housing-price-prediction

May 30, 2024

1 ABSTRACT

The "House Price Prediction" project aims to develop a machine learning model to predict housing prices based on various features such as lot size, building type, and neighborhood. Utilizing a dataset from a reputable source, the project involves data cleaning, exploratory data analysis (EDA), and the application of regression models. The model's performance is evaluated to ensure accurate and reliable predictions. The outcome of this project can assist stakeholders in making informed decisions in the real estate market.

2 OBJECTIVE

The primary objective of this project is to develop a machine learning model that can predict house prices based on various features of the properties. Specific objectives include:

1). Cleaning and preprocessing the dataset to ensure high-quality data.

2). Conducting exploratory data analysis (EDA) to understand the relationships between features and house prices.

3). Implementing and evaluating multiple regression models to determine the most accurate predictor.

4). Providing insights and recommendations based on the model's predictions to assist in real estate decision-making.

3 INTRODUCTION

The real estate market is a significant component of the global economy, where accurate price predictions can lead to better investment decisions and market understanding. This project focuses on predicting house prices using a dataset containing various features related to property characteristics. By leveraging machine learning techniques, the project aims to build a robust predictive model that can provide accurate price estimates, thereby benefiting buyers, sellers, and investors in making informed decisions.

4 METHODOLOGY

1). Importing Dataset and Data Inception:

With the help of Pandas library of python we had extracted the data from the CSV file named 'housing_price_prediction.csv' which was prepared by Kaggle Community.

Here data is also checked that how many null values are present in each columns. So that furthur while analysis and also while making models, we can't find difficulty.

2). Data Cleaning:

The main purpose of Data Cleaning is to fill the null values. We can also say that to handle the null value because if the data remain unclean then EDA can't be accurate.

Converting categorical variables into numerical formats using techniques like one-hot encoding.

If the dtypes of columns holding data, is non numeric, then fill it with 'None' rather then to keep it null because in Analysis, "None" is not count as null.

So for this we had filled the numeric values [Float64, int64, etc. dtypes], with either mean or mode as per need.

3). EDA:

We had done two types of EDA .. for better understanding of our data set.

a): Univariate Analysis:

Analyzing the distribution and statistics of individual features.

b): Bivariate and Multivariate Analysis:

Exploring relationships between features and the target variable (house prices), using visualizations like scatter plots, histograms, and correlation matrices.

4). Data Preparaton:

For Data Preparation, we had divide the whole in 'numeric' and 'non-numeric' values. Where leter with the help of '.dummies' module of pandas, we had converted non_numeric terms to numeric too, and later we concat them so that we not get the clear from of Data.

For model, we divided the whole into 4 parts. Suppose X is input and Y is output then, we split X as per train and test and smiliar with Y too. So in total we split whole data set with 4 parts. which can be X_train, X_test, y_train, y_test.

Scaling and normalizing the data to ensure that all features contribute equally to the model.

For spliting and scaling and normalizing we used Sklearn library

5). ML Model:

While preparing ML model we had split with two processes:

a). Model Implementation:

Here with the help of Sklearn, we make sure to apply ‘Linear Regression’, ‘Ridge’, ‘Lasso’. Each will do analysis first and then each will give output as per the working of the algorithms.

b). Model Evalution:

Evaluating the models using metrics like Mean Absolute Error (MAE), Mean Squared Error (MSE), and R-squared score. This will help to conclude that which model is best to use and which is not healthy for data.

5 CODE

[1]:
```
import warnings
warnings.filterwarnings('ignore')
```

[2]:
```
import numpy as np
import pandas as pd
```

[3]:
```
pd.set_option("display.max_columns",None)
pd.set_option("display.max_rows",None)
```

5.1 Importing Dataset & Data Inception

[4]:
```
housing = pd.read_csv('housing_price_prediction.csv')
```

[5]:
```
housing.head(5)
```

[5]:
```
   Id  MSSubClass MSZoning  LotFrontage  LotArea Street Alley LotShape  \
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

  LandContour Utilities LotConfig LandSlope Neighborhood Condition1  \
0         Lvl    AllPub    Inside       Gtl      CollgCr       Norm
1         Lvl    AllPub       FR2       Gtl      Veenker      Feedr
2         Lvl    AllPub    Inside       Gtl      CollgCr       Norm
3         Lvl    AllPub    Corner       Gtl      Crawfor       Norm
4         Lvl    AllPub       FR2       Gtl      NoRidge       Norm

  Condition2 BldgType HouseStyle  OverallQual  OverallCond  YearBuilt  \
0       Norm     1Fam     2Story            7            5       2003
1       Norm     1Fam     1Story            6            8       1976
2       Norm     1Fam     2Story            7            5       2001
```

```
3       Norm     1Fam     2Story            7            5       1915
4       Norm     1Fam     2Story            8            5       2000

   YearRemodAdd RoofStyle RoofMatl Exterior1st Exterior2nd MasVnrType  \
0          2003     Gable  CompShg     VinylSd     VinylSd    BrkFace
1          1976     Gable  CompShg     MetalSd     MetalSd        NaN
2          2002     Gable  CompShg     VinylSd     VinylSd    BrkFace
3          1970     Gable  CompShg     Wd Sdng     Wd Shng        NaN
4          2000     Gable  CompShg     VinylSd     VinylSd    BrkFace

   MasVnrArea ExterQual ExterCond Foundation BsmtQual BsmtCond BsmtExposure  \
0       196.0        Gd        TA      PConc       Gd       TA           No
1         0.0        TA        TA     CBlock       Gd       TA           Gd
2       162.0        Gd        TA      PConc       Gd       TA           Mn
3         0.0        TA        TA     BrkTil       TA       Gd           No
4       350.0        Gd        TA      PConc       Gd       TA           Av

  BsmtFinType1  BsmtFinSF1 BsmtFinType2  BsmtFinSF2  BsmtUnfSF  TotalBsmtSF  \
0          GLQ         706          Unf           0        150          856
1          ALQ         978          Unf           0        284         1262
2          GLQ         486          Unf           0        434          920
3          ALQ         216          Unf           0        540          756
4          GLQ         655          Unf           0        490         1145

  Heating HeatingQC CentralAir Electrical  1stFlrSF  2ndFlrSF  LowQualFinSF  \
0    GasA        Ex          Y      SBrkr       856       854             0
1    GasA        Ex          Y      SBrkr      1262         0             0
2    GasA        Ex          Y      SBrkr       920       866             0
3    GasA        Gd          Y      SBrkr       961       756             0
4    GasA        Ex          Y      SBrkr      1145      1053             0

   GrLivArea  BsmtFullBath  BsmtHalfBath  FullBath  HalfBath  BedroomAbvGr  \
0       1710             1             0         2         1             3
1       1262             0             1         2         0             3
2       1786             1             0         2         1             3
3       1717             1             0         1         0             3
4       2198             1             0         2         1             4

   KitchenAbvGr KitchenQual  TotRmsAbvGrd Functional  Fireplaces FireplaceQu  \
0             1          Gd             8        Typ           0         NaN
1             1          TA             6        Typ           1          TA
2             1          Gd             6        Typ           1          TA
3             1          Gd             7        Typ           1          Gd
4             1          Gd             9        Typ           1          TA

  GarageType  GarageYrBlt GarageFinish  GarageCars  GarageArea GarageQual  \
0     Attchd       2003.0          RFn           2         548         TA
```

```
1     Attchd       1976.0          RFn            2          460          TA
2     Attchd       2001.0          RFn            2          608          TA
3     Detchd       1998.0          Unf            3          642          TA
4     Attchd       2000.0          RFn            3          836          TA

  GarageCond PavedDrive  WoodDeckSF  OpenPorchSF  EnclosedPorch  3SsnPorch  \
0         TA          Y           0           61              0          0
1         TA          Y         298            0              0          0
2         TA          Y           0           42              0          0
3         TA          Y           0           35            272          0
4         TA          Y         192           84              0          0

   ScreenPorch  PoolArea PoolQC Fence MiscFeature  MiscVal  MoSold  YrSold  \
0            0         0    NaN   NaN         NaN        0       2    2008
1            0         0    NaN   NaN         NaN        0       5    2007
2            0         0    NaN   NaN         NaN        0       9    2008
3            0         0    NaN   NaN         NaN        0       2    2006
4            0         0    NaN   NaN         NaN        0      12    2008

  SaleType SaleCondition  SalePrice
0       WD        Normal     208500
1       WD        Normal     181500
2       WD        Normal     223500
3       WD       Abnorml     140000
4       WD        Normal     250000
```

[ ]:

[6]:
```
housing.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1460 entries, 0 to 1459
Data columns (total 81 columns):
 #   Column         Non-Null Count  Dtype
---  ------         --------------  -----
 0   Id             1460 non-null   int64
 1   MSSubClass     1460 non-null   int64
 2   MSZoning       1460 non-null   object
 3   LotFrontage    1201 non-null   float64
 4   LotArea        1460 non-null   int64
 5   Street         1460 non-null   object
 6   Alley          91 non-null     object
 7   LotShape       1460 non-null   object
 8   LandContour    1460 non-null   object
 9   Utilities      1460 non-null   object
 10  LotConfig      1460 non-null   object
 11  LandSlope      1460 non-null   object
```

```
12  Neighborhood   1460 non-null   object
13  Condition1     1460 non-null   object
14  Condition2     1460 non-null   object
15  BldgType       1460 non-null   object
16  HouseStyle     1460 non-null   object
17  OverallQual    1460 non-null   int64
18  OverallCond    1460 non-null   int64
19  YearBuilt      1460 non-null   int64
20  YearRemodAdd   1460 non-null   int64
21  RoofStyle      1460 non-null   object
22  RoofMatl       1460 non-null   object
23  Exterior1st    1460 non-null   object
24  Exterior2nd    1460 non-null   object
25  MasVnrType     588 non-null    object
26  MasVnrArea     1452 non-null   float64
27  ExterQual      1460 non-null   object
28  ExterCond      1460 non-null   object
29  Foundation     1460 non-null   object
30  BsmtQual       1423 non-null   object
31  BsmtCond       1423 non-null   object
32  BsmtExposure   1422 non-null   object
33  BsmtFinType1   1423 non-null   object
34  BsmtFinSF1     1460 non-null   int64
35  BsmtFinType2   1422 non-null   object
36  BsmtFinSF2     1460 non-null   int64
37  BsmtUnfSF      1460 non-null   int64
38  TotalBsmtSF    1460 non-null   int64
39  Heating        1460 non-null   object
40  HeatingQC      1460 non-null   object
41  CentralAir     1460 non-null   object
42  Electrical     1459 non-null   object
43  1stFlrSF       1460 non-null   int64
44  2ndFlrSF       1460 non-null   int64
45  LowQualFinSF   1460 non-null   int64
46  GrLivArea      1460 non-null   int64
47  BsmtFullBath   1460 non-null   int64
48  BsmtHalfBath   1460 non-null   int64
49  FullBath       1460 non-null   int64
50  HalfBath       1460 non-null   int64
51  BedroomAbvGr   1460 non-null   int64
52  KitchenAbvGr   1460 non-null   int64
53  KitchenQual    1460 non-null   object
54  TotRmsAbvGrd   1460 non-null   int64
55  Functional     1460 non-null   object
56  Fireplaces     1460 non-null   int64
57  FireplaceQu    770 non-null    object
58  GarageType     1379 non-null   object
59  GarageYrBlt    1379 non-null   float64
```

```
 60  GarageFinish   1379 non-null   object
 61  GarageCars     1460 non-null   int64
 62  GarageArea     1460 non-null   int64
 63  GarageQual     1379 non-null   object
 64  GarageCond     1379 non-null   object
 65  PavedDrive     1460 non-null   object
 66  WoodDeckSF     1460 non-null   int64
 67  OpenPorchSF    1460 non-null   int64
 68  EnclosedPorch  1460 non-null   int64
 69  3SsnPorch      1460 non-null   int64
 70  ScreenPorch    1460 non-null   int64
 71  PoolArea       1460 non-null   int64
 72  PoolQC         7 non-null      object
 73  Fence          281 non-null    object
 74  MiscFeature    54 non-null     object
 75  MiscVal        1460 non-null   int64
 76  MoSold         1460 non-null   int64
 77  YrSold         1460 non-null   int64
 78  SaleType       1460 non-null   object
 79  SaleCondition  1460 non-null   object
 80  SalePrice      1460 non-null   int64
dtypes: float64(3), int64(35), object(43)
memory usage: 924.0+ KB
```

[ ]:

```
[7]: housing.isnull().sum()/housing.shape[0]*100
```

```
[7]: Id                0.000000
     MSSubClass        0.000000
     MSZoning          0.000000
     LotFrontage      17.739726
     LotArea           0.000000
     Street            0.000000
     Alley            93.767123
     LotShape          0.000000
     LandContour       0.000000
     Utilities         0.000000
     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       0.000000
Exterior2nd       0.000000
MasVnrType       59.726027
MasVnrArea        0.547945
ExterQual         0.000000
ExterCond         0.000000
Foundation        0.000000
BsmtQual          2.534247
BsmtCond          2.534247
BsmtExposure      2.602740
BsmtFinType1      2.534247
BsmtFinSF1        0.000000
BsmtFinType2      2.602740
BsmtFinSF2        0.000000
BsmtUnfSF         0.000000
TotalBsmtSF       0.000000
Heating           0.000000
HeatingQC         0.000000
CentralAir        0.000000
Electrical        0.068493
1stFlrSF          0.000000
2ndFlrSF          0.000000
LowQualFinSF      0.000000
GrLivArea         0.000000
BsmtFullBath      0.000000
BsmtHalfBath      0.000000
FullBath          0.000000
HalfBath          0.000000
BedroomAbvGr      0.000000
KitchenAbvGr      0.000000
KitchenQual       0.000000
TotRmsAbvGrd      0.000000
Functional        0.000000
Fireplaces        0.000000
FireplaceQu      47.260274
GarageType        5.547945
GarageYrBlt       5.547945
GarageFinish      5.547945
GarageCars        0.000000
GarageArea        0.000000
GarageQual        5.547945
GarageCond        5.547945
PavedDrive        0.000000
```

```
WoodDeckSF        0.000000
OpenPorchSF       0.000000
EnclosedPorch     0.000000
3SsnPorch         0.000000
ScreenPorch       0.000000
PoolArea          0.000000
PoolQC           99.520548
Fence            80.753425
MiscFeature      96.301370
MiscVal           0.000000
MoSold            0.000000
YrSold            0.000000
SaleType          0.000000
SaleCondition     0.000000
SalePrice         0.000000
dtype: float64
```

5.2 Data Cleaning

[ ]:

```

```

[8]:

```
na_col = [col for col in housing.columns if housing[col].isnull().any() and␣
↪housing[col].dtype == 'object']
```

[9]:

```
na_col
```

[9]:

```
['Alley',
 'MasVnrType',
 'BsmtQual',
 'BsmtCond',
 'BsmtExposure',
 'BsmtFinType1',
 'BsmtFinType2',
 'Electrical',
 'FireplaceQu',
 'GarageType',
 'GarageFinish',
 'GarageQual',
 'GarageCond',
 'PoolQC',
 'Fence',
 'MiscFeature']
```

[10]:

```
for feature in na_col:
    housing[feature].fillna('None',inplace=True)
```

[11]:

```
housing.isnull().sum()/housing.shape[0]*100
```

[11]:
```
Id                0.000000
MSSubClass        0.000000
MSZoning          0.000000
LotFrontage      17.739726
LotArea           0.000000
Street            0.000000
Alley             0.000000
LotShape          0.000000
LandContour       0.000000
Utilities         0.000000
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       0.000000
Exterior2nd       0.000000
MasVnrType        0.000000
MasVnrArea        0.547945
ExterQual         0.000000
ExterCond         0.000000
Foundation        0.000000
BsmtQual          0.000000
BsmtCond          0.000000
BsmtExposure      0.000000
BsmtFinType1      0.000000
BsmtFinSF1        0.000000
BsmtFinType2      0.000000
BsmtFinSF2        0.000000
BsmtUnfSF         0.000000
TotalBsmtSF       0.000000
Heating           0.000000
HeatingQC         0.000000
CentralAir        0.000000
Electrical        0.000000
1stFlrSF          0.000000
2ndFlrSF          0.000000
LowQualFinSF      0.000000
GrLivArea         0.000000
```

```
BsmtFullBath      0.000000
BsmtHalfBath      0.000000
FullBath          0.000000
HalfBath          0.000000
BedroomAbvGr      0.000000
KitchenAbvGr      0.000000
KitchenQual       0.000000
TotRmsAbvGrd      0.000000
Functional        0.000000
Fireplaces        0.000000
FireplaceQu       0.000000
GarageType        0.000000
GarageYrBlt       5.547945
GarageFinish      0.000000
GarageCars        0.000000
GarageArea        0.000000
GarageQual        0.000000
GarageCond        0.000000
PavedDrive        0.000000
WoodDeckSF        0.000000
OpenPorchSF       0.000000
EnclosedPorch     0.000000
3SsnPorch         0.000000
ScreenPorch       0.000000
PoolArea          0.000000
PoolQC            0.000000
Fence             0.000000
MiscFeature       0.000000
MiscVal           0.000000
MoSold            0.000000
YrSold            0.000000
SaleType          0.000000
SaleCondition     0.000000
SalePrice         0.000000
dtype: float64
```

[ ]:

```

```

[12]:

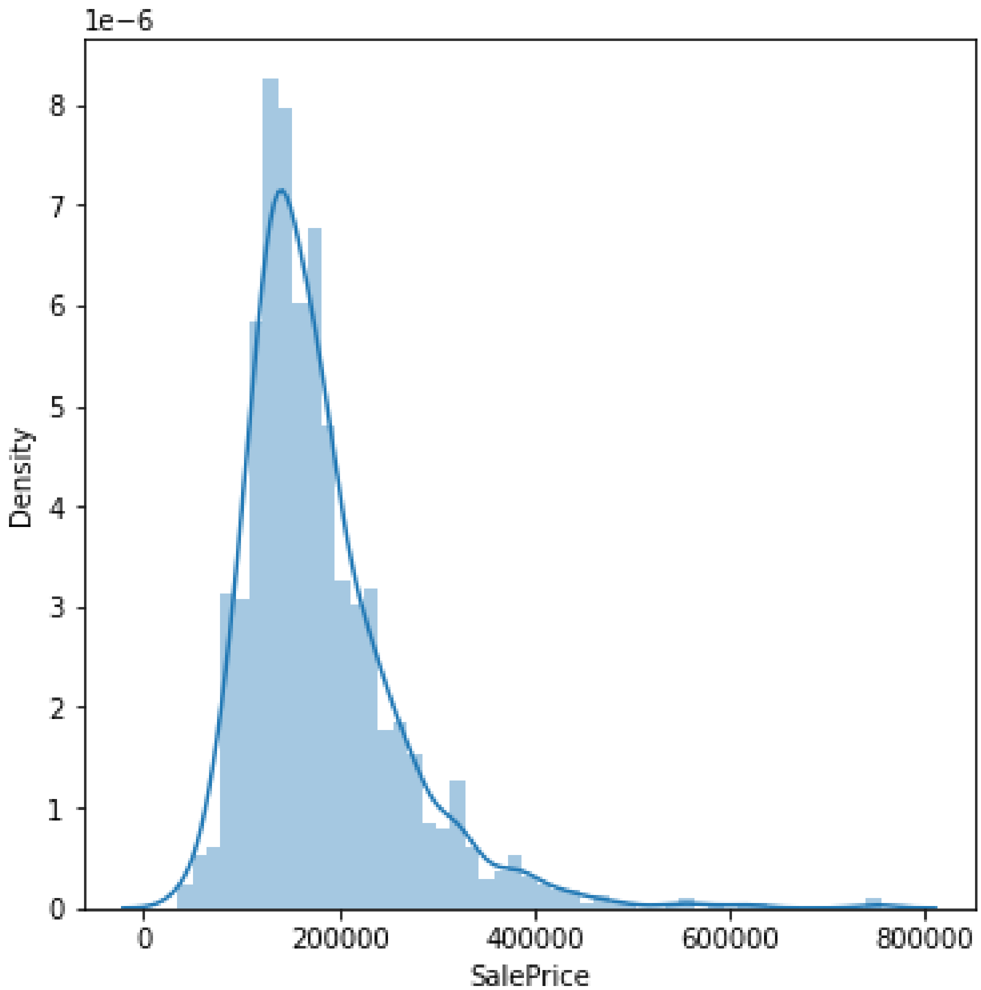
```
import seaborn as sns
import matplotlib.pyplot as plt
```

[13]:

```
plt.figure(figsize=(6,6))
sns.distplot(housing['SalePrice'])
```

[13]:

```
<Axes: xlabel='SalePrice', ylabel='Density'>
```



[ ]:

[14]:
```
housing['SalePrice'].skew()
```

[14]: 1.8828757597682129

[ ]:

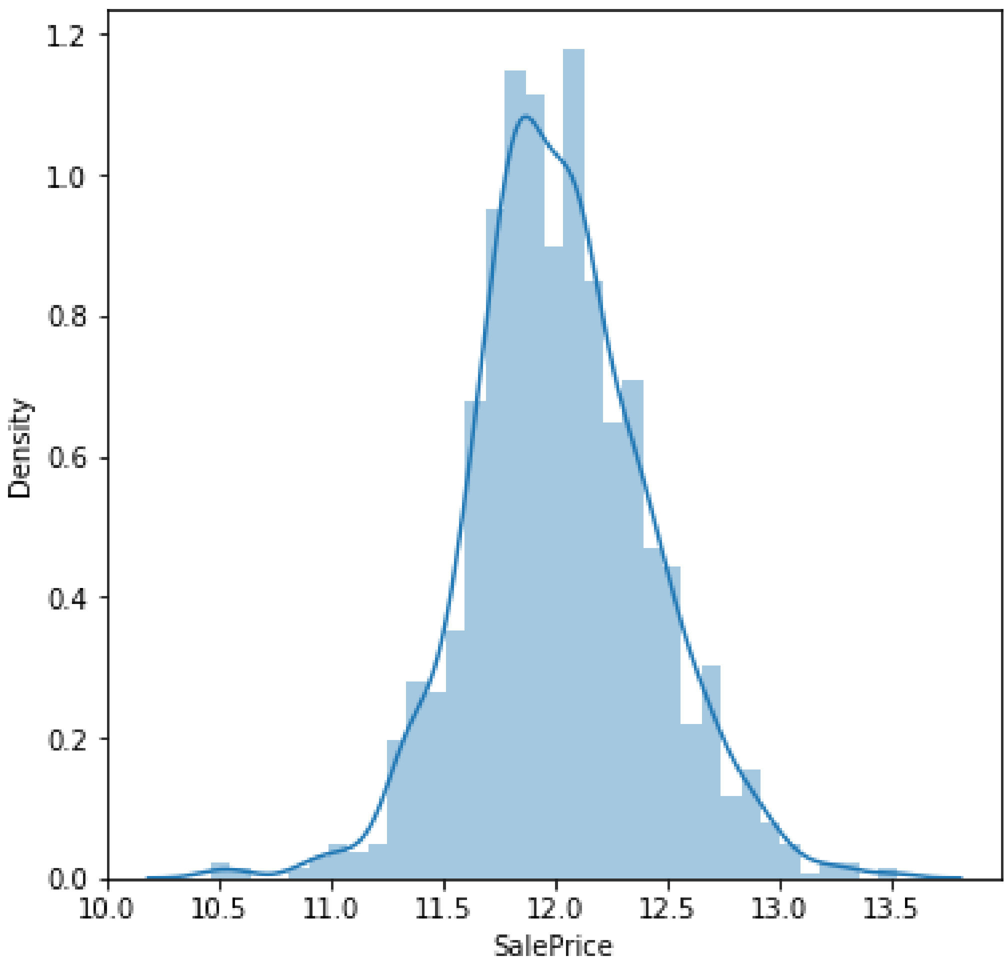
[15]:
```
housing['SalePrice'].kurt()
```

[15]: 6.536281860064529

[ ]:

[16]:
```
housing['SalePrice'] = np.log(housing['SalePrice'])
plt.figure(figsize=(6,6))
sns.distplot(housing['SalePrice'])
```

[16]: <Axes: xlabel='SalePrice', ylabel='Density'>



[ ]:
```

```

[17]:
```
housing['SalePrice'].skew()
```

[17]: 0.12133506220520406

[ ]:
```

```

[18]:
```
housing['SalePrice'].kurt()
```

[18]: 0.8095319958036296

[ ]:

[19]:
```
housing.drop('Id',axis=1,inplace=True)
```

[ ]:

[20]:
```
housing[['MSSubClass','OverallQual','OverallCond']] =␣
↪housing[['MSSubClass','OverallQual','OverallCond']].astype('object')
```

[21]:
```
housing['LotFrontage'] = pd.to_numeric(housing['LotFrontage'], errors='coerce')
housing['MasVnrArea'] = pd.to_numeric(housing['MasVnrArea'], errors='coerce')
```

[22]:
```
null_cols = housing.columns[housing.isnull().any()]
null_cols
```

[22]:
```
Index(['LotFrontage', 'MasVnrArea', 'GarageYrBlt'], dtype='object')
```

[ ]:

[23]:
```
for feature in null_cols:
    if housing[feature].dtype == np.float64 or housing[feature].dtype == np.
↪int64:
        housing[feature].fillna(housing[feature].mean(), inplace=True)
    else:
        housing[feature].fillna(housing[feature].mode()[0], inplace=True)
```

[24]:
```
housing.isnull().sum()
```

[24]:
```
MSSubClass       0
MSZoning         0
LotFrontage      0
LotArea          0
Street           0
Alley            0
LotShape         0
LandContour      0
Utilities        0
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      0
Exterior2nd      0
MasVnrType       0
MasVnrArea       0
ExterQual        0
ExterCond        0
Foundation       0
BsmtQual         0
BsmtCond         0
BsmtExposure     0
BsmtFinType1     0
BsmtFinSF1       0
BsmtFinType2     0
BsmtFinSF2       0
BsmtUnfSF        0
TotalBsmtSF      0
Heating          0
HeatingQC        0
CentralAir       0
Electrical       0
1stFlrSF         0
2ndFlrSF         0
LowQualFinSF     0
GrLivArea        0
BsmtFullBath     0
BsmtHalfBath     0
FullBath         0
HalfBath         0
BedroomAbvGr     0
KitchenAbvGr     0
KitchenQual      0
TotRmsAbvGrd     0
Functional       0
Fireplaces       0
FireplaceQu      0
GarageType       0
GarageYrBlt      0
GarageFinish     0
GarageCars       0
GarageArea       0
GarageQual       0
GarageCond       0
PavedDrive       0
WoodDeckSF       0
```

```
OpenPorchSF      0
EnclosedPorch    0
3SsnPorch        0
ScreenPorch      0
PoolArea         0
PoolQC           0
Fence            0
MiscFeature      0
MiscVal          0
MoSold           0
YrSold           0
SaleType         0
SaleCondition    0
SalePrice        0
dtype: int64
```

[ ]:

5.3 EDA

[25]:
```
cat_cols = housing.select_dtypes(include='object').columns
cat_cols
```

[25]:
```
Index(['MSSubClass', 'MSZoning', 'Street', 'Alley', 'LotShape', 'LandContour',
       'Utilities', 'LotConfig', 'LandSlope', 'Neighborhood', 'Condition1',
       'Condition2', 'BldgType', 'HouseStyle', 'OverallQual', 'OverallCond',
       'RoofStyle', 'RoofMatl', 'Exterior1st', 'Exterior2nd', 'MasVnrType',
       'ExterQual', 'ExterCond', 'Foundation', 'BsmtQual', 'BsmtCond',
       'BsmtExposure', 'BsmtFinType1', 'BsmtFinType2', 'Heating', 'HeatingQC',
       'CentralAir', 'Electrical', 'KitchenQual', 'Functional', 'FireplaceQu',
       'GarageType', 'GarageFinish', 'GarageQual', 'GarageCond', 'PavedDrive',
       'PoolQC', 'Fence', 'MiscFeature', 'SaleType', 'SaleCondition'],
      dtype='object')
```

[ ]:

[26]:
```
num_cols = housing.select_dtypes(include=['float64', 'int64']).columns
num_cols
```

[26]:
```
Index(['LotFrontage', 'LotArea', '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'],
      dtype='object')
```

[ ]:

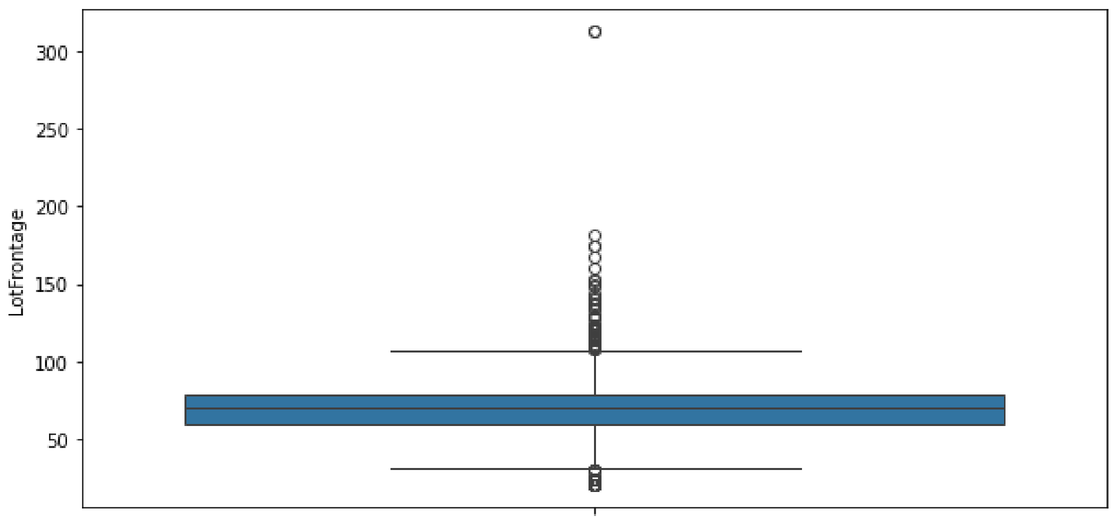
```

```

5.3.1 Univarite Analysis

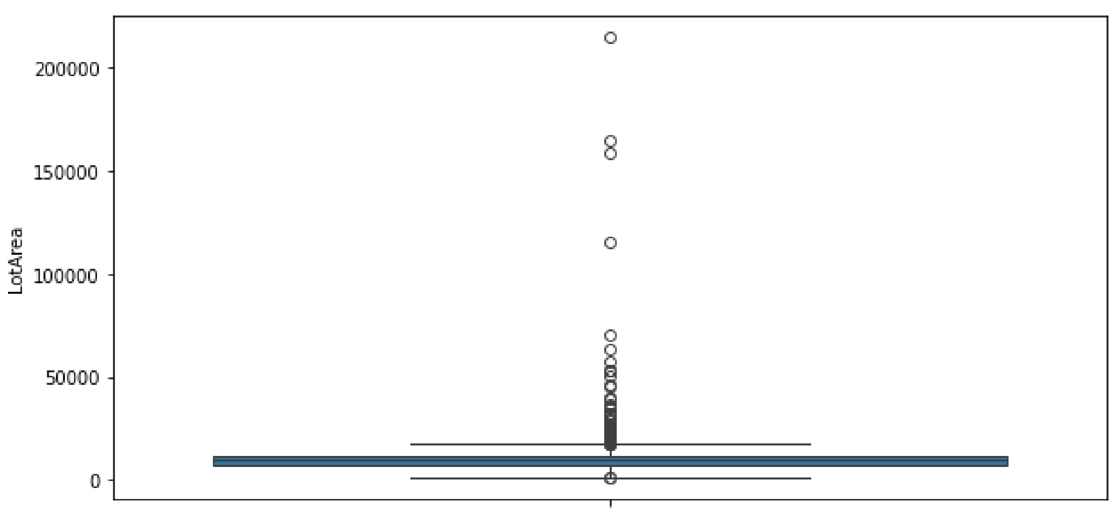
[27]:

```
for col in num_cols:
    plt.figure(figsize=(10,5))
    print(col)
    sns.boxplot(housing[col])
    plt.show()
```

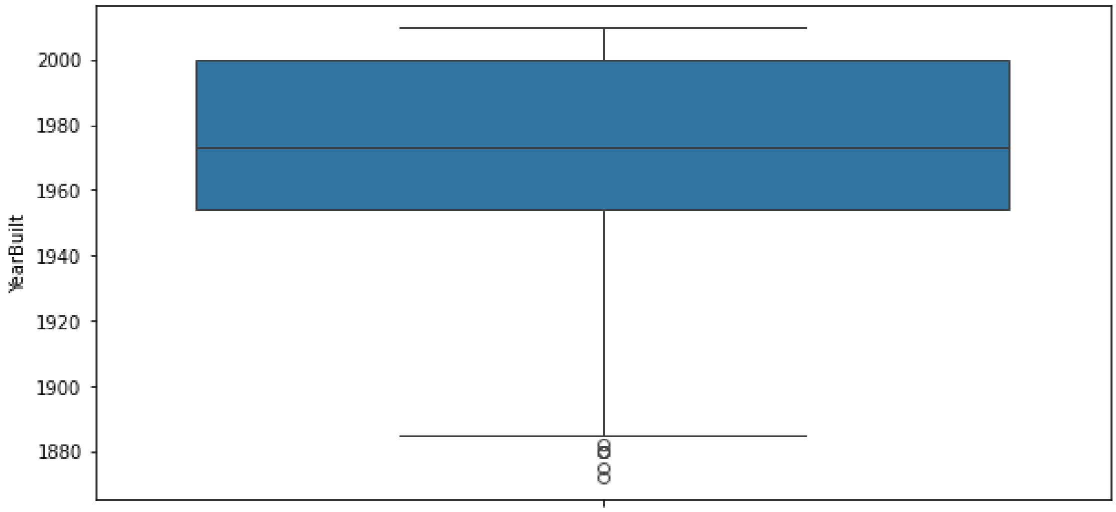
LotFrontage



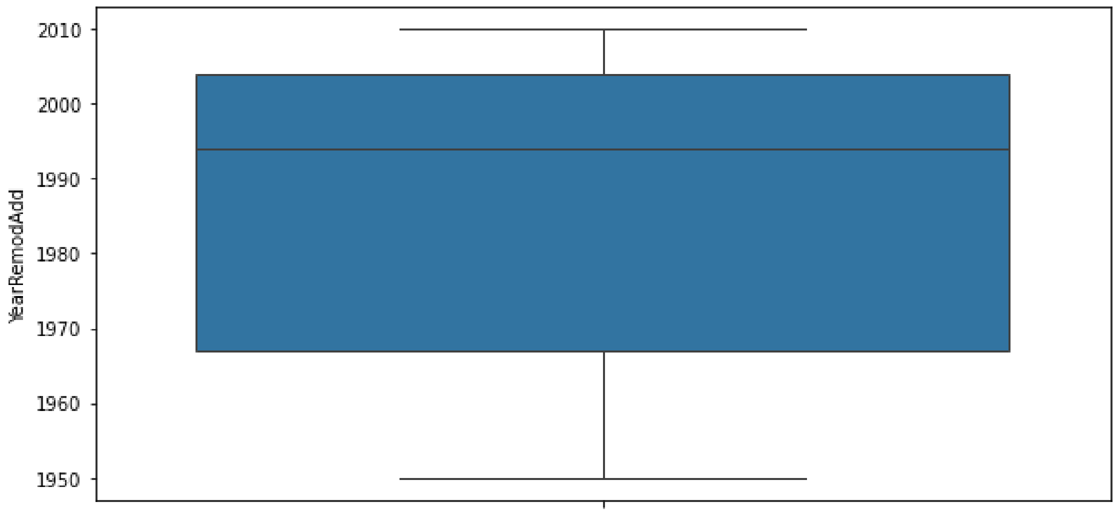
LotArea



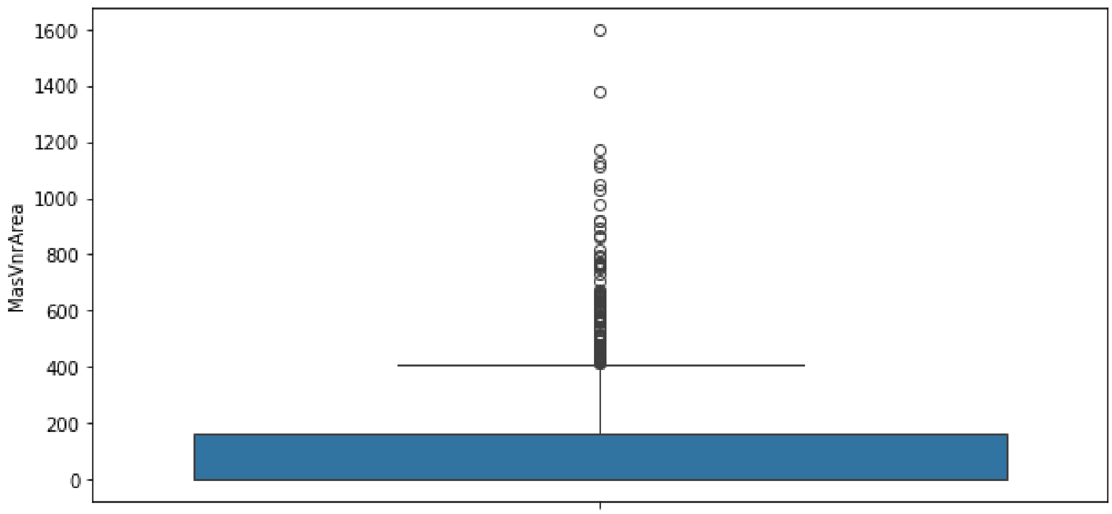
`YearBuilt`



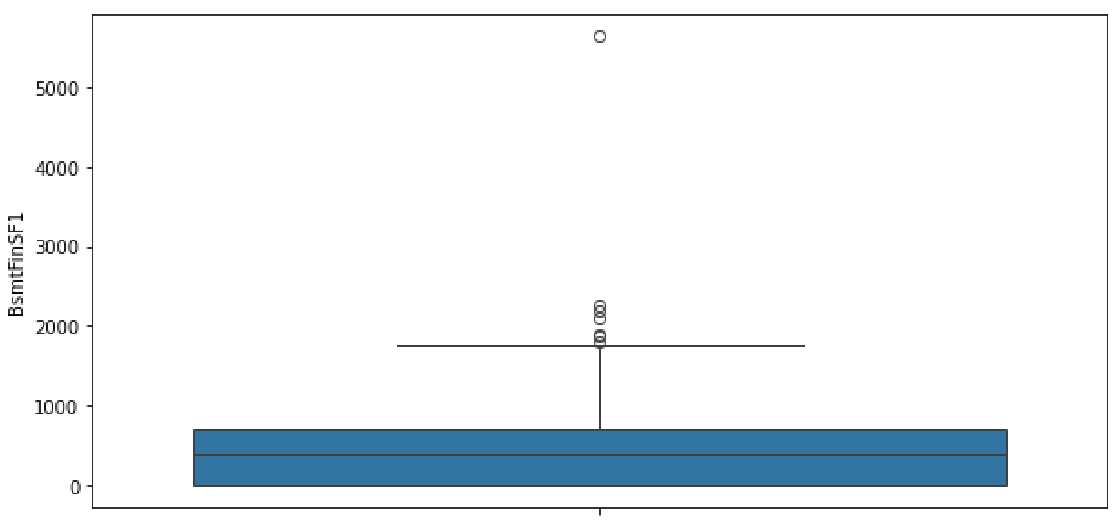
`YearRemodAdd`



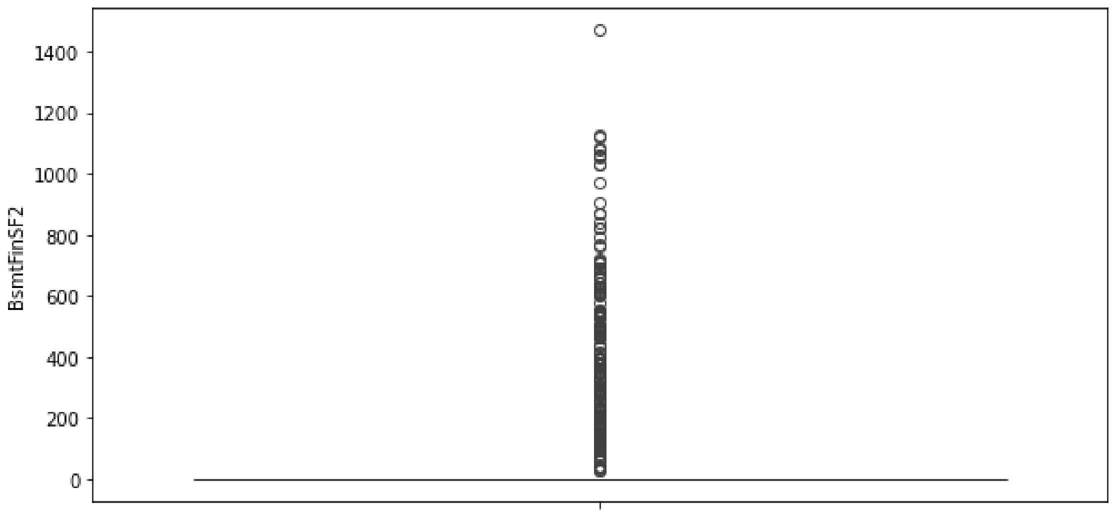
`MasVnrArea`



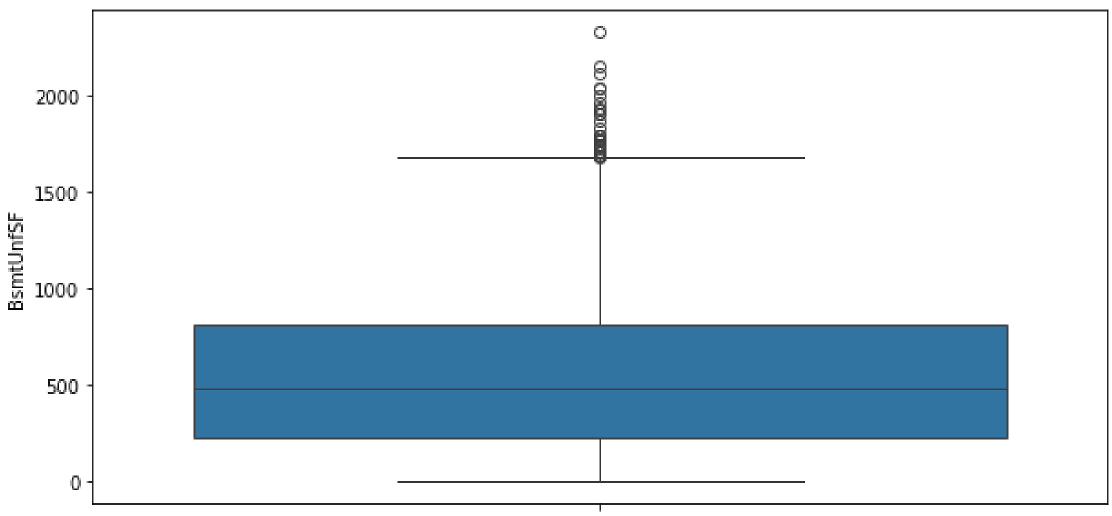
BsmtFinSF1



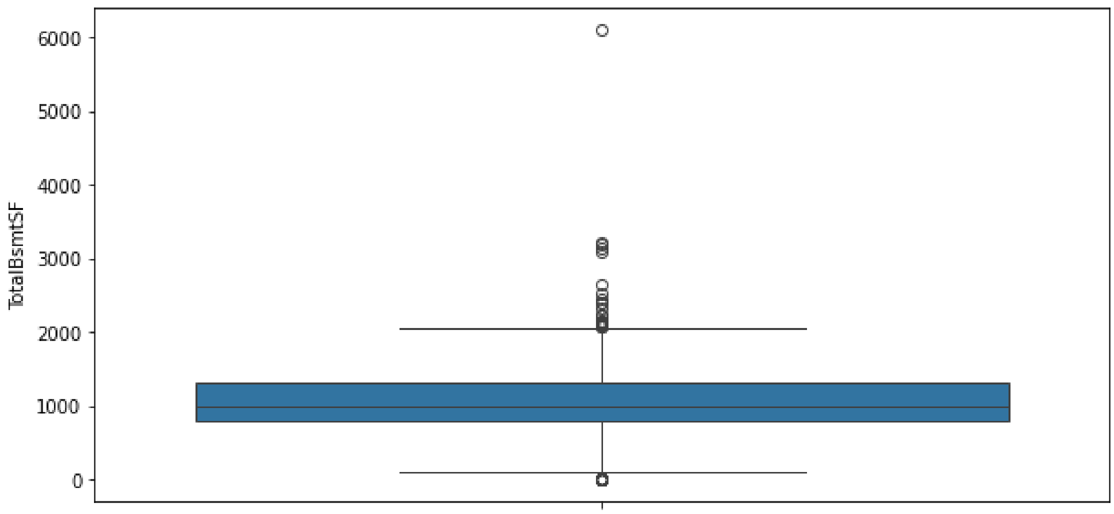
BsmtFinSF2



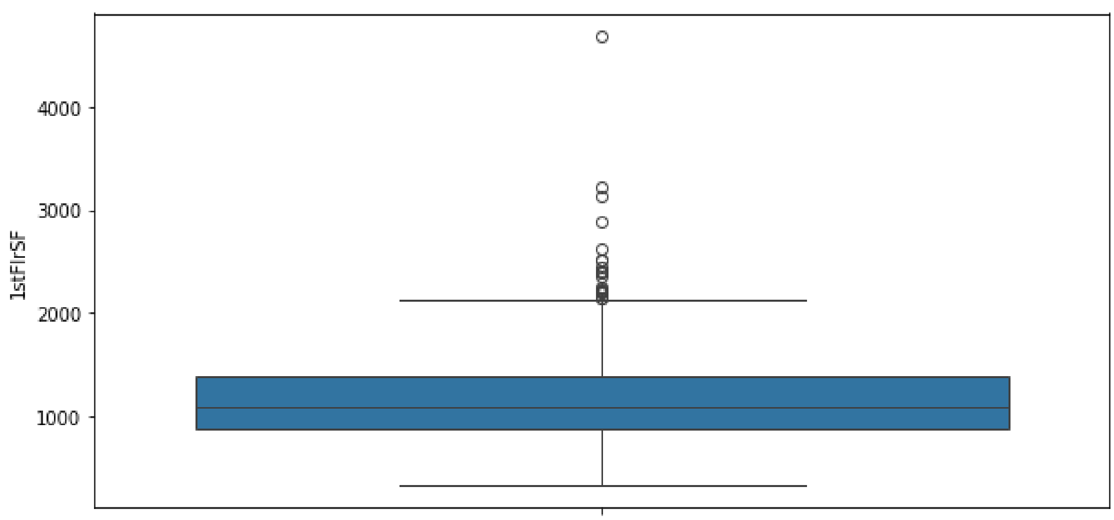
BsmtUnfSF



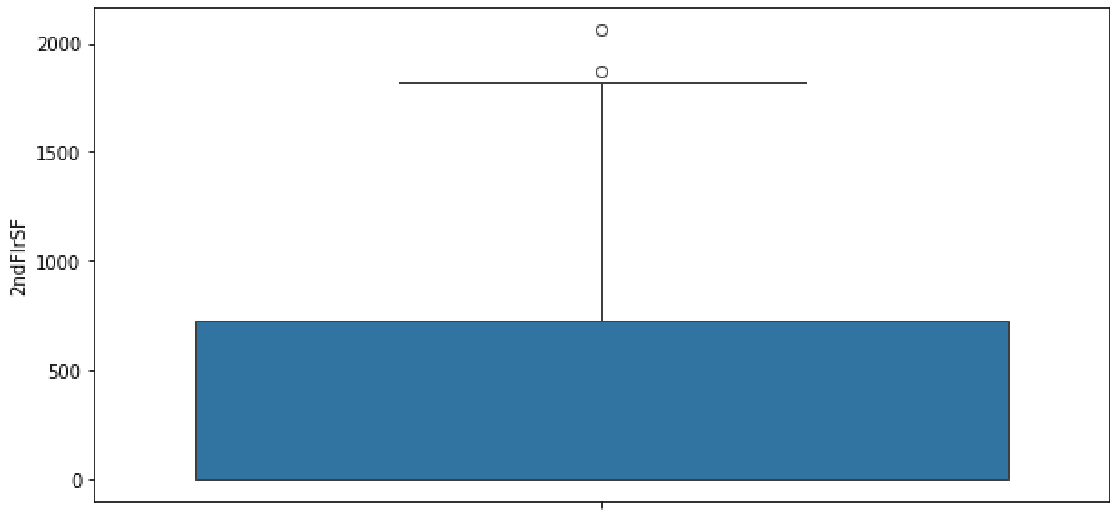
TotalBsmtSF



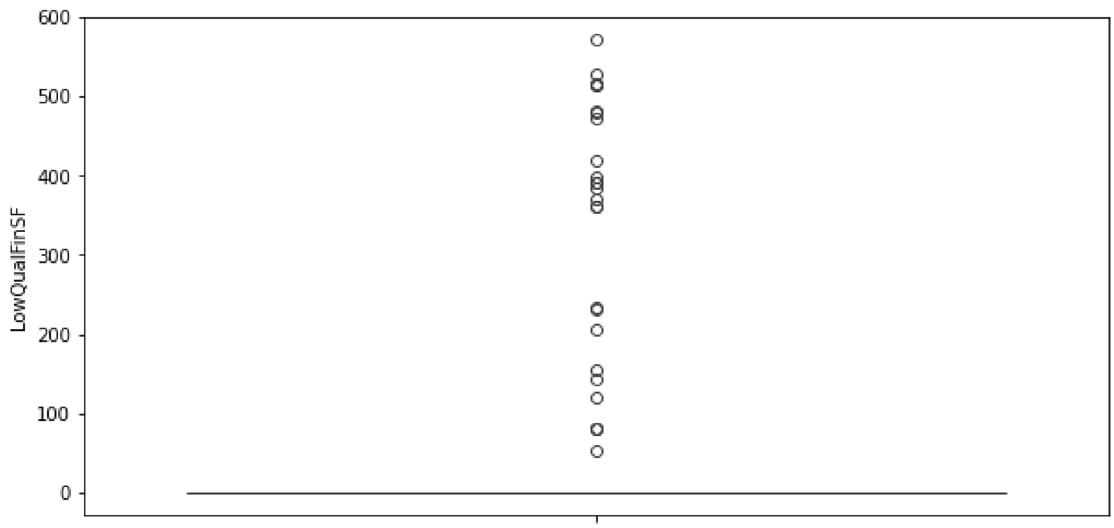
`1stFlrSF`



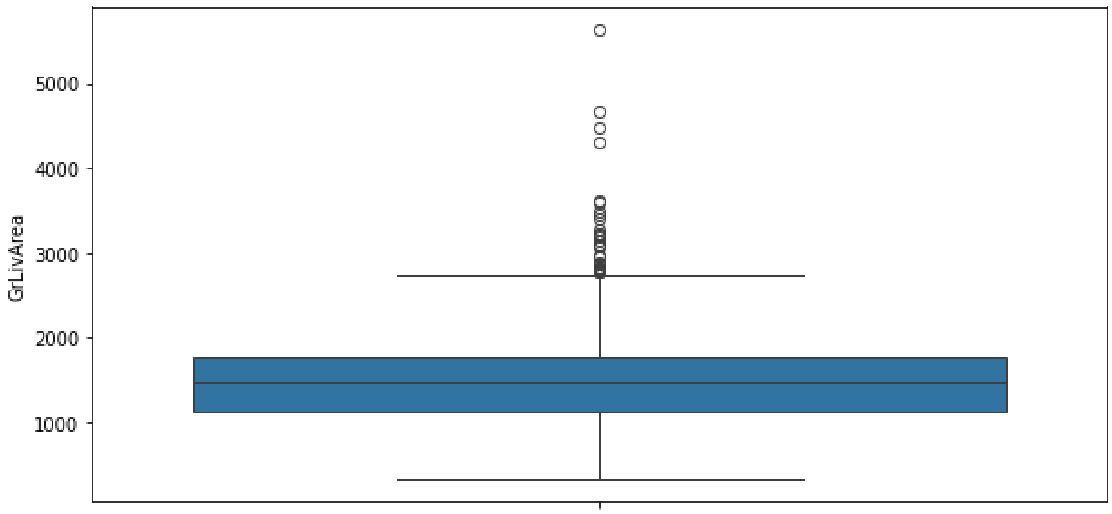
`2ndFlrSF`



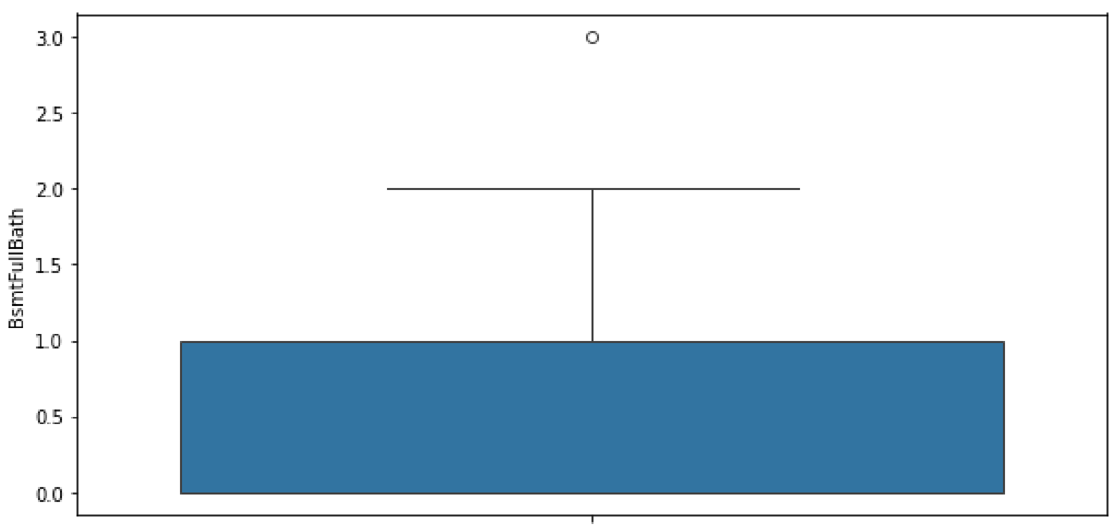
LowQualFinSF



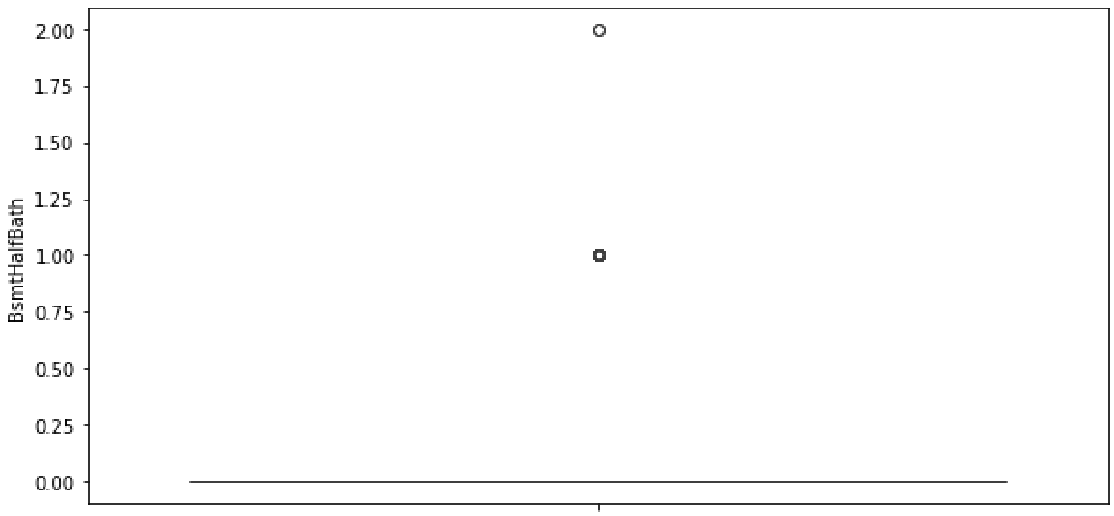
GrLivArea



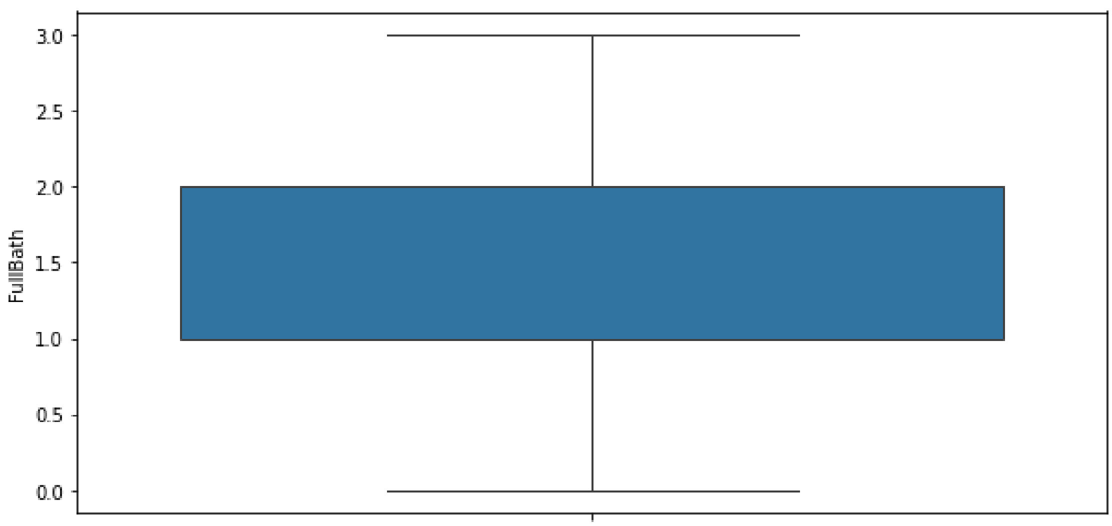
BsmtFullBath



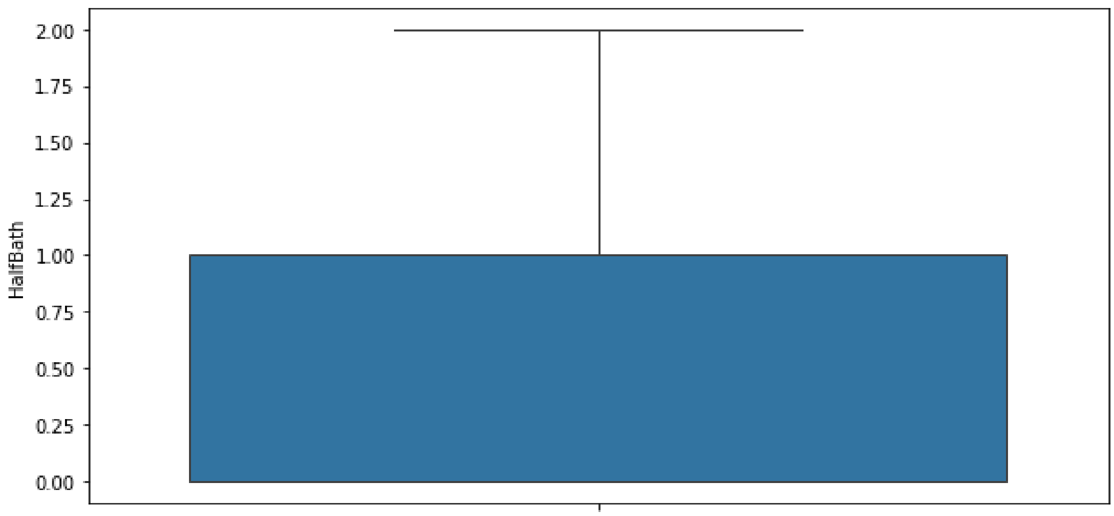
BsmtHalfBath



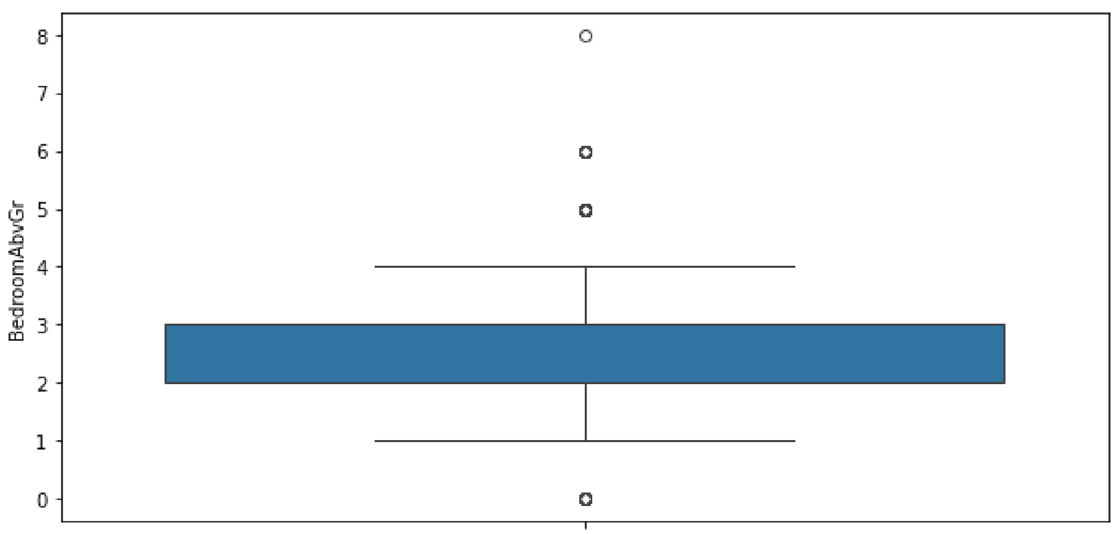
FullBath



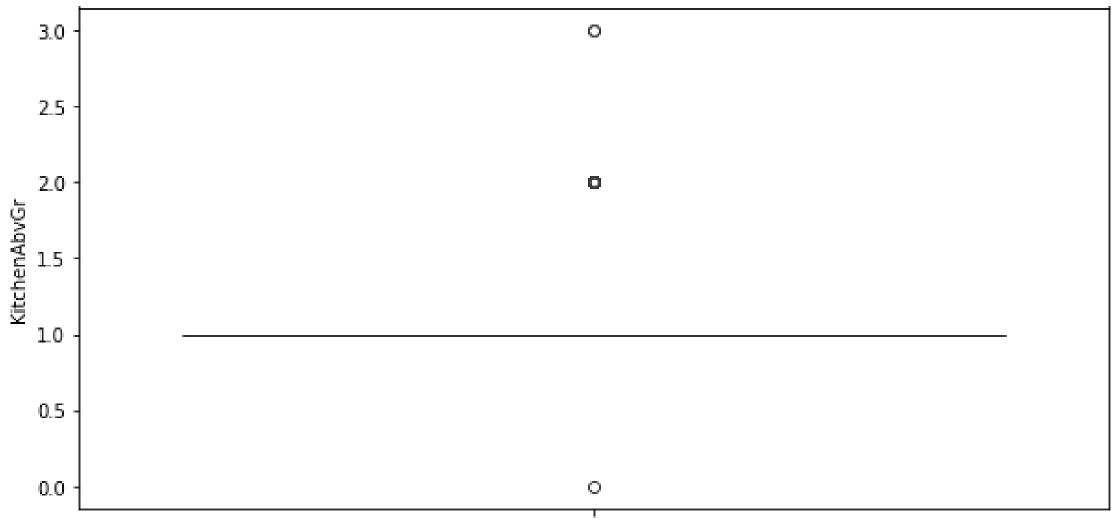
HalfBath



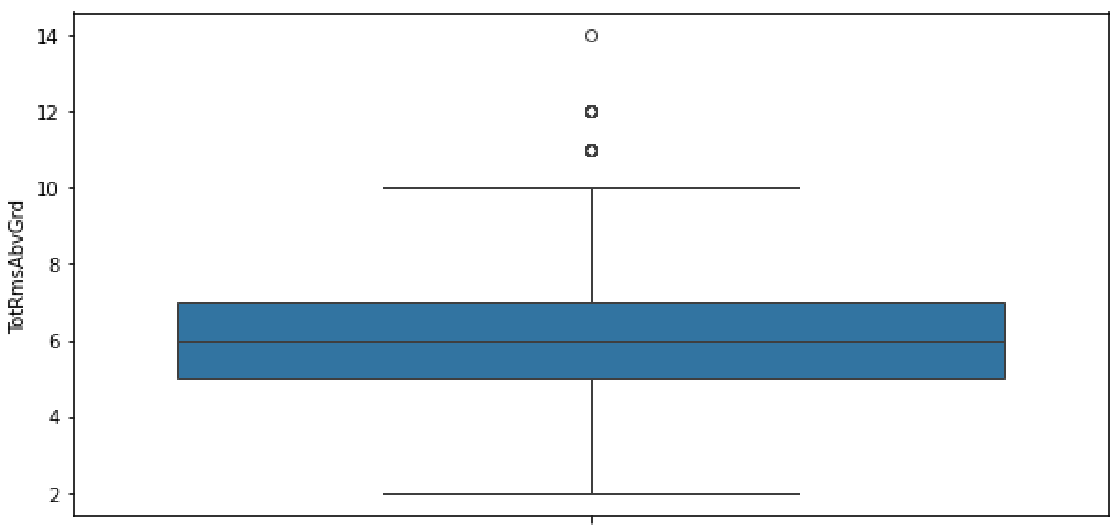
BedroomAbvGr



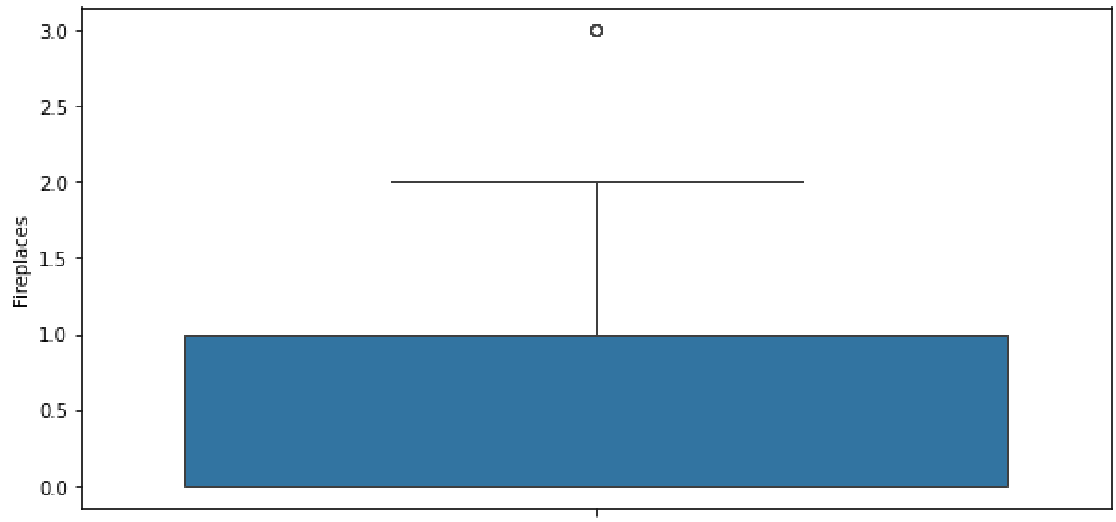
KitchenAbvGr



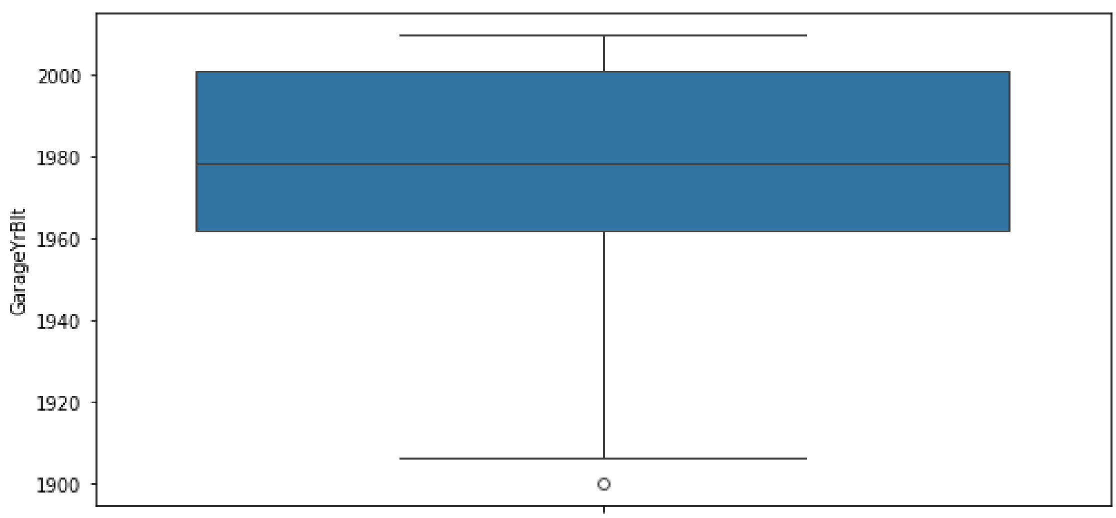
TotRmsAbvGrd



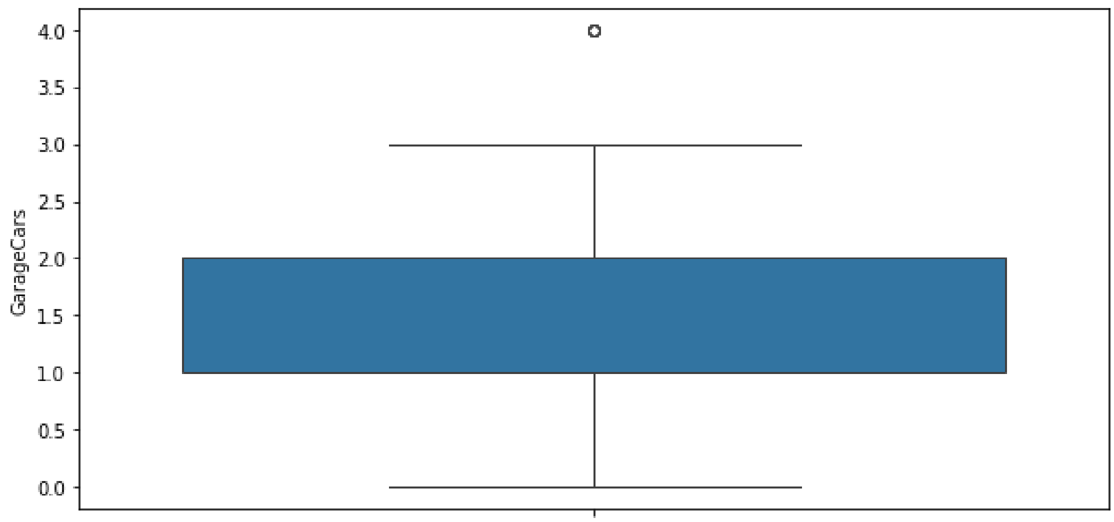
Fireplaces



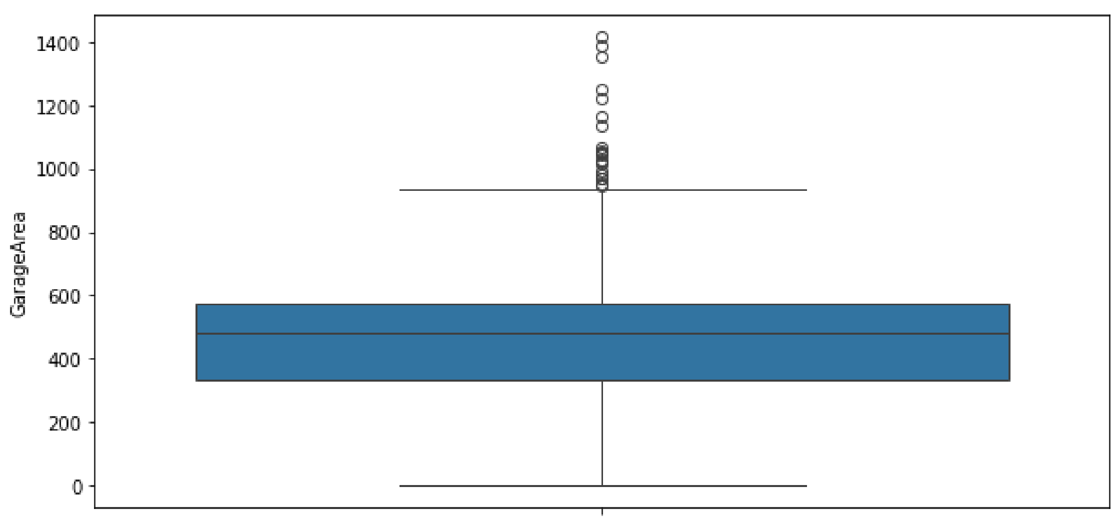
GarageYrBlt



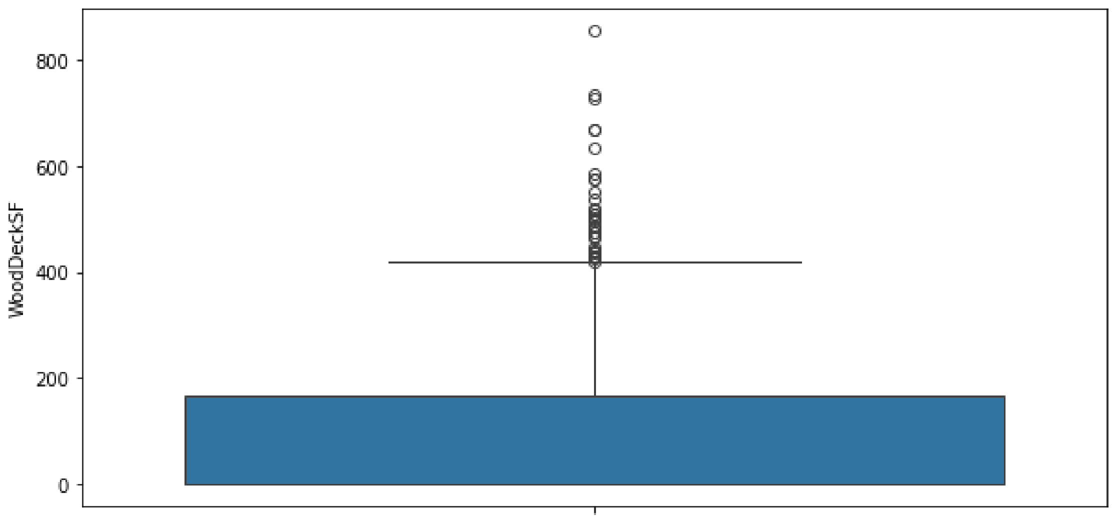
GarageCars



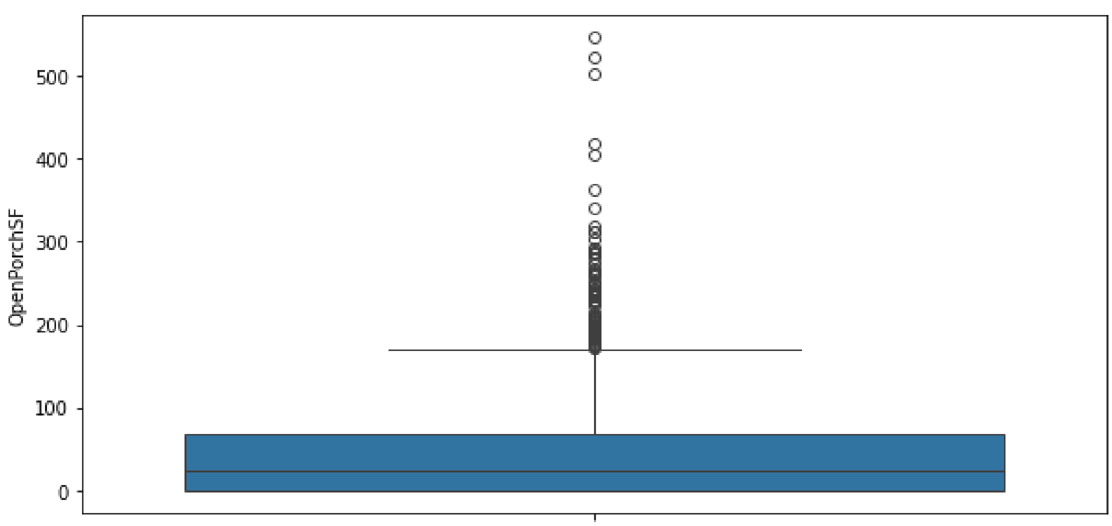
GarageArea



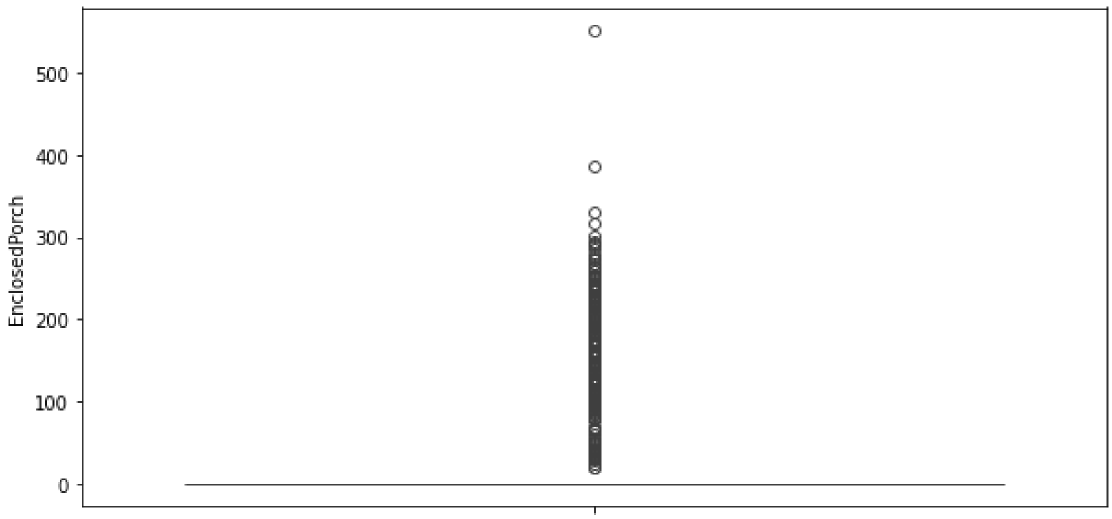
WoodDeckSF



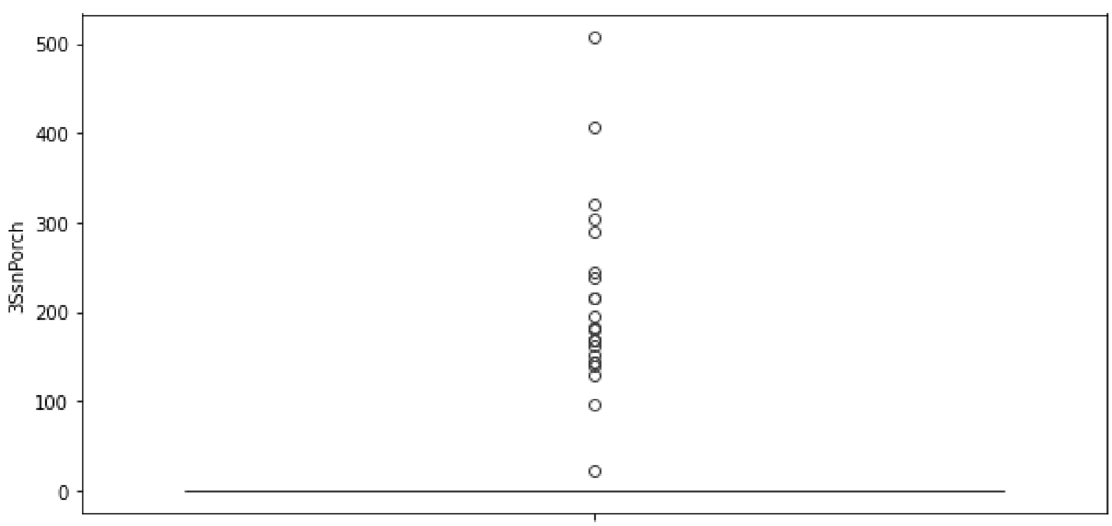
OpenPorchSF



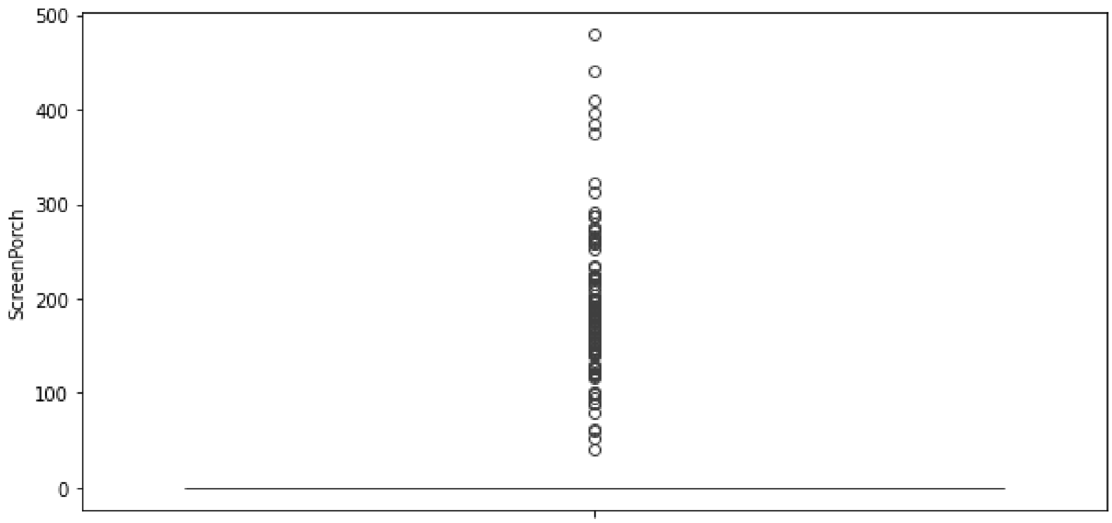
EnclosedPorch



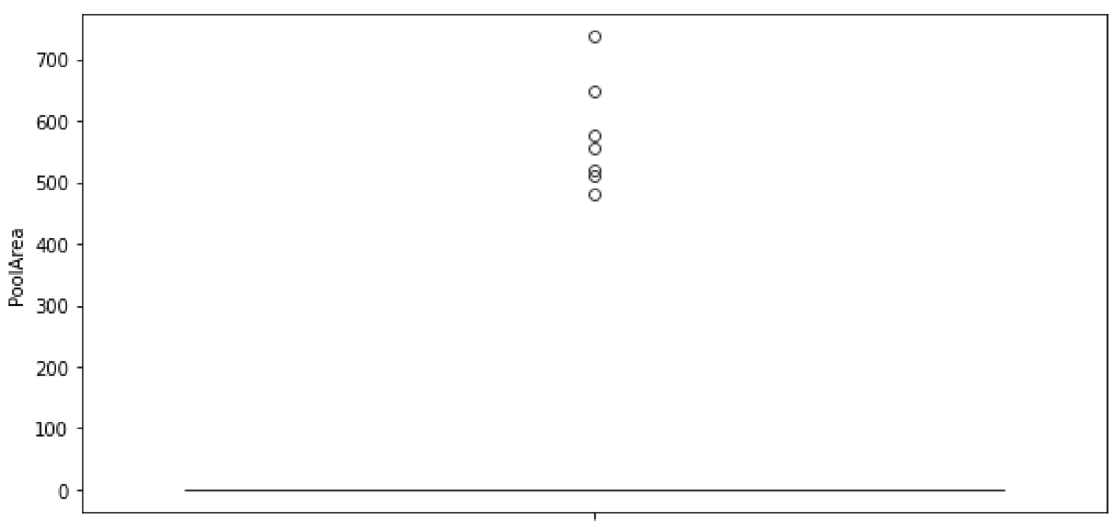
3SsnPorch



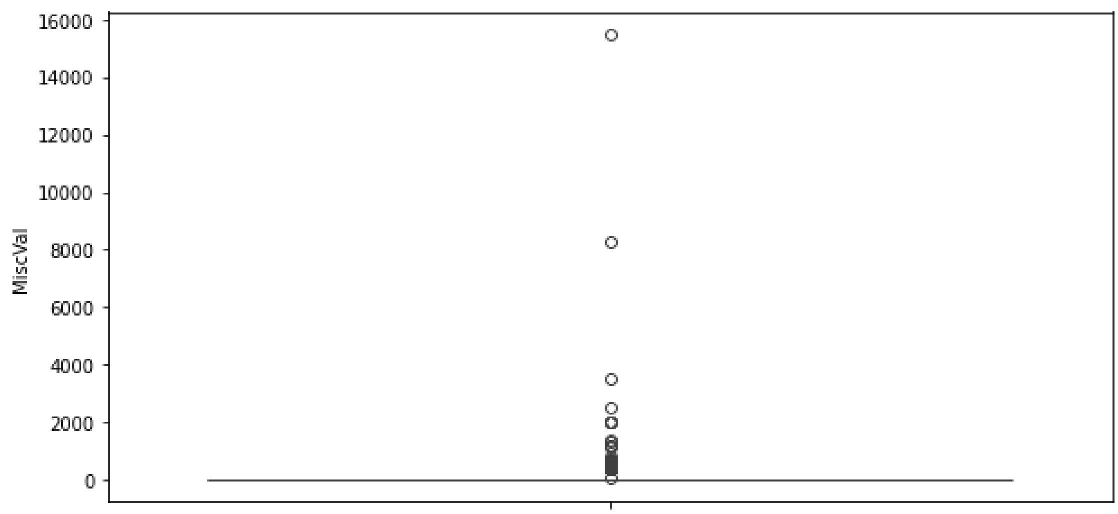
ScreenPorch



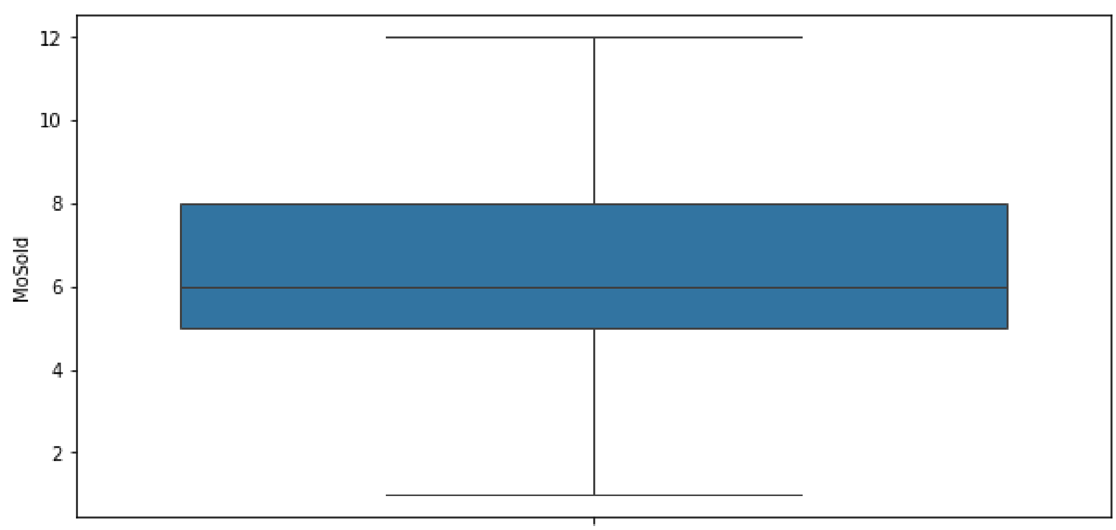
PoolArea



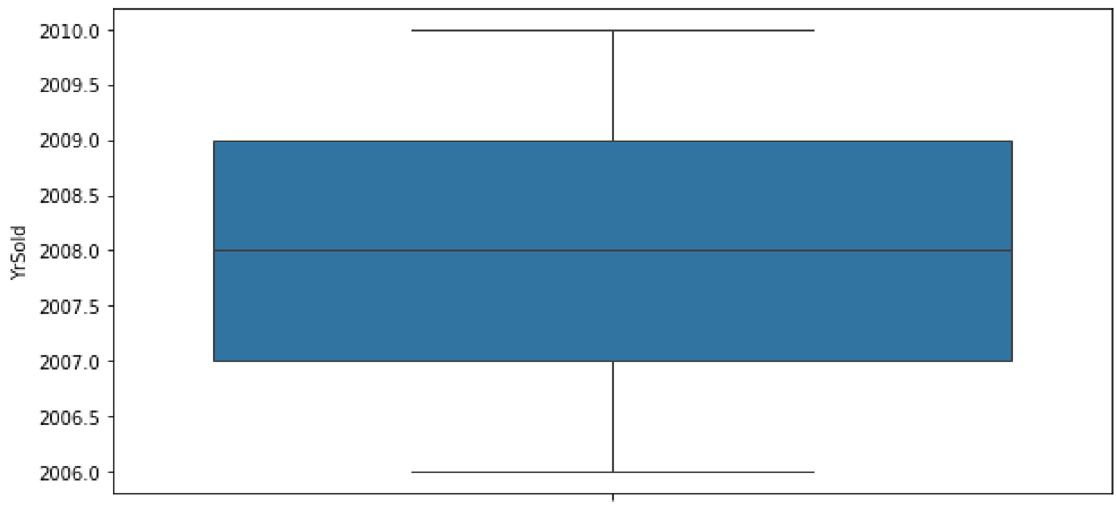
MiscVal



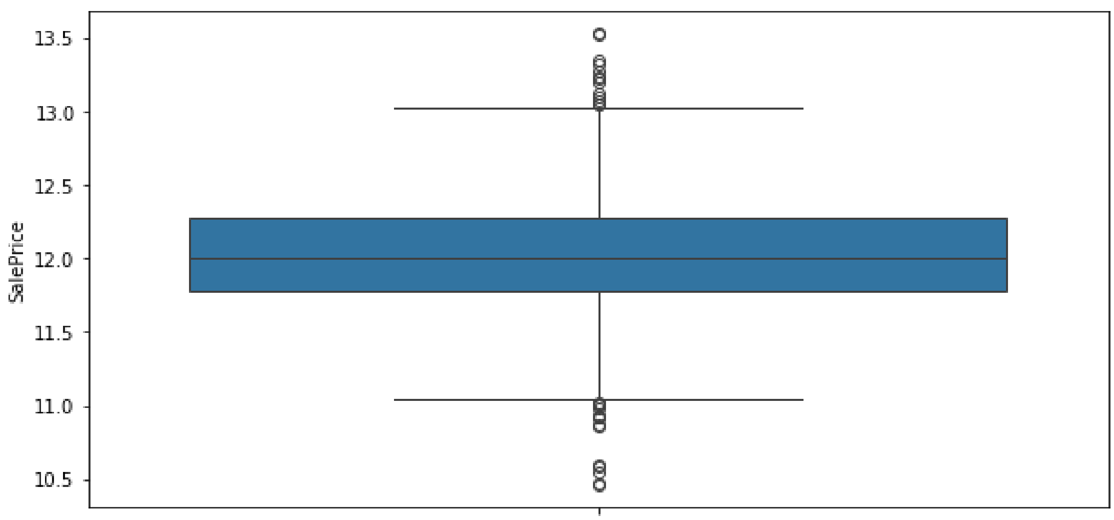
MoSold



YrSold



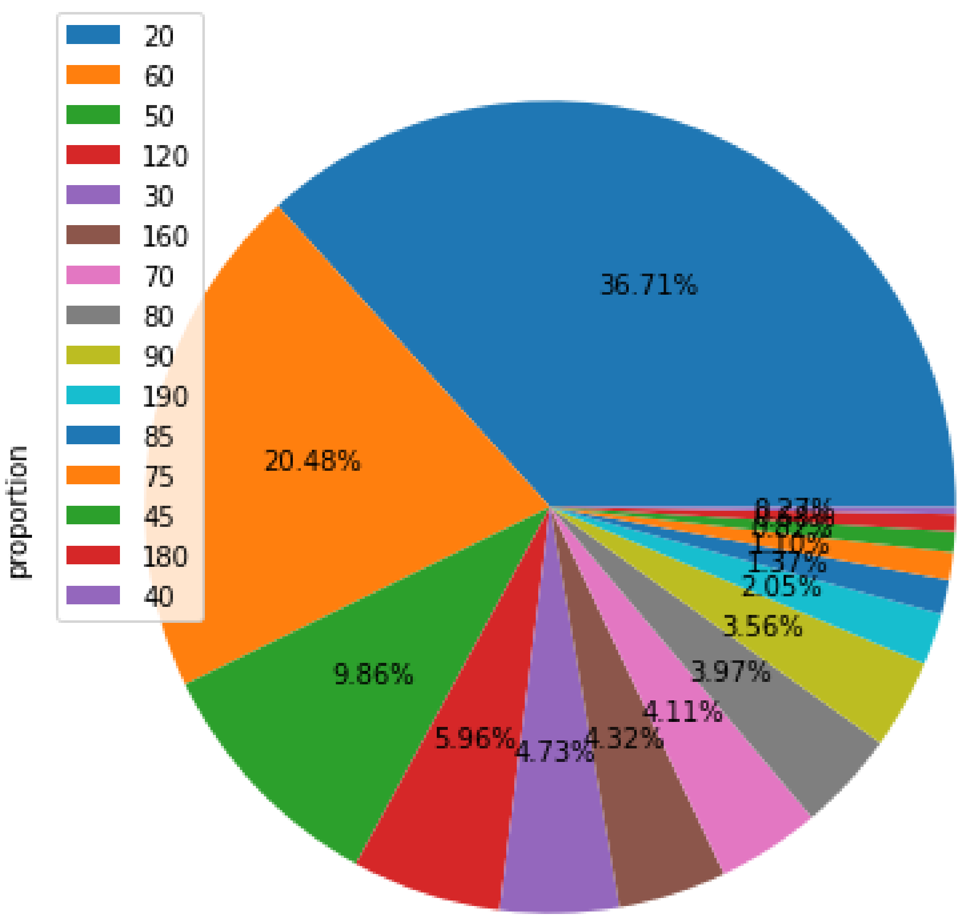
SalePrice



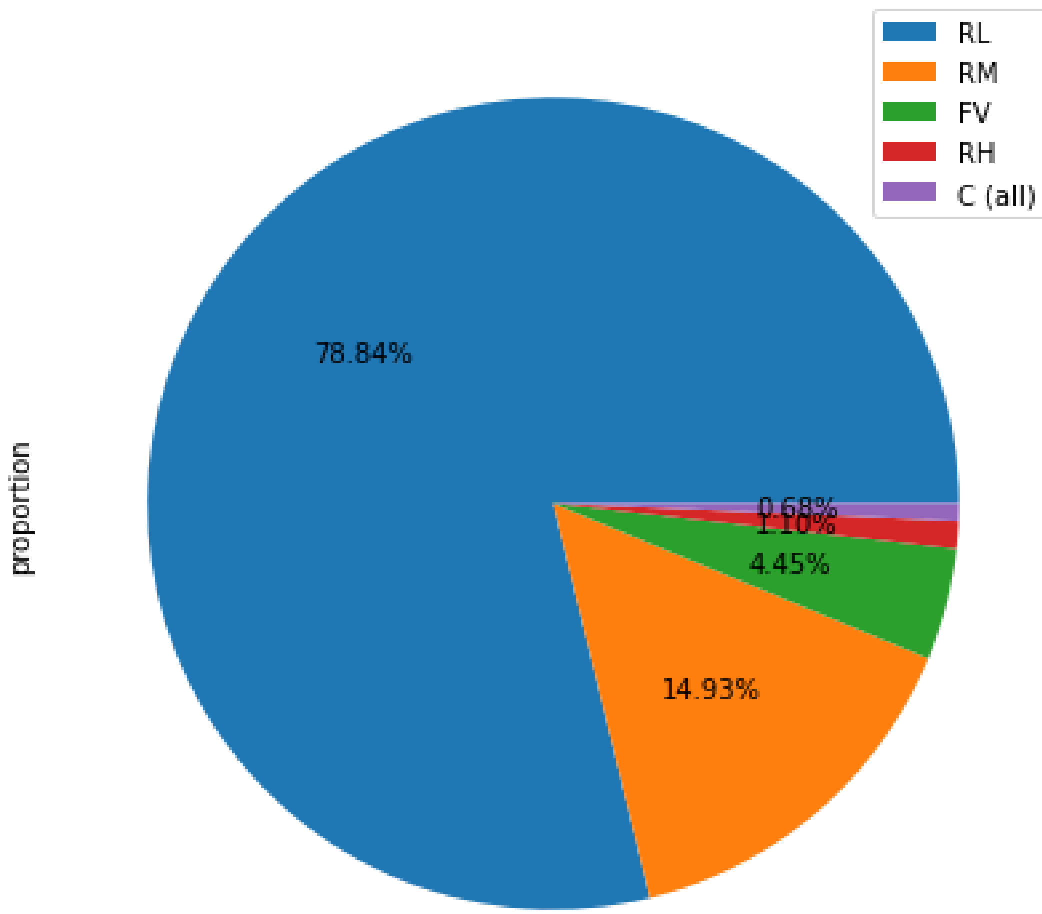
[ ]:

```
[28]: for col in cat_cols:
    print(housing[col].value_counts(normalize=True))
    plt.figure(figsize=(7,7))
    housing[col].value_counts(normalize=True).plot.pie(labeldistance=None, autopct='%1.2f%%')
    plt.legend()
    plt.show()
```

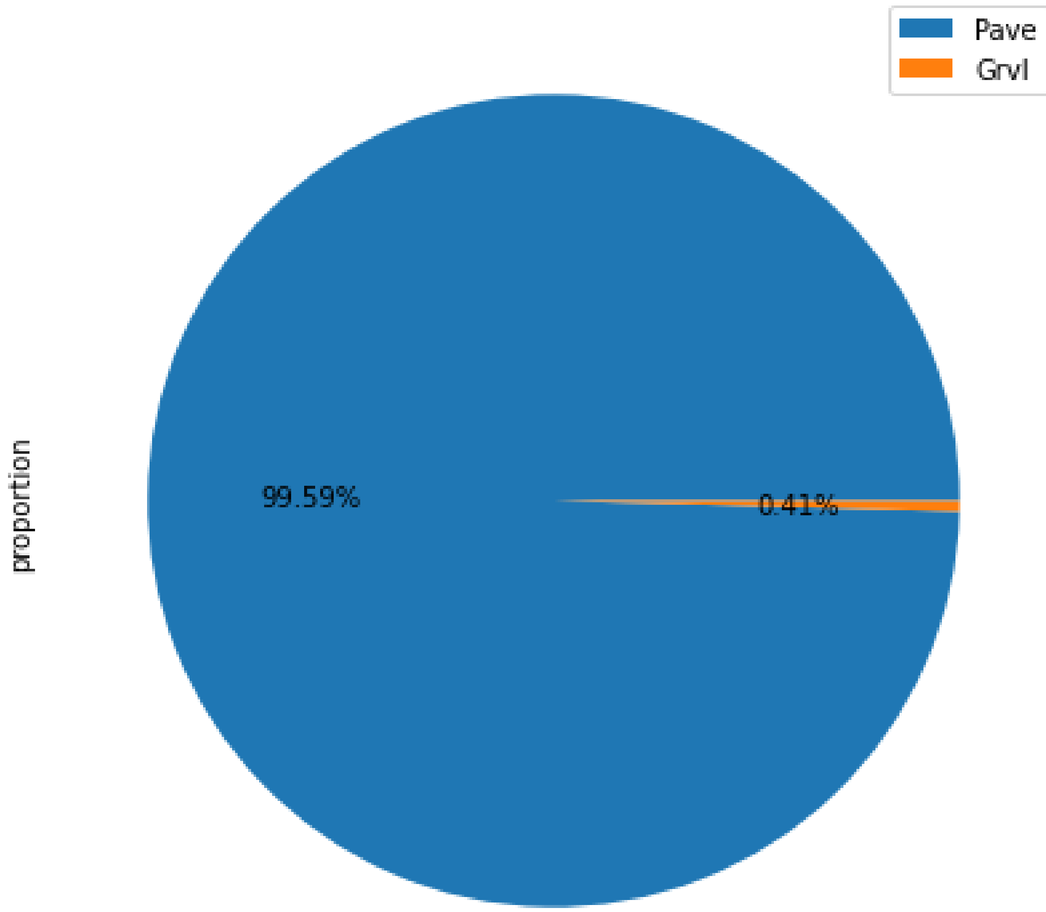
```
MSSubClass
20     0.367123
60     0.204795
50     0.098630
120    0.059589
30     0.047260
160    0.043151
70     0.041096
80     0.039726
90     0.035616
190    0.020548
85     0.013699
75     0.010959
45     0.008219
180    0.006849
40     0.002740
Name: proportion, dtype: float64
```



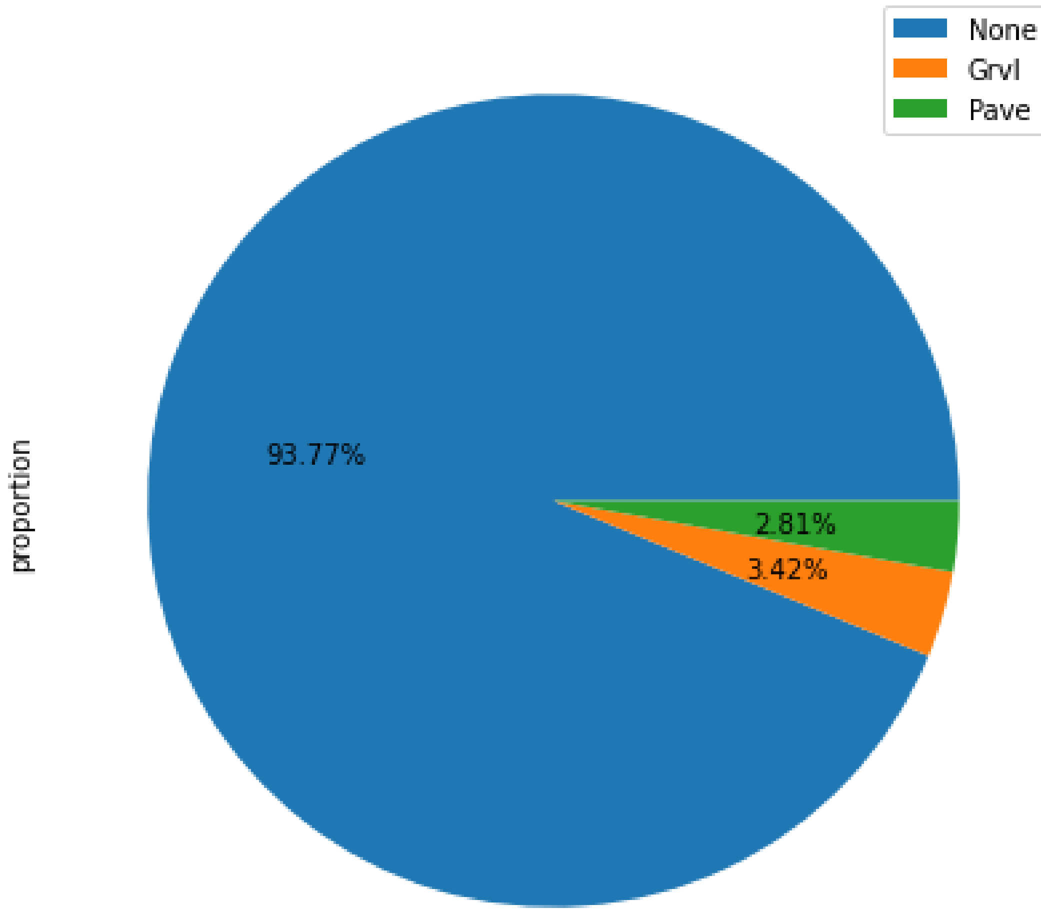
```
MSZoning
RL         0.788356
RM         0.149315
FV         0.044521
RH         0.010959
C (all)    0.006849
Name: proportion, dtype: float64
```



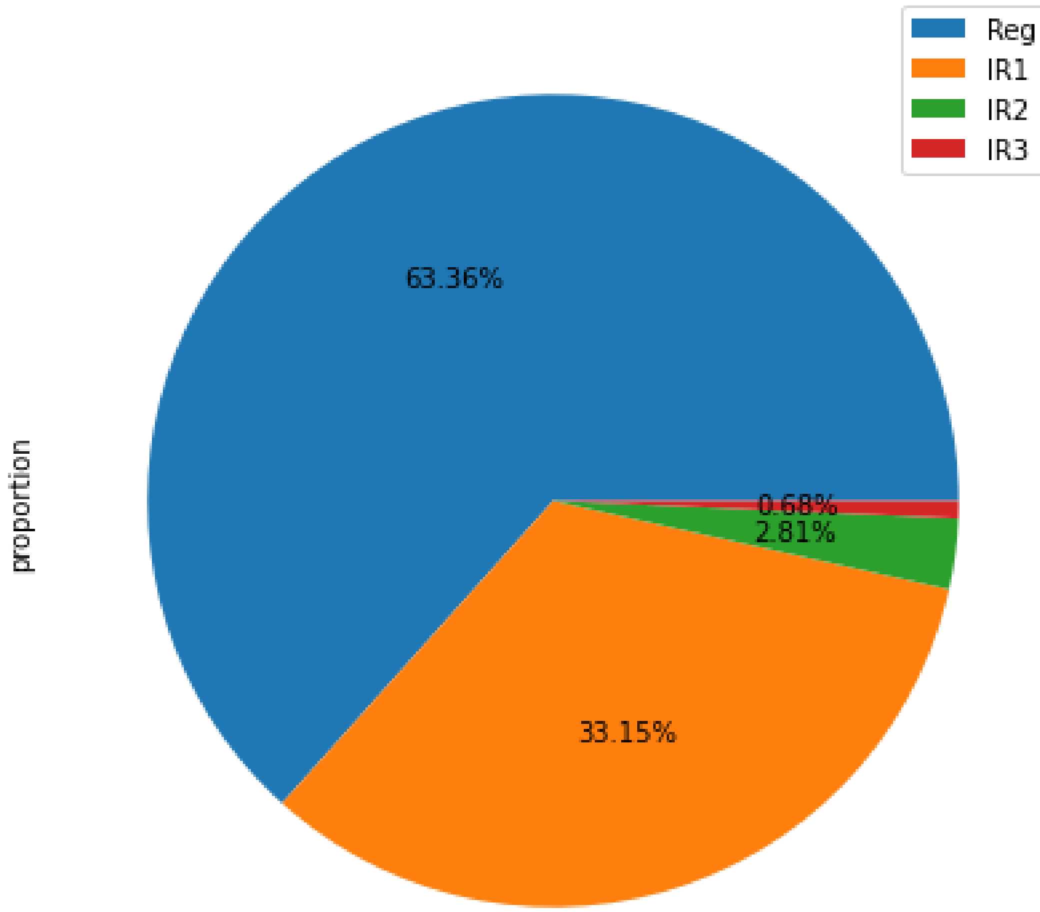

```
Street
Pave    0.99589
Grvl    0.00411
Name: proportion, dtype: float64
```



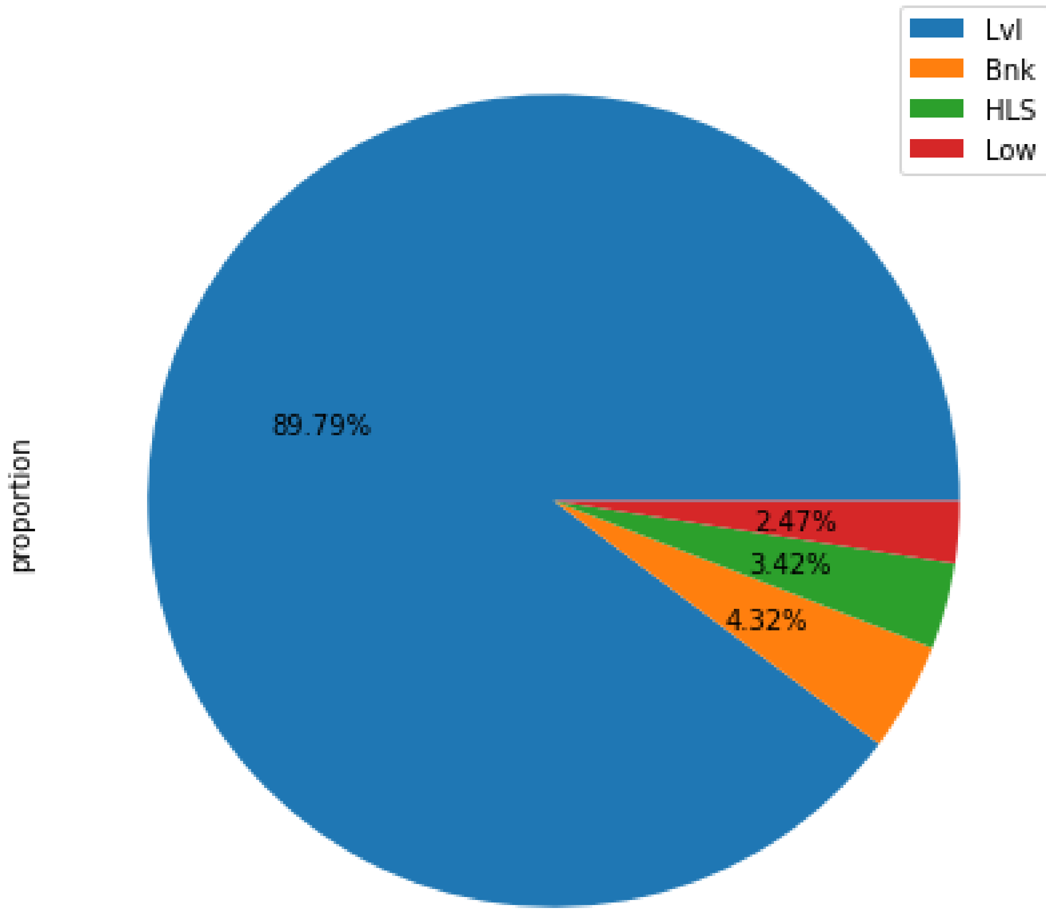

```
Alley
None    0.937671
Grvl    0.034247
Pave    0.028082
Name: proportion, dtype: float64
```



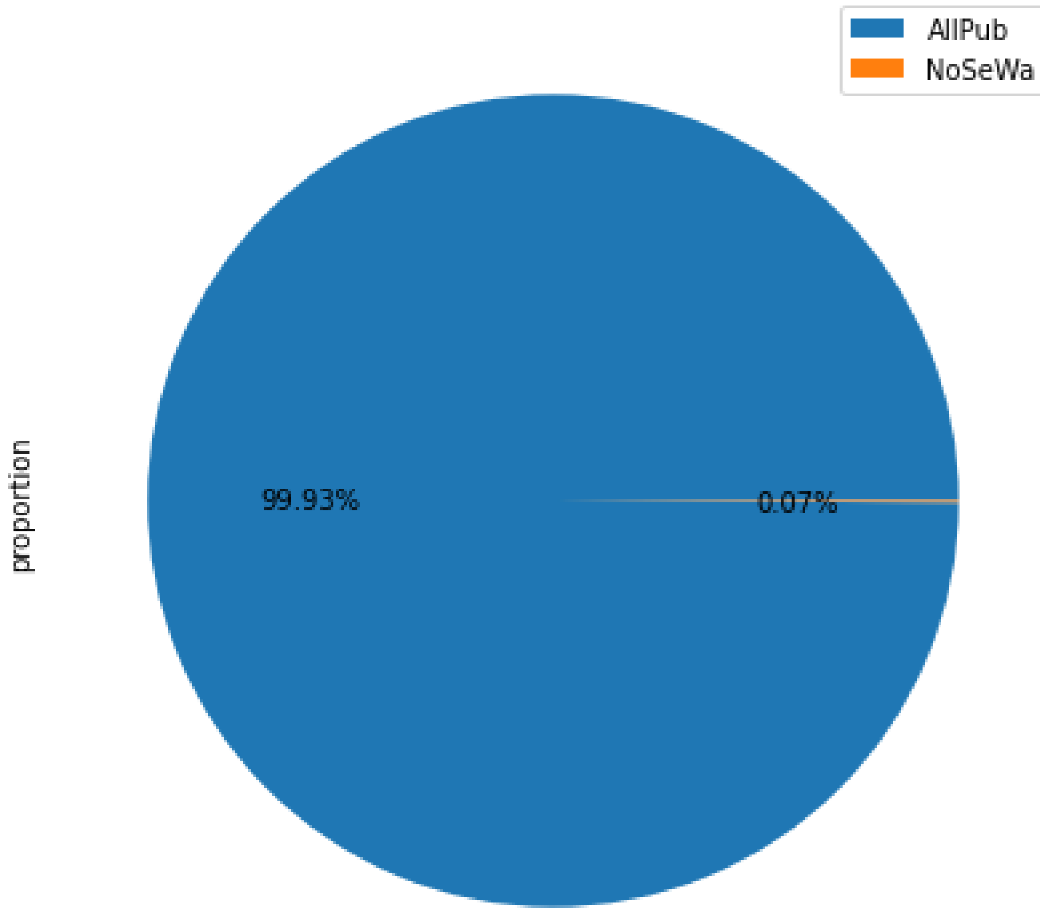

```
LotShape
Reg    0.633562
IR1    0.331507
IR2    0.028082
IR3    0.006849
Name: proportion, dtype: float64
```



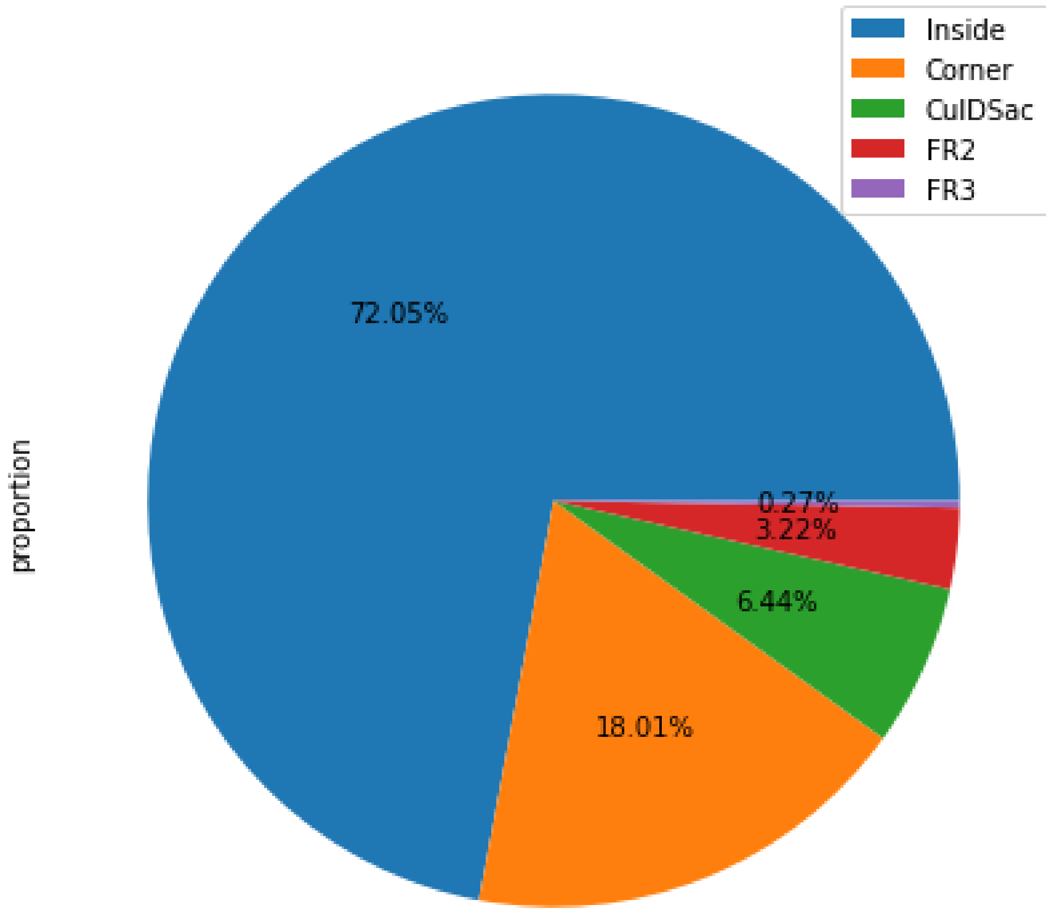

```
LandContour
Lvl    0.897945
Bnk    0.043151
HLS    0.034247
Low    0.024658
Name: proportion, dtype: float64
```



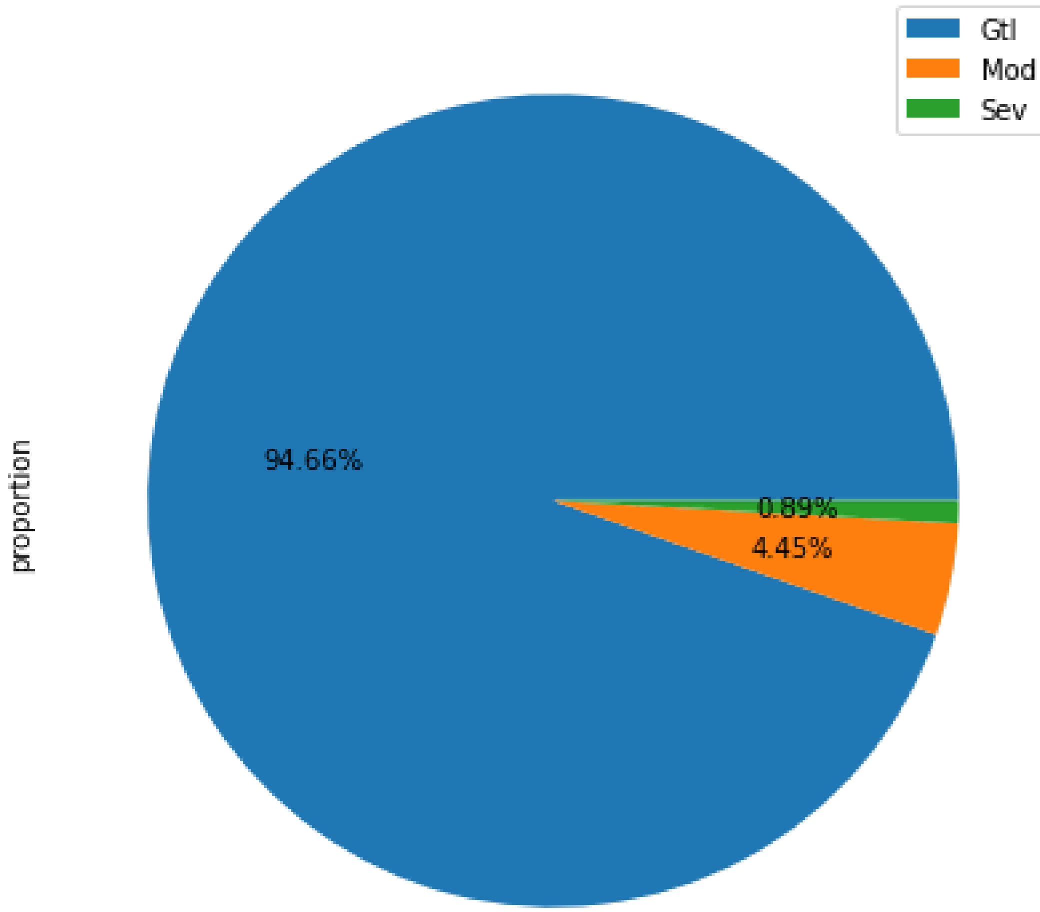

```
Utilities
AllPub    0.999315
NoSeWa    0.000685
Name: proportion, dtype: float64
```




```
LotConfig
Inside     0.720548
Corner     0.180137
CulDSac    0.064384
FR2        0.032192
FR3        0.002740
Name: proportion, dtype: float64
```

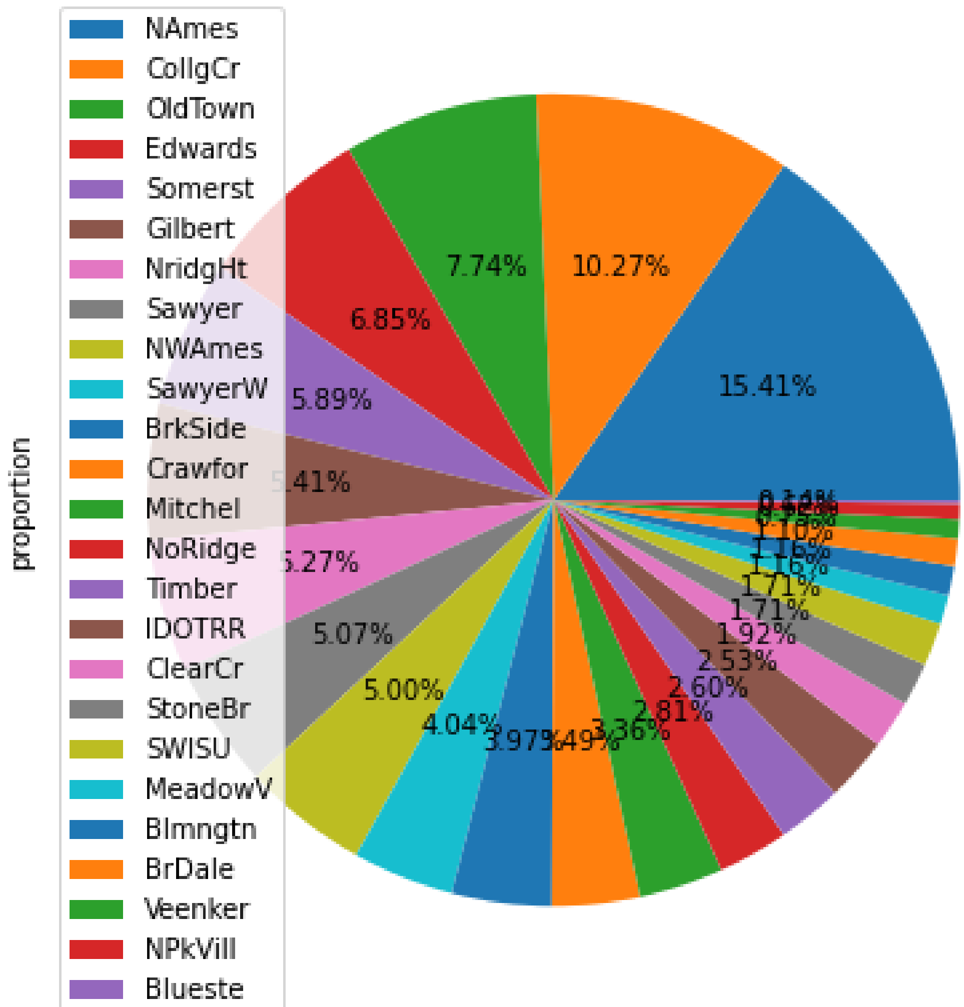



```
LandSlope
Gtl    0.946575
Mod    0.044521
Sev    0.008904
Name: proportion, dtype: float64
```



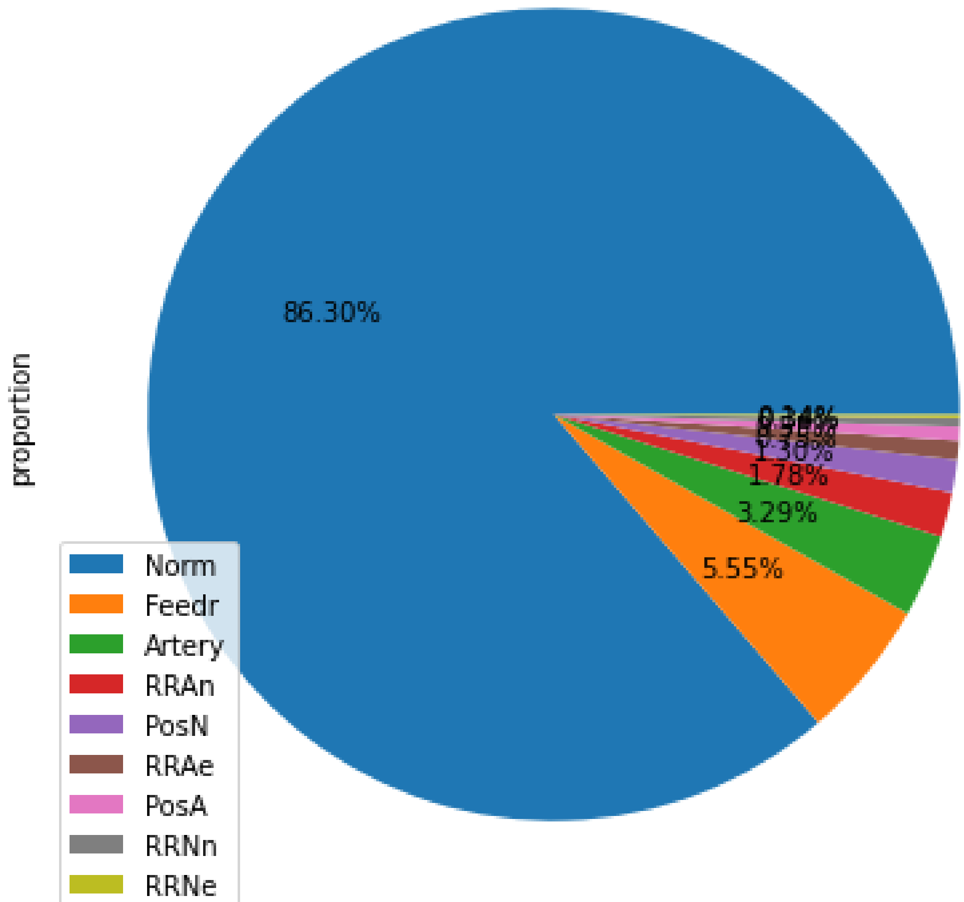

```
Neighborhood
NAmes      0.154110
CollgCr    0.102740
OldTown    0.077397
Edwards    0.068493
Somerst    0.058904
Gilbert    0.054110
NridgHt    0.052740
Sawyer     0.050685
NWAmes     0.050000
SawyerW    0.040411
BrkSide    0.039726
Crawfor    0.034932
Mitchel    0.033562
NoRidge    0.028082
```

```
Timber     0.026027
IDOTRR     0.025342
ClearCr    0.019178
StoneBr    0.017123
SWISU      0.017123
MeadowV    0.011644
Blmngtn    0.011644
BrDale     0.010959
Veenker    0.007534
NPkVill    0.006164
Blueste    0.001370
Name: proportion, dtype: float64
```



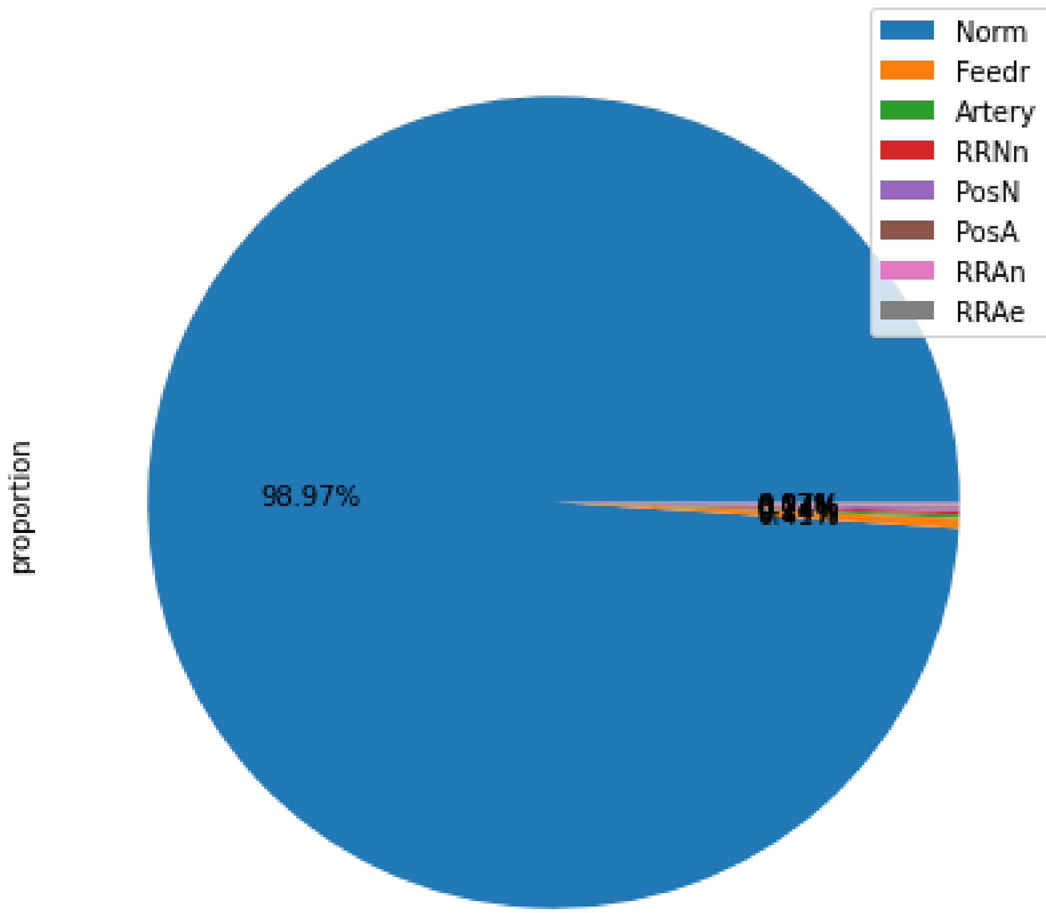

```
Condition1
Norm       0.863014
```

```
Feedr      0.055479
Artery     0.032877
RRAn       0.017808
PosN       0.013014
RRAe       0.007534
PosA       0.005479
RRNn       0.003425
RRNe       0.001370
Name: proportion, dtype: float64
```

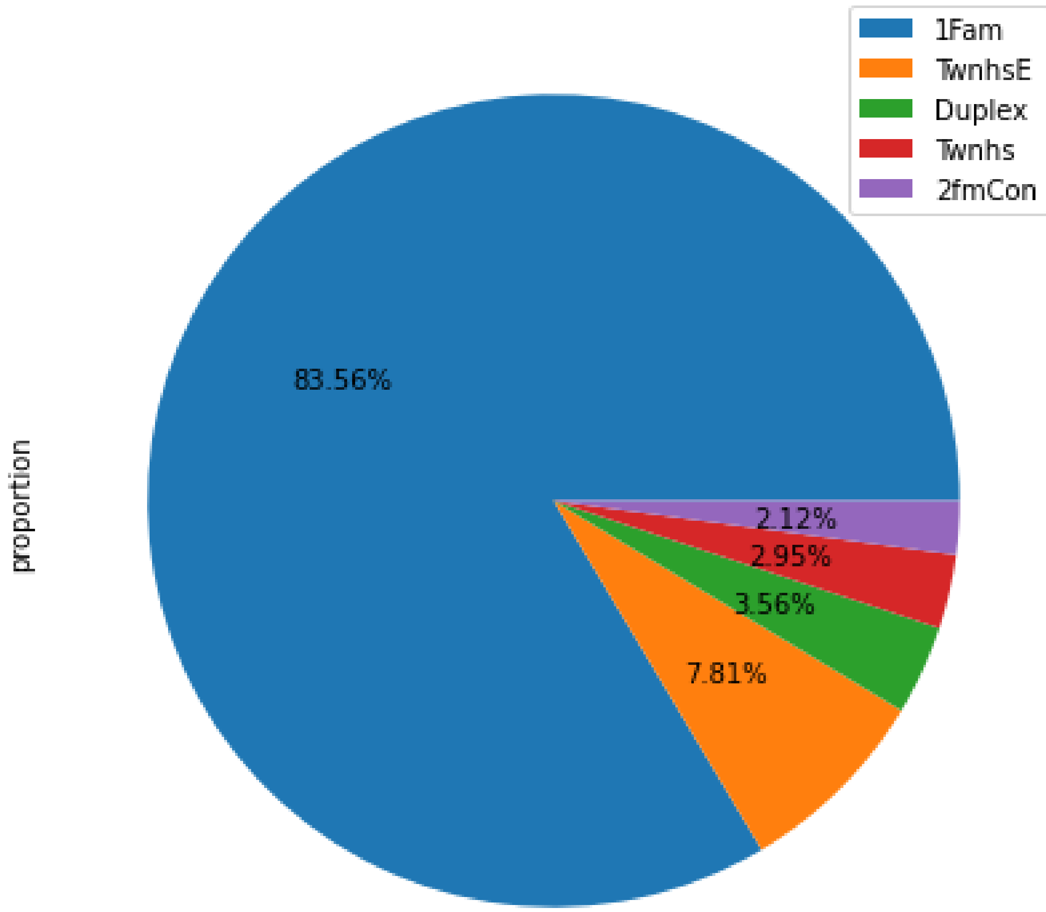



```
Condition2
Norm       0.989726
Feedr      0.004110
Artery     0.001370
RRNn       0.001370
PosN       0.001370
```

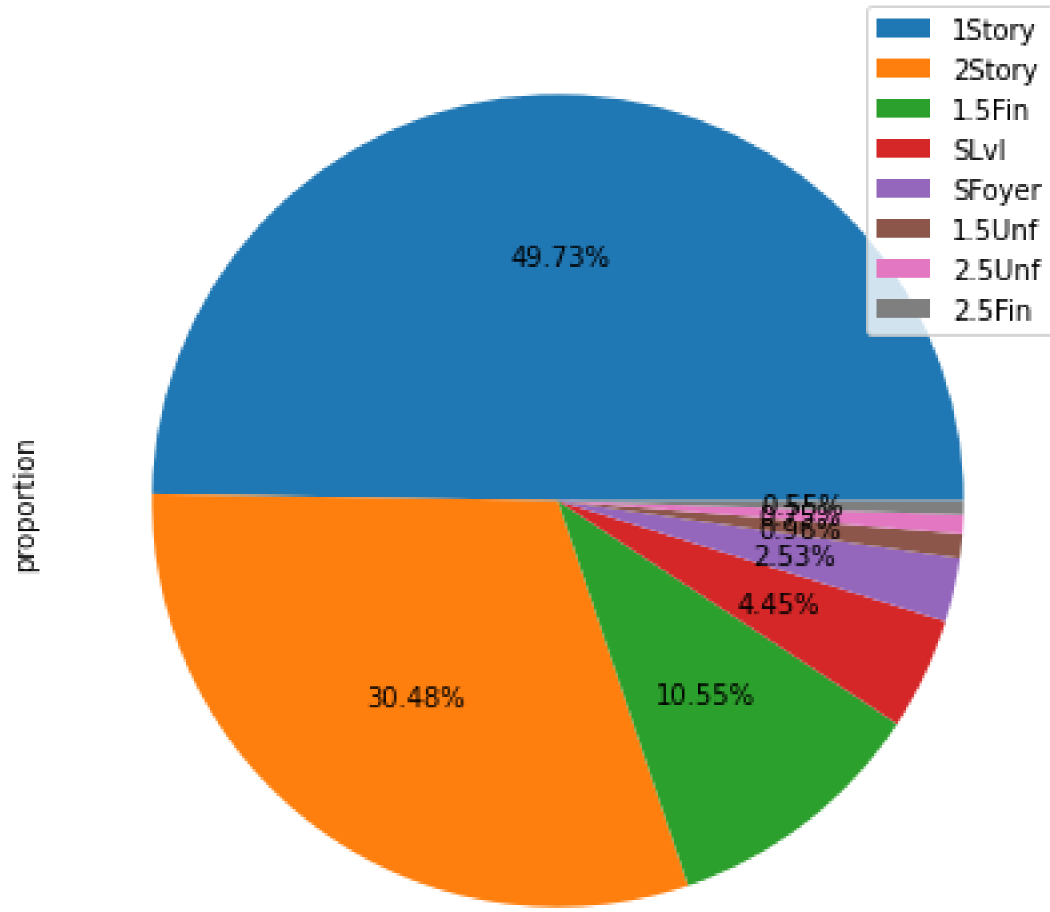
```
PosA       0.000685
RRAn       0.000685
RRAe       0.000685
Name: proportion, dtype: float64
```



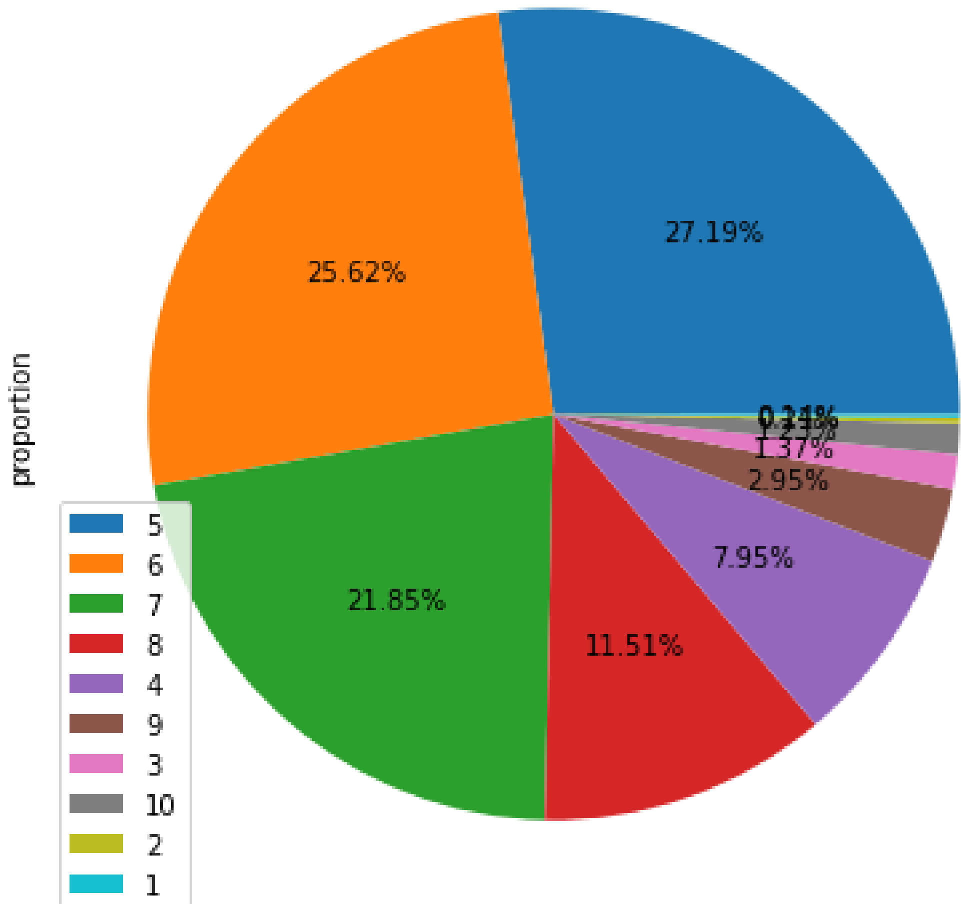

```
BldgType
1Fam       0.835616
TwnhsE     0.078082
Duplex     0.035616
Twnhs      0.029452
2fmCon     0.021233
Name: proportion, dtype: float64
```



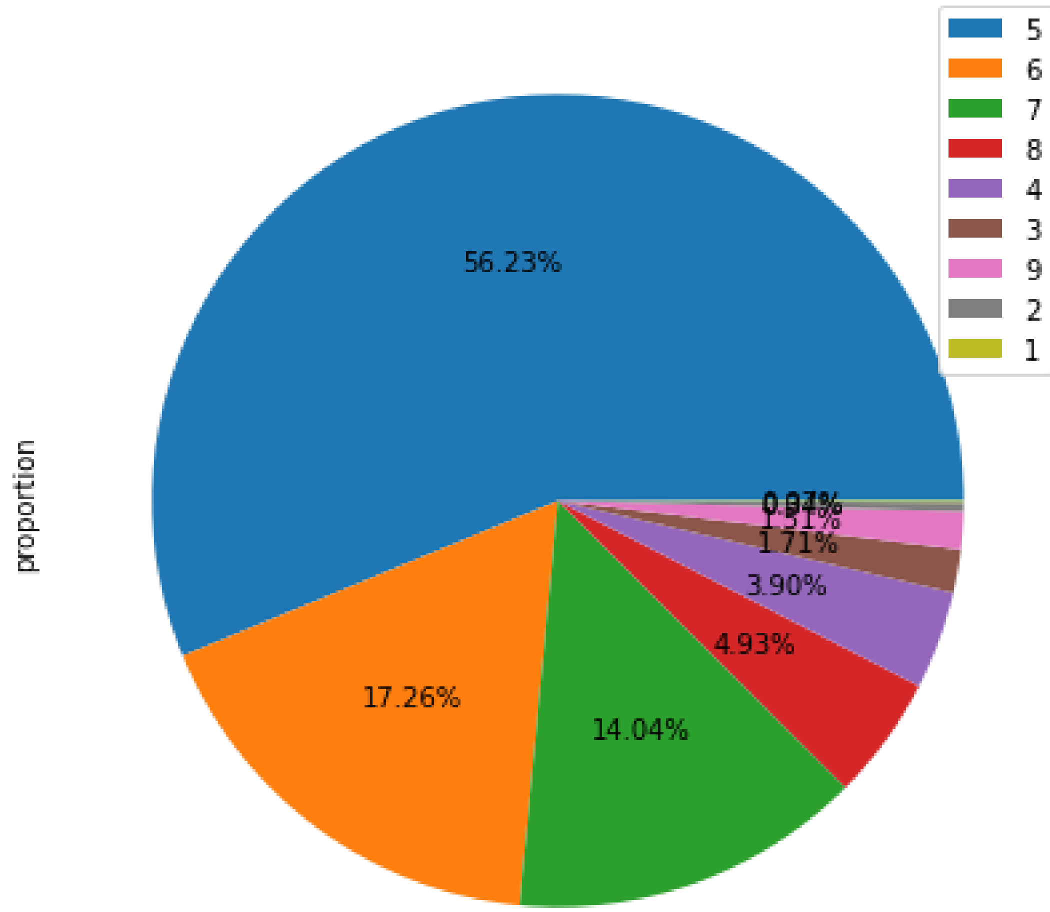

```
HouseStyle
1Story    0.497260
2Story    0.304795
1.5Fin    0.105479
SLvl      0.044521
SFoyer    0.025342
1.5Unf    0.009589
2.5Unf    0.007534
2.5Fin    0.005479
Name: proportion, dtype: float64
```



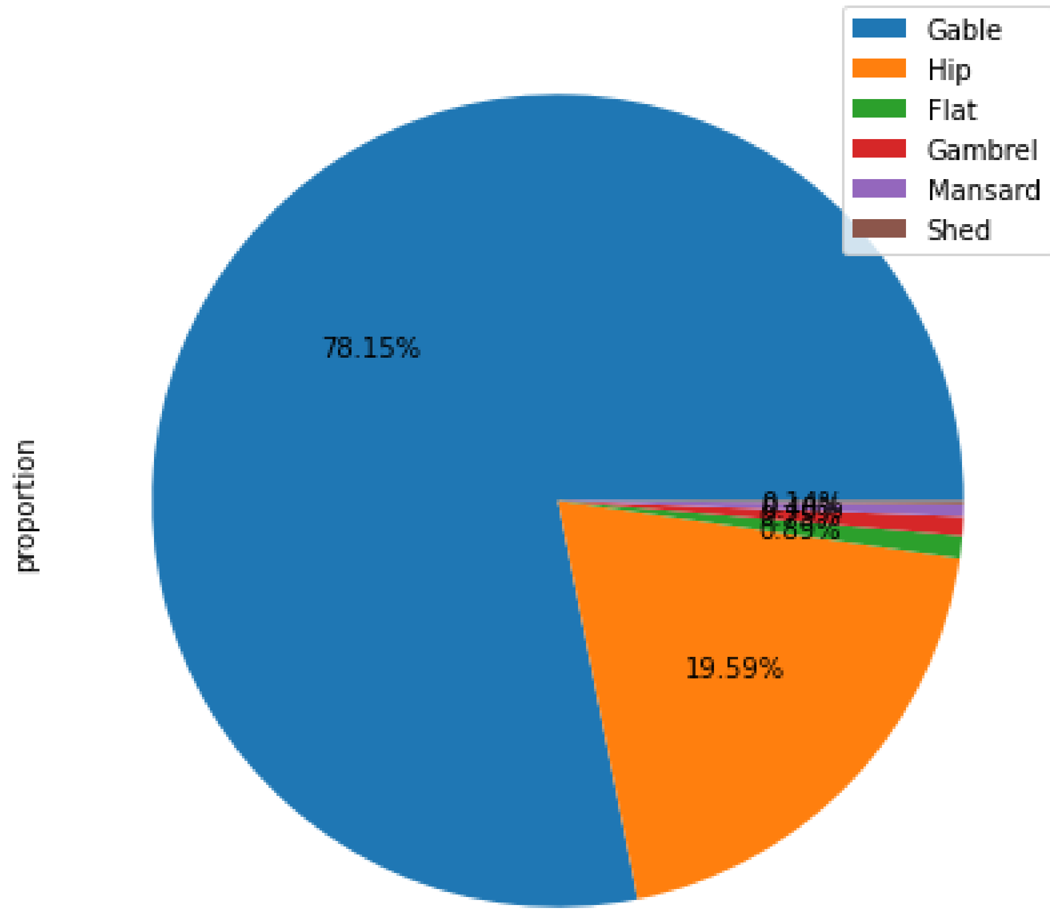

```
OverallQual
5     0.271918
6     0.256164
7     0.218493
8     0.115068
4     0.079452
9     0.029452
3     0.013699
10    0.012329
2     0.002055
1     0.001370
Name: proportion, dtype: float64
```



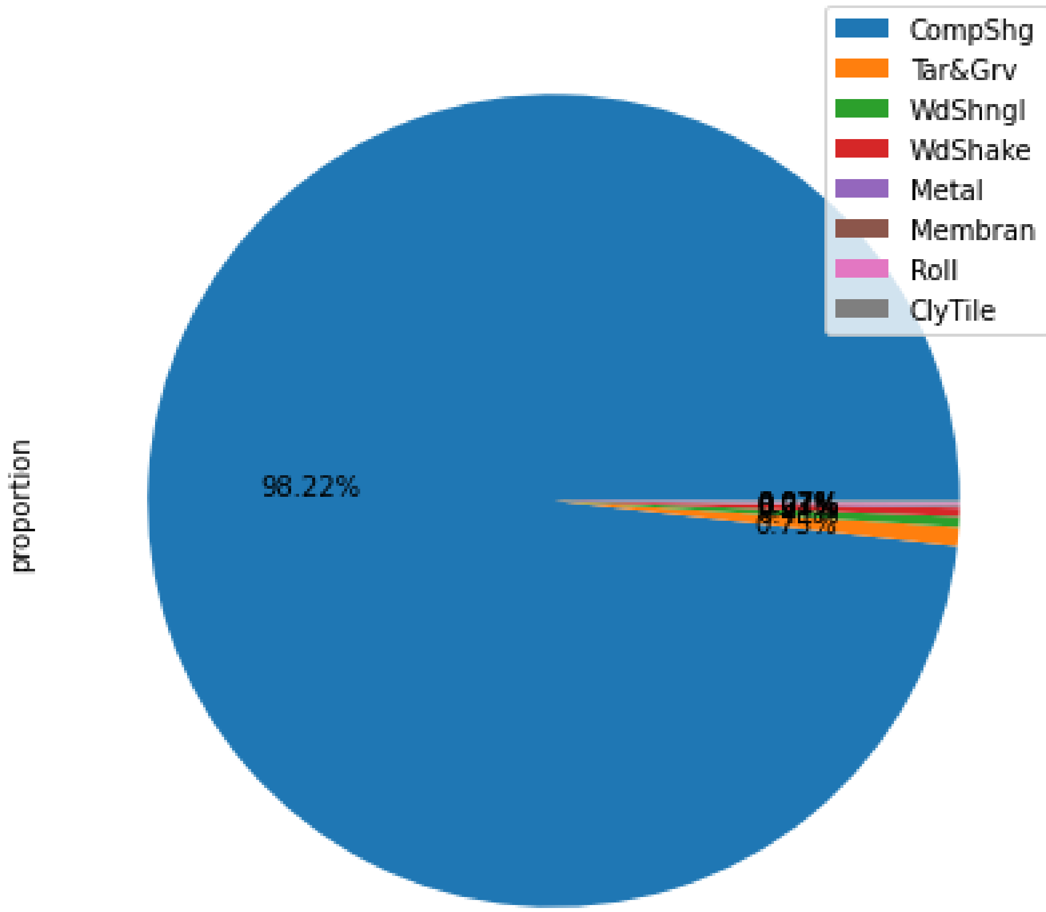

```
OverallCond
5     0.562329
6     0.172603
7     0.140411
8     0.049315
4     0.039041
3     0.017123
9     0.015068
2     0.003425
1     0.000685
Name: proportion, dtype: float64
```




```
RoofStyle
Gable      0.781507
Hip        0.195890
Flat       0.008904
Gambrel    0.007534
Mansard    0.004795
Shed       0.001370
Name: proportion, dtype: float64
```

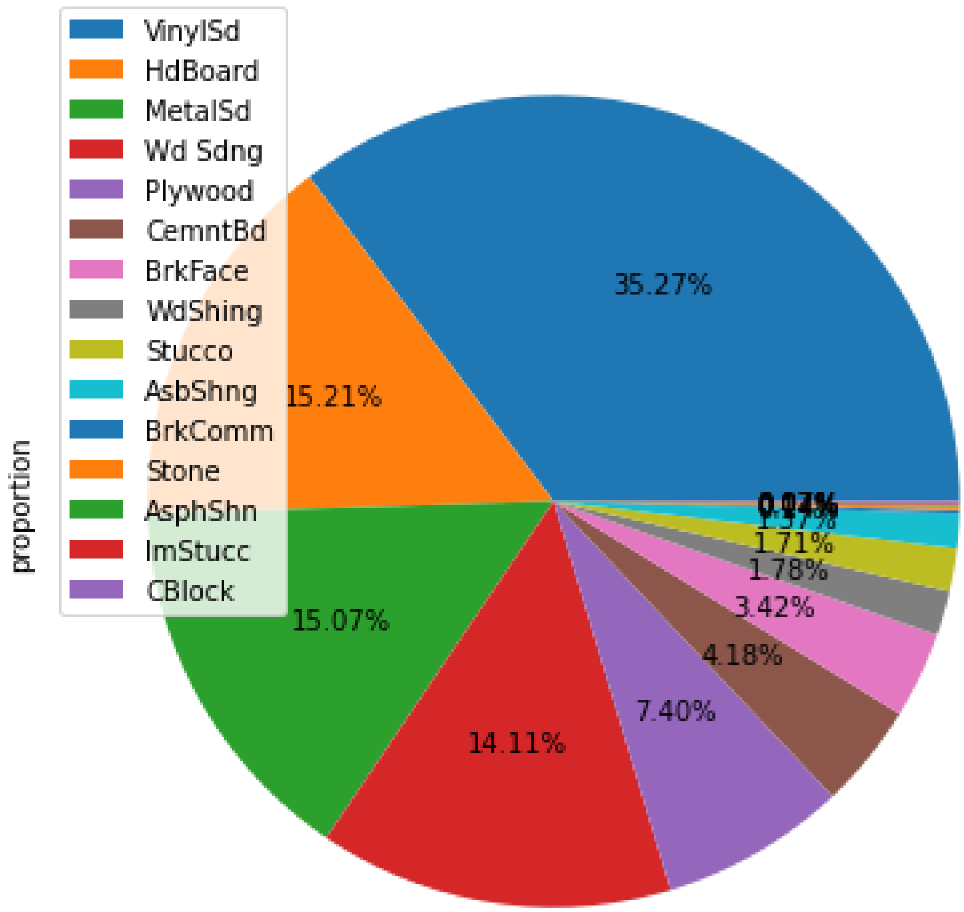



```
RoofMatl
CompShg    0.982192
Tar&Grv    0.007534
WdShngl    0.004110
WdShake    0.003425
Metal      0.000685
Membran    0.000685
Roll       0.000685
ClyTile    0.000685
Name: proportion, dtype: float64
```



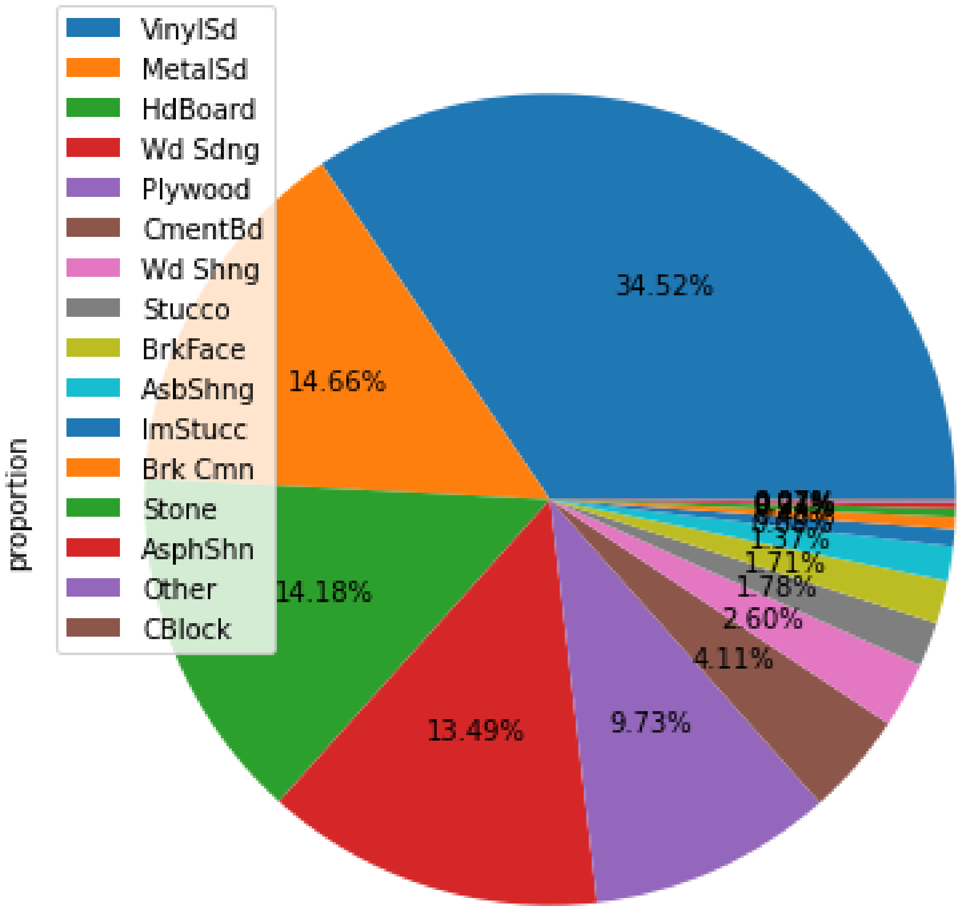

```
Exterior1st
VinylSd     0.352740
HdBoard     0.152055
MetalSd     0.150685
Wd Sdng     0.141096
Plywood     0.073973
CemntBd     0.041781
BrkFace     0.034247
WdShing     0.017808
Stucco      0.017123
AsbShng     0.013699
BrkComm     0.001370
Stone       0.001370
AsphShn     0.000685
ImStucc     0.000685
```

```
CBlock      0.000685
Name: proportion, dtype: float64
```

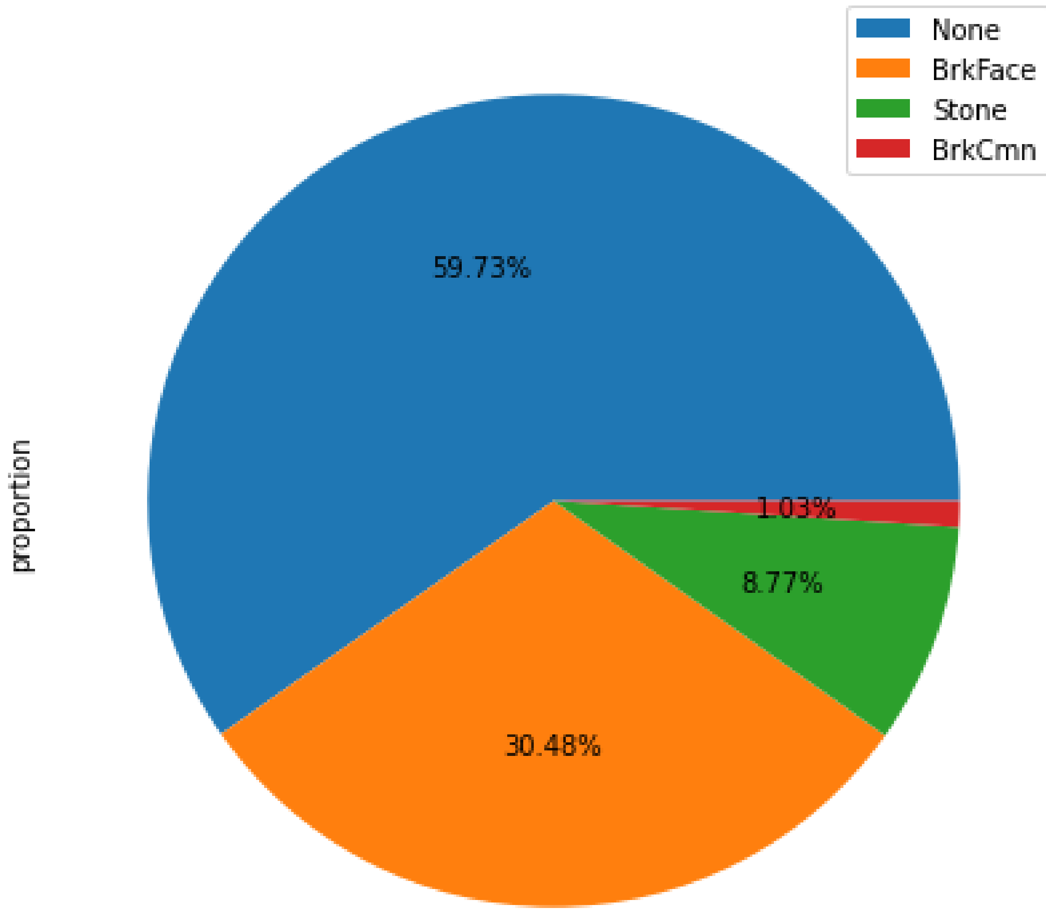



```
Exterior2nd
VinylSd     0.345205
MetalSd     0.146575
HdBoard     0.141781
Wd Sdng     0.134932
Plywood     0.097260
CmentBd     0.041096
Wd Shng     0.026027
Stucco      0.017808
BrkFace     0.017123
AsbShng     0.013699
ImStucc     0.006849
Brk Cmn     0.004795
```

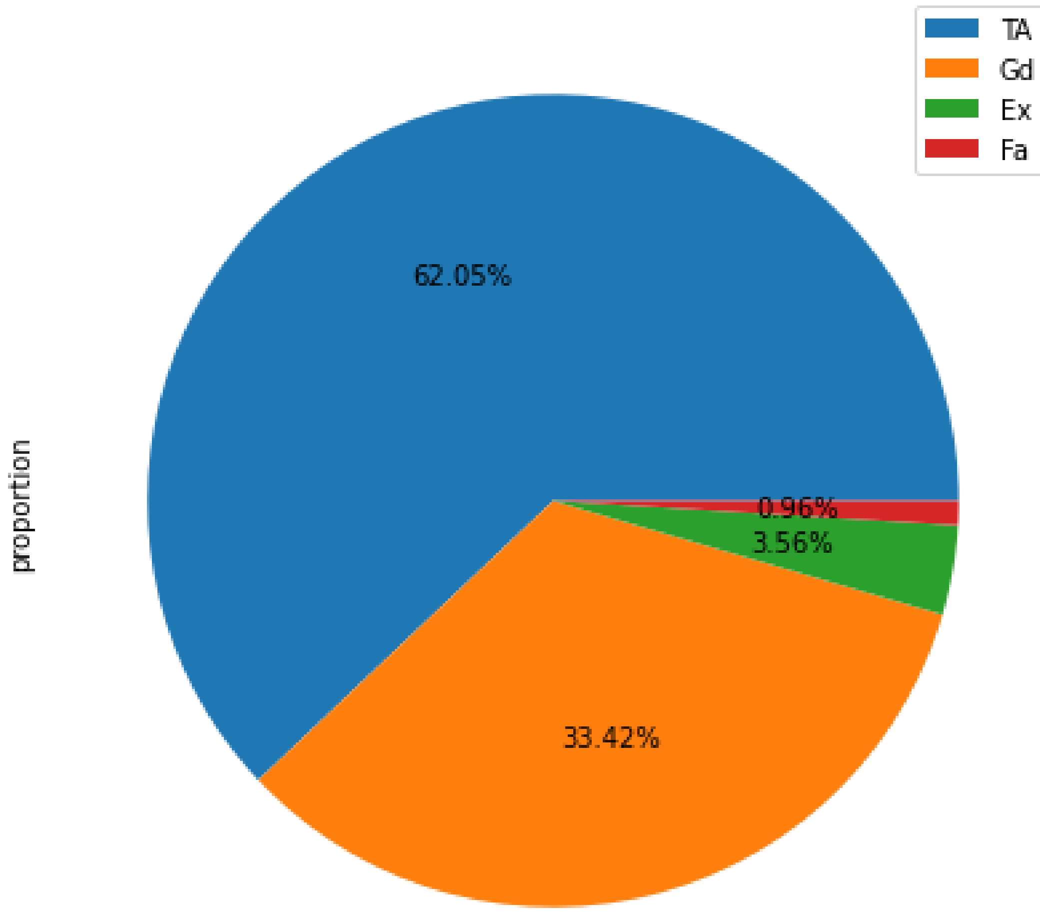
```
Stone      0.003425
AsphShn    0.002055
Other      0.000685
CBlock     0.000685
Name: proportion, dtype: float64
```



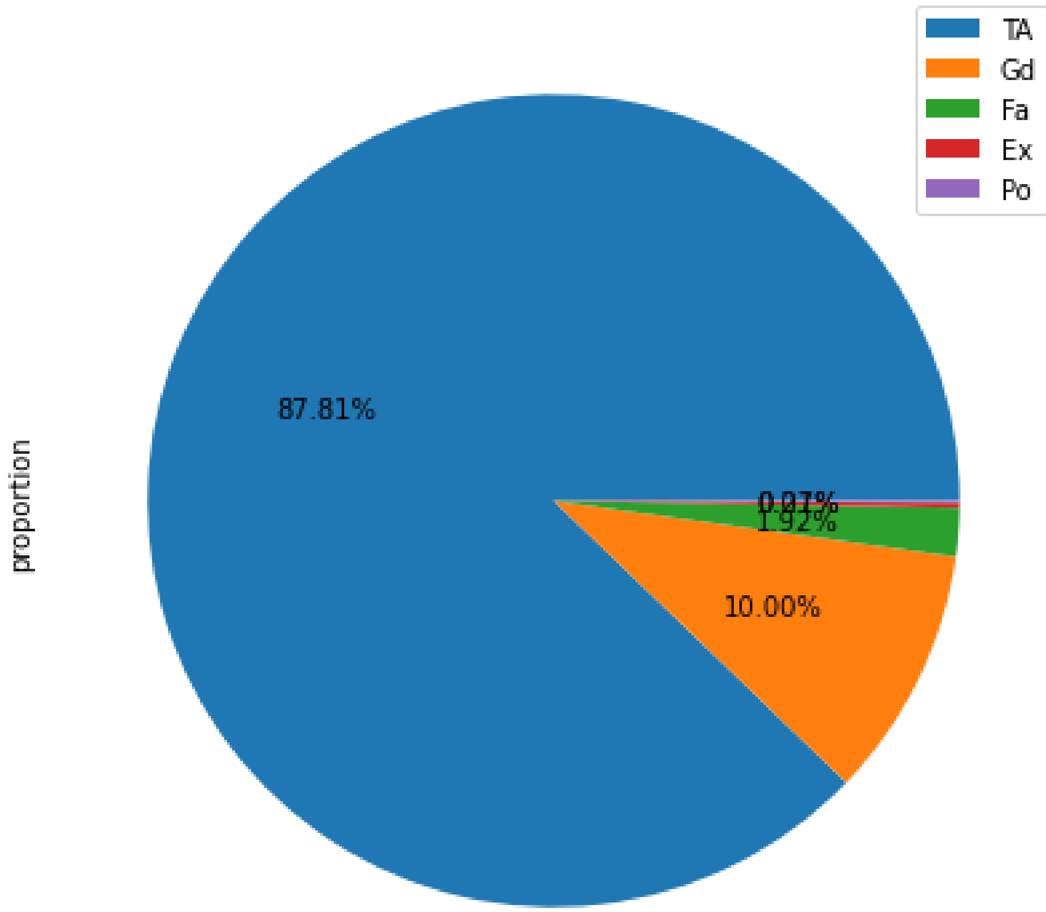

```
MasVnrType
None       0.597260
BrkFace    0.304795
Stone      0.087671
BrkCmn     0.010274
Name: proportion, dtype: float64
```



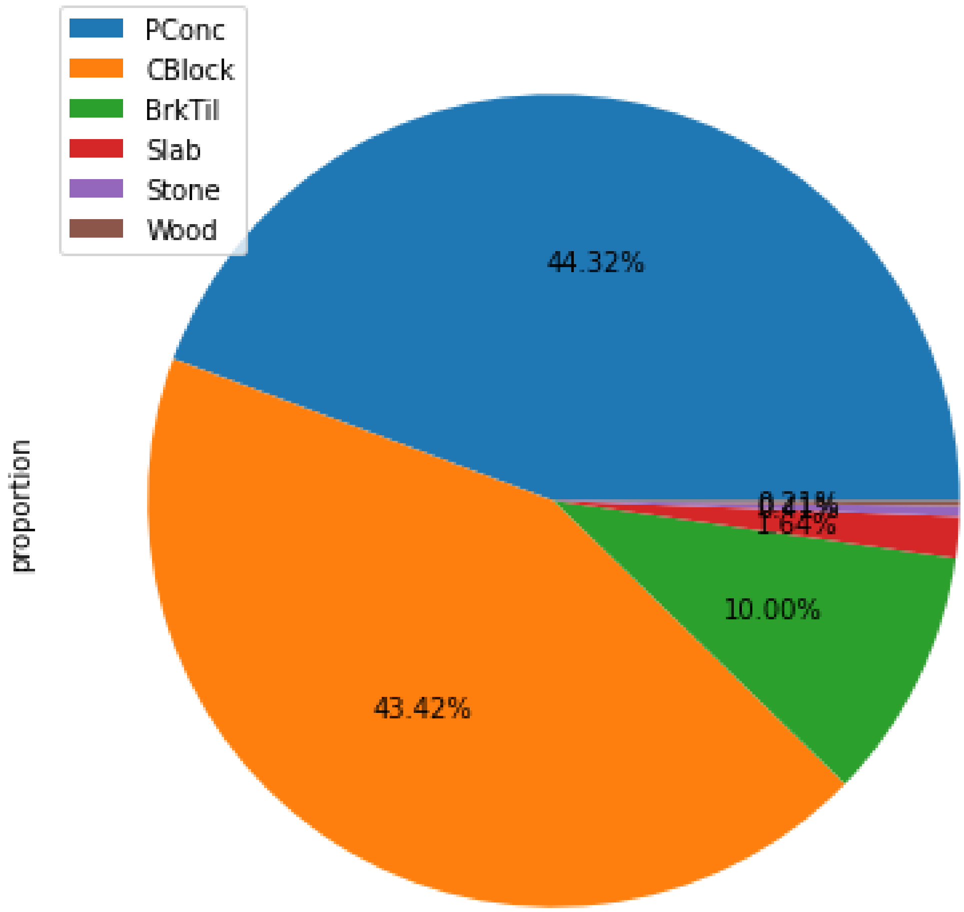

```
ExterQual
TA    0.620548
Gd    0.334247
Ex    0.035616
Fa    0.009589
Name: proportion, dtype: float64
```



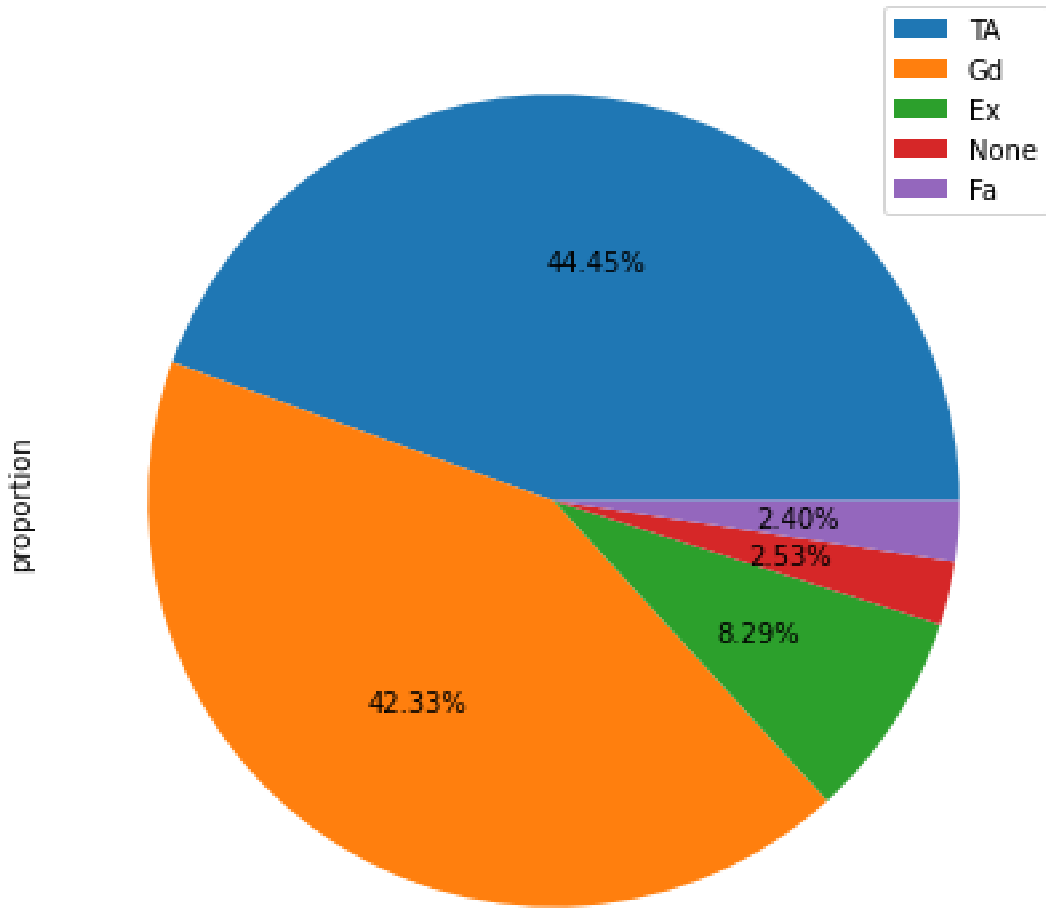

```
ExterCond
TA    0.878082
Gd    0.100000
Fa    0.019178
Ex    0.002055
Po    0.000685
Name: proportion, dtype: float64
```



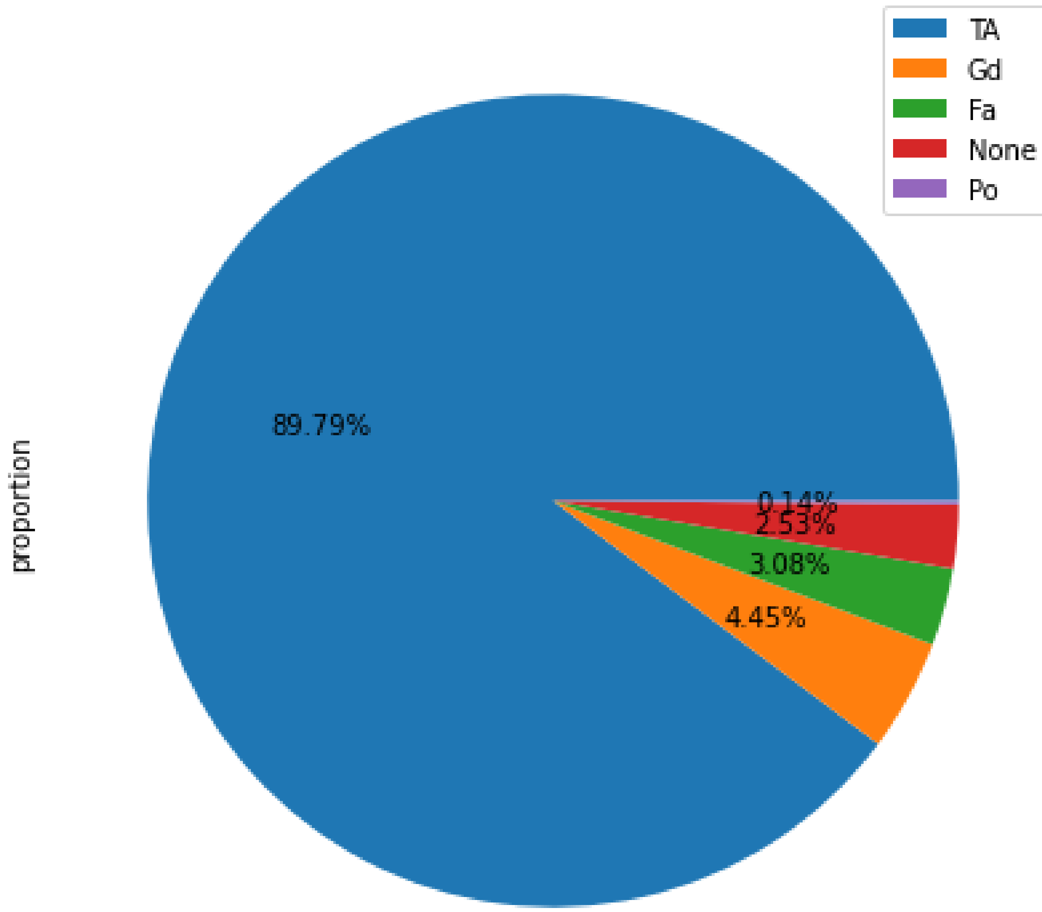

```
Foundation
PConc      0.443151
CBlock     0.434247
BrkTil     0.100000
Slab       0.016438
Stone      0.004110
Wood       0.002055
Name: proportion, dtype: float64
```



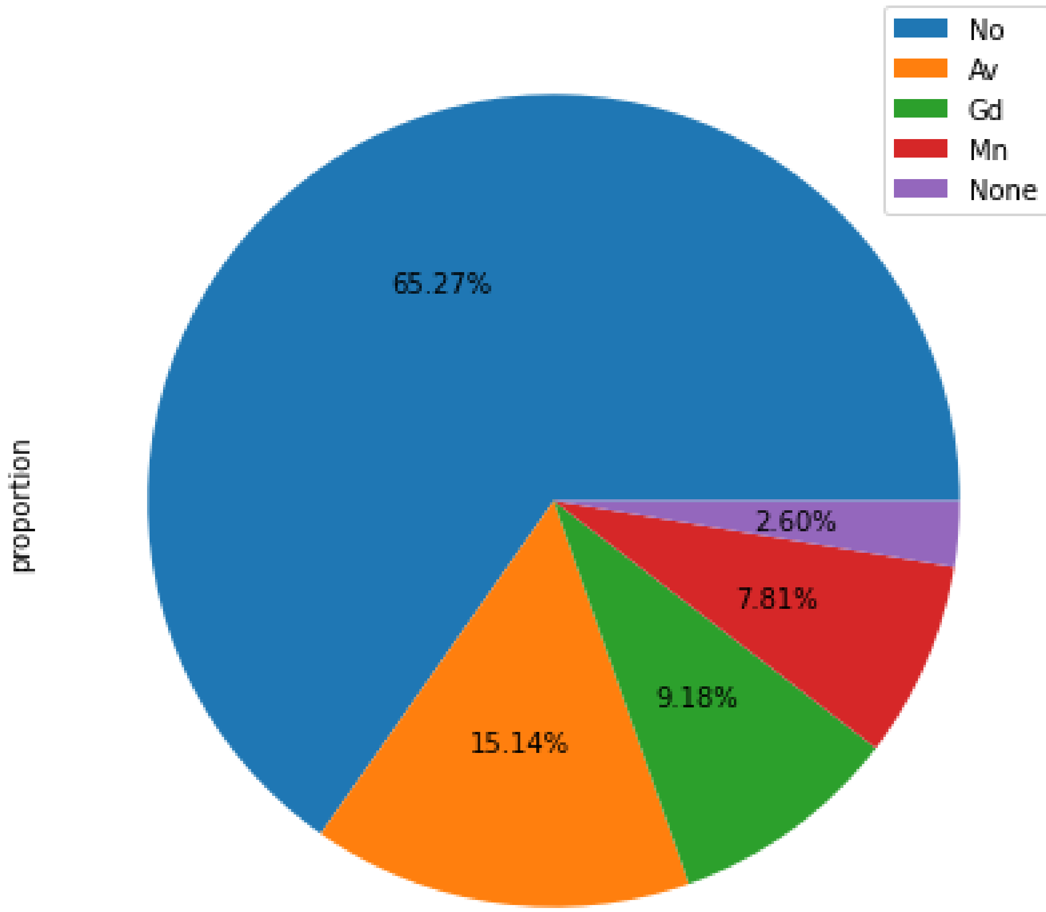

```
BsmtQual
TA      0.444521
Gd      0.423288
Ex      0.082877
None    0.025342
Fa      0.023973
Name: proportion, dtype: float64
```



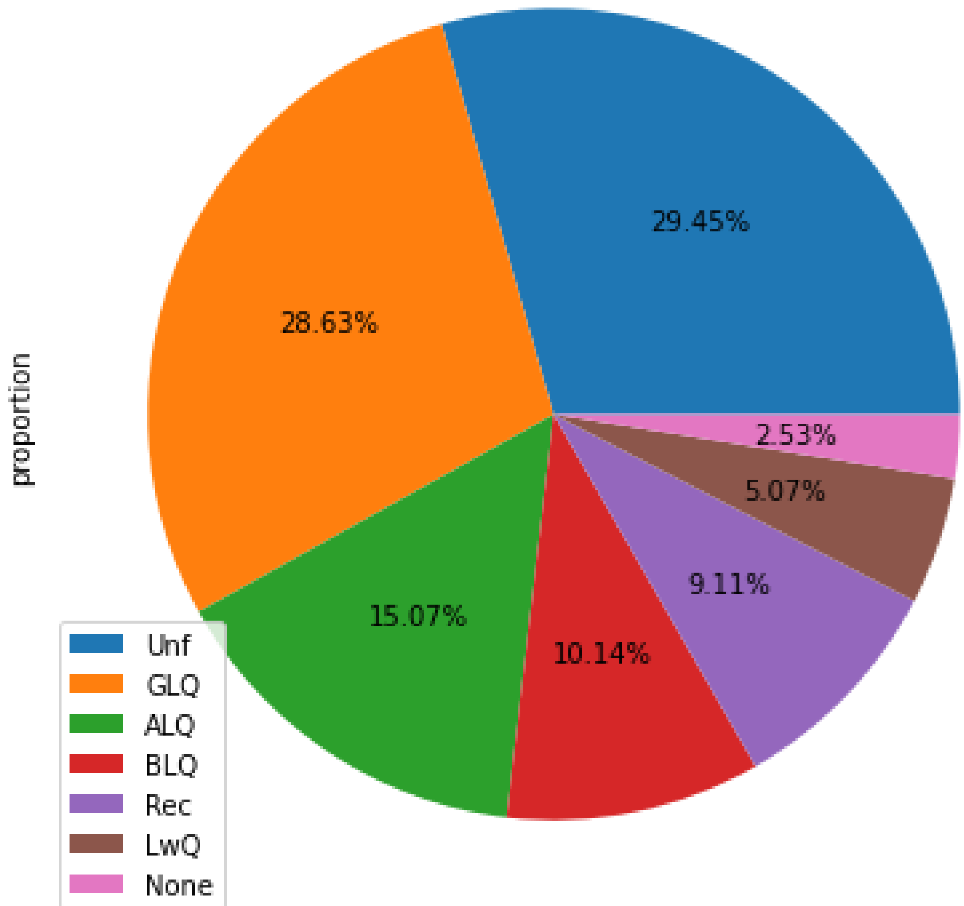

```
BsmtCond
TA      0.897945
Gd      0.044521
Fa      0.030822
None    0.025342
Po      0.001370
Name: proportion, dtype: float64
```



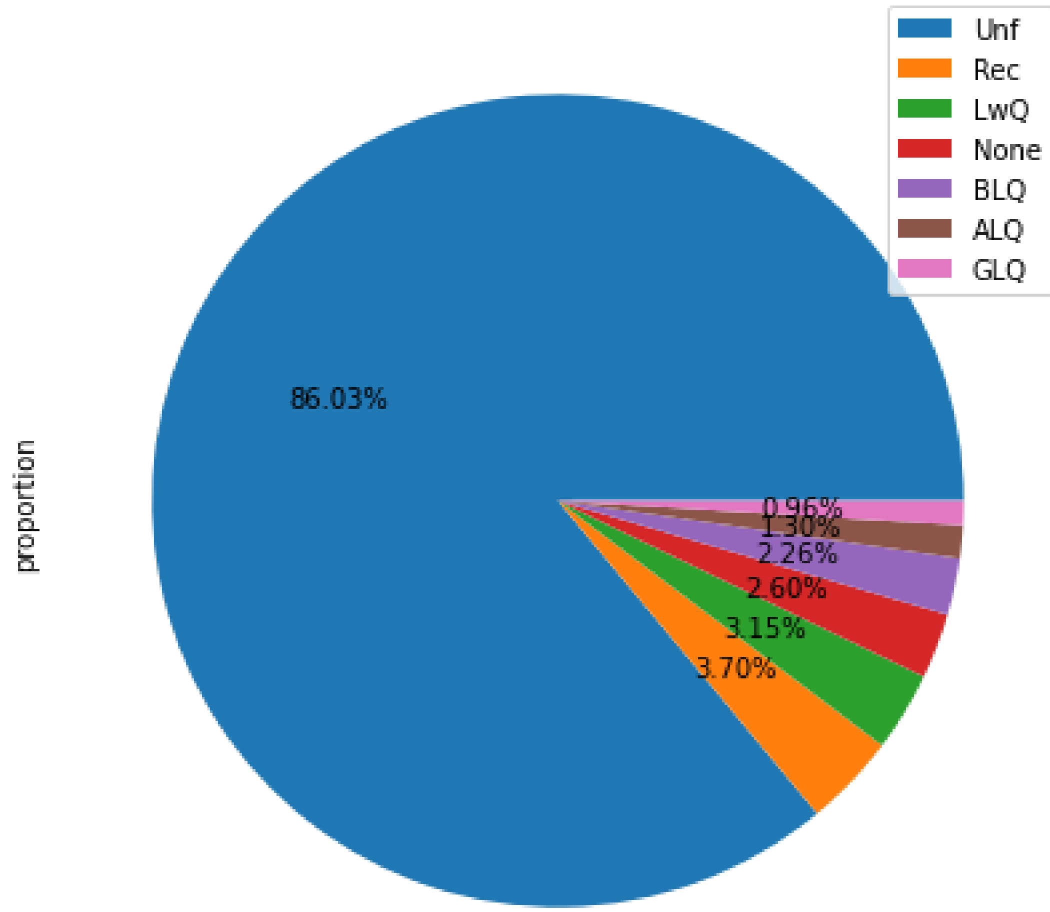

```
BsmtExposure
No      0.652740
Av      0.151370
Gd      0.091781
Mn      0.078082
None    0.026027
Name: proportion, dtype: float64
```



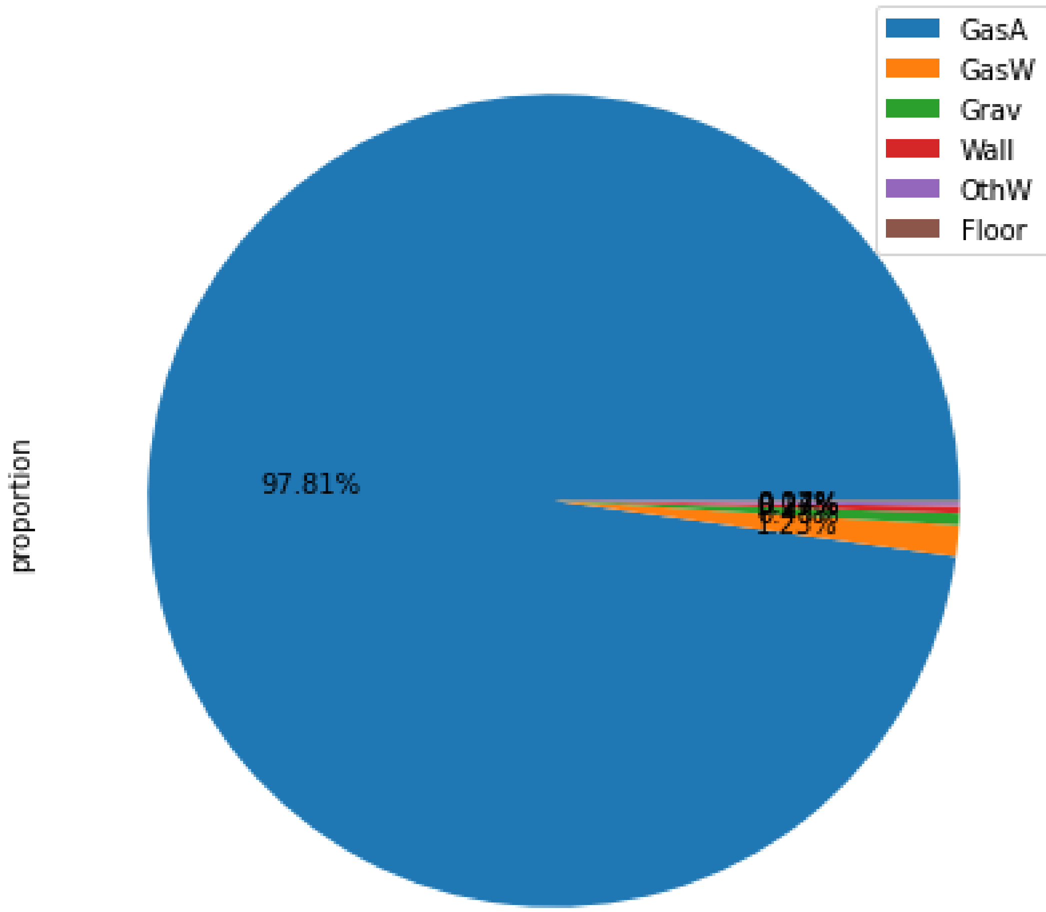

```
BsmtFinType1
Unf     0.294521
GLQ     0.286301
ALQ     0.150685
BLQ     0.101370
Rec     0.091096
LwQ     0.050685
None    0.025342
Name: proportion, dtype: float64
```



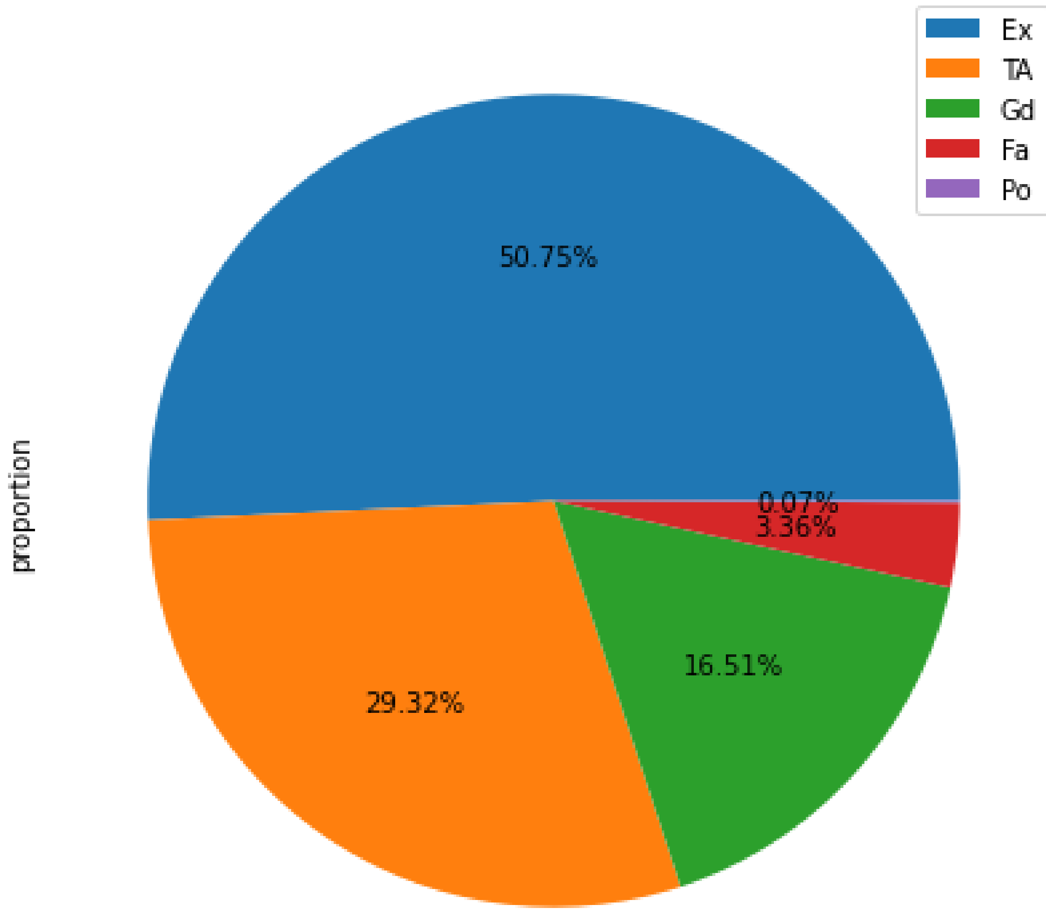

```
BsmtFinType2
Unf     0.860274
Rec     0.036986
LwQ     0.031507
None    0.026027
BLQ     0.022603
ALQ     0.013014
GLQ     0.009589
Name: proportion, dtype: float64
```



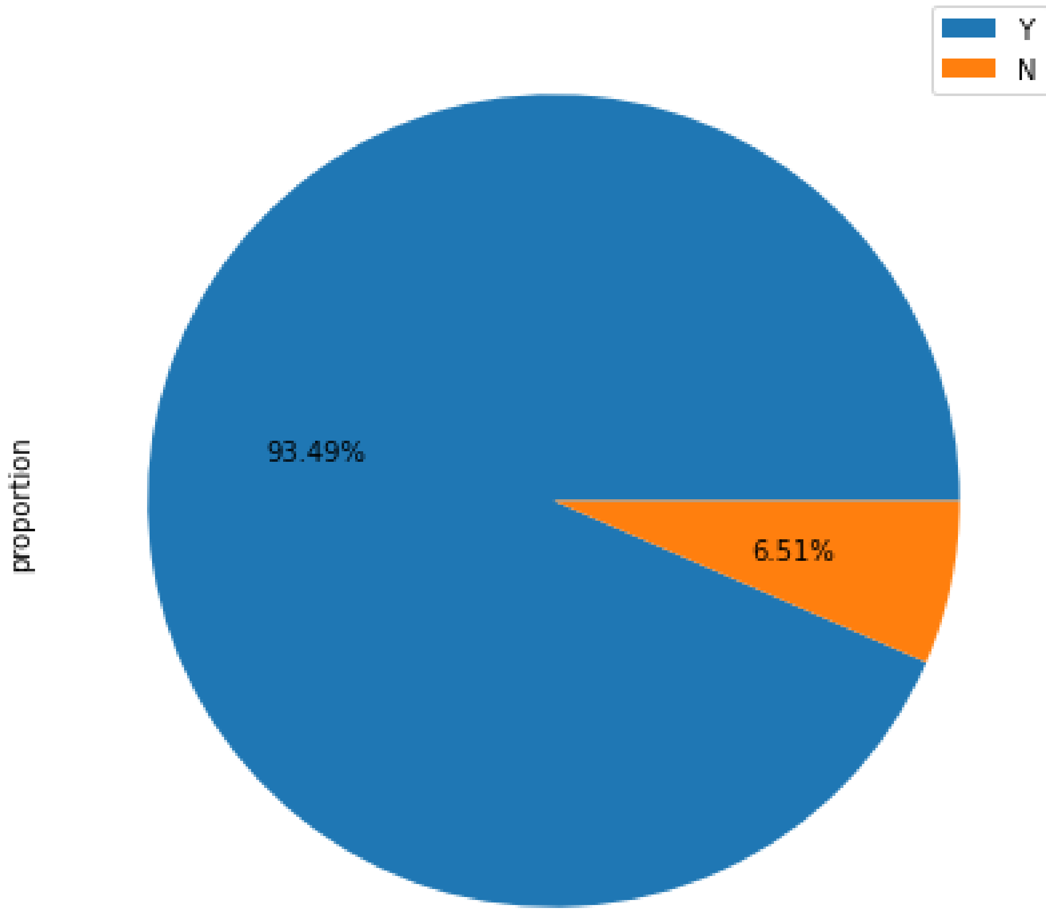

```
Heating
GasA     0.978082
GasW     0.012329
Grav     0.004795
Wall     0.002740
OthW     0.001370
Floor    0.000685
Name: proportion, dtype: float64
```



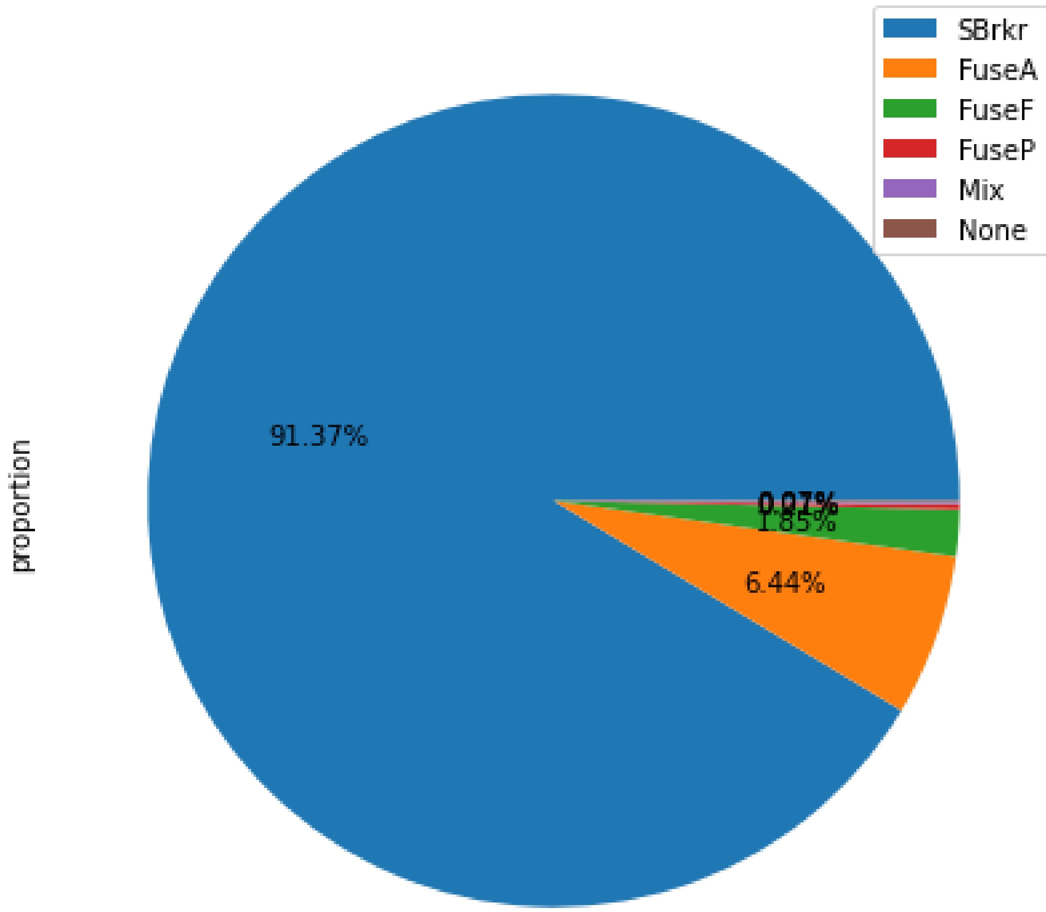

```
HeatingQC
Ex    0.507534
TA    0.293151
Gd    0.165068
Fa    0.033562
Po    0.000685
Name: proportion, dtype: float64
```



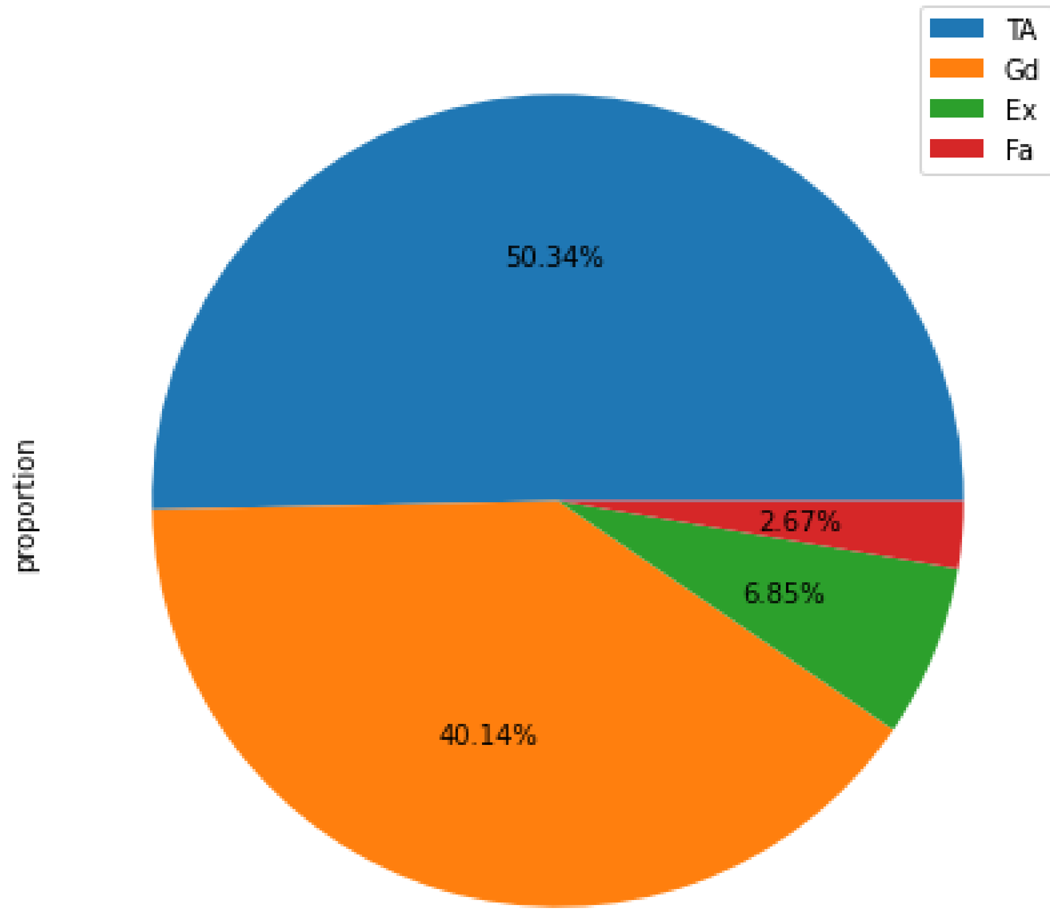

```
CentralAir
Y    0.934932
N    0.065068
Name: proportion, dtype: float64
```



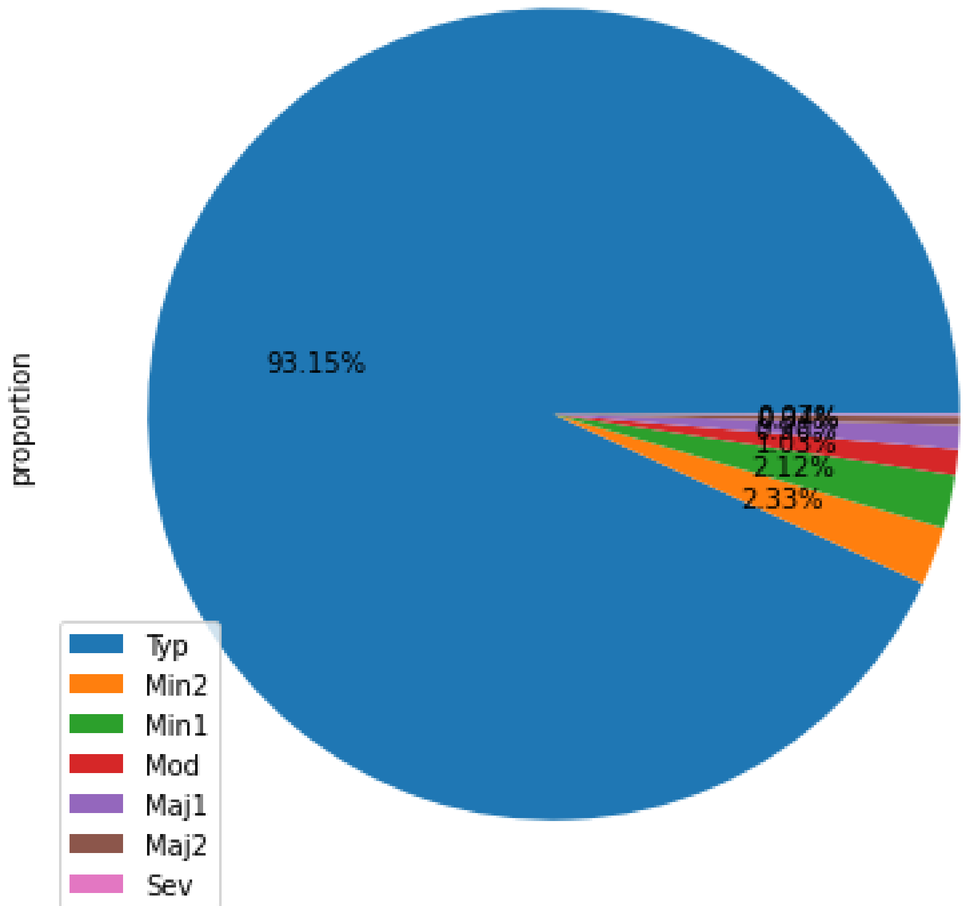

```
Electrical
SBrkr    0.913699
FuseA    0.064384
FuseF    0.018493
FuseP    0.002055
Mix      0.000685
None     0.000685
Name: proportion, dtype: float64
```



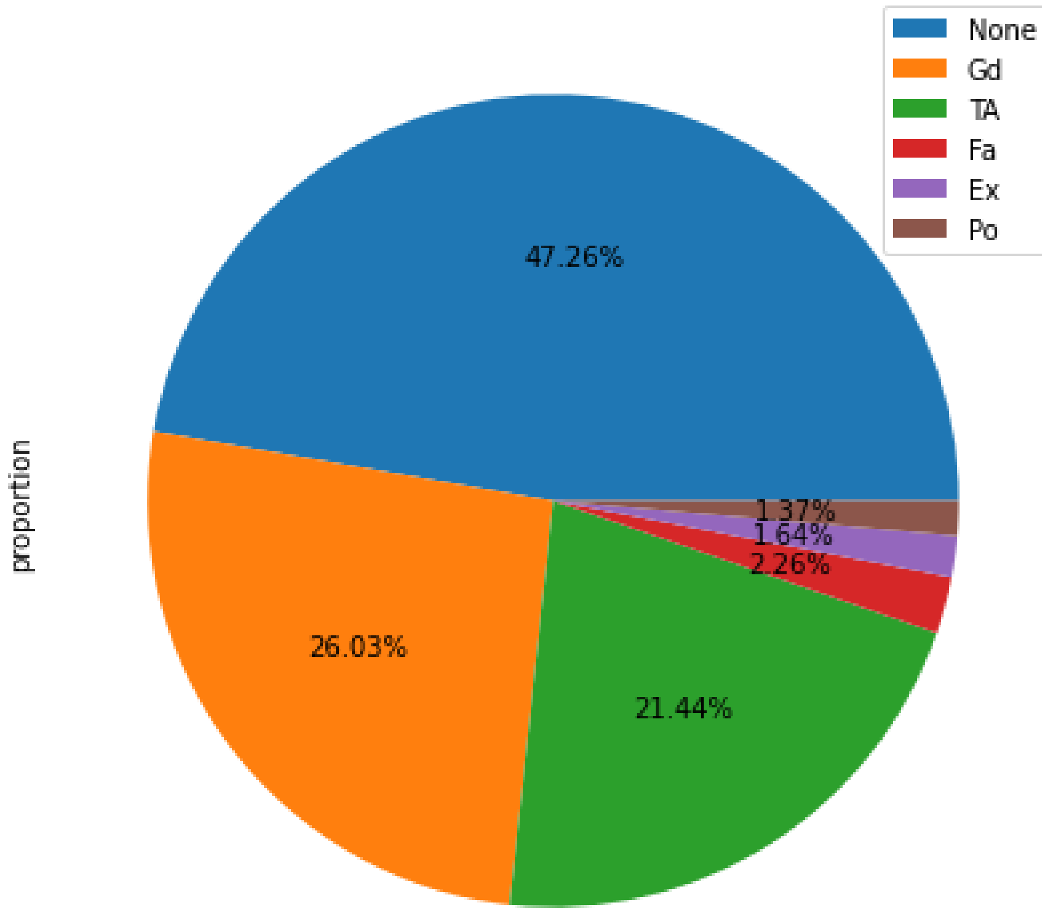

```
KitchenQual
TA    0.503425
Gd    0.401370
Ex    0.068493
Fa    0.026712
Name: proportion, dtype: float64
```



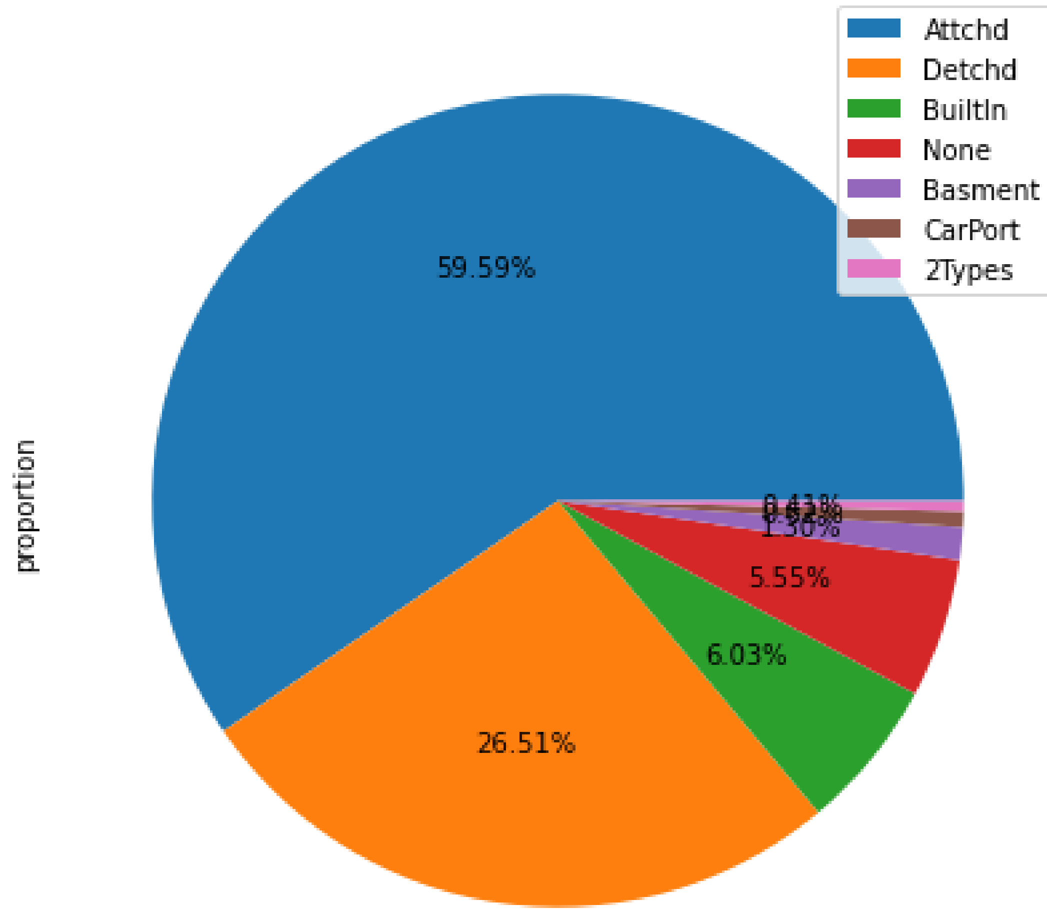

```
Functional
Typ     0.931507
Min2    0.023288
Min1    0.021233
Mod     0.010274
Maj1    0.009589
Maj2    0.003425
Sev     0.000685
Name: proportion, dtype: float64
```



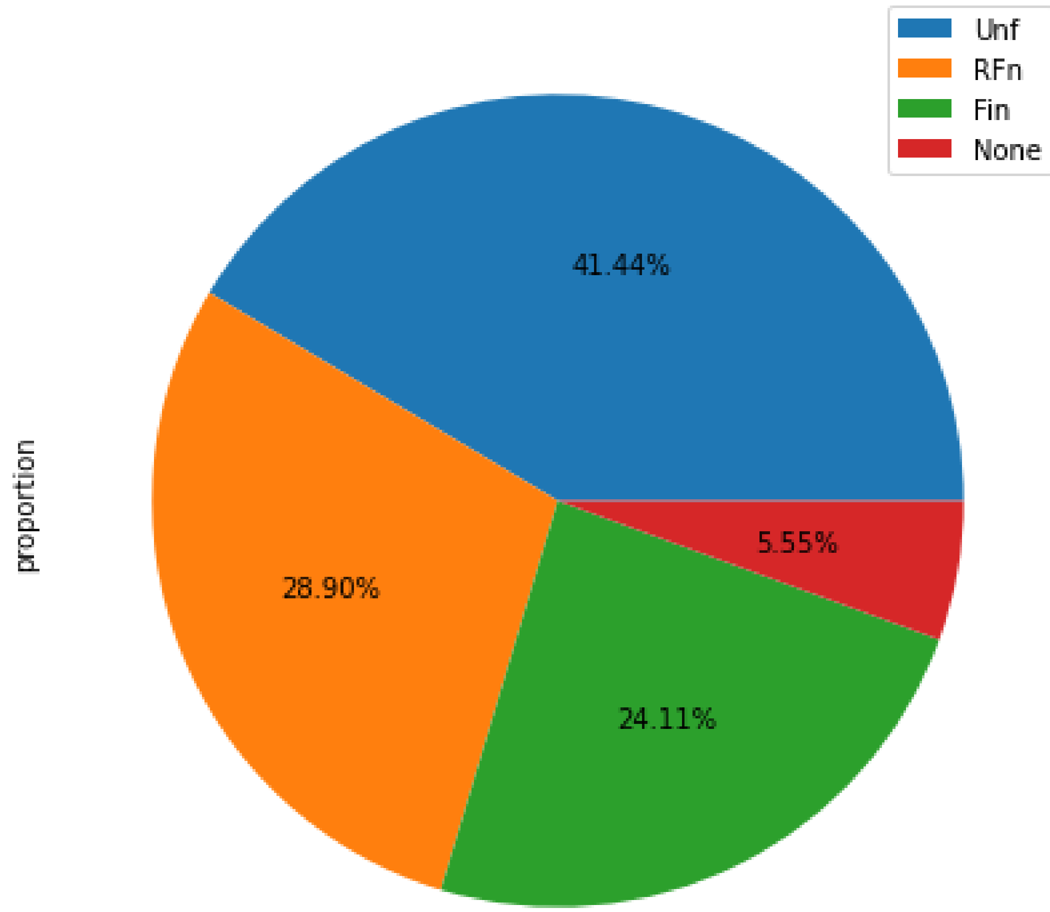

```
FireplaceQu
None     0.472603
Gd       0.260274
TA       0.214384
Fa       0.022603
Ex       0.016438
Po       0.013699
Name: proportion, dtype: float64
```



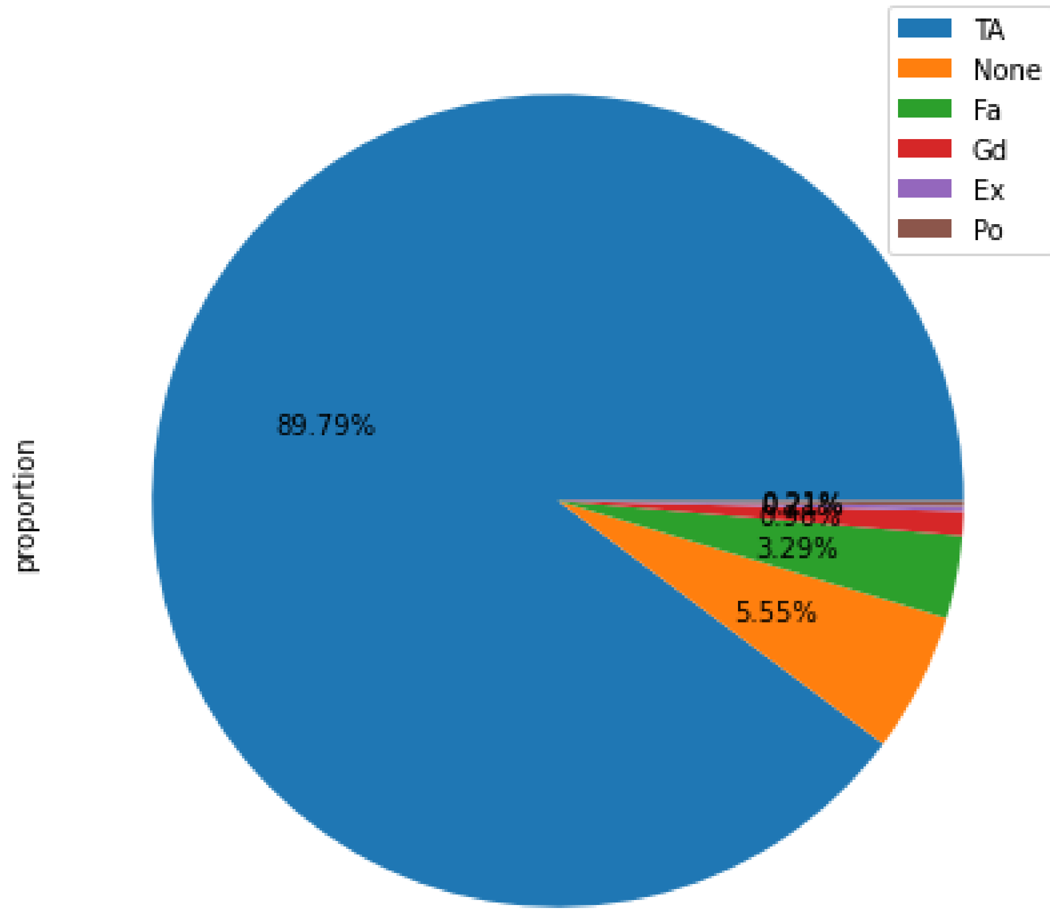

```
GarageType
Attchd      0.595890
Detchd      0.265068
BuiltIn     0.060274
None        0.055479
Basment     0.013014
CarPort     0.006164
2Types      0.004110
Name: proportion, dtype: float64
```



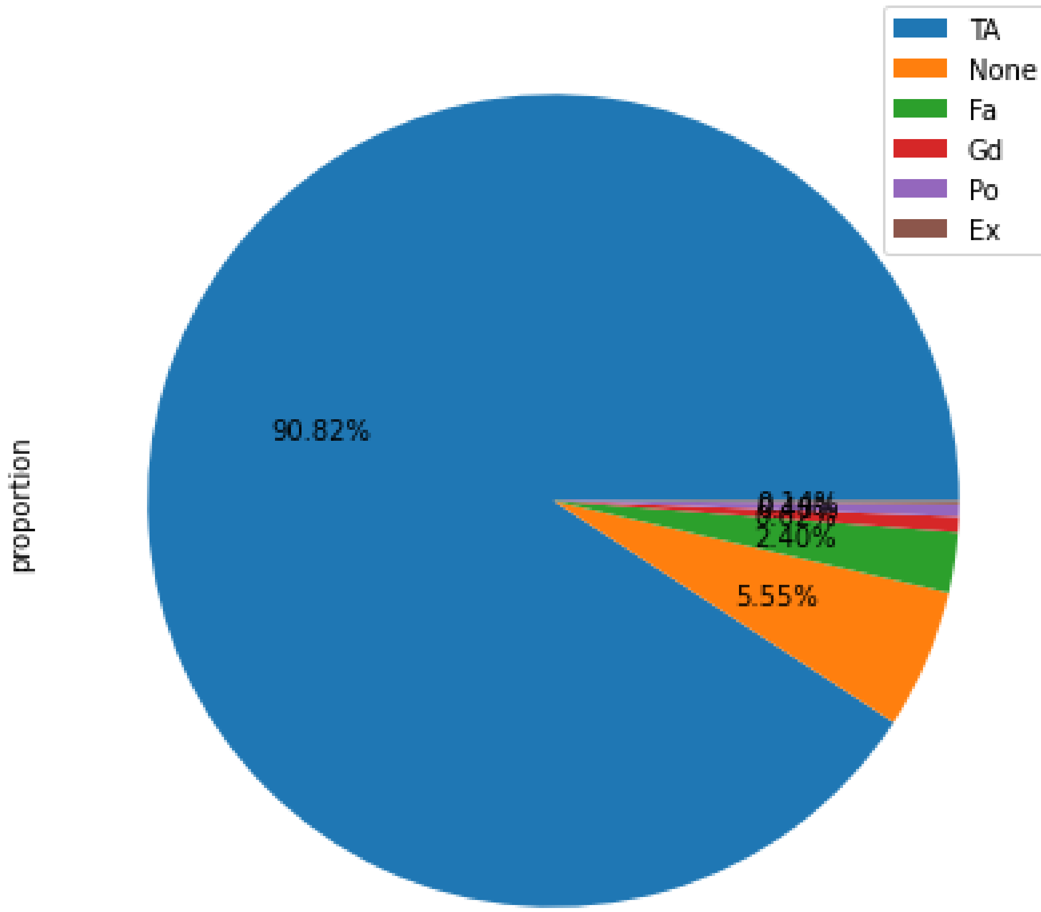

```
GarageFinish
Unf     0.414384
RFn     0.289041
Fin     0.241096
None    0.055479
Name: proportion, dtype: float64
```



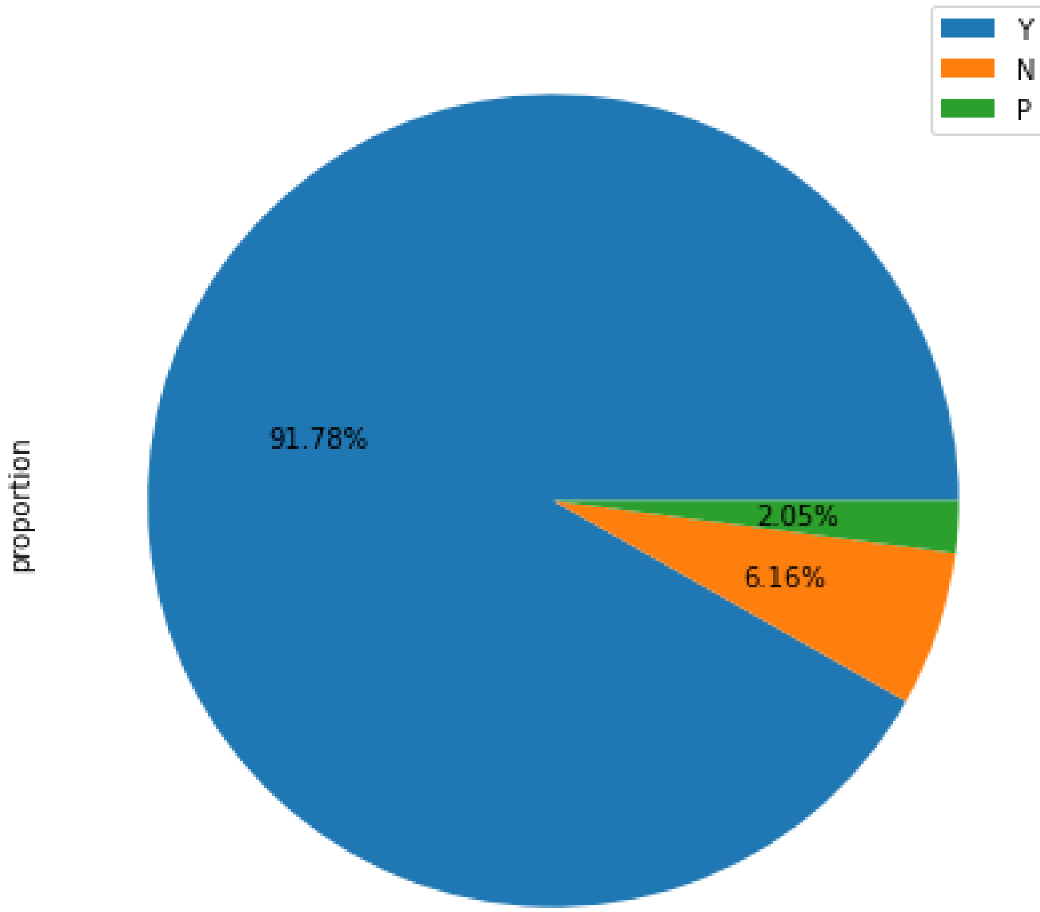

```
GarageQual
TA      0.897945
None    0.055479
Fa      0.032877
Gd      0.009589
Ex      0.002055
Po      0.002055
Name: proportion, dtype: float64
```



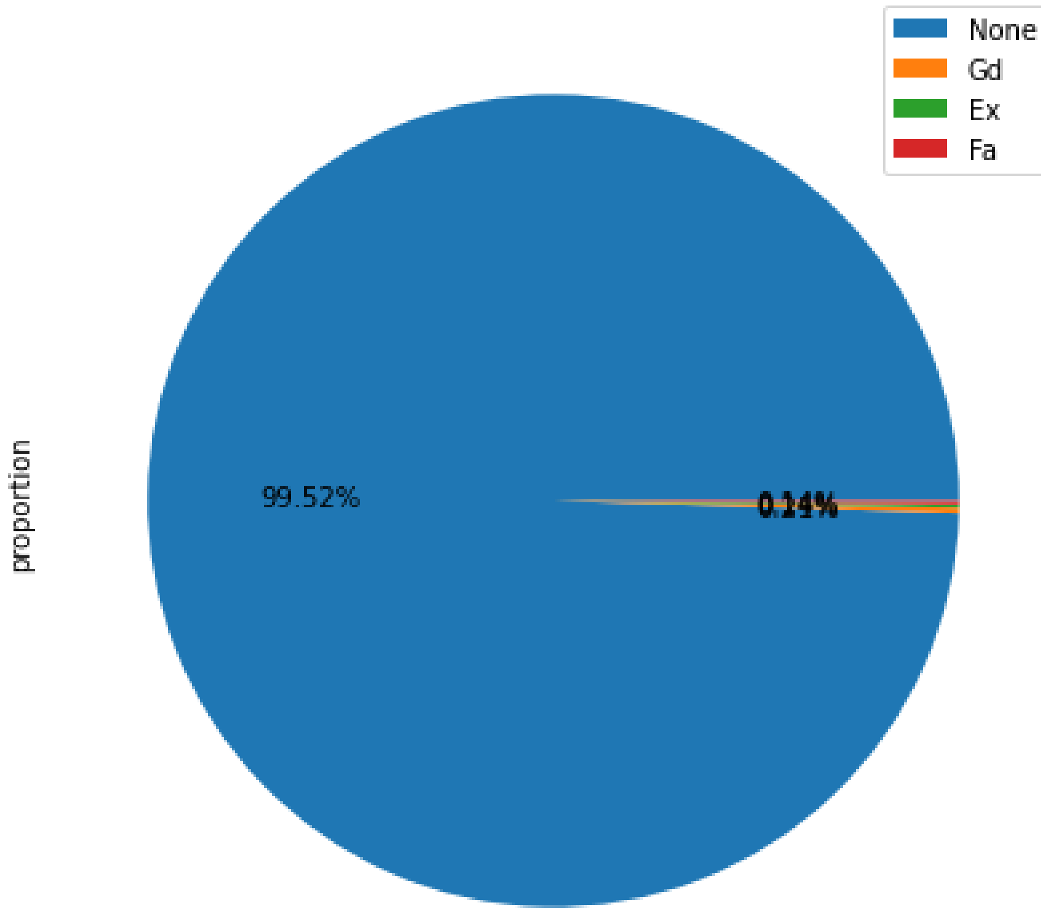

```
GarageCond
TA      0.908219
None    0.055479
Fa      0.023973
Gd      0.006164
Po      0.004795
Ex      0.001370
Name: proportion, dtype: float64
```



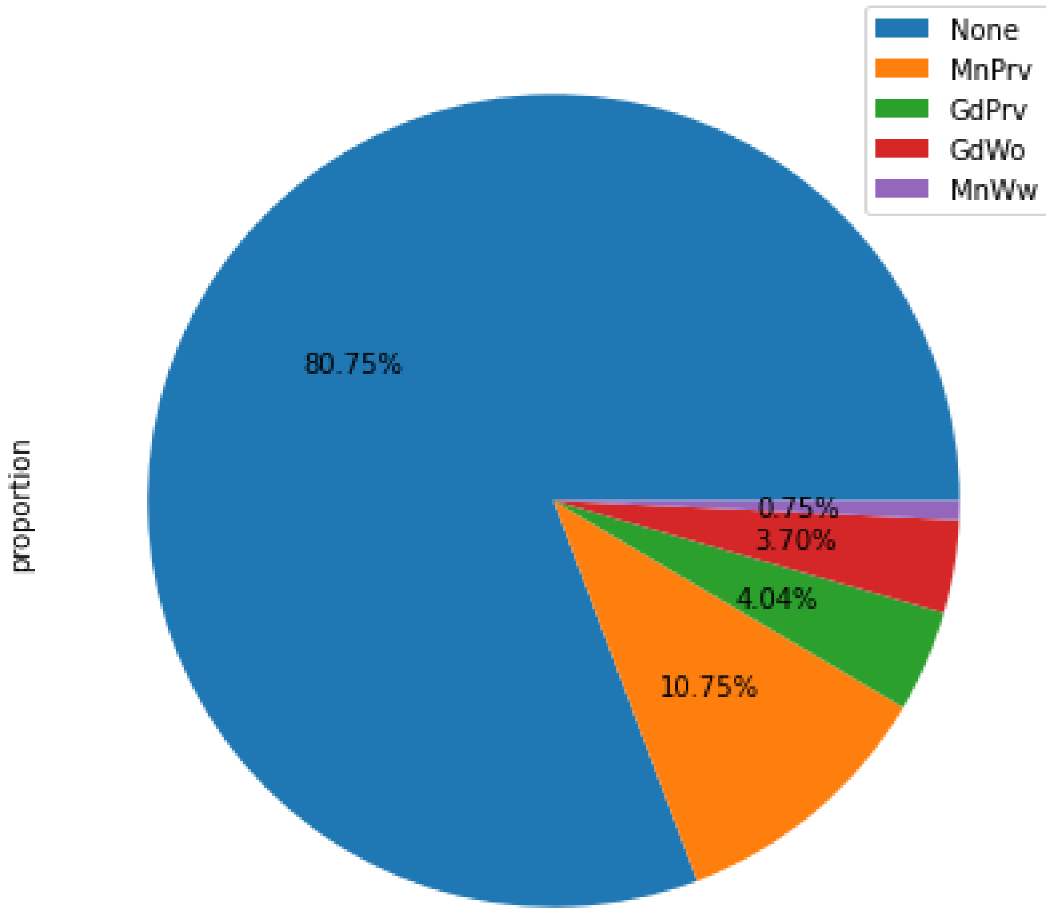

```
PavedDrive
Y    0.917808
N    0.061644
P    0.020548
Name: proportion, dtype: float64
```



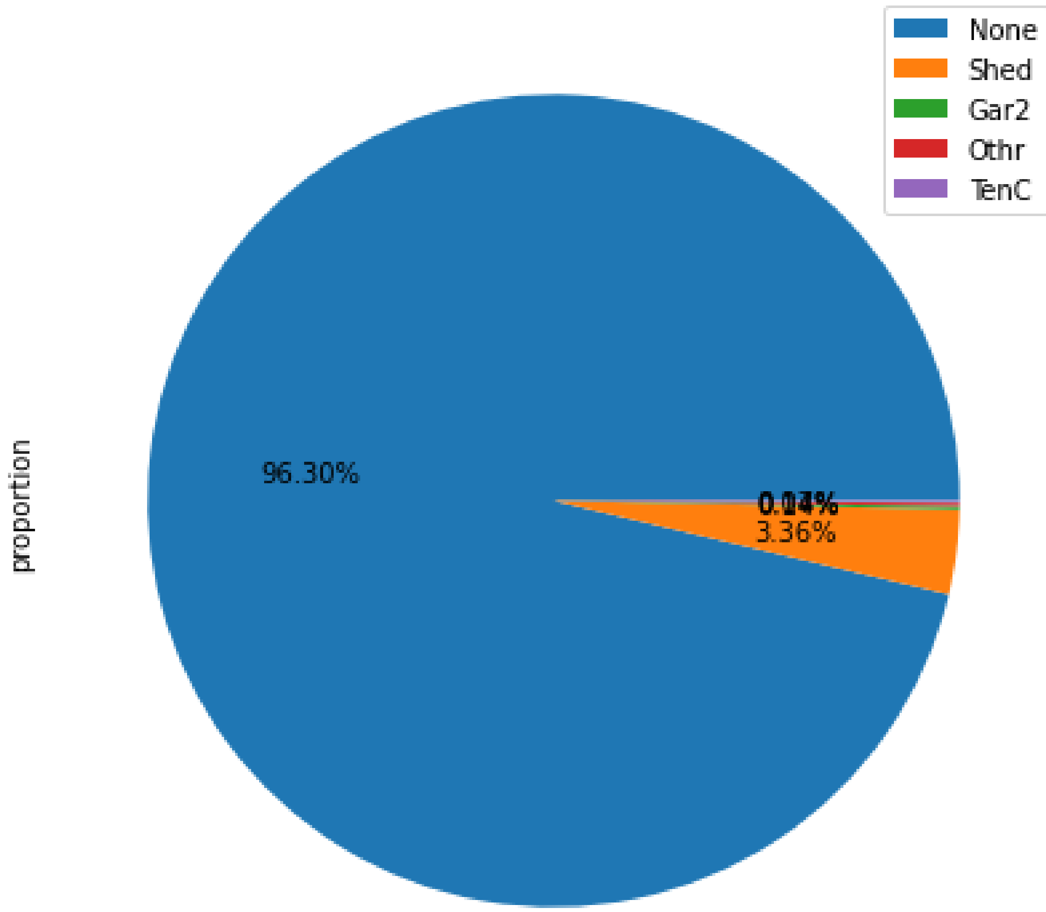

```
PoolQC
None     0.995205
Gd       0.002055
Ex       0.001370
Fa       0.001370
Name: proportion, dtype: float64
```



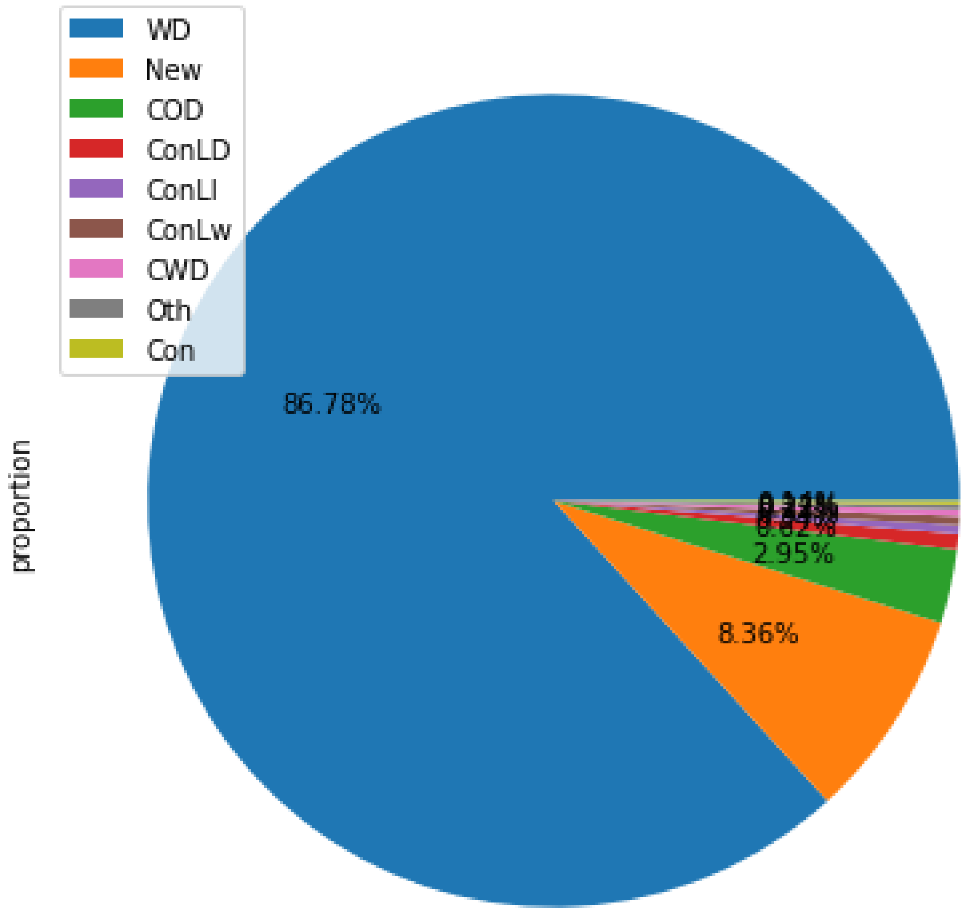

```
Fence
None     0.807534
MnPrv    0.107534
GdPrv    0.040411
GdWo     0.036986
MnWw     0.007534
Name: proportion, dtype: float64
```



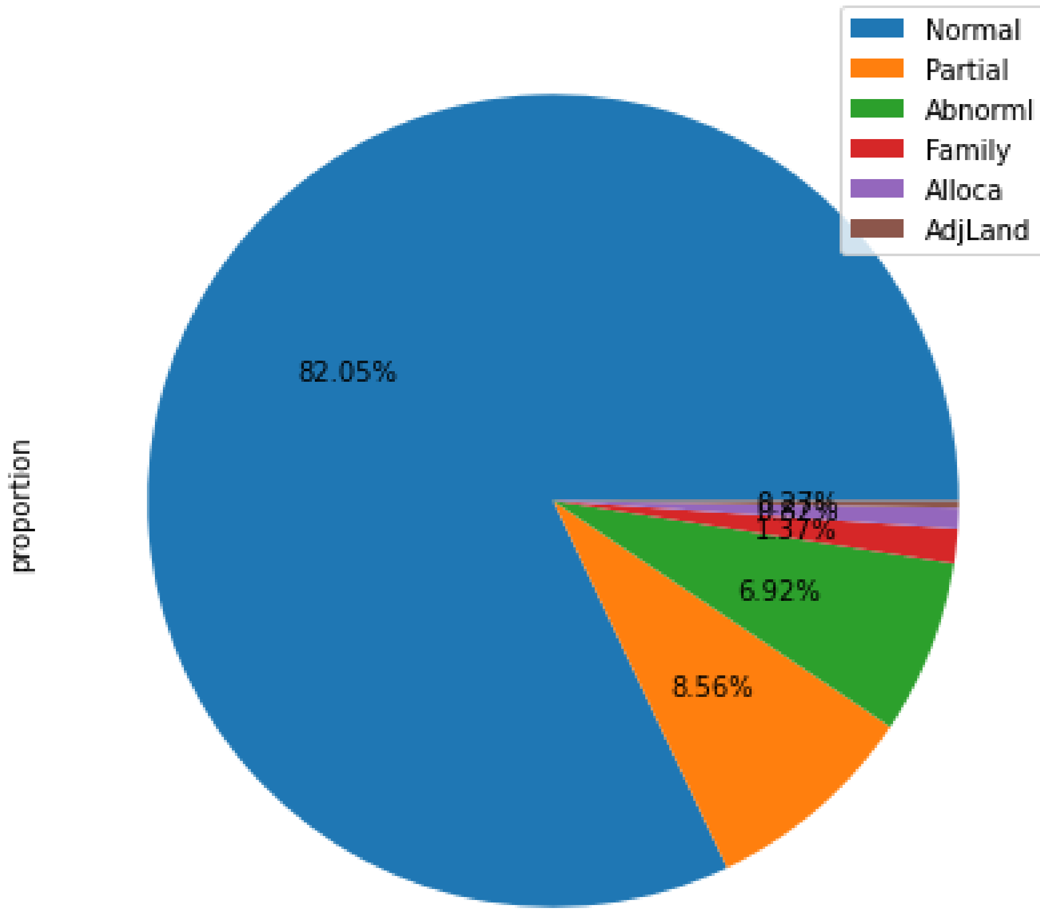

```
MiscFeature
None    0.963014
Shed    0.033562
Gar2    0.001370
Othr    0.001370
TenC    0.000685
Name: proportion, dtype: float64
```




```
SaleType
WD       0.867808
New      0.083562
COD      0.029452
ConLD    0.006164
ConLI    0.003425
ConLw    0.003425
CWD      0.002740
Oth      0.002055
Con      0.001370
Name: proportion, dtype: float64
```




```
SaleCondition
Normal     0.820548
Partial    0.085616
Abnorml    0.069178
Family     0.013699
Alloca     0.008219
AdjLand    0.002740
Name: proportion, dtype: float64
```



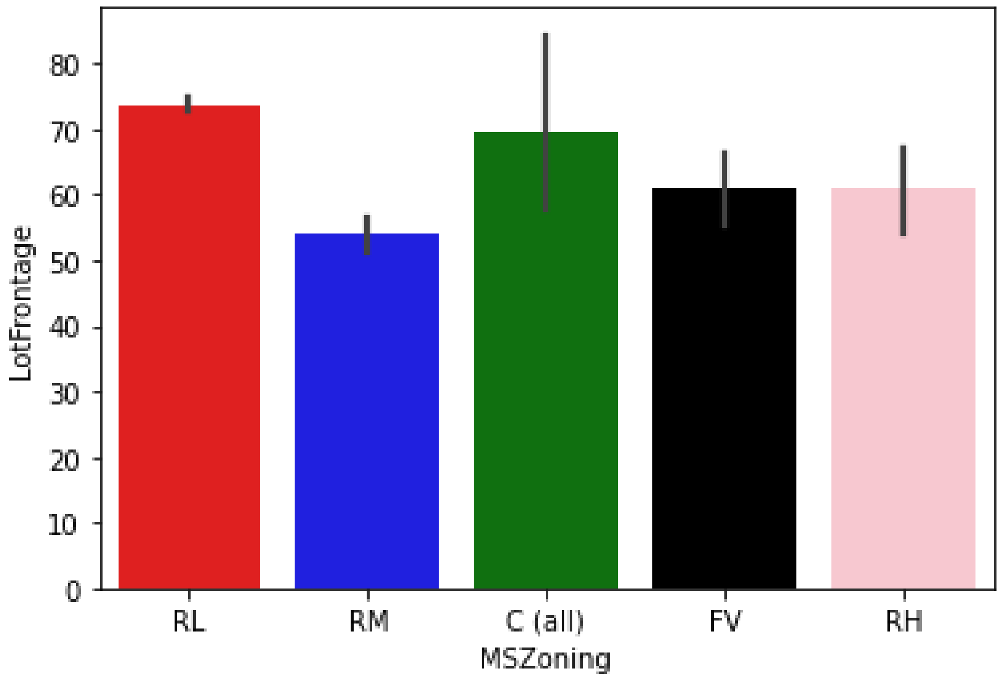
[ ]:

```

```

5.3.2 Bivariate / Multivaritate Analysis

[29]:

```
sns.barplot(x='MSZoning', y='LotFrontage',data=housing,␣
  ↪palette=['red','blue','green','black','pink'])
plt.show()
```

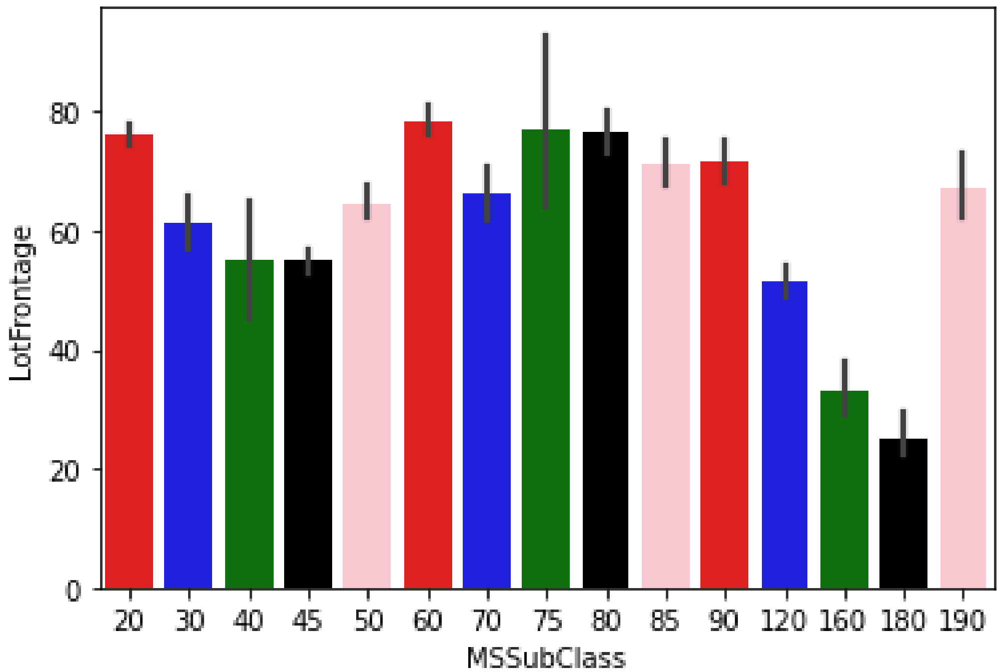


[ ]:

```

```

[30]:

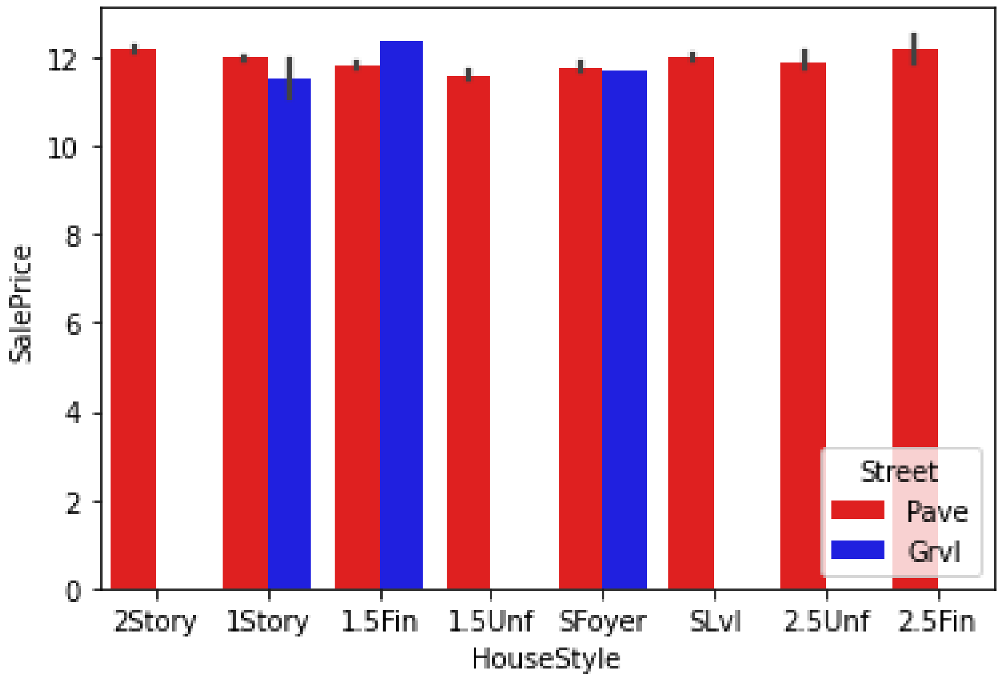
```
sns.barplot(x='MSSubClass', y='LotFrontage',data=housing,␣
↪palette=['red','blue','green','black','pink'])
plt.show()
```



[ ]:

[31]:

```
sns.barplot(x='HouseStyle', y='SalePrice',hue='Street',data=housing,
    palette=['red','blue','green','black','pink'])
plt.show()
```

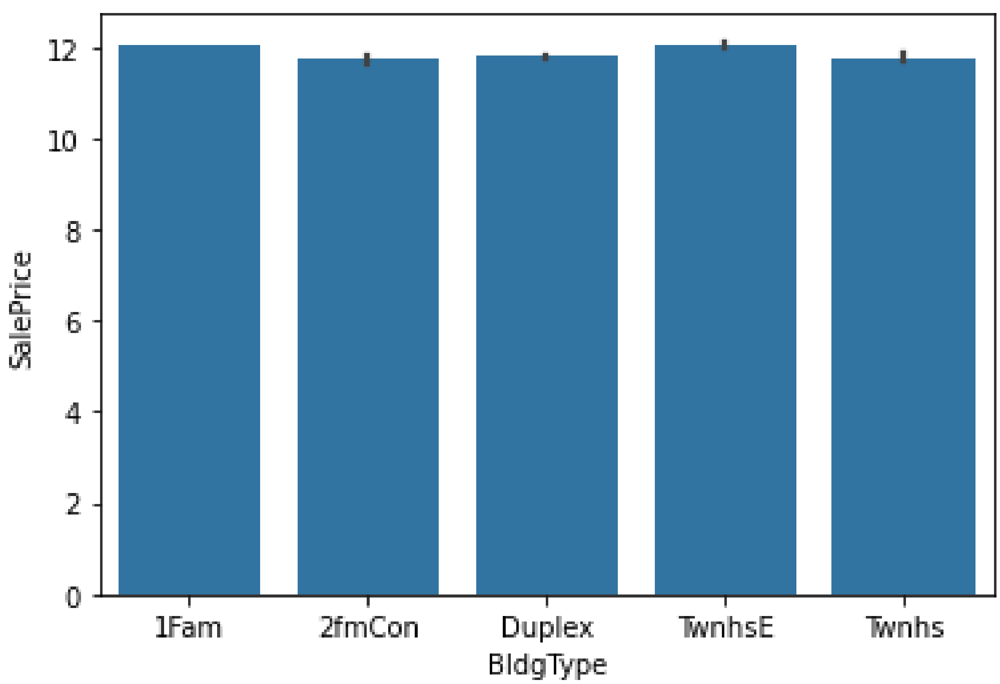


[ ]:

```

```

[32]:

```
sns.barplot(x="BldgType",y="SalePrice",data=housing)
plt.show()
```



[ ]:

```

```

Conclusion

We can see that RL(Residential Low Density) has highest lot frontage and RM (Residential Medium Density) has least

We can see that 2-story 1946 & Newer has highest lot frontGE and PUD-MULTILEVEL-INCL SPLIT LEV/FOYER has least

The SalesPrice is not showing much varience with respect to the Style of dwelling (1 story / 2 story)

The SalesPrice is almost same for all the Building Type (Type of Dwelling) and the basement quality so there is no significant pattern

[33]:

```
housing['Age'] = housing['YrSold'] - housing['YearBuilt']
```

[34]:

```
housing['Age'].head()
```

[34]:

```
0     5
1    31
2     7
3    91
4     8
Name: Age, dtype: int64
```

[ ]:

```

```

[35]:

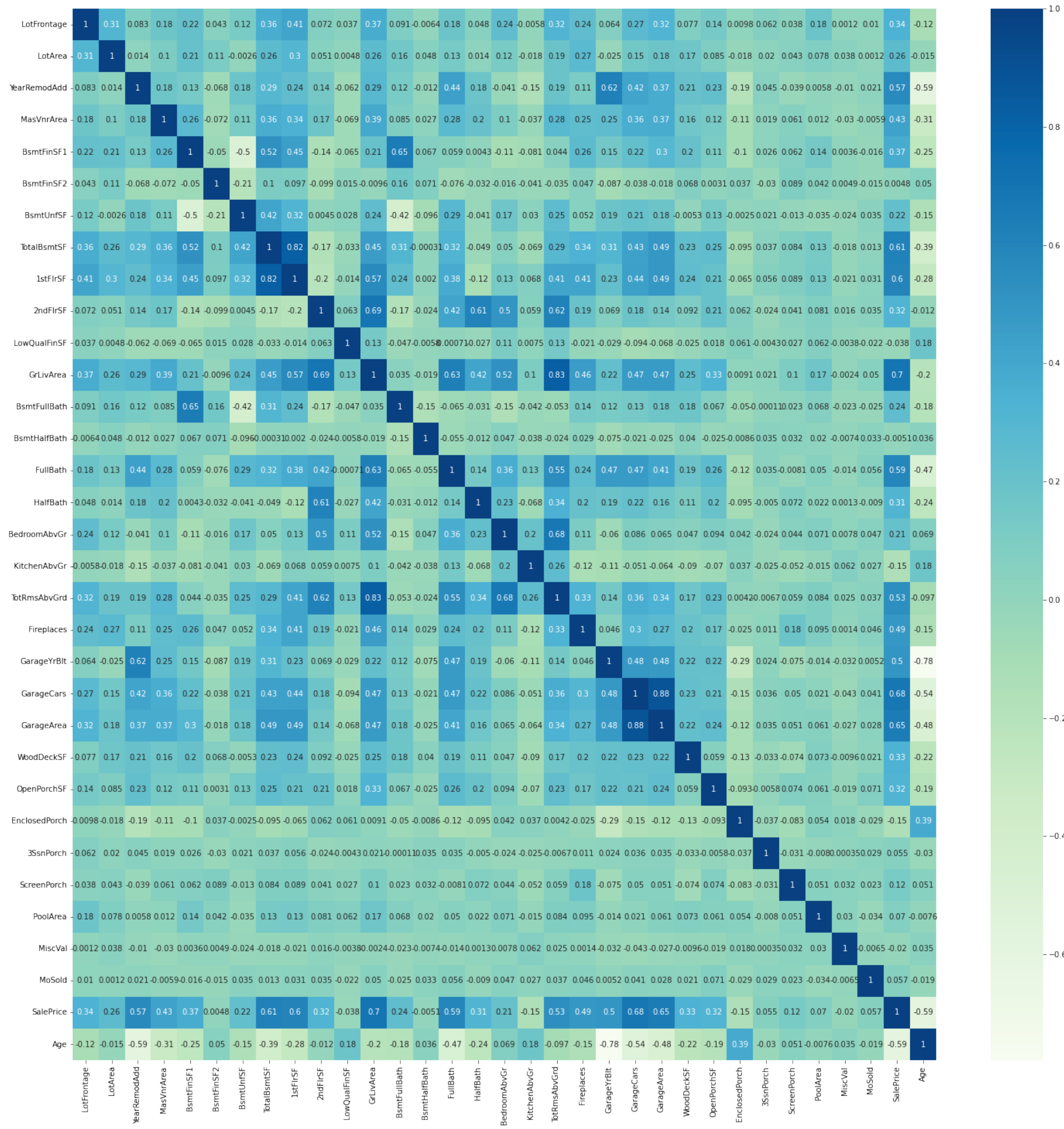
```
housing.drop(columns=['YearBuilt','YrSold'],axis=1, inplace=True)
```

[36]:

```
plt.figure(figsize=(25,25))
sns.heatmap(housing.corr(numeric_only=True), annot=True, cmap = 'GnBu')
```

[36]:

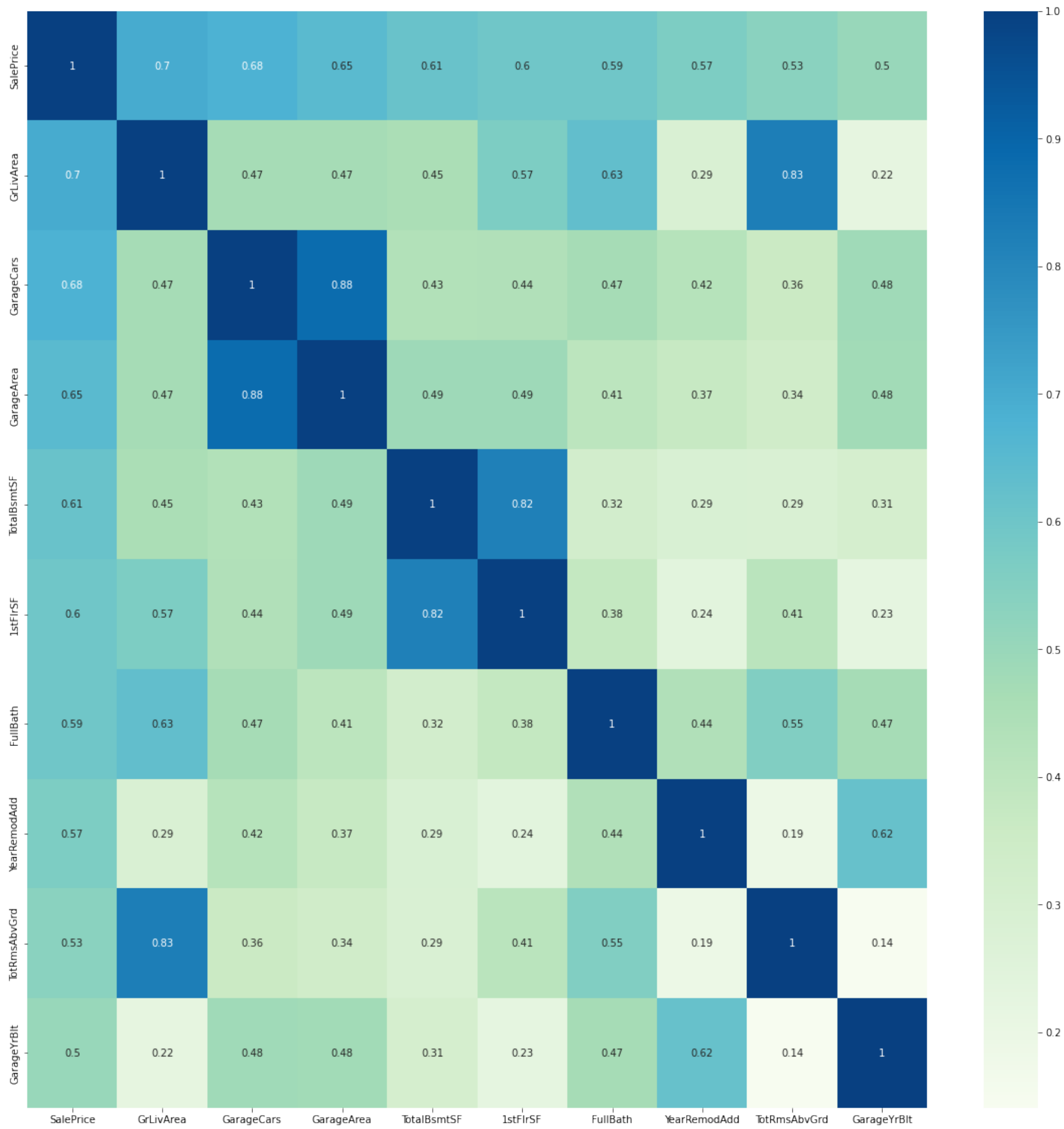
```
<Axes: >
```



[ ]:

[37]:
```
cols = housing.corr(numeric_only=True).nlargest(10,'SalePrice').index
cm=np.corrcoef(housing[cols].values.T)
plt.figure(figsize=(20,20))
sns.heatmap(cm, annot=True, cmap = 'GnBu', yticklabels=cols.values ,␣
↪xticklabels=cols.values)
```

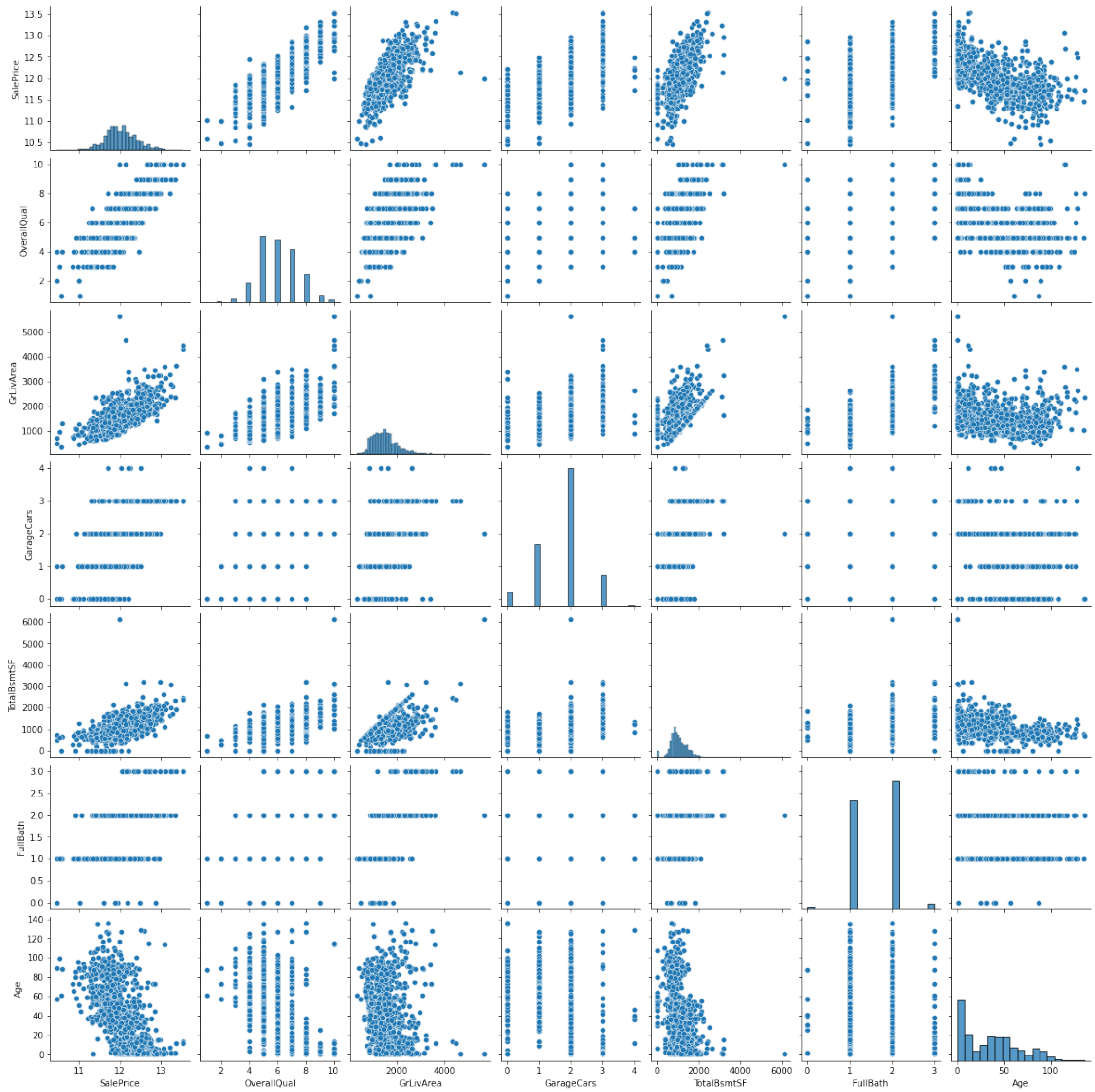
[37]: <Axes: >



[ ]:

[38]:
```
cols = ['SalePrice', 'OverallQual', 'GrLivArea', 'GarageCars', 'TotalBsmtSF',␣
↪'FullBath', 'Age']
plt.figure(figsize=(20,20))
sns.pairplot(housing[cols])
plt.show()
```

```
<Figure size 1440x1440 with 0 Axes>
```




```
[ ]:
```

5.4 Data Preparation

```
[39]: housing_num = housing.select_dtypes(include=['int64','float64'])
      housing_cat = housing.select_dtypes(include='object')
      housing_cat.head()
```

```
[39]:   MSSubClass MSZoning Street Alley LotShape LandContour Utilities LotConfig  \
0               60       RL   Pave  None      Reg         Lvl    AllPub    Inside
1               20       RL   Pave  None      Reg         Lvl    AllPub       FR2
2               60       RL   Pave  None      IR1         Lvl    AllPub    Inside
```

```
3         70       RL   Pave  None      IR1         Lvl    AllPub    Corner
4         60       RL   Pave  None      IR1         Lvl    AllPub       FR2

  LandSlope Neighborhood Condition1 Condition2 BldgType HouseStyle  \
0       Gtl      CollgCr       Norm       Norm     1Fam     2Story
1       Gtl      Veenker      Feedr       Norm     1Fam     1Story
2       Gtl      CollgCr       Norm       Norm     1Fam     2Story
3       Gtl      Crawfor       Norm       Norm     1Fam     2Story
4       Gtl      NoRidge       Norm       Norm     1Fam     2Story

  OverallQual OverallCond RoofStyle RoofMatl Exterior1st Exterior2nd  \
0           7           5     Gable  CompShg     VinylSd     VinylSd
1           6           8     Gable  CompShg     MetalSd     MetalSd
2           7           5     Gable  CompShg     VinylSd     VinylSd
3           7           5     Gable  CompShg     Wd Sdng     Wd Shng
4           8           5     Gable  CompShg     VinylSd     VinylSd

  MasVnrType ExterQual ExterCond Foundation BsmtQual BsmtCond BsmtExposure  \
0    BrkFace        Gd        TA      PConc       Gd       TA           No
1       None        TA        TA     CBlock       Gd       TA           Gd
2    BrkFace        Gd        TA      PConc       Gd       TA           Mn
3       None        TA        TA     BrkTil       TA       Gd           No
4    BrkFace        Gd        TA      PConc       Gd       TA           Av

  BsmtFinType1 BsmtFinType2 Heating HeatingQC CentralAir Electrical  \
0          GLQ          Unf    GasA        Ex          Y      SBrkr
1          ALQ          Unf    GasA        Ex          Y      SBrkr
2          GLQ          Unf    GasA        Ex          Y      SBrkr
3          ALQ          Unf    GasA        Gd          Y      SBrkr
4          GLQ          Unf    GasA        Ex          Y      SBrkr

  KitchenQual Functional FireplaceQu GarageType GarageFinish GarageQual  \
0          Gd        Typ        None     Attchd          RFn         TA
1          TA        Typ          TA     Attchd          RFn         TA
2          Gd        Typ          TA     Attchd          RFn         TA
3          Gd        Typ          Gd     Detchd          Unf         TA
4          Gd        Typ          TA     Attchd          RFn         TA

  GarageCond PavedDrive PoolQC Fence MiscFeature SaleType SaleCondition
0         TA          Y   None  None        None       WD        Normal
1         TA          Y   None  None        None       WD        Normal
2         TA          Y   None  None        None       WD        Normal
3         TA          Y   None  None        None       WD       Abnorml
4         TA          Y   None  None        None       WD        Normal
```

[ ]:

[40]:
```python
housing_cat_dn = pd.get_dummies(housing_cat, drop_first=True, dtype=int)
housing_cat_dn.head()
```

[40]:
```
   MSSubClass_30  MSSubClass_40  MSSubClass_45  MSSubClass_50  MSSubClass_60  \
0              0              0              0              0              1
1              0              0              0              0              0
2              0              0              0              0              1
3              0              0              0              0              0
4              0              0              0              0              1

   MSSubClass_70  MSSubClass_75  MSSubClass_80  MSSubClass_85  MSSubClass_90  \
0              0              0              0              0              0
1              0              0              0              0              0
2              0              0              0              0              0
3              1              0              0              0              0
4              0              0              0              0              0

   MSSubClass_120  MSSubClass_160  MSSubClass_180  MSSubClass_190  \
0               0               0               0               0
1               0               0               0               0
2               0               0               0               0
3               0               0               0               0
4               0               0               0               0

   MSZoning_FV  MSZoning_RH  MSZoning_RL  MSZoning_RM  Street_Pave  \
0            0            0            1            0            1
1            0            0            1            0            1
2            0            0            1            0            1
3            0            0            1            0            1
4            0            0            1            0            1

   Alley_None  Alley_Pave  LotShape_IR2  LotShape_IR3  LotShape_Reg  \
0           1           0             0             0             1
1           1           0             0             0             1
2           1           0             0             0             0
3           1           0             0             0             0
4           1           0             0             0             0

   LandContour_HLS  LandContour_Low  LandContour_Lvl  Utilities_NoSeWa  \
0                0                0                1                 0
1                0                0                1                 0
2                0                0                1                 0
3                0                0                1                 0
4                0                0                1                 0

   LotConfig_CulDSac  LotConfig_FR2  LotConfig_FR3  LotConfig_Inside  \
0                  0              0              0                 1
```

1	0	1	0	0
2	0	0	0	1
3	0	0	0	0
4	0	1	0	0

	LandSlope_Mod	LandSlope_Sev	Neighborhood_Blueste	Neighborhood_BrDale \
0	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0

	Neighborhood_BrkSide	Neighborhood_ClearCr	Neighborhood_CollgCr \
0	0	0	1
1	0	0	0
2	0	0	1
3	0	0	0
4	0	0	0

	Neighborhood_Crawfor	Neighborhood_Edwards	Neighborhood_Gilbert \
0	0	0	0
1	0	0	0
2	0	0	0
3	1	0	0
4	0	0	0

	Neighborhood_IDOTRR	Neighborhood_MeadowV	Neighborhood_Mitchel \
0	0	0	0
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0

	Neighborhood_NAmes	Neighborhood_NPkVill	Neighborhood_NWAmes \
0	0	0	0
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0

	Neighborhood_NoRidge	Neighborhood_NridgHt	Neighborhood_OldTown \
0	0	0	0
1	0	0	0
2	0	0	0
3	0	0	0
4	1	0	0

```
   Neighborhood_SWISU  Neighborhood_Sawyer  Neighborhood_SawyerW  \
0                   0                    0                     0
1                   0                    0                     0
2                   0                    0                     0
3                   0                    0                     0
4                   0                    0                     0

   Neighborhood_Somerst  Neighborhood_StoneBr  Neighborhood_Timber  \
0                     0                     0                    0
1                     0                     0                    0
2                     0                     0                    0
3                     0                     0                    0
4                     0                     0                    0

   Neighborhood_Veenker  Condition1_Feedr  Condition1_Norm  Condition1_PosA  \
0                     0                 0                1                0
1                     1                 1                0                0
2                     0                 0                1                0
3                     0                 0                1                0
4                     0                 0                1                0

   Condition1_PosN  Condition1_RRAe  Condition1_RRAn  Condition1_RRNe  \
0                0                0                0                0
1                0                0                0                0
2                0                0                0                0
3                0                0                0                0
4                0                0                0                0

   Condition1_RRNn  Condition2_Feedr  Condition2_Norm  Condition2_PosA  \
0                0                 0                1                0
1                0                 0                1                0
2                0                 0                1                0
3                0                 0                1                0
4                0                 0                1                0

   Condition2_PosN  Condition2_RRAe  Condition2_RRAn  Condition2_RRNn  \
0                0                0                0                0
1                0                0                0                0
2                0                0                0                0
3                0                0                0                0
4                0                0                0                0

   BldgType_2fmCon  BldgType_Duplex  BldgType_Twnhs  BldgType_TwnhsE  \
0                0                0               0                0
1                0                0               0                0
2                0                0               0                0
3                0                0               0                0
```

```
4                0                0                0                 0

   HouseStyle_1.5Unf  HouseStyle_1Story  HouseStyle_2.5Fin  HouseStyle_2.5Unf  \
0                  0                  0                  0                  0
1                  0                  1                  0                  0
2                  0                  0                  0                  0
3                  0                  0                  0                  0
4                  0                  0                  0                  0

   HouseStyle_2Story  HouseStyle_SFoyer  HouseStyle_SLvl  OverallQual_2  \
0                  1                  0                0              0
1                  0                  0                0              0
2                  1                  0                0              0
3                  1                  0                0              0
4                  1                  0                0              0

   OverallQual_3  OverallQual_4  OverallQual_5  OverallQual_6  OverallQual_7  \
0              0              0              0              0              1
1              0              0              0              1              0
2              0              0              0              0              1
3              0              0              0              0              1
4              0              0              0              0              0

   OverallQual_8  OverallQual_9  OverallQual_10  OverallCond_2  OverallCond_3  \
0              0              0               0              0              0
1              0              0               0              0              0
2              0              0               0              0              0
3              0              0               0              0              0
4              1              0               0              0              0

   OverallCond_4  OverallCond_5  OverallCond_6  OverallCond_7  OverallCond_8  \
0              0              1              0              0              0
1              0              0              0              0              1
2              0              1              0              0              0
3              0              1              0              0              0
4              0              1              0              0              0

   OverallCond_9  RoofStyle_Gable  RoofStyle_Gambrel  RoofStyle_Hip  \
0              0                1                  0              0
1              0                1                  0              0
2              0                1                  0              0
3              0                1                  0              0
4              0                1                  0              0

   RoofStyle_Mansard  RoofStyle_Shed  RoofMatl_CompShg  RoofMatl_Membran  \
0                  0               0                 1                 0
1                  0               0                 1                 0
```

```
2                 0               0                 1                 0
3                 0               0                 1                 0
4                 0               0                 1                 0

   RoofMatl_Metal  RoofMatl_Roll  RoofMatl_Tar&Grv  RoofMatl_WdShake  \
0               0              0                 0                 0
1               0              0                 0                 0
2               0              0                 0                 0
3               0              0                 0                 0
4               0              0                 0                 0

   RoofMatl_WdShngl  Exterior1st_AsphShn  Exterior1st_BrkComm  \
0                 0                    0                    0
1                 0                    0                    0
2                 0                    0                    0
3                 0                    0                    0
4                 0                    0                    0

   Exterior1st_BrkFace  Exterior1st_CBlock  Exterior1st_CemntBd  \
0                    0                   0                    0
1                    0                   0                    0
2                    0                   0                    0
3                    0                   0                    0
4                    0                   0                    0

   Exterior1st_HdBoard  Exterior1st_ImStucc  Exterior1st_MetalSd  \
0                    0                    0                    0
1                    0                    0                    1
2                    0                    0                    0
3                    0                    0                    0
4                    0                    0                    0

   Exterior1st_Plywood  Exterior1st_Stone  Exterior1st_Stucco  \
0                    0                  0                   0
1                    0                  0                   0
2                    0                  0                   0
3                    0                  0                   0
4                    0                  0                   0

   Exterior1st_VinylSd  Exterior1st_Wd Sdng  Exterior1st_WdShing  \
0                    1                    0                    0
1                    0                    0                    0
2                    1                    0                    0
3                    0                    1                    0
4                    1                    0                    0

   Exterior2nd_AsphShn  Exterior2nd_Brk Cmn  Exterior2nd_BrkFace  \
```

```
0                    0                    0                    0
1                    0                    0                    0
2                    0                    0                    0
3                    0                    0                    0
4                    0                    0                    0

   Exterior2nd_CBlock  Exterior2nd_CmentBd  Exterior2nd_HdBoard  \
0                   0                    0                    0
1                   0                    0                    0
2                   0                    0                    0
3                   0                    0                    0
4                   0                    0                    0

   Exterior2nd_ImStucc  Exterior2nd_MetalSd  Exterior2nd_Other  \
0                    0                    0                  0
1                    0                    1                  0
2                    0                    0                  0
3                    0                    0                  0
4                    0                    0                  0

   Exterior2nd_Plywood  Exterior2nd_Stone  Exterior2nd_Stucco  \
0                    0                  0                   0
1                    0                  0                   0
2                    0                  0                   0
3                    0                  0                   0
4                    0                  0                   0

   Exterior2nd_VinylSd  Exterior2nd_Wd Sdng  Exterior2nd_Wd Shng  \
0                    1                    0                    0
1                    0                    0                    0
2                    1                    0                    0
3                    0                    0                    1
4                    1                    0                    0

   MasVnrType_BrkFace  MasVnrType_None  MasVnrType_Stone  ExterQual_Fa  \
0                   1                0                 0             0
1                   0                1                 0             0
2                   1                0                 0             0
3                   0                1                 0             0
4                   1                0                 0             0

   ExterQual_Gd  ExterQual_TA  ExterCond_Fa  ExterCond_Gd  ExterCond_Po  \
0             1             0             0             0             0
1             0             1             0             0             0
2             1             0             0             0             0
3             0             1             0             0             0
4             1             0             0             0             0
```

```
   ExterCond_TA  Foundation_CBlock  Foundation_PConc  Foundation_Slab  \
0             1                  0                 1                0
1             1                  1                 0                0
2             1                  0                 1                0
3             1                  0                 0                0
4             1                  0                 1                0

   Foundation_Stone  Foundation_Wood  BsmtQual_Fa  BsmtQual_Gd  BsmtQual_None  \
0                 0                0            0            1              0
1                 0                0            0            1              0
2                 0                0            0            1              0
3                 0                0            0            0              0
4                 0                0            0            1              0

   BsmtQual_TA  BsmtCond_Gd  BsmtCond_None  BsmtCond_Po  BsmtCond_TA  \
0            0            0              0            0            1
1            0            0              0            0            1
2            0            0              0            0            1
3            1            1              0            0            0
4            0            0              0            0            1

   BsmtExposure_Gd  BsmtExposure_Mn  BsmtExposure_No  BsmtExposure_None  \
0                0                0                1                  0
1                1                0                0                  0
2                0                1                0                  0
3                0                0                1                  0
4                0                0                0                  0

   BsmtFinType1_BLQ  BsmtFinType1_GLQ  BsmtFinType1_LwQ  BsmtFinType1_None  \
0                 0                 1                 0                  0
1                 0                 0                 0                  0
2                 0                 1                 0                  0
3                 0                 0                 0                  0
4                 0                 1                 0                  0

   BsmtFinType1_Rec  BsmtFinType1_Unf  BsmtFinType2_BLQ  BsmtFinType2_GLQ  \
0                 0                 0                 0                 0
1                 0                 0                 0                 0
2                 0                 0                 0                 0
3                 0                 0                 0                 0
4                 0                 0                 0                 0

   BsmtFinType2_LwQ  BsmtFinType2_None  BsmtFinType2_Rec  BsmtFinType2_Unf  \
0                 0                  0                 0                 1
1                 0                  0                 0                 1
2                 0                  0                 0                 1
```

```
3               0                  0                  0                  1
4               0                  0                  0                  1

   Heating_GasA  Heating_GasW  Heating_Grav  Heating_OthW  Heating_Wall  \
0             1             0             0             0             0
1             1             0             0             0             0
2             1             0             0             0             0
3             1             0             0             0             0
4             1             0             0             0             0

   HeatingQC_Fa  HeatingQC_Gd  HeatingQC_Po  HeatingQC_TA  CentralAir_Y  \
0             0             0             0             0             1
1             0             0             0             0             1
2             0             0             0             0             1
3             0             1             0             0             1
4             0             0             0             0             1

   Electrical_FuseF  Electrical_FuseP  Electrical_Mix  Electrical_None  \
0                 0                 0               0                0
1                 0                 0               0                0
2                 0                 0               0                0
3                 0                 0               0                0
4                 0                 0               0                0

   Electrical_SBrkr  KitchenQual_Fa  KitchenQual_Gd  KitchenQual_TA  \
0                 1               0               1               0
1                 1               0               0               1
2                 1               0               1               0
3                 1               0               1               0
4                 1               0               1               0

   Functional_Maj2  Functional_Min1  Functional_Min2  Functional_Mod  \
0                0                0                0               0
1                0                0                0               0
2                0                0                0               0
3                0                0                0               0
4                0                0                0               0

   Functional_Sev  Functional_Typ  FireplaceQu_Fa  FireplaceQu_Gd  \
0               0               1               0               0
1               0               1               0               0
2               0               1               0               0
3               0               1               0               1
4               0               1               0               0

   FireplaceQu_None  FireplaceQu_Po  FireplaceQu_TA  GarageType_Attchd  \
0                 1               0               0                  1
```

```
1                 0                0               1                  1
2                 0                0               1                  1
3                 0                0               0                  0
4                 0                0               1                  1

   GarageType_Basment  GarageType_BuiltIn  GarageType_CarPort  \
0                   0                   0                   0
1                   0                   0                   0
2                   0                   0                   0
3                   0                   0                   0
4                   0                   0                   0

   GarageType_Detchd  GarageType_None  GarageFinish_None  GarageFinish_RFn  \
0                  0                0                  0                 1
1                  0                0                  0                 1
2                  0                0                  0                 1
3                  1                0                  0                 0
4                  0                0                  0                 1

   GarageFinish_Unf  GarageQual_Fa  GarageQual_Gd  GarageQual_None  \
0                 0              0              0                0
1                 0              0              0                0
2                 0              0              0                0
3                 1              0              0                0
4                 0              0              0                0

   GarageQual_Po  GarageQual_TA  GarageCond_Fa  GarageCond_Gd  \
0              0              1              0              0
1              0              1              0              0
2              0              1              0              0
3              0              1              0              0
4              0              1              0              0

   GarageCond_None  GarageCond_Po  GarageCond_TA  PavedDrive_P  PavedDrive_Y  \
0                0              0              1             0             1
1                0              0              1             0             1
2                0              0              1             0             1
3                0              0              1             0             1
4                0              0              1             0             1

   PoolQC_Fa  PoolQC_Gd  PoolQC_None  Fence_GdWo  Fence_MnPrv  Fence_MnWw  \
0          0          0            1           0            0           0
1          0          0            1           0            0           0
2          0          0            1           0            0           0
3          0          0            1           0            0           0
4          0          0            1           0            0           0
```

```
   Fence_None  MiscFeature_None  MiscFeature_Othr  MiscFeature_Shed  \
0           1                 1                 0                 0
1           1                 1                 0                 0
2           1                 1                 0                 0
3           1                 1                 0                 0
4           1                 1                 0                 0

   MiscFeature_TenC  SaleType_CWD  SaleType_Con  SaleType_ConLD  \
0                 0             0             0               0
1                 0             0             0               0
2                 0             0             0               0
3                 0             0             0               0
4                 0             0             0               0

   SaleType_ConLI  SaleType_ConLw  SaleType_New  SaleType_Oth  SaleType_WD  \
0               0               0             0             0            1
1               0               0             0             0            1
2               0               0             0             0            1
3               0               0             0             0            1
4               0               0             0             0            1

   SaleCondition_AdjLand  SaleCondition_Alloca  SaleCondition_Family  \
0                      0                     0                     0
1                      0                     0                     0
2                      0                     0                     0
3                      0                     0                     0
4                      0                     0                     0

   SaleCondition_Normal  SaleCondition_Partial
0                     1                      0
1                     1                      0
2                     1                      0
3                     0                      0
4                     1                      0
```

[ ]:

[41]:
```
house = pd.concat([housing_num, housing_cat_dn], axis=1)
```

[42]:
```
house.shape
```

[42]: (1460, 288)

[ ]:

[43]:
```
x = house.drop(['SalePrice'], axis=1).copy()
y = house['SalePrice'].copy()
```

```
[44]: x.head()
```

```
[44]:    LotFrontage  LotArea  YearRemodAdd  MasVnrArea  BsmtFinSF1  BsmtFinSF2  \
      0         65.0     8450          2003       196.0         706           0
      1         80.0     9600          1976         0.0         978           0
      2         68.0    11250          2002       162.0         486           0
      3         60.0     9550          1970         0.0         216           0
      4         84.0    14260          2000       350.0         655           0

         BsmtUnfSF  TotalBsmtSF  1stFlrSF  2ndFlrSF  LowQualFinSF  GrLivArea  \
      0        150          856       856       854             0       1710
      1        284         1262      1262         0             0       1262
      2        434          920       920       866             0       1786
      3        540          756       961       756             0       1717
      4        490         1145      1145      1053             0       2198

         BsmtFullBath  BsmtHalfBath  FullBath  HalfBath  BedroomAbvGr  KitchenAbvGr  \
      0             1             0         2         1             3             1
      1             0             1         2         0             3             1
      2             1             0         2         1             3             1
      3             1             0         1         0             3             1
      4             1             0         2         1             4             1

         TotRmsAbvGrd  Fireplaces  GarageYrBlt  GarageCars  GarageArea  WoodDeckSF  \
      0             8           0       2003.0           2         548           0
      1             6           1       1976.0           2         460         298
      2             6           1       2001.0           2         608           0
      3             7           1       1998.0           3         642           0
      4             9           1       2000.0           3         836         192

         OpenPorchSF  EnclosedPorch  3SsnPorch  ScreenPorch  PoolArea  MiscVal  \
      0           61              0          0            0         0        0
      1            0              0          0            0         0        0
      2           42              0          0            0         0        0
      3           35            272          0            0         0        0
      4           84              0          0            0         0        0

         MoSold  Age  MSSubClass_30  MSSubClass_40  MSSubClass_45  MSSubClass_50  \
      0       2    5              0              0              0              0
      1       5   31              0              0              0              0
      2       9    7              0              0              0              0
      3       2   91              0              0              0              0
      4      12    8              0              0              0              0

         MSSubClass_60  MSSubClass_70  MSSubClass_75  MSSubClass_80  MSSubClass_85  \
      0              1              0              0              0              0
      1              0              0              0              0              0
```

```
2            1            0            0            0            0
3            0            1            0            0            0
4            1            0            0            0            0

   MSSubClass_90  MSSubClass_120  MSSubClass_160  MSSubClass_180  \
0              0               0               0               0
1              0               0               0               0
2              0               0               0               0
3              0               0               0               0
4              0               0               0               0

   MSSubClass_190  MSZoning_FV  MSZoning_RH  MSZoning_RL  MSZoning_RM  \
0               0            0            0            1            0
1               0            0            0            1            0
2               0            0            0            1            0
3               0            0            0            1            0
4               0            0            0            1            0

   Street_Pave  Alley_None  Alley_Pave  LotShape_IR2  LotShape_IR3  \
0            1           1           0             0             0
1            1           1           0             0             0
2            1           1           0             0             0
3            1           1           0             0             0
4            1           1           0             0             0

   LotShape_Reg  LandContour_HLS  LandContour_Low  LandContour_Lvl  \
0             1                0                0                1
1             1                0                0                1
2             0                0                0                1
3             0                0                0                1
4             0                0                0                1

   Utilities_NoSeWa  LotConfig_CulDSac  LotConfig_FR2  LotConfig_FR3  \
0                 0                  0              0              0
1                 0                  0              1              0
2                 0                  0              0              0
3                 0                  0              0              0
4                 0                  0              1              0

   LotConfig_Inside  LandSlope_Mod  LandSlope_Sev  Neighborhood_Blueste  \
0                 1              0              0                     0
1                 0              0              0                     0
2                 1              0              0                     0
3                 0              0              0                     0
4                 0              0              0                     0

   Neighborhood_BrDale  Neighborhood_BrkSide  Neighborhood_ClearCr  \
```

```
0                    0                     0                     0
1                    0                     0                     0
2                    0                     0                     0
3                    0                     0                     0
4                    0                     0                     0

   Neighborhood_CollgCr  Neighborhood_Crawfor  Neighborhood_Edwards  \
0                     1                     0                     0
1                     0                     0                     0
2                     1                     0                     0
3                     0                     1                     0
4                     0                     0                     0

   Neighborhood_Gilbert  Neighborhood_IDOTRR  Neighborhood_MeadowV  \
0                     0                    0                     0
1                     0                    0                     0
2                     0                    0                     0
3                     0                    0                     0
4                     0                    0                     0

   Neighborhood_Mitchel  Neighborhood_NAmes  Neighborhood_NPkVill  \
0                     0                   0                     0
1                     0                   0                     0
2                     0                   0                     0
3                     0                   0                     0
4                     0                   0                     0

   Neighborhood_NWAmes  Neighborhood_NoRidge  Neighborhood_NridgHt  \
0                    0                     0                     0
1                    0                     0                     0
2                    0                     0                     0
3                    0                     0                     0
4                    0                     1                     0

   Neighborhood_OldTown  Neighborhood_SWISU  Neighborhood_Sawyer  \
0                     0                   0                    0
1                     0                   0                    0
2                     0                   0                    0
3                     0                   0                    0
4                     0                   0                    0

   Neighborhood_SawyerW  Neighborhood_Somerst  Neighborhood_StoneBr  \
0                     0                     0                     0
1                     0                     0                     0
2                     0                     0                     0
3                     0                     0                     0
4                     0                     0                     0
```

```
   Neighborhood_Timber  Neighborhood_Veenker  Condition1_Feedr  \
0                    0                     0                 0
1                    0                     1                 1
2                    0                     0                 0
3                    0                     0                 0
4                    0                     0                 0

   Condition1_Norm  Condition1_PosA  Condition1_PosN  Condition1_RRAe  \
0                1                0                0                0
1                0                0                0                0
2                1                0                0                0
3                1                0                0                0
4                1                0                0                0

   Condition1_RRAn  Condition1_RRNe  Condition1_RRNn  Condition2_Feedr  \
0                0                0                0                 0
1                0                0                0                 0
2                0                0                0                 0
3                0                0                0                 0
4                0                0                0                 0

   Condition2_Norm  Condition2_PosA  Condition2_PosN  Condition2_RRAe  \
0                1                0                0                0
1                1                0                0                0
2                1                0                0                0
3                1                0                0                0
4                1                0                0                0

   Condition2_RRAn  Condition2_RRNn  BldgType_2fmCon  BldgType_Duplex  \
0                0                0                0                0
1                0                0                0                0
2                0                0                0                0
3                0                0                0                0
4                0                0                0                0

   BldgType_Twnhs  BldgType_TwnhsE  HouseStyle_1.5Unf  HouseStyle_1Story  \
0               0                0                  0                  0
1               0                0                  0                  1
2               0                0                  0                  0
3               0                0                  0                  0
4               0                0                  0                  0

   HouseStyle_2.5Fin  HouseStyle_2.5Unf  HouseStyle_2Story  HouseStyle_SFoyer  \
0                  0                  0                  1                  0
1                  0                  0                  0                  0
2                  0                  0                  1                  0
```

```
3                 0                  0                  1                    0
4                 0                  0                  1                    0

   HouseStyle_SLvl  OverallQual_2  OverallQual_3  OverallQual_4  \
0                0              0              0              0
1                0              0              0              0
2                0              0              0              0
3                0              0              0              0
4                0              0              0              0

   OverallQual_5  OverallQual_6  OverallQual_7  OverallQual_8  OverallQual_9  \
0              0              0              1              0              0
1              0              1              0              0              0
2              0              0              1              0              0
3              0              0              1              0              0
4              0              0              0              1              0

   OverallQual_10  OverallCond_2  OverallCond_3  OverallCond_4  OverallCond_5  \
0               0              0              0              0              1
1               0              0              0              0              0
2               0              0              0              0              1
3               0              0              0              0              1
4               0              0              0              0              1

   OverallCond_6  OverallCond_7  OverallCond_8  OverallCond_9  \
0              0              0              0              0
1              0              0              1              0
2              0              0              0              0
3              0              0              0              0
4              0              0              0              0

   RoofStyle_Gable  RoofStyle_Gambrel  RoofStyle_Hip  RoofStyle_Mansard  \
0                1                  0              0                  0
1                1                  0              0                  0
2                1                  0              0                  0
3                1                  0              0                  0
4                1                  0              0                  0

   RoofStyle_Shed  RoofMatl_CompShg  RoofMatl_Membran  RoofMatl_Metal  \
0               0                 1                 0               0
1               0                 1                 0               0
2               0                 1                 0               0
3               0                 1                 0               0
4               0                 1                 0               0

   RoofMatl_Roll  RoofMatl_Tar&Grv  RoofMatl_WdShake  RoofMatl_WdShngl  \
0              0                 0                 0                 0
```

```
1             0                 0                 0                 0
2             0                 0                 0                 0
3             0                 0                 0                 0
4             0                 0                 0                 0

   Exterior1st_AsphShn  Exterior1st_BrkComm  Exterior1st_BrkFace  \
0                    0                    0                    0
1                    0                    0                    0
2                    0                    0                    0
3                    0                    0                    0
4                    0                    0                    0

   Exterior1st_CBlock  Exterior1st_CemntBd  Exterior1st_HdBoard  \
0                   0                    0                    0
1                   0                    0                    0
2                   0                    0                    0
3                   0                    0                    0
4                   0                    0                    0

   Exterior1st_ImStucc  Exterior1st_MetalSd  Exterior1st_Plywood  \
0                    0                    0                    0
1                    0                    1                    0
2                    0                    0                    0
3                    0                    0                    0
4                    0                    0                    0

   Exterior1st_Stone  Exterior1st_Stucco  Exterior1st_VinylSd  \
0                  0                   0                    1
1                  0                   0                    0
2                  0                   0                    1
3                  0                   0                    0
4                  0                   0                    1

   Exterior1st_Wd Sdng  Exterior1st_WdShing  Exterior2nd_AsphShn  \
0                    0                    0                    0
1                    0                    0                    0
2                    0                    0                    0
3                    1                    0                    0
4                    0                    0                    0

   Exterior2nd_Brk Cmn  Exterior2nd_BrkFace  Exterior2nd_CBlock  \
0                    0                    0                   0
1                    0                    0                   0
2                    0                    0                   0
3                    0                    0                   0
4                    0                    0                   0
```

```
   Exterior2nd_CmentBd  Exterior2nd_HdBoard  Exterior2nd_ImStucc  \
0                    0                    0                    0
1                    0                    0                    0
2                    0                    0                    0
3                    0                    0                    0
4                    0                    0                    0

   Exterior2nd_MetalSd  Exterior2nd_Other  Exterior2nd_Plywood  \
0                    0                  0                    0
1                    1                  0                    0
2                    0                  0                    0
3                    0                  0                    0
4                    0                  0                    0

   Exterior2nd_Stone  Exterior2nd_Stucco  Exterior2nd_VinylSd  \
0                  0                   0                    1
1                  0                   0                    0
2                  0                   0                    1
3                  0                   0                    0
4                  0                   0                    1

   Exterior2nd_Wd Sdng  Exterior2nd_Wd Shng  MasVnrType_BrkFace  \
0                    0                    0                   1
1                    0                    0                   0
2                    0                    0                   1
3                    0                    1                   0
4                    0                    0                   1

   MasVnrType_None  MasVnrType_Stone  ExterQual_Fa  ExterQual_Gd  \
0                0                 0             0             1
1                1                 0             0             0
2                0                 0             0             1
3                1                 0             0             0
4                0                 0             0             1

   ExterQual_TA  ExterCond_Fa  ExterCond_Gd  ExterCond_Po  ExterCond_TA  \
0             0             0             0             0             1
1             1             0             0             0             1
2             0             0             0             0             1
3             1             0             0             0             1
4             0             0             0             0             1

   Foundation_CBlock  Foundation_PConc  Foundation_Slab  Foundation_Stone  \
0                  0                 1                0                 0
1                  1                 0                0                 0
2                  0                 1                0                 0
3                  0                 0                0                 0
```

```
4                 0                 1                 0                 0

   Foundation_Wood  BsmtQual_Fa  BsmtQual_Gd  BsmtQual_None  BsmtQual_TA  \
0                0            0            1              0            0
1                0            0            1              0            0
2                0            0            1              0            0
3                0            0            0              0            1
4                0            0            1              0            0

   BsmtCond_Gd  BsmtCond_None  BsmtCond_Po  BsmtCond_TA  BsmtExposure_Gd  \
0            0              0            0            1                0
1            0              0            0            1                1
2            0              0            0            1                0
3            1              0            0            0                0
4            0              0            0            1                0

   BsmtExposure_Mn  BsmtExposure_No  BsmtExposure_None  BsmtFinType1_BLQ  \
0                0                1                  0                 0
1                0                0                  0                 0
2                1                0                  0                 0
3                0                1                  0                 0
4                0                0                  0                 0

   BsmtFinType1_GLQ  BsmtFinType1_LwQ  BsmtFinType1_None  BsmtFinType1_Rec  \
0                 1                 0                  0                 0
1                 0                 0                  0                 0
2                 1                 0                  0                 0
3                 0                 0                  0                 0
4                 1                 0                  0                 0

   BsmtFinType1_Unf  BsmtFinType2_BLQ  BsmtFinType2_GLQ  BsmtFinType2_LwQ  \
0                 0                 0                 0                 0
1                 0                 0                 0                 0
2                 0                 0                 0                 0
3                 0                 0                 0                 0
4                 0                 0                 0                 0

   BsmtFinType2_None  BsmtFinType2_Rec  BsmtFinType2_Unf  Heating_GasA  \
0                  0                 0                 1             1
1                  0                 0                 1             1
2                  0                 0                 1             1
3                  0                 0                 1             1
4                  0                 0                 1             1

   Heating_GasW  Heating_Grav  Heating_OthW  Heating_Wall  HeatingQC_Fa  \
0             0             0             0             0             0
1             0             0             0             0             0
```

```
2            0            0            0            0            0
3            0            0            0            0            0
4            0            0            0            0            0

   HeatingQC_Gd  HeatingQC_Po  HeatingQC_TA  CentralAir_Y  Electrical_FuseF  \
0             0             0             0             1                 0
1             0             0             0             1                 0
2             0             0             0             1                 0
3             1             0             0             1                 0
4             0             0             0             1                 0

   Electrical_FuseP  Electrical_Mix  Electrical_None  Electrical_SBrkr  \
0                 0               0                0                 1
1                 0               0                0                 1
2                 0               0                0                 1
3                 0               0                0                 1
4                 0               0                0                 1

   KitchenQual_Fa  KitchenQual_Gd  KitchenQual_TA  Functional_Maj2  \
0               0               1               0                0
1               0               0               1                0
2               0               1               0                0
3               0               1               0                0
4               0               1               0                0

   Functional_Min1  Functional_Min2  Functional_Mod  Functional_Sev  \
0                0                0               0               0
1                0                0               0               0
2                0                0               0               0
3                0                0               0               0
4                0                0               0               0

   Functional_Typ  FireplaceQu_Fa  FireplaceQu_Gd  FireplaceQu_None  \
0               1               0               0                 1
1               1               0               0                 0
2               1               0               0                 0
3               1               0               1                 0
4               1               0               0                 0

   FireplaceQu_Po  FireplaceQu_TA  GarageType_Attchd  GarageType_Basment  \
0               0               0                  1                   0
1               0               1                  1                   0
2               0               1                  1                   0
3               0               0                  0                   0
4               0               1                  1                   0

   GarageType_BuiltIn  GarageType_CarPort  GarageType_Detchd  GarageType_None  \
```

```
0                    0                    0                   0                 0
1                    0                    0                   0                 0
2                    0                    0                   0                 0
3                    0                    0                   1                 0
4                    0                    0                   0                 0

   GarageFinish_None  GarageFinish_RFn  GarageFinish_Unf  GarageQual_Fa  \
0                  0                 1                 0              0
1                  0                 1                 0              0
2                  0                 1                 0              0
3                  0                 0                 1              0
4                  0                 1                 0              0

   GarageQual_Gd  GarageQual_None  GarageQual_Po  GarageQual_TA  \
0              0                0              0              1
1              0                0              0              1
2              0                0              0              1
3              0                0              0              1
4              0                0              0              1

   GarageCond_Fa  GarageCond_Gd  GarageCond_None  GarageCond_Po  \
0              0              0                0              0
1              0              0                0              0
2              0              0                0              0
3              0              0                0              0
4              0              0                0              0

   GarageCond_TA  PavedDrive_P  PavedDrive_Y  PoolQC_Fa  PoolQC_Gd  \
0              1             0             1          0          0
1              1             0             1          0          0
2              1             0             1          0          0
3              1             0             1          0          0
4              1             0             1          0          0

   PoolQC_None  Fence_GdWo  Fence_MnPrv  Fence_MnWw  Fence_None  \
0            1           0            0           0           1
1            1           0            0           0           1
2            1           0            0           0           1
3            1           0            0           0           1
4            1           0            0           0           1

   MiscFeature_None  MiscFeature_Othr  MiscFeature_Shed  MiscFeature_TenC  \
0                 1                 0                 0                 0
1                 1                 0                 0                 0
2                 1                 0                 0                 0
3                 1                 0                 0                 0
4                 1                 0                 0                 0
```

```
   SaleType_CWD  SaleType_Con  SaleType_ConLD  SaleType_ConLI  SaleType_ConLw  \
0             0             0               0               0               0
1             0             0               0               0               0
2             0             0               0               0               0
3             0             0               0               0               0
4             0             0               0               0               0

   SaleType_New  SaleType_Oth  SaleType_WD  SaleCondition_AdjLand  \
0             0             0            1                      0
1             0             0            1                      0
2             0             0            1                      0
3             0             0            1                      0
4             0             0            1                      0

   SaleCondition_Alloca  SaleCondition_Family  SaleCondition_Normal  \
0                     0                     0                     1
1                     0                     0                     1
2                     0                     0                     1
3                     0                     0                     0
4                     0                     0                     1

   SaleCondition_Partial
0                      0
1                      0
2                      0
3                      0
4                      0
```

[ ]:

```

```

Data Split

[45]:

```python
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
```

[46]:

```python
X_train ,X_test, y_train, y_test = train_test_split(x,y,test_size = 0.33,␣
↪random_state=42)
```

[47]:

```python
num_cols = list(X_train.select_dtypes(include=['int64', 'float64']).columns)
```

[48]:

```python
num_cols
```

[48]:

```
['LotFrontage',
 'LotArea',
 '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',
'Age',
'MSSubClass_30',
'MSSubClass_40',
'MSSubClass_45',
'MSSubClass_50',
'MSSubClass_60',
'MSSubClass_70',
'MSSubClass_75',
'MSSubClass_80',
'MSSubClass_85',
'MSSubClass_90',
'MSSubClass_120',
'MSSubClass_160',
'MSSubClass_180',
'MSSubClass_190',
'MSZoning_FV',
'MSZoning_RH',
'MSZoning_RL',
'MSZoning_RM',
'Street_Pave',
```

```
'Alley_None',
'Alley_Pave',
'LotShape_IR2',
'LotShape_IR3',
'LotShape_Reg',
'LandContour_HLS',
'LandContour_Low',
'LandContour_Lvl',
'Utilities_NoSeWa',
'LotConfig_CulDSac',
'LotConfig_FR2',
'LotConfig_FR3',
'LotConfig_Inside',
'LandSlope_Mod',
'LandSlope_Sev',
'Neighborhood_Blueste',
'Neighborhood_BrDale',
'Neighborhood_BrkSide',
'Neighborhood_ClearCr',
'Neighborhood_CollgCr',
'Neighborhood_Crawfor',
'Neighborhood_Edwards',
'Neighborhood_Gilbert',
'Neighborhood_IDOTRR',
'Neighborhood_MeadowV',
'Neighborhood_Mitchel',
'Neighborhood_NAmes',
'Neighborhood_NPkVill',
'Neighborhood_NWAmes',
'Neighborhood_NoRidge',
'Neighborhood_NridgHt',
'Neighborhood_OldTown',
'Neighborhood_SWISU',
'Neighborhood_Sawyer',
'Neighborhood_SawyerW',
'Neighborhood_Somerst',
'Neighborhood_StoneBr',
'Neighborhood_Timber',
'Neighborhood_Veenker',
'Condition1_Feedr',
'Condition1_Norm',
'Condition1_PosA',
'Condition1_PosN',
'Condition1_RRAe',
'Condition1_RRAn',
'Condition1_RRNe',
'Condition1_RRNn',
```

```
'Condition2_Feedr',
'Condition2_Norm',
'Condition2_PosA',
'Condition2_PosN',
'Condition2_RRAe',
'Condition2_RRAn',
'Condition2_RRNn',
'BldgType_2fmCon',
'BldgType_Duplex',
'BldgType_Twnhs',
'BldgType_TwnhsE',
'HouseStyle_1.5Unf',
'HouseStyle_1Story',
'HouseStyle_2.5Fin',
'HouseStyle_2.5Unf',
'HouseStyle_2Story',
'HouseStyle_SFoyer',
'HouseStyle_SLvl',
'OverallQual_2',
'OverallQual_3',
'OverallQual_4',
'OverallQual_5',
'OverallQual_6',
'OverallQual_7',
'OverallQual_8',
'OverallQual_9',
'OverallQual_10',
'OverallCond_2',
'OverallCond_3',
'OverallCond_4',
'OverallCond_5',
'OverallCond_6',
'OverallCond_7',
'OverallCond_8',
'OverallCond_9',
'RoofStyle_Gable',
'RoofStyle_Gambrel',
'RoofStyle_Hip',
'RoofStyle_Mansard',
'RoofStyle_Shed',
'RoofMatl_CompShg',
'RoofMatl_Membran',
'RoofMatl_Metal',
'RoofMatl_Roll',
'RoofMatl_Tar&Grv',
'RoofMatl_WdShake',
'RoofMatl_WdShngl',
```

```
'Exterior1st_AsphShn',
'Exterior1st_BrkComm',
'Exterior1st_BrkFace',
'Exterior1st_CBlock',
'Exterior1st_CemntBd',
'Exterior1st_HdBoard',
'Exterior1st_ImStucc',
'Exterior1st_MetalSd',
'Exterior1st_Plywood',
'Exterior1st_Stone',
'Exterior1st_Stucco',
'Exterior1st_VinylSd',
'Exterior1st_Wd Sdng',
'Exterior1st_WdShing',
'Exterior2nd_AsphShn',
'Exterior2nd_Brk Cmn',
'Exterior2nd_BrkFace',
'Exterior2nd_CBlock',
'Exterior2nd_CmentBd',
'Exterior2nd_HdBoard',
'Exterior2nd_ImStucc',
'Exterior2nd_MetalSd',
'Exterior2nd_Other',
'Exterior2nd_Plywood',
'Exterior2nd_Stone',
'Exterior2nd_Stucco',
'Exterior2nd_VinylSd',
'Exterior2nd_Wd Sdng',
'Exterior2nd_Wd Shng',
'MasVnrType_BrkFace',
'MasVnrType_None',
'MasVnrType_Stone',
'ExterQual_Fa',
'ExterQual_Gd',
'ExterQual_TA',
'ExterCond_Fa',
'ExterCond_Gd',
'ExterCond_Po',
'ExterCond_TA',
'Foundation_CBlock',
'Foundation_PConc',
'Foundation_Slab',
'Foundation_Stone',
'Foundation_Wood',
'BsmtQual_Fa',
'BsmtQual_Gd',
'BsmtQual_None',
```

```
'BsmtQual_TA',
'BsmtCond_Gd',
'BsmtCond_None',
'BsmtCond_Po',
'BsmtCond_TA',
'BsmtExposure_Gd',
'BsmtExposure_Mn',
'BsmtExposure_No',
'BsmtExposure_None',
'BsmtFinType1_BLQ',
'BsmtFinType1_GLQ',
'BsmtFinType1_LwQ',
'BsmtFinType1_None',
'BsmtFinType1_Rec',
'BsmtFinType1_Unf',
'BsmtFinType2_BLQ',
'BsmtFinType2_GLQ',
'BsmtFinType2_LwQ',
'BsmtFinType2_None',
'BsmtFinType2_Rec',
'BsmtFinType2_Unf',
'Heating_GasA',
'Heating_GasW',
'Heating_Grav',
'Heating_OthW',
'Heating_Wall',
'HeatingQC_Fa',
'HeatingQC_Gd',
'HeatingQC_Po',
'HeatingQC_TA',
'CentralAir_Y',
'Electrical_FuseF',
'Electrical_FuseP',
'Electrical_Mix',
'Electrical_None',
'Electrical_SBrkr',
'KitchenQual_Fa',
'KitchenQual_Gd',
'KitchenQual_TA',
'Functional_Maj2',
'Functional_Min1',
'Functional_Min2',
'Functional_Mod',
'Functional_Sev',
'Functional_Typ',
'FireplaceQu_Fa',
'FireplaceQu_Gd',
```

```
'FireplaceQu_None',
'FireplaceQu_Po',
'FireplaceQu_TA',
'GarageType_Attchd',
'GarageType_Basment',
'GarageType_BuiltIn',
'GarageType_CarPort',
'GarageType_Detchd',
'GarageType_None',
'GarageFinish_None',
'GarageFinish_RFn',
'GarageFinish_Unf',
'GarageQual_Fa',
'GarageQual_Gd',
'GarageQual_None',
'GarageQual_Po',
'GarageQual_TA',
'GarageCond_Fa',
'GarageCond_Gd',
'GarageCond_None',
'GarageCond_Po',
'GarageCond_TA',
'PavedDrive_P',
'PavedDrive_Y',
'PoolQC_Fa',
'PoolQC_Gd',
'PoolQC_None',
'Fence_GdWo',
'Fence_MnPrv',
'Fence_MnWw',
'Fence_None',
'MiscFeature_None',
'MiscFeature_Othr',
'MiscFeature_Shed',
'MiscFeature_TenC',
'SaleType_CWD',
'SaleType_Con',
'SaleType_ConLD',
'SaleType_ConLI',
'SaleType_ConLw',
'SaleType_New',
'SaleType_Oth',
'SaleType_WD',
'SaleCondition_AdjLand',
'SaleCondition_Alloca',
'SaleCondition_Family',
'SaleCondition_Normal',
```

'SaleCondition_Partial']

[ ]:

[49]:
```
scaler = StandardScaler()
X_train[num_cols] = scaler.fit_transform(X_train[num_cols])
X_test[num_cols] = scaler.fit_transform(X_test[num_cols])
```

[50]:
```
def eval_metrics(y_train, y_train_pred, y_test, y_test_pred):

    # r2 values for train and test
    print('r2 score (train) - ', '%.2f' % r2_score(y_train,y_train_pred))
    print('r2 score (test) - ', '%.2f' % r2_score(y_test,y_test_pred))

    ## RMSE for train and test data
    mse_train = mean_squared_error(y_train,y_train_pred)
    mse_test = mean_squared_error(y_test,y_test_pred)
    rmse_train = mse_train**0.5
    rmse_test = mse_test**0.5

    print("RMSE(TRAIN) - ", '%.2f' % rmse_train)
    print("RMSE(TEST) - ", '%.2f' % rmse_test)
```

5.5 ML MODEL

[51]:
```
import sklearn
from sklearn.feature_selection import RFE
from sklearn.linear_model import LinearRegression
from sklearn.metrics import r2_score, mean_squared_error
from sklearn.linear_model import Ridge, Lasso
from sklearn.model_selection import GridSearchCV
```

[52]:
```
from sklearn.linear_model import Ridge
from sklearn.model_selection import GridSearchCV

params = {'alpha':
          [0.0001, 0.001, 0.01, 0.05, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.
 ↪9, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 25, 50, 75, 100, 250, 500, 750, 1000]
         }

ridge = Ridge()
ridgeCV = GridSearchCV(estimator=ridge, param_grid=params,␣
 ↪scoring='neg_mean_absolute_error', cv=5, return_train_score=True, verbose=1,␣
 ↪n_jobs=1)
ridgeCV.fit(X_train, y_train)
```

```
Fitting 5 folds for each of 32 candidates, totalling 160 fits
```

[52]: GridSearchCV(cv=5, estimator=Ridge(), n_jobs=1,
             param_grid={'alpha': [0.0001, 0.001, 0.01, 0.05, 0.1, 0.2, 0.3,
                                   0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1, 2, 3, 4, 5,
                                   6, 7, 8, 9, 10, 20, 25, 50, 75, 100, 250,
                                   500, …]},
             return_train_score=True, scoring='neg_mean_absolute_error',
             verbose=1)

[ ]:

[53]:
```
ridgeCV.best_params_
```

[53]: {'alpha': 250}

[ ]:

[54]:
```
ridgeCV.cv_results_
```

[54]:
```
{'mean_fit_time': array([0.0879035 , 0.08687029, 0.07577825, 0.0755312 ,
0.07479348,
        0.07905078, 0.08429389, 0.08706932, 0.08368921, 0.08998322,
        0.07541676, 0.08752074, 0.08594232, 0.08607178, 0.08531208,
        0.0811583 , 0.06979175, 0.07075171, 0.07719626, 0.08130217,
        0.07936773, 0.06606183, 0.08393402, 0.05928211, 0.06819053,
        0.0789144 , 0.06750736, 0.08448939, 0.08441358, 0.08480988,
        0.08471651, 0.08316207]),
 'std_fit_time': array([0.04597761, 0.01236269, 0.00977123, 0.03088432,
0.01295795,
        0.00880811, 0.00137102, 0.0021064 , 0.00235141, 0.01406186,
        0.01399517, 0.00514582, 0.0018703 , 0.00281302, 0.00130704,
        0.01623709, 0.01463442, 0.01444202, 0.01270581, 0.00381954,
        0.01332118, 0.02274605, 0.01595511, 0.02505871, 0.01572118,
        0.01566747, 0.006522  , 0.01161833, 0.00090567, 0.00057201,
        0.00065993, 0.00379906]),
 'mean_score_time': array([0.05911541, 0.08071237, 0.05309186, 0.02615752,
0.04332337,
        0.06106305, 0.04901495, 0.04834385, 0.04917574, 0.04904785,
        0.05622959, 0.04826484, 0.04835591, 0.04808297, 0.04816327,
        0.03980894, 0.02977624, 0.03468914, 0.03964577, 0.0496047 ,
        0.10831199, 0.03609529, 0.05374885, 0.06438694, 0.02742629,
        0.04867282, 0.05029893, 0.04822898, 0.04802637, 0.04747496,
        0.04781432, 0.04311996]),
 'std_score_time': array([2.40487824e-02, 1.79224577e-02, 9.59164610e-03,
2.02028572e-04,
        1.13811726e-02, 2.21855676e-02, 2.96565749e-04, 2.06031095e-03,
        2.99653098e-04, 3.53858622e-04, 9.86223932e-03, 2.62163864e-04,
        3.51321716e-04, 1.44432204e-04, 1.41744335e-04, 1.26344061e-02,
```

```
       1.03717908e-02, 1.21697034e-02, 1.24327482e-02, 1.83345650e-03,
       1.24486535e-01, 1.34331295e-02, 1.21108773e-02, 1.01273043e-02,
       7.51217231e-04, 1.73447043e-02, 8.72465619e-03, 6.28183678e-03,
       4.29587288e-04, 9.51426480e-05, 4.47419876e-04, 9.14309221e-03]),
 'param_alpha': masked_array(data=[0.0001, 0.001, 0.01, 0.05, 0.1, 0.2, 0.3,
0.4, 0.5,
                   0.6, 0.7, 0.8, 0.9, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20,
                   25, 50, 75, 100, 250, 500, 750, 1000],
             mask=[False, False, False, False, False, False, False, False,
                   False, False, False, False, False, False, False, False,
                   False, False, False, False, False, False, False, False,
                   False, False, False, False, False, False, False, False],
       fill_value='?',
            dtype=object),
 'params': [{'alpha': 0.0001},
  {'alpha': 0.001},
  {'alpha': 0.01},
  {'alpha': 0.05},
  {'alpha': 0.1},
  {'alpha': 0.2},
  {'alpha': 0.3},
  {'alpha': 0.4},
  {'alpha': 0.5},
  {'alpha': 0.6},
  {'alpha': 0.7},
  {'alpha': 0.8},
  {'alpha': 0.9},
  {'alpha': 1},
  {'alpha': 2},
  {'alpha': 3},
  {'alpha': 4},
  {'alpha': 5},
  {'alpha': 6},
  {'alpha': 7},
  {'alpha': 8},
  {'alpha': 9},
  {'alpha': 10},
  {'alpha': 20},
  {'alpha': 25},
  {'alpha': 50},
  {'alpha': 75},
  {'alpha': 100},
  {'alpha': 250},
  {'alpha': 500},
  {'alpha': 750},
  {'alpha': 1000}],
 'split0_test_score': array([-0.1081354 , -0.10813011, -0.10807762, -0.10785282,
```

```
-0.10759944,
        -0.10714982, -0.10675376, -0.10639564, -0.1060812 , -0.10579298,
        -0.10552539, -0.10527524, -0.10503998, -0.10481904, -0.10347827,
        -0.1026274 , -0.10199151, -0.10146577, -0.1010282 , -0.10064712,
        -0.10032384, -0.10002332, -0.09974587, -0.09785385, -0.09719699,
        -0.09517043, -0.09402131, -0.0933147 , -0.09222951, -0.09415239,
        -0.09694953, -0.09975034]),
 'split1_test_score': array([-0.11704567, -0.11704724, -0.11706208, -0.11711289,
-0.11724618,
        -0.11755135, -0.11771725, -0.1177954 , -0.11782005, -0.11780789,
        -0.11776994, -0.11771376, -0.11764443, -0.11757196, -0.11667041,
        -0.11573994, -0.11492204, -0.11424224, -0.11365868, -0.11312632,
        -0.11265518, -0.11223772, -0.11184761, -0.1090066 , -0.10801746,
        -0.10502548, -0.10362202, -0.10264378, -0.10026259, -0.1002254 ,
        -0.10135933, -0.10325652]),
 'split2_test_score': array([-0.11390045, -0.11386392, -0.11351017, -0.11215609,
-0.11084421,
        -0.10902431, -0.10816938, -0.10755279, -0.10707397, -0.10668746,
        -0.10638972, -0.1062716 , -0.1062677 , -0.1062628 , -0.10642655,
        -0.1063922 , -0.10635415, -0.10627525, -0.10618395, -0.10613879,
        -0.10609011, -0.10603696, -0.10598997, -0.10543159, -0.10512938,
        -0.10377669, -0.10269111, -0.10184112, -0.09981971, -0.10151928,
        -0.10543341, -0.10951323]),
 'split3_test_score': array([-0.10861138, -0.1086083 , -0.10857759, -0.10844477,
-0.10830694,
        -0.10817885, -0.10807806, -0.10796697, -0.10785795, -0.10774713,
        -0.10763376, -0.10751916, -0.10740416, -0.1072906 , -0.1064039 ,
        -0.10577784, -0.10523837, -0.10477929, -0.10439956, -0.10403452,
        -0.10368141, -0.10333582, -0.10299788, -0.10022146, -0.09911211,
        -0.09514967, -0.09293295, -0.09187003, -0.0903111 , -0.09215608,
        -0.09489088, -0.09739477]),
 'split4_test_score': array([-0.10267967, -0.10265759, -0.10244313, -0.1016464 ,
-0.10093655,
        -0.09989797, -0.09926722, -0.09882811, -0.09847062, -0.09819932,
        -0.09808736, -0.0979827 , -0.09788393, -0.09779004, -0.09731596,
        -0.09709478, -0.09688106, -0.09688386, -0.09684008, -0.0968561 ,
        -0.09687889, -0.09690954, -0.09692111, -0.0964555 , -0.09605839,
        -0.09448759, -0.09344609, -0.09247928, -0.09187593, -0.09360063,
        -0.09594534, -0.09823913]),
 'mean_test_score': array([-0.11007452, -0.11006143, -0.10993412, -0.10944259,
-0.10898667,
        -0.10836046, -0.10799714, -0.10770778, -0.10746076, -0.10724695,
        -0.10708123, -0.10695249, -0.10684804, -0.10674689, -0.10605902,
        -0.10552643, -0.10507743, -0.10472928, -0.10442209, -0.10416057,
        -0.10392589, -0.10370867, -0.10350049, -0.1017938 , -0.10110287,
        -0.09872197, -0.0973427 , -0.09642978, -0.09489977, -0.09633076,
        -0.0989157 , -0.1016308 ]),
```

```
 'std_test_score': array([0.00497633, 0.00497833, 0.00499995, 0.00510882,
0.00526993,
        0.00562184, 0.00586983, 0.00604023, 0.00617006, 0.00626211,
        0.00629829, 0.00632234, 0.00633771, 0.00635065, 0.0062603 ,
        0.00607661, 0.00592074, 0.00574613, 0.00561114, 0.00547747,
        0.00535871, 0.00525575, 0.0051674 , 0.0047276 , 0.0046624 ,
        0.00466024, 0.00476857, 0.00477489, 0.0042496 , 0.00378724,
        0.00393293, 0.00442175]),
 'rank_test_score': array([32, 31, 30, 29, 28, 27, 26, 25, 24, 23, 22, 21, 20,
19, 18, 17, 16,
        15, 14, 13, 12, 11, 10,  9,  7,  5,  4,  3,  1,  2,  6,  8],
       dtype=int32),
 'split0_train_score': array([-0.05604602, -0.05604613, -0.05604717,
-0.05605173, -0.05605829,
        -0.05607769, -0.05610337, -0.05612871, -0.05615379, -0.05617924,
        -0.05620651, -0.05623713, -0.05626753, -0.05629891, -0.05664859,
        -0.0570584 , -0.05743644, -0.05778317, -0.05811974, -0.05845079,
        -0.05877077, -0.05906244, -0.05932946, -0.06133342, -0.06208223,
        -0.06437915, -0.06584234, -0.06693408, -0.07173764, -0.07772336,
        -0.08265918, -0.08704335]),
 'split1_train_score': array([-0.05522149, -0.05522186, -0.05522615,
-0.05526979, -0.05533319,
        -0.05546905, -0.05558386, -0.05567685, -0.0557617 , -0.05583425,
        -0.05589549, -0.05595241, -0.05600973, -0.05606171, -0.05638922,
        -0.0565843 , -0.05674309, -0.05686728, -0.05697163, -0.0570632 ,
        -0.05714758, -0.05722493, -0.05730281, -0.05791191, -0.05814577,
        -0.05919188, -0.06019735, -0.06116395, -0.06620689, -0.07285971,
        -0.07840056, -0.08300725]),
 'split2_train_score': array([-0.05288177, -0.05288334, -0.05289869,
-0.05297275, -0.05305482,
        -0.05323843, -0.05341845, -0.05357001, -0.05370126, -0.05382171,
        -0.05393063, -0.05402774, -0.05411551, -0.05419607, -0.05485804,
        -0.05536962, -0.05581957, -0.05624029, -0.05664021, -0.05699387,
        -0.057309  , -0.05759683, -0.05786219, -0.05982506, -0.06049684,
        -0.06285908, -0.06442276, -0.06561875, -0.07055981, -0.0767388 ,
        -0.08192475, -0.08644165]),
 'split3_train_score': array([-0.05698323, -0.05698494, -0.0570026 ,
-0.05708592, -0.05718162,
        -0.05739032, -0.05755677, -0.05769975, -0.05782252, -0.05792931,
        -0.05802561, -0.05811086, -0.05818776, -0.05825859, -0.05880115,
        -0.05921657, -0.05962349, -0.05998159, -0.06030275, -0.06059372,
        -0.06087841, -0.06114802, -0.06139866, -0.06333139, -0.06401018,
        -0.06610777, -0.06747705, -0.0685724 , -0.07373494, -0.08004127,
        -0.08517634, -0.08953242]),
 'split4_train_score': array([-0.05856724, -0.05857043, -0.05860275,
-0.05873269, -0.05886917,
        -0.05909703, -0.05926421, -0.05940031, -0.05951565, -0.05961009,
```

```
         -0.05969648, -0.05977023, -0.05983365, -0.05989034, -0.06022812,
         -0.06044907, -0.06063053, -0.06078009, -0.06091134, -0.06103048,
         -0.06113999, -0.06124085, -0.06133682, -0.06208958, -0.06238183,
         -0.06355209, -0.0645493 , -0.06549444, -0.07060602, -0.07766581,
         -0.08325636, -0.08801752]),
 'mean_train_score': array([-0.05593995, -0.05594134, -0.05595547, -0.05602258,
-0.05609942,
         -0.0562545 , -0.05638533, -0.05649512, -0.05659099, -0.05667492,
         -0.05675095, -0.05681967, -0.05688284, -0.05694112, -0.05738502,
         -0.05773559, -0.05805062, -0.05833048, -0.05858913, -0.05882641,
         -0.05904915, -0.05925461, -0.05944599, -0.06089827, -0.06142337,
         -0.063218  , -0.06449776, -0.06555672, -0.07056906, -0.07700579,
         -0.08228344, -0.08680844]),
 'std_train_score': array([0.00189055, 0.00189109, 0.00189678, 0.00191543,
0.00193396,
         0.00195525, 0.0019588 , 0.00196221, 0.00196467, 0.00196377,
         0.00196384, 0.00196262, 0.00196006, 0.00195728, 0.0018978 ,
         0.00184055, 0.00179968, 0.00176273, 0.00172998, 0.00170819,
         0.00169938, 0.00169912, 0.00170314, 0.0018761 , 0.00198219,
         0.00228688, 0.00241602, 0.00246153, 0.00246651, 0.00234205,
         0.0022209 , 0.0021689 ])}
```

[ ]:

```
[55]: y_train_pred = ridgeCV.predict(X_train)
      y_test_pred = ridgeCV.predict(X_test)
```

```
[56]: eval_metrics(y_train, y_train_pred, y_test, y_test_pred)
```

```
r2 score (train) -  0.93
r2 score (test) -  0.88
RMSE(TRAIN) -  0.10
RMSE(TEST) -  0.14
```

[ ]:

```
[57]: ridgeCV_res = pd.DataFrame(ridgeCV.cv_results_)
      ridgeCV_res.head()
```

[57]:

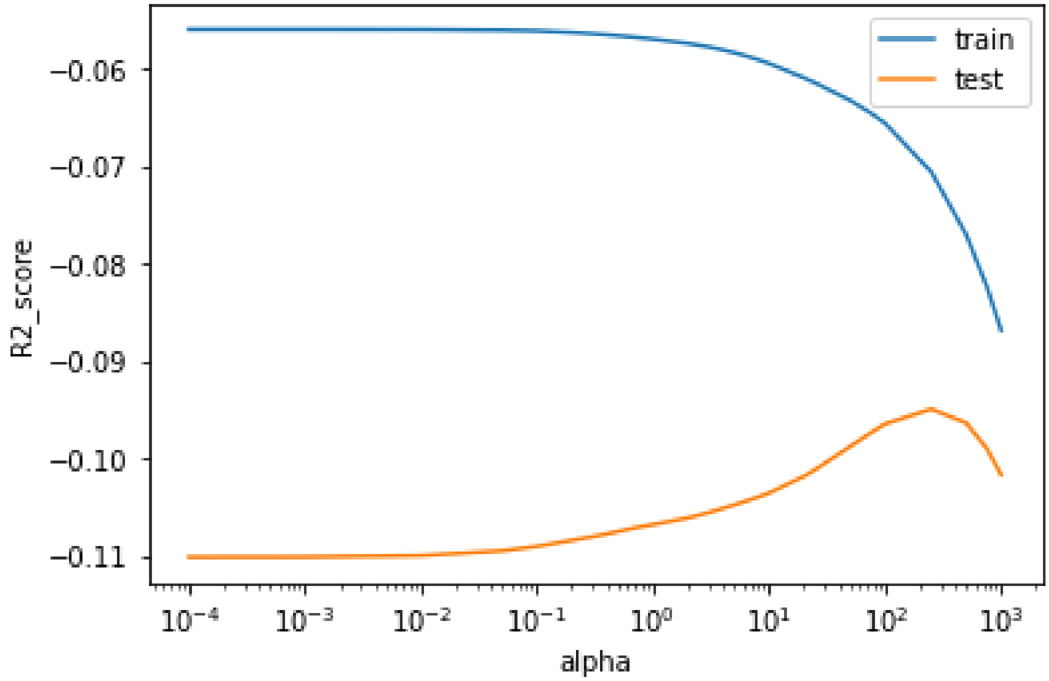
```
   mean_fit_time  std_fit_time  mean_score_time  std_score_time param_alpha  \
0       0.087903      0.045978         0.059115        0.024049      0.0001
1       0.086870      0.012363         0.080712        0.017922       0.001
2       0.075778      0.009771         0.053092        0.009592        0.01
3       0.075531      0.030884         0.026158        0.000202        0.05
4       0.074793      0.012958         0.043323        0.011381         0.1

             params  split0_test_score  split1_test_score  split2_test_score  \
```

```
0  {'alpha': 0.0001}          -0.108135          -0.117046          -0.113900
1   {'alpha': 0.001}          -0.108130          -0.117047          -0.113864
2    {'alpha': 0.01}          -0.108078          -0.117062          -0.113510
3    {'alpha': 0.05}          -0.107853          -0.117113          -0.112156
4     {'alpha': 0.1}          -0.107599          -0.117246          -0.110844

   split3_test_score  split4_test_score  mean_test_score  std_test_score  \
0          -0.108611          -0.102680        -0.110075        0.004976
1          -0.108608          -0.102658        -0.110061        0.004978
2          -0.108578          -0.102443        -0.109934        0.005000
3          -0.108445          -0.101646        -0.109443        0.005109
4          -0.108307          -0.100937        -0.108987        0.005270

   rank_test_score  split0_train_score  split1_train_score  \
0               32           -0.056046           -0.055221
1               31           -0.056046           -0.055222
2               30           -0.056047           -0.055226
3               29           -0.056052           -0.055270
4               28           -0.056058           -0.055333

   split2_train_score  split3_train_score  split4_train_score  \
0           -0.052882           -0.056983           -0.058567
1           -0.052883           -0.056985           -0.058570
2           -0.052899           -0.057003           -0.058603
3           -0.052973           -0.057086           -0.058733
4           -0.053055           -0.057182           -0.058869

   mean_train_score  std_train_score
0         -0.055940         0.001891
1         -0.055941         0.001891
2         -0.055955         0.001897
3         -0.056023         0.001915
4         -0.056099         0.001934
```

[ ]:

[58]:

```
plt.plot(ridgeCV_res['param_alpha'], ridgeCV_res['mean_train_score'],␣
 ↪label='train')
plt.plot(ridgeCV_res['param_alpha'], ridgeCV_res['mean_test_score'],␣
 ↪label='test')
plt.xlabel('alpha')
plt.ylabel('R2_score')
plt.xscale('log')
plt.legend()
plt.show()
```



[ ]:

```

```

[59]:

```
params = {'alpha':
          [0.0001, 0.001, 0.01, 0.05, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.
 ↪9, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 25, 50, 75, 100, 250, 500, 750, 1000]
         }

lasso = Lasso()
lassoCV = GridSearchCV(estimator=ridge, param_grid=params,␣
 ↪scoring='neg_mean_absolute_error', cv=5, return_train_score=True, verbose=1,␣
 ↪n_jobs=1)
lassoCV.fit(X_train, y_train)
print(lassoCV.best_params_)
print(lassoCV.cv_results_)
y_train_pred = lassoCV.predict(X_train)
y_test_pred = lassoCV.predict(X_test)
eval_metrics(y_train, y_train_pred, y_test, y_test_pred)
lassoCV_res = pd.DataFrame(lassoCV.cv_results_)
lassoCV_res.head()

plt.plot(lassoCV_res['param_alpha'], lassoCV_res['mean_train_score'],␣
 ↪label='train')
plt.plot(lassoCV_res['param_alpha'], lassoCV_res['mean_test_score'],␣
 ↪label='test')
```

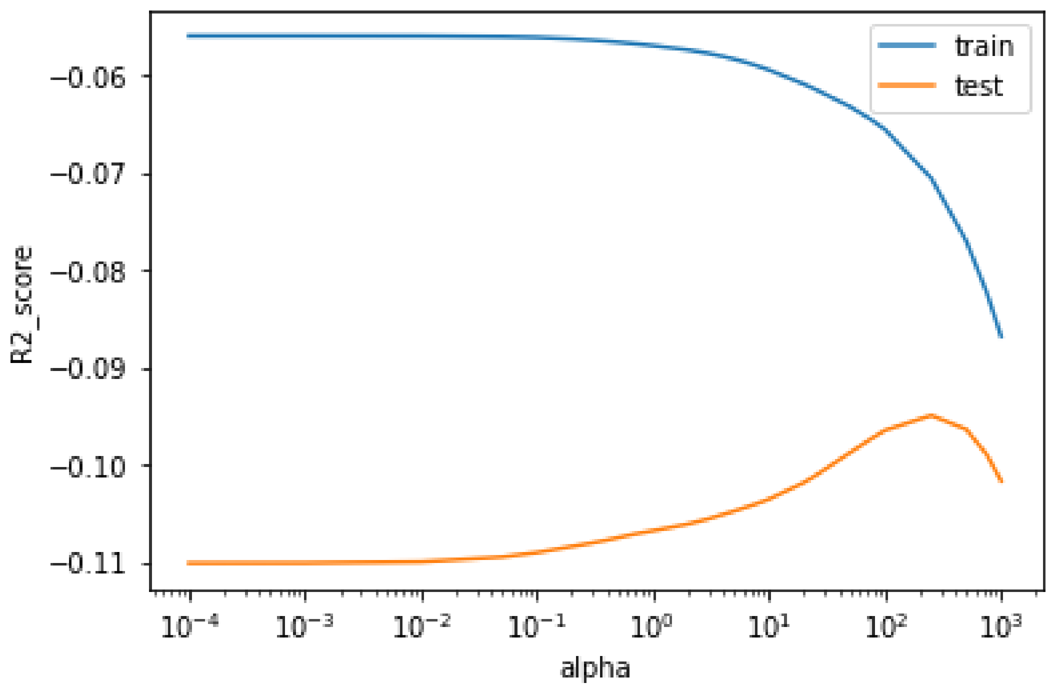
```python
plt.xlabel('alpha')
plt.ylabel('R2_score')
plt.xscale('log')
plt.legend()
plt.show()
```

```
Fitting 5 folds for each of 32 candidates, totalling 160 fits
{'alpha': 250}
{'mean_fit_time': array([0.06341128, 0.10694299, 0.08937616, 0.08766303,
0.08087215,
       0.08404932, 0.08354592, 0.08176651, 0.0669498 , 0.0771409 ,
       0.08318243, 0.08238325, 0.08292017, 0.07448511, 0.07552218,
       0.07084818, 0.07545304, 0.07516799, 0.07604194, 0.07370491,
       0.09406791, 0.07701616, 0.07123981, 0.06858101, 0.07801065,
       0.06911736, 0.06985073, 0.07475553, 0.07713628, 0.07191062,
       0.07209482, 0.07375689]), 'std_fit_time': array([0.0323913 , 0.05701231,
0.03335138, 0.02754676, 0.01078034,
       0.00086963, 0.00091308, 0.00173074, 0.01307185, 0.01816136,
       0.00117132, 0.00105149, 0.005543  , 0.01673155, 0.0113798 ,
       0.01948068, 0.01387246, 0.01211616, 0.01070922, 0.01240012,
       0.05722614, 0.01093784, 0.01907057, 0.01115639, 0.01614332,
       0.01528456, 0.0103198 , 0.01516204, 0.01901171, 0.01468172,
       0.01243274, 0.01211215]), 'mean_score_time': array([0.063972  ,
0.03923173, 0.04407496, 0.0434824 , 0.04918513,
       0.04918065, 0.04905467, 0.04922709, 0.03544593, 0.03571119,
       0.04952359, 0.04934635, 0.05133176, 0.04097962, 0.04026122,
       0.03578176, 0.04128637, 0.03998618, 0.04616222, 0.04819326,
       0.0333878 , 0.05015965, 0.03741269, 0.03891168, 0.04537034,
       0.03618999, 0.04244509, 0.04285278, 0.03141813, 0.03556561,
       0.03962684, 0.04614716]), 'std_score_time': array([0.02625963,
0.01604521, 0.01613107, 0.00951122, 0.00676221,
       0.00043343, 0.00027015, 0.00047912, 0.01124513, 0.01320565,
       0.00041951, 0.00043816, 0.00126377, 0.01312435, 0.01267413,
       0.01342693, 0.01355588, 0.01216865, 0.01084769, 0.00803358,
       0.0109085 , 0.00169772, 0.01535118, 0.01474108, 0.01095801,
       0.0130063 , 0.01180439, 0.01196886, 0.01088558, 0.01311043,
       0.01228166, 0.01080525]), 'param_alpha': masked_array(data=[0.0001,
0.001, 0.01, 0.05, 0.1, 0.2, 0.3, 0.4, 0.5,
                   0.6, 0.7, 0.8, 0.9, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20,
                   25, 50, 75, 100, 250, 500, 750, 1000],
             mask=[False, False, False, False, False, False, False, False,
                   False, False, False, False, False, False, False, False,
                   False, False, False, False, False, False, False, False,
                   False, False, False, False, False, False, False, False],
       fill_value='?',
            dtype=object), 'params': [{'alpha': 0.0001}, {'alpha': 0.001},
{'alpha': 0.01}, {'alpha': 0.05}, {'alpha': 0.1}, {'alpha': 0.2}, {'alpha':
```

```
0.3}, {'alpha': 0.4}, {'alpha': 0.5}, {'alpha': 0.6}, {'alpha': 0.7}, {'alpha':
0.8}, {'alpha': 0.9}, {'alpha': 1}, {'alpha': 2}, {'alpha': 3}, {'alpha': 4},
{'alpha': 5}, {'alpha': 6}, {'alpha': 7}, {'alpha': 8}, {'alpha': 9}, {'alpha':
10}, {'alpha': 20}, {'alpha': 25}, {'alpha': 50}, {'alpha': 75}, {'alpha': 100},
{'alpha': 250}, {'alpha': 500}, {'alpha': 750}, {'alpha': 1000}],
'split0_test_score': array([-0.1081354 , -0.10813011, -0.10807762, -0.10785282,
-0.10759944,
       -0.10714982, -0.10675376, -0.10639564, -0.1060812 , -0.10579298,
       -0.10552539, -0.10527524, -0.10503998, -0.10481904, -0.10347827,
       -0.1026274 , -0.10199151, -0.10146577, -0.1010282 , -0.10064712,
       -0.10032384, -0.10002332, -0.09974587, -0.09785385, -0.09719699,
       -0.09517043, -0.09402131, -0.0933147 , -0.09222951, -0.09415239,
       -0.09694953, -0.09975034]), 'split1_test_score': array([-0.11704567,
-0.11704724, -0.11706208, -0.11711289, -0.11724618,
       -0.11755135, -0.11771725, -0.1177954 , -0.11782005, -0.11780789,
       -0.11776994, -0.11771376, -0.11764443, -0.11757196, -0.11667041,
       -0.11573994, -0.11492204, -0.11424224, -0.11365868, -0.11312632,
       -0.11265518, -0.11223772, -0.11184761, -0.1090066 , -0.10801746,
       -0.10502548, -0.10362202, -0.10264378, -0.10026259, -0.1002254 ,
       -0.10135933, -0.10325652]), 'split2_test_score': array([-0.11390045,
-0.11386392, -0.11351017, -0.11215609, -0.11084421,
       -0.10902431, -0.10816938, -0.10755279, -0.10707397, -0.10668746,
       -0.10638972, -0.1062716 , -0.1062677 , -0.1062628 , -0.10642655,
       -0.1063922 , -0.10635415, -0.10627525, -0.10618395, -0.10613879,
       -0.10609011, -0.10603696, -0.10598997, -0.10543159, -0.10512938,
       -0.10377669, -0.10269111, -0.10184112, -0.09981971, -0.10151928,
       -0.10543341, -0.10951323]), 'split3_test_score': array([-0.10861138,
-0.1086083 , -0.10857759, -0.10844477, -0.10830694,
       -0.10817885, -0.10807806, -0.10796697, -0.10785795, -0.10774713,
       -0.10763376, -0.10751916, -0.10740416, -0.1072906 , -0.1064039 ,
       -0.10577784, -0.10523837, -0.10477929, -0.10439956, -0.10403452,
       -0.10368141, -0.10333582, -0.10299788, -0.10022146, -0.09911211,
       -0.09514967, -0.09293295, -0.09187003, -0.0903111 , -0.09215608,
       -0.09489088, -0.09739477]), 'split4_test_score': array([-0.10267967,
-0.10265759, -0.10244313, -0.1016464 , -0.10093655,
       -0.09989797, -0.09926722, -0.09882811, -0.09847062, -0.09819932,
       -0.09808736, -0.0979827 , -0.09788393, -0.09779004, -0.09731596,
       -0.09709478, -0.09688106, -0.09688386, -0.09684008, -0.0968561 ,
       -0.09687889, -0.09690954, -0.09692111, -0.0964555 , -0.09605839,
       -0.09448759, -0.09344609, -0.09247928, -0.09187593, -0.09360063,
       -0.09594534, -0.09823913]), 'mean_test_score': array([-0.11007452,
-0.11006143, -0.10993412, -0.10944259, -0.10898667,
       -0.10836046, -0.10799714, -0.10770778, -0.10746076, -0.10724695,
       -0.10708123, -0.10695249, -0.10684804, -0.10674689, -0.10605902,
       -0.10552643, -0.10507743, -0.10472928, -0.10442209, -0.10416057,
       -0.10392589, -0.10370867, -0.10350049, -0.1017938 , -0.10110287,
       -0.09872197, -0.0973427 , -0.09642978, -0.09489977, -0.09633076,
       -0.0989157 , -0.1016308 ]), 'std_test_score': array([0.00497633,
```

```
0.00497833, 0.00499995, 0.00510882, 0.00526993,
       0.00562184, 0.00586983, 0.00604023, 0.00617006, 0.00626211,
       0.00629829, 0.00632234, 0.00633771, 0.00635065, 0.0062603 ,
       0.00607661, 0.00592074, 0.00574613, 0.00561114, 0.00547747,
       0.00535871, 0.00525575, 0.0051674 , 0.0047276 , 0.0046624 ,
       0.00466024, 0.00476857, 0.00477489, 0.0042496 , 0.00378724,
       0.00393293, 0.00442175]), 'rank_test_score': array([32, 31, 30, 29, 28,
27, 26, 25, 24, 23, 22, 21, 20, 19, 18, 17, 16,
       15, 14, 13, 12, 11, 10,  9,  7,  5,  4,  3,  1,  2,  6,  8],
      dtype=int32), 'split0_train_score': array([-0.05604602, -0.05604613,
-0.05604717, -0.05605173, -0.05605829,
       -0.05607769, -0.05610337, -0.05612871, -0.05615379, -0.05617924,
       -0.05620651, -0.05623713, -0.05626753, -0.05629891, -0.05664859,
       -0.0570584 , -0.05743644, -0.05778317, -0.05811974, -0.05845079,
       -0.05877077, -0.05906244, -0.05932946, -0.06133342, -0.06208223,
       -0.06437915, -0.06584234, -0.06693408, -0.07173764, -0.07772336,
       -0.08265918, -0.08704335]), 'split1_train_score': array([-0.05522149,
-0.05522186, -0.05522615, -0.05526979, -0.05533319,
       -0.05546905, -0.05558386, -0.05567685, -0.0557617 , -0.05583425,
       -0.05589549, -0.05595241, -0.05600973, -0.05606171, -0.05638922,
       -0.0565843 , -0.05674309, -0.05686728, -0.05697163, -0.0570632 ,
       -0.05714758, -0.05722493, -0.05730281, -0.05791191, -0.05814577,
       -0.05919188, -0.06019735, -0.06116395, -0.06620689, -0.07285971,
       -0.07840056, -0.08300725]), 'split2_train_score': array([-0.05288177,
-0.05288334, -0.05289869, -0.05297275, -0.05305482,
       -0.05323843, -0.05341845, -0.05357001, -0.05370126, -0.05382171,
       -0.05393063, -0.05402774, -0.05411551, -0.05419607, -0.05485804,
       -0.05536962, -0.05581957, -0.05624029, -0.05664021, -0.05699387,
       -0.057309  , -0.05759683, -0.05786219, -0.05982506, -0.06049684,
       -0.06285908, -0.06442276, -0.06561875, -0.07055981, -0.0767388 ,
       -0.08192475, -0.08644165]), 'split3_train_score': array([-0.05698323,
-0.05698494, -0.0570026 , -0.05708592, -0.05718162,
       -0.05739032, -0.05755677, -0.05769975, -0.05782252, -0.05792931,
       -0.05802561, -0.05811086, -0.05818776, -0.05825859, -0.05880115,
       -0.05921657, -0.05962349, -0.05998159, -0.06030275, -0.06059372,
       -0.06087841, -0.06114802, -0.06139866, -0.06333139, -0.06401018,
       -0.06610777, -0.06747705, -0.0685724 , -0.07373494, -0.08004127,
       -0.08517634, -0.08953242]), 'split4_train_score': array([-0.05856724,
-0.05857043, -0.05860275, -0.05873269, -0.05886917,
       -0.05909703, -0.05926421, -0.05940031, -0.05951565, -0.05961009,
       -0.05969648, -0.05977023, -0.05983365, -0.05989034, -0.06022812,
       -0.06044907, -0.06063053, -0.06078009, -0.06091134, -0.06103048,
       -0.06113999, -0.06124085, -0.06133682, -0.06208958, -0.06238183,
       -0.06355209, -0.0645493 , -0.06549444, -0.07060602, -0.07766581,
       -0.08325636, -0.08801752]), 'mean_train_score': array([-0.05593995,
-0.05594134, -0.05595547, -0.05602258, -0.05609942,
       -0.0562545 , -0.05638533, -0.05649512, -0.05659099, -0.05667492,
       -0.05675095, -0.05681967, -0.05688284, -0.05694112, -0.05738502,
```

```
       -0.05773559, -0.05805062, -0.05833048, -0.05858913, -0.05882641,
       -0.05904915, -0.05925461, -0.05944599, -0.06089827, -0.06142337,
       -0.063218  , -0.06449776, -0.06555672, -0.07056906, -0.07700579,
       -0.08228344, -0.08680844]), 'std_train_score': array([0.00189055,
0.00189109, 0.00189678, 0.00191543, 0.00193396,
       0.00195525, 0.0019588 , 0.00196221, 0.00196467, 0.00196377,
       0.00196384, 0.00196262, 0.00196006, 0.00195728, 0.0018978 ,
       0.00184055, 0.00179968, 0.00176273, 0.00172998, 0.00170819,
       0.00169938, 0.00169912, 0.00170314, 0.0018761 , 0.00198219,
       0.00228688, 0.00241602, 0.00246153, 0.00246651, 0.00234205,
       0.0022209 , 0.0021689 ])}
r2 score (train) -  0.93
r2 score (test) -  0.88
RMSE(TRAIN) -  0.10
RMSE(TEST) -  0.14
```



[ ]:

[60]:
```
best_ridge = ridgeCV.best_estimator_
best_lasso = lassoCV.best_estimator_


beats = pd.DataFrame(index = x.columns)
beats.rows = x.columns
beats['Ridge'] = best_ridge.coef_
```

```python
beats['Lasso'] = best_lasso.coef_
beats
```

[60]:

	Ridge	Lasso
LotFrontage	0.000827	0.000827
LotArea	0.013938	0.013938
YearRemodAdd	0.019722	0.019722
MasVnrArea	0.009757	0.009757
BsmtFinSF1	0.009438	0.009438
BsmtFinSF2	0.005310	0.005310
BsmtUnfSF	0.003365	0.003365
TotalBsmtSF	0.014836	0.014836
1stFlrSF	0.023885	0.023885
2ndFlrSF	0.016167	0.016167
LowQualFinSF	0.005832	0.005832
GrLivArea	0.031856	0.031856
BsmtFullBath	0.013907	0.013907
BsmtHalfBath	-0.002217	-0.002217
FullBath	0.019654	0.019654
HalfBath	0.016722	0.016722
BedroomAbvGr	0.010503	0.010503
KitchenAbvGr	-0.010644	-0.010644
TotRmsAbvGrd	0.022304	0.022304
Fireplaces	0.014674	0.014674
GarageYrBlt	0.004733	0.004733
GarageCars	0.023721	0.023721
GarageArea	0.018956	0.018956
WoodDeckSF	0.011385	0.011385
OpenPorchSF	0.001850	0.001850
EnclosedPorch	0.003743	0.003743
3SsnPorch	0.006549	0.006549
ScreenPorch	0.012044	0.012044
PoolArea	0.005551	0.005551
MiscVal	0.000246	0.000246
MoSold	0.003180	0.003180
Age	-0.016451	-0.016451
MSSubClass_30	-0.017343	-0.017343
MSSubClass_40	0.002550	0.002550
MSSubClass_45	-0.000851	-0.000851
MSSubClass_50	0.001294	0.001294
MSSubClass_60	0.002010	0.002010
MSSubClass_70	0.006207	0.006207
MSSubClass_75	0.006207	0.006207
MSSubClass_80	-0.002916	-0.002916
MSSubClass_85	-0.001198	-0.001198
MSSubClass_90	-0.004598	-0.004598
MSSubClass_120	-0.004561	-0.004561

MSSubClass_160	-0.015000	-0.015000
MSSubClass_180	-0.005280	-0.005280
MSSubClass_190	-0.001294	-0.001294
MSZoning_FV	0.007578	0.007578
MSZoning_RH	0.001448	0.001448
MSZoning_RL	0.009843	0.009843
MSZoning_RM	-0.006350	-0.006350
Street_Pave	0.004067	0.004067
Alley_None	-0.001902	-0.001902
Alley_Pave	0.008105	0.008105
LotShape_IR2	0.004953	0.004953
LotShape_IR3	-0.005358	-0.005358
LotShape_Reg	-0.002022	-0.002022
LandContour_HLS	0.010439	0.010439
LandContour_Low	-0.000337	-0.000337
LandContour_Lvl	0.010855	0.010855
Utilities_NoSeWa	-0.006878	-0.006878
LotConfig_CulDSac	0.009609	0.009609
LotConfig_FR2	-0.006253	-0.006253
LotConfig_FR3	-0.003128	-0.003128
LotConfig_Inside	-0.003404	-0.003404
LandSlope_Mod	-0.000496	-0.000496
LandSlope_Sev	0.000460	0.000460
Neighborhood_Blueste	-0.001436	-0.001436
Neighborhood_BrDale	-0.002165	-0.002165
Neighborhood_BrkSide	0.001524	0.001524
Neighborhood_ClearCr	0.007937	0.007937
Neighborhood_CollgCr	-0.001761	-0.001761
Neighborhood_Crawfor	0.018133	0.018133
Neighborhood_Edwards	-0.012329	-0.012329
Neighborhood_Gilbert	-0.004123	-0.004123
Neighborhood_IDOTRR	-0.008007	-0.008007
Neighborhood_MeadowV	-0.015515	-0.015515
Neighborhood_Mitchel	-0.000396	-0.000396
Neighborhood_NAmes	-0.010222	-0.010222
Neighborhood_NPkVill	0.001245	0.001245
Neighborhood_NWAmes	-0.002998	-0.002998
Neighborhood_NoRidge	0.011335	0.011335
Neighborhood_NridgHt	0.021087	0.021087
Neighborhood_OldTown	-0.009498	-0.009498
Neighborhood_SWISU	-0.000127	-0.000127
Neighborhood_Sawyer	-0.002855	-0.002855
Neighborhood_SawyerW	-0.001036	-0.001036
Neighborhood_Somerst	0.006152	0.006152
Neighborhood_StoneBr	0.017797	0.017797
Neighborhood_Timber	0.004006	0.004006
Neighborhood_Veenker	0.005511	0.005511

Condition1_Feedr	-0.002697	-0.002697
Condition1_Norm	0.011905	0.011905
Condition1_PosA	-0.001591	-0.001591
Condition1_PosN	0.001633	0.001633
Condition1_RRAe	-0.004991	-0.004991
Condition1_RRAn	0.003093	0.003093
Condition1_RRNe	0.000471	0.000471
Condition1_RRNn	0.001554	0.001554
Condition2_Feedr	0.004647	0.004647
Condition2_Norm	0.007151	0.007151
Condition2_PosA	0.000000	0.000000
Condition2_PosN	-0.016772	-0.016772
Condition2_RRAe	-0.001379	-0.001379
Condition2_RRAn	0.001915	0.001915
Condition2_RRNn	0.000000	0.000000
BldgType_2fmCon	-0.001403	-0.001403
BldgType_Duplex	-0.004598	-0.004598
BldgType_Twnhs	-0.009058	-0.009058
BldgType_TwnhsE	-0.011362	-0.011362
HouseStyle_1.5Unf	0.001856	0.001856
HouseStyle_1Story	0.002458	0.002458
HouseStyle_2.5Fin	0.000725	0.000725
HouseStyle_2.5Unf	0.001742	0.001742
HouseStyle_2Story	-0.002399	-0.002399
HouseStyle_SFoyer	-0.005053	-0.005053
HouseStyle_SLvl	-0.001892	-0.001892
OverallQual_2	-0.007130	-0.007130
OverallQual_3	-0.018202	-0.018202
OverallQual_4	-0.016084	-0.016084
OverallQual_5	-0.013436	-0.013436
OverallQual_6	-0.003148	-0.003148
OverallQual_7	0.007517	0.007517
OverallQual_8	0.022802	0.022802
OverallQual_9	0.026090	0.026090
OverallQual_10	0.009309	0.009309
OverallCond_2	-0.002750	-0.002750
OverallCond_3	-0.019080	-0.019080
OverallCond_4	-0.006153	-0.006153
OverallCond_5	-0.008644	-0.008644
OverallCond_6	0.003820	0.003820
OverallCond_7	0.011804	0.011804
OverallCond_8	0.006735	0.006735
OverallCond_9	0.010137	0.010137
RoofStyle_Gable	-0.006769	-0.006769
RoofStyle_Gambrel	0.001195	0.001195
RoofStyle_Hip	0.001288	0.001288
RoofStyle_Mansard	0.007167	0.007167

RoofStyle_Shed	0.003399	0.003399
RoofMatl_CompShg	0.008265	0.008265
RoofMatl_Membran	0.000000	0.000000
RoofMatl_Metal	0.002475	0.002475
RoofMatl_Roll	0.003351	0.003351
RoofMatl_Tar&Grv	0.012191	0.012191
RoofMatl_WdShake	0.003126	0.003126
RoofMatl_WdShngl	0.010667	0.010667
Exterior1st_AsphShn	0.000526	0.000526
Exterior1st_BrkComm	0.001828	0.001828
Exterior1st_BrkFace	0.016004	0.016004
Exterior1st_CBlock	-0.001623	-0.001623
Exterior1st_CemntBd	0.004500	0.004500
Exterior1st_HdBoard	-0.004880	-0.004880
Exterior1st_ImStucc	0.000000	0.000000
Exterior1st_MetalSd	0.001587	0.001587
Exterior1st_Plywood	0.002476	0.002476
Exterior1st_Stone	0.002644	0.002644
Exterior1st_Stucco	-0.000170	-0.000170
Exterior1st_VinylSd	-0.001591	-0.001591
Exterior1st_Wd Sdng	-0.005965	-0.005965
Exterior1st_WdShing	-0.001805	-0.001805
Exterior2nd_AsphShn	0.003451	0.003451
Exterior2nd_Brk Cmn	0.000319	0.000319
Exterior2nd_BrkFace	0.000071	0.000071
Exterior2nd_CBlock	-0.001623	-0.001623
Exterior2nd_CmentBd	0.006787	0.006787
Exterior2nd_HdBoard	-0.001579	-0.001579
Exterior2nd_ImStucc	-0.001555	-0.001555
Exterior2nd_MetalSd	-0.001154	-0.001154
Exterior2nd_Other	-0.002004	-0.002004
Exterior2nd_Plywood	-0.004631	-0.004631
Exterior2nd_Stone	-0.000743	-0.000743
Exterior2nd_Stucco	-0.000578	-0.000578
Exterior2nd_VinylSd	-0.000480	-0.000480
Exterior2nd_Wd Sdng	0.005775	0.005775
Exterior2nd_Wd Shng	-0.004316	-0.004316
MasVnrType_BrkFace	0.001981	0.001981
MasVnrType_None	-0.000848	-0.000848
MasVnrType_Stone	0.003939	0.003939
ExterQual_Fa	-0.004032	-0.004032
ExterQual_Gd	0.001332	0.001332
ExterQual_TA	-0.010062	-0.010062
ExterCond_Fa	-0.003273	-0.003273
ExterCond_Gd	-0.001920	-0.001920
ExterCond_Po	-0.002386	-0.002386
ExterCond_TA	0.002399	0.002399

Foundation_CBlock	-0.000390	-0.000390
Foundation_PConc	0.010176	0.010176
Foundation_Slab	-0.002964	-0.002964
Foundation_Stone	-0.000747	-0.000747
Foundation_Wood	-0.002588	-0.002588
BsmtQual_Fa	-0.003668	-0.003668
BsmtQual_Gd	-0.005848	-0.005848
BsmtQual_None	-0.003221	-0.003221
BsmtQual_TA	-0.017634	-0.017634
BsmtCond_Gd	0.005172	0.005172
BsmtCond_None	-0.003221	-0.003221
BsmtCond_Po	-0.007162	-0.007162
BsmtCond_TA	0.011528	0.011528
BsmtExposure_Gd	0.014506	0.014506
BsmtExposure_Mn	-0.003033	-0.003033
BsmtExposure_No	-0.008891	-0.008891
BsmtExposure_None	-0.003221	-0.003221
BsmtFinType1_BLQ	-0.003942	-0.003942
BsmtFinType1_GLQ	0.012488	0.012488
BsmtFinType1_LwQ	-0.002830	-0.002830
BsmtFinType1_None	-0.003221	-0.003221
BsmtFinType1_Rec	-0.001242	-0.001242
BsmtFinType1_Unf	-0.011330	-0.011330
BsmtFinType2_BLQ	-0.003457	-0.003457
BsmtFinType2_GLQ	0.002535	0.002535
BsmtFinType2_LwQ	0.000849	0.000849
BsmtFinType2_None	-0.003221	-0.003221
BsmtFinType2_Rec	-0.001004	-0.001004
BsmtFinType2_Unf	-0.001489	-0.001489
Heating_GasA	0.002615	0.002615
Heating_GasW	0.004539	0.004539
Heating_Grav	-0.012122	-0.012122
Heating_OthW	-0.001409	-0.001409
Heating_Wall	0.003066	0.003066
HeatingQC_Fa	-0.005973	-0.005973
HeatingQC_Gd	-0.008056	-0.008056
HeatingQC_Po	-0.002708	-0.002708
HeatingQC_TA	-0.010667	-0.010667
CentralAir_Y	0.017404	0.017404
Electrical_FuseF	-0.001586	-0.001586
Electrical_FuseP	-0.001371	-0.001371
Electrical_Mix	0.000000	0.000000
Electrical_None	0.001087	0.001087
Electrical_SBrkr	-0.001681	-0.001681
KitchenQual_Fa	-0.000545	-0.000545
KitchenQual_Gd	-0.004383	-0.004383
KitchenQual_TA	-0.014860	-0.014860

Functional_Maj2	-0.010894	-0.010894
Functional_Min1	-0.001818	-0.001818
Functional_Min2	-0.003580	-0.003580
Functional_Mod	0.004222	0.004222
Functional_Sev	-0.007892	-0.007892
Functional_Typ	0.006004	0.006004
FireplaceQu_Fa	-0.002237	-0.002237
FireplaceQu_Gd	0.004236	0.004236
FireplaceQu_None	-0.013861	-0.013861
FireplaceQu_Po	-0.002776	-0.002776
FireplaceQu_TA	0.005399	0.005399
GarageType_Attchd	0.004507	0.004507
GarageType_Basment	0.000489	0.000489
GarageType_BuiltIn	0.003887	0.003887
GarageType_CarPort	-0.002485	-0.002485
GarageType_Detchd	-0.001534	-0.001534
GarageType_None	-0.004899	-0.004899
GarageFinish_None	-0.004899	-0.004899
GarageFinish_RFn	0.002608	0.002608
GarageFinish_Unf	-0.004731	-0.004731
GarageQual_Fa	-0.003499	-0.003499
GarageQual_Gd	0.008161	0.008161
GarageQual_None	-0.004899	-0.004899
GarageQual_Po	-0.000116	-0.000116
GarageQual_TA	-0.001406	-0.001406
GarageCond_Fa	-0.004160	-0.004160
GarageCond_Gd	0.001492	0.001492
GarageCond_None	-0.004899	-0.004899
GarageCond_Po	0.009000	0.009000
GarageCond_TA	0.002031	0.002031
PavedDrive_P	0.003722	0.003722
PavedDrive_Y	0.007823	0.007823
PoolQC_Fa	-0.000039	-0.000039
PoolQC_Gd	-0.023152	-0.023152
PoolQC_None	0.011530	0.011530
Fence_GdWo	-0.007762	-0.007762
Fence_MnPrv	-0.003277	-0.003277
Fence_MnWw	-0.001894	-0.001894
Fence_None	-0.001657	-0.001657
MiscFeature_None	0.001654	0.001654
MiscFeature_Othr	-0.005092	-0.005092
MiscFeature_Shed	-0.000614	-0.000614
MiscFeature_TenC	-0.000039	-0.000039
SaleType_CWD	0.004342	0.004342
SaleType_Con	0.002921	0.002921
SaleType_ConLD	0.006036	0.006036
SaleType_ConLI	-0.001578	-0.001578

```
SaleType_ConLw          0.000532  0.000532
SaleType_New            0.008830  0.008830
SaleType_Oth            0.007225  0.007225
SaleType_WD            -0.003668 -0.003668
SaleCondition_AdjLand   0.003461  0.003461
SaleCondition_Alloca    0.017280  0.017280
SaleCondition_Family   -0.002218 -0.002218
SaleCondition_Normal    0.010352  0.010352
SaleCondition_Partial   0.009449  0.009449
```

[ ]:

```
[61]: lasso_cols_removed = list(beats[beats['Lasso']==0].index)
print(lasso_cols_removed)
```

```
['Condition2_PosA', 'Condition2_RRNn', 'RoofMatl_Membran',
'Exterior1st_ImStucc', 'Electrical_Mix']
```

[ ]:

```
[62]: lasso_cols_selected = list(beats[beats['Lasso']!=0].index)
print(lasso_cols_selected)
print(len(lasso_cols_selected))
```

```
['LotFrontage', 'LotArea', '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',
'Age', 'MSSubClass_30', 'MSSubClass_40', 'MSSubClass_45', 'MSSubClass_50',
'MSSubClass_60', 'MSSubClass_70', 'MSSubClass_75', 'MSSubClass_80',
'MSSubClass_85', 'MSSubClass_90', 'MSSubClass_120', 'MSSubClass_160',
'MSSubClass_180', 'MSSubClass_190', 'MSZoning_FV', 'MSZoning_RH', 'MSZoning_RL',
'MSZoning_RM', 'Street_Pave', 'Alley_None', 'Alley_Pave', 'LotShape_IR2',
'LotShape_IR3', 'LotShape_Reg', 'LandContour_HLS', 'LandContour_Low',
'LandContour_Lvl', 'Utilities_NoSeWa', 'LotConfig_CulDSac', 'LotConfig_FR2',
'LotConfig_FR3', 'LotConfig_Inside', 'LandSlope_Mod', 'LandSlope_Sev',
'Neighborhood_Blueste', 'Neighborhood_BrDale', 'Neighborhood_BrkSide',
'Neighborhood_ClearCr', 'Neighborhood_CollgCr', 'Neighborhood_Crawfor',
'Neighborhood_Edwards', 'Neighborhood_Gilbert', 'Neighborhood_IDOTRR',
'Neighborhood_MeadowV', 'Neighborhood_Mitchel', 'Neighborhood_NAmes',
'Neighborhood_NPkVill', 'Neighborhood_NWAmes', 'Neighborhood_NoRidge',
'Neighborhood_NridgHt', 'Neighborhood_OldTown', 'Neighborhood_SWISU',
'Neighborhood_Sawyer', 'Neighborhood_SawyerW', 'Neighborhood_Somerst',
'Neighborhood_StoneBr', 'Neighborhood_Timber', 'Neighborhood_Veenker',
'Condition1_Feedr', 'Condition1_Norm', 'Condition1_PosA', 'Condition1_PosN',
```

```
'Condition1_RRAe', 'Condition1_RRAn', 'Condition1_RRNe', 'Condition1_RRNn',
'Condition2_Feedr', 'Condition2_Norm', 'Condition2_PosN', 'Condition2_RRAe',
'Condition2_RRAn', 'BldgType_2fmCon', 'BldgType_Duplex', 'BldgType_Twnhs',
'BldgType_TwnhsE', 'HouseStyle_1.5Unf', 'HouseStyle_1Story',
'HouseStyle_2.5Fin', 'HouseStyle_2.5Unf', 'HouseStyle_2Story',
'HouseStyle_SFoyer', 'HouseStyle_SLvl', 'OverallQual_2', 'OverallQual_3',
'OverallQual_4', 'OverallQual_5', 'OverallQual_6', 'OverallQual_7',
'OverallQual_8', 'OverallQual_9', 'OverallQual_10', 'OverallCond_2',
'OverallCond_3', 'OverallCond_4', 'OverallCond_5', 'OverallCond_6',
'OverallCond_7', 'OverallCond_8', 'OverallCond_9', 'RoofStyle_Gable',
'RoofStyle_Gambrel', 'RoofStyle_Hip', 'RoofStyle_Mansard', 'RoofStyle_Shed',
'RoofMatl_CompShg', 'RoofMatl_Metal', 'RoofMatl_Roll', 'RoofMatl_Tar&Grv',
'RoofMatl_WdShake', 'RoofMatl_WdShngl', 'Exterior1st_AsphShn',
'Exterior1st_BrkComm', 'Exterior1st_BrkFace', 'Exterior1st_CBlock',
'Exterior1st_CemntBd', 'Exterior1st_HdBoard', 'Exterior1st_MetalSd',
'Exterior1st_Plywood', 'Exterior1st_Stone', 'Exterior1st_Stucco',
'Exterior1st_VinylSd', 'Exterior1st_Wd Sdng', 'Exterior1st_WdShing',
'Exterior2nd_AsphShn', 'Exterior2nd_Brk Cmn', 'Exterior2nd_BrkFace',
'Exterior2nd_CBlock', 'Exterior2nd_CmentBd', 'Exterior2nd_HdBoard',
'Exterior2nd_ImStucc', 'Exterior2nd_MetalSd', 'Exterior2nd_Other',
'Exterior2nd_Plywood', 'Exterior2nd_Stone', 'Exterior2nd_Stucco',
'Exterior2nd_VinylSd', 'Exterior2nd_Wd Sdng', 'Exterior2nd_Wd Shng',
'MasVnrType_BrkFace', 'MasVnrType_None', 'MasVnrType_Stone', 'ExterQual_Fa',
'ExterQual_Gd', 'ExterQual_TA', 'ExterCond_Fa', 'ExterCond_Gd', 'ExterCond_Po',
'ExterCond_TA', 'Foundation_CBlock', 'Foundation_PConc', 'Foundation_Slab',
'Foundation_Stone', 'Foundation_Wood', 'BsmtQual_Fa', 'BsmtQual_Gd',
'BsmtQual_None', 'BsmtQual_TA', 'BsmtCond_Gd', 'BsmtCond_None', 'BsmtCond_Po',
'BsmtCond_TA', 'BsmtExposure_Gd', 'BsmtExposure_Mn', 'BsmtExposure_No',
'BsmtExposure_None', 'BsmtFinType1_BLQ', 'BsmtFinType1_GLQ', 'BsmtFinType1_LwQ',
'BsmtFinType1_None', 'BsmtFinType1_Rec', 'BsmtFinType1_Unf', 'BsmtFinType2_BLQ',
'BsmtFinType2_GLQ', 'BsmtFinType2_LwQ', 'BsmtFinType2_None', 'BsmtFinType2_Rec',
'BsmtFinType2_Unf', 'Heating_GasA', 'Heating_GasW', 'Heating_Grav',
'Heating_OthW', 'Heating_Wall', 'HeatingQC_Fa', 'HeatingQC_Gd', 'HeatingQC_Po',
'HeatingQC_TA', 'CentralAir_Y', 'Electrical_FuseF', 'Electrical_FuseP',
'Electrical_None', 'Electrical_SBrkr', 'KitchenQual_Fa', 'KitchenQual_Gd',
'KitchenQual_TA', 'Functional_Maj2', 'Functional_Min1', 'Functional_Min2',
'Functional_Mod', 'Functional_Sev', 'Functional_Typ', 'FireplaceQu_Fa',
'FireplaceQu_Gd', 'FireplaceQu_None', 'FireplaceQu_Po', 'FireplaceQu_TA',
'GarageType_Attchd', 'GarageType_Basment', 'GarageType_BuiltIn',
'GarageType_CarPort', 'GarageType_Detchd', 'GarageType_None',
'GarageFinish_None', 'GarageFinish_RFn', 'GarageFinish_Unf', 'GarageQual_Fa',
'GarageQual_Gd', 'GarageQual_None', 'GarageQual_Po', 'GarageQual_TA',
'GarageCond_Fa', 'GarageCond_Gd', 'GarageCond_None', 'GarageCond_Po',
'GarageCond_TA', 'PavedDrive_P', 'PavedDrive_Y', 'PoolQC_Fa', 'PoolQC_Gd',
'PoolQC_None', 'Fence_GdWo', 'Fence_MnPrv', 'Fence_MnWw', 'Fence_None',
'MiscFeature_None', 'MiscFeature_Othr', 'MiscFeature_Shed', 'MiscFeature_TenC',
'SaleType_CWD', 'SaleType_Con', 'SaleType_ConLD', 'SaleType_ConLI',
'SaleType_ConLw', 'SaleType_New', 'SaleType_Oth', 'SaleType_WD',
```

```
'SaleCondition_AdjLand', 'SaleCondition_Alloca', 'SaleCondition_Family',
'SaleCondition_Normal', 'SaleCondition_Partial']
282
```

[ ]:

[63]:
```python
beats["Ridge"].sort_values(ascending=False)[:10]
```

[63]:
```
GrLivArea               0.031856
OverallQual_9           0.026090
1stFlrSF                0.023885
GarageCars              0.023721
OverallQual_8           0.022802
TotRmsAbvGrd            0.022304
Neighborhood_NridgHt    0.021087
YearRemodAdd            0.019722
FullBath                0.019654
GarageArea              0.018956
Name: Ridge, dtype: float64
```

[ ]:

[64]:
```python
ridge_coeffs = np.exp(beats['Ridge'])
ridge_coeffs.sort_values(ascending=False)[:10]
```

[64]:
```
GrLivArea               1.032369
OverallQual_9           1.026433
1stFlrSF                1.024172
GarageCars              1.024005
OverallQual_8           1.023064
TotRmsAbvGrd            1.022555
Neighborhood_NridgHt    1.021311
YearRemodAdd            1.019918
FullBath                1.019848
GarageArea              1.019137
Name: Ridge, dtype: float64
```

[ ]:

[65]:
```python
beats["Lasso"].sort_values(ascending=False)[:10]
lasso_coeffs = np.exp(beats['Lasso'])
lasso_coeffs.sort_values(ascending=False)[:10]
```

[65]:
```
GrLivArea               1.032369
OverallQual_9           1.026433
1stFlrSF                1.024172
GarageCars              1.024005
```

```
OverallQual_8           1.023064
TotRmsAbvGrd            1.022555
Neighborhood_NridgHt    1.021311
YearRemodAdd            1.019918
FullBath                1.019848
GarageArea              1.019137
Name: Lasso, dtype: float64
```

[ ]:

```

```

6 CONCLUSION:

6.0.1 Below are the top 10 features with corresponding coefficients according to Ridge model:

1). GrLivArea 1.032369

2). OverallQual_9 1.026433

3). 1stFlrSF 1.024172

4). GarageCars 1.024005

5). OverallQual_8 1.023064

6). TotRmsAbvGrd 1.022555

7). Neighborhood_NridgHt 1.021311

8). YearRemodAdd 1.019918

9). FullBath 1.019848

10). GarageArea 1.019137

6.0.2 Below are the top 10 features with corresponding coefficients according to Lasso model:

1). GrLivArea 1.032369

2). OverallQual_9 1.026433

3). 1stFlrSF 1.024172

4). GarageCars 1.024005

5). OverallQual_8 1.023064

6). TotRmsAbvGrd 1.022555

7). Neighborhood_NridgHt 1.021311

8). YearRemodAdd 1.019918

9). FullBath 1.019848

10).GarageArea 1.019137

So here to highlight that both RIdge and Lasso algorithms will give us appropreate results only.

6.0.3 The list of features and their respective importance values indicates which attributes of a house have the most significant impact on predicting its price. Here's a detailed interpretation:

1) GrLivArea:

Gross Living Area is the most influential feature in predicting house prices. This makes sense as larger living spaces typically command higher prices due to the increased usable area. Which means that if GrLivArea increases then price will increase 1.032369 times.

2) OverallQual_9:

Overall Quality of house with Quality rating of 9, will increase the price of house 1.026433 times.

3) 1stFlrSF:

First Floor Square Footage is another critical feature. Larger first-floor areas are desirable and add significant value to a house. This means if Larger first floor areas, price increase 1.024172 times.

4) GarageCars:

The number of Garage Spaces impacts house prices notably. More garage spaces are often associated with larger, more valuable properties. WHich means that if Garage cars space increase then price hike will be 1.024005 times.

5) OverallQual_8:

Overall Quality of house with Quality rating of 8, will increase the price of house 1.023065 times.

6) TotRmsAbvGrd:

The total number of Rooms Above Ground affects the price. More rooms typically mean a larger and potentially more versatile living space, which buyers value. Means price will hike 1.022555 times

7) Neighborhood_NridgHt:

The house being located in the Neighborhood of NridgHt (Northridge Heights) is a significant predictor. This suggests that houses in this neighborhood are generally priced higher, possibly due to better amenities, location, or reputation. Means hike of 1.021311 times.

8) YearRemodAdd :

The Year the House was Remodeled or Added to impacts its value. More recent renovations usually mean the house is more up-to-date and potentially more appealing to buyers. Means price will hike 1.019918 times.

9) FullBath:

The number of Full Bathrooms is an important feature. More full bathrooms increase the convenience and utility of the property, thereby increasing its value. Means if number of full bathrooms increases, price will rise with 1.019848 times.

10) GarageArea:

The Area of the Garage also influences house prices. Larger garages provide more storage and utility space, which can be attractive features for buyers. Means Area increases then price will hike 1.019137 times.

6.0.4 Overall Insights:

Living Space and Quality:

The size of the living area (GrLivArea, 1stFlrSF) and overall quality ratings (OverallQual) are the most critical factors in determining house prices. Larger and higher-quality homes naturally fetch higher prices.

Garage and Bathrooms:

The presence and size of garages (GarageCars, GarageArea) and the number of full bathrooms significantly contribute to the house price, highlighting the importance of these features in buyer decisions.

Neighborhood Influence:

Location remains a crucial factor, as indicated by the importance of the Neighborhood feature (NridgHt). This aligns with real estate trends where location often dictates property values.

Recent Renovations:

The recency of renovations (YearRemodAdd) affects house prices, emphasizing the value of updated and modernized homes.

These insights can help real estate professionals, buyers, and sellers understand which features are most valued in the market, thereby informing decisions related to property improvements, pricing strategies, and purchase considerations.

[ ]:
```

```