LR_MLR_PR_Mano

July 25, 2022

[1]:
```
# importing the necessary Libraries
```

[2]:
```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

np.random.seed(11)
```

[3]:
```
# Importing the dataset
```

[4]:
```
adv_data = pd.read_csv("Advertising.csv")
adv_data.head()
```

[4]:

	Unnamed: 0	TV	radio	newspaper	sales
0	1	230.1	37.8	69.2	22.1
1	2	44.5	39.3	45.1	10.4
2	3	17.2	45.9	69.3	9.3
3	4	151.5	41.3	58.5	18.5
4	5	180.8	10.8	58.4	12.9

[5]:
```
adv_data = pd.read_csv("Advertising.csv",index_col=0) ## Removing the first␣
 ↪column
adv_data.head()
```

[5]:

	TV	radio	newspaper	sales
1	230.1	37.8	69.2	22.1
2	44.5	39.3	45.1	10.4
3	17.2	45.9	69.3	9.3
4	151.5	41.3	58.5	18.5
5	180.8	10.8	58.4	12.9

[6]:
```
adv_data.shape
```

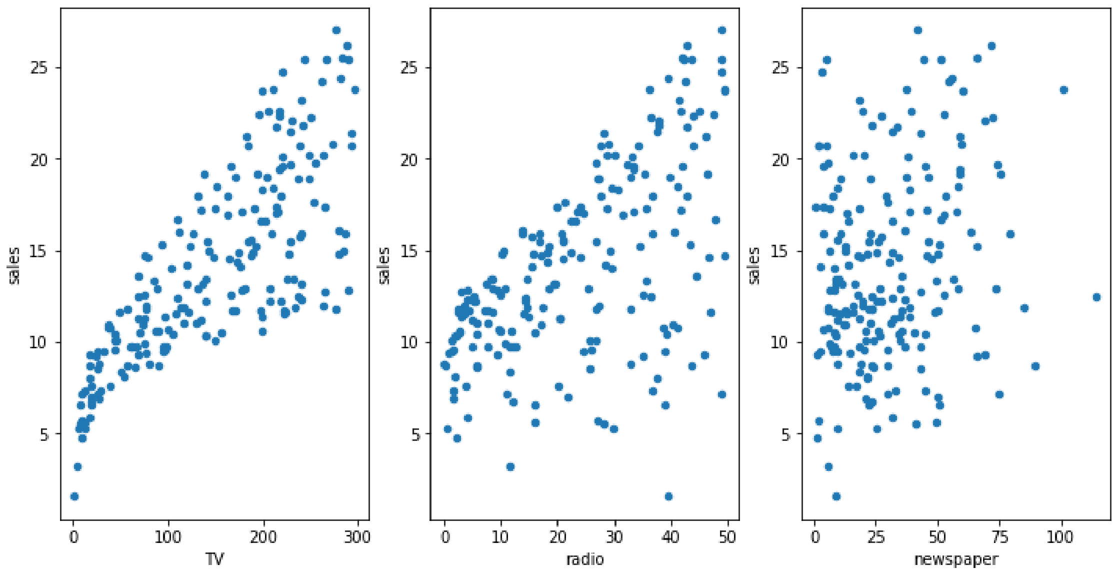
[6]: (200, 4)

[7]:
```
adv_data.columns
```

[7]: Index(['TV', 'radio', 'newspaper', 'sales'], dtype='object')

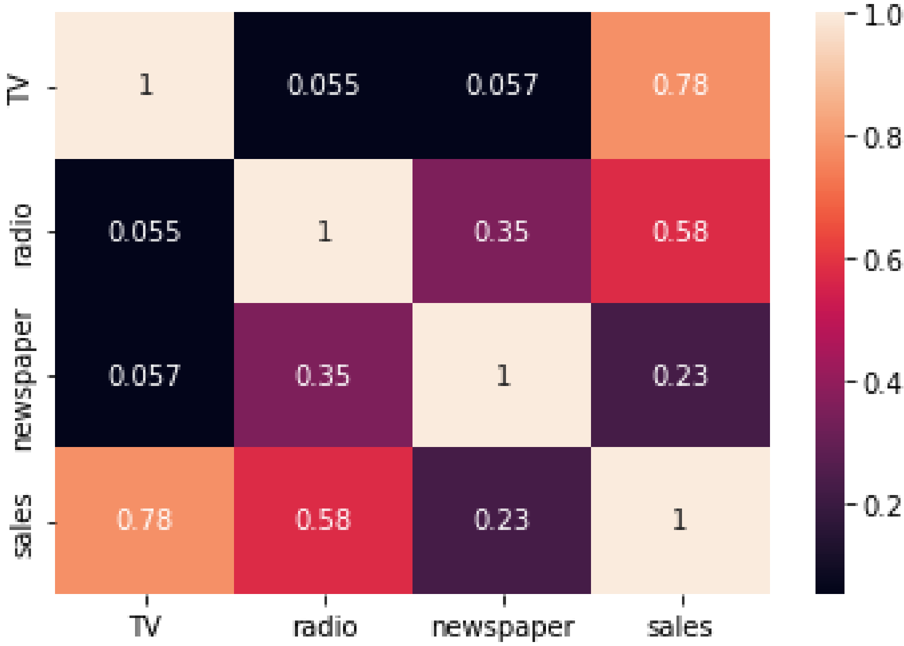
[8]:
```
# Scatter plot to view the relation between the features(Tv/radio/newspaper)␣
↪and Targert(Sales)
```

[9]:
```
fig, axs = plt.subplots(1, 3)
adv_data.plot(kind='scatter', x='TV', y='sales', ax=axs[0], figsize=(12,6))
adv_data.plot(kind='scatter', x='radio', y='sales', ax=axs[1])
adv_data.plot(kind='scatter', x='newspaper', y='sales', ax=axs[2]);
```



[10]:
```
# Checking the co-relation between the features and target
```

[11]:
```
sns.heatmap(adv_data.corr(), annot = True);
```



[12]:
```
## Individually doing the linear regression for all the feature
```

[13]:
```
adv_data.columns
```

[13]:
```
Index(['TV', 'radio', 'newspaper', 'sales'], dtype='object')
```

[14]:
```
# For only TV
features_TV = adv_data[['TV']].values
target_sales = adv_data[['sales']].values
```

[15]:
```
# For only radio
features_radio = adv_data[['radio']].values
target_sales = adv_data[['sales']]
```

[16]:
```
# For only newspaper
features_newspaper = adv_data[['newspaper']].values
target_sales = adv_data[['sales']]
```

[17]:
```
## Splitting the data as train and test data
from sklearn.model_selection import train_test_split
```

[18]:
```
X_train_TV,X_test_TV,y_train_TV,y_test_TV =␣
↪train_test_split(features_TV,target_sales,random_state=6)
```

[19]:
```
print(X_train_TV.shape)
print(X_test_TV.shape)
print(y_train_TV.shape)
print(y_test_TV.shape)
```

```
(150, 1)
(50, 1)
(150, 1)
(50, 1)
```

[20]:
```
X_train_radio,X_test_radio,y_train_radio,y_test_radio =␣
↪train_test_split(features_radio,target_sales,random_state=6)
```

[21]:
```
print(X_train_radio.shape)
print(X_test_radio.shape)
print(y_train_radio.shape)
print(y_test_radio.shape)
```

```
(150, 1)
(50, 1)
(150, 1)
(50, 1)
```

[22]:
```
X_train_newspaper,X_test_newspaper,y_train_newspaper,y_test_newspaper =␣
↪train_test_split(features_newspaper,target_sales,random_state=6)
```

[23]:
```
print(X_train_newspaper.shape)
print(X_test_newspaper.shape)
print(y_train_newspaper.shape)
print(y_test_newspaper.shape)
```

```
(150, 1)
(50, 1)
(150, 1)
(50, 1)
```

[24]:
```
# importing the library
from sklearn.linear_model import LinearRegression
```

[25]:
```
my_tv_model = LinearRegression()
my_radio_model = LinearRegression()
my_newspaper_model = LinearRegression()
```

0.1 TV - Model Fit

[26]:
```
my_tv_model.fit(X_train_TV,y_train_TV)
```

[26]:
```
LinearRegression()
```

[27]:
```
my_tv_model.coef_
```

[27]:
```
array([[0.04873499]])
```

[28]:
```
my_tv_model.intercept_
```

[28]:
```
array([6.70910349])
```

0.2 Radio - Model Fit

[29]:
```
my_radio_model.fit(X_train_radio,y_train_radio)
```

[29]:
```
LinearRegression()
```

[30]:
```
my_radio_model.coef_
```

[30]:
```
array([[0.21590796]])
```

[31]:
```
my_radio_model.intercept_
```

[31]:
```
array([9.17863927])
```

0.3 Newspaper - Model Fit

[32]:
```
my_newspaper_model.fit(X_train_newspaper,y_train_newspaper)
```

[32]:
```
LinearRegression()
```

[33]:
```
my_newspaper_model.coef_
```

[33]:
```
array([[0.07750161]])
```

[34]:
```
my_newspaper_model.intercept_
```

[34]:
```
array([11.88037471])
```

0.4 Plot the best fit Line - TV/Radio/Newspaper

[35]:
```
X_new_TV = pd.DataFrame({'TV':[adv_data.TV.min(),adv_data.TV.max()]})
X_new_radio = pd.DataFrame({'radio':[adv_data.radio.min(),adv_data.radio.
 ↪max()]})
X_new_newspaper = pd.DataFrame({'newspaper':[adv_data.newspaper.min(),adv_data.
 ↪newspaper.max()]})
X_new_TV.head()
```

[35]:

	TV
0	0.7
1	296.4

[36]:
```
X_new_radio.head()
```

[36]:

	radio
0	0.0
1	49.6

[37]:
```
X_new_newspaper.head()
```

[37]:

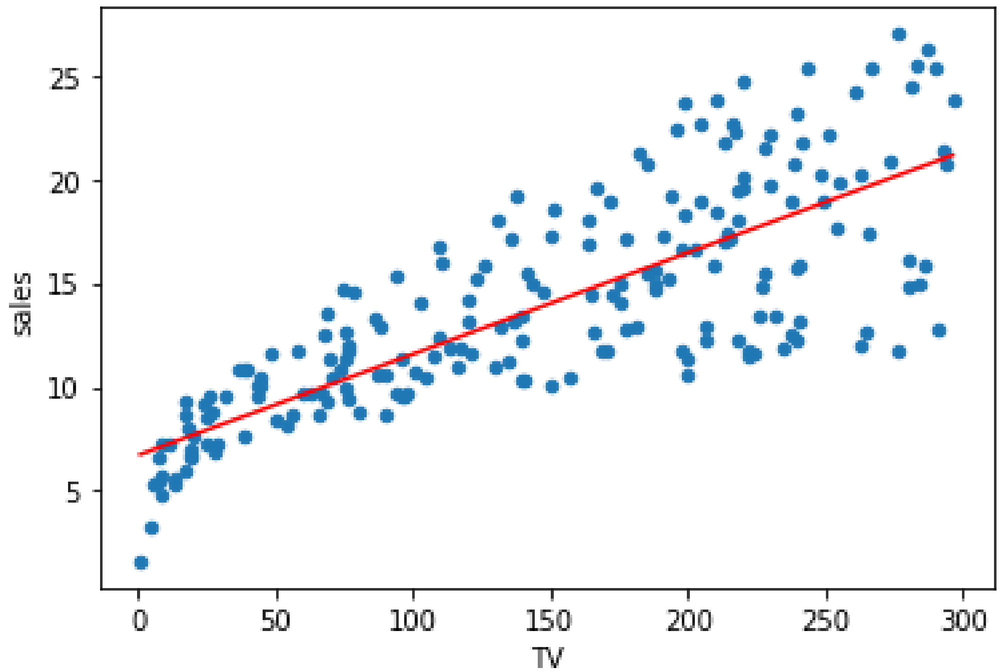
	newspaper
0	0.3
1	114.0

[38]:
```
TV_pred = my_tv_model.predict(X_new_TV)
radio_pred = my_tv_model.predict(X_new_radio)
newspaper_pred = my_tv_model.predict(X_new_newspaper)
```

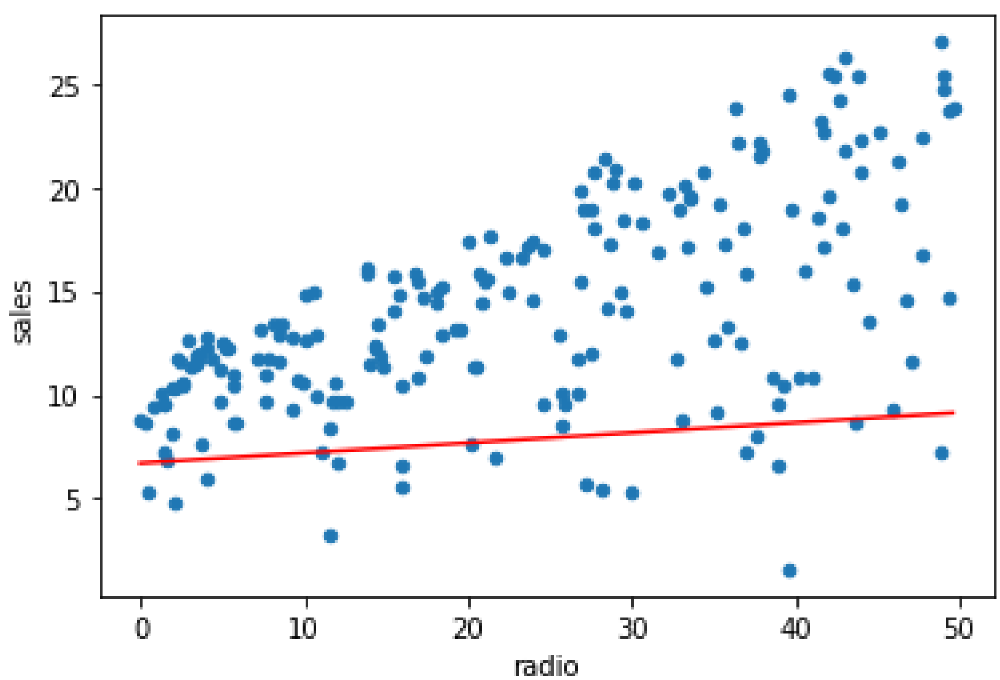
```
/usr/local/lib/python3.7/site-packages/sklearn/base.py:444: UserWarning: X has
feature names, but LinearRegression was fitted without feature names
  f"X has feature names, but {self.__class__.__name__} was fitted without"
/usr/local/lib/python3.7/site-packages/sklearn/base.py:444: UserWarning: X has
feature names, but LinearRegression was fitted without feature names
  f"X has feature names, but {self.__class__.__name__} was fitted without"
/usr/local/lib/python3.7/site-packages/sklearn/base.py:444: UserWarning: X has
feature names, but LinearRegression was fitted without feature names
  f"X has feature names, but {self.__class__.__name__} was fitted without"
```

[39]:
```
#data.plot(kind='scatter', x='TV', y='sales')
#plt.plot(X_new,preds,c='red');
```

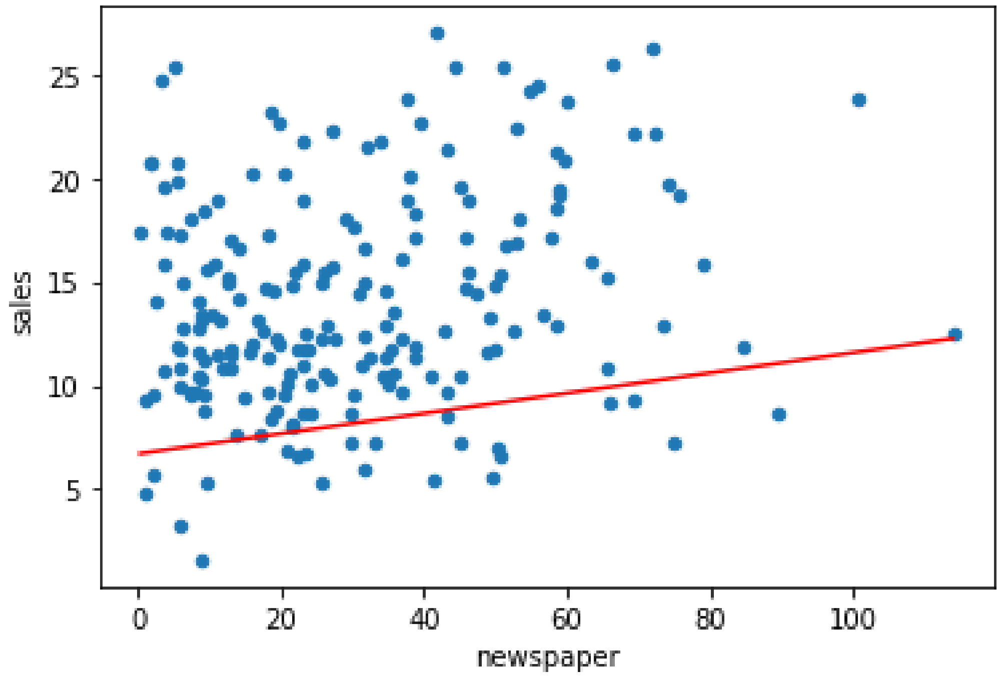
[40]:
```
adv_data.plot(kind='scatter', x='TV', y='sales')
plt.plot(X_new_TV,TV_pred,c='red');
```



[41]:
```
adv_data.plot(kind='scatter', x='radio', y='sales')
plt.plot(X_new_radio,radio_pred,c='red');
```



[42]:
```
adv_data.plot(kind='scatter', x='newspaper', y='sales')
plt.plot(X_new_newspaper,newspaper_pred,c='red');
```



0.5 STAT - Calculation

[43]:
```
import statsmodels.formula.api as smf
```

[44]:
```
adv_data.columns
```

[44]:
```
Index(['TV', 'radio', 'newspaper', 'sales'], dtype='object')
```

[45]:
```
my_stat_model_TV = smf.ols(formula='sales ~ TV', data=adv_data).fit()
my_stat_model_TV.pvalues
```

[45]:
```
Intercept    1.406300e-35
TV           1.467390e-42
dtype: float64
```

[46]:
```
my_stat_model_radio = smf.ols(formula='sales ~ radio', data=adv_data).fit()
my_stat_model_radio.pvalues
```

[46]:
```
Intercept    3.561071e-39
radio        4.354966e-19
```

```
dtype: float64
```

[47]:
```
my_stat_model_newspaper = smf.ols(formula='sales ~ newspaper', data=adv_data).
↪fit()
my_stat_model_newspaper.pvalues
```

[47]:
```
Intercept    4.713507e-49
newspaper    1.148196e-03
dtype: float64
```

[48]:
```
my_stat_model_TV.rsquared
```

[48]:
```
0.611875050850071
```

[49]:
```
my_stat_model_radio.rsquared
```

[49]:
```
0.33203245544529525
```

[50]:
```
my_stat_model_newspaper.rsquared
```

[50]:
```
0.05212044544430516
```

1 Model Predication - for Train data - TV/Radio/Newspaper

[52]:
```
model_TV_pred_train = my_tv_model.predict(X_train_TV)
model_radio_pred_train = my_radio_model.predict(X_train_radio)
model_newspaper_pred_train = my_newspaper_model.predict(X_train_newspaper)
```

[53]:
```
from sklearn.metrics import mean_squared_error,mean_absolute_error
```

[54]:
```
#MAE
TV_MAE_train = mean_absolute_error(model_TV_pred_train,y_train_TV)
Radio_MAE_train = mean_absolute_error(model_radio_pred_train,y_train_TV)
Newspaper_MAE_train = mean_absolute_error(model_newspaper_pred_train,y_train_TV)
print(" Mean Absolute Error_Train_data - TV - 'Predicted' and 'Actual_Test'␣
↪value is :{}".format(round(TV_MAE_train,3)))
print(" Mean Absolute Error_Train_data - Radio - 'Predicted' and 'Actual_Test'␣
↪value is :{}".format(round(Radio_MAE_train,3)))
print(" Mean Absolute Error_Train_data - Newspaper - 'Predicted' and␣
↪'Actual_Test' value is :{}".format(round(Newspaper_MAE_train,3)))
```

```
 Mean Absolute Error_Train_data - TV - 'Predicted' and 'Actual_Test' value is
:2.56
 Mean Absolute Error_Train_data - Radio - 'Predicted' and 'Actual_Test' value is
:3.297
```

```
 Mean Absolute Error_Train_data - Newspaper - 'Predicted' and 'Actual_Test'
value is :4.171
```

[55]:

```
#MSE
TV_MSE_train = mean_squared_error(model_TV_pred_train,y_train_TV)
Radio_MSE_train = mean_squared_error(model_radio_pred_train,y_train_TV)
Newspaper_MSE_train = mean_squared_error(model_newspaper_pred_train,y_train_TV)
print(" Mean Squared Error_Train_data - TV - 'Predicted' and 'Actual_Test'␣
 ↪value is :{}".format(round(TV_MSE_train,3)))
print(" Mean Squared Error_Train_data - Radio - 'Predicted' and 'Actual_Test'␣
 ↪value is :{}".format(round(Radio_MSE_train,3)))
print(" Mean Squared Error_Train_Data - Newspaper - 'Predicted' and␣
 ↪'Actual_Test' value is :{}".format(round(Newspaper_MSE_train,3)))
```

```
 Mean Squared Error_Train_data - TV - 'Predicted' and 'Actual_Test' value is
:10.892
 Mean Squared Error_Train_data - Radio - 'Predicted' and 'Actual_Test' value is
:18.476
 Mean Squared Error_Train_Data - Newspaper - 'Predicted' and 'Actual_Test' value
is :26.4
```

[134]:

```
#RMSE
TV_RMSE_train = np.sqrt(mean_squared_error(model_TV_pred_train,y_train_TV))
Radio_RMSE_train = np.
 ↪sqrt(mean_squared_error(model_radio_pred_train,y_train_TV))
Newspaper_RMSE_train = np.
 ↪sqrt(mean_squared_error(model_newspaper_pred_train,y_train_TV))
print(" Root Mean Squared Error_Train_data - TV - 'Predicted' and 'Actual_Test'␣
 ↪value is :{}".format(round(TV_RMSE_train,3)))
print(" Root Mean Squared Error_Train_data - Radio - 'Predicted' and␣
 ↪'Actual_Test' value is :{}".format(round(Radio_RMSE_train,3)))
print(" Root Mean Squared Error_Train_data - Newspaper - 'Predicted' and␣
 ↪'Actual_Test' value is :{}".format(round(Newspaper_RMSE_train,3)))
```

```
 Root Mean Squared Error_Train_data - TV - 'Predicted' and 'Actual_Test' value
is :3.3
 Root Mean Squared Error_Train_data - Radio - 'Predicted' and 'Actual_Test'
value is :4.298
 Root Mean Squared Error_Train_data - Newspaper - 'Predicted' and 'Actual_Test'
value is :5.138
```

[57]:

```
# R- Squared on test data
TV_R2_train = my_tv_model.score(X_train_TV,y_train_TV)
Radio_R2_train = my_radio_model.score(X_train_radio,y_train_radio)
Newspaper_R2_train = my_newspaper_model.
 ↪score(X_train_newspaper,y_train_newspaper)
print(" R-squared value on Train Data - TV :{}".format(round(TV_R2_train,3)))
```

```
print(" R-squared value on Train Data - Radio :{}".
↪format(round(Radio_R2_train,3)))
print(" R-squared value on Train Data - Newspaper :{}".
↪format(round(Newspaper_R2_train,3)))
```

```
R-squared value on Train Data - TV :0.623
R-squared value on Train Data - Radio :0.361
R-squared value on Train Data - Newspaper :0.087
```

2 Model Predication - for new data(Test data) - TV/Radio/Newspaper

[58]:
```
model_TV_pred = my_tv_model.predict(X_test_TV)
model_radio_pred = my_radio_model.predict(X_test_radio)
model_newspaper_pred = my_newspaper_model.predict(X_test_newspaper)
```

[59]:
```
from sklearn.metrics import mean_squared_error,mean_absolute_error
```

3 Error - Predicted and Actual - Test data

[60]:
```
#MAE
TV_MAE = mean_absolute_error(model_TV_pred,y_test_TV)
Radio_MAE = mean_absolute_error(model_radio_pred,y_test_TV)
Newspaper_MAE = mean_absolute_error(model_newspaper_pred,y_test_TV)
print(" Mean Absolute Error - TV - 'Predicted' and 'Actual_Test' value is :{}".
↪format(round(TV_MAE,3)))
print(" Mean Absolute Error - Radio - 'Predicted' and 'Actual_Test' value is :
↪{}".format(round(Radio_MAE,3)))
print(" Mean Absolute Error - Newspaper - 'Predicted' and 'Actual_Test' value␣
↪is :{}".format(round(Newspaper_MAE,3)))
```

```
Mean Absolute Error - TV - 'Predicted' and 'Actual_Test' value is :2.469
Mean Absolute Error - Radio - 'Predicted' and 'Actual_Test' value is :3.294
Mean Absolute Error - Newspaper - 'Predicted' and 'Actual_Test' value is :4.156
```

[61]:
```
#MSE
TV_MSE = mean_squared_error(model_TV_pred,y_test_radio)
Radio_MSE = mean_squared_error(model_radio_pred,y_test_radio)
Newspaper_MSE = mean_squared_error(model_newspaper_pred,y_test_radio)
print(" Mean Squared Error - TV - 'Predicted' and 'Actual_Test' value is :{}".
↪format(round(TV_MSE,3)))
print(" Mean Squared Error - Radio - 'Predicted' and 'Actual_Test' value is :
↪{}".format(round(Radio_MSE,3)))
```

```
print(" Mean Squared Error - Newspaper - 'Predicted' and 'Actual_Test' value is␣
↪:{}".format(round(Newspaper_MSE,3)))
```

```
Mean Squared Error - TV - 'Predicted' and 'Actual_Test' value is :9.503
Mean Squared Error - Radio - 'Predicted' and 'Actual_Test' value is :17.228
Mean Squared Error - Newspaper - 'Predicted' and 'Actual_Test' value is :24.681
```

[62]:
```
#RMSE
TV_RMSE = np.sqrt(mean_squared_error(model_TV_pred,y_test_newspaper))
Radio_RMSE = np.sqrt(mean_squared_error(model_radio_pred,y_test_newspaper))
Newspaper_RMSE = np.
↪sqrt(mean_squared_error(model_newspaper_pred,y_test_newspaper))
print(" Root Mean Squared Error - TV - 'Predicted' and 'Actual_Test' value is :
↪{}".format(round(TV_RMSE,3)))
print(" Root Mean Squared Error - Radio - 'Predicted' and 'Actual_Test' value␣
↪is :{}".format(round(Radio_RMSE,3)))
print(" Root Mean Squared Error - Newspaper - 'Predicted' and 'Actual_Test'␣
↪value is :{}".format(round(Newspaper_RMSE,3)))
```

```
Root Mean Squared Error - TV - 'Predicted' and 'Actual_Test' value is :3.083
Root Mean Squared Error - Radio - 'Predicted' and 'Actual_Test' value is :4.151
Root Mean Squared Error - Newspaper - 'Predicted' and 'Actual_Test' value is
:4.968
```

[63]:
```
##print('R-squared on Train Data :', my_mlr_model.score(X_train, y_train)) -->␣
↪Reference line

# R- Squared on test data
TV_R2 = my_tv_model.score(X_test_TV,y_test_TV)
Radio_R2 = my_radio_model.score(X_test_radio,y_test_radio)
Newspaper_R2 = my_newspaper_model.score(X_test_newspaper,y_test_newspaper)
print(" R-squared value on Test Data - TV :{}".format(round(TV_R2,3)))
print(" R-squared value on Test Data - Radio :{}".format(round(Radio_R2,3)))
print(" R-squared value on Test Data - Newspaper :{}".
↪format(round(Newspaper_R2,3)))
```

```
R-squared value on Test Data - TV :0.56
R-squared value on Test Data - Radio :0.202
R-squared value on Test Data - Newspaper :-0.143
```

3.1 **********Multiple Linear Regression*****************

[64]:
```
adv_data
```

[64]:

	TV	radio	newspaper	sales
1	230.1	37.8	69.2	22.1

```
2     44.5   39.3        45.1   10.4
3     17.2   45.9        69.3    9.3
4    151.5   41.3        58.5   18.5
5    180.8   10.8        58.4   12.9
..     …      …       …     …
196   38.2    3.7        13.8    7.6
197   94.2    4.9         8.1    9.7
198  177.0    9.3         6.4   12.8
199  283.6   42.0        66.2   25.5
200  232.1    8.6         8.7   13.4

[200 rows x 4 columns]
```

[65]:
```python
adv_data.columns
```

[65]:
```
Index(['TV', 'radio', 'newspaper', 'sales'], dtype='object')
```

[66]:
```python
features_all = adv_data[['TV','radio','newspaper']]
target_all = adv_data[['sales']]
```

[67]:
```python
features_all.head()
```

[67]:

	TV	radio	newspaper
1	230.1	37.8	69.2
2	44.5	39.3	45.1
3	17.2	45.9	69.3
4	151.5	41.3	58.5
5	180.8	10.8	58.4

[68]:
```python
target_all.head()
```

[68]:

	sales
1	22.1
2	10.4
3	9.3
4	18.5
5	12.9

4 1- Splitting the data as Train and test

[69]:
```python
from sklearn.linear_model import LinearRegression
from sklearn.model_selection import train_test_split
```

[70]:
```python
X_train_all, X_test_all, y_train_all, y_test_all =␣
↪train_test_split(features_all,target_all,random_state=10,test_size=.20)
```

[71]:
```
# Getting the shape of the train and split data
print(X_train_all.shape)
print(X_test_all.shape)
print(y_train_all.shape)
print(y_test_all.shape)
```

```
(160, 3)
(40, 3)
(160, 1)
(40, 1)
```

[72]:
```
# call the model
```

[73]:
```
my_mlr_model = LinearRegression()
my_mlr_model
```

[73]:
```
LinearRegression()
```

[74]:
```
my_mlr_model.fit(X_train_all,y_train_all)
```

[74]:
```
LinearRegression()
```

[75]:
```
my_mlr_model.coef_
```

[75]:
```
array([[ 0.0437726 ,  0.19343299, -0.00222879]])
```

[76]:
```
my_mlr_model.intercept_
```

[76]:
```
array([3.25409711])
```

5 Multiple linear regression - Model predict for new data (X_test)

[82]:
```
MLR_predict = my_mlr_model.predict(X_test_all)
```

5.0.1 Evaluation on Train data

[83]:
```
MLR_predict_train = my_mlr_model.predict(X_train_all)
print('MAE on Train Data :', mean_absolute_error(MLR_predict_train,y_train_all))
print('MSE on Train Data :', mean_squared_error(MLR_predict_train,y_train_all))
print('RMSE on Train Data :', np.
 ↪sqrt(mean_squared_error(MLR_predict_train,y_train_all)))
print('R-squared on Train Data :', my_mlr_model.score(X_train_all, y_train_all))
```

```
MAE on Train Data : 1.0661435033472693
MSE on Train Data : 1.8585966709492499
RMSE on Train Data : 1.3633035872281896
R-squared on Train Data : 0.9209087553499528
```

5.1 Evaluatio on test data

[84]:
```python
MLR_predict_test = my_mlr_model.predict(X_test_all)
#MLR_predict_test
```

[85]:
```python
MLR_predict_test = my_mlr_model.predict(X_test_all)
print('MAE on Test Data :', mean_absolute_error(MLR_predict_test,y_test_all))
print('MSE on Test Data :', mean_squared_error(MLR_predict_test,y_test_all))
print('RMSE on Test Data :', np.
 ↪sqrt(mean_squared_error(MLR_predict_test,y_test_all)))
print('R-squared on Test Data :', my_mlr_model.score(X_test_all, y_test_all))
```

```
MAE on Test Data : 1.8850130310423148
MSE on Test Data : 6.700486756528875
RMSE on Test Data : 2.58852984462781
R-squared on Test Data : 0.8353672324670594
```

5.2 OLS Model

[86]:
```python
my_ols_model = smf.ols(formula='sales ~ TV + radio + newspaper', data =␣
 ↪adv_data).fit()
```

[87]:
```python
my_ols_model.summary()
```

[87]:
```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results
==============================================================================
Dep. Variable:                  sales   R-squared:                       0.897
Model:                            OLS   Adj. R-squared:                  0.896
Method:                 Least Squares   F-statistic:                     570.3
Date:                Mon, 25 Jul 2022   Prob (F-statistic):           1.58e-96
Time:                        22:43:31   Log-Likelihood:                -386.18
No. Observations:                 200   AIC:                             780.4
Df Residuals:                     196   BIC:                             793.6
Df Model:                           3
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
Intercept      2.9389      0.312      9.422      0.000       2.324       3.554
```

```
TV              0.0458      0.001     32.809      0.000       0.043       0.049
radio           0.1885      0.009     21.893      0.000       0.172       0.206
newspaper      -0.0010      0.006     -0.177      0.860      -0.013       0.011
==============================================================================
Omnibus:                       60.414   Durbin-Watson:                   2.084
Prob(Omnibus):                  0.000   Jarque-Bera (JB):              151.241
Skew:                          -1.327   Prob(JB):                     1.44e-33
Kurtosis:                       6.332   Cond. No.                         454.
==============================================================================

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
"""
```

5.3 ******************** Polynominal Regression **************************

[88]:
```
adv_data
```

[88]:

	TV	radio	newspaper	sales
1	230.1	37.8	69.2	22.1
2	44.5	39.3	45.1	10.4
3	17.2	45.9	69.3	9.3
4	151.5	41.3	58.5	18.5
5	180.8	10.8	58.4	12.9
..	…	…	…	…
196	38.2	3.7	13.8	7.6
197	94.2	4.9	8.1	9.7
198	177.0	9.3	6.4	12.8
199	283.6	42.0	66.2	25.5
200	232.1	8.6	8.7	13.4

[200 rows x 4 columns]

[89]:
```
# Importing the necessary library for polynominal Regression
from sklearn.preprocessing import PolynomialFeatures
```

[90]:
```
adv_data.columns
```

[90]:
```
Index(['TV', 'radio', 'newspaper', 'sales'], dtype='object')
```

5.4 converting the Features to Polynominal features - Degree 2

[92]:
```python
features_poly = PolynomialFeatures(degree=2)
TV_poly2 = features_poly.fit_transform(features_all[['TV']])
radio_poly2 = features_poly.fit_transform(features_all[['radio']])
newspaper_poly2 = features_poly.fit_transform(features_all[['newspaper']])
```

[93]:
```python
# Checking the data - How will it looks in polynominal degree 2
pd.DataFrame(TV_poly2, columns = ['constant', 'TV', 'TV-squared'])
```

[93]:

	constant	TV	TV-squared
0	1.0	230.1	52946.01
1	1.0	44.5	1980.25
2	1.0	17.2	295.84
3	1.0	151.5	22952.25
4	1.0	180.8	32688.64
..	…	…	…
195	1.0	38.2	1459.24
196	1.0	94.2	8873.64
197	1.0	177.0	31329.00
198	1.0	283.6	80428.96
199	1.0	232.1	53870.41

[200 rows x 3 columns]

[94]:
```python
features_poly2 = pd.concat([pd.DataFrame(TV_poly2),pd.DataFrame(radio_poly2),pd.
↪DataFrame(newspaper_poly2)],axis=1)
features_poly2
```

[94]:

	0	1	2	0	1	2	0	1	2
0	1.0	230.1	52946.01	1.0	37.8	1428.84	1.0	69.2	4788.64
1	1.0	44.5	1980.25	1.0	39.3	1544.49	1.0	45.1	2034.01
2	1.0	17.2	295.84	1.0	45.9	2106.81	1.0	69.3	4802.49
3	1.0	151.5	22952.25	1.0	41.3	1705.69	1.0	58.5	3422.25
4	1.0	180.8	32688.64	1.0	10.8	116.64	1.0	58.4	3410.56
..	…	…	…	…	…	…	…	…	…
195	1.0	38.2	1459.24	1.0	3.7	13.69	1.0	13.8	190.44
196	1.0	94.2	8873.64	1.0	4.9	24.01	1.0	8.1	65.61
197	1.0	177.0	31329.00	1.0	9.3	86.49	1.0	6.4	40.96
198	1.0	283.6	80428.96	1.0	42.0	1764.00	1.0	66.2	4382.44
199	1.0	232.1	53870.41	1.0	8.6	73.96	1.0	8.7	75.69

[200 rows x 9 columns]

[95]:
```python
target_all
```

[95]:
```
     sales
1     22.1
2     10.4
3      9.3
4     18.5
5     12.9
..     …
196    7.6
197    9.7
198   12.8
199   25.5
200   13.4

[200 rows x 1 columns]
```

[96]:
```
# Splitting the data - test and train
```

[97]:
```
X_train_poly2, X_test_poly2, y_train_poly2, y_test_poly2 =␣
 ↪train_test_split(features_poly2,target_all,random_state=6)
```

[98]:
```
print(X_train_poly2.shape)
print(X_test_poly2.shape)
print(y_train_poly2.shape)
print(y_test_poly2.shape)
```

```
(150, 9)
(50, 9)
(150, 1)
(50, 1)
```

[99]:
```
from sklearn.linear_model import LinearRegression
```

[100]:
```
my_model_ploy2 = LinearRegression()
my_model_ploy2
```

[100]:
```
LinearRegression()
```

[101]:
```
my_model_ploy2.fit(X_train_poly2,y_train_poly2)
```

[101]:
```
LinearRegression()
```

[102]:
```
my_model_ploy2.coef_
```

[102]:
```
array([[ 0.00000000e+00,  7.76366570e-02, -1.12220872e-04,
         6.95624114e-16,  1.46025928e-01,  9.36830450e-04,
        -2.77555756e-17,  2.13781336e-02, -2.07802344e-04]])
```

[103]:
```
my_model_ploy2.intercept_
```

[103]:
```
array([1.41776908])
```

6 Prediction and Evaluation on Train data - Degree 2

[104]:
```
pred_poly2_train = my_model_ploy2.predict(X_train_poly2)
print("Mean Absolute Error for Deg-2 :␣
↪",mean_absolute_error(pred_poly2_train,y_train_poly2))
print("Mean Squared Error for  Deg-2 :␣
↪",mean_squared_error(pred_poly2_train,y_train_poly2))
print("RMSE for Deg-2 : ", np.
↪sqrt(mean_squared_error(pred_poly2_train,y_train_poly2)))
print("R2 Score for Deg-2 : ",my_model_ploy2.score(X_train_poly2,y_train_poly2))
```

```
Mean Absolute Error for Deg-2 :  1.2028934896198527
Mean Squared Error for  Deg-2 :  2.488776665854576
RMSE for Deg-2 :  1.5775857079266964
R2 Score for Deg-2 :  0.9139135358655949
```

7 Predication and Evaluation on Test data - Degree 2

[105]:
```
pred_poly2_test = my_model_ploy2.predict(X_test_poly2)
print("Mean Absolute Error for Deg-2 :␣
↪",mean_absolute_error(pred_poly2_test,y_test_poly2))
print("Mean Squared Error for  Deg-2 :␣
↪",mean_squared_error(pred_poly2_test,y_test_poly2))
print("RMSE for Deg-2 : ", np.
↪sqrt(mean_squared_error(pred_poly2_test,y_test_poly2)))
print("R2 Score for Deg-2 : ",my_model_ploy2.score(X_test_poly2,y_test_poly2))
```

```
Mean Absolute Error for Deg-2 :  0.991274151067495
Mean Squared Error for  Deg-2 :  1.527021925756564
RMSE for Deg-2 :  1.2357272861584647
R2 Score for Deg-2 :  0.9293009924314459
```

7.0.1 **********Calculation on other poynominal degress(3/5/10/100/150) -- This is for observation

[106]:
```
## Orginal source data
adv_data
```

[106]:

```
        TV  radio  newspaper  sales
1    230.1   37.8       69.2   22.1
2     44.5   39.3       45.1   10.4
3     17.2   45.9       69.3    9.3
4    151.5   41.3       58.5   18.5
5    180.8   10.8       58.4   12.9
..     …      …       …     …
196   38.2    3.7       13.8    7.6
197   94.2    4.9        8.1    9.7
198  177.0    9.3        6.4   12.8
199  283.6   42.0       66.2   25.5
200  232.1    8.6        8.7   13.4

[200 rows x 4 columns]
```

[107]:

```
# Columns of the dataset
adv_data.columns
```

[107]:

```
Index(['TV', 'radio', 'newspaper', 'sales'], dtype='object')
```

[109]:

```
# Importing the necessary library for polynominal Regression
from sklearn.preprocessing import PolynomialFeatures

## Converting the features to polynominal feature

## Degree--> 3
#------------------------------------------------

features_poly3 = PolynomialFeatures(degree=3)
TV_poly3 = features_poly3.fit_transform(features_all[['TV']])
radio_poly3 = features_poly3.fit_transform(features_all[['radio']])
newspaper_poly3 = features_poly3.fit_transform(features_all[['newspaper']])

## Degree--> 5
#------------------------------------------------

features_poly5 = PolynomialFeatures(degree=5)
TV_poly5 = features_poly5.fit_transform(features_all[['TV']])
radio_poly5 = features_poly5.fit_transform(features_all[['radio']])
newspaper_poly5 = features_poly5.fit_transform(features_all[['newspaper']])

## Degree--> 10
#------------------------------------------------

features_poly10 = PolynomialFeatures(degree=10)
TV_poly10 = features_poly10.fit_transform(features_all[['TV']])
radio_poly10 = features_poly10.fit_transform(features_all[['radio']])
```

```
newspaper_poly10 = features_poly10.fit_transform(features_all[['newspaper']])

## Degree--> 100
#-----------------------------------------------

features_poly100 = PolynomialFeatures(degree=100)
TV_poly100 = features_poly100.fit_transform(features_all[['TV']])
radio_poly100 = features_poly100.fit_transform(features_all[['radio']])
newspaper_poly100 = features_poly100.fit_transform(features_all[['newspaper']])

## Degree--> 150
#-----------------------------------------------

features_poly150 = PolynomialFeatures(degree=150)
TV_poly150 = features_poly150.fit_transform(features_all[['TV']])
radio_poly150 = features_poly150.fit_transform(features_all[['radio']])
newspaper_poly150 = features_poly150.fit_transform(features_all[['newspaper']])
```

```
/usr/local/lib/python3.7/site-packages/sklearn/preprocessing/_polynomial.py:469:
RuntimeWarning: overflow encountered in multiply
  casting="no",
/usr/local/lib/python3.7/site-packages/sklearn/preprocessing/_polynomial.py:469:
RuntimeWarning: overflow encountered in multiply
  casting="no",
```

[ ]:

```
```

[110]:

```
## Concatenate the data
#features_poly2 = pd.concat([pd.DataFrame(TV_poly2),pd.
 ↪DataFrame(radio_poly2),pd.DataFrame(newspaper_poly2)],axis=1)
#features_poly2
features_poly3 = pd.concat([pd.DataFrame(TV_poly3),pd.DataFrame(radio_poly3),pd.
 ↪DataFrame(newspaper_poly3)],axis=1)
features_poly5 = pd.concat([pd.DataFrame(TV_poly5),pd.DataFrame(radio_poly5),pd.
 ↪DataFrame(newspaper_poly5)],axis=1)
features_poly10 = pd.concat([pd.DataFrame(TV_poly10),pd.
 ↪DataFrame(radio_poly10),pd.DataFrame(newspaper_poly10)],axis=1)
features_poly100 = pd.concat([pd.DataFrame(TV_poly100),pd.
 ↪DataFrame(radio_poly100),pd.DataFrame(newspaper_poly100)],axis=1)
features_poly150 = pd.concat([pd.DataFrame(TV_poly150),pd.
 ↪DataFrame(radio_poly150),pd.DataFrame(newspaper_poly150)],axis=1)
```

[111]:

```
# Shape of the polynominal feature
print(features_poly3.shape)
print(features_poly5.shape)
print(features_poly10.shape)
print(features_poly100.shape)
```

```
print(features_poly150.shape)
```

```
(200, 12)
(200, 18)
(200, 33)
(200, 303)
(200, 453)
```

[113]:
```
target_all
```

[113]:
```
     sales
1     22.1
2     10.4
3      9.3
4     18.5
5     12.9
..     ...
196    7.6
197    9.7
198   12.8
199   25.5
200   13.4

[200 rows x 1 columns]
```

[114]:
```
# Splitting the data - test and train
```

[116]:
```
X_train_poly3, X_test_poly3, y_train_poly3, y_test_poly3 =␣
 ↪train_test_split(features_poly3,target_all,random_state=6)           ##␣
 ↪Degree -->3 (Data split - Train and Test)
X_train_poly5, X_test_poly5, y_train_poly5, y_test_poly5 =␣
 ↪train_test_split(features_poly5,target_all,random_state=6)           ##␣
 ↪Degree -->5 (Data split - Train and Test)
X_train_poly10, X_test_poly10, y_train_poly10, y_test_poly10 =␣
 ↪train_test_split(features_poly10,target_all,random_state=6)      ## Degree␣
 ↪-->10 (Data split - Train and Test)
X_train_poly100, X_test_poly100, y_train_poly100, y_test_poly100 =␣
 ↪train_test_split(features_poly100,target_all,random_state=6) ## Degree␣
 ↪-->100 (Data split - Train and Test)
X_train_poly150, X_test_poly150, y_train_poly150, y_test_poly150 =␣
 ↪train_test_split(features_poly150,target_all,random_state=6) ## Degree␣
 ↪-->150 (Data split - Train and Test)
```

[117]:
```
print(X_train_poly3.shape)
print(X_test_poly3.shape)
print(y_train_poly3.shape)
print(y_test_poly3.shape)
```

```
(150, 12)
(50, 12)
(150, 1)
(50, 1)
```

[118]:
```
from sklearn.linear_model import LinearRegression
```

[119]:
```
my_model_ploy3 = LinearRegression()
my_model_ploy5 = LinearRegression()
my_model_ploy10 = LinearRegression()
my_model_ploy100 = LinearRegression()
my_model_ploy150 = LinearRegression()
```

[120]:
```
my_model_ploy3.fit(X_train_poly3,y_train_poly3)
my_model_ploy5.fit(X_train_poly5,y_train_poly5)
my_model_ploy10.fit(X_train_poly10,y_train_poly10)
my_model_ploy100.fit(X_train_poly100,y_train_poly100)
#my_model_ploy150.fit(X_train_poly150,y_train_poly150)
```

[120]:
```
LinearRegression()
```

[135]:
```
my_model_ploy150.fit(X_train_poly150,y_train_poly150)
```

```
/usr/local/lib/python3.7/site-packages/numpy/core/fromnumeric.py:86:
RuntimeWarning: overflow encountered in reduce
  return ufunc.reduce(obj, axis, dtype, out, **passkwargs)


        ␣
 ↪---------------------------------------------------------------------------

        ValueError                                Traceback (most recent call␣
 ↪last)

        <ipython-input-135-08ed31da5842> in <module>
    ----> 1 my_model_ploy150.fit(X_train_poly150,y_train_poly150)


        /usr/local/lib/python3.7/site-packages/sklearn/linear_model/_base.py in␣
 ↪fit(self, X, y, sample_weight)
        661
        662         X, y = self._validate_data(
    --> 663             X, y, accept_sparse=accept_sparse, y_numeric=True,␣
 ↪multi_output=True
        664         )
        665
```

```
    /usr/local/lib/python3.7/site-packages/sklearn/base.py in␣
↪_validate_data(self, X, y, reset, validate_separately, **check_params)
    579                 y = check_array(y, **check_y_params)
    580             else:
--> 581                 X, y = check_X_y(X, y, **check_params)
    582             out = X, y
    583


    /usr/local/lib/python3.7/site-packages/sklearn/utils/validation.py in␣
↪check_X_y(X, y, accept_sparse, accept_large_sparse, dtype, order, copy,␣
↪force_all_finite, ensure_2d, allow_nd, multi_output, ensure_min_samples,␣
↪ensure_min_features, y_numeric, estimator)
    974         ensure_min_samples=ensure_min_samples,
    975         ensure_min_features=ensure_min_features,
--> 976         estimator=estimator,
    977     )
    978


    /usr/local/lib/python3.7/site-packages/sklearn/utils/validation.py in␣
↪check_array(array, accept_sparse, accept_large_sparse, dtype, order, copy,␣
↪force_all_finite, ensure_2d, allow_nd, ensure_min_samples,␣
↪ensure_min_features, estimator)
    798
    799         if force_all_finite:
--> 800             _assert_all_finite(array, allow_nan=force_all_finite ==␣
↪"allow-nan")
    801
    802     if ensure_min_samples > 0:


    /usr/local/lib/python3.7/site-packages/sklearn/utils/validation.py in␣
↪_assert_all_finite(X, allow_nan, msg_dtype)
    114             raise ValueError(
    115                 msg_err.format(
--> 116                     type_err, msg_dtype if msg_dtype is not None␣
↪else X.dtype
    117                 )
    118             )


    ValueError: Input contains NaN, infinity or a value too large for␣
↪dtype('float64').
```

[121]:
```
#print("Poly Degree 3 Coefficent : ", my_model_ploy3.coef_)
#print("Poly Degree 3 Coefficent : ", my_model_ploy3.coef_)
#print("Poly Degree 3 Coefficent : ", my_model_ploy3.coef_)
#print("Poly Degree 3 Coefficent : ", my_model_ploy3.coef_)
#print("Poly Degree 3 Coefficent : ", my_model_ploy3.coef_)
```

8 Prediction and Evaluation on Train data - Degree 3/5/10/100/150

[122]:
```
# pred_poly2_train = my_model_ploy2.predict(X_train_poly2)
# print("Mean Absolute Error for Deg-2 :␣
↪",mean_absolute_error(pred_poly2_train,y_train_poly2))
# print("Mean Squared Error for  Deg-2 :␣
↪",mean_squared_error(pred_poly2_train,y_train_poly2))
# print("R2 Score for Deg-2 : ",my_model_ploy2.
↪score(X_train_poly2,y_train_poly2))
```

8.1 Polynominal Degree 3 - Train data

[123]:
```
pred_poly3_train = my_model_ploy3.predict(X_train_poly3)
print("Mean Absolute Error for Deg-3 :␣
↪",mean_absolute_error(pred_poly3_train,y_train_poly3))
print("Mean Squared Error for  Deg-3 :␣
↪",mean_squared_error(pred_poly3_train,y_train_poly3))
print("RMSE for Deg-100 : ", np.
↪sqrt(mean_squared_error(pred_poly3_train,y_train_poly3)))
print("R2 Score for Deg-3 : ",my_model_ploy3.score(X_train_poly3,y_train_poly3))
```

```
Mean Absolute Error for Deg-3 :  1.0981257976964192
Mean Squared Error for  Deg-3 :  2.120643703536337
RMSE for Deg-100 :  1.456243009781107
R2 Score for Deg-3 :  0.926647207589578
```

8.2 Polynominal Degree 5 - Train data

[124]:
```
pred_poly5_train = my_model_ploy5.predict(X_train_poly5)
print("Mean Absolute Error for Deg-3 :␣
↪",mean_absolute_error(pred_poly5_train,y_train_poly5))
print("Mean Squared Error for  Deg-3 :␣
↪",mean_squared_error(pred_poly5_train,y_train_poly5))
print("RMSE for Deg-100 : ", np.
↪sqrt(mean_squared_error(pred_poly5_train,y_train_poly5)))
```

```
print("R2 Score for Deg-3 : ",my_model_ploy5.score(X_train_poly5,y_train_poly5))
```

```
Mean Absolute Error for Deg-3 :  1.0595851105502019
Mean Squared Error for  Deg-3 :  1.8922826954150969
RMSE for Deg-100 :  1.3756026662576286
R2 Score for Deg-3 :  0.9345461854307959
```

8.3 Polynominal Degree 10 - Train data

[125]:
```
pred_poly10_train = my_model_ploy10.predict(X_train_poly10)
print("Mean Absolute Error for Deg-3 :␣
 ↪",mean_absolute_error(pred_poly10_train,y_train_poly10))
print("Mean Squared Error for  Deg-3 :␣
 ↪",mean_squared_error(pred_poly10_train,y_train_poly10))
print("RMSE for Deg-100 : ", np.
 ↪sqrt(mean_squared_error(pred_poly10_train,y_train_poly10)))
print("R2 Score for Deg-3 : ",my_model_ploy10.
 ↪score(X_train_poly10,y_train_poly10))
```

```
Mean Absolute Error for Deg-3 :  1.6513966080825802
Mean Squared Error for  Deg-3 :  4.710914902602763
RMSE for Deg-100 :  2.170464213619465
R2 Score for Deg-3 :  0.8370500606313366
```

8.4 Polynominal Degree 100 - Train data

[126]:
```
pred_poly100_train = my_model_ploy100.predict(X_train_poly100)
print("Mean Absolute Error for Deg-3 :␣
 ↪",mean_absolute_error(pred_poly100_train,y_train_poly100))
print("Mean Squared Error for  Deg-3 :␣
 ↪",mean_squared_error(pred_poly100_train,y_train_poly100))
print("RMSE for Deg-100 : ", np.
 ↪sqrt(mean_squared_error(pred_poly100_train,y_train_poly100)))
print("R2 Score for Deg-3 : ",my_model_ploy100.
 ↪score(X_train_poly100,y_train_poly100))
```

```
Mean Absolute Error for Deg-3 :  4.1761220444034
Mean Squared Error for  Deg-3 :  25.407476171600422
RMSE for Deg-100 :  5.040582919821915
R2 Score for Deg-3 :  0.12115867357620169
```

9 Prediction and Evaluation on Test data - Degree 3/5/10/100/150

[127]:
```
#pred_poly2_test = my_model_ploy2.predict(X_test_poly2)
#print("Mean Absolute Error for Deg-2 :␣
↪",mean_absolute_error(pred_poly2_test,y_test_poly2))
#print("Mean Squared Error for  Deg-2 :␣
↪",mean_squared_error(pred_poly2_test,y_test_poly2))
#print("R2 Score for Deg-2 : ",my_model_ploy2.score(X_test_poly2,y_test_poly2))
```

[128]:
```
pred_poly3_test = my_model_ploy3.predict(X_test_poly3)
print("Mean Absolute Error for Deg-3 :␣
↪",mean_absolute_error(pred_poly3_test,y_test_poly3))
print("Mean Squared Error for  Deg-3 :␣
↪",mean_squared_error(pred_poly3_test,y_test_poly3))
print("RMSE for Deg-3 : ", np.
↪sqrt(mean_squared_error(pred_poly3_test,y_test_poly3)))
print("R2 Score for Deg-3 : ",my_model_ploy3.score(X_test_poly3,y_test_poly3))
```

```
Mean Absolute Error for Deg-3 :  1.011890531356669
Mean Squared Error for  Deg-3 :  1.656634448047036
RMSE for Deg-3 :  1.287103122537987
R2 Score for Deg-3 :  0.9233001115404571
```

[129]:
```
pred_poly5_test = my_model_ploy5.predict(X_test_poly5)
print("Mean Absolute Error for Deg-5 :␣
↪",mean_absolute_error(pred_poly5_test,y_test_poly5))
print("Mean Squared Error for  Deg-5 :␣
↪",mean_squared_error(pred_poly5_test,y_test_poly5))
print("RMSE for Deg-5 : ", np.
↪sqrt(mean_squared_error(pred_poly5_test,y_test_poly5)))
print("R2 Score for Deg-5 : ",my_model_ploy5.score(X_test_poly5,y_test_poly5))
```

```
Mean Absolute Error for Deg-5 :  1.042980523465403
Mean Squared Error for  Deg-5 :  2.535458724171236
RMSE for Deg-5 :  1.5923123827224468
R2 Score for Deg-5 :  0.8826117605082016
```

[130]:
```
pred_poly10_test = my_model_ploy10.predict(X_test_poly10)
print("Mean Absolute Error for Deg-10 :␣
↪",mean_absolute_error(pred_poly10_test,y_test_poly10))
print("Mean Squared Error for  Deg-10 :␣
↪",mean_squared_error(pred_poly10_test,y_test_poly10))
print("RMSE for Deg-10 : ", np.
↪sqrt(mean_squared_error(pred_poly10_test,y_test_poly10)))
```

```
print("R2 Score for Deg-10 : ",my_model_ploy10.
↪score(X_test_poly10,y_test_poly10))
```

```
Mean Absolute Error for Deg-10 :  1.9393912179254782
Mean Squared Error for  Deg-10 :  5.43395305572854
RMSE for Deg-10 :  2.3310840945209463
R2 Score for Deg-10 :  0.7484154734557724
```

[131]:
```
pred_poly100_test = my_model_ploy100.predict(X_test_poly100)
print("Mean Absolute Error for Deg-100 :␣
↪",mean_absolute_error(pred_poly100_test,y_test_poly100))
print("Mean Squared Error for  Deg-100 :␣
↪",mean_squared_error(pred_poly100_test,y_test_poly100))
print("RMSE for Deg-100 : ", np.
↪sqrt(mean_squared_error(pred_poly100_test,y_test_poly100)))
print("R2 Score for Deg-100 : ",my_model_ploy100.
↪score(X_test_poly100,y_test_poly100))
```

```
Mean Absolute Error for Deg-100 :  3.6754222244411863
Mean Squared Error for  Deg-100 :  20.174031770485307
RMSE for Deg-100 :  4.491551154165486
R2 Score for Deg-100 :  0.06597017320289067
```

[132]:
```
#print('RMSE on Train Data :', np.
↪sqrt(mean_squared_error(MLR_predict_test,y_test)))
```

[133]:
```
##print("RMSE for Deg-100 : ", np.
↪sqrt(mean_squared_error(pred_poly100_test,y_test_poly100)))
```

[ ]:
```

```