Create a **Linear Regression** Model using Python/R to predict home prices using Boston Housing Dataset

```
import numpy as np
import pandas as pd
import sklearn
import matplotlib.pyplot as plt
```

Loading the Dataset, checking for null values and preprocessing data

```
col_names = ['CRIM', 'ZN', 'INDUS', 'CHAS', 'NOX', 'RM', 'AGE', 'DIS', 'RAD', 'TAX', 'PTRATIO', 'B', 'LSTAT', 'MEDV']
df = pd.read_csv ('/content/drive/MyDrive/TE/Colab Notebooks/Datasets/housing.csv', header = None, names = col_names, delimiter = r"\s+")
df
```

	CRIM	ZN	INDUS	CHAS	NOX	RM	AGE	DIS	RAD	TAX	PTRATIO	B	LSTAT	MEDV
0	0.00632	18.0	2.31	0	0.538	6.575	65.2	4.0900	1	296.0	15.3	396.90	4.98	24.0
1	0.02731	0.0	7.07	0	0.469	6.421	78.9	4.9671	2	242.0	17.8	396.90	9.14	21.6
2	0.02729	0.0	7.07	0	0.469	7.185	61.1	4.9671	2	242.0	17.8	392.83	4.03	34.7
3	0.03237	0.0	2.18	0	0.458	6.998	45.8	6.0622	3	222.0	18.7	394.63	2.94	33.4
4	0.06905	0.0	2.18	0	0.458	7.147	54.2	6.0622	3	222.0	18.7	396.90	5.33	36.2
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
501	0.06263	0.0	11.93	0	0.573	6.593	69.1	2.4786	1	273.0	21.0	391.99	9.67	22.4
502	0.04527	0.0	11.93	0	0.573	6.120	76.7	2.2875	1	273.0	21.0	396.90	9.08	20.6
503	0.06076	0.0	11.93	0	0.573	6.976	91.0	2.1675	1	273.0	21.0	396.90	5.64	23.9
504	0.10959	0.0	11.93	0	0.573	6.794	89.3	2.3889	1	273.0	21.0	393.45	6.48	22.0
505	0.04741	0.0	11.93	0	0.573	6.030	80.8	2.5050	1	273.0	21.0	396.90	7.88	11.9

506 rows × 14 columns

```
df.shape
```

```
(506, 14)
```

```
df.head()
```

	CRIM	ZN	INDUS	CHAS	NOX	RM	AGE	DIS	RAD	TAX	PTRATIO	B	LSTAT	MEDV
0	0.00632	18.0	2.31	0	0.538	6.575	65.2	4.0900	1	296.0	15.3	396.90	4.98	24.0
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4	0.06905	0.0	2.18	0	0.458	7.147	54.2	6.0622	3	222.0	18.7	396.90	5.33	36.2

```
df.notnull()
```

	CRIM	ZN	INDUS	CHAS	NOX	RM	AGE	DIS	RAD	TAX	PTRATIO	B	LSTAT	MEDV
0	True	True	True	True	True	True	True	True	True	True	True	True	True	True
1	True	True	True	True	True	True	True	True	True	True	True	True	True	True
2	True	True	True	True	True	True	True	True	True	True	True	True	True	True
3	True	True	True	True	True	True	True	True	True	True	True	True	True	True
4	True	True	True	True	True	True	True	True	True	True	True	True	True	True
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
501	True	True	True	True	True	True	True	True	True	True	True	True	True	True
502	True	True	True	True	True	True	True	True	True	True	True	True	True	True
503	True	True	True	True	True	True	True	True	True	True	True	True	True	True
504	True	True	True	True	True	True	True	True	True	True	True	True	True	True
505	True	True	True	True	True	True	True	True	True	True	True	True	True	True

506 rows × 14 columns

```
df.isnull().sum()
```

```
CRIM       0
ZN         0
INDUS      0
CHAS       0
NOX        0
RM         0
AGE        0
DIS        0
RAD        0
TAX        0
PTRATIO    0
B          0
LSTAT      0
MEDV       0
dtype: int64
```

Split dependent (y) variable and independent (x) variables as y = mx + c

```
x = df.drop(['MEDV'], axis = 1)
y = df['MEDV']
```

Splitting data to training and testing dataset.

```
from sklearn.model_selection import train_test_split
xtrain, xtest, ytrain, ytest = train_test_split(x, y, test_size =0.2,random_state = 0)
```

Use linear regression(Train the Machine) to Create Model

```
from sklearn.linear_model import LinearRegression
lm = LinearRegression()


# fit the model
model=lm.fit(xtrain, ytrain)
```

Predict the y_pred for all values of train_x and test_x

```
ytrain_pred = lm.predict(xtrain)
ytest_pred = lm.predict(xtest)
```

Evaluate the performance of Model for train_y and test_y

```
df1 = pd.DataFrame(ytrain_pred,ytrain)
df2 = pd.DataFrame(ytest_pred,ytest)


df1
```

MEDV	0
26.7	32.556927
21.7	21.927095
22.0	27.543826
22.9	23.603188
10.4	6.571910
...	...
18.5	19.494951
36.4	33.326364
19.2	23.796208
16.6	18.458353
23.1	23.249181

404 rows × 1 columns

```
df2
```

MEDV	0
22.6	24.889638
50.0	23.721411
23.0	29.364999
8.3	12.122386
21.2	21.443823
...	...
24.7	25.442171
14.1	15.571783
18.7	17.937195
28.1	25.305888
19.8	22.373233

102 rows × 1 columns

Calculate Mean Square Paper for train_y and test_y

```
from sklearn.metrics import mean_squared_error, r2_score
mse = mean_squared_error(ytest, ytest_pred)
print(mse)
```

```
33.44897999767639
```

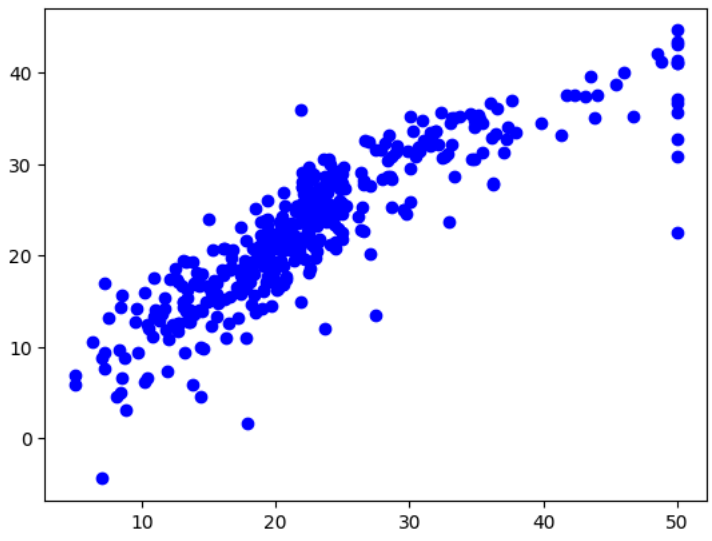
```
mse = mean_squared_error(ytrain_pred,ytrain)
print(mse)
```

```
19.326470203585725
```

Plotting the linear regression model

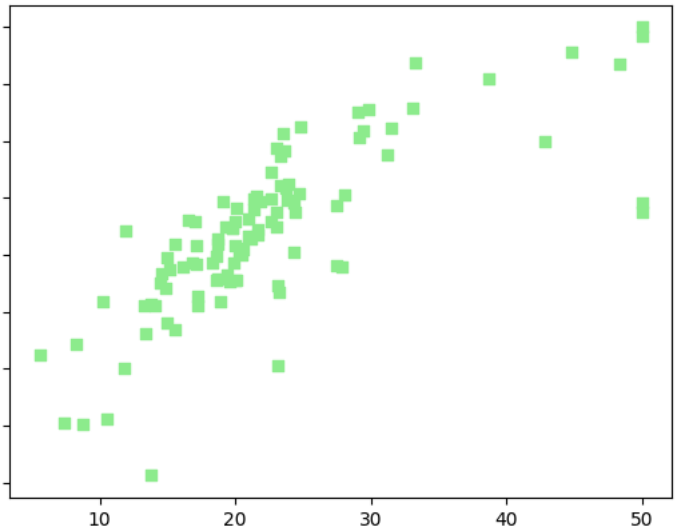
```
plt.scatter(ytrain ,ytrain_pred,c='blue',marker='o',label='Training data')
```

```
<matplotlib.collections.PathCollection at 0x7f6d7ba659c0>
```



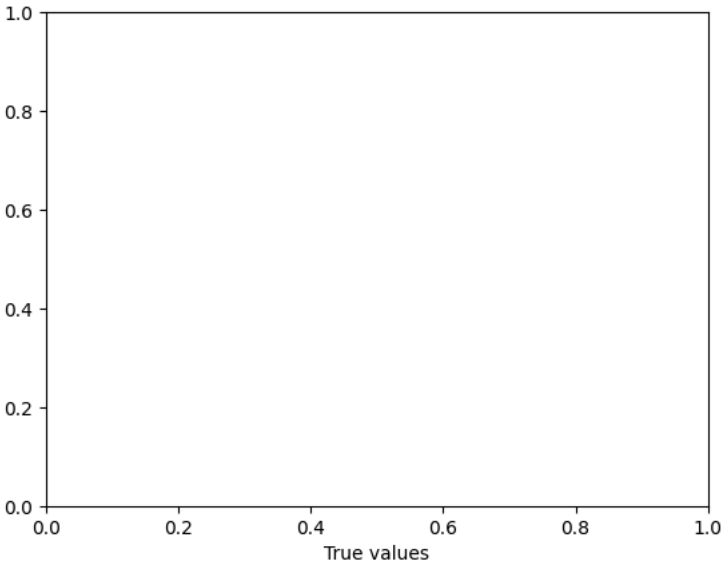

```
plt.scatter(ytest,ytest_pred ,c='lightgreen',marker='s',label='Test data')
```

```
<matplotlib.collections.PathCollection at 0x7f6d778753c0>
```



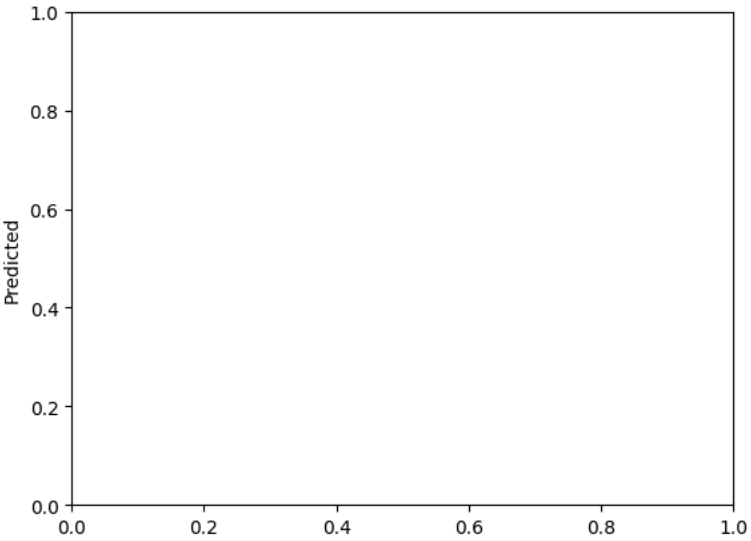

```
plt.xlabel('True values')
```

```
Text(0.5, 0, 'True values')
```



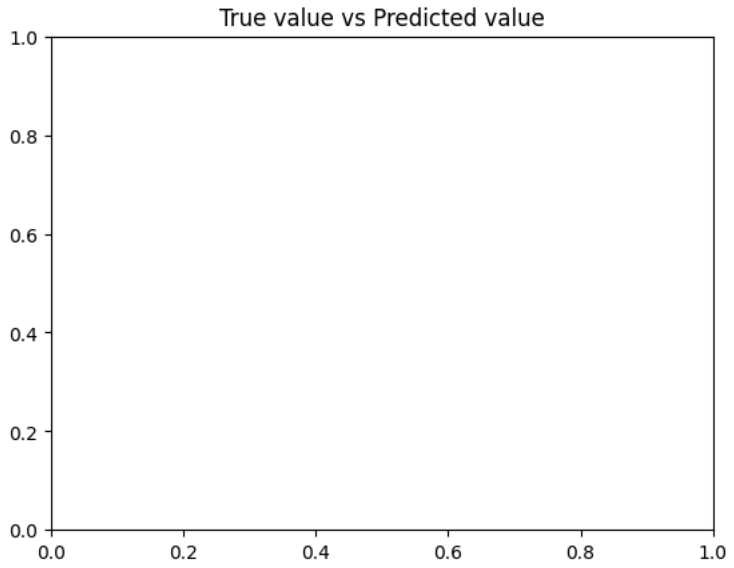

```
plt.ylabel('Predicted')
```

```
Text(0, 0.5, 'Predicted')
```



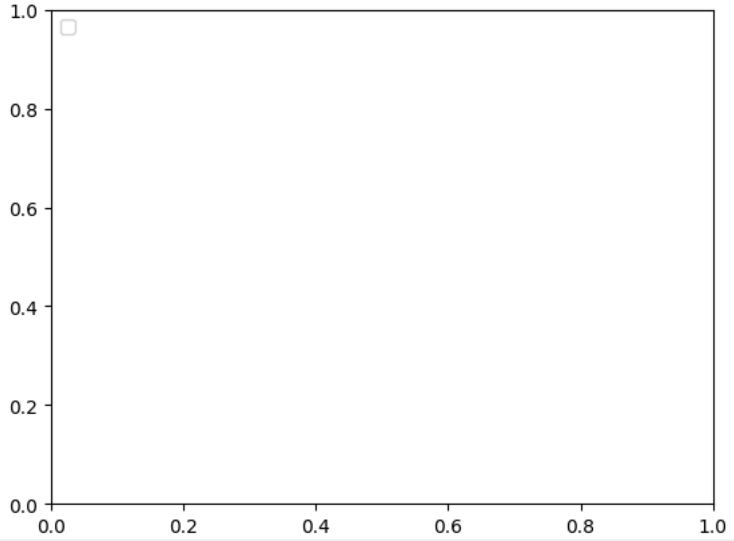

```
plt.title("True value vs Predicted value")
```

```
Text(0.5, 1.0, 'True value vs Predicted value')
```



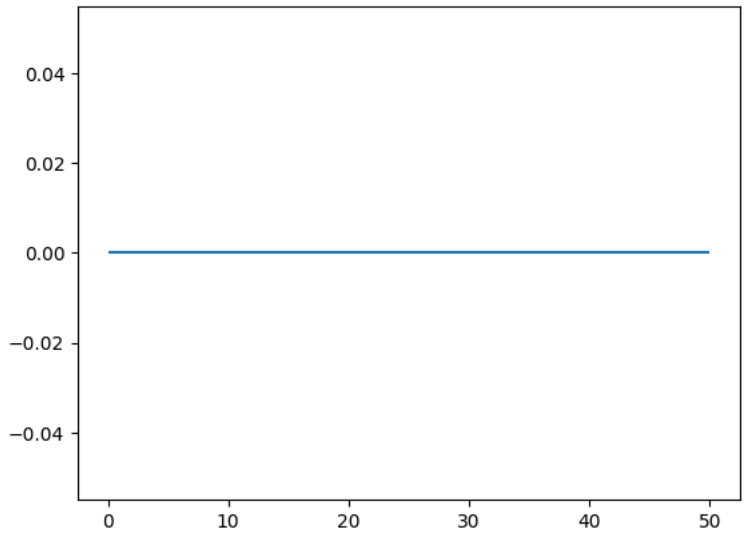

```
plt.legend(loc= 'upper left')
```

```
WARNING:matplotlib.legend:No artists with labels found to put in legend.  Note that artists whose label start with an underscore are ignored when leger
<matplotlib.legend.Legend at 0x7f6d7762fd00>
```

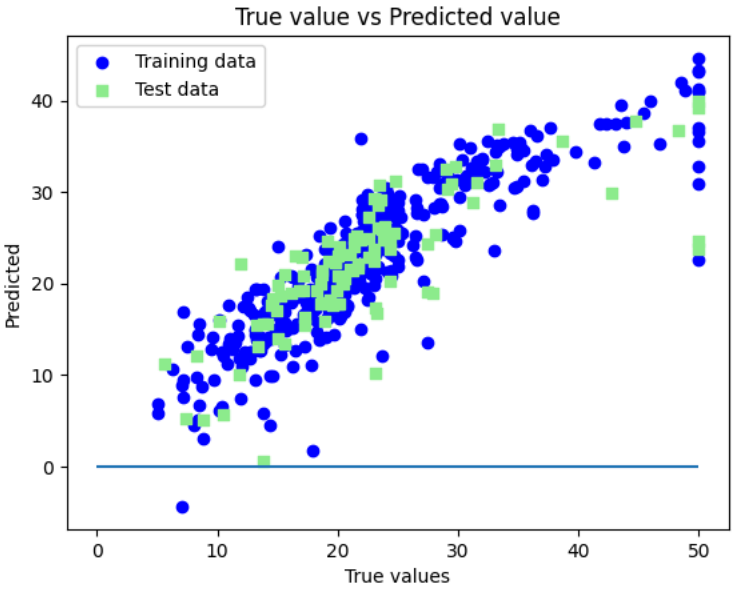



```
plt.hlines(y=0,xmin=0,xmax=50)
```

```
<matplotlib.collections.LineCollection at 0x7f6d776964d0>
```



```
plt.scatter(ytrain ,ytrain_pred,c='blue',marker='o',label='Training data')
plt.scatter(ytest,ytest_pred ,c='lightgreen',marker='s',label='Test data')
plt.xlabel('True values')
plt.ylabel('Predicted')
plt.title("True value vs Predicted value")
plt.legend(loc= 'upper left')
plt.hlines(y=0,xmin=0,xmax=50)
plt.plot()
plt.show()
```




```
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plt.scatter(ytest,ytest_pred ,c='lightgreen',marker='s',label='Test data')
plt.xlabel('True values')
plt.ylabel('Predicted')
plt.title("True value vs Predicted value")
plt.legend(loc= 'upper left')
plt.plot()
plt.show()
```
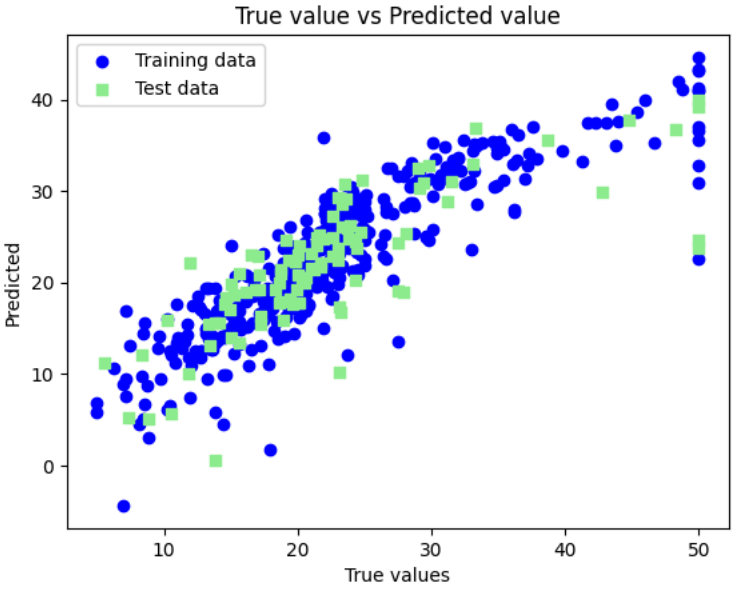



Conclusion: data analysis using linear regression for Boston Dataset and predict the price of houses using the features of the Boston Dataset has been done successfully.

TEST CASES:

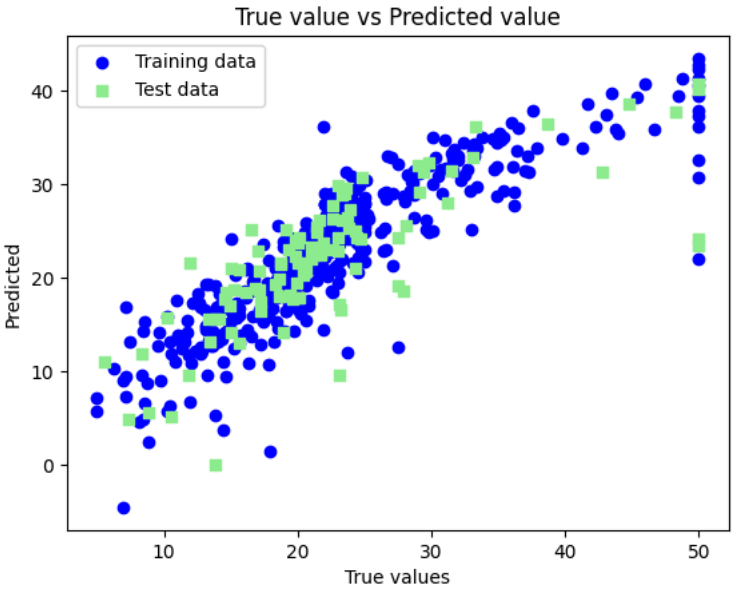
```
x1 = df.drop(['MEDV','AGE', 'ZN'], axis=1)
y1 = df['MEDV']
x1train, x1test, y1train, y1test = train_test_split(x1,y1, test_size=0.2, random_state=0)
model = lm.fit(x1train, y1train)
y1train_predict = lm.predict(x1train)
y1test_predict = lm.predict(x1test)


mse_train = mean_squared_error(y1train, y1train_predict)
mse_train
```

```
19.82688747948868
```

```
mse_test = mean_squared_error(y1test, y1test_predict)
mse_test
```

```
34.05875247632637
```

```
plt.scatter(y1train ,y1train_predict,c='blue',marker='o',label='Training data')
plt.scatter(y1test,y1test_predict ,c='lightgreen',marker='s',label='Test data')
plt.xlabel('True values')
plt.ylabel('Predicted')
plt.title("True value vs Predicted value")
plt.legend(loc= 'upper left')
plt.plot()
plt.show()
```



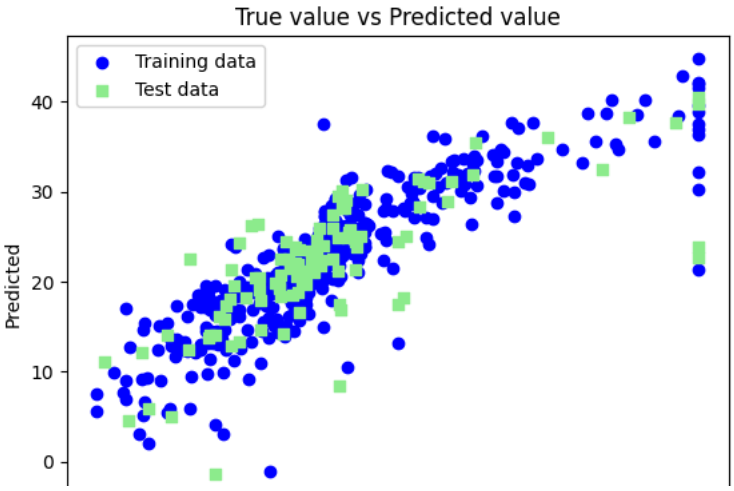

```
x1 = df.drop(['MEDV','AGE', 'ZN', 'NOX'], axis=1)
y1 = df['MEDV']
x1train, x1test, y1train, y1test = train_test_split(x1,y1, test_size=0.2, random_state=0)
model = lm.fit(x1train, y1train)
y1train_predict = lm.predict(x1train)
y1test_predict = lm.predict(x1test)


mse_train = mean_squared_error(y1train, y1train_predict)
mse_train
```

```
20.773890874497237
```

```
mse_test = mean_squared_error(y1test, y1test_predict)
mse_test
```

```
36.31028539535624
```

```
plt.scatter(y1train ,y1train_predict,c='blue',marker='o',label='Training data')
plt.scatter(y1test,y1test_predict ,c='lightgreen',marker='s',label='Test data')
plt.xlabel('True values')
plt.ylabel('Predicted')
plt.title("True value vs Predicted value")
plt.legend(loc= 'upper left')
plt.plot()
plt.show()
```


True value vs Predicted value
Training data
Test data
Predicted
40
30
20
10
0