Multiple Linear Regression

- More than **two variables**
- **Multiple independent variables** and **one dependent variable**

In [ ]:
```
# Import libraries
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D
from sklearn.linear_model import LinearRegression
from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_squared_error
```

Import Dataset

In [ ]:
```
# Load data
df = pd.read_csv('../../datasets/ml_data_salary.csv')
df.head()
```

Out[ ]:

	age	distance	YearsExperience	Salary
0	31.1	77.75	1.1	39343
1	31.3	78.25	1.3	46205
2	31.5	78.75	1.5	37731
3	32.0	80.00	2.0	43525
4	32.2	80.50	2.2	39891

Split Data into Train and Test

In [ ]:
```
# Split data into input (X) and output (y)
X = df[['age', 'distance', 'YearsExperience']]
y = df['Salary']
```

In [ ]:
```
X.head()
```

Out[ ]:

	age	distance	YearsExperience
0	31.1	77.75	1.1
1	31.3	78.25	1.3
2	31.5	78.75	1.5
3	32.0	80.00	2.0
4	32.2	80.50	2.2

In [ ]:
```
y.head()
```

Out[ ]:
```
0    39343
1    46205
2    37731
3    43525
4    39891
Name: Salary, dtype: int64
```

In [ ]:
```
# Split data into train and test
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=0)
```

In [ ]:
```
# View training dataset
print(f'Training inputs:\n{X_train.head()}')
print(f'Training outputs:\n{y_train.head()}')
print(f'Training input shape: {X_train.shape}')
print(f'Training input shape: {y_train.shape}')
```

```
Training inputs:
     age  distance  YearsExperience
27  39.6     99.00              9.6
11  34.0     85.00              4.0
17  35.3     88.25              5.3
22  37.9     94.75              7.9
5   32.9     82.25              2.9
Training outputs:
27    112635
11     55794
17     83088
22    101302
5      56642
Name: Salary, dtype: int64
Training input shape: (24, 3)
Training input shape: (24,)
```

Fit Linear Regression Model

In [ ]:
```
# Create model
model = LinearRegression()
# Fit model
model = model.fit(X_train, y_train)
print('Training completed!!')
```

```
Training completed!!
```

In [ ]:
```
# Find coefficient
m1, m2, m3 = model.coef_

print(f'First coefficient: {m1}')
print(f'Second coefficient: {m2}')
print(f'Third coefficient: {m3}')
```

```
First coefficient: -7234721743167015.0
Second coefficient: -2168138394069688.5
Third coefficient: 7776756478356546.0
```

In [ ]:
```
# Find interception
interception = model.intercept_
print(f'Interception: {interception}')
```

```
Interception: 2.3330269435026387e+17
```

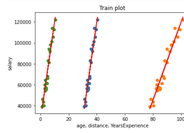
Make Predictions

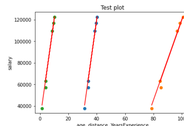
In [ ]:
```
y_preds = model.predict(X_test)
y_preds[:10] # first 10 predictions
```

Out[ ]:
```
array([ 40768., 122752.,  64960.,  63104., 115200., 107776.])
```

Plotting

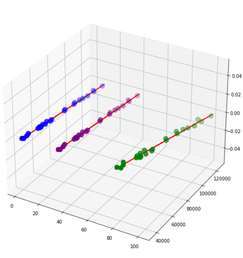
In [ ]:
```
# Plotting on Training data
plt.scatter(X_train.age, y_train)
plt.scatter(X_train.distance, y_train)
plt.scatter(X_train.YearsExperience, y_train)

plt.plot(X_train.age, model.predict(X_train), color='red')
plt.plot(X_train.distance, model.predict(X_train), color='red')
plt.plot(X_train.YearsExperience, model.predict(X_train), color='red')
plt.xlabel('age, distance, YearsExperience')
plt.ylabel('salary')
plt.title('Train plot')
plt.show()

# Plotting on Test data
plt.scatter(X_test.age, y_test)
plt.scatter(X_test.distance, y_test)
plt.scatter(X_test.YearsExperience, y_test)

plt.plot(X_test.age, model.predict(X_test), color='red')
plt.plot(X_test.distance, model.predict(X_test), color='red')
plt.plot(X_test.YearsExperience, model.predict(X_test), color='red')
plt.xlabel('age, distance, YearsExperience')
plt.ylabel('salary')
plt.title('Test plot')
plt.show()
```



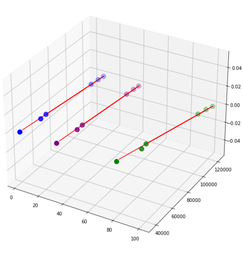


3D plot of Multi Linear Regression

In [ ]:
```
# 3d scatterplot using matplotlib on Training data
fig = plt.figure(figsize=(10,10))
ax = fig.add_subplot(111, projection='3d')

plt.scatter(X_train.age, y_train, s=100, c='purple', label='age')
plt.scatter(X_train.distance, y_train, s=100, c='green', label='distance')
plt.scatter(X_train.YearsExperience, y_train, s=100, c='blue', label='YearsExperience')

# Plot predictions
plt.plot(X_train.age, model.predict(X_train), color='red')
plt.plot(X_train.distance, model.predict(X_train), color='red')
plt.plot(X_train.YearsExperience, model.predict(X_train), color='red')
plt.show()
```



In [ ]:
```
# 3d scatterplot using matplotlib on Test data
fig = plt.figure(figsize=(10,10))
ax = fig.add_subplot(111, projection='3d')

plt.scatter(X_test.age, y_test, s=100, c='purple', label='age')
plt.scatter(X_test.distance, y_test, s=100, c='green', label='distance')
plt.scatter(X_test.YearsExperience, y_test, s=100, c='blue', label='YearsExperience')

# Plot predictions
plt.plot(X_test.age, model.predict(X_test), color='red')
plt.plot(X_test.distance, model.predict(X_test), color='red')
plt.plot(X_test.YearsExperience, model.predict(X_test), color='red')
plt.show()
```



Evaluate Model

In [ ]:
```
print(f'Train score: {model.score(X_train, y_train):.2f}')
print(f'Test score: {model.score(X_test, y_test):.2f}')
print(f'Model RMSE: {np.sqrt(mean_squared_error(y_test, y_preds)):.2f}')
```

```
Train score: 0.94
Test score: 0.99
Model RMSE: 3589.65
```