# Lecture 10

May 26, 2023

## 1 Linear regression

### 1.1 Import necessary libraries

[1]:
```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
```

### 1.2 Import dataset

[2]:
```
data = pd.read_csv("Salary_data.csv")
```

[3]:
```
data.head()
```

[3]:

| | YearsExperience | Salary |
|---|---|---|
| 0 | 1.1 | 39343.0 |
| 1 | 1.3 | 46205.0 |
| 2 | 1.5 | 37731.0 |
| 3 | 2.0 | 43525.0 |
| 4 | 2.2 | 39891.0 |

[4]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 30 entries, 0 to 29
Data columns (total 2 columns):
 #   Column           Non-Null Count  Dtype  
---  ------           --------------  -----  
 0   YearsExperience  30 non-null     float64
 1   Salary           30 non-null     float64
dtypes: float64(2)
memory usage: 608.0 bytes
```

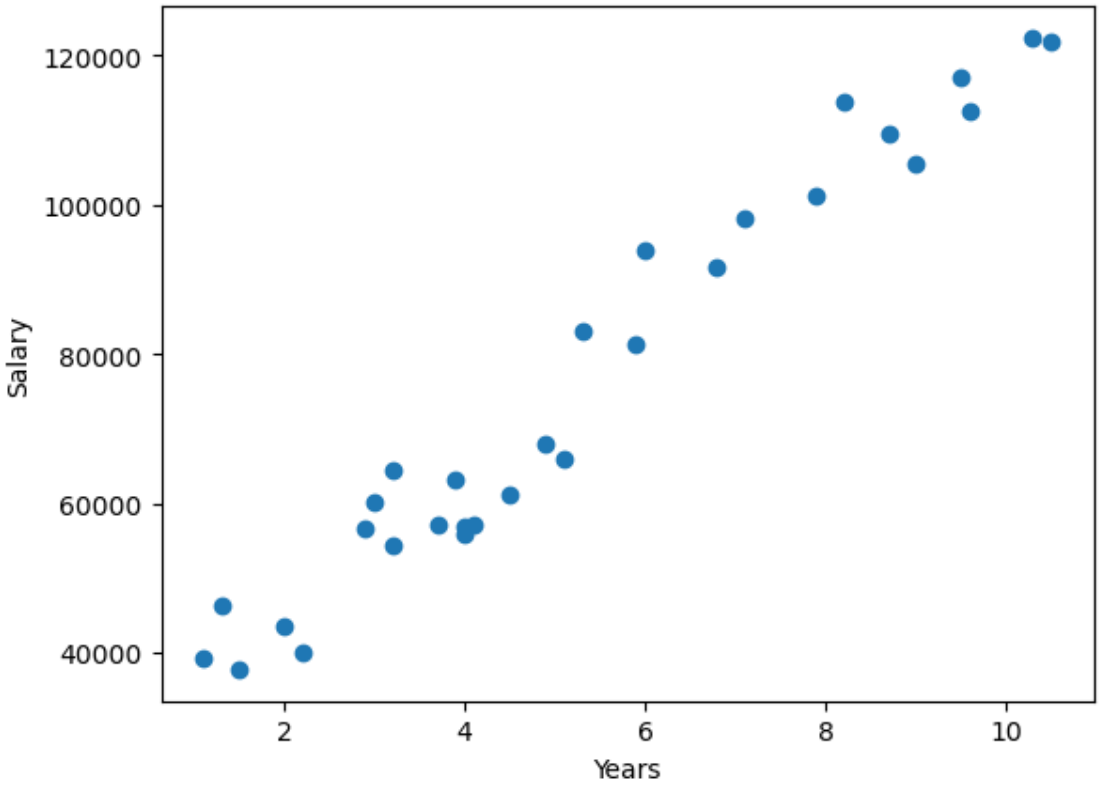
[5]:
```
data.isnull().any()
```

[5]:
```
YearsExperience    False
Salary             False
```

```
dtype: bool
```

[6]:
```
plt.scatter(data.YearsExperience, data.Salary)
plt.xlabel("Years")
plt.ylabel("Salary")
```

[6]:
```
Text(0, 0.5, 'Salary')
```




### 1.3 Train test split

[17]:
```
X = data.iloc[:, 0:1]
X
```

[17]:

| | YearsExperience |
|---|---|
| 0 | 1.1 |
| 1 | 1.3 |
| 2 | 1.5 |
| 3 | 2.0 |
| 4 | 2.2 |
| 5 | 2.9 |
| 6 | 3.0 |

```
7                3.2
8                3.2
9                3.7
10               3.9
11               4.0
12               4.0
13               4.1
14               4.5
15               4.9
16               5.1
17               5.3
18               5.9
19               6.0
20               6.8
21               7.1
22               7.9
23               8.2
24               8.7
25               9.0
26               9.5
27               9.6
28              10.3
29              10.5
```

[18]:
```
y = data.iloc[:, 1:]
```

[19]:
```
y
```

[19]:
```
      Salary
0    39343.0
1    46205.0
2    37731.0
3    43525.0
4    39891.0
5    56642.0
6    60150.0
7    54445.0
8    64445.0
9    57189.0
10   63218.0
11   55794.0
12   56957.0
13   57081.0
14   61111.0
15   67938.0
16   66029.0
17   83088.0
```

```
18   81363.0
19   93940.0
20   91738.0
21   98273.0
22  101302.0
23  113812.0
24  109431.0
25  105582.0
26  116969.0
27  112635.0
28  122391.0
29  121872.0
```

[20]:
```
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_state=0)#Splitting the dataset into train and test
```

[21]:
```
print(X_train.shape)
print(X_test.shape)
print(y_train.shape)
print(y_test.shape)
```

```
(24, 1)
(6, 1)
(24, 1)
(6, 1)
```

### 1.4 Model building

[22]:
```
from sklearn.linear_model import LinearRegression
lr=LinearRegression()
```

### 1.5 Train the model

[23]:
```
lr.fit(X_train,y_train)
```

[23]:
```
LinearRegression()
```

### 1.6 Test the model

[24]:
```
y_pred=lr.predict(X_test)
```

[25]:
```
y_pred #prediction
```

[25]:
```
array([[ 40748.96184072],
       [122699.62295594],
       [ 64961.65717022],
       [ 63099.14214487],
```

```
       [115249.56285456],
       [107799.50275317]])
```

[26]:
```
y_test # Actual outcome
```

[26]:
```
      Salary
2    37731.0
28  122391.0
13   57081.0
10   63218.0
26  116969.0
24  109431.0
```

### 1.7 Error

[27]:
```
E=y_test-y_pred
E
```

[27]:
```
          Salary
2  -3017.961841
28   -308.622956
13 -7880.657170
10   118.857855
26  1719.437145
24  1631.497247
```

### 1.8 R2 score

[28]:
```
from sklearn.metrics import r2_score
acc=r2_score(y_pred,y_test)
acc
```

[28]:
```
0.9864826731176541
```

### 1.9 Predict random valuea

[29]:
```
#Predict with random Values
y_pr=lr.predict([[12]])
y_pr
```

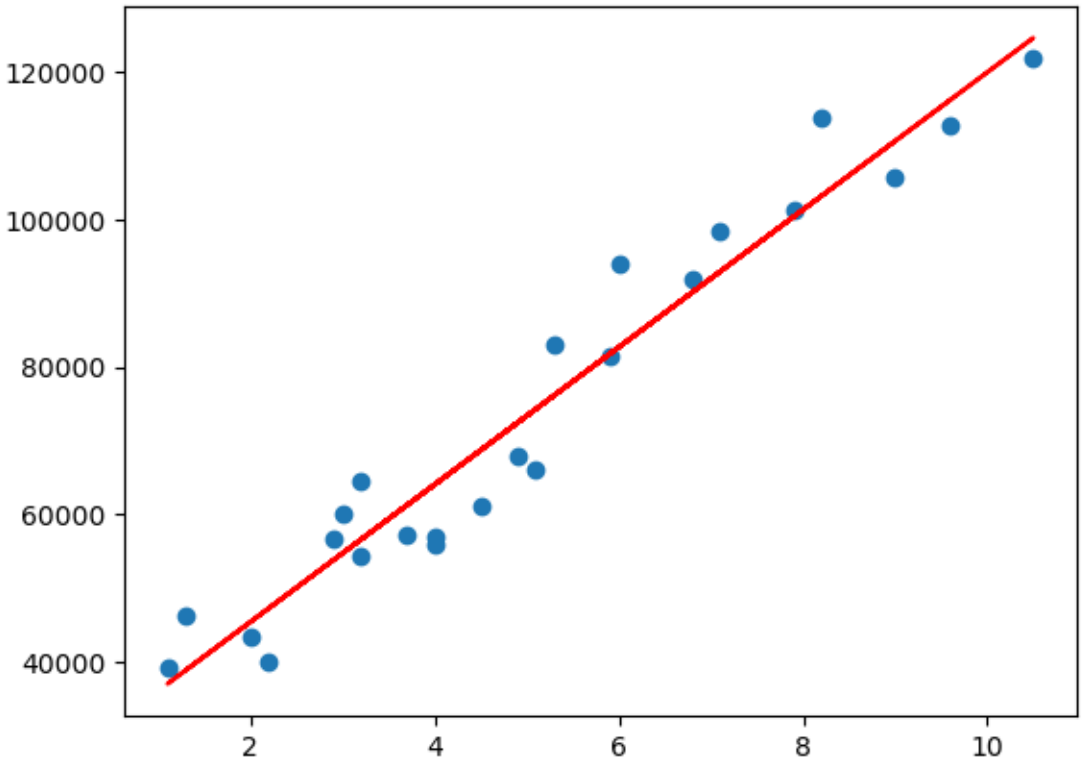
```
/Users/akashr/anaconda3/lib/python3.10/site-packages/sklearn/base.py:420:
UserWarning: X does not have valid feature names, but LinearRegression was
fitted with feature names
  warnings.warn(
```

[29]:
```
array([[138531.00067138]])
```

### 1.10 Plotting regression line

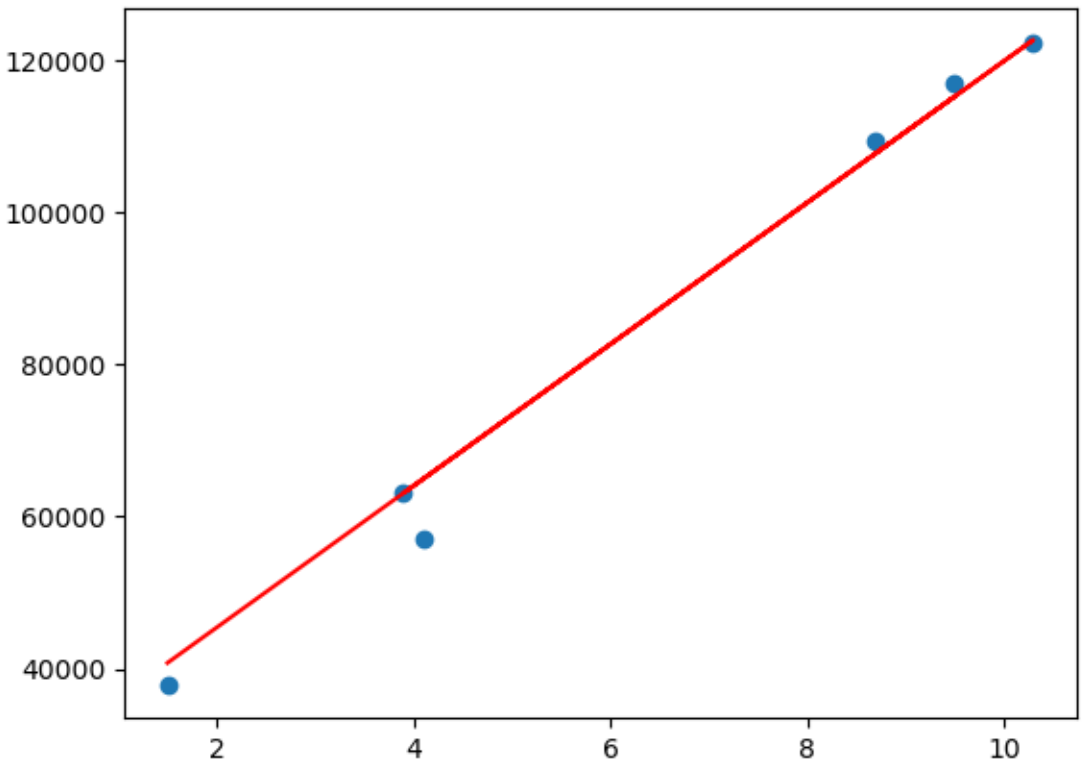
[30]:
```
plt.scatter(X_train,y_train)
plt.plot(X_train,lr.predict(X_train),'r')
```

[30]:
```
[<matplotlib.lines.Line2D at 0x14d037cd0>]
```




[32]:
```
plt.scatter(X_test,y_test)
plt.plot(X_test,y_pred,'r')
```

[32]:
```
[<matplotlib.lines.Line2D at 0x14d0ac250>]
```




# 2 Multilinear Regression

## 2.1 Import necessary libraries

[33]:
```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
```

## 2.2 Import dataset

[34]:
```
data = pd.read_csv("50_Startups.csv")
```

[35]:
```
data.head()
```

[35]:

| | R&D Spend | Administration | Marketing Spend | State | Profit |
|---|---|---|---|---|---|
| 0 | 165349.20 | 136897.80 | 471784.10 | New York | 192261.83 |
| 1 | 162597.70 | 151377.59 | 443898.53 | California | 191792.06 |
| 2 | 153441.51 | 101145.55 | 407934.54 | Florida | 191050.39 |
| 3 | 144372.41 | 118671.85 | 383199.62 | New York | 182901.99 |
| 4 | 142107.34 | 91391.77 | 366168.42 | Florida | 166187.94 |

[36]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 108 entries, 0 to 107
Data columns (total 5 columns):
 #   Column           Non-Null Count  Dtype
---  ------           --------------  -----
 0   R&D Spend        108 non-null    float64
 1   Administration   108 non-null    float64
 2   Marketing Spend  108 non-null    float64
 3   State            108 non-null    object
 4   Profit           108 non-null    float64
dtypes: float64(4), object(1)
memory usage: 4.3+ KB
```

[37]:
```
data.isnull().any()
```

[37]:
```
R&D Spend          False
Administration     False
Marketing Spend    False
State              False
Profit             False
dtype: bool
```

[38]:
```
data.isnull().sum()
```

[38]:
```
R&D Spend          0
Administration     0
Marketing Spend    0
State              0
Profit             0
dtype: int64
```

[39]:
```
data.State.value_counts()
```

[39]:
```
New York      39
California    36
Florida       33
Name: State, dtype: int64
```

[40]:
```
data.head()
```

[40]:

| | R&D Spend | Administration | Marketing Spend | State | Profit |
|---|---|---|---|---|---|
| 0 | 165349.20 | 136897.80 | 471784.10 | New York | 192261.83 |
| 1 | 162597.70 | 151377.59 | 443898.53 | California | 191792.06 |
| 2 | 153441.51 | 101145.55 | 407934.54 | Florida | 191050.39 |
| 3 | 144372.41 | 118671.85 | 383199.62 | New York | 182901.99 |
| 4 | 142107.34 | 91391.77 | 366168.42 | Florida | 166187.94 |

### 2.3 Encoding

[41]:
```
from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()
```

[44]:
```
data.State = le.fit_transform(data.State)
```

[45]:
```
data.head()
```

[45]:

| | R&D Spend | Administration | Marketing Spend | State | Profit |
|---|---|---|---|---|---|
| 0 | 165349.20 | 136897.80 | 471784.10 | 2 | 192261.83 |
| 1 | 162597.70 | 151377.59 | 443898.53 | 0 | 191792.06 |
| 2 | 153441.51 | 101145.55 | 407934.54 | 1 | 191050.39 |
| 3 | 144372.41 | 118671.85 | 383199.62 | 2 | 182901.99 |
| 4 | 142107.34 | 91391.77 | 366168.42 | 1 | 166187.94 |

[46]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 108 entries, 0 to 107
Data columns (total 5 columns):
 #   Column           Non-Null Count  Dtype
---  ------           --------------  -----
 0   R&D Spend        108 non-null    float64
 1   Administration   108 non-null    float64
 2   Marketing Spend  108 non-null    float64
 3   State            108 non-null    int64
 4   Profit           108 non-null    float64
dtypes: float64(4), int64(1)
memory usage: 4.3 KB
```

### 2.4 Dependent and Independent variables

[52]:
```
y = data.loc[:, "Profit":]
X = data.drop(columns=["Profit"], axis=1)
```

[53]:
```
y
```

[53]:

| | Profit |
|---|---|
| 0 | 192261.83 |
| 1 | 191792.06 |
| 2 | 191050.39 |
| 3 | 182901.99 |
| 4 | 166187.94 |
| .. | … |
| 103 | 132602.65 |
| 104 | 129917.04 |
| 105 | 126992.93 |

```
106  125370.37
107  124266.90

[108 rows x 1 columns]
```

[54]:
```
X
```

[54]:
```
      R&D Spend  Administration  Marketing Spend  State
0     165349.20       136897.80        471784.10      2
1     162597.70       151377.59        443898.53      0
2     153441.51       101145.55        407934.54      1
3     144372.41       118671.85        383199.62      2
4     142107.34        91391.77        366168.42      1
..          …              …                …    …
103   119943.24       156547.42        256512.92      1
104   114523.61       122616.84        261776.23      2
105    78013.11       121597.55        264346.06      0
106    94657.16       145077.58        282574.31      2
107    91749.16       114175.79        294919.57      1

[108 rows x 4 columns]
```

### 2.5 Scaling

[50]:
```
from sklearn.preprocessing import StandardScaler
scale = StandardScaler()
```

[55]:
```
columns = X.columns
```

[57]:
```
X = scale.fit_transform(X)
X
```

[57]:
```
array([[ 2.01819092,  0.55696553,  2.18783528,  1.16731536],
       [ 1.95675646,  1.0893969 ,  1.95029024, -1.23401909],
       [ 1.75232048, -0.75766814,  1.64392865, -0.03335187],
       [ 1.54982902, -0.1132146 ,  1.43322263,  1.16731536],
       [ 1.49925539, -1.11632102,  1.28814125, -0.03335187],
       [ 1.27083396, -0.806604  ,  1.25996984,  1.16731536],
       [ 1.3319795 ,  0.93574262, -0.74312422, -1.23401909],
       [ 1.23558377,  0.87437939,  0.92787631, -0.03335187],
       [ 1.01776417,  0.99163696,  0.82340982,  1.16731536],
       [ 1.08011094, -0.48065199,  0.76691751, -1.23401909],
       [ 0.60181303, -0.4102384 ,  0.1210342 , -0.03335187],
       [ 0.57410176, -1.10165542,  0.29637694, -1.23401909],
       [ 0.4220906 ,  0.20479752,  0.29718526, -0.03335187],
       [ 0.38030758,  0.50538623,  0.32125438, -1.23401909],
       [ 1.00438367,  1.27949493,  0.35403374, -0.03335187],
```

```
[ 0.88337621,  0.03184527,  0.39886959,  1.16731536],
[ 0.06818346, -0.00563469,  0.42076085, -1.23401909],
[ 0.43980557,  0.8577414 ,  0.57603938,  1.16731536],
[ 0.37487683, -0.27853767,  0.68120328, -0.03335187],
[ 0.25588265,  1.16795814, -1.83108825,  1.16731536],
[ 0.02890359, -0.28988105,  0.71310446, -1.23401909],
[ 0.07658668,  1.1774935 ,  0.72224334,  1.16731536],
[-0.02154122,  0.03794589,  0.75275659, -0.03335187],
[-0.165823  , -0.58832162,  0.76510399, -0.03335187],
[ 0.04654576, -0.82621636, -0.63359259,  1.16731536],
[-0.22985461,  0.65460485, -0.6558447 , -1.23401909],
[ 0.00825076,  0.82311815, -0.68917401, -0.03335187],
[-0.06367255,  0.224807  ,  1.177531  ,  1.16731536],
[-0.19889043,  2.23914065, -0.82463513, -0.03335187],
[-0.20884945,  1.15023284, -0.918423  ,  1.16731536],
[-0.2894745 , -0.22465065, -1.05478086, -0.03335187],
[-0.30863384,  1.13809338, -1.07959552,  1.16731536],
[-0.25789476,  0.27463345, -1.43850805, -1.23401909],
[-0.4346159 , -0.68736485, -0.00270767, -0.03335187],
[-0.63708012,  1.32165249, -0.03539459, -1.23401909],
[-0.64628022, -1.3496062 , -0.08037287,  1.16731536],
[-1.03367032,  0.19508381, -0.11777636, -0.03335187],
[-0.68968668, -2.59114164, -0.15268033, -1.23401909],
[-1.2219853 , -2.0519077 , -0.25289545,  1.16731536],
[-0.81274405, -1.42555047, -0.34034534, -1.23401909],
[-1.0316481 , -0.11784035, -0.3591171 , -1.23401909],
[-1.05088134, -1.36198577, -0.43003381, -0.03335187],
[-1.14581818, -0.93990057, -0.57033117, -1.23401909],
[-1.32745787,  0.20707435, -1.52838812,  1.16731536],
[-1.17848774,  1.21546693, -1.5897171 , -1.23401909],
[-1.65133124,  0.08833235, -1.8148695 ,  1.16731536],
[-1.6442929 , -0.21821836,  0.6999006 , -0.03335187],
[-1.673664  ,  0.50288031, -1.83108825, -1.23401909],
[-1.66156131, -2.57422677, -1.83108825,  1.16731536],
[-1.673664  , -0.17528531, -1.4462786 , -1.23401909],
[ 0.57410176, -1.10165542,  0.29637694, -1.23401909],
[ 0.4220906 ,  0.20479752,  0.29718526, -0.03335187],
[ 0.38030758,  0.50538623,  0.32125438, -1.23401909],
[ 1.00438367,  1.27949493,  0.35403374, -0.03335187],
[ 0.88337621,  0.03184527,  0.39886959,  1.16731536],
[ 0.06818346, -0.00563469,  0.42076085, -1.23401909],
[ 0.43980557,  0.8577414 ,  0.57603938,  1.16731536],
[ 0.37487683, -0.27853767,  0.68120328, -0.03335187],
[ 0.25588265,  1.16795814, -1.83108825,  1.16731536],
[ 0.02890359, -0.28988105,  0.71310446, -1.23401909],
[ 0.07658668,  1.1774935 ,  0.72224334,  1.16731536],
[-0.02154122,  0.03794589,  0.75275659, -0.03335187],
```

```
[-0.165823  , -0.58832162,  0.76510399, -0.03335187],
[ 0.04654576, -0.82621636, -0.63359259,  1.16731536],
[-0.22985461,  0.65460485, -0.6558447 , -1.23401909],
[ 0.00825076,  0.82311815, -0.68917401, -0.03335187],
[-0.06367255,  0.224807  ,  1.177531  ,  1.16731536],
[-0.19889043,  2.23914065, -0.82463513, -0.03335187],
[-0.20884945,  1.15023284, -0.918423  ,  1.16731536],
[-0.2894745 , -0.22465065, -1.05478086,  1.16731536],
[-1.2219853 ,  1.13809338, -1.07959552,  1.16731536],
[-0.25789476,  0.27463345, -1.43850805, -1.23401909],
[-0.4346159 , -0.68736485, -0.00270767, -0.03335187],
[-0.63708012,  1.32165249, -0.03539459,  1.16731536],
[-1.2219853 , -1.3496062 , -0.08037287,  1.16731536],
[-1.03367032,  0.19508381, -0.11777636, -0.03335187],
[-0.68968668, -2.59114164, -0.15268033, -1.23401909],
[-1.2219853 , -2.0519077 , -0.25289545,  1.16731536],
[-0.81274405, -1.42555047, -0.34034534, -1.23401909],
[-1.0316481 , -0.11784035, -0.3591171 , -1.23401909],
[-1.05088134, -1.36198577, -0.43003381,  1.16731536],
[-1.14581818, -0.93990057, -0.57033117, -1.23401909],
[-1.2219853 ,  0.20707435, -1.52838812,  1.16731536],
[-1.17848774,  1.21546693, -1.5897171 , -1.23401909],
[-1.65133124,  0.08833235, -1.8148695 ,  1.16731536],
[-1.6442929 , -0.21821836,  0.6999006 , -0.03335187],
[-1.673664  ,  0.50288031, -1.83108825, -1.23401909],
[-1.66156131, -2.57422677, -1.83108825,  1.16731536],
[-1.673664  , -0.17528531, -1.4462786 , -1.23401909],
[ 2.01819092,  0.55696553,  2.18783528,  1.16731536],
[ 1.95675646,  1.0893969 ,  1.95029024, -1.23401909],
[ 1.75232048, -0.75766814,  1.64392865, -0.03335187],
[ 1.54982902, -0.1132146 ,  1.43322263,  1.16731536],
[ 1.49925539, -1.11632102,  1.28814125, -0.03335187],
[ 1.27083396, -0.806604  ,  1.25996984,  1.16731536],
[ 1.3319795 ,  0.93574262, -0.74312422, -1.23401909],
[ 1.23558377,  0.87437939,  0.92787631, -0.03335187],
[ 1.01776417,  0.99163696,  0.82340982,  1.16731536],
[ 1.08011094, -0.48065199,  0.76691751, -1.23401909],
[ 0.60181303, -0.4102384 ,  0.1210342 , -0.03335187],
[ 0.57410176, -1.10165542,  0.29637694, -1.23401909],
[ 0.4220906 ,  0.20479752,  0.29718526, -0.03335187],
[ 0.38030758,  0.50538623,  0.32125438, -1.23401909],
[ 1.00438367,  1.27949493,  0.35403374, -0.03335187],
[ 0.88337621,  0.03184527,  0.39886959,  1.16731536],
[ 0.06818346, -0.00563469,  0.42076085, -1.23401909],
[ 0.43980557,  0.8577414 ,  0.57603938,  1.16731536],
[ 0.37487683, -0.27853767,  0.68120328, -0.03335187]])
```

[58]:
```
X= pd.DataFrame(X, columns=columns)
X
```

[58]:

| | R&D Spend | Administration | Marketing Spend | State |
|---|---|---|---|---|
| 0 | 2.018191 | 0.556966 | 2.187835 | 1.167315 |
| 1 | 1.956756 | 1.089397 | 1.950290 | -1.234019 |
| 2 | 1.752320 | -0.757668 | 1.643929 | -0.033352 |
| 3 | 1.549829 | -0.113215 | 1.433223 | 1.167315 |
| 4 | 1.499255 | -1.116321 | 1.288141 | -0.033352 |
| .. | … | … | … | … |
| 103 | 1.004384 | 1.279495 | 0.354034 | -0.033352 |
| 104 | 0.883376 | 0.031845 | 0.398870 | 1.167315 |
| 105 | 0.068183 | -0.005635 | 0.420761 | -1.234019 |
| 106 | 0.439806 | 0.857741 | 0.576039 | 1.167315 |
| 107 | 0.374877 | -0.278538 | 0.681203 | -0.033352 |

[108 rows x 4 columns]

### 2.6 Train test split

[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_state=0)#Splitting the dataset into train and test
```

[60]:
```
print(X_train.shape)
print(X_test.shape)
print(y_train.shape)
print(y_test.shape)
```

```
(86, 4)
(22, 4)
(86, 1)
(22, 1)
```

### 2.7 Model building

[61]:
```
from sklearn.linear_model import LinearRegression
lr=LinearRegression()
```

### 2.8 Train the model

[62]:
```
lr.fit(X_train,y_train)
```

[62]:
```
LinearRegression()
```

### 2.9 Test the model

[63]:
```
y_pred=lr.predict(X_test)
```

[64]:
```
y_pred #prediction
```

[64]:
```
array([[ 48379.24868386],
       [134848.9192467 ],
       [ 76483.10965225],
       [181561.78529188],
       [112966.00035112],
       [134241.68257226],
       [129222.38731942],
       [160017.05919784],
       [116752.96050775],
       [ 46260.9926407 ],
       [102266.36060189],
       [115568.27177598],
       [ 48379.24868386],
       [119114.16525526],
       [ 88602.22002789],
       [127101.40273623],
       [127101.40273623],
       [ 90942.33421515],
       [ 58677.7334991 ],
       [146304.26215166],
       [149410.05441   ],
       [152502.87810448]])
```

[65]:
```
y_test # Actual outcome
```

[65]:

| | Profit |
|---|---|
| 84 | 64926.08 |
| 10 | 146121.95 |
| 75 | 90708.19 |
| 2 | 191050.39 |
| 24 | 108552.04 |
| 100 | 144259.40 |
| 107 | 124266.90 |
| 7 | 155752.60 |
| 16 | 126992.93 |
| 86 | 42559.73 |
| 68 | 101004.64 |
| 22 | 110352.25 |
| 45 | 64926.08 |
| 60 | 111313.02 |
| 76 | 89949.14 |
| 52 | 134307.35 |

```
13   134307.35
73    96712.80
85    49490.75
54   129917.04
103  132602.65
8    152211.77
```

### 2.10 Error

[66]:
```
E=y_test-y_pred
E
```

[66]:
```
            Profit
84   16546.831316
10   11273.030753
75   14225.080348
2     9488.604708
24   -4413.960351
100  10017.717428
107  -4955.487319
7    -4264.459198
16   10239.969492
86   -3701.262641
68   -1261.720602
22   -5216.021776
45   16546.831316
60   -7801.145255
76    1346.919972
52    7205.947264
13    7205.947264
73    5770.465785
85   -9186.983499
54  -16387.222152
103 -16807.404410
8     -291.108104
```

## 3 Polynomial regression

### 3.1 Import necessary libraries

[1]:
```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
```

### 3.2 Import dataset

[68]:
```
data = pd.read_csv("Position_Salaries.csv")
```

[69]:
```
data.head()
```

[69]:

| | Position | Level | Salary |
|---|---|---|---|
| 0 | Business Analyst | 1 | 45000 |
| 1 | Junior Consultant | 2 | 50000 |
| 2 | Senior Consultant | 3 | 60000 |
| 3 | Manager | 4 | 80000 |
| 4 | Country Manager | 5 | 110000 |

[70]:
```
data.info()
```

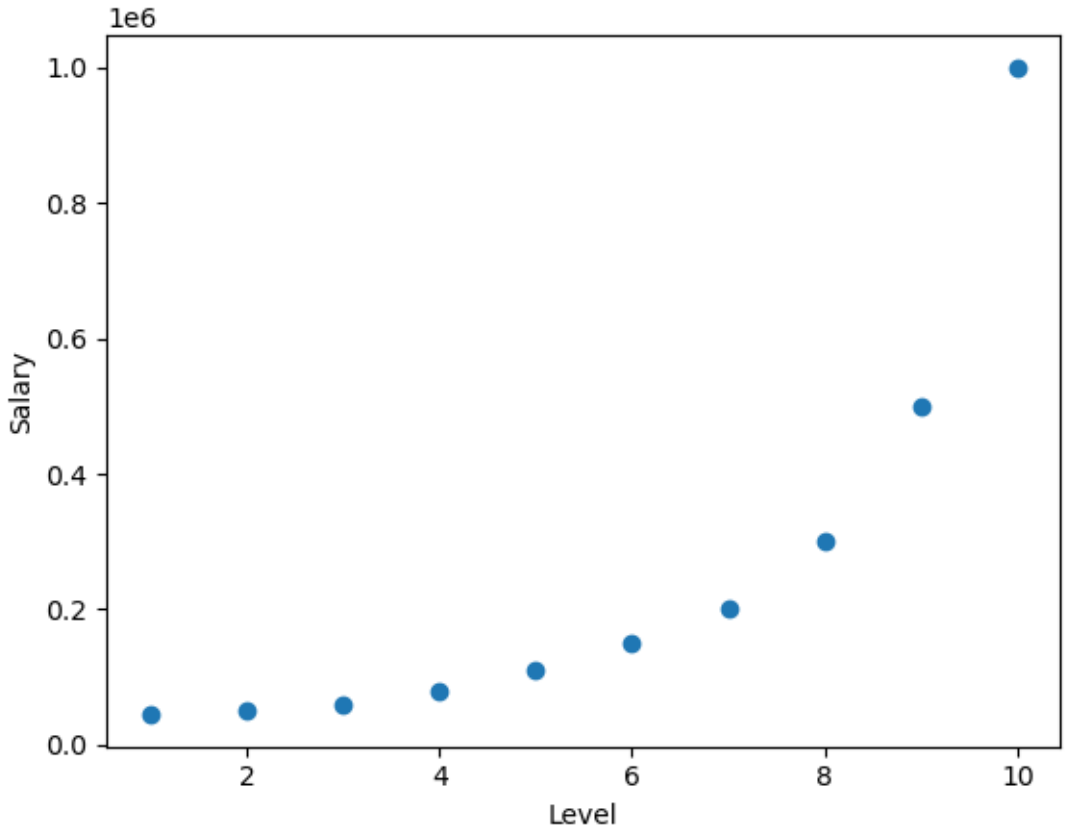
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 10 entries, 0 to 9
Data columns (total 3 columns):
 #   Column    Non-Null Count  Dtype
---  ------    --------------  -----
 0   Position  10 non-null     object
 1   Level     10 non-null     int64
 2   Salary    10 non-null     int64
dtypes: int64(2), object(1)
memory usage: 368.0+ bytes
```

[71]:
```
data.isnull().any()
```

[71]:
```
Position    False
Level       False
Salary      False
dtype: bool
```

[73]:
```
plt.scatter(data.Level, data.Salary)
plt.xlabel("Level")
plt.ylabel("Salary")
```

[73]:
```
Text(0, 0.5, 'Salary')
```




### 3.3 Train test split

[74]:
```
X = data.iloc[:, 1:2]
X
```

[74]:

| | Level |
|---|---|
| 0 | 1 |
| 1 | 2 |
| 2 | 3 |
| 3 | 4 |
| 4 | 5 |
| 5 | 6 |
| 6 | 7 |
| 7 | 8 |
| 8 | 9 |
| 9 | 10 |

[75]:
```
y = data.iloc[:, 2:3]
```

[76]:
```
y
```

[76]:
```
    Salary
0    45000
1    50000
2    60000
3    80000
4   110000
5   150000
6   200000
7   300000
8   500000
9  1000000
```

[77]:
```
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_state=0)#Splitting the dataset into train and test
```

[78]:
```
print(X_train.shape)
print(X_test.shape)
print(y_train.shape)
print(y_test.shape)
```

```
(8, 1)
(2, 1)
(8, 1)
(2, 1)
```

### 3.4 Model building

[79]:
```
from sklearn.linear_model import LinearRegression
lr=LinearRegression()
```

### 3.5 Train the model

[80]:
```
lr.fit(X_train,y_train)
```

[80]:
```
LinearRegression()
```

### 3.6 Test the model

[81]:
```
y_pred=lr.predict(X_test)
```

[82]:
```
y_pred #prediction
```

[82]:
```
array([[ 44275.9295499 ],
       [543473.58121331]])
```

[83]:
```
y_test # Actual outcome
```

[83]:
```
   Salary
2   60000
8  500000
```

### 3.7 Error

[84]:
```
E=y_test-y_pred
E
```

[84]:
```
          Salary
2  15724.070450
8 -43473.581213
```

### 3.8 R2 score

[85]:
```
from sklearn.metrics import r2_score
acc=r2_score(y_pred,y_test)
acc
```

[85]:
```
0.982847405505933
```

### 3.9 Predict random valuea

[86]:
```
#Predict with random Values
y_pr=lr.predict([[12]])
y_pr
```

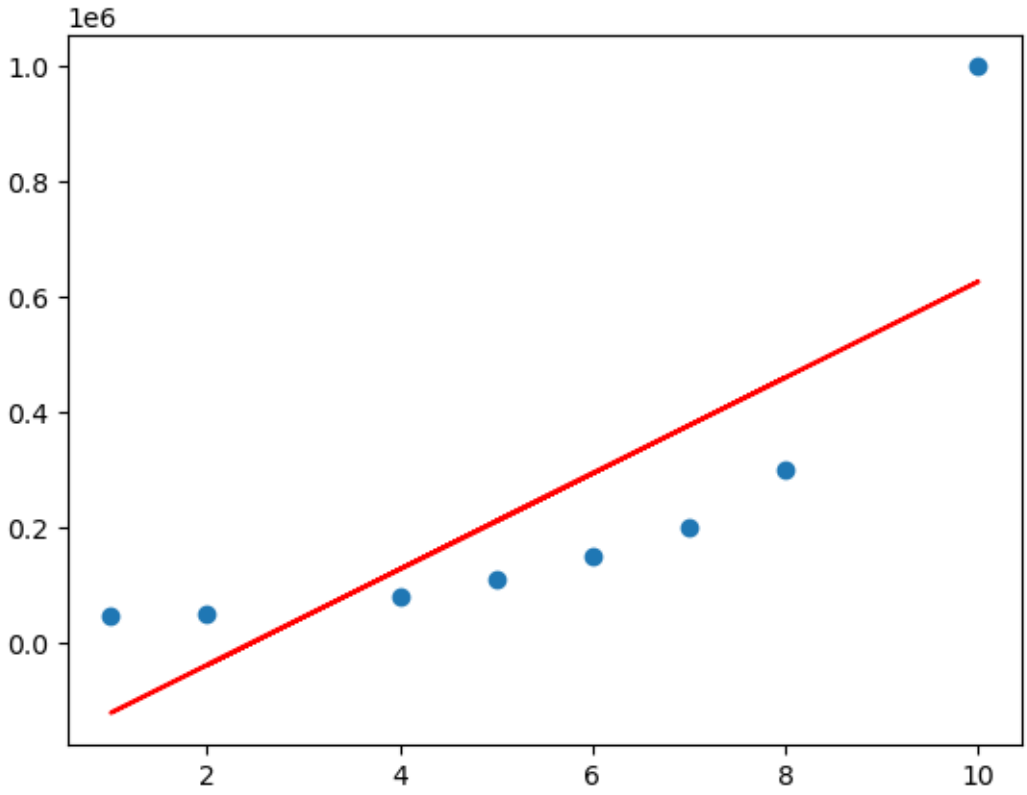
```
/Users/akashr/anaconda3/lib/python3.10/site-packages/sklearn/base.py:420:
UserWarning: X does not have valid feature names, but LinearRegression was
fitted with feature names
  warnings.warn(
```

[86]:
```
array([[793072.40704501]])
```

### 3.10 Plotting regression line

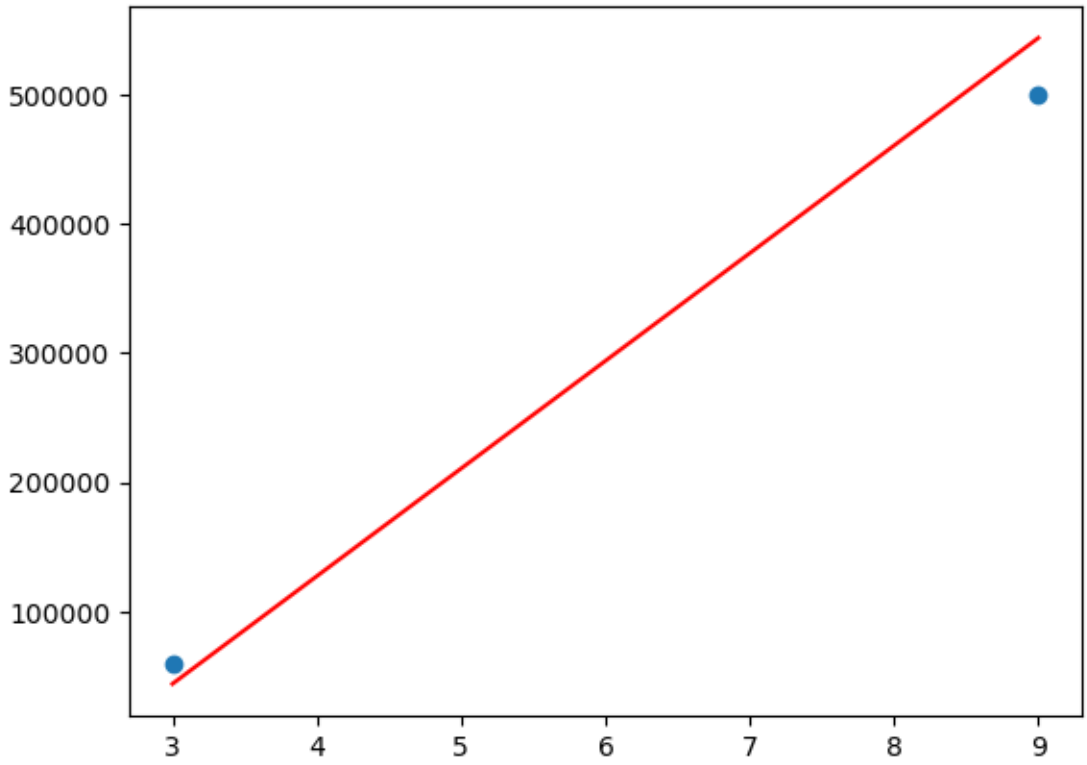
[87]:
```
plt.scatter(X_train,y_train)
plt.plot(X_train,lr.predict(X_train),'r')
```

[87]:
```
[<matplotlib.lines.Line2D at 0x14f3d1270>]
```




[88]:
```
plt.scatter(X_test,y_test)
plt.plot(X_test,y_pred,'r')
```

[88]: [<matplotlib.lines.Line2D at 0x14f43d930>]




### 3.11 R2 score

[89]:
```
from sklearn.metrics import r2_score
acc=r2_score(y_pred,y_test)
acc
```

[89]:
```
0.982847405505933
```

### 3.12 Adding Polynomial feautures

[90]:
```
#convert the normal values to polynomial features
from sklearn.preprocessing import PolynomialFeatures
pr=PolynomialFeatures(degree=4)
#x0,x1,x2,x3,x4
X_poly=pr.fit_transform(X)
X_poly
```

[90]:
```
array([[1.000e+00, 1.000e+00, 1.000e+00, 1.000e+00, 1.000e+00],
       [1.000e+00, 2.000e+00, 4.000e+00, 8.000e+00, 1.600e+01],
       [1.000e+00, 3.000e+00, 9.000e+00, 2.700e+01, 8.100e+01],
       [1.000e+00, 4.000e+00, 1.600e+01, 6.400e+01, 2.560e+02],
       [1.000e+00, 5.000e+00, 2.500e+01, 1.250e+02, 6.250e+02],
```

```
       [1.000e+00, 6.000e+00, 3.600e+01, 2.160e+02, 1.296e+03],
       [1.000e+00, 7.000e+00, 4.900e+01, 3.430e+02, 2.401e+03],
       [1.000e+00, 8.000e+00, 6.400e+01, 5.120e+02, 4.096e+03],
       [1.000e+00, 9.000e+00, 8.100e+01, 7.290e+02, 6.561e+03],
       [1.000e+00, 1.000e+01, 1.000e+02, 1.000e+03, 1.000e+04]])
```

[91]:
```
#associating above values with y
pr.fit(X_poly,y)
```

[91]:
```
PolynomialFeatures(degree=4)
```

[93]:
```
from sklearn.linear_model import LinearRegression
lr=LinearRegression()

lr.fit(X_poly,y)

pred=lr.predict(X_poly)
```

[94]:
```
pred
```

[94]:
```
array([[ 53356.6433568 ],
       [ 31759.90675996],
       [ 58642.19114221],
       [ 94632.86713289],
       [121724.94172497],
       [143275.05827508],
       [184003.49650349],
       [289994.17249411],
       [528694.63869453],
       [988916.08391595]])
```

[95]:
```
y
```

[95]:
```
     Salary
0     45000
1     50000
2     60000
3     80000
4    110000
5    150000
6    200000
7    300000
8    500000
9   1000000
```

[96]:
```
plt.scatter(X,y)
plt.plot(X,pred,'r')
```

[96]: [<matplotlib.lines.Line2D at 0x14f4ec070>]