AKADEMIA WSB

DATA EXPLORATION METHODS

LAB.1
SIMPLE LINEAR REGRESSION

Teacher:

Msc. Damian Skipiol

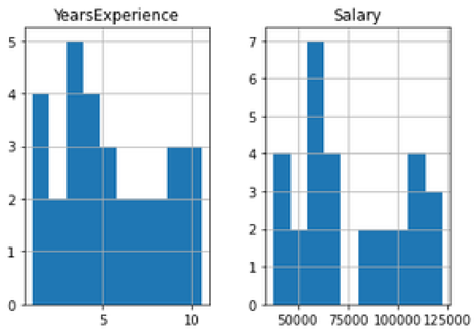
Student:

Alessandro Vavalà
48045

BUSINESS PROBLEM

The purpose of this analysis is the salary forecast by using a **Simple Linear Regression model** and the analysis of earned salaries vs forecast.

The dataset is composed of 30 instances and for each of them it is specified YearsExperince and Salary



	YearsExperience	Salary
count	30.000000	30.000000
mean	5.313333	76003.000000
std	2.837888	27414.429785
min	1.100000	37731.000000
25%	3.200000	56720.750000
50%	4.700000	65237.000000
75%	7.700000	100544.750000
max	10.500000	122391.000000

By looking at the Standard Deviation, it is possible to state that both attributes are slightly unbalanced. In fact, the distribution is wide.

SIMPLE LINEAR REGRESSION MODEL

Salary is the dependent variable and YearsExperience is the independent variable. The dataset has been splitted in: 2/3 test set and 1/3 training set, random state = 120.

```
X_train Dataset Description and values:
DescribeResult(nobs=10, minmax=(array([1.1]), array([8.7])), mean=array([4.52]), variance=array([5.564]), skewness=ar
ray([0.11236426]), kurtosis=array([-0.66684495]))
X_test Array Size: 10

X_test Dataset Description and values:
DescribeResult(nobs=20, minmax=(array([1.5]), array([10.5])), mean=array([5.71]), variance=array([9.15989474]), skewn
ess=array([0.26885926]), kurtosis=array([-1.3933746]))
X_test Array Size: 20

y_train Dataset Description and values:
DescribeResult(nobs=10, minmax=(39343.0, 109431.0), mean=70630.3, variance=526241098.23333335, skewness=0.29100883924
1123, kurtosis=-1.1253288184481411)

y_test Dataset Description and values:
DescribeResult(nobs=20, minmax=(37731.0, 122391.0), mean=78689.35, variance=875043125.7131579, skewness=0.23155521474
206187, kurtosis=-1.4888346983672696)

X_Train and y_train shape definition:
(10, 1)
(10,)
```

Here some statistics of the two sets are presented.

RESULTS

	Actual	Predict	Difference
0	55794.0	65726.591381	-9932.591381
1	43525.0	46866.173616	-3341.173616
2	122391.0	125136.907341	-2745.907341
3	112635.0	118535.761123	-5900.761123
4	66029.0	76099.821152	-10070.821152
5	37731.0	42151.069175	-4420.069175
6	64445.0	58182.424275	6262.575725
7	116969.0	117592.740235	-623.740235
8	56642.0	55353.361610	1288.638390
9	39891.0	48752.215393	-8861.215393
10	101302.0	102504.406023	-1202.406023
11	98273.0	94960.238917	3312.761083
12	113812.0	105333.468688	8478.531312
13	57081.0	66669.612269	-9588.612269
14	121872.0	127022.949117	-5150.949117
15	61111.0	70441.695822	-9330.695822
16	60150.0	56296.382499	3853.617501
17	81363.0	83643.988258	-2280.988258
18	105582.0	112877.635794	-7295.635794
19	57189.0	62897.528716	-5708.528716

```
y_pred Dataset Description and values:
DescribeResult(nobs=20, minmax=(42151.069174854216, 127022.94911734163), mean=81852.24857017331, variance=814578809.5
08328, skewness=0.2688592624966764, kurtosis=-1.3933746025308222)
```

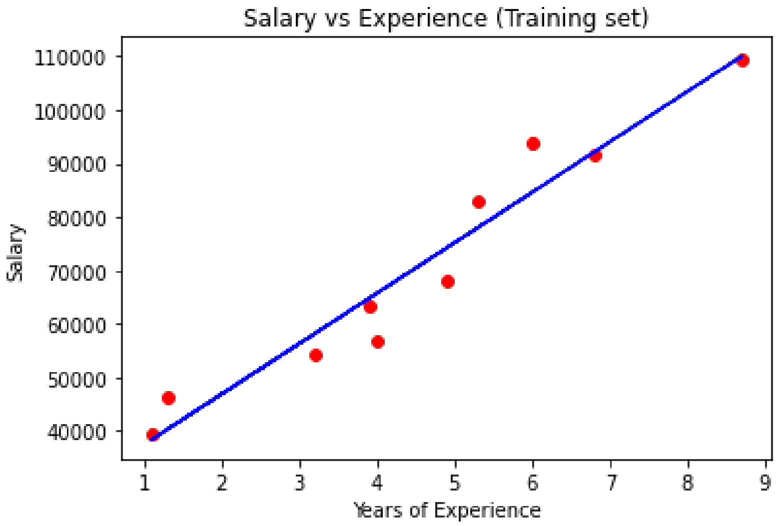
The mean value predicted it is higher than the actual min value (81852 vs.76003), as well as the variance.

Coefficient: 9430.2088825
the positive coefficient indicates the positive relationship between Salary and YearsExpering: the value of the independent variable increases (YearsExperince), and the mean of the dependent (Salary) variable also tends to increase

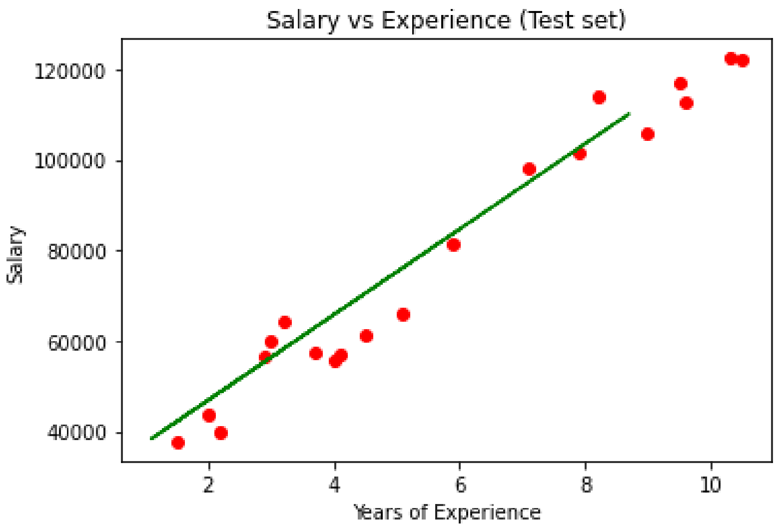
Intercept: 28005.75585110631
The value of the intercept indicates the expected mean value of Y (Salary) when all X (YearsExperince) =0. In this case, such value can be understood as the salary for an entry-level with 0 years of experience.

Mean Squared Error: 39431803.43
The MSE is the average squared distance between the actual and predicted values.

R squared: 95.26%
The independent variable (YearsExperince) can explain a portion of 95.26% of the variance in the dependent variable (Salary). It indicates a high correlation between the two variables.



Salary vs Experience (Training set)
110000
100000
90000
80000
70000
60000
50000
40000
Salary
1
2
3
4
5
6
7
8
9
Years of Experience



Salary vs Experience (Test set)
120000
100000
80000
60000
40000
Salary
2
4
6
8
10
Years of Experience

Laboratory 1 - Data Exploration

25th June 2022

Linear regression

In [1]:
```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
from scipy import stats

import sklearn as skl
from sklearn import linear_model
from sklearn.metrics import r2_score, mean_squared_error, mean_absolute_error
import sklearn.utils, sklearn.preprocessing
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split
```

In [2]:
```
# importing dataset and visulising the first five rows
dataset = pd.read_excel(r'file:/Users/AlessandroVavala/Desktop/Alessandro/Uni
X = dataset.iloc[:, :-1].values # creating an array with values from YearsExp
y = dataset.iloc[:, 1].values # creating an array with values from Salary, th
print("Dataset values")
dataset.head()
```

```
Dataset values
```

Out[2]:

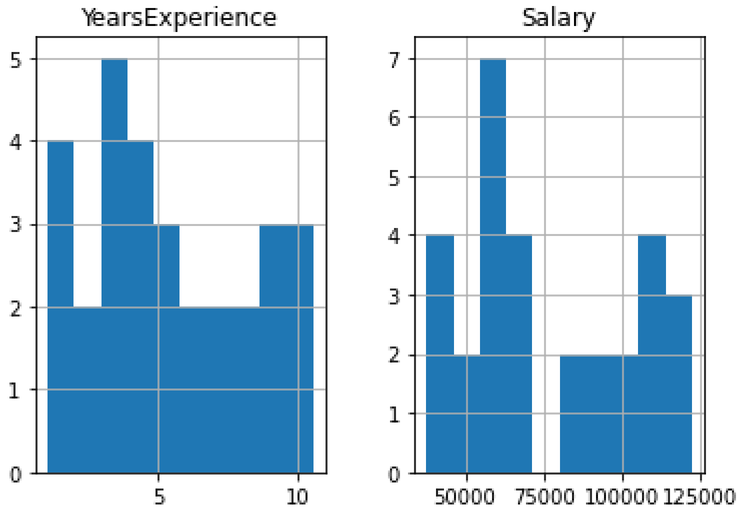
	YearsExperience	Salary
0	1.1	39343.0
1	1.3	46205.0
2	1.5	37731.0
3	2.0	43525.0
4	2.2	39891.0

In [3]:
```
print(dataset.describe())
```

```
       YearsExperience         Salary
count        30.000000      30.000000
mean          5.313333   76003.000000
std           2.837888   27414.429785
min           1.100000   37731.000000
25%           3.200000   56720.750000
50%           4.700000   65237.000000
75%           7.700000  100544.750000
max          10.500000  122391.000000
```

In [4]:
```
dataset.hist()
```

Out[4]:
```
array([[<AxesSubplot:title={'center':'YearsExperience'}>,
        <AxesSubplot:title={'center':'Salary'}>]], dtype=object)
```



In [5]:

```
# splitting the dataset into training set and test set.
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size= 2/3, ran

# printing out the training sets and test sets, the size along with various s
print()
print("X_train Dataset Description and values:")
print(stats.describe(X_train))
print("X_test Array Size: " + str(X_train.size))
#print(X_train)
print()
print("X_test Dataset Description and values:")
print(stats.describe(X_test))
print("X_test Array Size: " + str(X_test.size))
#print(X_test)
print()
print("y_train Dataset Description and values:")
print(stats.describe(y_train))
#print(y_train)
print()
print("y_test Dataset Description and values:")
print(stats.describe(y_test))
#print(y_test)
print()
print("X_Train and y_train shape definition:")
print(X_train.shape)
print(y_train.shape)
```

```
X_train Dataset Description and values:
DescribeResult(nobs=10, minmax=(array([1.1]), array([8.7])), mean=array([4.5
2]), variance=array([5.564]), skewness=array([0.11236426]), kurtosis=array([-
0.66684495]))
X_test Array Size: 10

X_test Dataset Description and values:
DescribeResult(nobs=20, minmax=(array([1.5]), array([10.5])), mean=array([5.7
1]), variance=array([9.15989474]), skewness=array([0.26885926]), kurtosis=arra
y([-1.3933746]))
X_test Array Size: 20

y_train Dataset Description and values:
DescribeResult(nobs=10, minmax=(39343.0, 109431.0), mean=70630.3, variance=526
241098.23333335, skewness=0.291008839241123, kurtosis=-1.1253288184481411)

y_test Dataset Description and values:
DescribeResult(nobs=20, minmax=(37731.0, 122391.0), mean=78689.35, variance=87
5043125.7131579, skewness=0.23155521474206187, kurtosis=-1.4888346983672696)
```

```
X_Train and y_train shape definition:
(10, 1)
(10,)
```

In [6]:

```
# Feature Scaling

'''sc_X = StandardScaler()
X_train = sc_X.fit_transform(X_train)
X_test = sc_X.transform(X_test)
sc_y = StandardScaler()
y_train = sc_y.fit_transform(y_train)'''


scaler = StandardScaler()
X_train_sc = scaler.fit_transform(X_train.reshape(-1, 1))
X_test_sc = scaler.fit_transform(X_test.reshape(-1, 1))
y_train_sc = scaler.fit_transform(y_train.reshape(-1, 1))
y_test_sc = scaler.fit_transform(y_test.reshape(-1, 1))
```

In [7]:

```
# printing out the scaled sets along with statistics
print("X_train scaled Dataset Description and values:")
print(stats.describe(X_train_sc))
print(X_train_sc)
print()
print("X_test scaled Dataset Description and values:")
print(stats.describe(X_test_sc))
print("X_test Array Size: " + str(X_test.size))
print(X_test_sc)
print()
print("y_train Dataset scaled Description and values:")
print(stats.describe(y_train_sc))
print(y_train_sc)
print()
print("y_test Dataset scaled Description and values:")
print(stats.describe(y_test_sc))
print(y_test_sc)
print()
print("X_Train scaled and y_train scaled shape definition:")
print(X_train_sc.shape)
print(y_train_sc.shape)
```

```
X_train scaled Dataset Description and values:
DescribeResult(nobs=10, minmax=(array([-1.52830942]), array([1.86793374])), me
an=array([-6.88338275e-16]), variance=array([1.11111111]), skewness=array([0.1
1236426]), kurtosis=array([-0.66684495]))
[[ 0.66137367]
 [-1.4389346 ]
 [-0.23237453]
 [ 0.3485618 ]
 [ 1.01887295]
 [ 1.86793374]
 [ 0.16981216]
 [-0.27706194]
 [-1.52830942]
 [-0.58987381]]

X_test scaled Dataset Description and values:
DescribeResult(nobs=20, minmax=(array([-1.42716784]), array([1.62378479])), me
an=array([-1.11022302e-17]), variance=array([1.05263158]), skewness=array([0.2
6885926]), kurtosis=array([-1.3933746]))
X_test Array Size: 20
[[-0.579681  ]
 [-1.25767047]
 [ 1.55598584]
```

```
 [ 1.31868953]
 [-0.20678679]
 [-1.42716784]
 [-0.85087679]
 [ 1.28479005]
 [-0.95257521]
 [-1.18987153]
 [ 0.74239847]
 [ 0.47120268]
 [ 0.8440969 ]
 [-0.54578153]
 [ 1.62378479]
 [-0.41018363]
 [-0.91867574]
 [ 0.064409  ]
 [ 1.11529269]
 [-0.68137942]]

y_train Dataset scaled Description and values:
DescribeResult(nobs=10, minmax=(array([-1.43765424]), array([1.78289565])), me
an=array([-1.66533454e-16]), variance=array([1.11111111]), skewness=array([0.2
9100884]), kurtosis=array([-1.12532882]))
[[ 1.07108281]
 [-1.12234473]
 [-0.62828936]
 [ 0.57243243]
 [ 0.96990071]
 [ 1.78289565]
 [-0.12371143]
 [-0.34059585]
 [-1.43765424]
 [-0.74371599]]

y_test Dataset scaled Description and values:
DescribeResult(nobs=20, minmax=(array([-1.42058074]), array([1.5157281])), mea
n=array([-1.94289029e-16]), variance=array([1.05263158]), skewness=array([0.23
155521]), kurtosis=array([-1.4888347]))
[[-0.79409188]
 [-1.21962428]
 [ 1.5157281 ]
 [ 1.17735545]
 [-0.43910581]
 [-1.42058074]
 [-0.49404454]
 [ 1.32767393]
 [-0.76468024]
 [-1.34566428]
 [ 0.78428684]
 [ 0.67923039]
 [ 1.21817798]
 [-0.74945416]
 [ 1.49772734]
 [-0.60967948]
 [-0.64301036]
 [ 0.09273166]
 [ 0.93273241]
 [-0.74570834]]

X_Train scaled and y_train scaled shape definition:
(10, 1)
(10, 1)
```

In [8]:

```
# importing Linear Regression from scikit-learn
from sklearn.linear_model import LinearRegression

# Creating the regressor. passing the training sets into the regressor to tra
regressor = LinearRegression()
regressor.fit(X_train, y_train )
```

Out[8]: LinearRegression()

In [9]:
```
# checking what are
regressor.__dir__()
```

Out[9]:
```
['fit_intercept',
 'normalize',
 'copy_X',
 'n_jobs',
 'positive',
 'n_features_in_',
 'coef_',
 '_residues',
 'rank_',
 'singular_',
 'intercept_',
 '__module__',
 '__doc__',
 '__init__',
 'fit',
 '__abstractmethods__',
 '_abc_impl',
 '_more_tags',
 '__dict__',
 '__weakref__',
 '__repr__',
 '__hash__',
 '__str__',
 '__getattribute__',
 '__setattr__',
 '__delattr__',
 '__lt__',
 '__le__',
 '__eq__',
 '__ne__',
 '__gt__',
 '__ge__',
 '__new__',
 '__reduce_ex__',
 '__reduce__',
 '__subclasshook__',
 '__init_subclass__',
 '__format__',
 '__sizeof__',
 '__dir__',
 '__class__',
 '_estimator_type',
 'score',
 '_decision_function',
 'predict',
 '_preprocess_data',
 '_set_intercept',
 '_get_param_names',
 'get_params',
 'set_params',
 '__getstate__',
 '__setstate__',
 '_get_tags',
 '_check_n_features',
 '_validate_data',
 '_repr_html_',
 '_repr_html_inner',
 '_repr_mimebundle_']
```

In [10]:
```
inter = regressor.intercept_ #intercept
coe = regressor.coef_ #corfficient
```

```python
# printing result of intercept and coefficient
print()
print("Intercept parameter and coefficient (slope):")
print('Intercept (b) is : ', inter)
print('Coefficient (m) is : ', coe)
```

```
Intercept parameter and coefficient (slope):
Intercept (b) is :  28005.75585110631
Coefficient (m) is :  [9430.2088825]
```

In [11]:

```python
# creating a data prediction model
y_pred = regressor.predict(X_test)

print()
print("y_pred Dataset Description and values:") # printing statistics about t
print(stats.describe(y_pred))

#comparison between predicted values, actual values and their variance
print()
print("Comparing Predicted Values vs Actual for Test set results:")
df1 = pd.DataFrame({'Actual': y_test, 'Predict': y_pred})
print(df1)
print()
print("Comparing Predicted Values vs Actual + Difference for Test set results
df2 = pd.DataFrame({'Actual': y_test, 'Predict': y_pred, 'Difference': y_test
print(df2)
```

```
y_pred Dataset Description and values:
DescribeResult(nobs=20, minmax=(42151.069174854216, 127022.94911734163), mean=
81852.24857017331, variance=814578809.508328, skewness=0.2688592624966764, kur
tosis=-1.3933746025308222)

Comparing Predicted Values vs Actual for Test set results:
      Actual        Predict
0    55794.0   65726.591381
1    43525.0   46866.173616
2   122391.0  125136.907341
3   112635.0  118535.761123
4    66029.0   76099.821152
5    37731.0   42151.069175
6    64445.0   58182.424275
7   116969.0  117592.740235
8    56642.0   55353.361610
9    39891.0   48752.215393
10  101302.0  102504.406023
11   98273.0   94960.238917
12  113812.0  105333.468688
13   57081.0   66669.612269
14  121872.0  127022.949117
15   61111.0   70441.695822
16   60150.0   56296.382499
17   81363.0   83643.988258
18  105582.0  112877.635794
19   57189.0   62897.528716

Comparing Predicted Values vs Actual + Difference for Test set results:
      Actual        Predict    Difference
0    55794.0   65726.591381  -9932.591381
1    43525.0   46866.173616  -3341.173616
2   122391.0  125136.907341  -2745.907341
3   112635.0  118535.761123  -5900.761123
4    66029.0   76099.821152 -10070.821152
5    37731.0   42151.069175  -4420.069175
6    64445.0   58182.424275   6262.575725
7   116969.0  117592.740235   -623.740235
```

```
8    56642.0   55353.361610   1288.638390
9    39891.0   48752.215393  -8861.215393
10  101302.0  102504.406023  -1202.406023
11   98273.0   94960.238917   3312.761083
12  113812.0  105333.468688   8478.531312
13   57081.0   66669.612269  -9588.612269
14  121872.0  127022.949117  -5150.949117
15   61111.0   70441.695822  -9330.695822
16   60150.0   56296.382499   3853.617501
17   81363.0   83643.988258  -2280.988258
18  105582.0  112877.635794  -7295.635794
19   57189.0   62897.528716  -5708.528716
```

In [12]:

```
# Eveluation metrics
print("__ \n")
print('Coefficients: \n', regressor.coef_)
print("__ \n")
print('Intercept: \n', regressor.intercept_)
print("__ \n")
# The mean squared error
print('Mean squared error: %.2f'
      % mean_squared_error(y_test, y_pred))
print("__ \n")

# The coefficient of determination: 1 is perfect prediction
print('Coefficient of determination: %.2f'
      % r2_score(y_test, y_pred))
print("__ \n")

print("MAE: %.2f" % mean_absolute_error(y_test, y_pred))
print("__\n")
```

```
__

Coefficients: 
 [9430.2088825]
__

Intercept: 
 28005.75585110631
__

Mean squared error: 39431803.43
__

Coefficient of determination: 0.95
__

MAE: 5482.51
__
```

In [13]:

```
# r2 metric
Score = r2_score(y_test, y_pred) * 100
print()
print('Score is : ', Score)
```

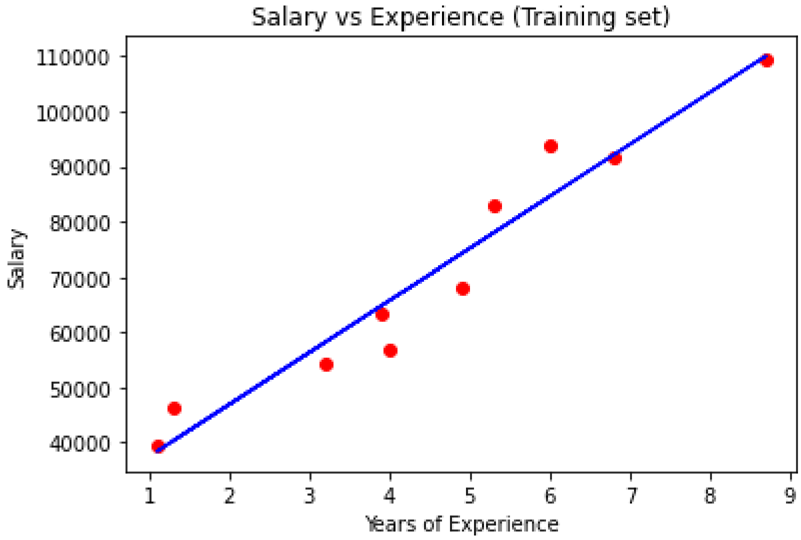
```
Score is :  95.25655818717182
```

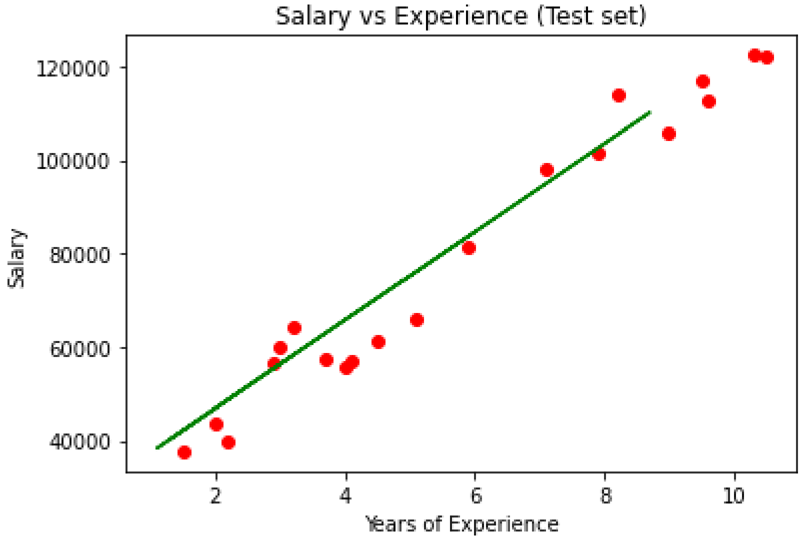
In [14]:

```
print()
print('Mean Absolute Error : ', mean_absolute_error(y_test, y_pred))
print('Mean Squared Error : ', mean_squared_error(y_test, y_pred))
print('Root Mean Squared Error : ', np.sqrt(mean_squared_error(y_test, y_pred

# Visualising the Training set results
```

```
plt.scatter(X_train, y_train, color='red')
plt.plot(X_train, regressor.predict(X_train), color='blue')
plt.title('Salary vs Experience (Training set)')
plt.xlabel('Years of Experience')
plt.ylabel('Salary')
plt.show()

# Visualising the Test set results
plt.scatter(X_test, y_test, color='red')
plt.plot(X_train, regressor.predict(X_train), color='green')
plt.title('Salary vs Experience (Test set)')
plt.xlabel('Years of Experience')
plt.ylabel('Salary')
plt.show()
```

```
Mean Absolute Error :  5482.510971323585
Mean Squared Error :  39431803.43008877
Root Mean Squared Error :  6279.4747734256225
```





In [ ]: