Import Libraries

In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import calendar
from pandas.api.types import CategoricalDtype
from sklearn.preprocessing import StandardScaler
```

Data Loading

In [ ]:
```
train_data_path=r"train.csv"
test_data_path=r"test.csv"

df_train=pd.read_csv(train_data_path)
df_test=pd.read_csv(test_data_path)

print(df_train.shape)
print(df_test.shape)
```

```
(1460, 81)
(1459, 80)
```

Data Analysis

In [3]:
```
pd.set_option('display.max_columns',None) #to display all columns
pd.set_option('display.max_rows',None) #to display all rows
```

In [4]:
```
df_train.head()
```

Out[4]:

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

In [5]:
```
df_test.head()
```

Out[5]:

	Id	MSSubClass	MSZoning	LotFrontage	LotArea	Street	Alley	LotShape	L
0	1461	20	RH	80.0	11622	Pave	NaN	Reg	
1	1462	20	RL	81.0	14267	Pave	NaN	IR1	
2	1463	60	RL	74.0	13830	Pave	NaN	IR1	
3	1464	60	RL	78.0	9978	Pave	NaN	IR1	
4	1465	120	RL	43.0	5005	Pave	NaN	IR1	

data integration

In [6]:
```
df=pd.concat((df_train,df_test))
temp_df=df
print(df.shape)
```

```
(2919, 81)
```

In [7]:
```
df.head()
```

Out[7]:

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

In [8]:
```
df.tail()
```

Out[8]:

	Id	MSSubClass	MSZoning	LotFrontage	LotArea	Street	Alley	LotShap
1454	2915	160	RM	21.0	1936	Pave	NaN	Re
1455	2916	160	RM	21.0	1894	Pave	NaN	Re
1456	2917	20	RL	160.0	20000	Pave	NaN	Re
1457	2918	85	RL	62.0	10441	Pave	NaN	Re
1458	2919	60	RL	74.0	9627	Pave	NaN	Re

Exploratory data analysis

In [9]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
```

```
Int64Index: 2919 entries, 0 to 1458
Data columns (total 81 columns):
 #   Column         Non-Null Count  Dtype  
---  ------         --------------  -----  
 0   Id             2919 non-null   int64  
 1   MSSubClass     2919 non-null   int64  
 2   MSZoning       2915 non-null   object 
 3   LotFrontage    2433 non-null   float64
 4   LotArea        2919 non-null   int64  
 5   Street         2919 non-null   object 
 6   Alley          198 non-null    object 
 7   LotShape       2919 non-null   object 
 8   LandContour    2919 non-null   object 
 9   Utilities      2917 non-null   object 
 10  LotConfig      2919 non-null   object 
 11  LandSlope      2919 non-null   object 
 12  Neighborhood   2919 non-null   object 
 13  Condition1     2919 non-null   object 
 14  Condition2     2919 non-null   object 
 15  BldgType       2919 non-null   object 
 16  HouseStyle     2919 non-null   object 
 17  OverallQual    2919 non-null   int64  
 18  OverallCond    2919 non-null   int64  
 19  YearBuilt      2919 non-null   int64  
 20  YearRemodAdd   2919 non-null   int64  
 21  RoofStyle      2919 non-null   object 
 22  RoofMatl       2919 non-null   object 
 23  Exterior1st    2918 non-null   object 
 24  Exterior2nd    2918 non-null   object 
 25  MasVnrType     2895 non-null   object 
 26  MasVnrArea     2896 non-null   float64
 27  ExterQual      2919 non-null   object 
 28  ExterCond      2919 non-null   object 
 29  Foundation     2919 non-null   object 
 30  BsmtQual       2838 non-null   object 
 31  BsmtCond       2837 non-null   object 
 32  BsmtExposure   2837 non-null   object 
 33  BsmtFinType1   2840 non-null   object 
 34  BsmtFinSF1     2918 non-null   float64
 35  BsmtFinType2   2839 non-null   object 
 36  BsmtFinSF2     2918 non-null   float64
 37  BsmtUnfSF      2918 non-null   float64
 38  TotalBsmtSF    2918 non-null   float64
 39  Heating        2919 non-null   object 
 40  HeatingQC      2919 non-null   object 
 41  CentralAir     2919 non-null   object 
 42  Electrical     2918 non-null   object 
 43  1stFlrSF       2919 non-null   int64  
 44  2ndFlrSF       2919 non-null   int64  
 45  LowQualFinSF   2919 non-null   int64  
 46  GrLivArea      2919 non-null   int64  
 47  BsmtFullBath   2917 non-null   float64
 48  BsmtHalfBath   2917 non-null   float64
```

```
 49  FullBath       2919 non-null   int64
 50  HalfBath       2919 non-null   int64
 51  BedroomAbvGr   2919 non-null   int64
 52  KitchenAbvGr   2919 non-null   int64
 53  KitchenQual    2918 non-null   object
 54  TotRmsAbvGrd   2919 non-null   int64
 55  Functional     2917 non-null   object
 56  Fireplaces     2919 non-null   int64
 57  FireplaceQu    1499 non-null   object
 58  GarageType     2762 non-null   object
 59  GarageYrBlt    2760 non-null   float64
 60  GarageFinish   2760 non-null   object
 61  GarageCars     2918 non-null   float64
 62  GarageArea     2918 non-null   float64
 63  GarageQual     2760 non-null   object
 64  GarageCond     2760 non-null   object
 65  PavedDrive     2919 non-null   object
 66  WoodDeckSF     2919 non-null   int64
 67  OpenPorchSF    2919 non-null   int64
 68  EnclosedPorch  2919 non-null   int64
 69  3SsnPorch      2919 non-null   int64
 70  ScreenPorch    2919 non-null   int64
 71  PoolArea       2919 non-null   int64
 72  PoolQC         10 non-null     object
 73  Fence          571 non-null    object
 74  MiscFeature    105 non-null    object
 75  MiscVal        2919 non-null   int64
 76  MoSold         2919 non-null   int64
 77  YrSold         2919 non-null   int64
 78  SaleType       2918 non-null   object
 79  SaleCondition  2919 non-null   object
 80  SalePrice      1460 non-null   float64
dtypes: float64(12), int64(26), object(43)
memory usage: 1.8+ MB
```

In [10]:

```
df.describe()
```

Out[10]:

	Id	MSSubClass	LotFrontage	LotArea	OverallQual	Ove
count	2919.000000	2919.000000	2433.000000	2919.000000	2919.000000	2919
mean	1460.000000	57.137718	69.305795	10168.114080	6.089072	5
std	842.787043	42.517628	23.344905	7886.996359	1.409947	
min	1.000000	20.000000	21.000000	1300.000000	1.000000	1
25%	730.500000	20.000000	59.000000	7478.000000	5.000000	5
50%	1460.000000	50.000000	68.000000	9453.000000	6.000000	5
75%	2189.500000	70.000000	80.000000	11570.000000	7.000000	6
max	2919.000000	190.000000	313.000000	215245.000000	10.000000	9

In [11]:
```
int_feature=df.select_dtypes(include=['int64']).columns
```

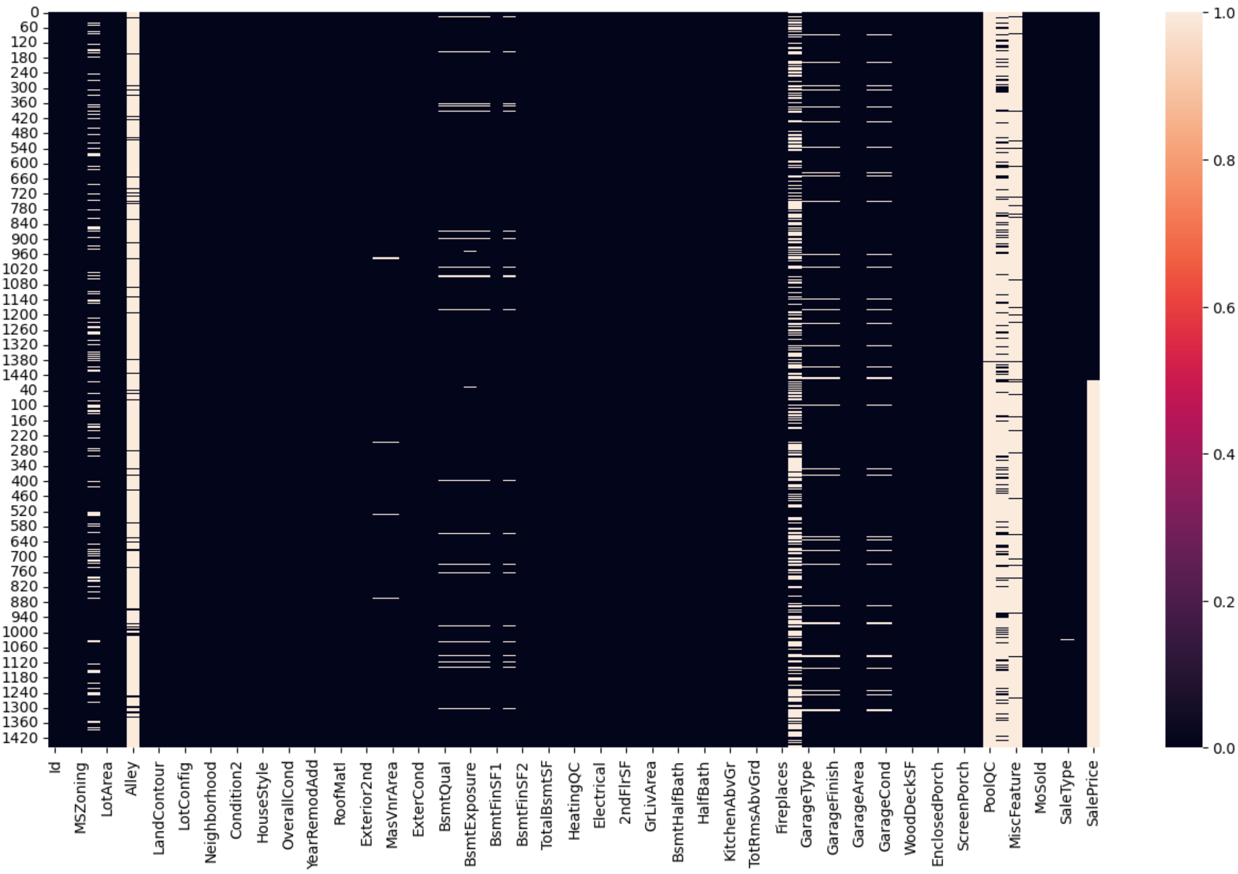
In [12]:
```
float_feature=df.select_dtypes(include=['float64']).columns
```

In [13]:
```
cat_feature=df.select_dtypes(include=['object']).columns
```

visualing missing value

In [14]:
```
plt.figure(figsize=(16,9))
sns.heatmap(df.isnull())
```

Out[14]: <AxesSubplot: >



In [15]:
```
# set index as is column
df=df.set_index("Id")
```

get the null value percentage for every feature

In [16]:
```
null_count=df.isnull().sum()
null_count
```

Out[16]:
```
MSSubClass         0
MSZoning           4
LotFrontage      486
LotArea            0
```

```
Street              0
Alley            2721
LotShape            0
LandContour         0
Utilities           2
LotConfig           0
LandSlope           0
Neighborhood        0
Condition1          0
Condition2          0
BldgType            0
HouseStyle          0
OverallQual         0
OverallCond         0
YearBuilt           0
YearRemodAdd        0
RoofStyle           0
RoofMatl            0
Exterior1st         1
Exterior2nd         1
MasVnrType         24
MasVnrArea         23
ExterQual           0
ExterCond           0
Foundation          0
BsmtQual           81
BsmtCond           82
BsmtExposure       82
BsmtFinType1       79
BsmtFinSF1          1
BsmtFinType2       80
BsmtFinSF2          1
BsmtUnfSF           1
TotalBsmtSF         1
Heating             0
HeatingQC           0
CentralAir          0
Electrical          1
1stFlrSF            0
2ndFlrSF            0
LowQualFinSF        0
GrLivArea           0
BsmtFullBath        2
BsmtHalfBath        2
FullBath            0
HalfBath            0
BedroomAbvGr        0
KitchenAbvGr        0
KitchenQual         1
TotRmsAbvGrd        0
Functional          2
Fireplaces          0
FireplaceQu      1420
```

```
GarageType        157
GarageYrBlt       159
GarageFinish      159
GarageCars          1
GarageArea          1
GarageQual        159
GarageCond        159
PavedDrive          0
WoodDeckSF          0
OpenPorchSF         0
EnclosedPorch       0
3SsnPorch           0
ScreenPorch         0
PoolArea            0
PoolQC           2909
Fence            2348
MiscFeature      2814
MiscVal             0
MoSold              0
YrSold              0
SaleType            1
SaleCondition       0
SalePrice        1459
dtype: int64
```

In [17]:

```python
null_percent=df.isnull().sum()/df.shape[0]*100
null_percent
```

Out[17]:

```
MSSubClass        0.000000
MSZoning          0.137033
LotFrontage      16.649538
LotArea           0.000000
Street            0.000000
Alley            93.216855
LotShape          0.000000
LandContour       0.000000
Utilities         0.068517
LotConfig         0.000000
LandSlope         0.000000
Neighborhood      0.000000
Condition1        0.000000
Condition2        0.000000
BldgType          0.000000
HouseStyle        0.000000
OverallQual       0.000000
OverallCond       0.000000
YearBuilt         0.000000
YearRemodAdd      0.000000
RoofStyle         0.000000
RoofMatl          0.000000
Exterior1st       0.034258
Exterior2nd       0.034258
MasVnrType        0.822199
MasVnrArea        0.787941
```

ExterQual	0.000000
ExterCond	0.000000
Foundation	0.000000
BsmtQual	2.774923
BsmtCond	2.809181
BsmtExposure	2.809181
BsmtFinType1	2.706406
BsmtFinSF1	0.034258
BsmtFinType2	2.740665
BsmtFinSF2	0.034258
BsmtUnfSF	0.034258
TotalBsmtSF	0.034258
Heating	0.000000
HeatingQC	0.000000
CentralAir	0.000000
Electrical	0.034258
1stFlrSF	0.000000
2ndFlrSF	0.000000
LowQualFinSF	0.000000
GrLivArea	0.000000
BsmtFullBath	0.068517
BsmtHalfBath	0.068517
FullBath	0.000000
HalfBath	0.000000
BedroomAbvGr	0.000000
KitchenAbvGr	0.000000
KitchenQual	0.034258
TotRmsAbvGrd	0.000000
Functional	0.068517
Fireplaces	0.000000
FireplaceQu	48.646797
GarageType	5.378554
GarageYrBlt	5.447071
GarageFinish	5.447071
GarageCars	0.034258
GarageArea	0.034258
GarageQual	5.447071
GarageCond	5.447071
PavedDrive	0.000000
WoodDeckSF	0.000000
OpenPorchSF	0.000000
EnclosedPorch	0.000000
3SsnPorch	0.000000
ScreenPorch	0.000000
PoolArea	0.000000
PoolQC	99.657417
Fence	80.438506
MiscFeature	96.402878
MiscVal	0.000000
MoSold	0.000000
YrSold	0.000000
SaleType	0.034258
SaleCondition	0.000000

```
SalePrice       49.982871
dtype: float64
```

drop column/features

In [18]:
```
""" as per domain knowldge we will not drop this featurre rather we add s
miss_value_50_perc=null_percent[null_percent>50]
miss_value_50_perc
```

Out[18]:
```
Alley          93.216855
PoolQC         99.657417
Fence          80.438506
MiscFeature    96.402878
dtype: float64
```

In [19]:
```
""" as per domain knowldge we will not drop this featurre rather we add s
miss_value_20_50_perc=null_percent[(null_percent>20)& (null_percent<51)]
miss_value_20_50_perc
```

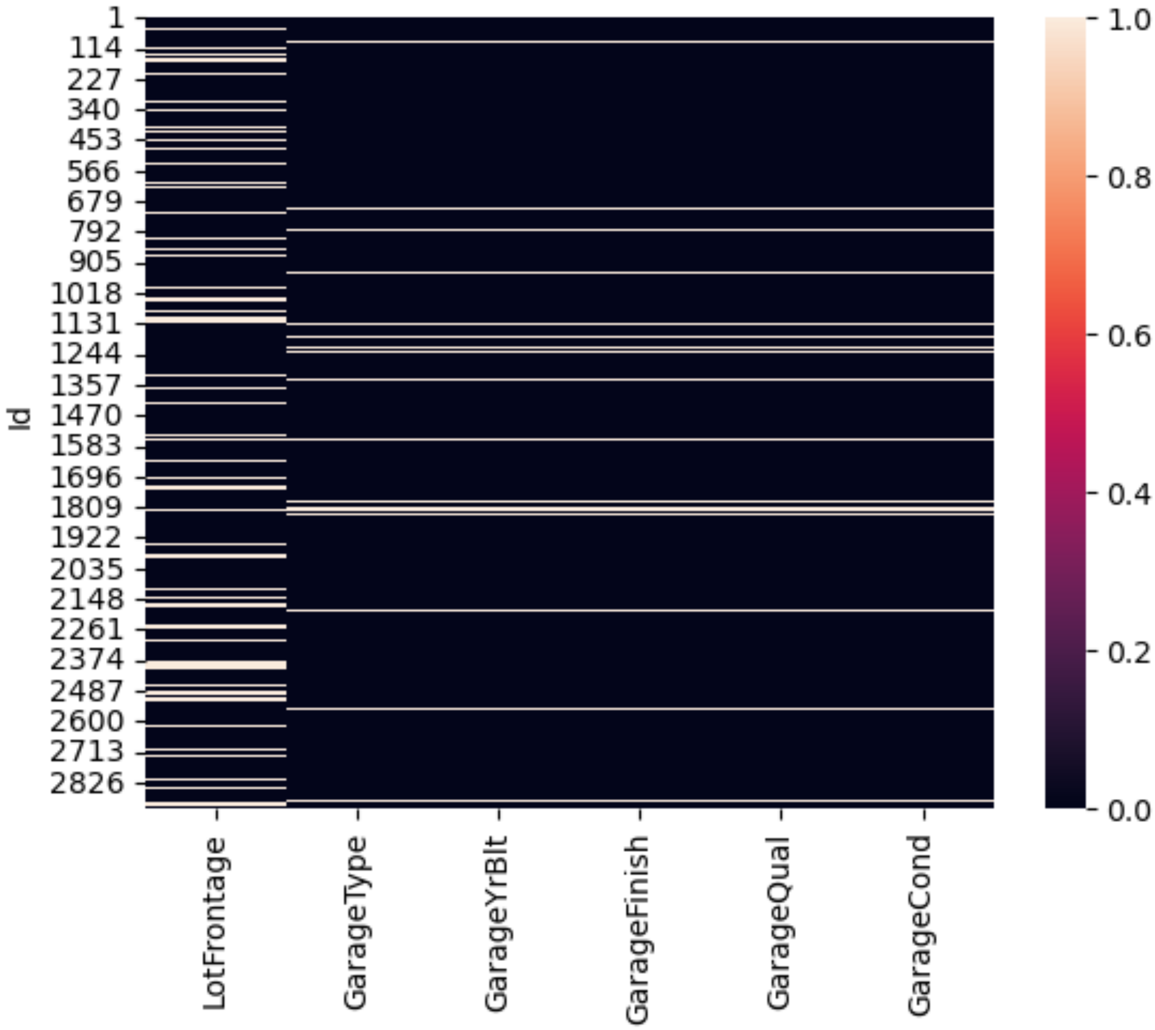
Out[19]:
```
FireplaceQu    48.646797
SalePrice      49.982871
dtype: float64
```

In [20]:
```
miss_value_5_20_perc=null_percent[(null_percent>5)& (null_percent<21)]
miss_value_5_20_perc
```

Out[20]:
```
LotFrontage     16.649538
GarageType       5.378554
GarageYrBlt      5.447071
GarageFinish     5.447071
GarageQual       5.447071
GarageCond       5.447071
dtype: float64
```

In [21]:
```
sns.heatmap(df[miss_value_5_20_perc.keys()].isnull())
```

Out[21]:
```
<AxesSubplot: ylabel='Id'>
```



In [22]:
```
## as per observation we will not drop any feature from data set
```

missing value imputation

In [23]:
```
missing_value_feat=null_percent[null_percent>0]
print("Total missing value feature=",len(missing_value_feat))
missing_value_feat
```

```
Total missing value feature= 35
```

Out[23]:
```
MSZoning          0.137033
LotFrontage      16.649538
Alley            93.216855
Utilities         0.068517
Exterior1st       0.034258
Exterior2nd       0.034258
MasVnrType        0.822199
MasVnrArea        0.787941
BsmtQual          2.774923
BsmtCond          2.809181
BsmtExposure      2.809181
BsmtFinType1      2.706406
BsmtFinSF1        0.034258
BsmtFinType2      2.740665
BsmtFinSF2        0.034258
BsmtUnfSF         0.034258
TotalBsmtSF       0.034258
Electrical        0.034258
BsmtFullBath      0.068517
BsmtHalfBath      0.068517
KitchenQual       0.034258
Functional        0.068517
FireplaceQu      48.646797
GarageType        5.378554
GarageYrBlt       5.447071
GarageFinish      5.447071
GarageCars        0.034258
GarageArea        0.034258
GarageQual        5.447071
GarageCond        5.447071
PoolQC           99.657417
Fence            80.438506
MiscFeature      96.402878
SaleType          0.034258
SalePrice        49.982871
dtype: float64
```

In [24]:
```python
cat_na_feat=missing_value_feat[missing_value_feat.keys().isin(cat_feature
print("total number of categorical missing feature",len(cat_na_feat))
cat_na_feat
```

```
total number of categorical missing feature 23
```

Out[24]:
```
MSZoning          0.137033
Alley            93.216855
Utilities         0.068517
Exterior1st       0.034258
Exterior2nd       0.034258
MasVnrType        0.822199
BsmtQual          2.774923
BsmtCond          2.809181
BsmtExposure      2.809181
BsmtFinType1      2.706406
BsmtFinType2      2.740665
Electrical        0.034258
KitchenQual       0.034258
Functional        0.068517
FireplaceQu      48.646797
GarageType        5.378554
GarageFinish      5.447071
GarageQual        5.447071
GarageCond        5.447071
PoolQC           99.657417
Fence            80.438506
MiscFeature      96.402878
SaleType          0.034258
dtype: float64
```

In [25]:
```
int_na_feat=missing_value_feat[missing_value_feat.keys().isin(int_feature
print("total number of int missing feature",len(int_na_feat))
int_na_feat
```

```
total number of int missing feature 0
```

Out[25]:
```
Series([], dtype: float64)
```

In [26]:
```
float_na_feat=missing_value_feat[missing_value_feat.keys().isin(float_fea
print("total number of float missing feature",len(float_na_feat))
float_na_feat
```

```
total number of float missing feature 12
```

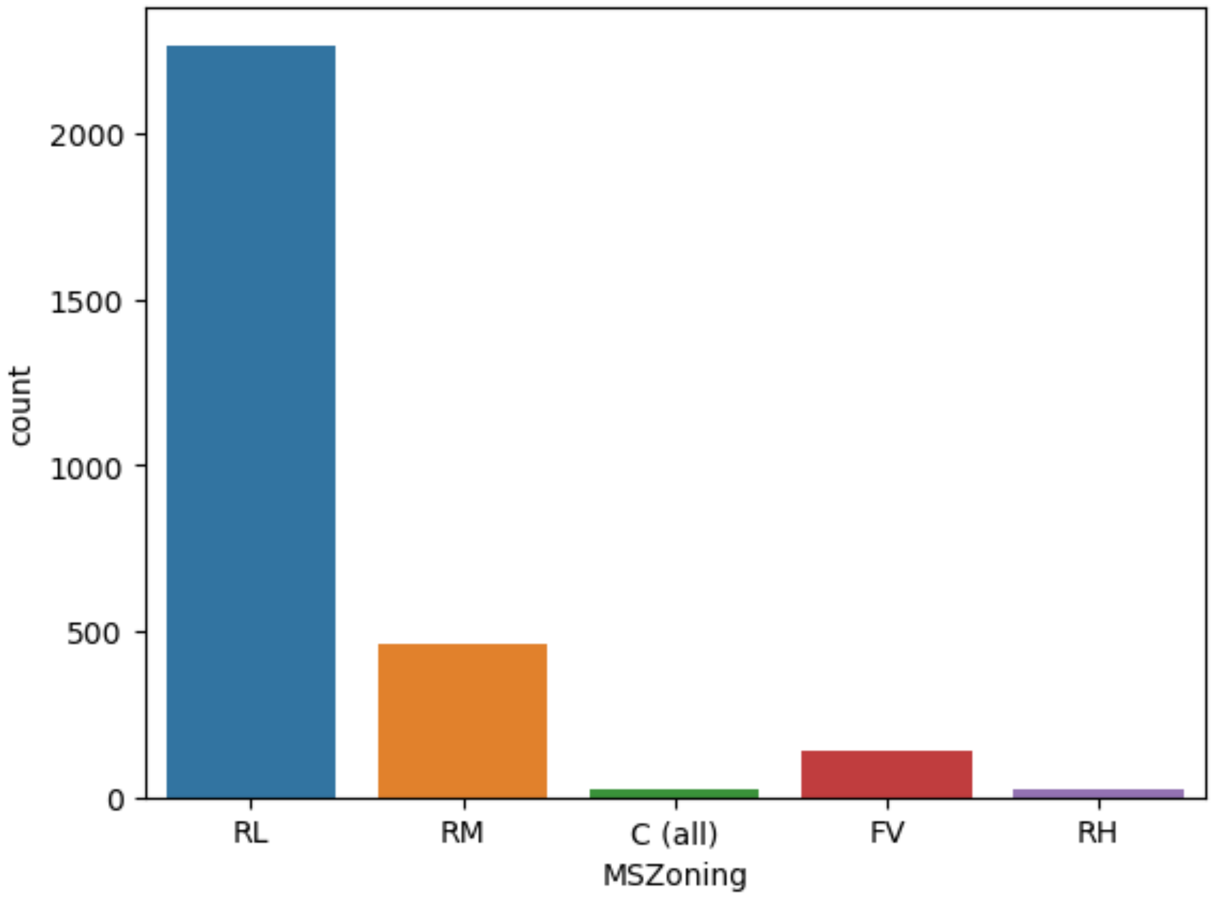
Out[26]:
```
LotFrontage      16.649538
MasVnrArea        0.787941
BsmtFinSF1        0.034258
BsmtFinSF2        0.034258
BsmtUnfSF         0.034258
TotalBsmtSF       0.034258
BsmtFullBath      0.068517
BsmtHalfBath      0.068517
GarageYrBlt       5.447071
GarageCars        0.034258
GarageArea        0.034258
SalePrice        49.982871
dtype: float64
```

In [27]:
```
## funtion to visualize data feature before and after imputation of missi
def plot_data(df, df_new, feature):
```

```
    plt.subplot(121)
    sns.countplot(x=feature, data=df)
    plt.title("Before Imputation")
    plt.subplot(122)
    sns.countplot(x=feature, data=df_new)
    plt.title("After Imputation")
    plt.show()
```

In [28]:
```
### handling MSZoning=0.137033

df["MSZoning"].value_counts()

# count plot in graph form
sns.countplot(x=df["MSZoning"])
```

Out[28]: <AxesSubplot: xlabel='MSZoning', ylabel='count'>



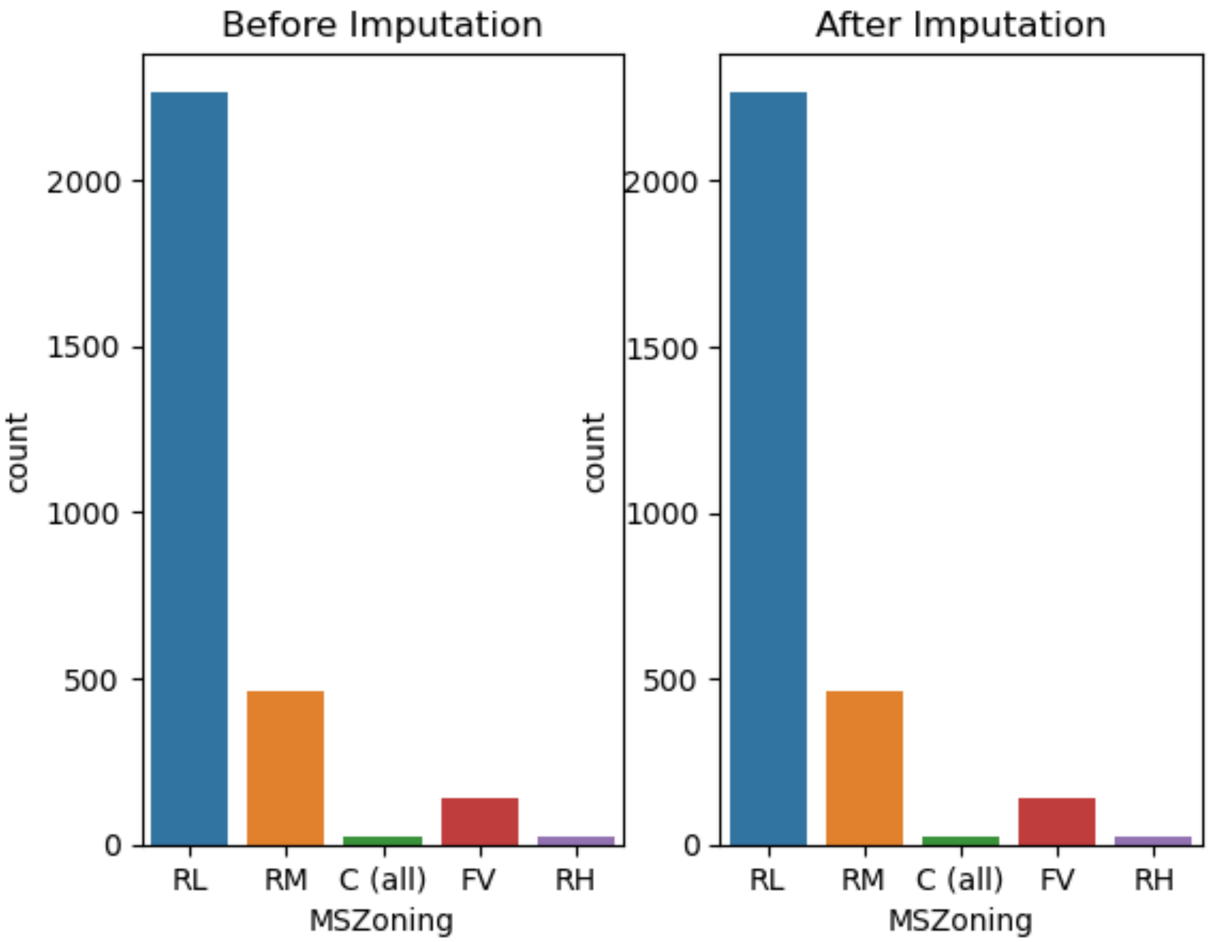
In [29]:
```
## backing up origianl data frame
df_mvi=df.copy()
```

In [30]:
```
# as we can see here RL is the mode for this feature
mszoning_mode=df["MSZoning"].mode()[0]
mszoning_mode
df_mvi["MSZoning"].replace(np.nan,mszoning_mode,inplace=True)
# now chceck do we have any missinf vLUE
df_mvi["MSZoning"].isnull().sum()
```

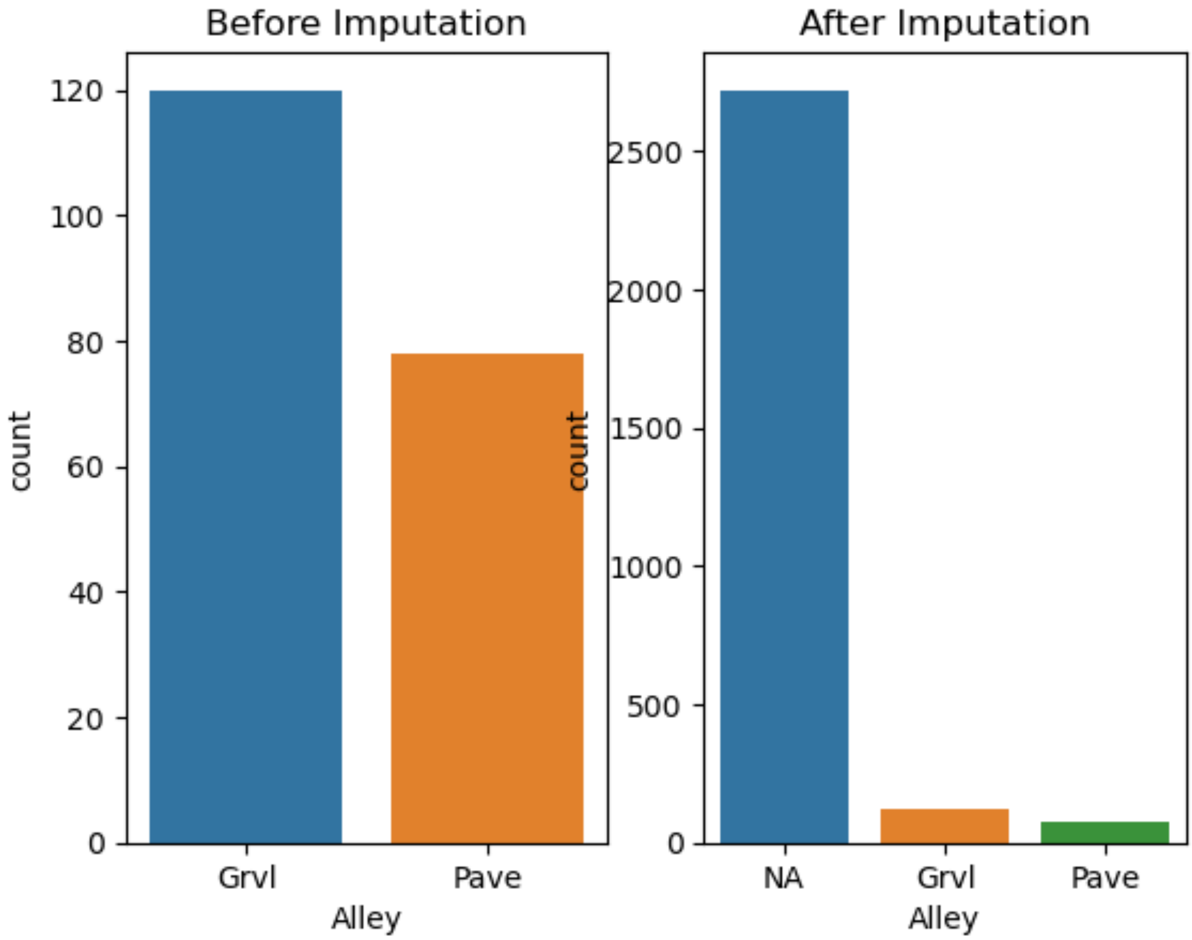
Out[30]: 0

In [ ]:

In [31]:
```
#compare before and after imputation
feature="MSZoning"
plot_data(df,df_mvi,feature)
```

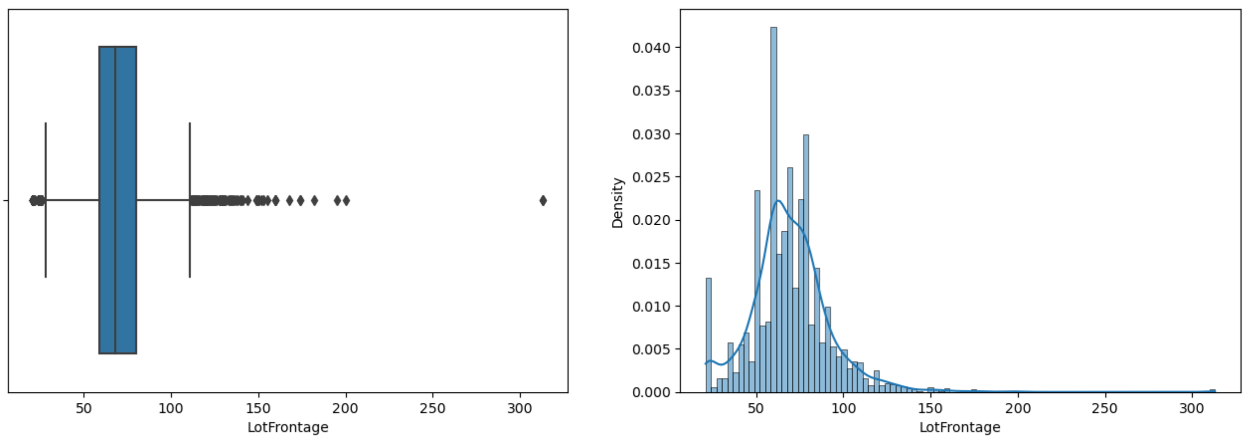


In [32]:
```
## handleing alley = 93.216855

df_mvi["Alley"].value_counts()
alley_cont="NA"
df_mvi["Alley"].replace(np.nan,alley_cont,inplace=True) # replace missing
df_mvi["Alley"].isnull().sum()

# compare before and after imputation
plot_data(df,df_mvi,"Alley")
```



In [33]:
```
#LotFrontage=16.649538
def boxHistPlot(df,feature, figsize=(16,5)):
    plt.figure(figsize=figsize)
    plt.subplot(121)
    sns.boxplot(x=feature, data=df)
    plt.subplot(122)
    sns.histplot(x=feature,data=df,stat="density", kde=True)
    plt.show()
```

In [34]:
```
boxHistPlot(df,"LotFrontage")
```

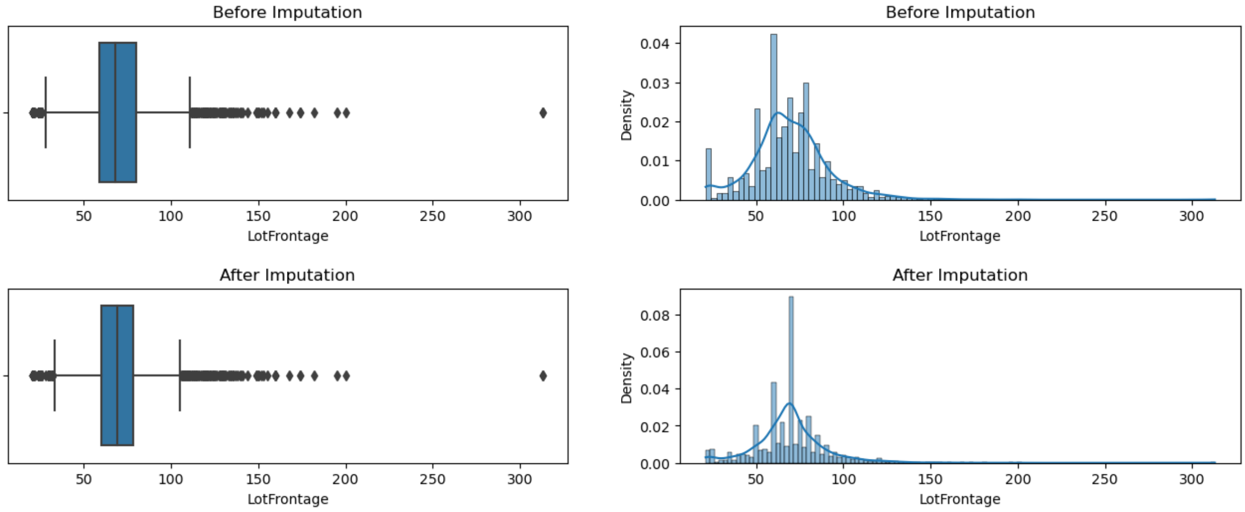


In [35]:
```
lotfrontage_mean=df["LotFrontage"].mean()
```

```
# lotfrontage_mean
df_mvi["LotFrontage"].replace(np.nan,lotfrontage_mean,inplace=True)
df_mvi["LotFrontage"].isnull().sum()
```

Out[35]: 0

In [36]:
```
# compare old and new box hist plot after imputation
def oldNewBoxHistPlot(df,df_new,feature, figsize=(16,5)):
    plt.figure(figsize=figsize)
    plt.subplot(221)
    sns.boxplot(x=feature, data=df)
    plt.title("Before Imputation")
    plt.subplot(222)
    sns.histplot(x=feature,data=df,stat="density", kde=True)
    plt.title("Before Imputation")
    plt.figure(figsize=figsize)
    plt.subplot(223)
    sns.boxplot(x=feature, data=df_new)
    plt.title("After Imputation")
    plt.subplot(224)
    sns.histplot(x=feature,data=df_new,stat="density", kde=True)
    plt.title("After Imputation")
    plt.show()

oldNewBoxHistPlot(df,df_mvi,"LotFrontage")
```



In [37]:
```
## handling utility
df["Utilities"].value_counts()
utility_const=df["Utilities"].mode()[0]
df_mvi["Utilities"].replace(np.nan,utility_const,inplace=True)
df_mvi["Utilities"].isnull().sum()
```

Out[37]: 0

In [38]:
```
# Exterior1st      0.034258
# Exterior2nd      0.034258
# both are object type
```

```
print(df["Exterior1st"].value_counts())
print("----")
print(df["Exterior2nd"].value_counts())
```

```
VinylSd    1025
MetalSd     450
HdBoard     442
Wd Sdng     411
Plywood     221
CemntBd     126
BrkFace      87
WdShing      56
AsbShng      44
Stucco       43
BrkComm       6
AsphShn       2
Stone         2
CBlock        2
ImStucc       1
Name: Exterior1st, dtype: int64
----
VinylSd    1014
MetalSd     447
HdBoard     406
Wd Sdng     391
Plywood     270
CmentBd     126
Wd Shng      81
BrkFace      47
Stucco       47
AsbShng      38
Brk Cmn      22
ImStucc      15
Stone         6
AsphShn       4
CBlock        3
Other         1
Name: Exterior2nd, dtype: int64
```

In [39]:
```
exterior_1_const=df["Exterior1st"].mode()[0]
df_mvi["Exterior1st"].replace(np.nan,exterior_1_const,inplace=True)
df_mvi["Exterior1st"].isnull().sum()
```

Out[39]: 0

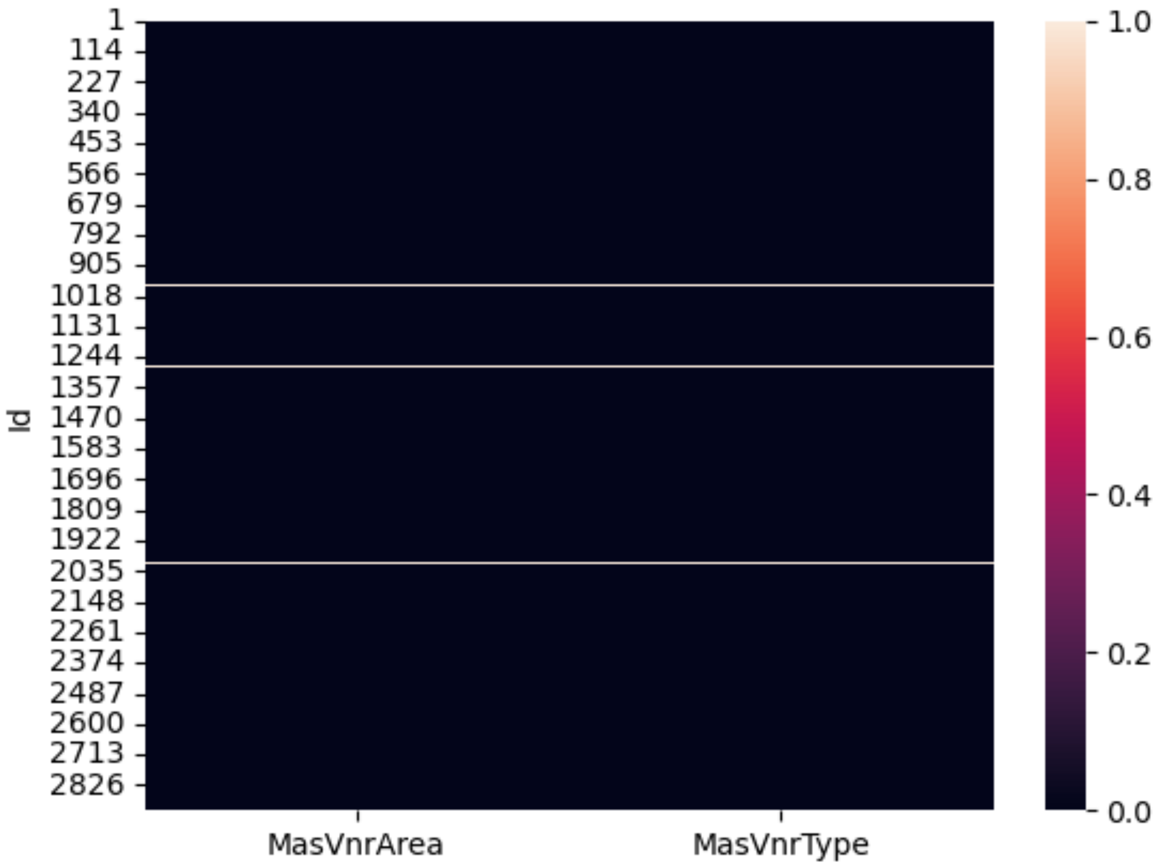
In [40]:
```
exterior_2_const=df["Exterior2nd"].mode()[0]
df_mvi["Exterior2nd"].replace(np.nan,exterior_2_const,inplace=True)
df_mvi["Exterior2nd"].isnull().sum()
```

Out[40]: 0

In [41]:
```
# MasVnrType       0.822199
# MasVnrArea       0.787941
```

```
sns.heatmap(df[["MasVnrArea", "MasVnrType"]].isnull())
```

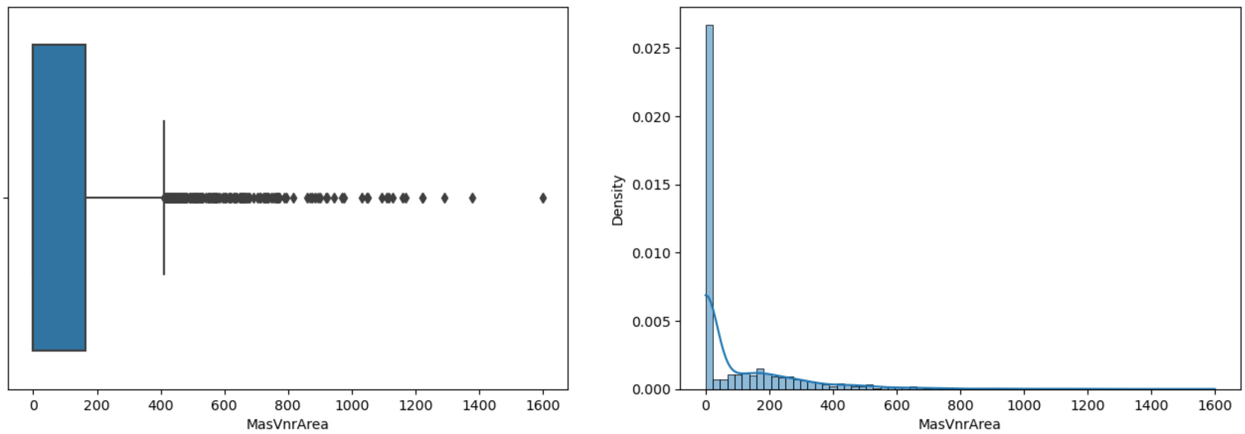
Out[41]: <AxesSubplot: ylabel='Id'>



In [42]:
```
mas_vnr_type_const=df["MasVnrType"].mode()[0]
df_mvi["MasVnrType"].replace(np.nan,mas_vnr_type_const,inplace=True)
df_mvi["MasVnrType"].isnull().sum()
```

Out[42]: 0

In [43]:
```
boxHistPlot(df,"MasVnrArea")
```



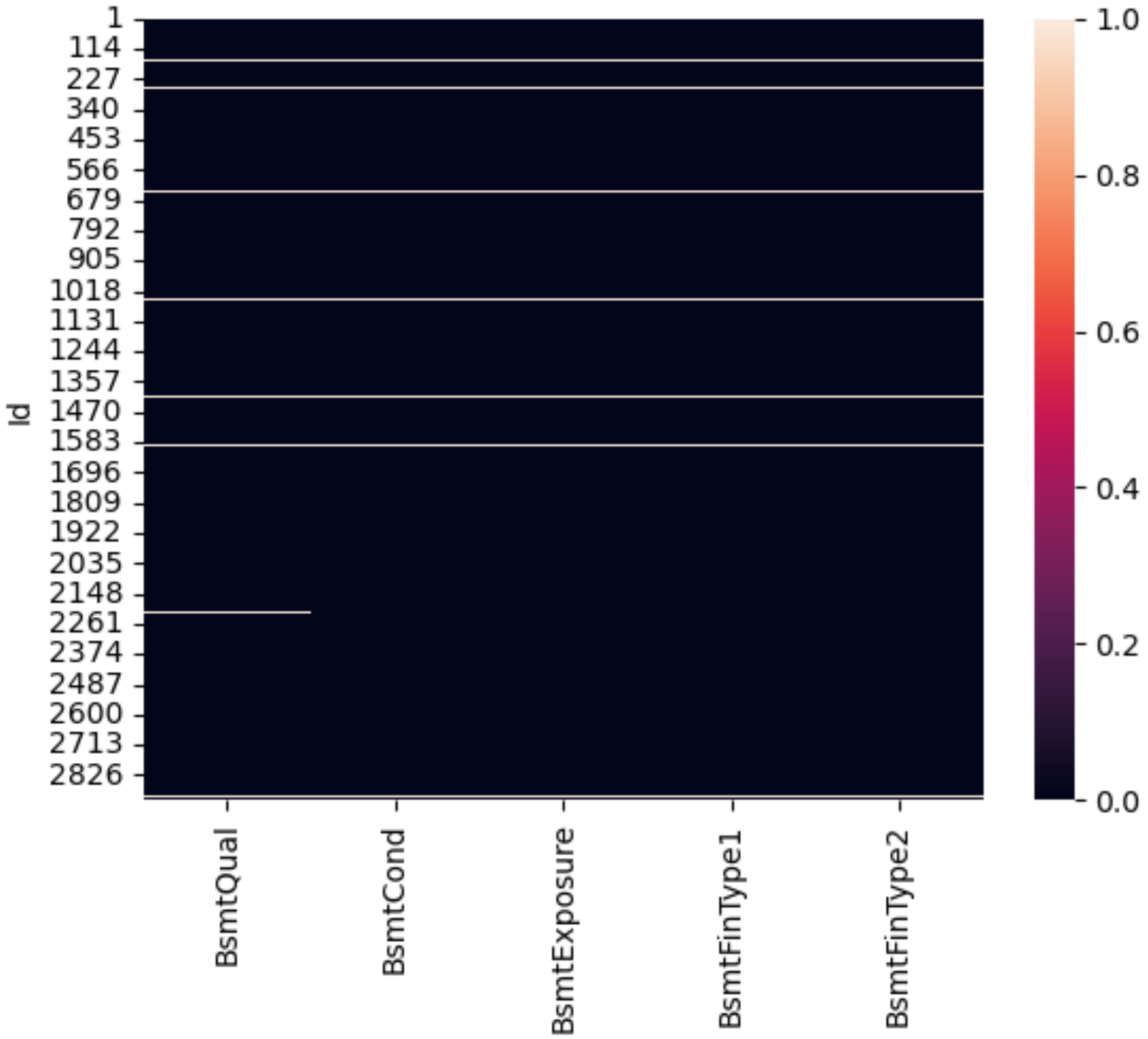
In [44]:
```
mas_vnr_area_const=0# as we can see the mode is 0 in above plots
df_mvi["MasVnrArea"].replace(np.nan,mas_vnr_area_const,inplace=True)
```

```
df_mvi["MasVnrArea"].isnull().sum()
```

Out[44]: 0

In [45]:
```
### handleing basement
## categarical
# BsmtQual         2.774923
# BsmtCond         2.809181
# BsmtExposure     2.809181
# BsmtFinType1     2.706406
# BsmtFinType2     2.740665

## numerical
# BsmtFinSF1       0.034258
# BsmtFinSF2       0.034258
# BsmtUnfSF        0.034258
# TotalBsmtSF      0.034258
# BsmtFullBath     0.068517
# BsmtHalfBath     0.068517


cat_bsmt_feat=["BsmtQual","BsmtCond","BsmtExposure","BsmtFinType1","BsmtF
num_bsmt_feat=["BsmtFinSF1","BsmtFinSF2","BsmtUnfSF","TotalBsmtSF","BsmtF

sns.heatmap(df[cat_bsmt_feat].isnull()) # check missing values in categor
for feat in cat_bsmt_feat:
    print(df[feat].value_counts())
    print("----")
```

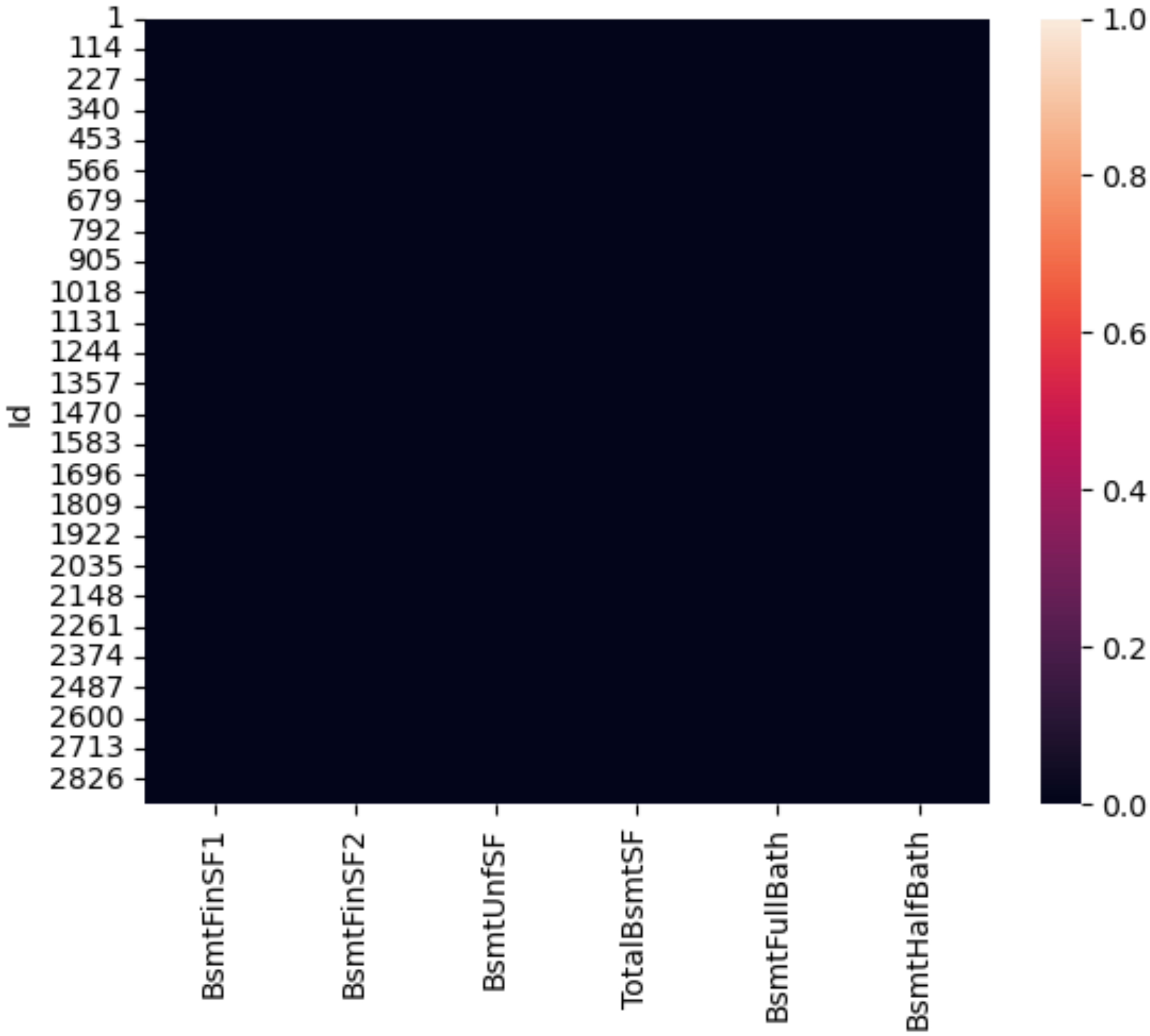
```
TA    1283
Gd    1209
Ex     258
Fa      88
Name: BsmtQual, dtype: int64
----
TA    2606
Gd     122
Fa     104
Po       5
Name: BsmtCond, dtype: int64
----
No    1904
Av     418
Gd     276
Mn     239
Name: BsmtExposure, dtype: int64
----
Unf    851
GLQ    849
ALQ    429
Rec    288
BLQ    269
LwQ    154
Name: BsmtFinType1, dtype: int64
----
Unf    2493
Rec     105
LwQ      87
BLQ      68
ALQ      52
GLQ      34
Name: BsmtFinType2, dtype: int64
----
```



In [46]:
```
bsmt_cont="NA"
for feat in cat_bsmt_feat:
    df_mvi[feat].replace(np.nan,bsmt_cont,inplace=True)
```

In [47]:
```
sns.heatmap(df[num_bsmt_feat].isnull()) # check missing values in numeric
```

Out[47]: <AxesSubplot: ylabel='Id'>



In [48]:
```
# analysing basement feature
df_bsmt=df[cat_bsmt_feat+num_bsmt_feat]
df_bsmt[df_bsmt.isnull().any(axis=1)]
```

Out[48]:

Id	BsmtQual	BsmtCond	BsmtExposure	BsmtFinType1	BsmtFinType2	BsmtFir
18	NaN	NaN	NaN	NaN	NaN	
40	NaN	NaN	NaN	NaN	NaN	
91	NaN	NaN	NaN	NaN	NaN	
103	NaN	NaN	NaN	NaN	NaN	
157	NaN	NaN	NaN	NaN	NaN	
183	NaN	NaN	NaN	NaN	NaN	
260	NaN	NaN	NaN	NaN	NaN	
333	Gd	TA	No	GLQ	NaN	11
343	NaN	NaN	NaN	NaN	NaN	

363	NaN	NaN	NaN	NaN	NaN
372	NaN	NaN	NaN	NaN	NaN
393	NaN	NaN	NaN	NaN	NaN
521	NaN	NaN	NaN	NaN	NaN
533	NaN	NaN	NaN	NaN	NaN
534	NaN	NaN	NaN	NaN	NaN
554	NaN	NaN	NaN	NaN	NaN
647	NaN	NaN	NaN	NaN	NaN
706	NaN	NaN	NaN	NaN	NaN
737	NaN	NaN	NaN	NaN	NaN
750	NaN	NaN	NaN	NaN	NaN
779	NaN	NaN	NaN	NaN	NaN
869	NaN	NaN	NaN	NaN	NaN
895	NaN	NaN	NaN	NaN	NaN
898	NaN	NaN	NaN	NaN	NaN
949	Gd	TA	NaN	Unf	Unf
985	NaN	NaN	NaN	NaN	NaN
1001	NaN	NaN	NaN	NaN	NaN
1012	NaN	NaN	NaN	NaN	NaN
1036	NaN	NaN	NaN	NaN	NaN
1046	NaN	NaN	NaN	NaN	NaN
1049	NaN	NaN	NaN	NaN	NaN
1050	NaN	NaN	NaN	NaN	NaN
1091	NaN	NaN	NaN	NaN	NaN
1180	NaN	NaN	NaN	NaN	NaN
1217	NaN	NaN	NaN	NaN	NaN
1219	NaN	NaN	NaN	NaN	NaN
1233	NaN	NaN	NaN	NaN	NaN
1322	NaN	NaN	NaN	NaN	NaN
1413	NaN	NaN	NaN	NaN	NaN
1488	Gd	TA	NaN	Unf	Unf
1586	NaN	NaN	NaN	NaN	NaN

1594	NaN	NaN	NaN	NaN	NaN	
1730	NaN	NaN	NaN	NaN	NaN	
1779	NaN	NaN	NaN	NaN	NaN	
1815	NaN	NaN	NaN	NaN	NaN	
1848	NaN	NaN	NaN	NaN	NaN	
1849	NaN	NaN	NaN	NaN	NaN	
1857	NaN	NaN	NaN	NaN	NaN	
1858	NaN	NaN	NaN	NaN	NaN	
1859	NaN	NaN	NaN	NaN	NaN	
1861	NaN	NaN	NaN	NaN	NaN	
1916	NaN	NaN	NaN	NaN	NaN	
2041	Gd	NaN	Mn	GLQ	Rec	10
2051	NaN	NaN	NaN	NaN	NaN	
2067	NaN	NaN	NaN	NaN	NaN	
2069	NaN	NaN	NaN	NaN	NaN	
2121	NaN	NaN	NaN	NaN	NaN	
2123	NaN	NaN	NaN	NaN	NaN	
2186	TA	NaN	No	BLQ	Unf	10
2189	NaN	NaN	NaN	NaN	NaN	
2190	NaN	NaN	NaN	NaN	NaN	
2191	NaN	NaN	NaN	NaN	NaN	
2194	NaN	NaN	NaN	NaN	NaN	
2217	NaN	NaN	NaN	NaN	NaN	
2218	NaN	Fa	No	Unf	Unf	
2219	NaN	TA	No	Unf	Unf	
2225	NaN	NaN	NaN	NaN	NaN	
2349	Gd	TA	NaN	Unf	Unf	
2388	NaN	NaN	NaN	NaN	NaN	
2436	NaN	NaN	NaN	NaN	NaN	
2453	NaN	NaN	NaN	NaN	NaN	
2454	NaN	NaN	NaN	NaN	NaN	

2491	NaN	NaN	NaN	NaN	NaN	
2499	NaN	NaN	NaN	NaN	NaN	
2525	TA	NaN	Av	ALQ	Unf	7
2548	NaN	NaN	NaN	NaN	NaN	
2553	NaN	NaN	NaN	NaN	NaN	
2565	NaN	NaN	NaN	NaN	NaN	
2579	NaN	NaN	NaN	NaN	NaN	
2600	NaN	NaN	NaN	NaN	NaN	
2703	NaN	NaN	NaN	NaN	NaN	
2764	NaN	NaN	NaN	NaN	NaN	
2767	NaN	NaN	NaN	NaN	NaN	
2804	NaN	NaN	NaN	NaN	NaN	
2805	NaN	NaN	NaN	NaN	NaN	
2825	NaN	NaN	NaN	NaN	NaN	
2892	NaN	NaN	NaN	NaN	NaN	
2905	NaN	NaN	NaN	NaN	NaN	

In [49]:
```
bsmt_num=0
for feat in num_bsmt_feat:
    df_mvi[feat].replace(np.nan,bsmt_num,inplace=True)
```

In [50]:
```
# Electrical        0.034258 -- KitchenQual      0.034258
df["Electrical"].value_counts()
```

Out[50]:
```
SBrkr    2671
FuseA     188
FuseF      50
FuseP       8
Mix         1
Name: Electrical, dtype: int64
```

In [51]:
```
df["KitchenQual"].value_counts()
```

Out[51]:
```
TA    1492
Gd    1151
Ex     205
Fa      70
Name: KitchenQual, dtype: int64
```

In [52]:
```
df_ekk=df[["Electrical","KitchenQual","KitchenAbvGr"]]
df_ekk[df_ekk.isnull().any(axis=1)]
```

Out[52]:

Id	Electrical	KitchenQual	KitchenAbvGr
1380	NaN	Gd	1
1556	SBrkr	NaN	1

In [53]:
```
electrical_mode=df["Electrical"].mode()[0]
df_mvi["Electrical"].replace(np.nan,electrical_mode,inplace=True)
df_mvi["Electrical"].isnull().sum()
```

Out[53]: 0

In [54]:
```
kitchenqual_mode=df["KitchenQual"].mode()[0]
df_mvi["KitchenQual"].replace(np.nan,kitchenqual_mode,inplace=True)
df_mvi["KitchenQual"].isnull().sum()
```

Out[54]: 0

In [55]:
```
# Functional       0.068517 - mode
# FireplaceQu     48.646797 - NA
# PoolQC          99.657417 - NA
# Fence           80.438506 - NA
# MiscFeature     96.402878 - NA
# SaleType         0.034258 - mode
```

In [56]:
```
print(df["Functional"].value_counts())
print("----")
print(df["FireplaceQu"].value_counts())
print("----")
print(df["PoolQC"].value_counts())
print("----")
print(df["Fence"].value_counts())
print("----")
print(df["MiscFeature"].value_counts())
print("----")
print(df["SaleType"].value_counts())
print("----")
```

```
Typ     2717
Min2      70
Min1      65
Mod       35
Maj1      19
Maj2       9
Sev        2
Name: Functional, dtype: int64
----
Gd    744
TA    592
Fa     74
Po     46
Ex     43
Name: FireplaceQu, dtype: int64
----
Ex    4
Gd    4
Fa    2
Name: PoolQC, dtype: int64
----
MnPrv    329
GdPrv    118
GdWo     112
MnWw      12
Name: Fence, dtype: int64
----
Shed    95
Gar2     5
Othr     4
TenC     1
Name: MiscFeature, dtype: int64
----
WD       2525
New       239
COD        87
ConLD      26
CWD        12
ConLI       9
ConLw       8
Oth         7
Con         5
Name: SaleType, dtype: int64
----
```

In [57]:
```
functional_mode=df["Functional"].mode()[0]
df_mvi["Functional"].replace(np.nan,functional_mode,inplace=True)
df_mvi["Functional"].isnull().sum()
```

Out[57]: 0

In [58]:
```
saletype_mode=df["SaleType"].mode()[0]
df_mvi["SaleType"].replace(np.nan,saletype_mode,inplace=True)
```

```
df_mvi["SaleType"].isnull().sum()
```

Out[58]: 0

In [59]:
```
other_cat_feat=["FireplaceQu","PoolQC","Fence","MiscFeature"]

other_cat_const="NA"
for feat in other_cat_feat:
    df_mvi[feat].replace(np.nan,other_cat_const,inplace=True)

for feat in other_cat_feat:
    print(df_mvi[feat].isnull().sum())
    print("----")
```

```
0
----
0
----
0
----
0
----
```

In [60]:
```
# cat
# GarageType        5.378554 - NA
# GarageFinish      5.447071 - NA
# GarageQual        5.447071 - NA
# GarageCond        5.447071 - NA

# num
# GarageYrBlt       5.447071
# GarageCars        0.034258
# GarageArea        0.034258
```

In [61]:
```
cat_garage_feat=["GarageType","GarageFinish","GarageQual","GarageCond"]
num_garage_feat=["GarageYrBlt","GarageCars","GarageArea"]

for feat in cat_garage_feat:
    print(df[feat].value_counts())
    print("----")

for feat in num_garage_feat:
    print(df[feat].value_counts())
    print("----")
```

```
Attchd     1723
Detchd      779
BuiltIn     186
Basment      36
2Types       23
CarPort      15
Name: GarageType, dtype: int64
----
Unf    1230
```

```
RFn     811
Fin     719
Name: GarageFinish, dtype: int64
----
TA    2604
Fa     124
Gd      24
Po       5
Ex       3
Name: GarageQual, dtype: int64
----
TA    2654
Fa      74
Gd      15
Po      14
Ex       3
Name: GarageCond, dtype: int64
----
2005.0    142
2006.0    115
2007.0    115
2004.0     99
2003.0     92
1977.0     66
2008.0     61
1998.0     58
2000.0     55
1999.0     54
2002.0     53
1950.0     51
1976.0     50
1993.0     49
1968.0     48
1997.0     44
1958.0     42
1978.0     41
1956.0     41
2001.0     41
1996.0     40
1994.0     39
1966.0     39
1960.0     37
1954.0     37
1967.0     36
1959.0     36
1964.0     35
1974.0     35
1979.0     35
1995.0     35
1962.0     35
1963.0     34
1957.0     34
1965.0     34
```

1920.0	33
1969.0	32
1970.0	32
1980.0	32
1961.0	31
2009.0	29
1973.0	29
1975.0	28
1992.0	27
1972.0	27
1930.0	27
1990.0	26
1940.0	25
1955.0	24
1971.0	24
1953.0	23
1939.0	21
1988.0	20
1984.0	19
1948.0	19
1989.0	19
1987.0	18
1985.0	18
1991.0	17
1951.0	17
1952.0	16
1926.0	15
1925.0	15
1981.0	15
1949.0	14
1941.0	14
1986.0	12
1938.0	11
1983.0	11
1910.0	10
1945.0	10
1946.0	9
1982.0	9
1924.0	8
1935.0	8
1922.0	8
1936.0	7
1928.0	7
1915.0	7
1916.0	6
1937.0	6
1900.0	6
1923.0	6
1942.0	6
1921.0	5
1947.0	5
2010.0	5
1927.0	5

```
1932.0      4
1934.0      4
1931.0      4
1918.0      3
1914.0      2
1929.0      2
1917.0      2
1895.0      1
1943.0      1
2207.0      1
1908.0      1
1896.0      1
1933.0      1
1906.0      1
1919.0      1
Name: GarageYrBlt, dtype: int64
----
2.0    1594
1.0     776
3.0     374
0.0     157
4.0      16
5.0       1
Name: GarageCars, dtype: int64
----
0.0       157
576.0      97
440.0      96
240.0      69
484.0      68
528.0      65
400.0      58
480.0      54
264.0      51
288.0      50
308.0      48
280.0      30
420.0      29
336.0      29
672.0      23
462.0      23
216.0      23
384.0      21
504.0      21
506.0      21
286.0      20
312.0      19
624.0      17
525.0      17
352.0      17
495.0      17
550.0      17
360.0      16
```

180.0	16
564.0	16
300.0	16
572.0	15
460.0	14
588.0	14
660.0	14
390.0	14
540.0	14
478.0	14
520.0	13
539.0	12
297.0	12
720.0	11
252.0	11
432.0	11
472.0	11
200.0	11
470.0	11
502.0	10
294.0	10
450.0	10
461.0	10
530.0	9
482.0	9
434.0	9
578.0	9
473.0	9
542.0	9
492.0	9
529.0	9
441.0	9
490.0	9
396.0	9
474.0	9
270.0	9
552.0	8
648.0	8
527.0	8
430.0	8
431.0	8
299.0	8
451.0	8
546.0	8
676.0	8
560.0	7
512.0	7
380.0	7
616.0	7
393.0	7
392.0	7
880.0	7
610.0	7

315.0	7
410.0	7
870.0	6
840.0	6
625.0	6
388.0	6
516.0	6
786.0	6
784.0	6
500.0	6
256.0	6
642.0	6
670.0	6
486.0	6
544.0	6
575.0	6
452.0	6
320.0	6
338.0	6
600.0	6
632.0	6
250.0	6
864.0	6
541.0	5
626.0	5
498.0	5
615.0	5
438.0	5
260.0	5
437.0	5
570.0	5
463.0	5
531.0	5
820.0	5
398.0	5
429.0	5
621.0	5
319.0	5
758.0	5
275.0	5
225.0	5
650.0	5
515.0	5
612.0	5
483.0	5
517.0	5
551.0	5
521.0	5
534.0	5
433.0	5
577.0	5
608.0	5
678.0	5

```
467.0        5
532.0        5
656.0        5
850.0        5
511.0        5
583.0        5
596.0        5
442.0        5
834.0        5
402.0        5
522.0        5
379.0        4
836.0        4
496.0        4
370.0        4
477.0        4
350.0        4
418.0        4
342.0        4
730.0        4
776.0        4
281.0        4
436.0        4
746.0        4
220.0        4
888.0        4
364.0        4
580.0        4
795.0        4
792.0        4
487.0        4
598.0        4
471.0        4
499.0        4
628.0        4
586.0        4
368.0        4
416.0        4
556.0        4
305.0        4
330.0        4
253.0        4
666.0        4
276.0        4
644.0        4
210.0        4
246.0        4
627.0        4
736.0        4
810.0        4
774.0        4
397.0        4
205.0        4
```

816.0	4
630.0	4
900.0	3
228.0	3
508.0	3
874.0	3
878.0	3
668.0	3
768.0	3
686.0	3
619.0	3
574.0	3
409.0	3
444.0	3
756.0	3
788.0	3
796.0	3
614.0	3
510.0	3
554.0	3
160.0	3
403.0	3
704.0	3
326.0	3
567.0	3
779.0	3
928.0	3
466.0	3
230.0	3
234.0	3
324.0	3
871.0	3
322.0	3
844.0	3
591.0	3
215.0	3
318.0	3
868.0	3
884.0	3
649.0	3
538.0	3
658.0	3
692.0	3
524.0	3
457.0	3
195.0	3
454.0	3
856.0	3
497.0	3
750.0	3
732.0	3
453.0	3
435.0	3

273.0	3
476.0	3
366.0	3
684.0	3
852.0	3
565.0	3
826.0	3
691.0	3
468.0	3
636.0	3
932.0	3
456.0	3
505.0	3
513.0	3
569.0	3
304.0	3
846.0	3
501.0	3
514.0	3
592.0	3
754.0	3
301.0	3
566.0	3
231.0	3
751.0	2
555.0	2
925.0	2
690.0	2
533.0	2
631.0	2
365.0	2
728.0	2
310.0	2
488.0	2
724.0	2
814.0	2
725.0	2
355.0	2
663.0	2
640.0	2
738.0	2
543.0	2
371.0	2
647.0	2
523.0	2
331.0	2
224.0	2
638.0	2
597.0	2
479.0	2
579.0	2
287.0	2
343.0	2

896.0	2
812.0	2
936.0	2
828.0	2
714.0	2
712.0	2
701.0	2
372.0	2
620.0	2
561.0	2
162.0	2
357.0	2
394.0	2
622.0	2
313.0	2
762.0	2
782.0	2
518.0	2
662.0	2
351.0	2
582.0	2
722.0	2
885.0	2
920.0	2
489.0	2
944.0	2
938.0	2
545.0	2
780.0	2
404.0	2
905.0	2
912.0	2
399.0	2
1052.0	2
464.0	2
311.0	2
748.0	2
548.0	2
968.0	2
894.0	2
386.0	2
590.0	2
866.0	2
683.0	2
447.0	2
271.0	2
839.0	2
680.0	2
711.0	2
772.0	2
282.0	2
685.0	2
702.0	2

898.0	2
606.0	2
843.0	2
594.0	2
573.0	2
641.0	2
509.0	2
493.0	2
296.0	2
617.0	2
422.0	2
427.0	2
908.0	2
706.0	2
721.0	2
164.0	2
603.0	2
292.0	2
765.0	2
558.0	2
645.0	2
408.0	2
283.0	2
349.0	2
789.0	2
605.0	2
618.0	2
865.0	2
675.0	2
682.0	2
412.0	2
895.0	2
423.0	2
818.0	2
481.0	2
389.0	2
924.0	2
303.0	2
726.0	2
831.0	2
494.0	2
800.0	2
439.0	2
249.0	1
266.0	1
904.0	1
207.0	1
811.0	1
1138.0	1
316.0	1
340.0	1
226.0	1
405.0	1

```
1184.0      1
1348.0      1
740.0       1
325.0       1
869.0       1
1314.0      1
1231.0      1
687.0       1
1150.0      1
557.0       1
698.0       1
715.0       1
428.0       1
1166.0      1
295.0       1
307.0       1
401.0       1
783.0       1
851.0       1
766.0       1
469.0       1
787.0       1
267.0       1
1488.0      1
1003.0      1
613.0       1
369.0       1
599.0       1
1154.0      1
100.0       1
571.0       1
1041.0      1
963.0       1
443.0       1
773.0       1
485.0       1
1085.0      1
899.0       1
959.0       1
803.0       1
760.0       1
584.0       1
449.0       1
688.0       1
568.0       1
353.0       1
791.0       1
1008.0      1
378.0       1
258.0       1
848.0       1
317.0       1
646.0       1
```

265.0	1
609.0	1
853.0	1
890.0	1
242.0	1
806.0	1
344.0	1
356.0	1
185.0	1
892.0	1
257.0	1
729.0	1
1110.0	1
585.0	1
1040.0	1
1174.0	1
916.0	1
876.0	1
933.0	1
747.0	1
1092.0	1
859.0	1
744.0	1
1105.0	1
293.0	1
1200.0	1
184.0	1
374.0	1
217.0	1
323.0	1
332.0	1
674.0	1
667.0	1
700.0	1
907.0	1
406.0	1
832.0	1
1134.0	1
1248.0	1
1043.0	1
254.0	1
719.0	1
862.0	1
562.0	1
749.0	1
261.0	1
842.0	1
1390.0	1
306.0	1
889.0	1
830.0	1
807.0	1
358.0	1

```
186.0       1
693.0       1
426.0       1
813.0       1
995.0       1
757.0       1
1356.0      1
459.0       1
367.0       1
716.0       1
739.0       1
290.0       1
665.0       1
611.0       1
425.0       1
1220.0      1
595.0       1
857.0       1
902.0       1
1020.0      1
455.0       1
414.0       1
354.0       1
602.0       1
327.0       1
284.0       1
833.0       1
601.0       1
841.0       1
689.0       1
808.0       1
752.0       1
255.0       1
424.0       1
824.0       1
328.0       1
983.0       1
475.0       1
858.0       1
954.0       1
549.0       1
927.0       1
535.0       1
263.0       1
375.0       1
363.0       1
209.0       1
1017.0      1
671.0       1
741.0       1
581.0       1
345.0       1
1053.0      1
```

```
413.0       1
458.0       1
694.0       1
886.0       1
949.0       1
673.0       1
309.0       1
815.0       1
623.0       1
972.0       1
984.0       1
604.0       1
845.0       1
559.0       1
465.0       1
713.0       1
962.0       1
958.0       1
708.0       1
526.0       1
1014.0      1
753.0       1
1418.0      1
213.0       1
198.0       1
860.0       1
248.0       1
696.0       1
825.0       1
947.0       1
373.0       1
770.0       1
639.0       1
377.0       1
804.0       1
244.0       1
208.0       1
445.0       1
189.0       1
1069.0      1
872.0       1
923.0       1
192.0       1
1025.0      1
272.0       1
Name: GarageArea, dtype: int64
----
```

In [62]:

```python
cat_garage_cont="NA"
for feat in cat_garage_feat:
    df_mvi[feat].replace(np.nan,cat_garage_cont,inplace=True)

num_garage_val=0
for feat in num_garage_feat:
```

```
    df_mvi[feat].replace(np.nan,num_garage_val,inplace=True)
```

In [63]:
```
# df_mvi[cat_garage_feat].isnull().sum()
# df_mvi[num_garage_feat].isnull().sum()
```

Feature Transformation

Numerical to Categorical

In [64]:
```
## MSSubClass,YearBuilt,YearRemodAdd,GarageYrBlt,MoSold,YrSold
for_num_con = ["MSSubClass","YearBuilt","YearRemodAdd","GarageYrBlt","MoS
for feat in for_num_con:
    print(f"{feat}: data type = {df_mvi[feat].dtype}")
```

```
MSSubClass: data type = int64
YearBuilt: data type = int64
YearRemodAdd: data type = int64
GarageYrBlt: data type = float64
MoSold: data type = int64
YrSold: data type = int64
```

In [65]:
```
df_mvi["MoSold"]=df_mvi["MoSold"].apply(lambda x: calendar.month_abbr[x])
```

In [66]:
```
for feat in for_num_con:
    df_mvi[feat]=df_mvi[feat].astype(str)
```

In [67]:
```
for feat in for_num_con:
    print(f"{feat}: data type = {df_mvi[feat].dtype}")
```

```
MSSubClass: data type = object
YearBuilt: data type = object
YearRemodAdd: data type = object
GarageYrBlt: data type = object
MoSold: data type = object
YrSold: data type = object
```

Categorial into Numerical(ordinal objects)

In [68]:
```
ordinal_end_var=[
"ExterQual",
"ExterCond",
"BsmtQual",
"BsmtCond",
"BsmtExposure",
"BsmtFinType1",
"BsmtFinType2",
"HeatingQC",
"KitchenQual",
"FireplaceQu",
"GarageQual",
```

```
"GarageCond",
"PoolQC",
"Functional",
"GarageFinish",
"PavedDrive",
"Utilities",
]
print(len(ordinal_end_var))
```

17

In [69]:
```
df_mvi["ExterQual"]=df_mvi["ExterQual"].astype(CategoricalDtype(categorie
df_mvi["ExterCond"]=df_mvi["ExterCond"].astype(CategoricalDtype(categorie
df_mvi["BsmtQual"]=df_mvi["BsmtQual"].astype(CategoricalDtype(categories=
df_mvi["BsmtCond"]=df_mvi["BsmtCond"].astype(CategoricalDtype(categories=
df_mvi["BsmtExposure"]=df_mvi["BsmtExposure"].astype(CategoricalDtype(cat
df_mvi["BsmtFinType1"]=df_mvi["BsmtFinType1"].astype(CategoricalDtype(cat
df_mvi["BsmtFinType2"]=df_mvi["BsmtFinType2"].astype(CategoricalDtype(cat
df_mvi["HeatingQC"]=df_mvi["HeatingQC"].astype(CategoricalDtype(categorie
df_mvi["KitchenQual"]=df_mvi["KitchenQual"].astype(CategoricalDtype(categ
df_mvi["FireplaceQu"]=df_mvi["FireplaceQu"].astype(CategoricalDtype(categ
df_mvi["GarageQual"]=df_mvi["GarageQual"].astype(CategoricalDtype(categor
df_mvi["GarageCond"]=df_mvi["GarageCond"].astype(CategoricalDtype(categor
df_mvi["PoolQC"]=df_mvi["PoolQC"].astype(CategoricalDtype(categories=["NA
df_mvi["Functional"]=df_mvi["Functional"].astype(CategoricalDtype(categor
df_mvi["GarageFinish"]=df_mvi["GarageFinish"].astype(CategoricalDtype(cat
df_mvi["PavedDrive"]=df_mvi["PavedDrive"].astype(CategoricalDtype(categor
df_mvi["Utilities"]=df_mvi["Utilities"].astype(CategoricalDtype(categorie
```

In [70]:
```
df_mvi.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 2919 entries, 1 to 2919
Data columns (total 80 columns):
 #   Column         Non-Null Count  Dtype
---  ------         --------------  -----
 0   MSSubClass     2919 non-null   object
 1   MSZoning       2919 non-null   object
 2   LotFrontage    2919 non-null   float64
 3   LotArea        2919 non-null   int64
 4   Street         2919 non-null   object
 5   Alley          2919 non-null   object
 6   LotShape       2919 non-null   object
 7   LandContour    2919 non-null   object
 8   Utilities      2919 non-null   int8
 9   LotConfig      2919 non-null   object
 10  LandSlope      2919 non-null   object
 11  Neighborhood   2919 non-null   object
 12  Condition1     2919 non-null   object
 13  Condition2     2919 non-null   object
 14  BldgType       2919 non-null   object
 15  HouseStyle     2919 non-null   object
 16  OverallQual    2919 non-null   int64
 17  OverallCond    2919 non-null   int64
```

```
 18  YearBuilt      2919 non-null   object 
 19  YearRemodAdd   2919 non-null   object 
 20  RoofStyle      2919 non-null   object 
 21  RoofMatl       2919 non-null   object 
 22  Exterior1st    2919 non-null   object 
 23  Exterior2nd    2919 non-null   object 
 24  MasVnrType     2919 non-null   object 
 25  MasVnrArea     2919 non-null   float64
 26  ExterQual      2919 non-null   int8   
 27  ExterCond      2919 non-null   int8   
 28  Foundation     2919 non-null   object 
 29  BsmtQual       2919 non-null   int8   
 30  BsmtCond       2919 non-null   int8   
 31  BsmtExposure   2919 non-null   int8   
 32  BsmtFinType1   2919 non-null   int8   
 33  BsmtFinSF1     2919 non-null   float64
 34  BsmtFinType2   2919 non-null   int8   
 35  BsmtFinSF2     2919 non-null   float64
 36  BsmtUnfSF      2919 non-null   float64
 37  TotalBsmtSF    2919 non-null   float64
 38  Heating        2919 non-null   object 
 39  HeatingQC      2919 non-null   int8   
 40  CentralAir     2919 non-null   object 
 41  Electrical     2919 non-null   object 
 42  1stFlrSF       2919 non-null   int64  
 43  2ndFlrSF       2919 non-null   int64  
 44  LowQualFinSF   2919 non-null   int64  
 45  GrLivArea      2919 non-null   int64  
 46  BsmtFullBath   2919 non-null   float64
 47  BsmtHalfBath   2919 non-null   float64
 48  FullBath       2919 non-null   int64  
 49  HalfBath       2919 non-null   int64  
 50  BedroomAbvGr   2919 non-null   int64  
 51  KitchenAbvGr   2919 non-null   int64  
 52  KitchenQual    2919 non-null   int8   
 53  TotRmsAbvGrd   2919 non-null   int64  
 54  Functional     2919 non-null   int8   
 55  Fireplaces     2919 non-null   int64  
 56  FireplaceQu    2919 non-null   int8   
 57  GarageType     2919 non-null   object 
 58  GarageYrBlt    2919 non-null   object 
 59  GarageFinish   2919 non-null   int8   
 60  GarageCars     2919 non-null   float64
 61  GarageArea     2919 non-null   float64
 62  GarageQual     2919 non-null   int8   
 63  GarageCond     2919 non-null   int8   
 64  PavedDrive     2919 non-null   int8   
 65  WoodDeckSF     2919 non-null   int64  
 66  OpenPorchSF    2919 non-null   int64  
 67  EnclosedPorch  2919 non-null   int64  
 68  3SsnPorch      2919 non-null   int64  
 69  ScreenPorch    2919 non-null   int64  
 70  PoolArea       2919 non-null   int64  
```

```
 71  PoolQC         2919 non-null   int8
 72  Fence          2919 non-null   object
 73  MiscFeature    2919 non-null   object
 74  MiscVal        2919 non-null   int64
 75  MoSold         2919 non-null   object
 76  YrSold         2919 non-null   object
 77  SaleType       2919 non-null   object
 78  SaleCondition  2919 non-null   object
 79  SalePrice      1460 non-null   float64
dtypes: float64(11), int64(20), int8(17), object(32)
memory usage: 1.5+ MB
```

In [71]:
```
# df_mvi["ExterQual"]
```

Categorial into Numerical(nominal objects)

In [72]:
```
df_encod=df_mvi.copy()

object_features=df_encod.select_dtypes(include="object").columns.to_list(
print(object_features)
```

```
['MSSubClass', 'MSZoning', 'Street', 'Alley', 'LotShape', 'LandContour', '
LotConfig', 'LandSlope', 'Neighborhood', 'Condition1', 'Condition2', 'Bldg
Type', 'HouseStyle', 'YearBuilt', 'YearRemodAdd', 'RoofStyle', 'RoofMatl',
'Exterior1st', 'Exterior2nd', 'MasVnrType', 'Foundation', 'Heating', 'Cent
ralAir', 'Electrical', 'GarageType', 'GarageYrBlt', 'Fence', 'MiscFeatur
e', 'MoSold', 'YrSold', 'SaleType', 'SaleCondition']
```

In [73]:
```
df_encod[object_features].head(2)
```

Out[73]:

	MSSubClass	MSZoning	Street	Alley	LotShape	LandContour	LotConfig	Lan
Id								
1	60	RL	Pave	NA	Reg	Lvl	Inside	
2	20	RL	Pave	NA	Reg	Lvl	FR2	

In [74]:
```
print("before",df_encod.shape)
df_encod=pd.get_dummies(df_encod,
                        columns=object_features,
                        prefix=object_features,
                        drop_first=True)
print("after",df_encod.shape)
```

```
before (2919, 80)
after (2919, 513)
```

In [75]:
```
df_encod.head(2)
```

Out[75]:

	LotFrontage	LotArea	Utilities	OverallQual	OverallCond	MasVnrArea	ExterQu
Id							
1	65.0	8450	3	7	5	196.0	
2	80.0	9600	3	6	8	0.0	

Split data

In [76]:
```
len_train=df_train.shape[0]
len_train
```

Out[76]: 1460

In [77]:
```
X_train=df_encod[:len_train].drop("SalePrice",axis=1)
y_train=df_encod[:len_train]["SalePrice"]
X_test=df_encod[len_train:].drop("SalePrice",axis=1)


print("Shape of X_train",X_train.shape)
print("Shape of y_train",y_train.shape)
print("Shape of X_test",X_test.shape)
```

```
Shape of X_train (1460, 512)
Shape of y_train (1460,)
Shape of X_test (1459, 512)
```

In [78]:
```
sc = StandardScaler()

sc.fit(X_train) # it will learn about mean and std variance
X_train=sc.transform(X_train)
X_test=sc.transform(X_test)
```

Cross Validation and Model Selection

In [79]:
```
from sklearn.svm import SVR
from sklearn.linear_model import LinearRegression
from sklearn.linear_model import SGDRegressor
from sklearn.neighbors import KNeighborsRegressor
from sklearn.gaussian_process import GaussianProcessRegressor
from sklearn.tree import DecisionTreeRegressor

from sklearn.ensemble import RandomForestRegressor
from sklearn.ensemble import GradientBoostingRegressor

from sklearn.neural_network import MLPRegressor

from xgboost import XGBRegressor
```

In [80]:
```
svr = SVR()
lr = LinearRegression()
sgdr = SGDRegressor()
knn = KNeighborsRegressor()
gpr = GaussianProcessRegressor()
dtr = DecisionTreeRegressor()
rfr = RandomForestRegressor()
gbr = GradientBoostingRegressor()
xgbr = XGBRegressor()

mlpr = MLPRegressor()
```

In [81]:
```
models = {"a":["LinearRegression",lr],
          "b":["SVR",svr],
          "c":["SGDRegressor",sgdr],
          "d":["KNeighborsRegressor",knn],
          "e":["GaussianProcessRegressor",gpr],
          "f":["DecisionTreeRegressor",dtr],
          "g":["GradientBoostingRegressor",gbr],
          "h":["RandomForestRegressor",rfr],
          "i":["XGBRegressor",xgbr],
          "j":["MLPRegressor",mlpr],
          }     # Create a dictionary to store the results
```

In [82]:
```
from sklearn.model_selection import cross_val_score, KFold
from sklearn.metrics import make_scorer,r2_score

def test_model(model, X_train=X_train,y_train=y_train):
    cv  = KFold(n_splits=7, random_state=45, shuffle=True)
    r2  = make_scorer(r2_score)
    r2_val_score = cross_val_score(model, X_train, y_train, cv=cv, scorin
    score = [r2_val_score.mean()]
    return score
```

In [83]:
```
models_score=[]
for model in models:
    print("Model Name: ",models[model][0])
    score = test_model(models[model][1], X_train, y_train)
    print("Score of Model:",score)
    print("------------------------")
    models_score.append([models[model][0],score])
```

```
Model Name:  LinearRegression
Score of Model: [-1.2722448407974715e+24]
-----------------------
Model Name:  SVR
Score of Model: [-0.052133548352104216]
-----------------------
Model Name:  SGDRegressor
Score of Model: [-6043.376589984432]
-----------------------
Model Name:  KNeighborsRegressor
Score of Model: [0.5585925623107102]
-----------------------
Model Name:  GaussianProcessRegressor
Score of Model: [-5.398916312612151]
-----------------------
Model Name:  DecisionTreeRegressor
Score of Model: [0.7008206494020515]
-----------------------
Model Name:  GradientBoostingRegressor
Score of Model: [0.8715666756167462]
-----------------------
Model Name:  RandomForestRegressor
Score of Model: [0.8457476035359204]
-----------------------
Model Name:  XGBRegressor
Score of Model: [0.8582487612757063]
-----------------------
Model Name:  MLPRegressor
```

```
c:\Users\nirde\anaconda3\lib\site-packages\sklearn\neural_network\_multila
yer_perceptron.py:684: ConvergenceWarning: Stochastic Optimizer: Maximum i
terations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
c:\Users\nirde\anaconda3\lib\site-packages\sklearn\neural_network\_multila
yer_perceptron.py:684: ConvergenceWarning: Stochastic Optimizer: Maximum i
terations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
c:\Users\nirde\anaconda3\lib\site-packages\sklearn\neural_network\_multila
yer_perceptron.py:684: ConvergenceWarning: Stochastic Optimizer: Maximum i
terations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
c:\Users\nirde\anaconda3\lib\site-packages\sklearn\neural_network\_multila
yer_perceptron.py:684: ConvergenceWarning: Stochastic Optimizer: Maximum i
terations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
c:\Users\nirde\anaconda3\lib\site-packages\sklearn\neural_network\_multila
yer_perceptron.py:684: ConvergenceWarning: Stochastic Optimizer: Maximum i
terations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
c:\Users\nirde\anaconda3\lib\site-packages\sklearn\neural_network\_multila
yer_perceptron.py:684: ConvergenceWarning: Stochastic Optimizer: Maximum i
terations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
```

```
Score of Model: [-4.852157124690591]
-----------------------
```

```
c:\Users\nirde\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptron.py:684: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
```

In [84]:
```
models_score
```

Out[84]:
```
[['LinearRegression', [-1.2722448407974715e+24]],
 ['SVR', [-0.05213354835210421 6]],
 ['SGDRegressor', [-6043.376589984432]],
 ['KNeighborsRegressor', [0.5585925623107102]],
 ['GaussianProcessRegressor', [-5.398916312612151]],
 ['DecisionTreeRegressor', [0.7008206494020515]],
 ['GradientBoostingRegressor', [0.8715666756167462]],
 ['RandomForestRegressor', [0.8457476035359204]],
 ['XGBRegressor', [0.8582487612757063]],
 ['MLPRegressor', [-4.852157124690591]]]
```

Model Training

In [85]:
```
gbr.fit(X_train,y_train)
```

Out[85]:
```
▾ GradientBoostingRegressor
GradientBoostingRegressor()
```

In [86]:
```
y_pred=gbr.predict(X_test)
```

In [87]:
```
# y_pred # is a numpy array hence we gonna convert it into dataframe
y_pred=pd.concat([df_test['Id'],pd.DataFrame(y_pred,columns=['SalePrice']
y_pred
```

Out[87]:

	Id	SalePrice
0	1461	122103.500909
1	1462	155398.306856
2	1463	175032.391922
3	1464	180116.442684
4	1465	204131.608740
5	1466	170930.824326
6	1467	157931.059686
7	1468	159943.505730
8	1469	190038.522001

9	1470	129854.392427
10	1471	200965.020774
11	1472	95461.489798
12	1473	95677.490047
13	1474	154819.496462
14	1475	137990.081928
15	1476	407464.266211
16	1477	277826.803080
17	1478	311162.185967
18	1479	286536.780138
19	1480	484967.859526
20	1481	319955.713640
21	1482	213799.485481
22	1483	165842.688843
23	1484	174316.540813
24	1485	175527.486372
25	1486	193866.191964
26	1487	350948.923099
27	1488	239107.506370
28	1489	200610.223162
29	1490	222909.030296
30	1491	190933.714005
31	1492	89257.865711
32	1493	188818.811478
33	1494	292143.047463
34	1495	301955.268491
35	1496	235919.708953
36	1497	182223.884972
37	1498	165683.328424
38	1499	167733.284069
39	1500	146715.310659
40	1501	165761.689504

41	1502	159338.955452
42	1503	290292.318318
43	1504	228485.048420
44	1505	213225.858751
45	1506	191678.968133
46	1507	228042.622860
47	1508	195479.689872
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1262	2723	145575.825905
1263	2724	130455.416018
1264	2725	132839.329707
1265	2726	141879.253836
1266	2727	180093.927092
1267	2728	166319.061480
1268	2729	151944.398559

1269	2730	141852.730709
1270	2731	134019.341310
1271	2732	128565.101317
1272	2733	154547.796104
1273	2734	157030.342938
1274	2735	138607.196576
1275	2736	143803.218195
1276	2737	122772.754375
1277	2738	139701.562058
1278	2739	161585.442242
1279	2740	136999.903080
1280	2741	147771.728268
1281	2742	145094.936797
1282	2743	142484.358922
1283	2744	148637.563701
1284	2745	143022.074618
1285	2746	143197.413301
1286	2747	161416.436657
1287	2748	120763.220077
1288	2749	130114.399214
1289	2750	139151.002706
1290	2751	138521.257288
1291	2752	216267.858226
1292	2753	149711.324974
1293	2754	215269.882938
1294	2755	126947.672571
1295	2756	101024.887233
1296	2757	72059.708609
1297	2758	88090.892202
1298	2759	151376.187730
1299	2760	132069.624440
1300	2761	143749.377606

1301	2762	143363.563916
1302	2763	183224.167044
1303	2764	166975.183665
1304	2765	270562.588959
1305	2766	132180.243031
1306	2767	83095.611824
1307	2768	138769.091878
1308	2769	133478.760237
1309	2770	155493.055312
1310	2771	115858.462673
1311	2772	120952.930458
1312	2773	145645.785504
1313	2774	133218.601428
1314	2775	111860.980952
1315	2776	142109.140016
1316	2777	153323.140683
1317	2778	126296.315071
1318	2779	137382.280783
1319	2780	99079.542143
1320	2781	99218.646103
1321	2782	96188.834980
1322	2783	104622.668433
1323	2784	127638.637128
1324	2785	135010.005472
1325	2786	80413.458786
1326	2787	121722.982415
1327	2788	80076.865084
1328	2789	183072.158559
1329	2790	90446.604580
1330	2791	110782.563497
1331	2792	66260.823710

1332	2793	165545.440050
1333	2794	105800.504428
1334	2795	114848.869321
1335	2796	99469.208755
1336	2797	191732.963886
1337	2798	110059.991420
1338	2799	111004.351926
1339	2800	79822.397495
1340	2801	112135.148774
1341	2802	140088.851416
1342	2803	166436.874598
1343	2804	151140.157198
1344	2805	106458.747976
1345	2806	85852.447328
1346	2807	161618.683749
1347	2808	148263.690743
1348	2809	137698.580262
1349	2810	135934.149222
1350	2811	162192.853713
1351	2812	144075.532885
1352	2813	176411.547371
1353	2814	167900.394699
1354	2815	102941.694881
1355	2816	223355.183109
1356	2817	153279.491193
1357	2818	134346.272503
1358	2819	184879.883815
1359	2820	135108.614761
1360	2821	100769.428695
1361	2822	190735.250371
1362	2823	226249.299484
1363	2824	178863.935650

1364	2825	157607.025989
1365	2826	131424.569711
1366	2827	136489.686972
1367	2828	224031.060327
1368	2829	202130.441377
1369	2830	235795.554918
1370	2831	183598.935732
1371	2832	246968.870803
1372	2833	304737.984603
1373	2834	210989.171318
1374	2835	207695.396828
1375	2836	187495.111599
1376	2837	164006.884718
1377	2838	143821.792286
1378	2839	178160.136132
1379	2840	193334.037724
1380	2841	203646.684602
1381	2842	219963.198816
1382	2843	145502.080201
1383	2844	139243.229353
1384	2845	119891.369739
1385	2846	205282.401587
1386	2847	191817.605914
1387	2848	219330.003836
1388	2849	201628.564364
1389	2850	287453.756854
1390	2851	236153.003061
1391	2852	223822.038215
1392	2853	230806.007405
1393	2854	142859.687416
1394	2855	201349.810671

1395	2856	202114.156817
1396	2857	187495.111599
1397	2858	210576.541508
1398	2859	125912.299923
1399	2860	128566.466755
1400	2861	130563.062325
1401	2862	195874.344536
1402	2863	132624.343778
1403	2864	250350.190115
1404	2865	140279.367259
1405	2866	149483.694981
1406	2867	100005.348742
1407	2868	104469.426224
1408	2869	105381.748515
1409	2870	138689.208714
1410	2871	91474.882384
1411	2872	51279.113382
1412	2873	108749.867332
1413	2874	128949.150407
1414	2875	110661.371033
1415	2876	170860.457861
1416	2877	140183.545417
1417	2878	184586.320687
1418	2879	139457.453874
1419	2880	98317.244197
1420	2881	166197.191030
1421	2882	167619.188677
1422	2883	194880.087035
1423	2884	207346.301791
1424	2885	188415.936454
1425	2886	223820.252844
1426	2887	99800.643271

1427	2888	137083.060890
1428	2889	57468.737035
1429	2890	86359.654738
1430	2891	138192.797032
1431	2892	69975.788043
1432	2893	98985.136419
1433	2894	73002.725122
1434	2895	294782.721766
1435	2896	289467.797250
1436	2897	196104.573949
1437	2898	154903.073955
1438	2899	229527.501384
1439	2900	152508.873443
1440	2901	221113.034781
1441	2902	180440.037247
1442	2903	341872.755824
1443	2904	374666.965953
1444	2905	94257.508999
1445	2906	210456.160406
1446	2907	117604.511717
1447	2908	131626.796280
1448	2909	154793.593428
1449	2910	90602.729709
1450	2911	79959.397309
1451	2912	143212.583712
1452	2913	87766.124948
1453	2914	75954.975933
1454	2915	82324.315442
1455	2916	84298.677180
1456	2917	167620.942720
1457	2918	123952.178061

1458	2919	217032.206363

In [88]:
```
y_pred.to_csv("\House Price Prediction\ML_Model\data_set\submission.csv",
```

In [89]:
```
#storing model in pickle file
import pickle

with open('gbr.pkl','wb') as f:
    pickle.dump(gbr,f)
```