Assignment 1

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- Date: **Aug 12, 2022**

(i) Download data

Data downloaded and stored at drive.

In [542…
```
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 [543…
```
import warnings
warnings.simplefilter(action='ignore', category=FutureWarning)
```

In [544…
```
BASE_PATH = '/content/drive/MyDrive/Colab_Notebooks/ML_DRIVE/Assign_1/dataset'
```

In [545…
```
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 [546…
```
dataset = pd.read_csv(f"{BASE_PATH}/train.csv")
scaler = StandardScaler()
```

In [547…
```
dataset.head()
```

Out[547]:

	Id	MSSubClass	MSZoning	LotFrontage	LotArea	Street	Alley	LotShape	LandContour	Utili
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`

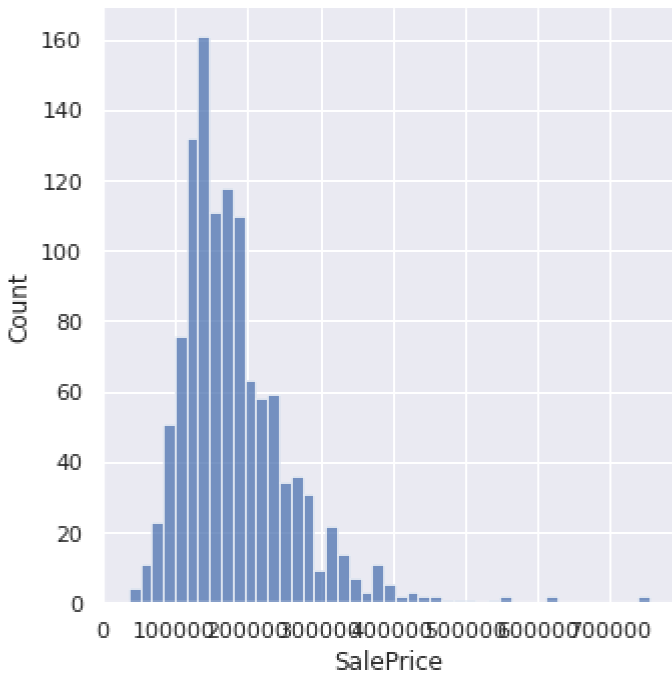
Remove the missing rows corresponding to only `SalePrice` and `LotArea` columns.

In [548…
```
df = dataset.loc[:, ['SalePrice', 'LotArea']].dropna()
```

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

In [549…
```
train_df, test_df = train_test_split(df, test_size=0.2)
```

In [550…
```
sns.displot(train_df['SalePrice']);
```



In [551…
```
train_df.head()
```

Out[551]:

	SalePrice	LotArea
926	285000	11999
649	84500	1936
64	219500	9375
189	286000	4923
1421	127500	4043

In [552…

```
test_df.head()
```

Out[552]:

	SalePrice	LotArea
468	250000	11428
470	212000	6820
968	37900	5925
376	148000	8846
865	148500	8750

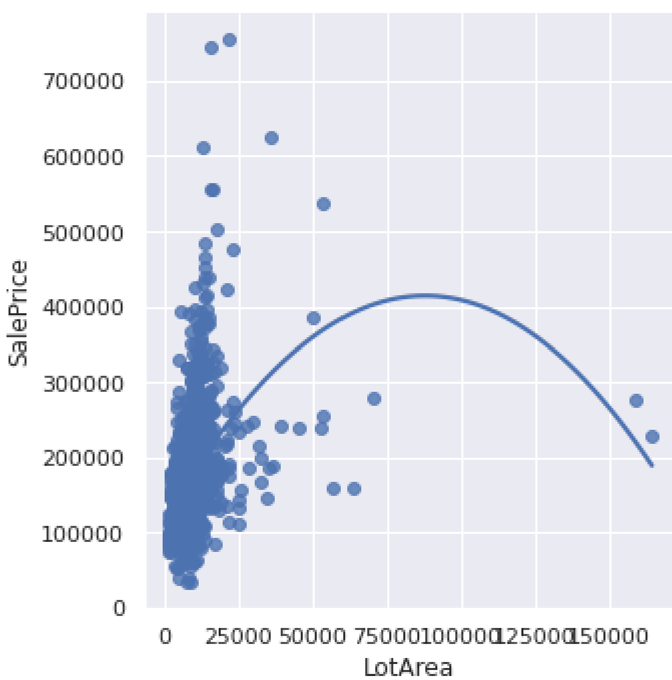
Scatter plot to see the relationship between `SalePrice` and `LotArea`.

In [553…

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

Out[553]:

```
<seaborn.axisgrid.FacetGrid at 0x7f322ef7cad0>
```



In [554…

```
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 [555…

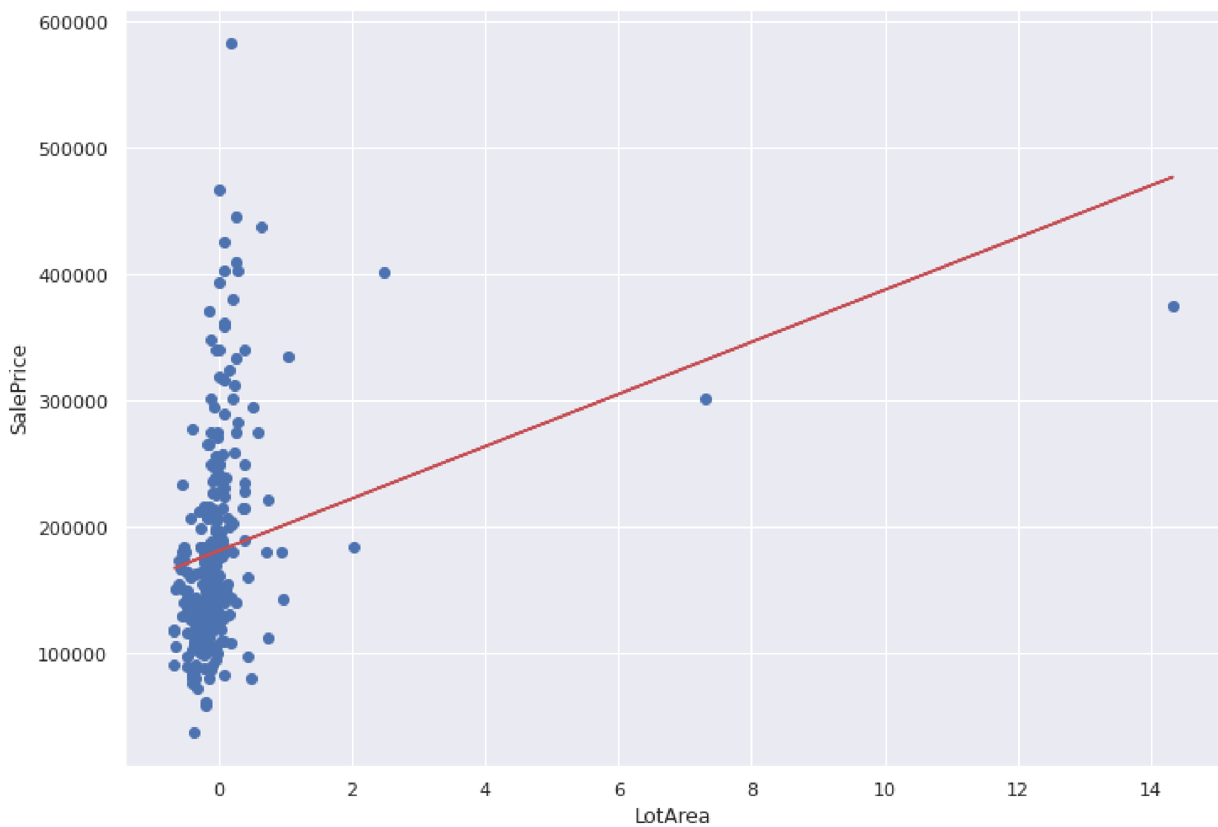
```
model = LinearRegression()

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

In [556…

```
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 [557…

```
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): 0.08266730291019242
intercept: [181174.69606164]
slope: [[20665.83775877]]
mean squared error: 6092303156.234104
```

(iv) Multiple Regression

Model 1: LotFrontage, LotArea

In [558…
```
lot_area_weights = [] # required for question (vii)
```

In [559…
```
df = dataset.loc[:, ['SalePrice', 'LotArea', 'LotFrontage']].dropna()
```

In [560…
```
train_df, test_df = train_test_split(df, test_size=0.2)
```

In [561…
```
train_df.head()
```

Out[561]:

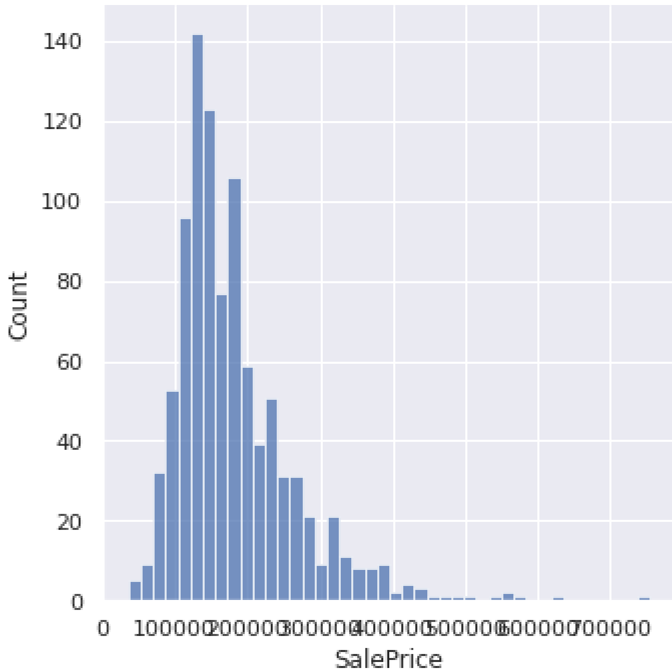
	SalePrice	LotArea	LotFrontage
1001	86000	5400	60.0
268	120500	6900	71.0
204	110000	3500	50.0
1212	113000	9340	50.0
365	147000	10690	59.0

In [562…
```
test_df.head()
```

Out[562]:

	SalePrice	LotArea	LotFrontage
1350	200000	11643	91.0
1175	285000	10678	85.0
1311	203000	8814	68.0
1410	230000	12420	79.0
1071	154000	11700	78.0

In [563…
```
sns.displot(train_df['SalePrice']);
```



In [564...
```
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 [565...
```
model = LinearRegression()
new_model = model.fit(X_train, y_train)
```

In [566...
```
y_pred = new_model.predict(X_train)
r2_m1_train = new_model.score(X_train, y_train)
mse_m1_train = mean_squared_error(y_train, y_pred)
print("[Model 1 training] mean squared error:", mse_m1_train)
print("[Model 1 training] r2 score:", r2_m1_train)

y_pred = new_model.predict(X_test)
r2_m1_test = new_model.score(X_test, y_test)
mse_m1_test = mean_squared_error(y_test, y_pred)
print("[Model 1 testing] mean squared error:", mse_m1_test)
print("[Model 1 testing] r2 score:", r2_m1_test)
```

```
[Model 1 training] mean squared error: 5624107998.43659
[Model 1 training] r2 score: 0.15674940645403534
[Model 1 testing] mean squared error: 6655777705.427111
[Model 1 testing] r2 score: 0.17303681161540152
```

In [567...
```
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                    14461.793682408417
LotFrontage                23384.152426978068
```

Model 2: LotFrontage, LotArea, OverallQual, OverallCond

In [568…
```
df = dataset.loc[:, ['SalePrice', 'LotArea', 'LotFrontage', 'OverallQual', 'Ove
```

In [569…
```
train_df, test_df = train_test_split(df, test_size=0.2)
```

In [570…
```
train_df.head()
```

Out[570]:

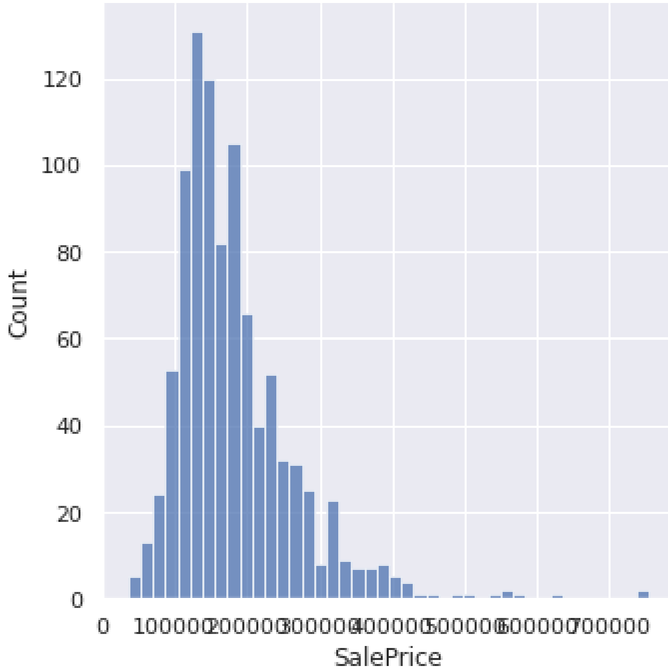
	SalePrice	LotArea	LotFrontage	OverallQual	OverallCond
190	315000	10570	70.0	8	8
999	206000	6762	64.0	7	5
1241	248328	9849	83.0	7	6
573	170000	9967	76.0	7	5
15	132000	6120	51.0	7	8

In [571…
```
test_df.head()
```

Out[571]:

	SalePrice	LotArea	LotFrontage	OverallQual	OverallCond
909	174000	12589	149.0	6	5
1133	239500	9828	80.0	8	5
603	151000	3182	30.0	7	5
60	158000	13072	63.0	6	5
1065	328000	14000	80.0	7	5

In [572…
```
sns.displot(train_df['SalePrice']);
```



In [573…

```
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 [574…

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

In [575…

```
y_pred = new_model.predict(X_train)
r2_m2_train = new_model.score(X_train, y_train)
mse_m2_train = mean_squared_error(y_train, y_pred)
print("[Model 2 training] mean squared error:", mse_m2_train)
print("[Model 2 training] r2 score:", r2_m2_train)

y_pred = new_model.predict(X_test)
r2_m2_test = new_model.score(X_test, y_test)
mse_m2_test = mean_squared_error(y_test, y_pred)
print("[Model 2 testing] mean squared error:", mse_m2_test)
print("[Model 2 testing] r2 score:", r2_m2_test)
```

```
[Model 2 training] mean squared error: 2173743721.3687043
[Model 2 training] r2 score: 0.6807952868198797
[Model 2 testing] mean squared error: 2367248284.9225645
[Model 2 testing] r2 score: 0.6842821691131709
```

In [576…

```
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                   11136.8044962903
LotFrontage               9244.841249409728
OverallQual               61583.28732019769
OverallCond               -102.41031001503097
```

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

In [577…

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

In [578…

```
train_df, test_df = train_test_split(df, test_size=0.2)
```

In [579…

```
train_df.head()
```

Out[579]:

	SalePrice	LotArea	LotFrontage	OverallQual	OverallCond	1stFlrSF	GrLivArea
587	137000	8740	74.0	5	6	860	860
1273	177000	11512	124.0	6	7	1357	1357
1379	167500	9735	73.0	5	5	754	1394
1151	149900	17755	134.0	5	4	1466	1466
1005	149900	8385	65.0	5	8	985	985

In [580…

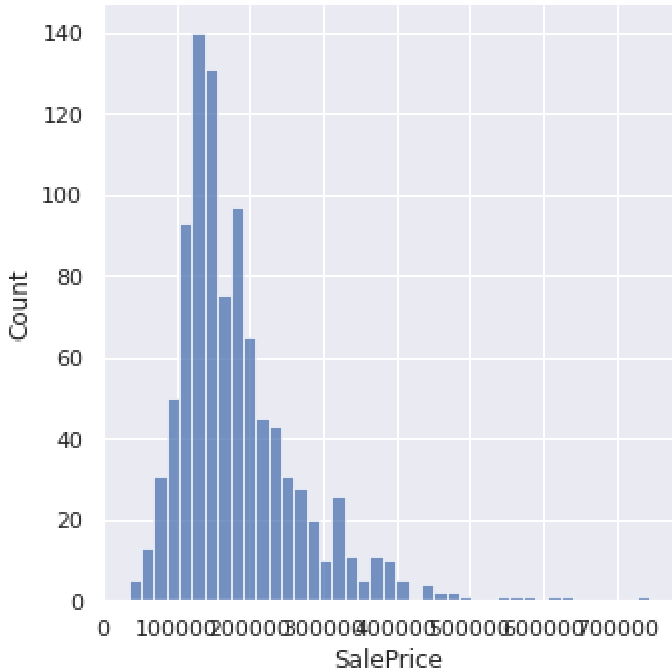
```
test_df.head()
```

Out[580]:

	SalePrice	LotArea	LotFrontage	OverallQual	OverallCond	1stFlrSF	GrLivArea
1329	176500	9084	63.0	7	5	955	1632
1332	100000	8877	67.0	4	6	816	816
876	132250	25286	94.0	4	5	1040	1040
1310	335000	17500	100.0	7	8	1902	1902
1255	127500	6240	52.0	6	6	959	1367

In [581…

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



In [582...

```
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 [583...

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

In [584...

```
y_pred = new_model.predict(X_train)
r2_m3_train = new_model.score(X_train, y_train)
mse_m3_train = mean_squared_error(y_train, y_pred)
print("[Model 3 training] mean squared error:", mse_m3_train)
print("[Model 3 training] r2 score:", r2_m3_train)

y_pred = new_model.predict(X_test)
r2_m3_test = new_model.score(X_test, y_test)
mse_m3_test = mean_squared_error(y_test, y_pred)
print("[Model 3 testing] mean squared error:", mse_m3_train)
print("[Model 3 testing] r2 score:", r2_m3_test)
```

```
[Model 3 training] mean squared error: 1705945890.8357406
[Model 3 training] r2 score: 0.7576982028082635
[Model 3 testing] mean squared error: 1705945890.8357406
[Model 3 testing] r2 score: 0.6695918826383475
```

In [585...

```
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                    6374.9246109743735
LotFrontage                1524.460617406945
OverallQual                47710.77823490351
OverallCond                1440.6205348023514
1stFlrSF                   13120.807238707632
GrLivArea                  20414.671183909024
```

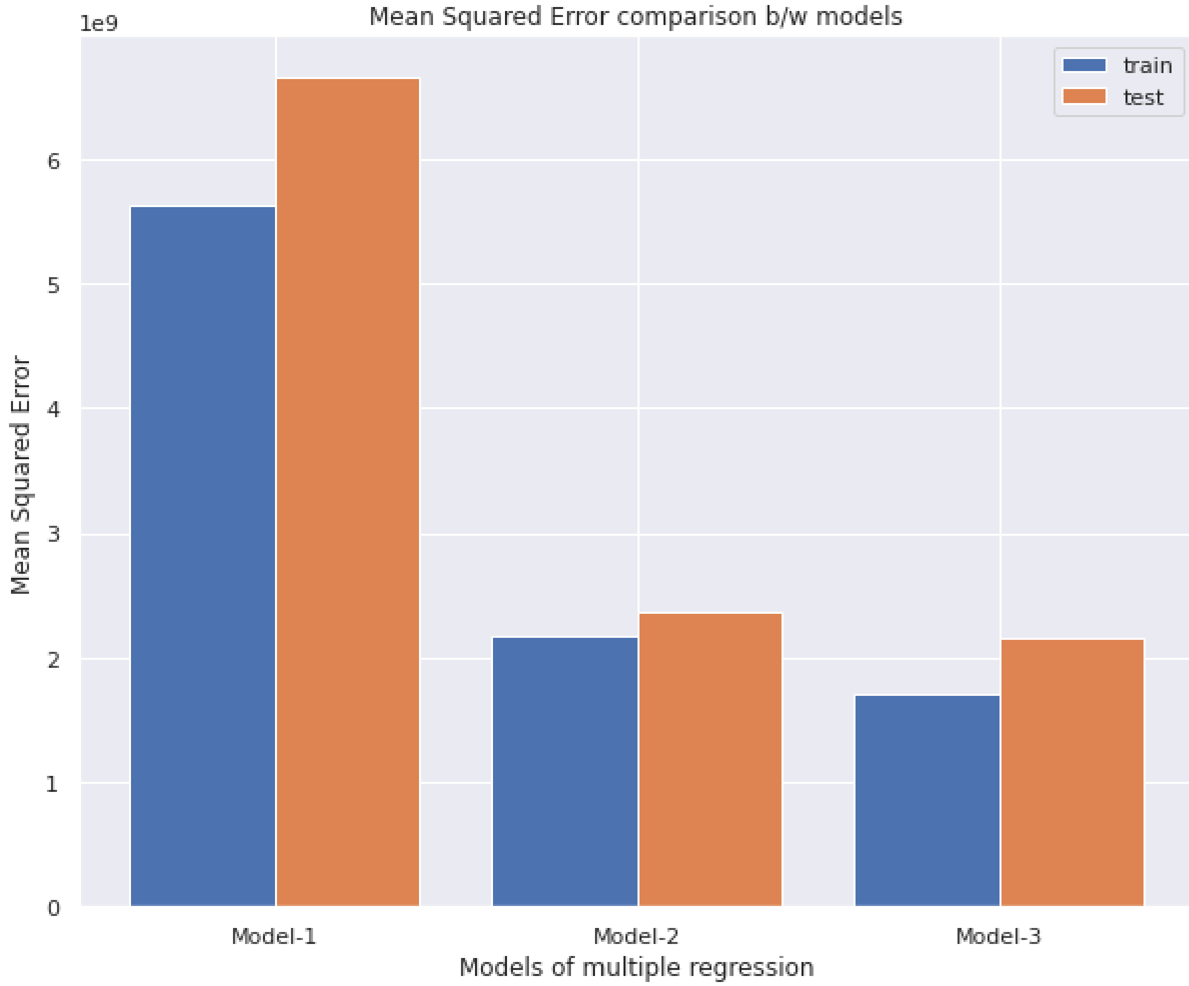
(v) Compare the Mean squared Error, R2 score

Comparing R2 score

Comparing Mean Squared Error

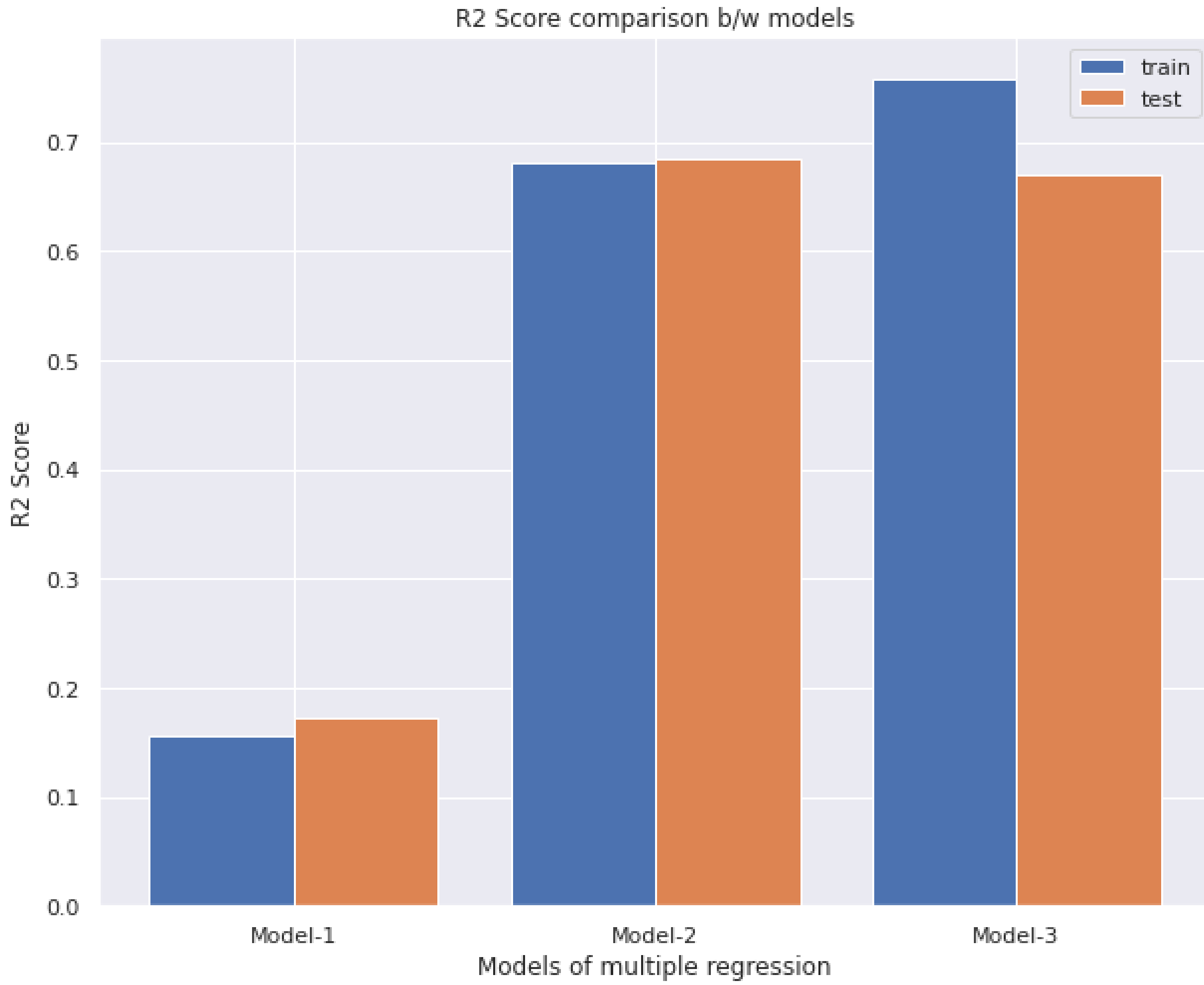
In [586…

```python
plt.figure(figsize=(10, 8))
plt.xlabel("Models of multiple regression")
plt.ylabel("Mean Squared Error")
plt.title("Mean Squared Error comparison b/w models")
x = ["Model-1", "Model-2", "Model-3"]
x_axis = np.arange(len(x))
plt.bar(x_axis-0.2, [mse_m1_train, mse_m2_train, mse_m3_train], width=0.4, labe
plt.bar(x_axis+0.2, [mse_m1_test, mse_m2_test, mse_m3_test], width=0.4, label='
plt.xticks(x_axis, x)
plt.legend()
plt.show()
```



In [587…

```
plt.figure(figsize=(10, 8))
plt.xlabel("Models of multiple regression")
plt.ylabel("R2 Score")
plt.title("R2 Score comparison b/w models")
plt.bar(x_axis-0.2, [r2_m1_train, r2_m2_train, r2_m3_train], width=0.4, label="
plt.bar(x_axis+0.2, [r2_m1_test, r2_m2_test, r2_m3_test], width=0.4, label="tes
plt.xticks(x_axis, x)
plt.legend()
plt.show()
```

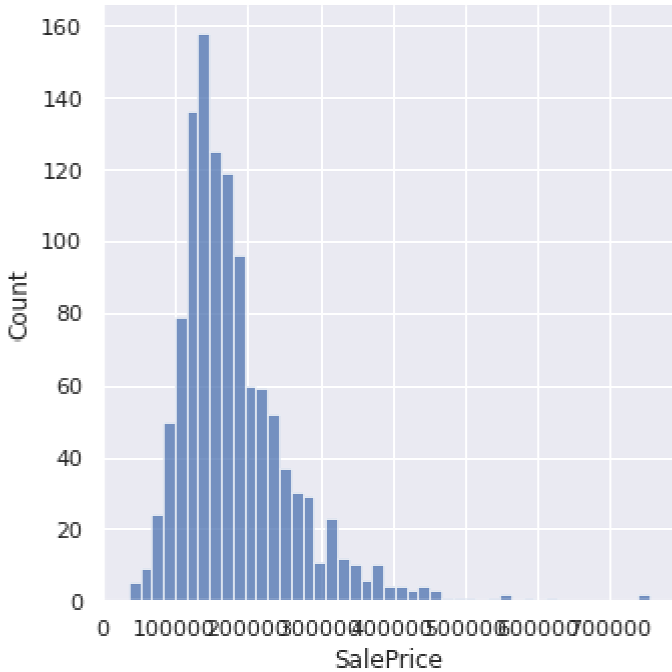


(vi) Multiple Regression (contd.)

Model 4: LotArea, Street

In [588…

```
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 [589…
```
test_df.head()
```

Out[589]:

	SalePrice	LotArea	Street_Grvl	Street_Pave
913	145000	6270	0	1
1204	153500	10140	0	1
1123	118000	9405	0	1
507	208300	7862	0	1
572	224500	13159	0	1

In [590…
```
train_df.head()
```

Out[590]:

	SalePrice	LotArea	Street_Grvl	Street_Pave
640	274000	12677	0	1
275	205000	7264	0	1
703	140000	7630	0	1
1425	142000	10721	0	1
691	755000	21535	0	1

In [591…
```
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 [592…
```
model = LinearRegression()
new_model = model.fit(X_train, y_train)
```

In [593…
```
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)
```

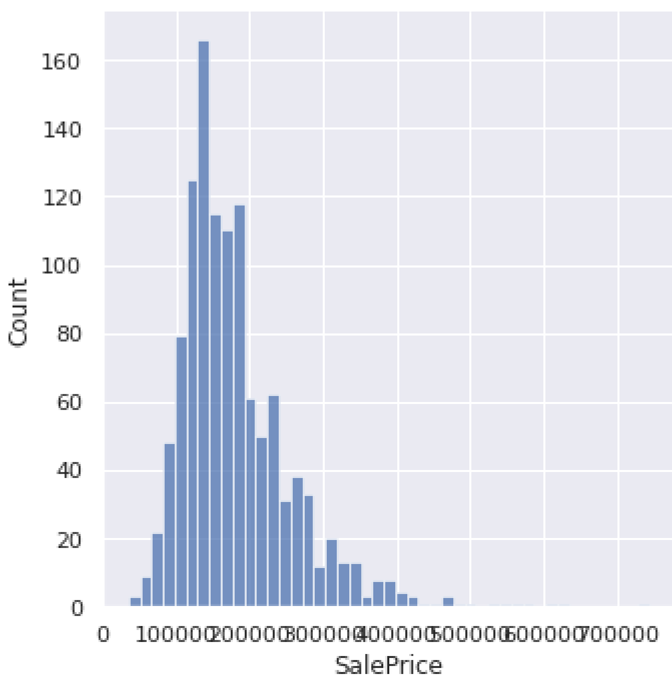
In [594…
```
print("Weights/Coefficients:\n")
for name, weight in zip(variables, new_model.coef_.reshape(-1)):
  if name == 'LotArea':
    lot_area_weights.append(weight)
  print(f"{name.ljust(25)} {weight}")
```

```
Weights/Coefficients:

LotArea                   23454.428840111013
Street_Grvl               -3821.8027884244875
Street_Pave               3821.802788424487
```

Model 5: LotArea, OverallCond, Street, Neighborhood

In [595…
```
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 [596…
```
train_df.head()
```

Out[596]:

	SalePrice	LotArea	OverallCond	Street_Grvl	Street_Pave	Neighborhood_Blmngtn	Neighbo
846	213000	9317	5	0	1	0	
1447	240000	10000	5	0	1	0	
1357	149900	12537	6	0	1	0	
1407	112000	8780	5	0	1	0	
1344	155835	11103	5	0	1	0	

5 rows × 30 columns

In [597…

```
test_df.head()
```

Out[597]:

	SalePrice	LotArea	OverallCond	Street_Grvl	Street_Pave	Neighborhood_Blmngtn	Neighbo
107	115000	6000	5	0	1	0	
1008	240000	12118	5	0	1	0	
35	309000	13418	5	0	1	0	
896	106500	8765	6	0	1	0	
661	402000	46589	7	0	1	0	

5 rows × 30 columns

In [598…

```
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 [599…

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

In [600…

```
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)
```

In [601…

```
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}")
```

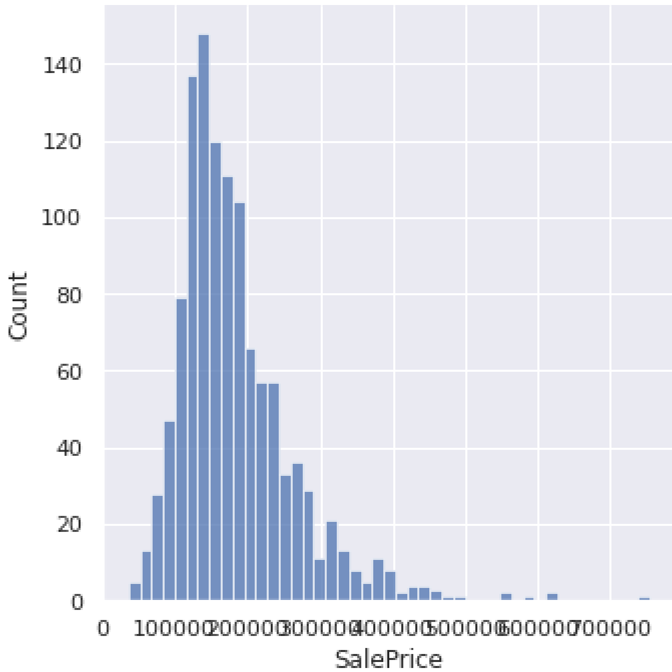
```
Weights/Coefficients:

LotArea                   17232.359311666838
OverallCond               5690.487380540634
Street_Grvl               6.327053544583567e+17
Street_Pave               6.327053544583633e+17
Neighborhood_Blmngtn      -2.590533868132571e+16
Neighborhood_Blueste      -1.0209180430317758e+16
Neighborhood_BrDale       -2.6871600147070444e+16
Neighborhood_BrkSide      -4.901807323061966e+16
Neighborhood_ClearCr      -3.1236575892665076e+16
Neighborhood_CollgCr      -7.765992363967229e+16
Neighborhood_Crawfor      -4.324727727979392e+16
Neighborhood_Edwards      -6.237147971180368e+16
Neighborhood_Gilbert      -5.977162952043296e+16
Neighborhood_IDOTRR       -3.710661263538179e+16
Neighborhood_MeadowV      -2.036575872723541e+16
Neighborhood_Mitchel      -4.267770627300958e+16
Neighborhood_NAmes        -8.955725171956658e+16
Neighborhood_NPkVill      -1.9058632514995564e+16
Neighborhood_NWAmes       -5.275614016006055e+16
Neighborhood_NoRidge      -4.1511898143531064e+16
Neighborhood_NridgHt      -5.3641645591026664e+16
Neighborhood_OldTown      -6.5174816951494e+16
Neighborhood_SWISU        -3.0416677914150104e+16
Neighborhood_Sawyer       -5.5779937075754104e+16
Neighborhood_SawyerW      -4.998417291005957e+16
Neighborhood_Somerst      -5.5779937075731304e+16
Neighborhood_StoneBr      -3.2034101561330188e+16
Neighborhood_Timber       -4.151189814354713e+16
Neighborhood_Veenker      -2.0365758727225176e+16
```

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

In [602…

```
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 [603…

```
train_df.head()
```

Out[603]:

	SalePrice	LotArea	OverallCond	1stFlrSF	YearBuilt	Street_Grvl	Street_Pave	Neighborhood
826	109500	6130	6	784	1924	0	1	
82	245000	10206	5	1563	2007	0	1	
943	143000	25000	4	1632	1967	0	1	
771	102000	8877	5	1220	1951	0	1	
695	176000	13811	6	1137	1987	0	1	

5 rows × 32 columns

In [604…

```
test_df.head()
```

Out[604]:

	SalePrice	LotArea	OverallCond	1stFlrSF	YearBuilt	Street_Grvl	Street_Pave	Neighborhoo
659	167000	9937	7	1486	1964	0	1	
1119	133700	7560	5	1040	1959	0	1	
28	207500	16321	6	1600	1957	0	1	
858	152000	10400	5	1370	1976	0	1	
521	150000	11988	6	1244	1957	0	1	

5 rows × 32 columns

In [605…

```
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 [606…

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

In [607…

```
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)
```

In [608…

```
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}")
```

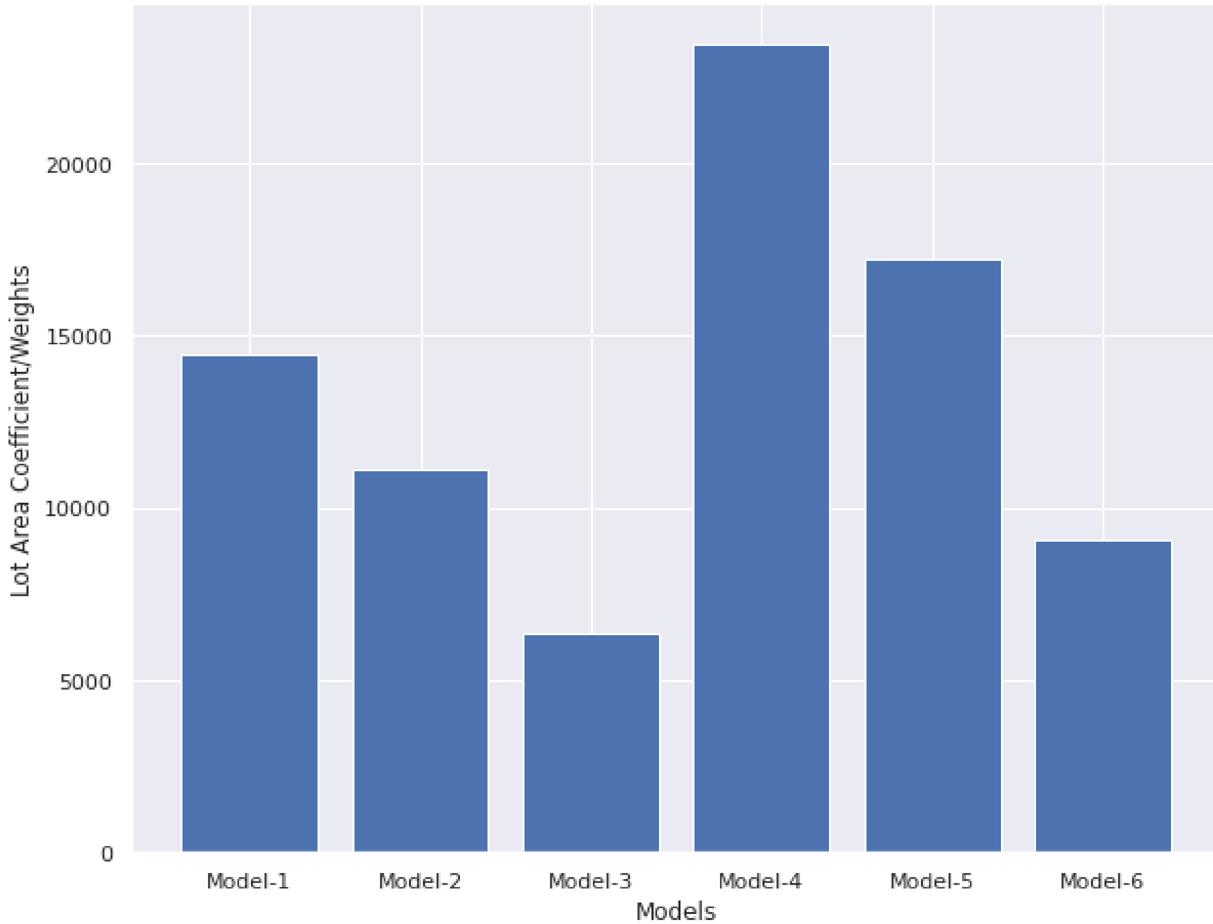
```
Weights/Coefficients:

LotArea                   9095.208739522406
OverallCond               12479.243545260257
1stFlrSF                  29698.585808062122
YearBuilt                 19379.890463052205
Street_Grvl               3227648041608409.5
Street_Pave               3227648041610349.5
Neighborhood_Blmngtn      7702836130916101.0
Neighborhood_Blueste      2828490006877084.5
Neighborhood_BrDale       6898583347436407.0
Neighborhood_BrkSide      1.3848294144969926e+16
Neighborhood_ClearCr      1.0092763613710126e+16
Neighborhood_CollgCr      2.084761612721487e+16
Neighborhood_Crawfor      1.3166990150151112e+16
Neighborhood_Edwards      1.717979040856982e+16
Neighborhood_Gilbert      1.5569149874755398e+16
Neighborhood_IDOTRR       1.064513654875348e+16
Neighborhood_MeadowV      6898583347434978.0
Neighborhood_Mitchel      1.2737500560328244e+16
Neighborhood_NAmes        2.3887916947579524e+16
Neighborhood_NPkVill      5280262405130682.0
Neighborhood_NWAmes       1.4861610052084344e+16
Neighborhood_NoRidge      1.0996423440632056e+16
Neighborhood_NridgHt      1.5908214437482888e+16
Neighborhood_OldTown      1.8878651880316016e+16
Neighborhood_SWISU        8875162581757856.0
Neighborhood_Sawyer       1.423854932814481e+16
Neighborhood_SawyerW      1.371524149406286e+16
Neighborhood_Somerst      1.5796218799714458e+16
Neighborhood_StoneBr      8654205238571872.0
Neighborhood_Timber       1.0996423440618706e+16
Neighborhood_Veenker      5280262405133614.0
```

(vi) Compare the feature “LotArea” weights/coefficients for all the six trained models and plot a graph using the Matplotlib library.

In [609…

```
x_values = [f"Model-{x}" for x in range(1, 7)]
y_values = lot_area_weights
plt.figure(figsize=(10,8))
plt.bar(x_values, y_values)
plt.ylabel('Lot Area Coefficient/Weights')
plt.xlabel('Models')
plt.show()
```

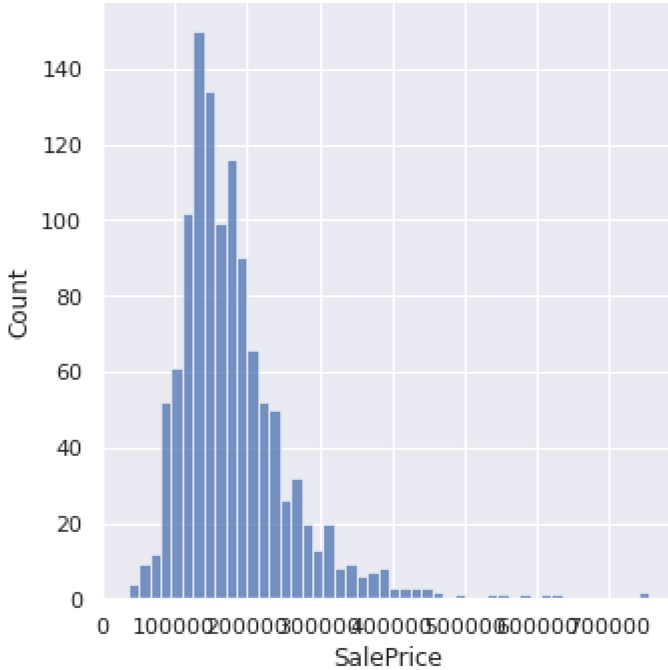


(vii) Polynomial regression

DegrDegree 2ee 2

In [610…

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



In [611…
```
train_df.head()
```

Out[611]:

	SalePrice	LotArea
735	163000	10800
311	132000	8000
1021	194000	7406
881	187500	13758
1148	116900	5700

In [612…
```
test_df.head()
```

Out[612]:

	SalePrice	LotArea
1358	177500	2117
652	191000	8750
900	110000	7340
681	159434	4500
541	248000	11000

In [613…
```
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 [614…
```
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 [615…

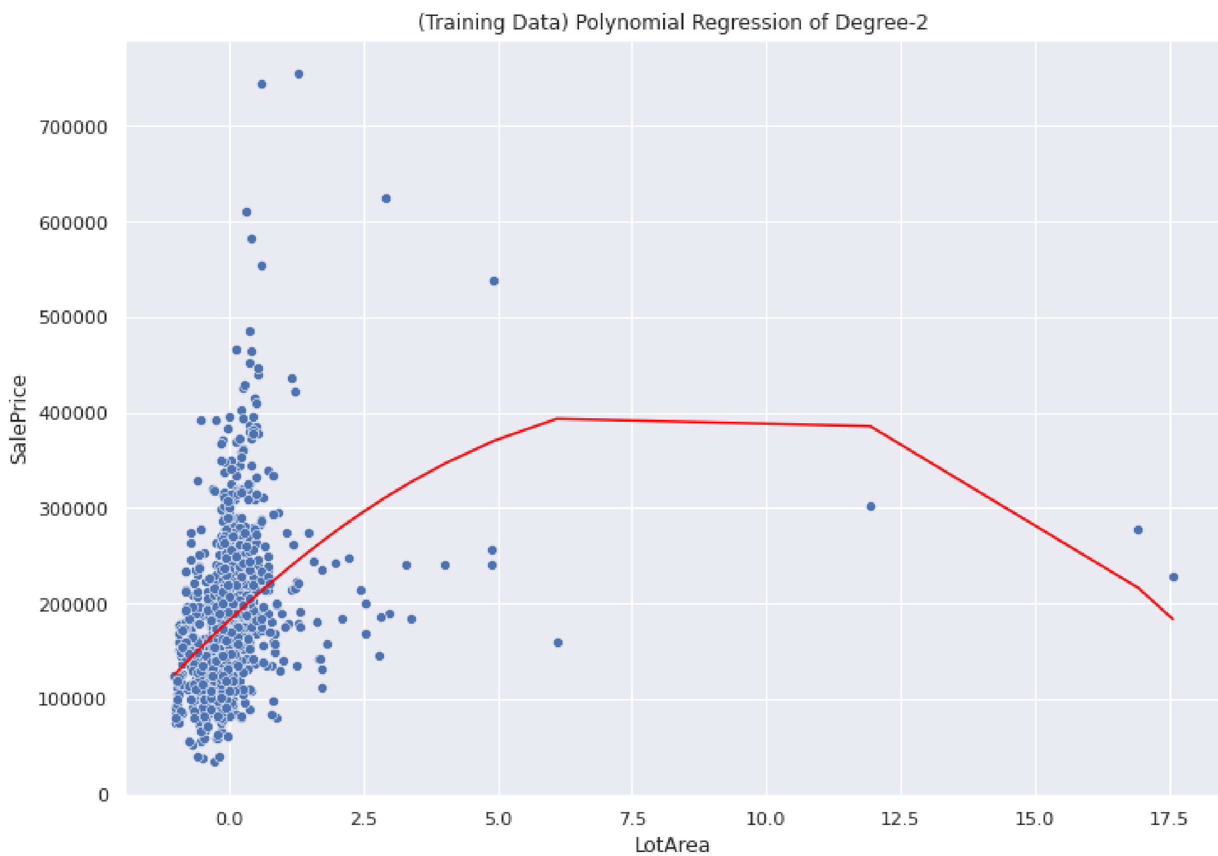
```
y_pred = new_model.predict(poly.fit_transform(X_train))
r2_score_poly = r2_score(y_train, y_pred)
mse_poly = mean_squared_error(y_train, y_pred)
print("[Poly training] r2 score:", r2_score_poly)
print("[Poly training] mean squared error:", mse_poly)
```

```
[Poly training] r2 score: 0.13866776027461258
[Poly training] mean squared error: 5264230361.419709
```

In [616…

```
sns.set(rc={'figure.figsize':(11.7,8.27)})
ax = sns.scatterplot(X_train.reshape(-1), y_train.reshape(-1))
ax.set_xlabel("LotArea")
ax.set_ylabel("SalePrice")
ax.set_title("(Training Data) Polynomial Regression of Degree-2")
sns.lineplot(X_train.reshape(-1), y_pred.reshape(-1), color = 'red')
```

Out[616]: <matplotlib.axes._subplots.AxesSubplot at 0x7f322ec48f90>



In [617…

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

```
(Training Data) Weights/Coefficients:
 [    0.          52938.45068525 -3009.53945681]
```

In [618…

```
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 testing] r2 score:", r2_score_poly)
print("[Poly testing] mean squared error:", mse_poly)
```

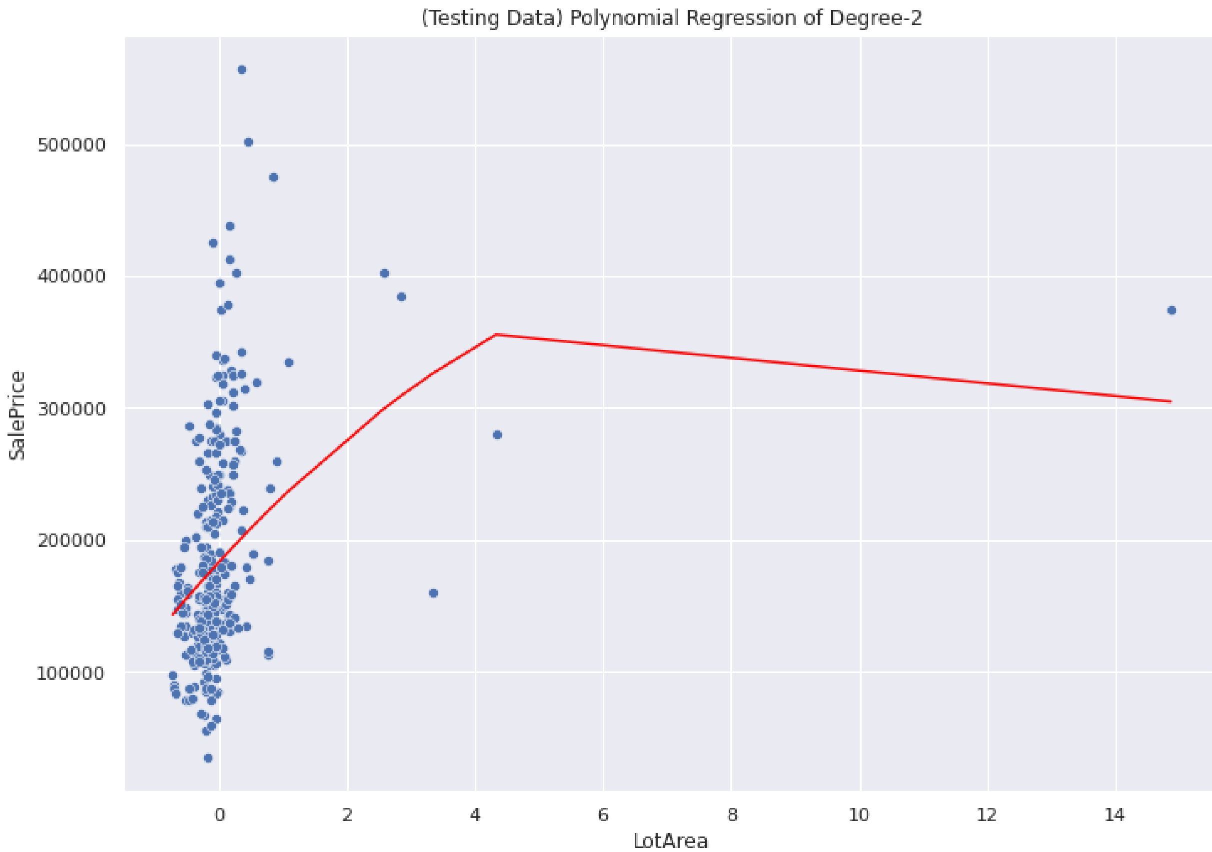
```
[Poly testing] r2 score: 0.1558252665513966
[Poly testing] mean squared error: 5954645391.883501
```

In [619…

```
sns.set(rc={'figure.figsize':(11.7,8.27)})
ax = sns.scatterplot(X_test.reshape(-1), y_test.reshape(-1))
ax.set_xlabel("LotArea")
ax.set_ylabel("SalePrice")
ax.set_title("(Testing Data) Polynomial Regression of Degree-2")
sns.lineplot(X_test.reshape(-1), y_pred.reshape(-1), color = 'red')
```

Out[619]:

```
&lt;matplotlib.axes._subplots.AxesSubplot at 0x7f322e5b8410&gt;
```



In [620…

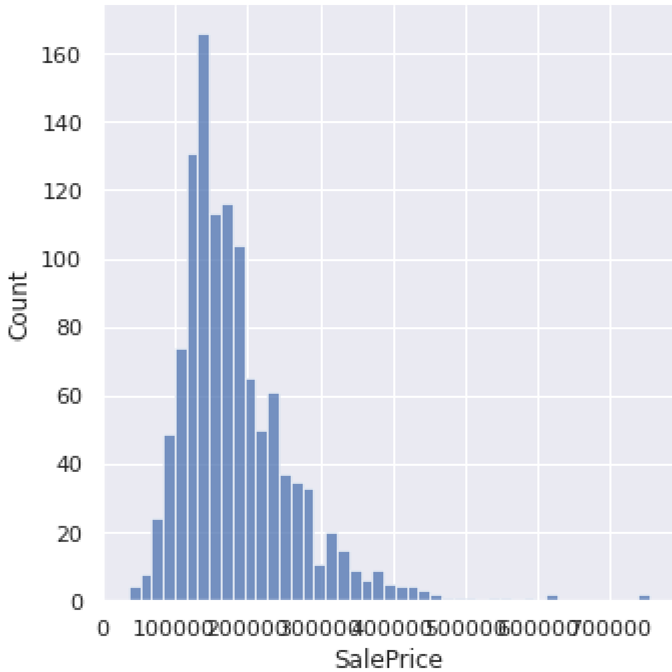
```
print("(Testing Data) Weights/Coefficients:\n", new_model.coef_.reshape(-1))
```

```
(Testing Data) Weights/Coefficients:
 [    0.          52938.45068525 -3009.53945681]
```

Degree 3

In [621…

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



In [622…

```
train_df.head()
```

Out[622]:

	SalePrice	LotArea
293	235000	16659
251	235000	4750
539	272000	11423
326	324000	10846
298	175000	11700

In [623…

```
test_df.head()
```

Out[623]:

	SalePrice	LotArea
1203	213000	9750
1293	162900	10140
605	205000	13600
618	314813	11694
427	109008	8593

In [624…

```
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 [625…

```
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 [626…

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

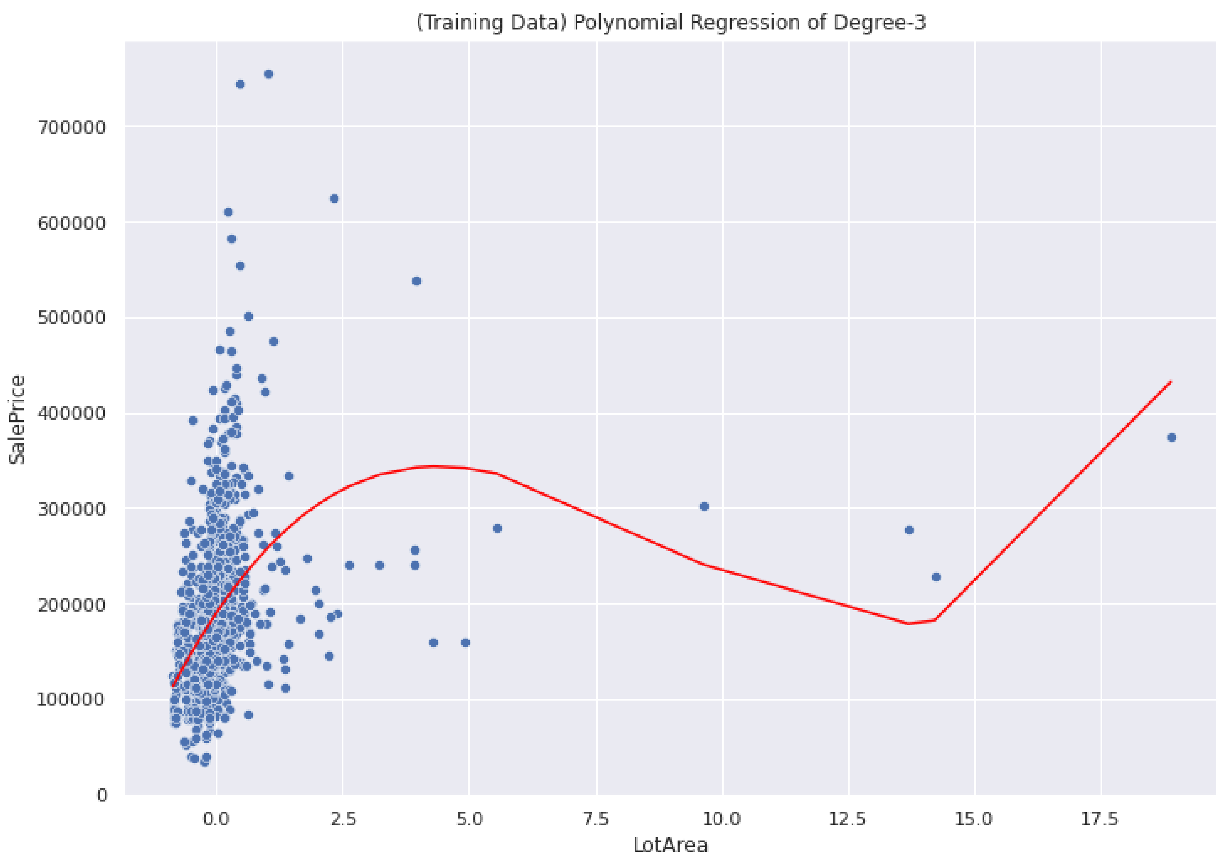
```
[Poly training] r2 score: 0.1687319597132202
[Poly training] mean squared error: 5392311367.540129
```

In [627…

```
sns.set(rc={'figure.figsize':(11.7,8.27)})
ax = sns.scatterplot(X_train.reshape(-1), y_train.reshape(-1))
ax.set_xlabel("LotArea")
ax.set_ylabel("SalePrice")
ax.set_title("(Training Data) Polynomial Regression of Degree-3")
sns.lineplot(X_train.reshape(-1), y_pred.reshape(-1), color = 'red')
```

Out[627]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f322e079f90>
```



In [628…

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

```
(Training Data) Weights/Coefficients:
 [     0.          78881.83508265 -11940.74092112    447.09782091]
```

In [629…

```
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 testing] r2 score:", r2_score_poly)
print("[Poly testing] mean squared error:", mse_poly)
```

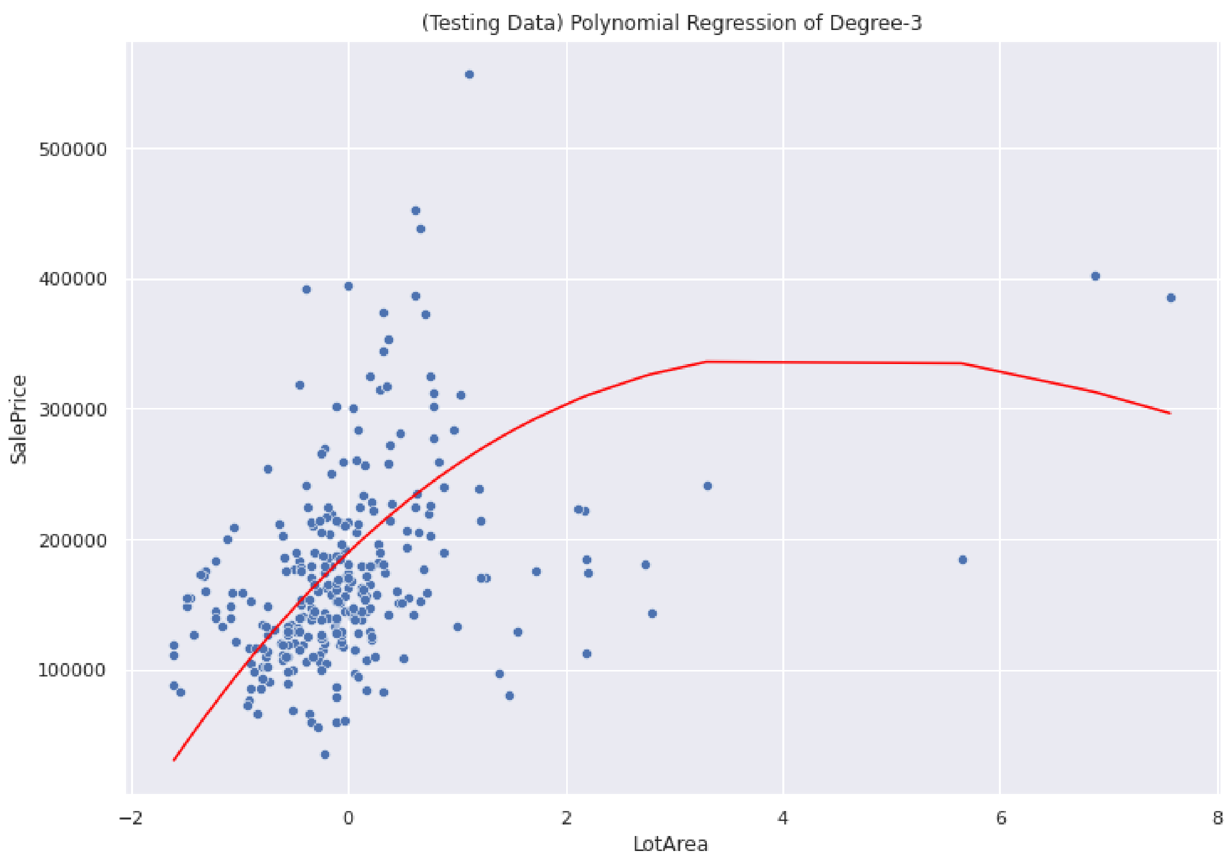
```
[Poly testing] r2 score: 0.01985733188443628
[Poly testing] mean squared error: 5393646937.95993
```

In [630…

```
sns.set(rc={'figure.figsize':(11.7,8.27)})
ax = sns.scatterplot(X_test.reshape(-1), y_test.reshape(-1))
ax.set_xlabel("LotArea")
ax.set_ylabel("SalePrice")
ax.set_title("(Testing Data) Polynomial Regression of Degree-3")
sns.lineplot(X_test.reshape(-1), y_pred.reshape(-1), color = 'red')
```

Out[630]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f322dea3910>
```



In [631…

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

```
(Testing Data) Weights/Coefficients:
 [     0.          78881.83508265 -11940.74092112    447.09782091]
```