Assignment 1

Name: **Arnab Sen** Roll: **510519006**

(i) Download data

Data downloaded and stored at drive.**bold text**

In [272…
```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call
drive.mount("/content/drive", force_remount=True).
```

In [273…
```
BASE_PATH = '/content/drive/MyDrive/Colab_Notebooks/ML_DRIVE/Assign_1/dataset'
```

In [274…
```
import numpy as np
import pandas as pd # read csv files
from sklearn.model_selection import train_test_split # test and train data spl…
from sklearn.preprocessing import OneHotEncoder
from sklearn.linear_model import LinearRegression
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import mean_squared_error, r2_score
import seaborn as sns # graph plot
import matplotlib.pyplot as plt # scatter plot
from sklearn.preprocessing import PolynomialFeatures # polynomial regression
```

(ii) Reading and formating dataset

Read the dataset in the Pandas data frame. Remove the rows with a missing value. Divide the training.csv into two sets of ratio 80:20 entitled to train and test set respectively.

In [275…
```
dataset = pd.read_csv(f"{BASE_PATH}/train.csv")
scaler = StandardScaler()
```

In [276…
```
dataset.head()
```

Out[276]:

	Id	MSSubClass	MSZoning	LotFrontage	LotArea	Street	Alley	LotShape	LandContour	Utilit
0	1	60	RL	65.0	8450	Pave	NaN	Reg	Lvl	AllI
1	2	20	RL	80.0	9600	Pave	NaN	Reg	Lvl	AllI
2	3	60	RL	68.0	11250	Pave	NaN	IR1	Lvl	AllI
3	4	70	RL	60.0	9550	Pave	NaN	IR1	Lvl	AllI
4	5	60	RL	84.0	14260	Pave	NaN	IR1	Lvl	AllI

5 rows × 81 columns

(iii) Linear Regression

Use the linear regression method to estimate the slope and intercept for predicting `SalePrice` based on `LotArea`

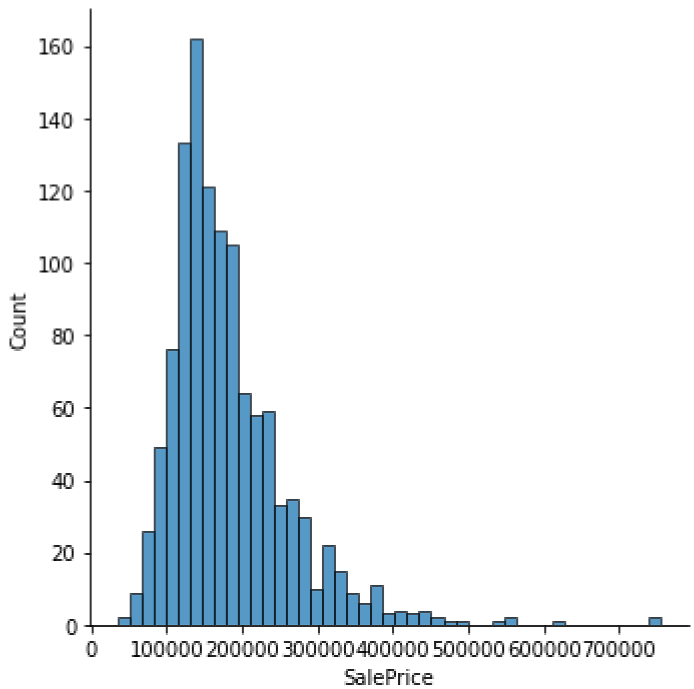
Remove the missing rows corresponding to only `SalePrice` and `LotArea` columns.

In [277…
```
df = dataset.loc[:, ['SalePrice', 'LotArea']].dropna()
```

Splitting the dataset in 80:20 ratio for fitting the model and then testing.

In [278…
```
train_df, test_df = train_test_split(df, test_size=0.2)
```

In [279…
```
sns.displot(train_df['SalePrice']);
```



In [280…
```
train_df.head()
```

Out[280]:

	SalePrice	LotArea
599	151000	1950
44	141000	7945
802	189000	8199
1438	149700	7407
1453	84500	17217

In [281…
```
test_df.head()
```

Out[281]:

	SalePrice	LotArea
75	91000	1596
53	385000	50271
906	255000	13501
1366	193000	9179
1104	106000	2016

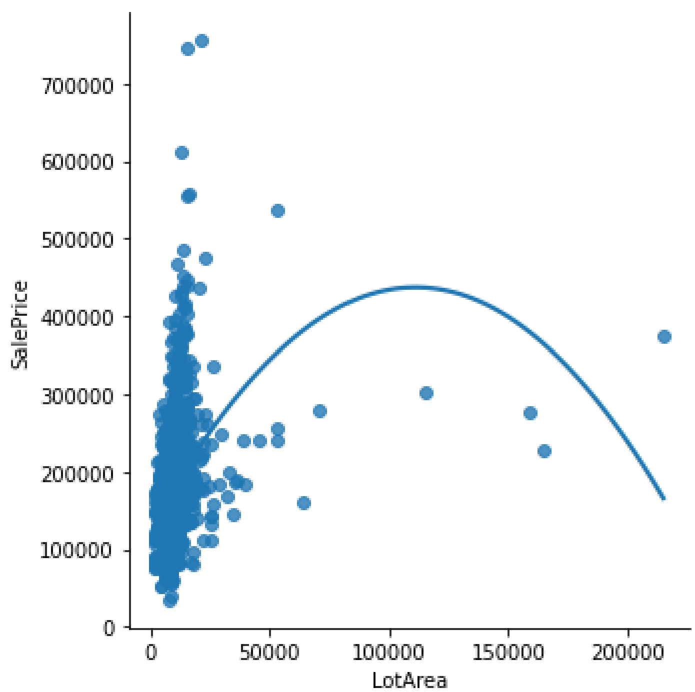
Scatter plot to see the relationship between `SalePrice` and `LotArea`.

In [282…

```
# ci: used to specify the size of the interval
sns.lmplot(x ="LotArea", y ="SalePrice", data = train_df, ci=None, order=2)
```

Out[282]:

```
<seaborn.axisgrid.FacetGrid at 0x7f28068e4bd0>
```



In [283…

```
X_train = np.array(train_df['LotArea']).reshape(-1, 1) # have one column and a
X_train = scaler.fit_transform(X_train)
y_train = np.array(train_df['SalePrice']).reshape(-1, 1)

X_test = np.array(test_df['LotArea']).reshape(-1, 1)
X_test = scaler.fit_transform(X_test)
y_test = np.array(test_df['SalePrice']).reshape(-1, 1)
```

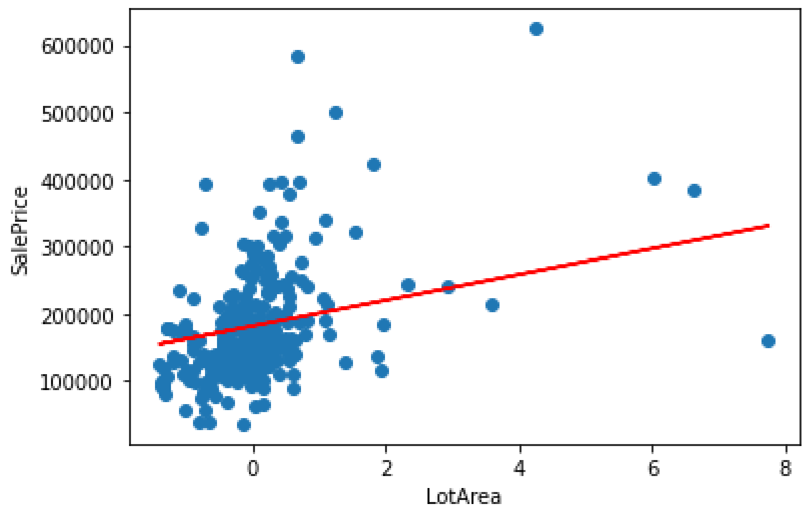
In [284…

```
model = LinearRegression()

new_model = model.fit(X_train, y_train)
y_pred = new_model.predict(X_test)
```

In [285…

```
plt.xlabel("LotArea")
plt.ylabel("SalePrice")
plt.scatter(X_test, y_test)
```

```
plt.plot(X_test, y_pred, color ='r')

plt.show()
```



- **Coefficient of Determination:** With linear regression, the coefficient of determination is equal to the square of the correlation between the x and y variables.

In [286…
```
print("Linear Regression\n====================")
print("coefficient of determination (r-squared):", new_model.score(X_test, y_te
print("intercept:", new_model.intercept_)
print("slope:", new_model.coef_)
mse_linear_regression = mean_squared_error(y_test, y_pred)
print("mean squared error:", mse_linear_regression)
```

```
Linear Regression
====================
coefficient of determination (r-squared): 0.14798131359437894
intercept: [181709.82363014]
slope: [[19170.85729063]]
mean squared error: 5767710272.245401
```

(iv) Multiple Regression

Model 1: LotFrontage, LotArea

In [287…
```
lot_area_weights = [] # required for question (vii)
```

In [288…
```
df = dataset.loc[:, ['SalePrice', 'LotArea', 'LotFrontage']].dropna()
```

In [289…
```
train_df, test_df = train_test_split(df, test_size=0.2)
```

In [290…
```
train_df.head()
```

Out[290]:

	SalePrice	LotArea	LotFrontage
467	146500	9480	79.0
119	163990	8461	65.0
875	303477	9000	75.0
480	326000	16033	98.0
906	255000	13501	116.0

In [291…

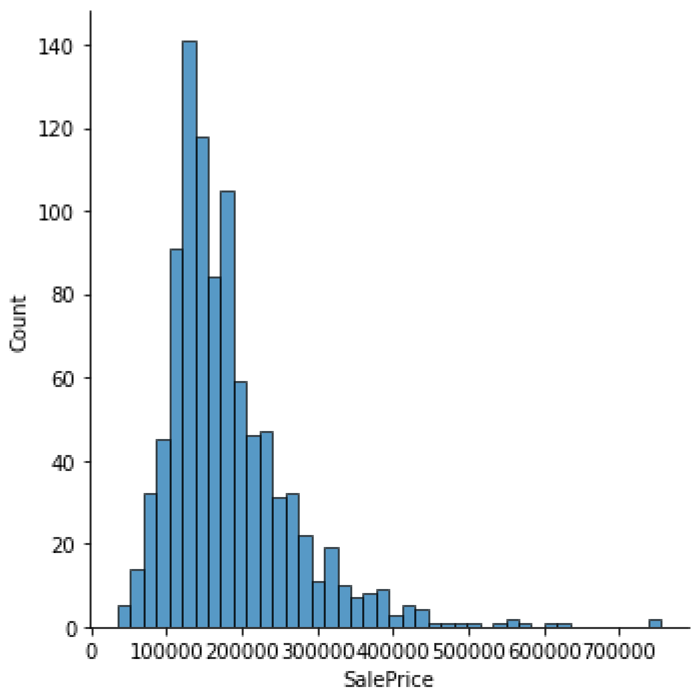
```
test_df.head()
```

Out[291]:

	SalePrice	LotArea	LotFrontage
1071	154000	11700	78.0
946	143000	8163	70.0
755	172500	3230	34.0
30	40000	8500	50.0
570	142600	13101	74.0

In [292…

```
sns.displot(train_df['SalePrice']);
```



In [293…

```
variables = ['LotArea', 'LotFrontage']
X_train = np.array(train_df[variables])
X_train = scaler.fit_transform(X_train)
y_train = np.array(train_df[['SalePrice']])

X_test = np.array(test_df[variables])
X_test = scaler.fit_transform(X_test)
y_test = np.array(test_df[['SalePrice']])
```

In [294…
```
model = LinearRegression()
new_model = model.fit(X_train, y_train)
```

In [295…
```
y_pred = new_model.predict(X_test)
r2_score_m1 = new_model.score(X_test, y_test)
mse_m1 = mean_squared_error(y_test, y_pred)
print("[Model 1] r2 score:", r2_score_m1) # same as sklearn.metrics.r2_score
print("[Model 1] mean squared error:", mse_m1)
```

```
[Model 1] r2 score: 0.18894409589343242
[Model 1] mean squared error: 4465301087.46941
```

In [296…
```
print("Weights/Coefficients:\n")
for name, weight in zip(variables, new_model.coef_.reshape(-1)):
  if name == 'LotArea':
    lot_area_weights.append(weight)

  print(f"{name.ljust(25)} {weight}")
```

```
Weights/Coefficients:

LotArea                   18003.076786530026
LotFrontage               21198.762404965273
```

Model 2: LotFrontage, LotArea, OverallQual, OverallCond

In [297…
```
df = dataset.loc[:, ['SalePrice', 'LotArea', 'LotFrontage', 'OverallQual', 'Ove
```

In [298…
```
train_df, test_df = train_test_split(df, test_size=0.2)
```

In [299…
```
train_df.head()
```

Out[299]:

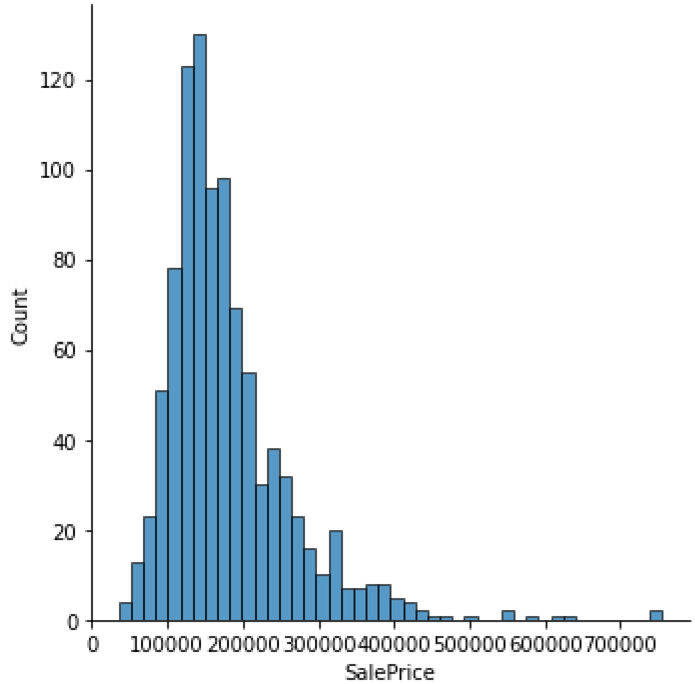
	SalePrice	LotArea	LotFrontage	OverallQual	OverallCond
1420	179900	11700	90.0	6	6
86	174000	11911	122.0	6	5
1403	282922	15256	49.0	8	5
267	179500	8400	60.0	5	8
248	180000	11317	72.0	7	5

In [300…
```
test_df.head()
```

Out[300]:

	SalePrice	LotArea	LotFrontage	OverallQual	OverallCond
588	143000	25095	65.0	5	8
1121	212900	10084	84.0	7	5
847	133500	15523	36.0	5	6
1204	153500	10140	78.0	5	6
1050	176485	8993	73.0	7	5

In [301…
```
sns.displot(train_df['SalePrice']);
```



In [302…
```
variables = ['LotArea', 'LotFrontage', 'OverallQual', 'OverallCond']
X_train = np.array(train_df[variables])
X_train = scaler.fit_transform(X_train)
y_train = np.array(train_df[['SalePrice']])

X_test = np.array(test_df[variables])
X_test = scaler.fit_transform(X_test)
y_test = np.array(test_df[['SalePrice']])
```

In [303…
```
model = LinearRegression()
new_model = model.fit(X_train, y_train)
```

In [304…
```
y_pred = new_model.predict(X_test)
r2_score_m2 = new_model.score(X_test, y_test)
mse_m2 = mean_squared_error(y_test, y_pred)
print("[Model 2] r2 score:", r2_score_m2) # same as sklearn.metrics.r2_score
print("[Model 2] mean squared error:", mse_m2)
```

```
[Model 2] r2 score: 0.7043508132745866
[Model 2] mean squared error: 2052790517.6136389
```

In [305…
```
print("Weights/Coefficients:\n")
for name, weight in zip(variables, new_model.coef_.reshape(-1)):
  if name == 'LotArea':
    lot_area_weights.append(weight)
  print(f"{name.ljust(25)} {weight}")
```

```
Weights/Coefficients:

LotArea                   8862.459778565702
LotFrontage               10739.146228055622
OverallQual               62472.4520137272
OverallCond               135.6182336392569
```

Model 3: LotFrontage, LotArea, OverallQual, OverallCond, 1stFlrSF, GrLivArea

In [306…
```
df = dataset.loc[:, ['SalePrice', 'LotArea', 'LotFrontage', 'OverallQual', 'Ove
```

In [307…
```
train_df, test_df = train_test_split(df, test_size=0.2)
```

In [308…
```
train_df.head()
```

Out[308]:

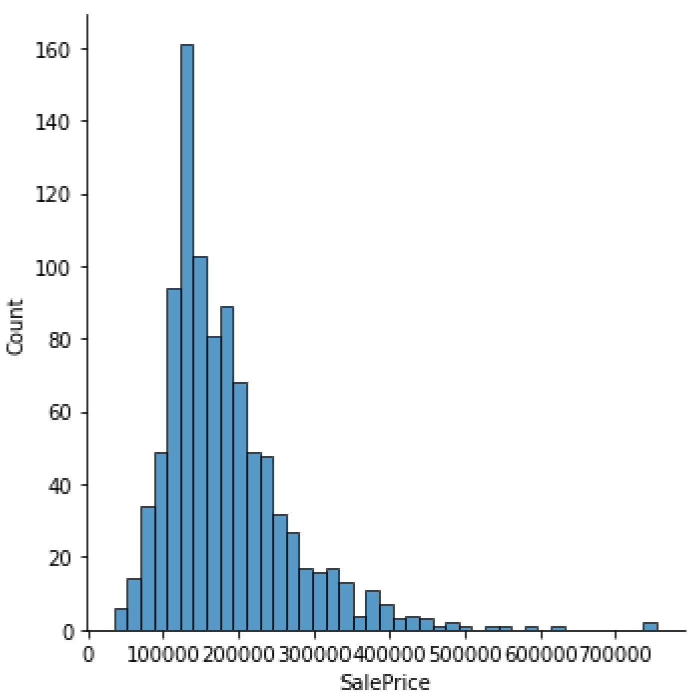
	SalePrice	LotArea	LotFrontage	OverallQual	OverallCond	1stFlrSF	GrLivArea
1075	219500	13125	75.0	7	6	960	1740
446	190000	16492	137.0	6	6	1888	1888
93	133900	7200	60.0	6	6	1260	2291
503	289000	15602	100.0	7	8	1801	1801
371	134432	17120	80.0	4	4	1120	1588

In [309…
```
test_df.head()
```

Out[309]:

	SalePrice	LotArea	LotFrontage	OverallQual	OverallCond	1stFlrSF	GrLivArea
595	319000	11302	69.0	8	5	1826	1826
365	147000	10690	59.0	5	7	672	1344
440	555000	15431	105.0	10	5	2402	2402
289	153575	8730	60.0	6	7	698	1396
981	336000	12203	98.0	8	5	1276	2612

In [310…
```
sns.displot(train_df['SalePrice']);
```



In [311…
```
variables = ['LotArea', 'LotFrontage', 'OverallQual', 'OverallCond', '1stFlrSF
X_train = np.array(train_df[variables])
```

```
X_train = scaler.fit_transform(X_train)
y_train = np.array(train_df[['SalePrice']])

X_test = np.array(test_df[variables])
X_test = scaler.fit_transform(X_test)
y_test = np.array(test_df[['SalePrice']])
```

In [312…

```
model = LinearRegression()
new_model = model.fit(X_train, y_train)
```

In [313…

```
y_pred = new_model.predict(X_test)
r2_score_m3 = new_model.score(X_test, y_test)
mse_m3 = mean_squared_error(y_test, y_pred)
print("[Model 3] r2 score:", r2_score_m3) # same as sklearn.metrics.r2_score
print("[Model 3] mean squared error:", mse_m3)
```

```
[Model 3] r2 score: 0.7180087039489944
[Model 3] mean squared error: 1704631344.9561703
```

In [314…

```
print("Weights/Coefficients:\n")
for name, weight in zip(variables, new_model.coef_.reshape(-1)):
  if name == 'LotArea':
    lot_area_weights.append(weight)
  print(f"{name.ljust(25)} {weight}")
```

```
Weights/Coefficients:

LotArea                  7057.920345774349
LotFrontage              -303.05755787223825
OverallQual              46592.153445790944
OverallCond              1552.500016010084
1stFlrSF                 12198.610608555135
GrLivArea                22959.99196815228
```

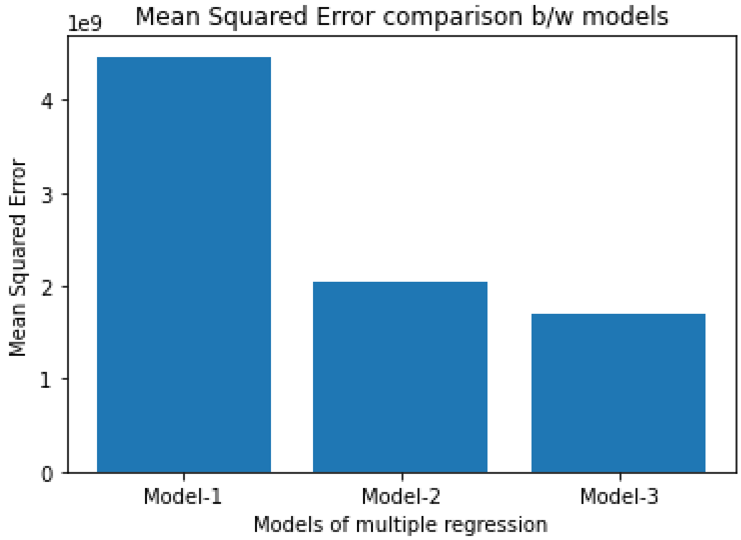
(v) Compare the Mean squared Error, R2 score

Comparing R2 score

Comparing Mean Squared Error

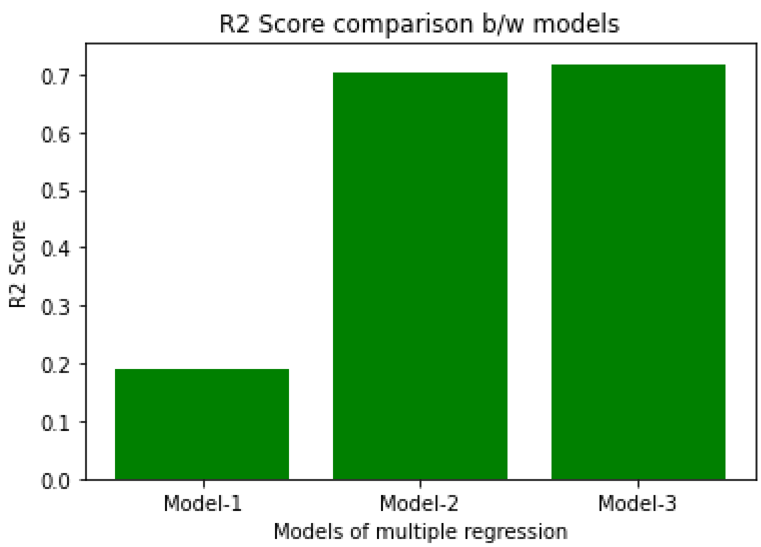
In [315…

```
plt.xlabel("Models of multiple regression")
plt.ylabel("Mean Squared Error")
plt.title("Mean Squared Error comparison b/w models")
plt.bar(["Model-1", "Model-2", "Model-3"], [mse_m1, mse_m2, mse_m3])
plt.show()
```



In [316…

```
plt.xlabel("Models of multiple regression")
plt.ylabel("R2 Score")
plt.title("R2 Score comparison b/w models")
plt.bar(["Model-1", "Model-2", "Model-3"], [r2_score_m1, r2_score_m2, r2_score_
plt.show()
```

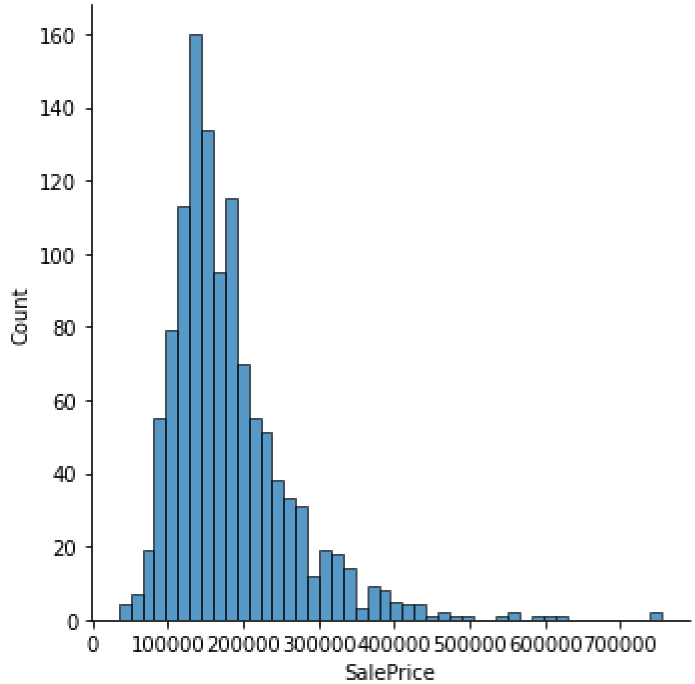


(vi) Multiple Regression (contd.)

Model 4: LotArea, Street

In [317…

```
df = dataset.loc[:, ['SalePrice', 'LotArea', 'Street']].dropna()
df = pd.get_dummies(df, columns = ['Street'])
train_df, test_df = train_test_split(df, test_size=0.2)
sns.displot(train_df['SalePrice']);
```



In [318…

```
test_df.head()
```

Out[318]:

	SalePrice	LotArea	Street_Grvl	Street_Pave
217	107000	9906	0	1
1242	170000	10625	0	1
945	124900	8820	0	1
1357	149900	12537	0	1
163	103200	5500	0	1

In [319…

```
train_df.head()
```

Out[319]:

	SalePrice	LotArea	Street_Grvl	Street_Pave
393	100000	7446	0	1
776	221500	11210	0	1
552	255500	11146	0	1
1304	130000	3363	0	1
1420	179900	11700	0	1

In [320…

```
variables = train_df.columns.array[1:]
X_train = np.array(train_df[variables])
X_train = scaler.fit_transform(X_train)
y_train = np.array(train_df[['SalePrice']])
X_test = np.array(test_df[variables])
X_test = scaler.fit_transform(X_test)
y_test = np.array(test_df[['SalePrice']])
```

In [321…

```
model = LinearRegression()
```

```
new_model = model.fit(X_train, y_train)
```

In [322…

```
y_pred = new_model.predict(X_test)
r2_score_m4 = new_model.score(X_test, y_test)
mse_m4 = mean_squared_error(y_test, y_pred)
print("[Model 4] r2 score:", r2_score_m4) # same as sklearn.metrics.r2_score
print("[Model 4] mean squared error:", mse_m4)
```

```
[Model 4] r2 score: 0.035927487038976 97
[Model 4] mean squared error: 4941760310.846153
```

In [323…

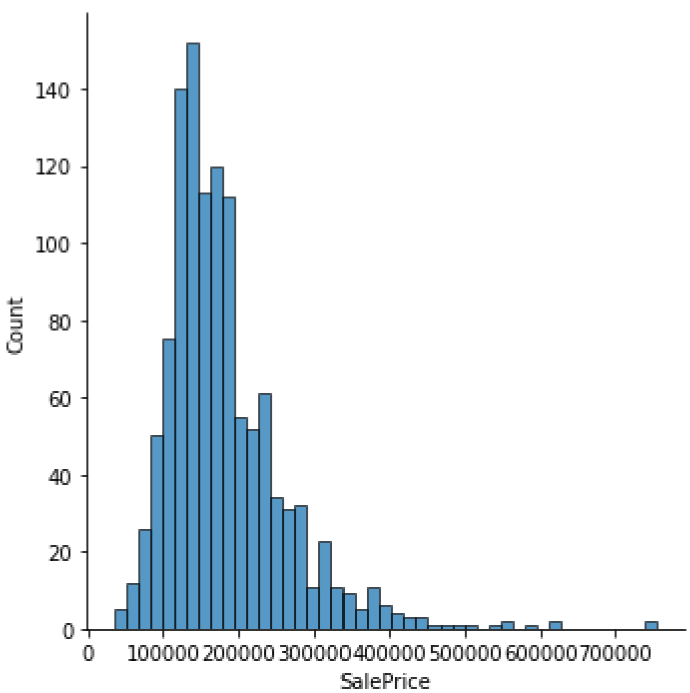
```
print("Weights/Coefficients:\n")
for name, weight in zip(variables, new_model.coef_.reshape(-1)):
  if name == 'LotArea':
    lot_area_weights.append(weight)
  print(f"{name.ljust(25)} {weight}")
```

```
Weights/Coefficients:

LotArea                   24258.824360028957
Street_Grvl               -2.103931852980475e+18
Street_Pave               -2.103931852980467e+18
```

Model 5: LotArea, OverallCond, Street, Neighborhood

In [324…

```
df = dataset.loc[:, ['SalePrice', 'LotArea', 'OverallCond', 'Street', 'Neighbo
df = pd.get_dummies(df, columns = ['Street', 'Neighborhood'])
train_df, test_df = train_test_split(df, test_size=0.2)
sns.displot(train_df['SalePrice']);
```



In [325…

```
train_df.head()
```

Out[325]:

	SalePrice	LotArea	OverallCond	Street_Grvl	Street_Pave	Neighborhood_Blmngtn	Neighbo
233	128200	10650	6	0	1	0	
1281	180000	8049	5	0	1	0	
938	239799	8760	5	0	1	0	
762	215200	8640	5	0	1	0	
1414	207000	13053	7	0	1	0	

5 rows × 30 columns

In [326…

```
test_df.head()
```

Out[326]:

	SalePrice	LotArea	OverallCond	Street_Grvl	Street_Pave	Neighborhood_Blmngtn	Neighbo
741	142000	6768	8	0	1	0	
570	142600	13101	5	0	1	0	
1271	185750	9156	7	0	1	0	
190	315000	10570	8	0	1	0	
503	289000	15602	8	0	1	0	

5 rows × 30 columns

In [327…

```
variables = train_df.columns.array[1:]
X_train = np.array(train_df[variables])
X_train = scaler.fit_transform(X_train)
y_train = np.array(train_df[['SalePrice']])

X_test = np.array(test_df[variables])
X_test = scaler.fit_transform(X_test)
y_test = np.array(test_df[['SalePrice']])
```

In [328…

```
model = LinearRegression()
new_model = model.fit(X_train, y_train)
```

In [329…

```
y_pred = new_model.predict(X_test)
r2_score_m5 = r2_score(y_test, y_pred)
mse_m5 = mean_squared_error(y_test, y_pred)
print("[Model 5] r2 score:", r2_score_m5) # same as sklearn.metrics.r2_score
print("[Model 5] mean squared error:", mse_m5)
```

```
[Model 5] r2 score: -5.462117067358696e+25
[Model 5] mean squared error: 2.842884981217866e+35
```

In [330…

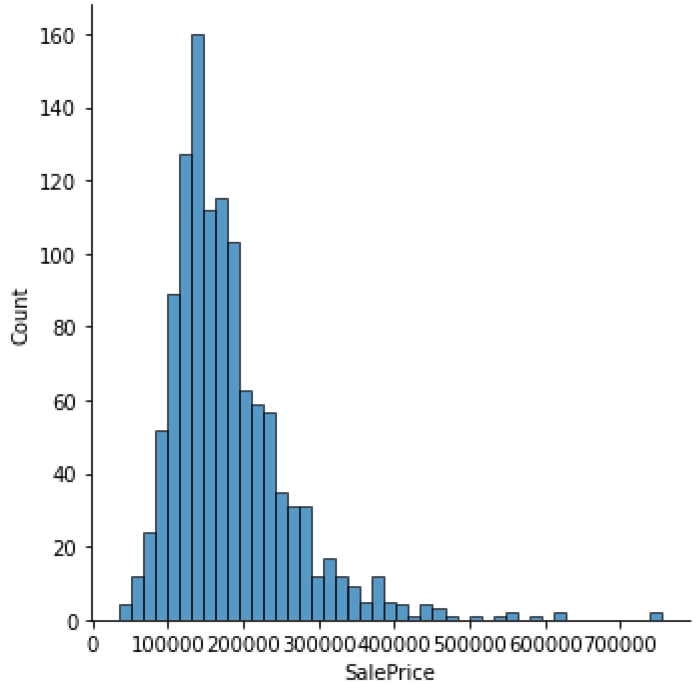
```
print("Weights/Coefficients:\n")
for name, weight in zip(variables, new_model.coef_.reshape(-1)):
  if name == 'LotArea':
    lot_area_weights.append(weight)
  print(f"{name.ljust(25)} {weight}")
```

```
Weights/Coefficients:

LotArea                   15977.35125907898
OverallCond               8291.768367203786
Street_Grvl               1.4985119376798313e+18
Street_Pave               1.4985119376798364e+18
Neighborhood_Blmngtn      -4.903717487170676e+17
Neighborhood_Blueste      -1.9325335685306864e+17
Neighborhood_BrDale       -4.5146677589772614e+17
Neighborhood_BrkSide      -8.996195991429783e+17
Neighborhood_ClearCr      -6.354281091819452e+17
Neighborhood_CollgCr      -1.38718857898456e+18
Neighborhood_Crawfor      -8.29265873648037e+17
Neighborhood_Edwards      -1.1737896044948403e+18
Neighborhood_Gilbert      -1.0715370892887411e+18
Neighborhood_IDOTRR       -7.630041994550884e+17
Neighborhood_MeadowV      -5.4331163342291085e+17
Neighborhood_Mitchel      -8.292658736480454e+17
Neighborhood_NAmes        -1.668231901758573e+18
Neighborhood_NPkVill      -3.8551098844421715e+17
Neighborhood_NWAmes       -1.0479394302686234e+18
Neighborhood_NoRidge      -7.744933160441996e+17
Neighborhood_NridgHt      -1.055879084370892e+18
Neighborhood_OldTown      -1.252827625423997e+18
Neighborhood_SWISU        -6.210894177653805e+17
Neighborhood_Sawyer       -1.0399237608182981e+18
Neighborhood_SawyerW      -9.278812597095914e+17
Neighborhood_Somerst      -1.102011597387187e+18
Neighborhood_StoneBr      -6.21089417765355e+17
Neighborhood_Timber       -7.513181019235105e+17
Neighborhood_Veenker      -4.306426636943415e+17
```

Model 6: LotArea, OverallCond, Street, 1stFlrSF, Neighborhood, Year

In [331…

```
df = dataset.loc[:, ['SalePrice', 'LotArea', 'OverallCond', 'Street', '1stFlrSF
df = pd.get_dummies(df, columns = ['Street', 'Neighborhood'])
train_df, test_df = train_test_split(df, test_size=0.2)
sns.displot(train_df['SalePrice']);
```



In [332…

```
train_df.head()
```

Out[332]:

	SalePrice	LotArea	OverallCond	1stFlrSF	YearBuilt	Street_Grvl	Street_Pave	Neighborhoo
405	150000	9991	4	1620	1976	0	1	
890	122900	8064	7	672	1949	0	1	
1256	301500	14303	5	1987	1994	0	1	
1219	91500	1680	5	672	1971	0	1	
1067	167900	9760	6	798	1964	0	1	

5 rows × 32 columns

In [333…

```
test_df.head()
```

Out[333]:

	SalePrice	LotArea	OverallCond	1stFlrSF	YearBuilt	Street_Grvl	Street_Pave	Neighborhoo
981	336000	12203	5	1276	1998	0	1	
798	485000	13518	5	1966	2008	0	1	
464	124000	8430	5	1040	1978	0	1	
1136	119000	9600	5	1032	1950	0	1	
401	164990	8767	5	1310	2005	0	1	

5 rows × 32 columns

In [334…

```
variables = train_df.columns.array[1:]
X_train = np.array(train_df[variables])
X_train = scaler.fit_transform(X_train)
y_train = np.array(train_df[['SalePrice']])
```

```
X_test = np.array(test_df[variables])
X_test = scaler.fit_transform(X_test)
y_test = np.array(test_df[['SalePrice']])
```

In [335…

```
model = LinearRegression()
new_model = model.fit(X_train, y_train)
```

In [336…

```
y_pred = new_model.predict(X_test)
r2_score_m6 = r2_score(y_test, y_pred)
mse_m6 = mean_squared_error(y_test, y_pred)
print("[Model 6] r2 score:", r2_score_m6) # same as sklearn.metrics.r2_score
print("[Model 6] mean squared error:", mse_m6)
```

```
[Model 6] r2 score: -5.457098552528068e+22
[Model 6] mean squared error: 2.9030478443896677e+32
```

In [337…

```
print("Weights/Coefficients:\n")
for name, weight in zip(variables, new_model.coef_.reshape(-1)):
  if name == 'LotArea':
    lot_area_weights.append(weight)
  print(f"{name.ljust(25)} {weight}")
```

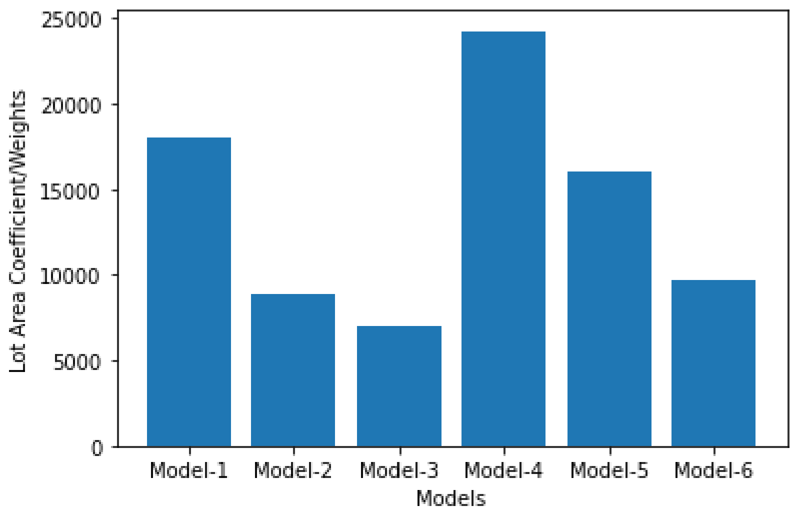
```
Weights/Coefficients:

LotArea                   9649.838114536089
OverallCond               12909.33574022097
1stFlrSF                  30241.98159192617
YearBuilt                 21322.116831710307
Street_Grvl               1.4247004510097416e+16
Street_Pave               1.4247004510100894e+16
Neighborhood_Blmngtn      1.2550049681081134e+16
Neighborhood_Blueste      4768071901278653.0
Neighborhood_BrDale       1.1629152423225832e+16
Neighborhood_BrkSide      2.3344491948968852e+16
Neighborhood_ClearCr      1.5323920108050198e+16
Neighborhood_CollgCr      3.4754750569005932e+16
Neighborhood_Crawfor      2.071847555367409e+16
Neighborhood_Edwards      2.9957268640653976e+16
Neighborhood_Gilbert      2.624539095563849e+16
Neighborhood_IDOTRR       1.8243589062267188e+16
Neighborhood_MeadowV      1.1138880501593168e+16
Neighborhood_Mitchel      1.9661991313214108e+16
Neighborhood_NAmes        4.106259003253796e+16
Neighborhood_NPkVill      8244365020842694.0
Neighborhood_NWAmes       2.484694393799061e+16
Neighborhood_NoRidge      1.910880037530304e+16
Neighborhood_NridgHt      2.5657672105554464e+16
Neighborhood_OldTown      3.106551603276723e+16
Neighborhood_SWISU        1.4588657808779264e+16
Neighborhood_Sawyer       2.4429099010471972e+16
Neighborhood_SawyerW      2.400235701786597e+16
Neighborhood_Somerst      2.8269572137679916e+16
Neighborhood_StoneBr      1.567769358324218e+16
Neighborhood_Timber       1.8243589062273212e+16
Neighborhood_Veenker      1.0625094527151932e+16
```

(vi) Compare the feature “LotArea” weights/coefficients

for all the six trained models and plot a graph using the Matplotlib library.

In [338…

```
x_values = [f"Model-{x}" for x in range(1, 7)]
y_values = lot_area_weights
plt.bar(x_values, y_values)
plt.ylabel('Lot Area Coefficient/Weights')
plt.xlabel('Models')
plt.show()
```

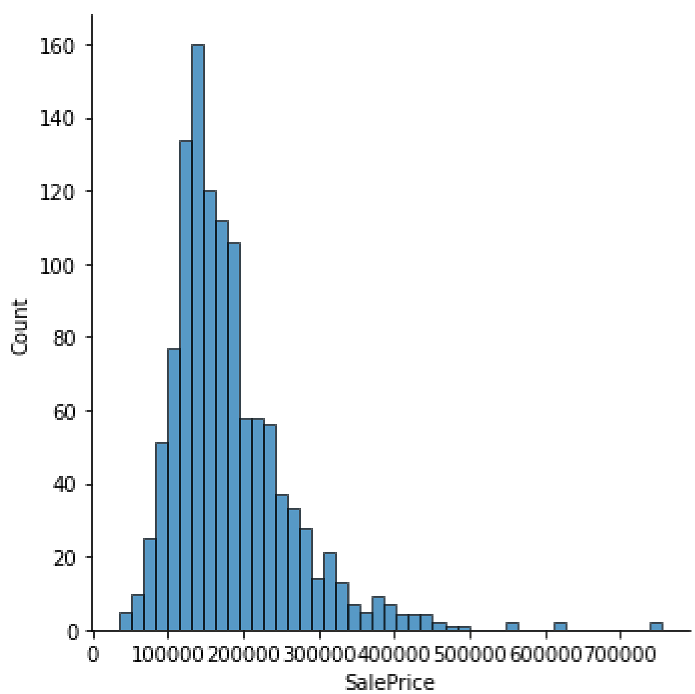


(vii) Polynomial regression

DegrDegree 2ee 2

In [339…

```
df = dataset.loc[:, ['SalePrice', 'LotArea']].dropna()
train_df, test_df = train_test_split(df, test_size=0.2)
sns.displot(train_df['SalePrice']);
```



In [340…

```
train_df.head()
```

Out[340]:

	SalePrice	LotArea
720	275000	6563
960	116500	7207
124	181000	17043
17	90000	10791
591	451950	13478

In [341…

```
test_df.head()
```

Out[341]:

	SalePrice	LotArea
908	131000	8885
1283	139000	9400
1193	165000	4500
998	91000	9786
83	126500	8892

In [342…

```
variables = train_df.columns.array[1:]
X_train = np.array(train_df[variables])
X_train = scaler.fit_transform(X_train)
y_train = np.array(train_df[['SalePrice']])

X_test = np.array(test_df[variables])
X_test = scaler.fit_transform(X_test)
y_test = np.array(test_df[['SalePrice']])
```

In [343…

```
poly = PolynomialFeatures(degree = 2)
X_poly = poly.fit_transform(X_train)
poly.fit(X_poly, y_train)
model = LinearRegression()
new_model = model.fit(X_poly, y_train)
```

In [344…

```
y_pred = new_model.predict(poly.fit_transform(X_test))
r2_score_poly = r2_score(y_test, y_pred)
mse_poly = mean_squared_error(y_test, y_pred)
print("[Poly] r2 score:", r2_score_poly)
print("[Poly] mean squared error:", mse_poly)
```

```
[Poly] r2 score: 0.14151946740561616
[Poly] mean squared error: 5232502359.016333
```

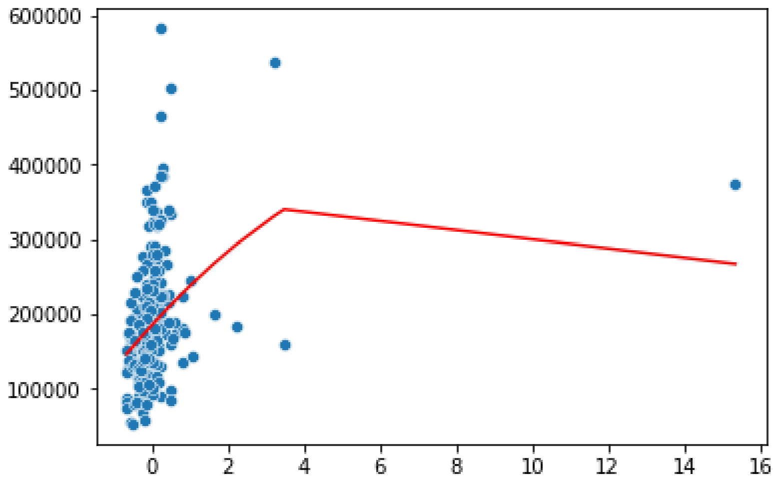
In [345…

```
sns.scatterplot(X_test.reshape(-1), y_test.reshape(-1))
sns.lineplot(X_test.reshape(-1), y_pred.reshape(-1), color = 'red')
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarnin
g: Pass the following variables as keyword args: x, y. From version 0.12, the
only valid positional argument will be `data`, and passing other arguments wit
hout an explicit keyword will result in an error or misinterpretation.
  FutureWarning
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarnin
g: Pass the following variables as keyword args: x, y. From version 0.12, the
only valid positional argument will be `data`, and passing other arguments wit
hout an explicit keyword will result in an error or misinterpretation.
  FutureWarning
```

Out[345]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f2806baa490>
```



In [346…

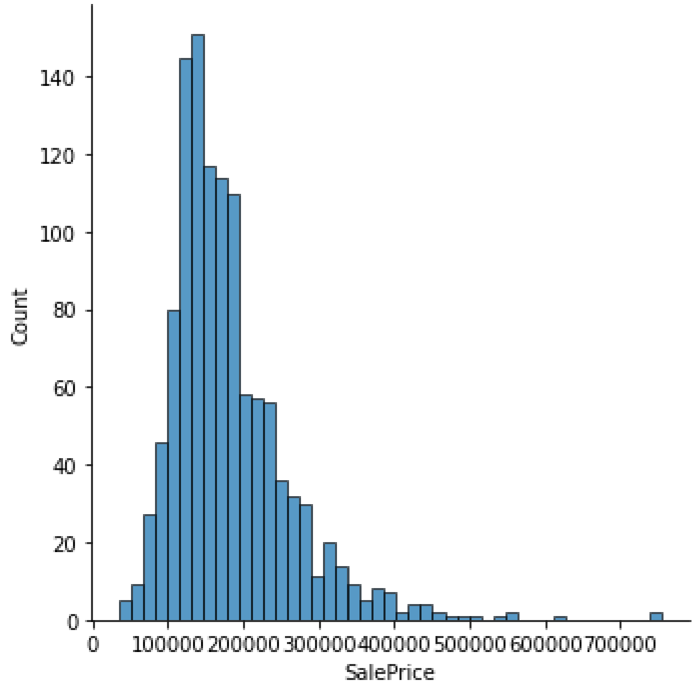
```
print("Weights/Coefficients:\n", new_model.coef_.reshape(-1))
```

```
Weights/Coefficients:
 [    0.          56060.78192413 -3300.9838299 ]
```

Degree 3

In [347…

```
df = dataset.loc[:, ['SalePrice', 'LotArea']].dropna()
train_df, test_df = train_test_split(df, test_size=0.2)
sns.displot(train_df['SalePrice']);
```



In [348…

```
train_df.head()
```

Out[348]:

	SalePrice	LotArea
1112	129900	7100
697	123500	6420
1079	126000	8775
89	123600	8070
1125	115000	10434

In [349…

```
test_df.head()
```

Out[349]:

	SalePrice	LotArea
385	192000	3182
896	106500	8765
622	135000	7064
162	220000	12182
1400	120000	6000

In [350…

```
variables = train_df.columns.array[1:]
X_train = np.array(train_df[variables])
X_train = scaler.fit_transform(X_train)
y_train = np.array(train_df[['SalePrice']])

X_test = np.array(test_df[variables])
X_test = scaler.fit_transform(X_test)
y_test = np.array(test_df[['SalePrice']])
```

In [351…
```
poly = PolynomialFeatures(degree = 3)
X_poly = poly.fit_transform(X_train)
poly.fit(X_poly, y_train)
model = LinearRegression()
new_model = model.fit(X_poly, y_train)
```

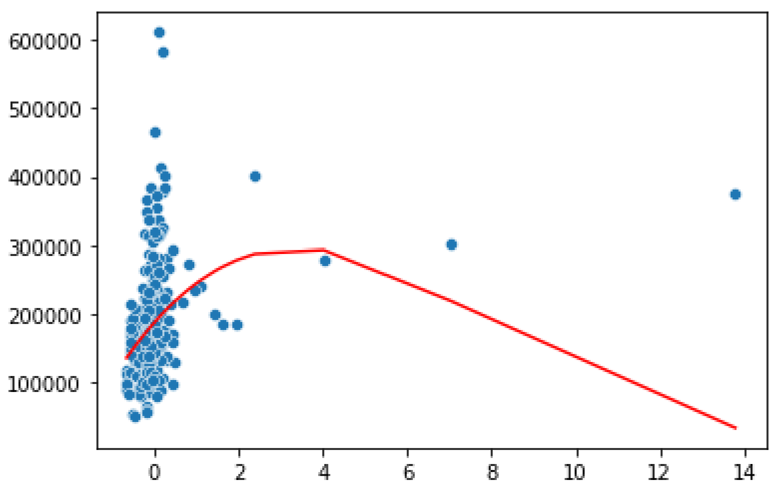
In [352…
```
y_pred = new_model.predict(poly.fit_transform(X_test))
r2_score_poly = r2_score(y_test, y_pred)
mse_poly = mean_squared_error(y_test, y_pred)
print("[Poly Deg 3] r2 score:", r2_score_poly)
print("[Poly Deg 3] mean squared error:", mse_poly)
```

```
[Poly Deg 3] r2 score: 0.08977086485503138
[Poly Deg 3] mean squared error: 5829891043.974915
```

In [353…
```
sns.scatterplot(X_test.reshape(-1), y_test.reshape(-1))
sns.lineplot(X_test.reshape(-1), y_pred.reshape(-1), color = 'red')
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass the following variables as keyword args: x, y. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
  FutureWarning
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass the following variables as keyword args: x, y. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
  FutureWarning
```

Out[353]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f28078b2910>
```



In [354…
```
new_model.coef_
```

Out[354]:
```
array([[     0.        ,  69593.45503156, -12804.01331804,
           503.80403025]])
```

In [355…
```
print("Weights/Coefficients:\n", new_model.coef_.reshape(-1))
```

```
Weights/Coefficients:
 [     0.          69593.45503156 -12804.01331804    503.80403025]
```