```
In [1]:
# import libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import StandardScaler, PolynomialFeatures, MinMaxScaler
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_absolute_error,mean_squared_error,r2_score
```

Data Exploration

```
In [10]:
# read the data and convert it into a dataframe
data = pd.read_csv("C:/Users/akula/Downloads/train.csv",index_col='Id')
```

```
In [11]:
# print the shape of the data frame
print('data frame shape: ', data.shape)
print("the data frame contains %2d rows, and %d columns (attributes)" % (data.shape[0], data.shape[1]))
```

```
data frame shape:  (1460, 80)
the data frame contains 1460 rows, and 80 columns (attributes)
```

```
In [12]:
# print information about the data
data.describe()
```

Out[12]:

	MSSubClass	LotFrontage	LotArea	OverallQual	OverallCond	YearBuilt	YearRemodAdd	MasVnrArea	BsmtFinSF1	BsmtFinSF2	...	WoodDeckSF	OpenPorchSF	Enclose
count	1460.000000	1201.000000	1460.000000	1460.000000	1460.000000	1460.000000	1460.000000	1452.000000	1460.000000	1460.000000	...	1460.000000	1460.000000	1460.
mean	56.897260	70.049958	10516.828082	6.099315	5.575342	1971.267808	1984.865753	103.685262	443.639726	46.549315	...	94.244521	46.660274	21.
std	42.300571	24.284752	9981.264932	1.382997	1.112799	30.202904	20.645407	181.066207	456.098091	161.319273	...	125.338794	66.256028	61.
min	20.000000	21.000000	1300.000000	1.000000	1.000000	1872.000000	1950.000000	0.000000	0.000000	0.000000	...	0.000000	0.000000	0.
25%	20.000000	59.000000	7553.500000	5.000000	5.000000	1954.000000	1967.000000	0.000000	0.000000	0.000000	...	0.000000	0.000000	0.
50%	50.000000	69.000000	9478.500000	6.000000	5.000000	1973.000000	1994.000000	0.000000	383.500000	0.000000	...	0.000000	25.000000	0.
75%	70.000000	80.000000	11601.500000	7.000000	6.000000	2000.000000	2004.000000	166.000000	712.250000	0.000000	...	168.000000	68.000000	0.
max	190.000000	313.000000	215245.000000	10.000000	9.000000	2010.000000	2010.000000	1600.000000	5644.000000	1474.000000	...	857.000000	547.000000	552.

8 rows × 37 columns

```
In [13]:
# print the first 10 rows of the dataframe
data.head()
```

Out[13]:

Id	MSSubClass	MSZoning	LotFrontage	LotArea	Street	Alley	LotShape	LandContour	Utilities	LotConfig	...	PoolArea	PoolQC	Fence	MiscFeature	MiscVal	MoSold	YrSold	SaleTy
1	60	RL	65.0	8450	Pave	NaN	Reg	Lvl	AllPub	Inside	...	0	NaN	NaN	NaN	0	2	2008	V
2	20	RL	80.0	9600	Pave	NaN	Reg	Lvl	AllPub	FR2	...	0	NaN	NaN	NaN	0	5	2007	V
3	60	RL	68.0	11250	Pave	NaN	IR1	Lvl	AllPub	Inside	...	0	NaN	NaN	NaN	0	9	2008	V
4	70	RL	60.0	9550	Pave	NaN	IR1	Lvl	AllPub	Corner	...	0	NaN	NaN	NaN	0	2	2006	V
5	60	RL	84.0	14260	Pave	NaN	IR1	Lvl	AllPub	FR2	...	0	NaN	NaN	NaN	0	12	2008	V

5 rows × 80 columns

Data Cleaning

```
In [14]:
# print the types of the attributes
print(data.dtypes.to_string())
```

```
MSSubClass         int64
MSZoning          object
LotFrontage      float64
LotArea            int64
Street            object
Alley             object
LotShape          object
LandContour       object
Utilities         object
LotConfig         object
LandSlope         object
Neighborhood      object
Condition1        object
Condition2        object
BldgType          object
HouseStyle        object
OverallQual        int64
OverallCond        int64
YearBuilt          int64
YearRemodAdd       int64
RoofStyle         object
RoofMatl          object
Exterior1st       object
Exterior2nd       object
MasVnrType        object
MasVnrArea       float64
ExterQual         object
ExterCond         object
Foundation        object
BsmtQual          object
BsmtCond          object
BsmtExposure      object
BsmtFinType1      object
BsmtFinSF1         int64
BsmtFinType2      object
BsmtFinSF2         int64
BsmtUnfSF          int64
TotalBsmtSF        int64
Heating           object
HeatingQC         object
CentralAir        object
Electrical        object
1stFlrSF           int64
2ndFlrSF           int64
LowQualFinSF       int64
GrLivArea          int64
BsmtFullBath       int64
BsmtHalfBath       int64
FullBath           int64
HalfBath           int64
BedroomAbvGr       int64
KitchenAbvGr       int64
KitchenQual       object
TotRmsAbvGrd       int64
Functional        object
Fireplaces         int64
FireplaceQu       object
GarageType        object
GarageYrBlt      float64
GarageFinish      object
GarageCars         int64
GarageArea         int64
GarageQual        object
GarageCond        object
PavedDrive        object
WoodDeckSF         int64
OpenPorchSF        int64
EnclosedPorch      int64
3SsnPorch          int64
ScreenPorch        int64
PoolArea           int64
PoolQC            object
Fence             object
MiscFeature       object
MiscVal            int64
MoSold             int64
YrSold             int64
SaleType          object
SaleCondition     object
SalePrice          int64
```

```
In [15]:
# for simplicity let's exclude the non numerical attributes
num_data = data.select_dtypes(exclude=['object'])
```

```
In [16]:
# check that now we do not have any non numerical attributes
print(num_data.dtypes.to_string())
```

```
MSSubClass         int64
LotFrontage      float64
LotArea            int64
OverallQual        int64
OverallCond        int64
YearBuilt          int64
YearRemodAdd       int64
MasVnrArea       float64
BsmtFinSF1         int64
BsmtFinSF2         int64
BsmtUnfSF          int64
TotalBsmtSF        int64
1stFlrSF           int64
2ndFlrSF           int64
LowQualFinSF       int64
GrLivArea          int64
BsmtFullBath       int64
BsmtHalfBath       int64
FullBath           int64
HalfBath           int64
BedroomAbvGr       int64
KitchenAbvGr       int64
TotRmsAbvGrd       int64
Fireplaces         int64
GarageYrBlt      float64
GarageCars         int64
GarageArea         int64
WoodDeckSF         int64
OpenPorchSF        int64
EnclosedPorch      int64
3SsnPorch          int64
ScreenPorch        int64
PoolArea           int64
MiscVal            int64
MoSold             int64
YrSold             int64
SalePrice          int64
```

```
In [17]:
# check for Nan values
# print the columns with NaN values
cols_with_nans = num_data.isnull().sum()
print("number of NaN values for the training data frame :")
print(cols_with_nans[cols_with_nans>0])
```

```
number of NaN values for the training data frame :
LotFrontage    259
MasVnrArea       8
GarageYrBlt     81
dtype: int64
```

```
In [18]:
# since all the attributes are numerical, we will replace all the Nan values with the mean of the attribute
# replace the NaN values with the mean
clean_data = num_data.fillna(num_data.mean())
```

```
In [19]:
# let's check that we do  not have any NaN values
# print the columns with NaN values
cols_with_nans = clean_data.isnull().sum()
print("number of NaN values for the training data frame :")
print(cols_with_nans[cols_with_nans>0])
```

```
number of NaN values for the training data frame :
Series([], dtype: int64)
```

```
In [20]:
# finally, let's check the shape of the cleaned data
print('the shape of the data: ', clean_data.shape)
print('the data frame contains %d rows, and %d columns (attributes)' % (clean_data.shape[0], clean_data.shape[1]))
```

```
the shape of the data:  (1460, 37)
the data frame contains 1460 rows, and 37 columns (attributes)
```

Exploratory Data Analysis

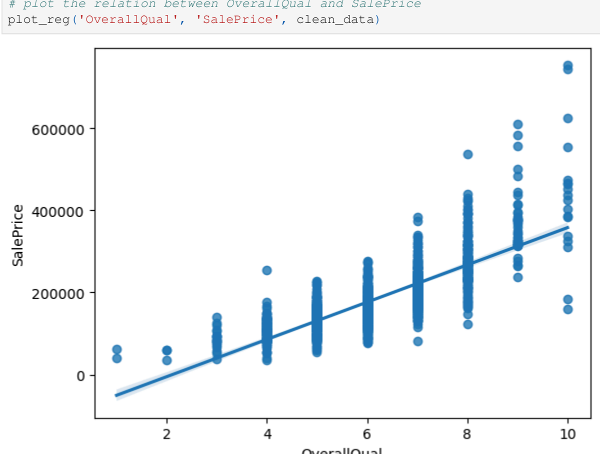
```
In [21]:
def plot_reg(x_var, y_var, DataFrame):
    # draw regplot
    sns.regplot(x = x_var,
                y = y_var,
                data = DataFrame)

    # show the plot
    plt.show()
```

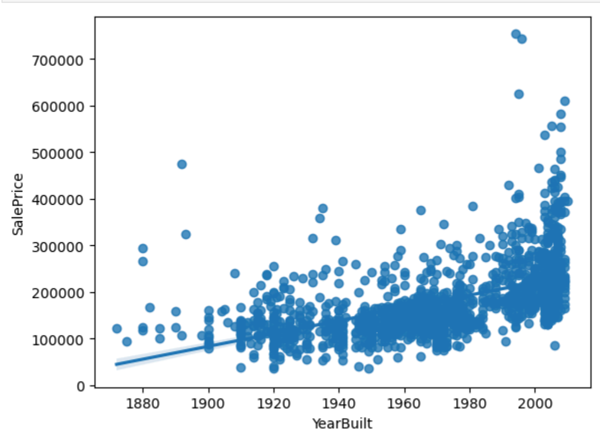
```
In [22]:
# extract the names of the attributes
att_names = clean_data.columns.tolist()
print(att_names)
```

```
['MSSubClass', 'LotFrontage', 'LotArea', 'OverallQual', 'OverallCond', 'YearBuilt', 'YearRemodAdd', 'MasVnrArea', 'BsmtFinSF1', 'BsmtFinSF2', 'BsmtUnfSF', 'TotalBsmtSF', '1stFlrSF', '2ndFlrSF', 'LowQualFinSF', 'GrLivArea', 'BsmtFullBath', 'BsmtHalfBath', 'FullBath', 'HalfBath', 'BedroomAbvGr', 'KitchenAbvGr', 'TotRmsAbvGrd', 'Fireplaces', 'GarageYrBlt', 'GarageCars', 'GarageArea', 'WoodDeckSF', 'OpenPorchSF', 'EnclosedPorch', '3SsnPorch', 'ScreenPorch', 'PoolArea', 'MiscVal', 'MoSold', 'YrSold', 'SalePrice']
```

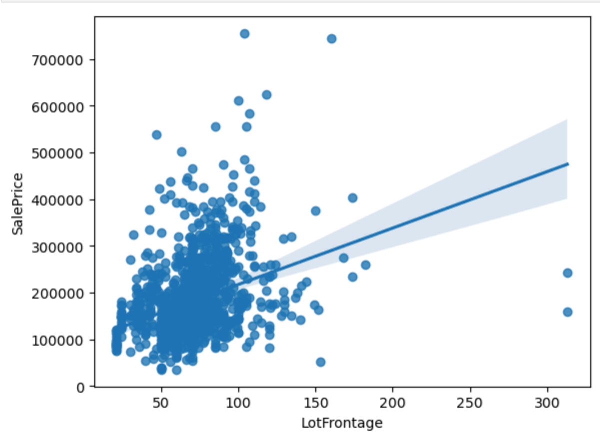
```
In [23]:
# plot the relation between OverallQual and SalePrice
plot_reg('OverallQual', 'SalePrice', clean_data)
```




```
In [24]:
# plot the relation between YearBuilt and SalePrice
plot_reg('YearBuilt', 'SalePrice', clean_data)
```




```
In [25]:
# plot the relation between LotFrontage and SalePrice
plot_reg('LotFrontage', 'SalePrice', clean_data)
```



Data Splitting

```
In [26]:
# extract the features from the data frame
columns = clean_data.columns
features_names = columns[columns != 'SalePrice']
features = clean_data[features_names]
target = clean_data['SalePrice']
```

```
In [27]:
# split the data
X_train, X_test, Y_train, Y_test = train_test_split(features, target, test_size=0.2, random_state=42)
```

Data Preprocessing

```
In [28]:
scaler = StandardScaler()
X_train_s = scaler.fit_transform(X_train)
X_test_s = scaler.transform(X_test)
```

```
In [29]:
# initialising the MinMaxScaler
scaler = MinMaxScaler(feature_range=(0, 1))

# learning the statistical parameters for each of the data and transforming
rescaledX_train = scaler.fit_transform(X_train)
rescaledX_test  = scaler.transform(X_test)
```

Linear Regression Model

```
In [30]:
# create a linear regression model
lr_model = LinearRegression()
```

```
In [31]:
# fit the model
lr_model.fit(rescaledX_train, Y_train)
```

```
Out[31]:
▾ LinearRegression
LinearRegression()
```

```
In [32]:
# get the prediction of the trained model
lr_predictions = lr_model.predict(rescaledX_test)
```

Scores and Results

```
In [33]:
# evaluate the regression results
LinearRegression_SCR  = lr_model.score(rescaledX_test, Y_test)
LinearRegression_MAE  = mean_absolute_error(Y_test, lr_predictions)
LinearRegression_MSE  = mean_squared_error(Y_test, lr_predictions)
LinearRegression_RMSE = np.sqrt(mean_squared_error(Y_test, lr_predictions))
LinearRegression_R2   = r2_score(Y_test, lr_predictions)
```

```
In [34]:
# convert the scores into a dataframe and print it
Report = pd.DataFrame({'Metric': ['Score', 'MAE', 'MSE', 'RMSE','R^2'],
        'Value': [LinearRegression_SCR, LinearRegression_MAE, LinearRegression_MSE,
                  LinearRegression_RMSE, LinearRegression_R2]})
Report
```

Out[34]:

	Metric	Value
0	Score	8.231506e-01
1	MAE	2.298050e+04
2	MSE	1.356493e+09
3	RMSE	3.683059e+04
4	R^2	8.231506e-01

```
In [35]:
# plot Actual Prices vs Predicted Prices
plt.figure(figsize=(10, 6))
plt.scatter(Y_test, lr_predictions, alpha=0.5)
plt.xlabel("Actual Prices")
plt.ylabel("Predicted Prices")
plt.title(f" Actual Prices vs Predicted Prices")
plt.show()
```


```
In [ ]:
```