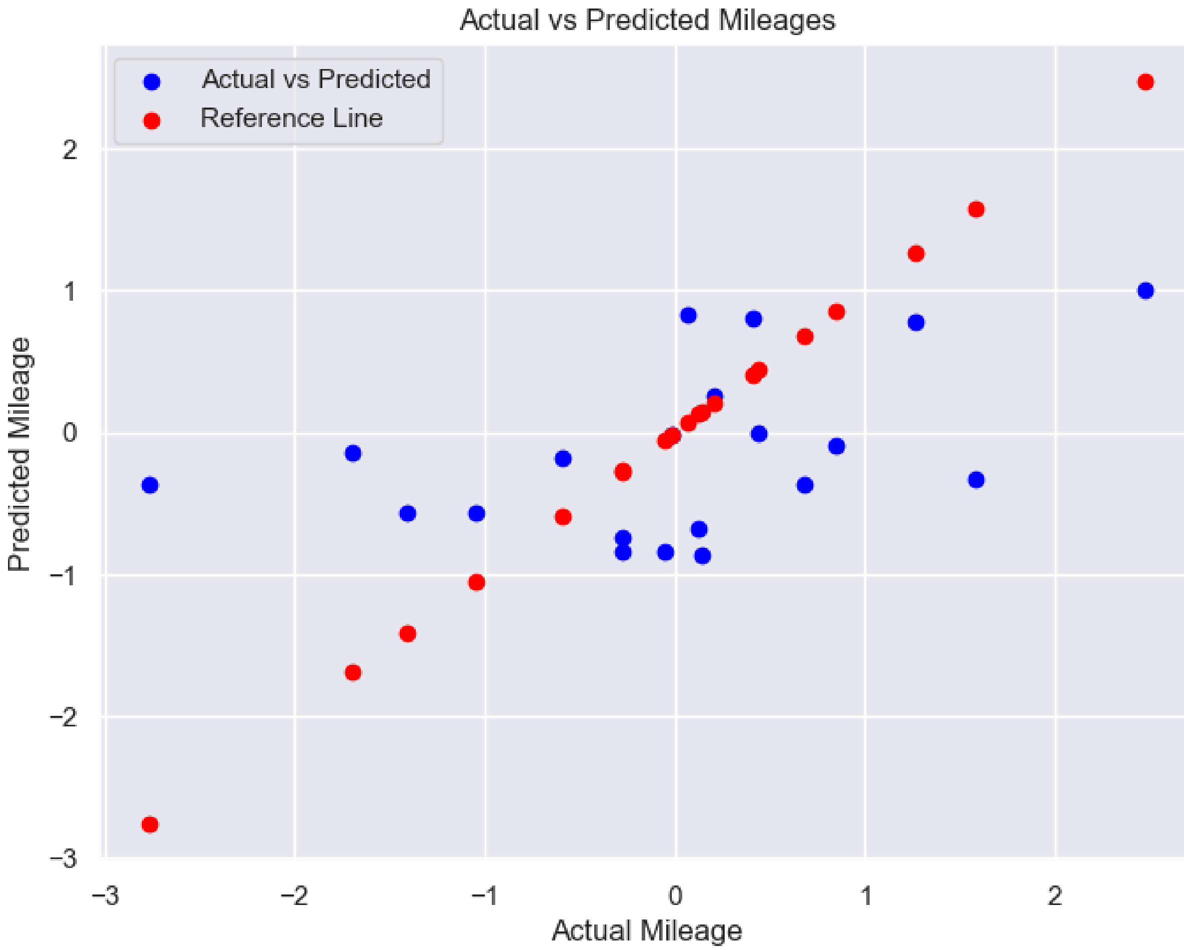
In [72]:
```
# Optionally for shorthand
new_dp = np.array([1, (3000 - df['Weight'].mean()) / df['Weight'].std(),
                    (150 - df['Horsepower'].mean()) / df['Horsepower'].std(),
                    (6 - df['Number of cylinders'].mean()) / df['Number of cylinder
```

In [73]:
```
predicted_mileage = hypothesis(new_dp, theta_final)
print("Predicted mileage:", predicted_mileage)
```

```
Predicted mileage: -0.06261989474615536
```

Plotting

In [88]:
```
plt.figure(figsize=(8, 6))
plt.scatter(y_test, predictions_test, color='blue', label='Actual vs Predicted')
plt.scatter(y_test, y_test, color='red', label='Reference Line')
plt.title('Actual vs Predicted Mileages')
plt.xlabel('Actual Mileage')
plt.ylabel('Predicted Mileage')
plt.legend()
plt.show()
```


Actual vs Predicted Mileages
Actual vs Predicted
Reference Line
Predicted Mileage
Actual Mileage
2
1
0
−1
−2
−3
−3
−2
−1
0
1
2