House shopping

January 7, 2023

1 Feature engineering for the dream house

Find the factors that influence price negotiations while buying a house.

Understand the dataset

[1]:
```
# import dependencies
%matplotlib inline
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import scipy.stats as stats
from scipy.stats import chi2_contingency
import seaborn as sns
import warnings
warnings.filterwarnings('ignore')
```

[2]:
```
# load in the data
df=pd.read_csv("PEP1.csv")
```

[3]:
```
# size of data
df.shape
```

[3]:
```
(1460, 81)
```

[4]:
```
# display all the rows
pd.set_option('display.max_rows', None)
```

[5]:
```
#pandas_profiling.ProfileReport(df)
```

[6]:
```
# amount of missing values
df.isnull().sum().sort_values(ascending=False)
```

[6]:
```
PoolQC          1453
MiscFeature     1406
Alley           1369
Fence           1179
```

```
FireplaceQu       690
LotFrontage       259
GarageCond         81
GarageType         81
GarageYrBlt        81
GarageFinish       81
GarageQual         81
BsmtExposure       38
BsmtFinType2       38
BsmtFinType1       37
BsmtCond           37
BsmtQual           37
MasVnrArea          8
MasVnrType          8
Electrical          1
Utilities           0
YearRemodAdd        0
MSSubClass          0
Foundation          0
ExterCond           0
ExterQual           0
Exterior2nd         0
Exterior1st         0
RoofMatl            0
RoofStyle           0
YearBuilt           0
LotConfig           0
OverallCond         0
OverallQual         0
HouseStyle          0
BldgType            0
Condition2          0
BsmtFinSF1          0
MSZoning            0
LotArea             0
Street              0
Condition1          0
Neighborhood        0
LotShape            0
LandContour         0
LandSlope           0
SalePrice           0
HeatingQC           0
BsmtFinSF2          0
EnclosedPorch       0
Fireplaces          0
GarageCars          0
```

```
GarageArea          0
PavedDrive          0
WoodDeckSF          0
OpenPorchSF         0
3SsnPorch           0
BsmtUnfSF           0
ScreenPorch         0
PoolArea            0
MiscVal             0
MoSold              0
YrSold              0
SaleType            0
Functiol            0
TotRmsAbvGrd        0
KitchenQual         0
KitchebvGr          0
BedroomAbvGr        0
HalfBath            0
FullBath            0
BsmtHalfBath        0
BsmtFullBath        0
GrLivArea           0
LowQualFinSF        0
2ndFlrSF            0
1stFlrSF            0
CentralAir          0
SaleCondition       0
Heating             0
TotalBsmtSF         0
Id                  0
dtype: int64
```

[7]:
```
# % of missing values
df.isnull().sum().sort_values(ascending=False)*100/1460
```

[7]:
```
PoolQC          99.520548
MiscFeature     96.301370
Alley           93.767123
Fence           80.753425
FireplaceQu     47.260274
LotFrontage     17.739726
GarageCond       5.547945
GarageType       5.547945
GarageYrBlt      5.547945
GarageFinish     5.547945
GarageQual       5.547945
BsmtExposure     2.602740
```

BsmtFinType2	2.602740
BsmtFinType1	2.534247
BsmtCond	2.534247
BsmtQual	2.534247
MasVnrArea	0.547945
MasVnrType	0.547945
Electrical	0.068493
Utilities	0.000000
YearRemodAdd	0.000000
MSSubClass	0.000000
Foundation	0.000000
ExterCond	0.000000
ExterQual	0.000000
Exterior2nd	0.000000
Exterior1st	0.000000
RoofMatl	0.000000
RoofStyle	0.000000
YearBuilt	0.000000
LotConfig	0.000000
OverallCond	0.000000
OverallQual	0.000000
HouseStyle	0.000000
BldgType	0.000000
Condition2	0.000000
BsmtFinSF1	0.000000
MSZoning	0.000000
LotArea	0.000000
Street	0.000000
Condition1	0.000000
Neighborhood	0.000000
LotShape	0.000000
LandContour	0.000000
LandSlope	0.000000
SalePrice	0.000000
HeatingQC	0.000000
BsmtFinSF2	0.000000
EnclosedPorch	0.000000
Fireplaces	0.000000
GarageCars	0.000000
GarageArea	0.000000
PavedDrive	0.000000
WoodDeckSF	0.000000
OpenPorchSF	0.000000
3SsnPorch	0.000000
BsmtUnfSF	0.000000
ScreenPorch	0.000000
PoolArea	0.000000

```
MiscVal           0.000000
MoSold            0.000000
YrSold            0.000000
SaleType          0.000000
Functiol          0.000000
TotRmsAbvGrd      0.000000
KitchenQual       0.000000
KitchebvGr        0.000000
BedroomAbvGr      0.000000
HalfBath          0.000000
FullBath          0.000000
BsmtHalfBath      0.000000
BsmtFullBath      0.000000
GrLivArea         0.000000
LowQualFinSF      0.000000
2ndFlrSF          0.000000
1stFlrSF          0.000000
CentralAir        0.000000
SaleCondition     0.000000
Heating           0.000000
TotalBsmtSF       0.000000
Id                0.000000
dtype: float64
```

[8]:
```
df.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     1452 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  KitchebvGr     1460 non-null   int64
53  KitchenQual    1460 non-null   object
54  TotRmsAbvGrd   1460 non-null   int64
55  Functiol       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
```

[9]:

```
# identify variables with unique values
for i in df.columns:
    print (i , df[i].unique())
    print (" - "*56)
```

```
Id [   1    2    3 … 1458 1459 1460]
 -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -
MSSubClass [ 60  20  70  50 190  45  90 120  30  85  80 160  75 180  40]
 -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -
MSZoning ['RL' 'RM' 'C (all)' 'FV' 'RH']
 -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -
LotFrontage [ 65.  80.  68.  60.  84.  85.  75.  nan  51.  50.  70.  91.  72.
66.
 101.  57.  44. 110.  98.  47. 108. 112.  74. 115.  61.  48.  33.  52.
 100.  24.  89.  63.  76.  81.  95.  69.  21.  32.  78. 121. 122.  40.
 105.  73.  77.  64.  94.  34.  90.  55.  88.  82.  71. 120. 107.  92.
 134.  62.  86. 141.  97.  54.  41.  79. 174.  99.  67.  83.  43. 103.
  93.  30. 129. 140.  35.  37. 118.  87. 116. 150. 111.  49.  96.  59.
  36.  56. 102.  58.  38. 109. 130.  53. 137.  45. 106. 104.  42.  39.
 144. 114. 128. 149. 313. 168. 182. 138. 160. 152. 124. 153.  46.]
 -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
```

```
- -
LotArea [ 8450  9600 11250 … 17217 13175  9717]
 - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - -
- -
Street ['Pave' 'Grvl']
 - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - -
- -
Alley [nan 'Grvl' 'Pave']
 - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - -
- -
LotShape ['Reg' 'IR1' 'IR2' 'IR3']
 - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - -
- -
LandContour ['Lvl' 'Bnk' 'Low' 'HLS']
 - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - -
- -
Utilities ['AllPub' 'NoSeWa']
 - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - -
- -
LotConfig ['Inside' 'FR2' 'Corner' 'CulDSac' 'FR3']
 - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - -
- -
LandSlope ['Gtl' 'Mod' 'Sev']
 - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - -
- -
Neighborhood ['CollgCr' 'Veenker' 'Crawfor' 'NoRidge' 'Mitchel' 'Somerst'
'NWAmes'
 'OldTown' 'BrkSide' 'Sawyer' 'NridgHt' 'mes' 'SawyerW' 'IDOTRR' 'MeadowV'
 'Edwards' 'Timber' 'Gilbert' 'StoneBr' 'ClearCr' 'NPkVill' 'Blmngtn'
 'BrDale' 'SWISU' 'Blueste']
 - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - -
- -
Condition1 ['Norm' 'Feedr' 'PosN' 'Artery' 'RRAe' 'RRNn' 'RRAn' 'PosA' 'RRNe']
 - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - -
- -
Condition2 ['Norm' 'Artery' 'RRNn' 'Feedr' 'PosN' 'PosA' 'RRAn' 'RRAe']
 - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

```
- -
BldgType ['1Fam' '2fmCon' 'Duplex' 'TwnhsE' 'Twnhs']
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- -
HouseStyle ['2Story' '1Story' '1.5Fin' '1.5Unf' 'SFoyer' 'SLvl' '2.5Unf'
'2.5Fin']
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- -
OverallQual [ 7  6  8  5  9  4 10  3  1  2]
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- -
OverallCond [5 8 6 7 4 2 3 9 1]
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- -
YearBuilt [2003 1976 2001 1915 2000 1993 2004 1973 1931 1939 1965 2005 1962 2006
 1960 1929 1970 1967 1958 1930 2002 1968 2007 1951 1957 1927 1920 1966
 1959 1994 1954 1953 1955 1983 1975 1997 1934 1963 1981 1964 1999 1972
 1921 1945 1982 1998 1956 1948 1910 1995 1991 2009 1950 1961 1977 1985
 1979 1885 1919 1990 1969 1935 1988 1971 1952 1936 1923 1924 1984 1926
 1940 1941 1987 1986 2008 1908 1892 1916 1932 1918 1912 1947 1925 1900
 1980 1989 1992 1949 1880 1928 1978 1922 1996 2010 1946 1913 1937 1942
 1938 1974 1893 1914 1906 1890 1898 1904 1882 1875 1911 1917 1872 1905]
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- -
YearRemodAdd [2003 1976 2002 1970 2000 1995 2005 1973 1950 1965 2006 1962 2007
1960
 2001 1967 2004 2008 1997 1959 1990 1955 1983 1980 1966 1963 1987 1964
 1972 1996 1998 1989 1953 1956 1968 1981 1992 2009 1982 1961 1993 1999
 1985 1979 1977 1969 1958 1991 1971 1952 1975 2010 1984 1986 1994 1988
 1954 1957 1951 1978 1974]
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- -
RoofStyle ['Gable' 'Hip' 'Gambrel' 'Mansard' 'Flat' 'Shed']
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- -
RoofMatl ['CompShg' 'WdShngl' 'Metal' 'WdShake' 'Membran' 'Tar&Grv' 'Roll'
 'ClyTile']
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- -
Exterior1st ['VinylSd' 'MetalSd' 'Wd Sdng' 'HdBoard' 'BrkFace' 'WdShing'
```

```
'CemntBd'
 'Plywood' 'AsbShng' 'Stucco' 'BrkComm' 'AsphShn' 'Stone' 'ImStucc'
 'CBlock']
 -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -
Exterior2nd ['VinylSd' 'MetalSd' 'Wd Shng' 'HdBoard' 'Plywood' 'Wd Sdng'
'CmentBd'
 'BrkFace' 'Stucco' 'AsbShng' 'Brk Cmn' 'ImStucc' 'AsphShn' 'Stone'
 'Other' 'CBlock']
 -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -
MasVnrType ['BrkFace' 'None' 'Stone' 'BrkCmn' nan]
 -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -
MasVnrArea [1.960e+02 0.000e+00 1.620e+02 3.500e+02 1.860e+02 2.400e+02
2.860e+02
 3.060e+02 2.120e+02 1.800e+02 3.800e+02 2.810e+02 6.400e+02 2.000e+02
 2.460e+02 1.320e+02 6.500e+02 1.010e+02 4.120e+02 2.720e+02 4.560e+02
 1.031e+03 1.780e+02 5.730e+02 3.440e+02 2.870e+02 1.670e+02 1.115e+03
 4.000e+01 1.040e+02 5.760e+02 4.430e+02 4.680e+02 6.600e+01 2.200e+01
 2.840e+02 7.600e+01 2.030e+02 6.800e+01 1.830e+02 4.800e+01 2.800e+01
 3.360e+02 6.000e+02 7.680e+02 4.800e+02 2.200e+02 1.840e+02 1.129e+03
 1.160e+02 1.350e+02 2.660e+02 8.500e+01 3.090e+02 1.360e+02 2.880e+02
 7.000e+01 3.200e+02 5.000e+01 1.200e+02 4.360e+02 2.520e+02 8.400e+01
 6.640e+02 2.260e+02 3.000e+02 6.530e+02 1.120e+02 4.910e+02 2.680e+02
 7.480e+02 9.800e+01 2.750e+02 1.380e+02 2.050e+02 2.620e+02 1.280e+02
 2.600e+02 1.530e+02 6.400e+01 3.120e+02 1.600e+01 9.220e+02 1.420e+02
 2.900e+02 1.270e+02 5.060e+02 2.970e+02       nan 6.040e+02 2.540e+02
 3.600e+01 1.020e+02 4.720e+02 4.810e+02 1.080e+02 3.020e+02 1.720e+02
 3.990e+02 2.700e+02 4.600e+01 2.100e+02 1.740e+02 3.480e+02 3.150e+02
 2.990e+02 3.400e+02 1.660e+02 7.200e+01 3.100e+01 3.400e+01 2.380e+02
 1.600e+03 3.650e+02 5.600e+01 1.500e+02 2.780e+02 2.560e+02 2.250e+02
 3.700e+02 3.880e+02 1.750e+02 2.960e+02 1.460e+02 1.130e+02 1.760e+02
 6.160e+02 3.000e+01 1.060e+02 8.700e+02 3.620e+02 5.300e+02 5.000e+02
 5.100e+02 2.470e+02 3.050e+02 2.550e+02 1.250e+02 1.000e+02 4.320e+02
 1.260e+02 4.730e+02 7.400e+01 1.450e+02 2.320e+02 3.760e+02 4.200e+01
 1.610e+02 1.100e+02 1.800e+01 2.240e+02 2.480e+02 8.000e+01 3.040e+02
 2.150e+02 7.720e+02 4.350e+02 3.780e+02 5.620e+02 1.680e+02 8.900e+01
 2.850e+02 3.600e+02 9.400e+01 3.330e+02 9.210e+02 7.620e+02 5.940e+02
 2.190e+02 1.880e+02 4.790e+02 5.840e+02 1.820e+02 2.500e+02 2.920e+02
 2.450e+02 2.070e+02 8.200e+01 9.700e+01 3.350e+02 2.080e+02 4.200e+02
 1.700e+02 4.590e+02 2.800e+02 9.900e+01 1.920e+02 2.040e+02 2.330e+02
 1.560e+02 4.520e+02 5.130e+02 2.610e+02 1.640e+02 2.590e+02 2.090e+02
 2.630e+02 2.160e+02 3.510e+02 6.600e+02 3.810e+02 5.400e+01 5.280e+02
 2.580e+02 4.640e+02 5.700e+01 1.470e+02 1.170e+03 2.930e+02 6.300e+02
```

```
 4.660e+02 1.090e+02 4.100e+01 1.600e+02 2.890e+02 6.510e+02 1.690e+02
 9.500e+01 4.420e+02 2.020e+02 3.380e+02 8.940e+02 3.280e+02 6.730e+02
 6.030e+02 1.000e+00 3.750e+02 9.000e+01 3.800e+01 1.570e+02 1.100e+01
 1.400e+02 1.300e+02 1.480e+02 8.600e+02 4.240e+02 1.047e+03 2.430e+02
 8.160e+02 3.870e+02 2.230e+02 1.580e+02 1.370e+02 1.150e+02 1.890e+02
 2.740e+02 1.170e+02 6.000e+01 1.220e+02 9.200e+01 4.150e+02 7.600e+02
 2.700e+01 7.500e+01 3.610e+02 1.050e+02 3.420e+02 2.980e+02 5.410e+02
 2.360e+02 1.440e+02 4.230e+02 4.400e+01 1.510e+02 9.750e+02 4.500e+02
 2.300e+02 5.710e+02 2.400e+01 5.300e+01 2.060e+02 1.400e+01 3.240e+02
 2.950e+02 3.960e+02 6.700e+01 1.540e+02 4.250e+02 4.500e+01 1.378e+03
 3.370e+02 1.490e+02 1.430e+02 5.100e+01 1.710e+02 2.340e+02 6.300e+01
 7.660e+02 3.200e+01 8.100e+01 1.630e+02 5.540e+02 2.180e+02 6.320e+02
 1.140e+02 5.670e+02 3.590e+02 4.510e+02 6.210e+02 7.880e+02 8.600e+01
 7.960e+02 3.910e+02 2.280e+02 8.800e+01 1.650e+02 4.280e+02 4.100e+02
 5.640e+02 3.680e+02 3.180e+02 5.790e+02 6.500e+01 7.050e+02 4.080e+02
 2.440e+02 1.230e+02 3.660e+02 7.310e+02 4.480e+02 2.940e+02 3.100e+02
 2.370e+02 4.260e+02 9.600e+01 4.380e+02 1.940e+02 1.190e+02]
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ExterQual ['Gd' 'TA' 'Ex' 'Fa']
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ExterCond ['TA' 'Gd' 'Fa' 'Po' 'Ex']
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Foundation ['PConc' 'CBlock' 'BrkTil' 'Wood' 'Slab' 'Stone']
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BsmtQual ['Gd' 'TA' 'Ex' nan 'Fa']
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BsmtCond ['TA' 'Gd' nan 'Fa' 'Po']
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-  -
BsmtExposure ['No' 'Gd' 'Mn' 'Av' nan]
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BsmtFinType1 ['GLQ' 'ALQ' 'Unf' 'Rec' 'BLQ' nan 'LwQ']
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BsmtFinSF1 [ 706  978  486  216  655  732 1369  859    0  851  906  998  737
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  588  600  713 1046  648  310 1162  520  108  569 1200  224  705  444
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  445  695  405 1005  668  821  432 1300  507  679 1332  209  680  716
 1400  416  429  222   57  660 1016  370  351  379 1288  360  639  495
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 1126 1036 1088  641  617  662  312 1065  787  468   36  822  378  946
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  783  969  673 1358 1260  144  584  554 1002  619  180  559  308  866
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 1480 2096 1159  440 1456  883  547  788  485  340 1220  427  344  756
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 1053  532 1158 1014  194  167  776 5644  694 1572  746 1406  925  482
  189  765   80 1443  259  735  734 1447  548  315 1282  408  309  203
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  580  678  958 1336 1079   49  830]
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-  -
BsmtFinSF2 [   0   32  668  486   93  491  506  712  362   41  169  869  150
670
   28 1080  181  768  215  374  208  441  184  279  306  180  580  690
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  294  258  121  391  531  344  539  713  210  311 1120  165  532   96
  495  174 1127  139  202  645  123  551  219  606  612  480  182  132
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  127  630  128  377  764  345 1085  435  823  500  290  324  634  411
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  791  240  547  469  177  108  600  492  211  168 1031  438  375  144
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  110  627  163 1029]
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-  -
BsmtUnfSF [ 150  284  434  540  490   64  317  216  952  140  134  177  175 1494
  520  832  426    0  468  525 1158  637 1777  200  204 1566  180  486
  207  649 1228 1234  380  408 1117 1097   84  326  445  383  167  465
 1296   83 1632  736  192  612  816   32  935  321  860 1410  148  217
  530 1346  576  318 1143 1035  440  747  701  343  280  404  840  724
  295 1768  448   36 1530 1065  384 1288  684 1013  402  635  163  168
  176  370  350  381  410  741 1226 1053  641  516  793 1139  550  905
  104  310  252 1125  203  728  732  510  899 1362   30  958  556  413
  479  297  658  262  891 1304  519 1907  336  107  432  403  811  396
  970  506  884  400  896  253  409   93 1200  572  774  769 1335  340
  882  779  112  470  294 1686  360  441  354  700  725  320  554  312
  968  504 1107  577  660   99  871  474  289  600  755  625 1121  276
  186 1424 1140  375   92  305 1176   78  274  311  710  686  457 1232
 1498 1010  160 2336  630  638  162   70 1357 1194  773  483  235  125
 1390  594 1694  488  357  626  916 1020 1367  798  452  392  975  361
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  768  386 1468 1145  244  698 1079  570  476  131  184  143 1092  324
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  545  121 2046  161  261  567 1195  874 1342  151  989 1073  927  219
  224  526 1164  761  461  876  859  171  718  138  941  464  250   72
  508 1584  415   82  948  893  864 1349   76  487  652 1240  801  279
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  102  374 1413  491 1129  255 1496  650 1926  154  999 1734  124 1417
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  227  907  528  189 1273  563  372  702 1090  435  198 1372  174 1638
  894  299  105  676 1120  431  218  110  795 1098 1043  481  666  142
  447  783 1670  277  412  794  239  662 1072  717  546  430  422  188
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TotalBsmtSF [ 856 1262  920  756 1145  796 1686 1107  952  991 1040 1175  912
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  824  680 1588  960  458  950 1610  741 1226 1053  641  789  793 1844
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 1930 1396  916  822  750 1700 1007 1187  691 1574 1680 1346  985 1657
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 1475 2524 1992 1193  973  854  662 1103 1154  942 1048  727  690 1096
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  931 1660  559 1300 1702 1075 1361 1106 1476 1689 2076  792 2110 1405
 1192  746 1986  841 2002 1332  935 1019  661 1309 1328 1085 6110 1246
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  693 1284 1732 2033  570 1980  814  873  757 1108 2633 1571  984 1205
  714 1746 1525  482 1356  862  839 1286 1485 1594  622  791  708 1223
  913  656 1319 1932  539 1221 1542]
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-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -
Heating ['GasA' 'GasW' 'Grav' 'Wall' 'OthW' 'Floor']
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-  -
HeatingQC ['Ex' 'Gd' 'TA' 'Fa' 'Po']
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Electrical ['SBrkr' 'FuseF' 'FuseA' 'FuseP' 'Mix' nan]
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BsmtHalfBath [0 1 2]
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FullBath [2 1 3 0]
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- - - - - - - - - - - - - - - - - - - - - - - - - - -
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Functiol ['Typ' 'Min1' 'Maj1' 'Min2' 'Mod' 'Maj2' 'Sev']
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- - - - - - - - - - - - - - - - - - - - - - - - - - -
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Fireplaces [0 1 2 3]
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PavedDrive ['Y' 'N' 'P']
 -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -
WoodDeckSF [  0 298 192  40 255 235  90 147 140 160  48 240 171 100 406 222 288
49
```

```
 203 113 392 145 196 168 112 106 857 115 120  12 576 301 144 300  74 127
 232 158 352 182 180 166 224  80 367  53 188 105  24  98 276 200 409 239
 400 476 178 574 237 210 441 116 280 104  87 132 238 149 355  60 139 108
 351 209 216 248 143 365 370  58 197 263 123 138 333 250 292  95 262  81
 289 124 172 110 208 468 256 302 190 340 233 184 201 142 122 155 670 135
 495 536 306  64 364 353  66 159 146 296 125  44 215 264  88  89  96 414
 519 206 141 260 324 156 220  38 261 126  85 466 270  78 169 320 268  72
 349  42  35 326 382 161 179 103 253 148 335 176 390 328 312 185 269 195
  57 236 517 304 198 426  28 316 322 307 257 219 416 344 380  68 114 327
 165 187 181  92 228 245 503 315 241 303 133 403  36  52 265 207 150 290
 486 278  70 418 234  26 342  97 272 121 243 511 154 164 173 384 202  56
 321  86 194 421 305 117 550 509 153 394 371  63 252 136 186 170 474 214
 199 728 436  55 431 448 361 362 162 229 439 379 356  84 635 325  33 212
 314 242 294  30 128  45 177 227 218 309 404 500 668 402 283 183 175 586
 295  32 366 736]
 -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -
OpenPorchSF [ 61   0  42  35  84  30  57 204   4  21  33 213 112 102 154 159 110
90
  56  32  50 258  54  65  38  47  64  52 138 104  82  43 146  75  72  70
  49  11  36 151  29  94 101 199  99 234 162  63  68  46  45 122 184 120
  20  24 130 205 108  80  66  48  25  96 111 106  40 114   8 136 132  62
 228  60 238 260  27  74  16 198  26  83  34  55  22  98 172 119 208 105
 140 168  28  39 148  12  51 150 117 250  10  81  44 144 175 195 128  76
  17  59 214 121  53 231 134 192 123  78 187  85 133 176 113 137 125 523
 100 285  88 406 155  73 182 502 274 158 142 243 235 312 124 267 265  87
 288  23 152 341 116 160 174 247 291  18 170 156 166 129 418 240  77 364
 188 207  67  69 131 191  41 118 252 189 282 135  95 224 169 319  58  93
 244 185 200  92 180 263 304 229 103 211 287 292 241 547  91  86 262 210
 141  15 126 236]
 -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -
EnclosedPorch [  0 272 228 205 176  87 172 102  37 144  64 114 202 128 156  44
77 192
 140 180 183  39 184  40 552  30 126  96  60 150 120 112 252  52 224 234
 244 268 137  24 108 294 177 218 242  91 160 130 169 105  34 248 236  32
  80 115 291 116 158 210  36 200  84 148 136 240  54 100 189 293 164 216
 239  67  90  56 129  98 143  70 386 154 185 134 196 264 275 230 254  68
 194 318  48  94 138 226 174  19 170 220 214 280 190 330 208 145 259  81
  42 123 162 286 168  20 301 198 221 212  50  99]
 -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -
3SsnPorch [  0 320 407 130 180 168 140 508 238 245 196 144 182 162  23 216  96
153
 290 304]
```

```
 -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -
ScreenPorch [  0 176 198 291 252  99 184 168 130 142 192 410 224 266 170 154 153
144
 128 259 160 271 234 374 185 182  90 396 140 276 180 161 145 200 122  95
 120  60 126 189 260 147 385 287 156 100 216 210 197 204 225 152 175 312
 222 265 322 190 233  63  53 143 273 288 263  80 163 116 480 178 440 155
 220 119 165  40]
 -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -
PoolArea [  0 512 648 576 555 480 519 738]
 -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -
PoolQC [nan 'Ex' 'Fa' 'Gd']
 -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -
Fence [nan 'MnPrv' 'GdWo' 'GdPrv' 'MnWw']
 -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -
MiscFeature [nan 'Shed' 'Gar2' 'Othr' 'TenC']
 -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -
MiscVal [    0   700   350   500   400   480   450 15500  1200   800  2000   600
  3500  1300    54   620   560  1400  8300  1150  2500]
 -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -
MoSold [ 2  5  9 12 10  8 11  4  1  7  3  6]
 -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -
YrSold [2008 2007 2006 2009 2010]
 -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -
SaleType ['WD' 'New' 'COD' 'ConLD' 'ConLI' 'CWD' 'ConLw' 'Con' 'Oth']
 -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -
SaleCondition ['Normal' 'Abnorml' 'Partial' 'AdjLand' 'Alloca' 'Family']
 -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
```

```
-  -
SalePrice [208500 181500 223500 140000 250000 143000 307000 200000 129900 118000
 129500 345000 144000 279500 157000 132000 149000  90000 159000 139000
 325300 139400 230000 154000 256300 134800 306000 207500  68500  40000
 149350 179900 165500 277500 309000 145000 153000 109000  82000 160000
 170000 130250 141000 319900 239686 249700 113000 127000 177000 114500
 110000 385000 130000 180500 172500 196500 438780 124900 158000 101000
 202500 219500 317000 180000 226000  80000 225000 244000 185000 144900
 107400  91000 135750 136500 193500 153500 245000 126500 168500 260000
 174000 164500  85000 123600 109900  98600 163500 133900 204750 214000
  94750  83000 128950 205000 178000 118964 198900 169500 100000 115000
 190000 136900 383970 217000 259500 176000 155000 320000 163990 136000
 153900 181000  84500 128000  87000 150000 150750 220000 171000 231500
 166000 204000 125000 105000 222500 122000 372402 235000  79000 109500
 269500 254900 162500 412500 103200 152000 127500 325624 183500 228000
 128500 215000 239000 163000 184000 243000 211000 501837 200100 120000
 475000 173000 135000 153337 286000 315000 192000 148500 311872 104000
 274900 171500 112000 143900 277000  98000 186000 252678 156000 161750
 134450 210000 107000 311500 167240 204900  97000 386250 290000 106000
 192500 148000 403000  94500 128200 216500  89500 185500 194500 318000
 262500 110500 241500 137000  76500 276000 151000  73000 175500 179500
 120500 266000 124500 201000 415298 228500 244600 179200 164700  88000
 153575 233230 135900 131000 167000 142500 175000 158500 267000 149900
 295000 305900  82500 360000 165600 119900 375000 188500 270000 187500
 342643 354000 301000 126175 242000 324000 145250 214500  78000 119000
 284000 207000 228950 377426 202900  87500 140200 151500 157500 437154
 318061  95000 105900 177500 134000 280000 198500 147000 165000 162000
 172400 134432 123000  61000 340000 394432 179000 187750 213500  76000
 240000  81000 191000 426000 106500 129000  67000 241000 245500 164990
 108000 258000 168000 339750  60000 222000 181134 149500 126000 142000
 206300 275000 109008 195400  85400  79900 122500 212000 116000  90350
 555000 162900 199900 119500 188000 256000 161000 263435  62383 188700
 124000 178740 146500 187000 440000 251000 132500 208900 380000 297000
  89471 326000 374000 164000  86000 133000 172785  91300  34900 430000
 226700 289000 208300 164900 202665  96500 402861 265000 234000 106250
 184750 315750 446261 200624 107500  39300 111250 272000 248000 213250
 179665 229000 263000 112500 255500 121500 268000 325000 316600 135960
 142600 224500 118500 146000 131500 181900 253293 369900  79500 185900
 451950 138000 319000 114504 194201 217500 221000 359100 313000 261500
  75500 137500 183200 105500 314813 305000 165150 139900 209500  93000
 264561 274000 370878 143250  98300 205950 350000 145500  97500 197900
 402000 423000 230500 173500 103600 257500 372500 159434 285000 227875
 148800 392000 194700 755000 335000 108480 141500  89000 123500 138500
 196000 312500 361919 213000  55000 302000 254000 179540  52000 102776
 189000 130500 159500 341000 103000 236500 131400  93500 239900 299800
 236000 265979 260400 275500 158900 179400 215200 337000 264132 216837
 538000 134900 102000 395000 221500 175900 187100 161500 233000 107900
 160200 146800 269790 143500 485000 582933 227680 135500 159950 144500
```

```
 55993 157900 224900 271000 224000 183000 139500 232600 147400 237000
139950 174900 133500 189950 250580 248900 169000 200500  66500 303477
132250 328900 122900 154500 118858 142953 611657 125500 255000 154300
173733  75000  35311 238000 176500 145900 169990 193000 117500 184900
253000 239799 244400 150900 197500 172000 116500 214900 178900  37900
 99500 182000 167500  85500 178400 336000 159895 255900 117000 395192
195000 197000 348000 173900 337500 121600 206000 232000 136905 119200
227000 203000 213490 194000 287000 293077 310000 119750  84000 315500
262280 278000 139600 556581  84900 176485 200141 185850 328000 167900
151400  91500 138800 155900  83500 252000  92900 176432 274725 134500
184100 133700 118400 212900 163900 259000 239500  94000 424870 174500
116900 201800 218000 235128 108959 233170 245350 625000 171900 154900
392500 745000 186700 104900 262000 219210 116050 271900 229456  80500
137900 367294 101800 138887 265900 248328 465000 186500 169900 171750
294000 165400 301500  99900 128900 183900 378500 381000 185750  68400
150500 281000 333168 206900 295493 111000 156500  72500  52500 155835
108500 283463 410000 156932 144152 216000 274300 466500  58500 237500
377500 246578 281213 137450 193879 282922 257000 223000 274970 182900
192140 143750  64500 394617 149700 149300 121000 179600  92000 287090
266500 142125 147500]
 -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-  -
```

[10]:
```
#unique variables
df.nunique().sort_values()
```

[10]:
```
CentralAir          2
Utilities           2
Street              2
Alley               2
BsmtHalfBath        3
LandSlope           3
GarageFinish        3
HalfBath            3
PavedDrive          3
PoolQC              3
FullBath            4
MasVnrType          4
BsmtExposure        4
ExterQual           4
MiscFeature         4
BsmtFullBath        4
Fence               4
KitchenQual         4
BsmtCond            4
Fireplaces          4
```

```
LandContour         4
LotShape            4
KitchebvGr          4
BsmtQual            4
FireplaceQu         5
Electrical          5
YrSold              5
GarageCars          5
GarageQual          5
GarageCond          5
HeatingQC           5
ExterCond           5
MSZoning            5
LotConfig           5
BldgType            5
BsmtFinType2        6
Foundation          6
RoofStyle           6
SaleCondition       6
GarageType          6
BsmtFinType1        6
Heating             6
Functiol            7
RoofMatl            8
HouseStyle          8
Condition2          8
PoolArea            8
BedroomAbvGr        8
SaleType            9
Condition1          9
OverallCond         9
OverallQual        10
TotRmsAbvGrd       12
MoSold             12
Exterior1st        15
MSSubClass         15
Exterior2nd        16
3SsnPorch          20
MiscVal            21
LowQualFinSF       24
Neighborhood       25
YearRemodAdd       61
ScreenPorch        76
GarageYrBlt        97
LotFrontage       110
YearBuilt         112
EnclosedPorch     120
```

```
BsmtFinSF2        144
OpenPorchSF       202
WoodDeckSF        274
MasVnrArea        327
2ndFlrSF          417
GarageArea        441
BsmtFinSF1        637
SalePrice         663
TotalBsmtSF       721
1stFlrSF          753
BsmtUnfSF         780
GrLivArea         861
LotArea          1073
Id               1460
dtype: int64
```

1.0.1 Generate a separate dataset for numerical variables

[11]:
```
#generate a dataset for numerical variables
df_num=df.select_dtypes(include=[np.number])
df_num.head()
```

[11]:

	Id	MSSubClass	LotFrontage	LotArea	OverallQual	OverallCond	YearBuilt	\
0	1	60	65.0	8450	7	5	2003	
1	2	20	80.0	9600	6	8	1976	
2	3	60	68.0	11250	7	5	2001	
3	4	70	60.0	9550	7	5	1915	
4	5	60	84.0	14260	8	5	2000	

	YearRemodAdd	MasVnrArea	BsmtFinSF1	…	WoodDeckSF	OpenPorchSF	\
0	2003	196.0	706	…	0	61	
1	1976	0.0	978	…	298	0	
2	2002	162.0	486	…	0	42	
3	1970	0.0	216	…	0	35	
4	2000	350.0	655	…	192	84	

	EnclosedPorch	3SsnPorch	ScreenPorch	PoolArea	MiscVal	MoSold	YrSold	\
0	0	0	0	0	0	2	2008	
1	0	0	0	0	0	5	2007	
2	0	0	0	0	0	9	2008	
3	272	0	0	0	0	2	2006	
4	0	0	0	0	0	12	2008	

	SalePrice
0	208500
1	181500

```
2     223500
3     140000
4     250000

[5 rows x 38 columns]
```

[12]:
```
df_num.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1460 entries, 0 to 1459
Data columns (total 38 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   Id              1460 non-null   int64
 1   MSSubClass      1460 non-null   int64
 2   LotFrontage     1201 non-null   float64
 3   LotArea         1460 non-null   int64
 4   OverallQual     1460 non-null   int64
 5   OverallCond     1460 non-null   int64
 6   YearBuilt       1460 non-null   int64
 7   YearRemodAdd    1460 non-null   int64
 8   MasVnrArea      1452 non-null   float64
 9   BsmtFinSF1      1460 non-null   int64
 10  BsmtFinSF2      1460 non-null   int64
 11  BsmtUnfSF       1460 non-null   int64
 12  TotalBsmtSF     1460 non-null   int64
 13  1stFlrSF        1460 non-null   int64
 14  2ndFlrSF        1460 non-null   int64
 15  LowQualFinSF    1460 non-null   int64
 16  GrLivArea       1460 non-null   int64
 17  BsmtFullBath    1460 non-null   int64
 18  BsmtHalfBath    1460 non-null   int64
 19  FullBath        1460 non-null   int64
 20  HalfBath        1460 non-null   int64
 21  BedroomAbvGr    1460 non-null   int64
 22  KitchebvGr      1460 non-null   int64
 23  TotRmsAbvGrd    1460 non-null   int64
 24  Fireplaces      1460 non-null   int64
 25  GarageYrBlt     1379 non-null   float64
 26  GarageCars      1460 non-null   int64
 27  GarageArea      1460 non-null   int64
 28  WoodDeckSF      1460 non-null   int64
 29  OpenPorchSF     1460 non-null   int64
 30  EnclosedPorch   1460 non-null   int64
 31  3SsnPorch       1460 non-null   int64
 32  ScreenPorch     1460 non-null   int64
 33  PoolArea        1460 non-null   int64
```

```
 34  MiscVal        1460 non-null   int64
 35  MoSold         1460 non-null   int64
 36  YrSold         1460 non-null   int64
 37  SalePrice      1460 non-null   int64
dtypes: float64(3), int64(35)
memory usage: 433.6 KB
```

1.0.2 EDA of numerical variables

[13]:
```
# missing numerical data
df_num.isnull().sum().sort_values(ascending=False)
```

[13]:
```
LotFrontage      259
GarageYrBlt       81
MasVnrArea         8
BsmtFinSF1         0
LowQualFinSF       0
2ndFlrSF           0
1stFlrSF           0
TotalBsmtSF        0
BsmtUnfSF          0
BsmtFinSF2         0
SalePrice          0
BsmtFullBath       0
YearRemodAdd       0
YearBuilt          0
OverallCond        0
OverallQual        0
LotArea            0
MSSubClass         0
GrLivArea          0
BsmtHalfBath       0
YrSold             0
FullBath           0
MoSold             0
MiscVal            0
PoolArea           0
ScreenPorch        0
3SsnPorch          0
EnclosedPorch      0
OpenPorchSF        0
WoodDeckSF         0
GarageArea         0
GarageCars         0
Fireplaces         0
TotRmsAbvGrd       0
```

```
KitchebvGr          0
BedroomAbvGr        0
HalfBath            0
Id                  0
dtype: int64
```

[14]:
```
# drop missing data
df_nd = df_num.dropna()
```

[15]:
```
# check if dropped
df_nd.isnull().sum()
```

[15]:
```
Id               0
MSSubClass       0
LotFrontage      0
LotArea          0
OverallQual      0
OverallCond      0
YearBuilt        0
YearRemodAdd     0
MasVnrArea       0
BsmtFinSF1       0
BsmtFinSF2       0
BsmtUnfSF        0
TotalBsmtSF      0
1stFlrSF         0
2ndFlrSF         0
LowQualFinSF     0
GrLivArea        0
BsmtFullBath     0
BsmtHalfBath     0
FullBath         0
HalfBath         0
BedroomAbvGr     0
KitchebvGr       0
TotRmsAbvGrd     0
Fireplaces       0
GarageYrBlt      0
GarageCars       0
GarageArea       0
WoodDeckSF       0
OpenPorchSF      0
EnclosedPorch    0
3SsnPorch        0
ScreenPorch      0
PoolArea         0
MiscVal          0
```

```
MoSold           0
YrSold           0
SalePrice        0
dtype: int64
```

[16]:
```
#Checking the skewness of entire data
df.skew(axis = 0, skipna = True)
```

[16]:
```
Id               0.000000
MSSubClass       1.407657
LotFrontage      2.163569
LotArea         12.207688
OverallQual      0.216944
OverallCond      0.693067
YearBuilt       -0.613461
YearRemodAdd    -0.503562
MasVnrArea       2.669084
BsmtFinSF1       1.685503
BsmtFinSF2       4.255261
BsmtUnfSF        0.920268
TotalBsmtSF      1.524255
1stFlrSF         1.376757
2ndFlrSF         0.813030
LowQualFinSF     9.011341
GrLivArea        1.366560
BsmtFullBath     0.596067
BsmtHalfBath     4.103403
FullBath         0.036562
HalfBath         0.675897
BedroomAbvGr     0.211790
KitchebvGr       4.488397
TotRmsAbvGrd     0.676341
Fireplaces       0.649565
GarageYrBlt     -0.649415
GarageCars      -0.342549
GarageArea       0.179981
WoodDeckSF       1.541376
OpenPorchSF      2.364342
EnclosedPorch    3.089872
3SsnPorch       10.304342
ScreenPorch      4.122214
PoolArea        14.828374
MiscVal         24.476794
MoSold           0.212053
YrSold           0.096269
SalePrice        1.882876
dtype: float64
```

[17]:
```
#Checking skewness and kurtosis of SalePrice
print("Skewness: %f" % df['SalePrice'].skew())
```

```
Skewness: 1.882876
```

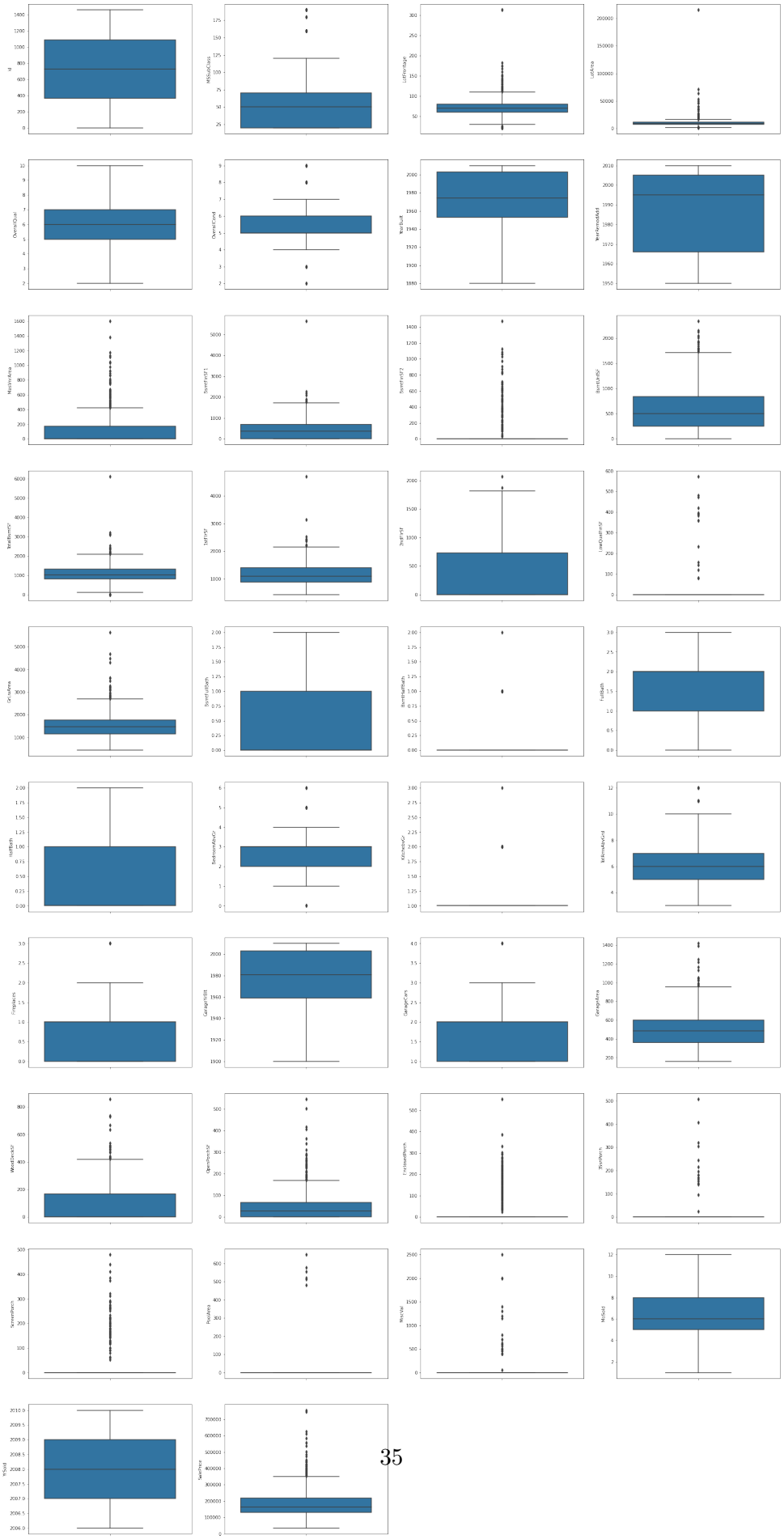
[18]:
```
n=np.ceil(df_num.shape[1]/2).astype(int)
n
```

[18]:
```
19
```

[19]:
```
# showing skew and distribution. besides the years things are made, most things␣
 ↪are right skewed.
plt.figure(figsize=(30,120))
for i,j in enumerate(df_nd.columns):
    plt.subplot(n,4,i+1)
    sns.histplot(data=df_nd,x=j)
plt.show()
```


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

[20]:
```
# looking at outliers
plt.figure(figsize=(30,120))
for i,j in enumerate(df_nd.columns):
    plt.subplot(n,4,i+1)
    sns.boxplot(data=df_nd,y=j)
plt.show()
```


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

[21]:
```
# checking for max house price
df_nd.SalePrice.describe()
```

[21]:
```
count      1121.000000
mean     185506.152542
std       82999.159004
min       35311.000000
25%      131000.000000
50%      164900.000000
75%      219500.000000
max      755000.000000
Name: SalePrice, dtype: float64
```

[22]:
```
# looking at top 5 house price info
df_nd.sort_values(by='SalePrice', ascending=False).head().transpose()
```

[22]:

	691	1182	1169	898	803
Id	692.0	1183.0	1170.0	899.0	804.0
MSSubClass	60.0	60.0	60.0	20.0	60.0
LotFrontage	104.0	160.0	118.0	100.0	107.0
LotArea	21535.0	15623.0	35760.0	12919.0	13891.0
OverallQual	10.0	10.0	10.0	9.0	9.0
OverallCond	6.0	5.0	5.0	5.0	5.0
YearBuilt	1994.0	1996.0	1995.0	2009.0	2008.0
YearRemodAdd	1995.0	1996.0	1996.0	2010.0	2009.0
MasVnrArea	1170.0	0.0	1378.0	760.0	424.0
BsmtFinSF1	1455.0	2096.0	1387.0	2188.0	0.0
BsmtFinSF2	0.0	0.0	0.0	0.0	0.0
BsmtUnfSF	989.0	300.0	543.0	142.0	1734.0
TotalBsmtSF	2444.0	2396.0	1930.0	2330.0	1734.0
1stFlrSF	2444.0	2411.0	1831.0	2364.0	1734.0
2ndFlrSF	1872.0	2065.0	1796.0	0.0	1088.0
LowQualFinSF	0.0	0.0	0.0	0.0	0.0
GrLivArea	4316.0	4476.0	3627.0	2364.0	2822.0
BsmtFullBath	0.0	1.0	1.0	1.0	0.0
BsmtHalfBath	1.0	0.0	0.0	0.0	0.0
FullBath	3.0	3.0	3.0	2.0	3.0
HalfBath	1.0	1.0	1.0	1.0	1.0
BedroomAbvGr	4.0	4.0	4.0	2.0	4.0
KitchebvGr	1.0	1.0	1.0	1.0	1.0
TotRmsAbvGrd	10.0	10.0	10.0	11.0	12.0
Fireplaces	2.0	2.0	1.0	2.0	1.0
GarageYrBlt	1994.0	1996.0	1995.0	2009.0	2009.0
GarageCars	3.0	3.0	3.0	3.0	3.0
GarageArea	832.0	813.0	807.0	820.0	1020.0

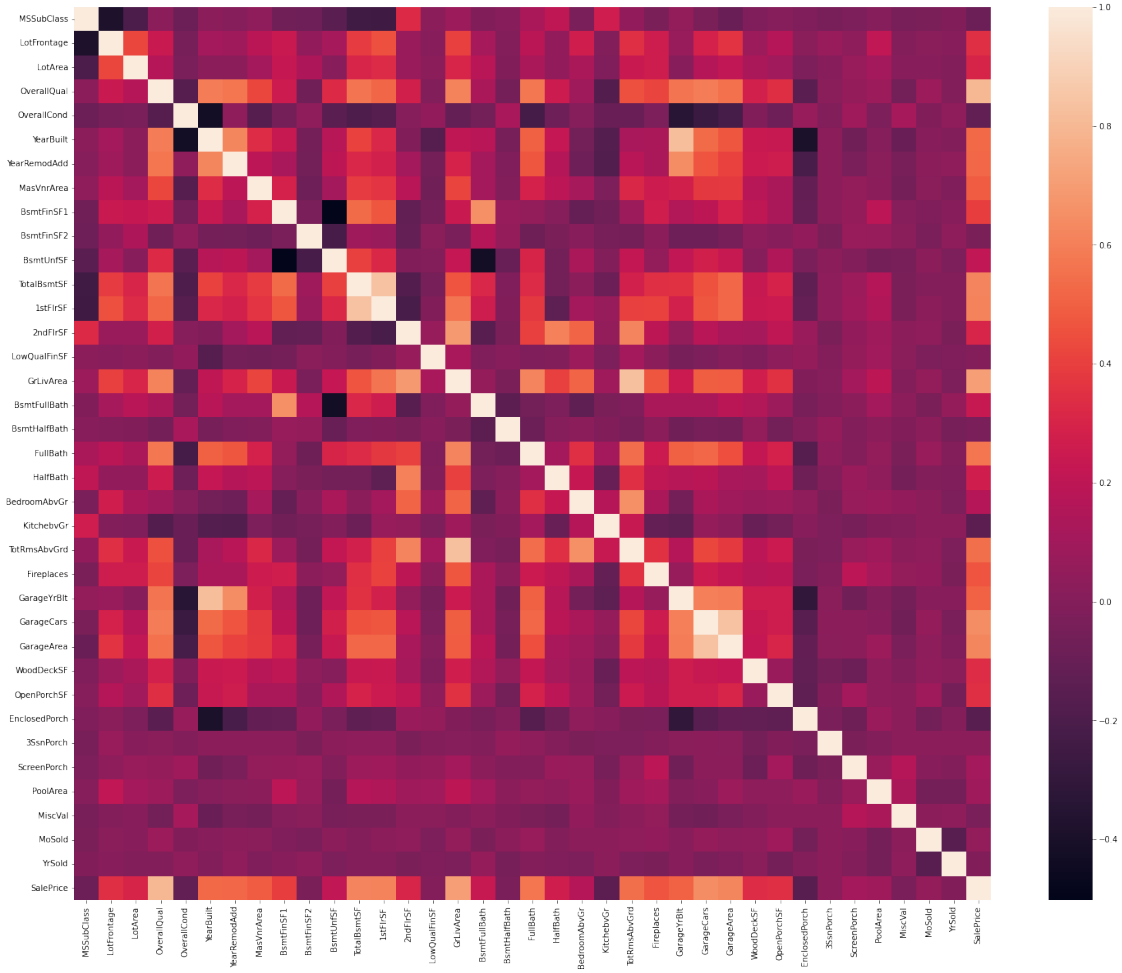
WoodDeckSF	382.0	171.0	361.0	0.0	52.0
OpenPorchSF	50.0	78.0	76.0	67.0	170.0
EnclosedPorch	0.0	0.0	0.0	0.0	0.0
3SsnPorch	0.0	0.0	0.0	0.0	0.0
ScreenPorch	0.0	0.0	0.0	0.0	192.0
PoolArea	0.0	555.0	0.0	0.0	0.0
MiscVal	0.0	0.0	0.0	0.0	0.0
MoSold	1.0	7.0	7.0	3.0	1.0
YrSold	2007.0	2007.0	2006.0	2010.0	2009.0
SalePrice	755000.0	745000.0	625000.0	611657.0	582933.0

[23]:
```
# dropping the id column because no need
df_nd.drop('Id', axis=1, inplace=True)
```

[24]:
```
#Code to find correlation
corr = df_nd.corr()
corr.style.background_gradient(cmap='coolwarm')
```

[24]:
```
<pandas.io.formats.style.Styler at 0x7f5140673190>
```

[25]:
```
# correlation heatmap of everything
plt.figure(figsize=(25,20))
sns.heatmap(df_nd.corr())
plt.show()
```



[26]:
```
#correlation matrix
corrData=df_nd.corr()['SalePrice'].sort_values(ascending=False)
corrData
#only correlated is SalePrice, OverallQual, GrLivArea, GarageCars, GarageArea,␣
↪TotalBsmtSF, 1stFlrSF, FullBath, TotRmsAbvGrd, YearBuilt, YearRemodAdd,␣
↪GarageYrBlt
```

[26]:
```
SalePrice       1.000000
OverallQual     0.797881
GrLivArea       0.705154
GarageCars      0.647034
GarageArea      0.619330
TotalBsmtSF     0.615612
1stFlrSF        0.607969
FullBath        0.566627
TotRmsAbvGrd    0.547067
YearBuilt       0.525394
```

```
YearRemodAdd     0.521253
GarageYrBlt      0.504753
MasVnrArea       0.488658
Fireplaces       0.461873
BsmtFinSF1       0.390301
LotFrontage      0.344270
OpenPorchSF      0.343354
WoodDeckSF       0.336855
2ndFlrSF         0.306879
LotArea          0.299962
HalfBath         0.268560
BsmtFullBath     0.236737
BsmtUnfSF        0.213129
BedroomAbvGr     0.166814
ScreenPorch      0.110427
PoolArea         0.092488
MoSold           0.051568
3SsnPorch        0.030777
LowQualFinSF    -0.001482
YrSold          -0.011869
BsmtFinSF2      -0.028021
MiscVal         -0.036041
BsmtHalfBath    -0.036513
MSSubClass      -0.088032
OverallCond     -0.124391
KitchebvGr      -0.140497
EnclosedPorch   -0.154843
Name: SalePrice, dtype: float64
```

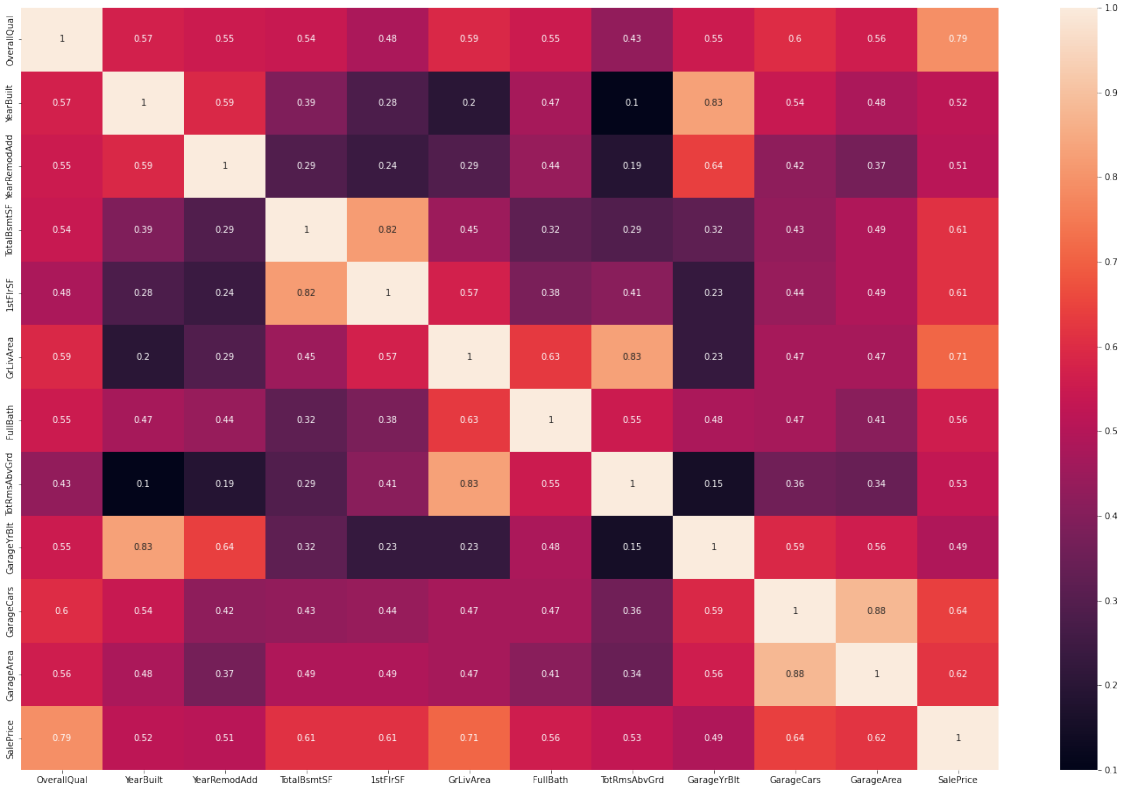
[27]:
```
# showing whatever columns with a correlation lower than .5
columnsDropped=corrData[corrData<.5].index
columnsDropped
```

[27]:
```
Index(['MasVnrArea', 'Fireplaces', 'BsmtFinSF1', 'LotFrontage', 'OpenPorchSF',
       'WoodDeckSF', '2ndFlrSF', 'LotArea', 'HalfBath', 'BsmtFullBath',
       'BsmtUnfSF', 'BedroomAbvGr', 'ScreenPorch', 'PoolArea', 'MoSold',
       '3SsnPorch', 'LowQualFinSF', 'YrSold', 'BsmtFinSF2', 'MiscVal',
       'BsmtHalfBath', 'MSSubClass', 'OverallCond', 'KitchebvGr',
       'EnclosedPorch'],
      dtype='object')
```

[28]:
```
# dropping whatever columns with a correlation lower than .5
df_nd2 = df_num.drop(columns=columnsDropped)
```

[29]:
```
# dropping the id column because no need
df_nd2.drop('Id', axis=1, inplace=True)
```

[30]:
```
# heatmap of whatever columns with a corr score > 0.5
plt.figure(figsize=(25,16))
sns.heatmap(df_nd2.corr().round(2), annot=True)
plt.show()
```



[31]:
```
#dropped YearRemodAdd, 1stFlrSF, TotRmsAbvGrd, GarageArea, GarageYrBlt.
#OverallQual is highly correlated to SalePrice
#GrLivArea is highly correlated with TotRmsAbvGrd, which means I can drop one␣
 ↪of the variables. I dropped TotRmsAbvGrd because GrLivArea is more␣
 ↪correlated with SalePrice.
#GarageCars and GarageArea are highly correlated with each other. I dropped␣
 ↪GarageArea because GarageCars is more correlated with SalePrice.
#TotalBsmtSF is highly correlated with 1stFlrSF, so I dropped 1stFlrSF.

#Only categorical variables left are OverallQual, GrLivArea, GarageCars,␣
 ↪TotalBsmtSF, FullBath, YearBuilt.
df_nd3=df_nd2.drop(['YearRemodAdd', '1stFlrSF', 'TotRmsAbvGrd','GarageArea',␣
 ↪'GarageYrBlt'], axis = 1)
df_nd3.head()
```

[31]:

	OverallQual	YearBuilt	TotalBsmtSF	GrLivArea	FullBath	GarageCars	SalePrice
0	7	2003	856	1710	2	2	208500
1	6	1976	1262	1262	2	2	181500
2	7	2001	920	1786	2	2	223500
3	7	1915	756	1717	1	3	140000
4	8	2000	1145	2198	2	3	250000

[32]:
```
num = ['SalePrice', 'OverallQual', 'GrLivArea', 'GarageCars', 'TotalBsmtSF',␣
 ↪'FullBath', 'YearBuilt']
sns.pairplot(df_nd3[num],hue="SalePrice")
plt.show()
```

1.0.3 Generate a separate dataset for categorical variables

[33]:
```
# select only categoricals
df_cat=df.select_dtypes(include=['object'])
df_cat.head()
```

[33]:

	MSZoning	Street	Alley	LotShape	LandContour	Utilities	LotConfig	LandSlope	\
0	RL	Pave	NaN	Reg	Lvl	AllPub	Inside	Gtl	
1	RL	Pave	NaN	Reg	Lvl	AllPub	FR2	Gtl	
2	RL	Pave	NaN	IR1	Lvl	AllPub	Inside	Gtl	
3	RL	Pave	NaN	IR1	Lvl	AllPub	Corner	Gtl	
4	RL	Pave	NaN	IR1	Lvl	AllPub	FR2	Gtl	

	Neighborhood	Condition1	…	GarageType	GarageFinish	GarageQual	GarageCond	\

```
0      CollgCr       Norm  …      Attchd          RFn         TA         TA
1      Veenker      Feedr  …      Attchd          RFn         TA         TA
2      CollgCr       Norm  …      Attchd          RFn         TA         TA
3      Crawfor       Norm  …      Detchd          Unf         TA         TA
4      NoRidge       Norm  …      Attchd          RFn         TA         TA

  PavedDrive PoolQC Fence MiscFeature SaleType SaleCondition
0          Y    NaN   NaN         NaN       WD        Normal
1          Y    NaN   NaN         NaN       WD        Normal
2          Y    NaN   NaN         NaN       WD        Normal
3          Y    NaN   NaN         NaN       WD       Abnorml
4          Y    NaN   NaN         NaN       WD        Normal

[5 rows x 43 columns]
```

1.0.4 EDA of categorical variables

[34]:
```
df_cat.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1460 entries, 0 to 1459
Data columns (total 43 columns):
 #   Column         Non-Null Count  Dtype
---  ------         --------------  -----
 0   MSZoning       1460 non-null   object
 1   Street         1460 non-null   object
 2   Alley          91 non-null     object
 3   LotShape       1460 non-null   object
 4   LandContour    1460 non-null   object
 5   Utilities      1460 non-null   object
 6   LotConfig      1460 non-null   object
 7   LandSlope      1460 non-null   object
 8   Neighborhood   1460 non-null   object
 9   Condition1     1460 non-null   object
 10  Condition2     1460 non-null   object
 11  BldgType       1460 non-null   object
 12  HouseStyle     1460 non-null   object
 13  RoofStyle      1460 non-null   object
 14  RoofMatl       1460 non-null   object
 15  Exterior1st    1460 non-null   object
 16  Exterior2nd    1460 non-null   object
 17  MasVnrType     1452 non-null   object
 18  ExterQual      1460 non-null   object
 19  ExterCond      1460 non-null   object
 20  Foundation     1460 non-null   object
 21  BsmtQual       1423 non-null   object
```

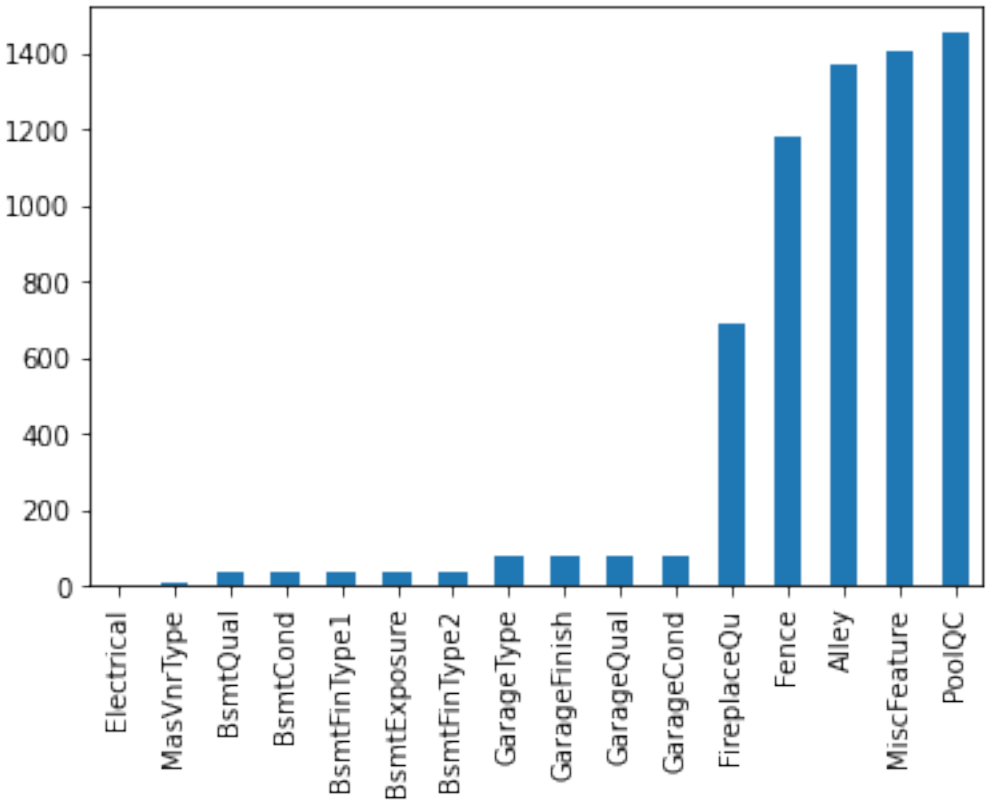
```
 22  BsmtCond       1423 non-null   object
 23  BsmtExposure   1422 non-null   object
 24  BsmtFinType1   1423 non-null   object
 25  BsmtFinType2   1422 non-null   object
 26  Heating        1460 non-null   object
 27  HeatingQC      1460 non-null   object
 28  CentralAir     1460 non-null   object
 29  Electrical     1459 non-null   object
 30  KitchenQual    1460 non-null   object
 31  Functiol       1460 non-null   object
 32  FireplaceQu    770 non-null    object
 33  GarageType     1379 non-null   object
 34  GarageFinish   1379 non-null   object
 35  GarageQual     1379 non-null   object
 36  GarageCond     1379 non-null   object
 37  PavedDrive     1460 non-null   object
 38  PoolQC         7 non-null      object
 39  Fence          281 non-null    object
 40  MiscFeature    54 non-null     object
 41  SaleType       1460 non-null   object
 42  SaleCondition  1460 non-null   object
dtypes: object(43)
memory usage: 490.6+ KB
```

[35]:
```
# missing categorical data
df_cat.isnull().sum().sort_values(ascending=False)
```

[35]:
```
PoolQC          1453
MiscFeature     1406
Alley           1369
Fence           1179
FireplaceQu      690
GarageCond        81
GarageQual        81
GarageFinish      81
GarageType        81
BsmtFinType2      38
BsmtExposure      38
BsmtFinType1      37
BsmtQual          37
BsmtCond          37
MasVnrType         8
Electrical         1
Condition2         0
Condition1         0
Neighborhood       0
LandSlope          0
```

```
BldgType            0
LandContour         0
LotConfig           0
Utilities           0
RoofStyle           0
LotShape            0
Street              0
HouseStyle          0
SaleCondition       0
RoofMatl            0
Exterior1st         0
Exterior2nd         0
ExterQual           0
ExterCond           0
Foundation          0
SaleType            0
Heating             0
HeatingQC           0
CentralAir          0
KitchenQual         0
Functiol            0
PavedDrive          0
MSZoning            0
dtype: int64
```

[36]:
```
#plotting the missing data. 5 have over 50% of data missing
missing = df_cat.isnull().sum()
missing = missing[missing > 0]
missing.sort_values(inplace=True)
missing.plot.bar()
plt.show()
```



[37]:
```
# drop missing data
df_cat2 = df_cat.drop(['PoolQC','MiscFeature','Alley','Fence','FireplaceQu'],␣
↪axis=1)
```

[38]:
```
# check if dropped
df_cat2.isnull().sum(axis=0).sort_values(ascending=False)
```

[38]:
```
GarageCond       81
GarageQual       81
GarageFinish     81
GarageType       81
BsmtFinType2     38
BsmtExposure     38
BsmtCond         37
BsmtQual         37
BsmtFinType1     37
MasVnrType        8
Electrical        1
SaleCondition     0
BldgType          0
Condition2        0
```

```
Condition1        0
Neighborhood      0
LandSlope         0
RoofStyle         0
LotConfig         0
Utilities         0
LandContour       0
LotShape          0
Street            0
HouseStyle        0
ExterCond         0
RoofMatl          0
Exterior1st       0
Exterior2nd       0
ExterQual         0
SaleType          0
Foundation        0
Heating           0
HeatingQC         0
CentralAir        0
KitchenQual       0
Functiol          0
PavedDrive        0
MSZoning          0
dtype: int64
```

[39]:
```
df_cat2.dropna(inplace=True)
df_cat2.isnull().sum(axis=0)
```

[39]:
```
MSZoning         0
Street           0
LotShape         0
LandContour      0
Utilities        0
LotConfig        0
LandSlope        0
Neighborhood     0
Condition1       0
Condition2       0
BldgType         0
HouseStyle       0
RoofStyle        0
RoofMatl         0
Exterior1st      0
Exterior2nd      0
MasVnrType       0
ExterQual        0
```

```
ExterCond        0
Foundation       0
BsmtQual         0
BsmtCond         0
BsmtExposure     0
BsmtFinType1     0
BsmtFinType2     0
Heating          0
HeatingQC        0
CentralAir       0
Electrical       0
KitchenQual      0
Functiol         0
GarageType       0
GarageFinish     0
GarageQual       0
GarageCond       0
PavedDrive       0
SaleType         0
SaleCondition    0
dtype: int64
```

[40]:
```
# add SalePrice to the df_cat2
df_cat2['SalePrice'] = df.loc[df_cat2.index, 'SalePrice'].copy()
df_cat2.head()
```

[40]:

	MSZoning	Street	LotShape	LandContour	Utilities	LotConfig	LandSlope	\
0	RL	Pave	Reg	Lvl	AllPub	Inside	Gtl	
1	RL	Pave	Reg	Lvl	AllPub	FR2	Gtl	
2	RL	Pave	IR1	Lvl	AllPub	Inside	Gtl	
3	RL	Pave	IR1	Lvl	AllPub	Corner	Gtl	
4	RL	Pave	IR1	Lvl	AllPub	FR2	Gtl	

	Neighborhood	Condition1	Condition2	…	KitchenQual	Functiol	GarageType	\
0	CollgCr	Norm	Norm	…	Gd	Typ	Attchd	
1	Veenker	Feedr	Norm	…	TA	Typ	Attchd	
2	CollgCr	Norm	Norm	…	Gd	Typ	Attchd	
3	Crawfor	Norm	Norm	…	Gd	Typ	Detchd	
4	NoRidge	Norm	Norm	…	Gd	Typ	Attchd	

	GarageFinish	GarageQual	GarageCond	PavedDrive	SaleType	SaleCondition	\
0	RFn	TA	TA	Y	WD	Normal	
1	RFn	TA	TA	Y	WD	Normal	
2	RFn	TA	TA	Y	WD	Normal	
3	Unf	TA	TA	Y	WD	Abnorml	
4	RFn	TA	TA	Y	WD	Normal	

```
  SalePrice
0    208500
1    181500
2    223500
3    140000
4    250000

[5 rows x 39 columns]
```

[41]:
```
#how many rows needed for subplots
r=np.ceil(df_cat2.shape[1]/2).astype(int)
r
```

[41]:
```
20
```

[42]:
```
#bivariate analysis countplot for the categorical variables
plt.figure(figsize=(30,90))
for i, j in enumerate (df_cat2):
    plt.subplot(r,4,i+1)
    sns.countplot(j,data=df_cat2)
plt.show()
```

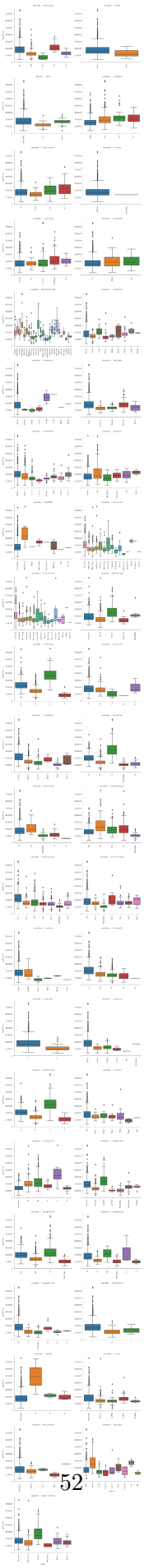

count
MSZoning
RL RM C (all) FV RH
Street
Pave Grvl
LotShape
Reg IR1 IR2 IR3
LandContour
Lvl Bnk Low HLS
Utilities
AllPub NoSeWa
LotConfig
Inside FR2 Corner CulDSac FR3
LandSlope
Gtl Mod Sev
Neighborhood
Condition1
Norm Feedr PosN Artery RRAe RRNn RRAn PosA RRNe
Condition2
Norm Artery RRNn Feedr PosN PosA RRAn RRAe
BldgType
1Fam 2fmCon TwnhsE Duplex Twnhs
HouseStyle
2Story 1Story 1.5Fin 1.5Unf SFoyer SLvl 2.5Unf 2.5Fin
RoofStyle
Gable Hip Gambrel Mansard Flat Shed
RoofMatl
CompShg WdShngl Metal WdShake Membran Tar&Grv Roll ClyTile
Exterior1st
Exterior2nd
MasVnrType
BrkFace None Stone BrkCmn
ExterQual
Gd TA Ex Fa
ExterCond
TA Gd Fa Ex
Foundation
PConc CBlock BrkTil Wood Stone
BsmtQual
Gd TA Ex Fa
BsmtCond
TA Gd Fa Po
BsmtExposure
No Gd Mn Av
BsmtFinType1
GLQ ALQ Unf Rec BLQ LwQ
BsmtFinType2
Unf BLQ ALQ Rec LwQ GLQ
Heating
GasA GasW Grav OthW
HeatingQC
Ex Gd TA Fa Po
CentralAir
Y N
Electrical
SBrkr FuseF FuseA FuseP Mix
KitchenQual
Gd TA Ex Fa
Functional
Typ Min1 Maj1 Min2 Mod Maj2 Sev
GarageType
Attchd Detchd BuiltIn CarPort Basment 2Types
GarageFinish
RFn Unf Fin
GarageQual
TA Fa Gd Ex Po
GarageCond
TA Fa Gd Po Ex
PavedDrive
Y N P
SaleType
WD New COD ConLI ConLw Con ConLD Oth
SaleCondition
Normal Abnorml Partial Family Alloca AdjLand
SalePrice

[43]:
```
#check distribution of SalePrice with respect to variable values

qualitative = [f for f in df.columns if df.dtypes[f] == 'object']

for c in qualitative:
    df[c] = df[c].astype('category')
    if df[c].isnull().any():
        df[c] = df[c].cat.add_categories(['MISSING'])
        df[c] = df[c].fillna('MISSING')

def boxplot(x, y, **kwargs):
    sns.boxplot(x=x, y=y)
    x=plt.xticks(rotation=90)
f = pd.melt(df, id_vars=['SalePrice'], value_vars=qualitative)
g = sns.FacetGrid(f, col="variable",  col_wrap=2, sharex=False, sharey=False,␣
 ↪size=5)
g = g.map(boxplot, "value", "SalePrice")
```



[44]:
```
#finding significant variables using p-value and chi squared test

class ChiSquared:
#Function finding p-value for chi-squared test
    def __init__(self, df):
        self.df = df
        self.p = None #P-Value
        self.chi2 = None #Chi-square Test Statistic
        self.dof = None

        self.dfObserved = None
        self.dfExpected = None

#Function prining results of p-value and chi-square test
    def _print_chisquare_result(self, colX, alpha):
        result = ""
        if self.p<alpha:
            result="KEEP {0} for prediction. {0} passes".format(colX)
        else:
            result="DO NOT keep {0}.".format(colX)
        print(result)

#Function determining chi-square and p-value less than or equal to 0.05
    def TestIndependence(self,colX,colY, alpha=0.05):
        X = self.df[colX].astype(str)
        Y = self.df[colY].astype(str)

        self.dfObserved = pd.crosstab(Y,X)
        chi2, p, dof, expected = stats.chi2_contingency(self.dfObserved.values)
        self.p = p
        self.chi2 = chi2
        self.dof = dof
        self.dfExpected = pd.DataFrame(expected, columns=self.dfObserved.
 ↪columns, index = self.dfObserved.index)
        self._print_chisquare_result(colX,alpha)
```

[45]:
```
#Initializing ChiSquare Class
chi_results = ChiSquared(df_cat2)
#Perform Feature Selection
test_cols = ['MSZoning', 'Street', 'LotShape', 'LandContour', 'Utilities',␣
 ↪'LotConfig', 'LandSlope', 'Neighborhood', 'Condition1', 'Condition2',␣
 ↪'BldgType', 'HouseStyle', 'RoofStyle',
```

```
            'RoofMatl', 'Exterior1st', 'Exterior2nd', 'MasVnrType',␣
 ↪'ExterQual', 'ExterCond', 'Foundation', 'BsmtQual', 'BsmtCond',␣
 ↪'BsmtExposure', 'BsmtFinType1', 'BsmtFinType2', 'Heating',
            'HeatingQC', 'CentralAir', 'Electrical', 'KitchenQual',␣
 ↪'Functiol', 'GarageType', 'GarageFinish', 'GarageQual', 'GarageCond',␣
 ↪'PavedDrive', 'SaleType', 'SaleCondition','SalePrice']
for var in test_cols:
    chi_results.TestIndependence(colX=var,colY="SalePrice" )
```

```
KEEP MSZoning for prediction. MSZoning passes
KEEP Street for prediction. Street passes
KEEP LotShape for prediction. LotShape passes
DO NOT keep LandContour.
DO NOT keep Utilities.
DO NOT keep LotConfig.
DO NOT keep LandSlope.
KEEP Neighborhood for prediction. Neighborhood passes
DO NOT keep Condition1.
KEEP Condition2 for prediction. Condition2 passes
DO NOT keep BldgType.
DO NOT keep HouseStyle.
DO NOT keep RoofStyle.
DO NOT keep RoofMatl.
DO NOT keep Exterior1st.
DO NOT keep Exterior2nd.
KEEP MasVnrType for prediction. MasVnrType passes
KEEP ExterQual for prediction. ExterQual passes
DO NOT keep ExterCond.
KEEP Foundation for prediction. Foundation passes
KEEP BsmtQual for prediction. BsmtQual passes
KEEP BsmtCond for prediction. BsmtCond passes
KEEP BsmtExposure for prediction. BsmtExposure passes
DO NOT keep BsmtFinType1.
DO NOT keep BsmtFinType2.
DO NOT keep Heating.
DO NOT keep HeatingQC.
KEEP CentralAir for prediction. CentralAir passes
KEEP Electrical for prediction. Electrical passes
KEEP KitchenQual for prediction. KitchenQual passes
DO NOT keep Functiol.
KEEP GarageType for prediction. GarageType passes
KEEP GarageFinish for prediction. GarageFinish passes
KEEP GarageQual for prediction. GarageQual passes
DO NOT keep GarageCond.
DO NOT keep PavedDrive.
KEEP SaleType for prediction. SaleType passes
KEEP SaleCondition for prediction. SaleCondition passes
```

KEEP SalePrice for prediction. SalePrice passes

[46]:
```
#from the chi squrared and pvalue test, all of these are significant:
'''Important variables: MSZoningStreet, LotShape, Neighborhood, Condition2,␣
 ↪MasVnrType, ExterQual,
Foundation, BsmtQual, BsmtCond, BsmtExposure, CentralAir, Electrical,
KitchenQual, GarageType, GarageFinish, GarageQual, SaleType, SaleCondition, and␣
 ↪SalePrice'''
```

[46]:
```
'Important variables: MSZoningStreet, LotShape, Neighborhood, Condition2,
MasVnrType, ExterQual,\nFoundation, BsmtQual, BsmtCond, BsmtExposure,
CentralAir, Electrical, \nKitchenQual, GarageType, GarageFinish, GarageQual,
SaleType, SaleCondition, and SalePrice'
```

[47]:
```
#Significant variabes
df_sigcat =␣
 ↪df_cat2[['MSZoning','Street','LotShape','Neighborhood','Condition2','MasVnrType','ExterQual
                    ␣
 ↪'Electrical','KitchenQual','GarageType','GarageFinish','GarageQual','SaleType','SaleConditi
```

[48]:
```
df_sigcat.head()
```

[48]:

	MSZoning	Street	LotShape	Neighborhood	Condition2	MasVnrType	ExterQual	\
0	RL	Pave	Reg	CollgCr	Norm	BrkFace	Gd	
1	RL	Pave	Reg	Veenker	Norm	None	TA	
2	RL	Pave	IR1	CollgCr	Norm	BrkFace	Gd	
3	RL	Pave	IR1	Crawfor	Norm	None	TA	
4	RL	Pave	IR1	NoRidge	Norm	BrkFace	Gd	

	Foundation	BsmtQual	BsmtCond	BsmtExposure	CentralAir	Electrical	KitchenQual	\
0	PConc	Gd	TA	No	Y	SBrkr	Gd	
1	CBlock	Gd	TA	Gd	Y	SBrkr	TA	
2	PConc	Gd	TA	Mn	Y	SBrkr	Gd	
3	BrkTil	TA	Gd	No	Y	SBrkr	Gd	
4	PConc	Gd	TA	Av	Y	SBrkr	Gd	

	GarageType	GarageFinish	GarageQual	SaleType	SaleCondition	SalePrice
0	Attchd	RFn	TA	WD	Normal	208500
1	Attchd	RFn	TA	WD	Normal	181500
2	Attchd	RFn	TA	WD	Normal	223500
3	Detchd	Unf	TA	WD	Abnorml	140000
4	Attchd	RFn	TA	WD	Normal	250000

Combine all significant categorical and numerical variables

[49]:
```
#Combining significant categories and numericals
combined_signum = pd.merge(df_sigcat, df_num, how="outer", on=["SalePrice"])
```

[50]:
```
combined_signum.head()
```

[50]:

	MSZoning	Street	LotShape	Neighborhood	Condition2	MasVnrType	ExterQual	\
0	RL	Pave	Reg	CollgCr	Norm	BrkFace	Gd	
1	RL	Pave	Reg	Veenker	Norm	None	TA	
2	RL	Pave	IR1	CollgCr	Norm	BrkFace	Gd	
3	RL	Pave	IR1	CollgCr	Norm	BrkFace	Gd	
4	RL	Pave	Reg	BrkSide	Norm	None	TA	

	Foundation	BsmtQual	BsmtCond	…	GarageArea	WoodDeckSF	OpenPorchSF	\
0	PConc	Gd	TA	…	548	0	61	
1	CBlock	Gd	TA	…	460	298	0	
2	PConc	Gd	TA	…	608	0	42	
3	PConc	Gd	TA	…	528	0	312	
4	CBlock	TA	TA	…	608	0	42	

	EnclosedPorch	3SsnPorch	ScreenPorch	PoolArea	MiscVal	MoSold	YrSold
0	0	0	0	0	0	2	2008
1	0	0	0	0	0	5	2007
2	0	0	0	0	0	9	2008
3	0	0	0	0	0	5	2009
4	0	0	0	0	0	9	2008

[5 rows x 57 columns]

[51]:
```
combined_signum.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 6383 entries, 0 to 6382
Data columns (total 57 columns):
 #   Column         Non-Null Count  Dtype
---  ------         --------------  -----
 0   MSZoning       6336 non-null   object
 1   Street         6336 non-null   object
 2   LotShape       6336 non-null   object
 3   Neighborhood   6336 non-null   object
 4   Condition2     6336 non-null   object
 5   MasVnrType     6336 non-null   object
 6   ExterQual      6336 non-null   object
 7   Foundation     6336 non-null   object
 8   BsmtQual       6336 non-null   object
 9   BsmtCond       6336 non-null   object
 10  BsmtExposure   6336 non-null   object
 11  CentralAir     6336 non-null   object
 12  Electrical     6336 non-null   object
 13  KitchenQual    6336 non-null   object
 14  GarageType     6336 non-null   object
```

```
 15  GarageFinish   6336 non-null   object
 16  GarageQual     6336 non-null   object
 17  SaleType       6336 non-null   object
 18  SaleCondition  6336 non-null   object
 19  SalePrice      6383 non-null   int64
 20  Id             6383 non-null   int64
 21  MSSubClass     6383 non-null   int64
 22  LotFrontage    5193 non-null   float64
 23  LotArea        6383 non-null   int64
 24  OverallQual    6383 non-null   int64
 25  OverallCond    6383 non-null   int64
 26  YearBuilt      6383 non-null   int64
 27  YearRemodAdd   6383 non-null   int64
 28  MasVnrArea     6375 non-null   float64
 29  BsmtFinSF1     6383 non-null   int64
 30  BsmtFinSF2     6383 non-null   int64
 31  BsmtUnfSF      6383 non-null   int64
 32  TotalBsmtSF    6383 non-null   int64
 33  1stFlrSF       6383 non-null   int64
 34  2ndFlrSF       6383 non-null   int64
 35  LowQualFinSF   6383 non-null   int64
 36  GrLivArea      6383 non-null   int64
 37  BsmtFullBath   6383 non-null   int64
 38  BsmtHalfBath   6383 non-null   int64
 39  FullBath       6383 non-null   int64
 40  HalfBath       6383 non-null   int64
 41  BedroomAbvGr   6383 non-null   int64
 42  KitchebvGr     6383 non-null   int64
 43  TotRmsAbvGrd   6383 non-null   int64
 44  Fireplaces     6383 non-null   int64
 45  GarageYrBlt    6144 non-null   float64
 46  GarageCars     6383 non-null   int64
 47  GarageArea     6383 non-null   int64
 48  WoodDeckSF     6383 non-null   int64
 49  OpenPorchSF    6383 non-null   int64
 50  EnclosedPorch  6383 non-null   int64
 51  3SsnPorch      6383 non-null   int64
 52  ScreenPorch    6383 non-null   int64
 53  PoolArea       6383 non-null   int64
 54  MiscVal        6383 non-null   int64
 55  MoSold         6383 non-null   int64
 56  YrSold         6383 non-null   int64
dtypes: float64(3), int64(35), object(19)
memory usage: 2.8+ MB
```

[52]:
```
df_sigcat.info()
```

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

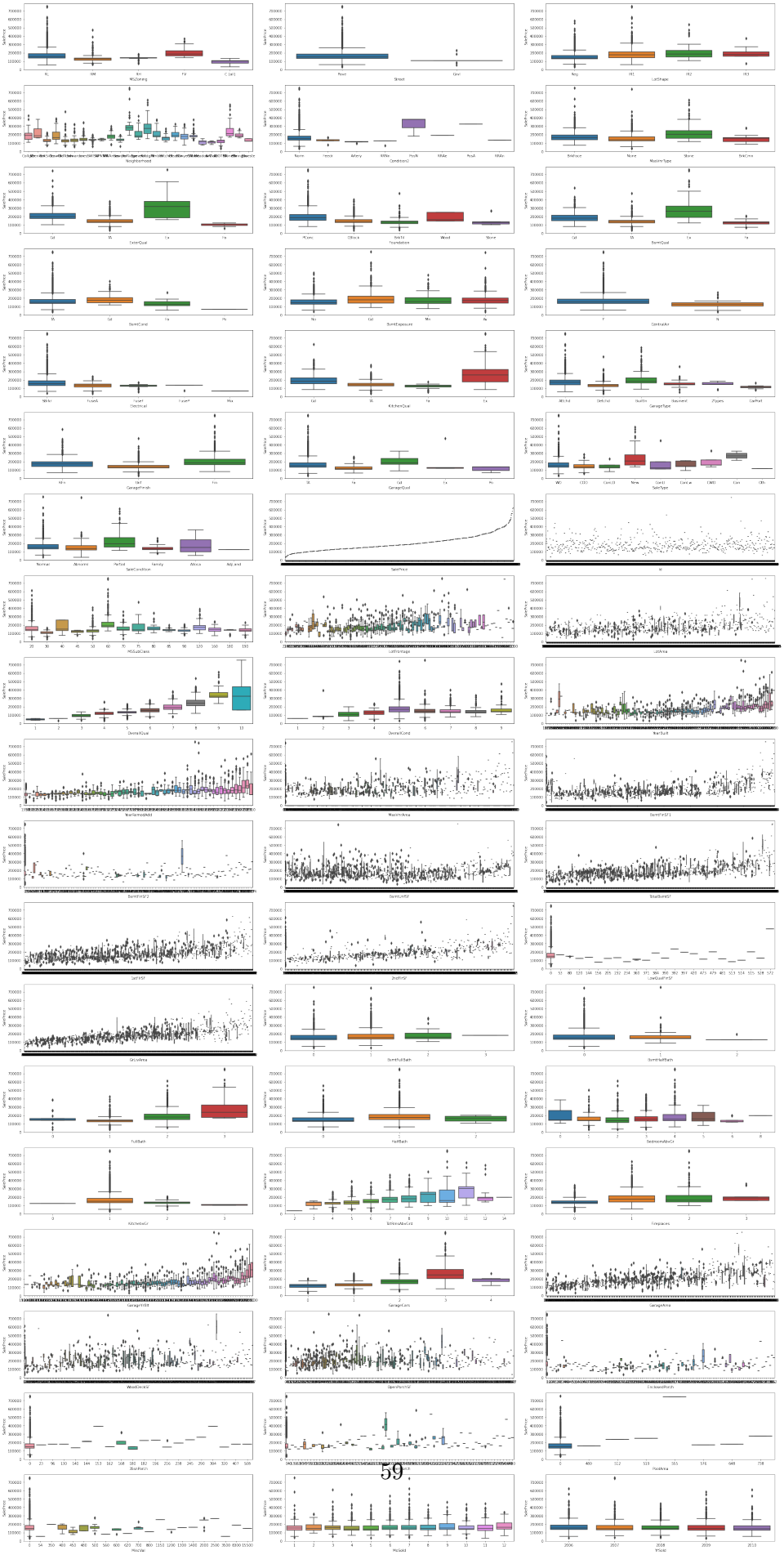
```
Int64Index: 1338 entries, 0 to 1459
Data columns (total 20 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   MSZoning        1338 non-null   object
 1   Street          1338 non-null   object
 2   LotShape        1338 non-null   object
 3   Neighborhood    1338 non-null   object
 4   Condition2      1338 non-null   object
 5   MasVnrType      1338 non-null   object
 6   ExterQual       1338 non-null   object
 7   Foundation      1338 non-null   object
 8   BsmtQual        1338 non-null   object
 9   BsmtCond        1338 non-null   object
 10  BsmtExposure    1338 non-null   object
 11  CentralAir      1338 non-null   object
 12  Electrical      1338 non-null   object
 13  KitchenQual     1338 non-null   object
 14  GarageType      1338 non-null   object
 15  GarageFinish    1338 non-null   object
 16  GarageQual      1338 non-null   object
 17  SaleType        1338 non-null   object
 18  SaleCondition   1338 non-null   object
 19  SalePrice       1338 non-null   int64
dtypes: int64(1), object(19)
memory usage: 259.5+ KB
```

1.0.5 Plot box plot for the new dataset to find the variables with outliers

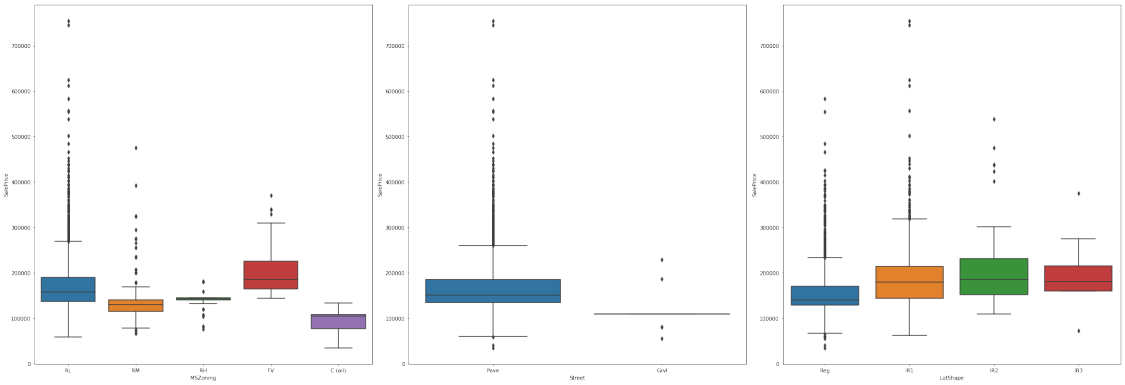
[53]:
```
m=np.ceil(combined_signum.shape[1]/2).astype(int)
m
```

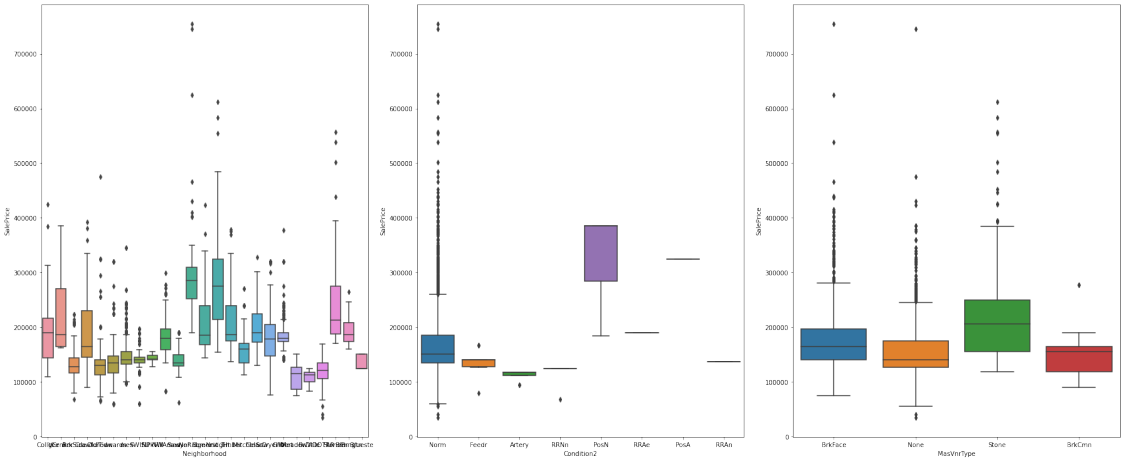
[53]: 29

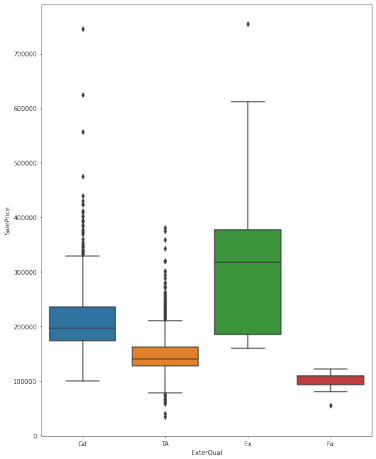
[54]:
```
#Function to plot all independent categorical variables with SalePrice and␣
 ↪count plot
plt.figure(figsize=(30,90))
for i, j in enumerate (combined_signum.columns):
    plt.subplot(m,3,i+1)
    sns.boxplot(j,'SalePrice',data=combined_signum)
    plt.tight_layout()
plt.show()
```

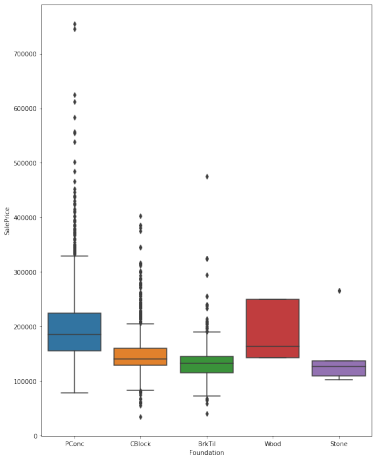


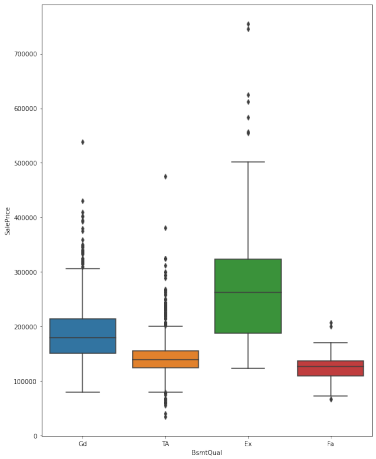
[55]:
```
#Function to plot all independent categorical variables with SalePrice and count plot
ix = 1
fig = plt.figure(figsize = (30,20))
for c in list(combined_signum.columns):
    if ix <= 3:
        if c != 'SalePrice':
            ax2 = fig.add_subplot(2,3,ix+3)
            sns.boxplot(data=combined_signum, x=c, y='SalePrice', ax=ax2) #for boxplot
            plt.tight_layout()
    ix = ix +1
    if ix == 4:
        fig = plt.figure(figsize = (25,20))
        ix =1
```

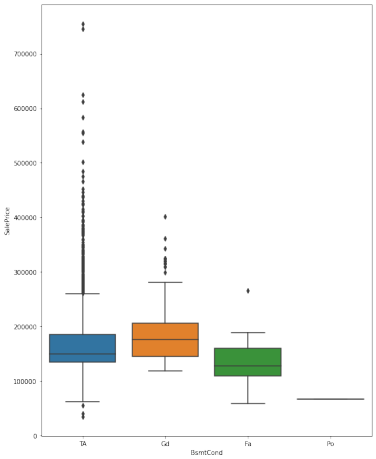


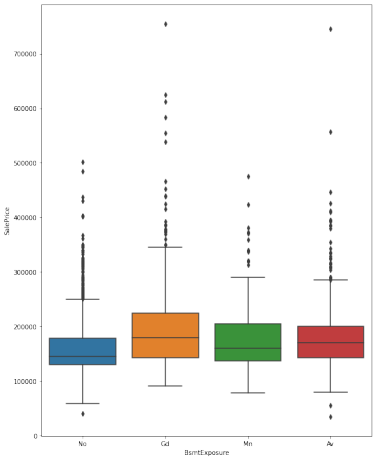


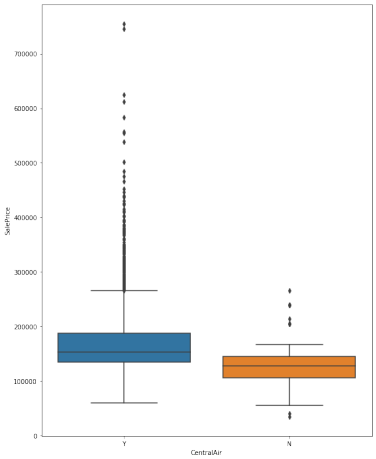

SalePrice
ExterQual
Gd
TA
Ex
Fa

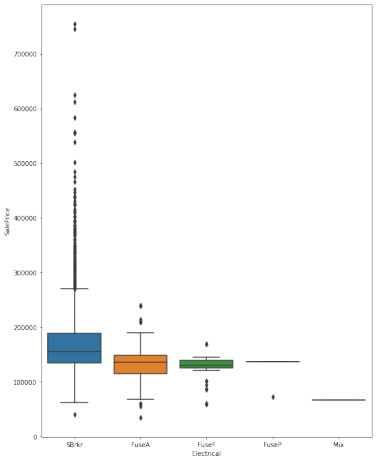

SalePrice
Foundation
PConc
CBlock
BrkTil
Wood
Stone

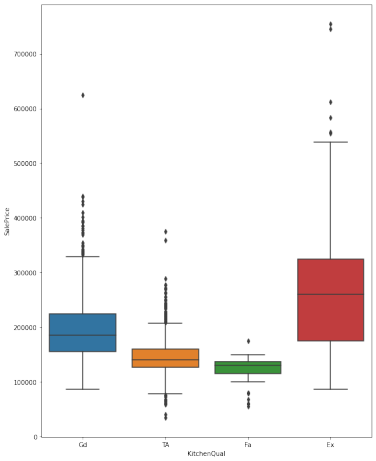

SalePrice
BsmtQual
Gd
TA
Ex
Fa

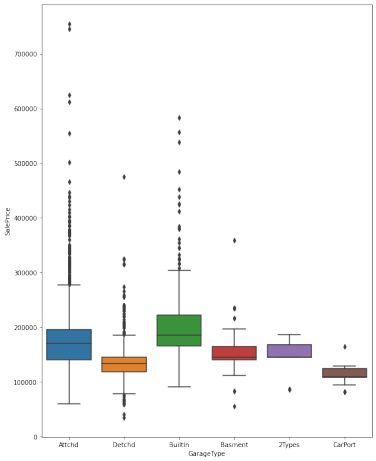

SalePrice
BsmtCond
TA
Gd
Fa
Po

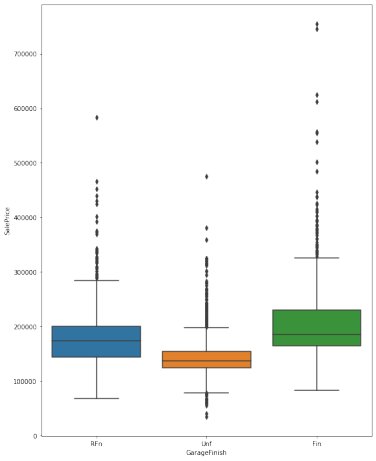

SalePrice
BsmtExposure
No
Gd
Mn
Av

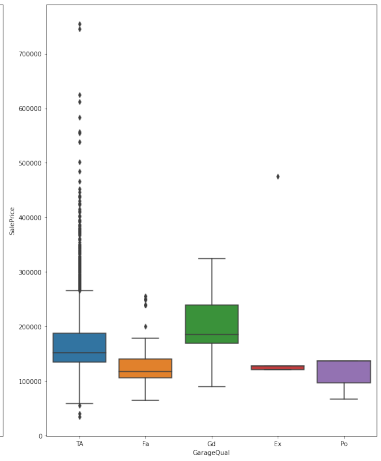

SalePrice
CentralAir
Y
N

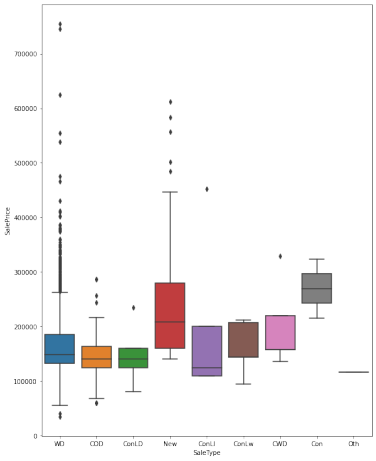

SalePrice
Electrical
SBrkr
FuseA
FuseF
FuseP
Mix

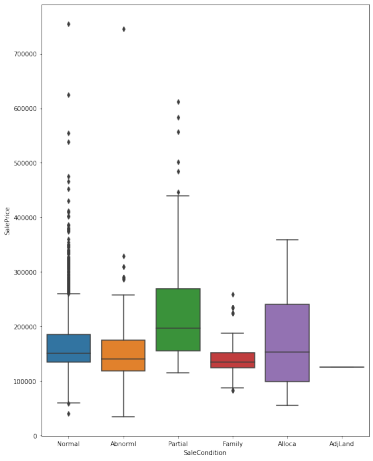

SalePrice
KitchenQual
Gd
TA
Fa
Ex

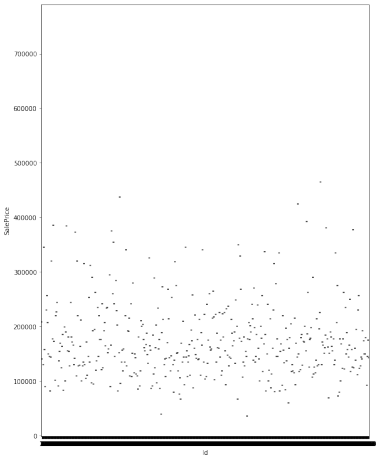

SalePrice
GarageType
Attchd
Detchd
BuiltIn
Basment
2Types
CarPort

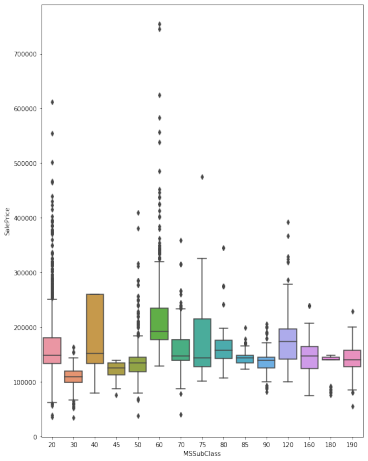

SalePrice
GarageFinish
RFn
Unf
Fin

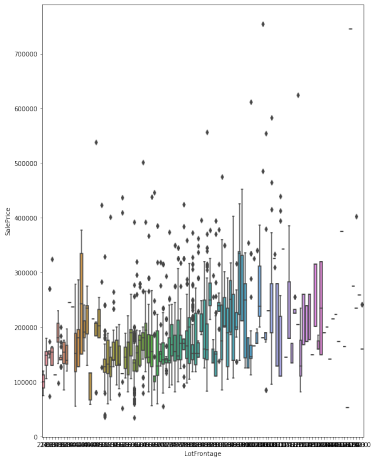

SalePrice
GarageQual
TA
Fa
Gd
Ex
Po

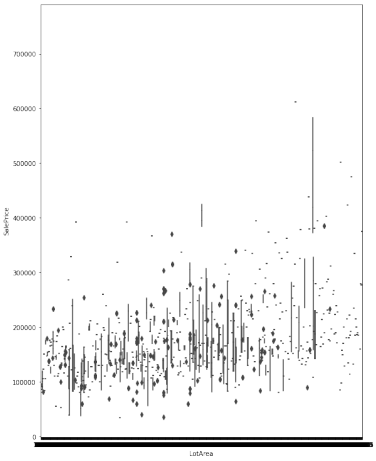

SalePrice
SaleType
WD
COD
ConLD
New
ConLI
ConLw
CWD
Con
Oth

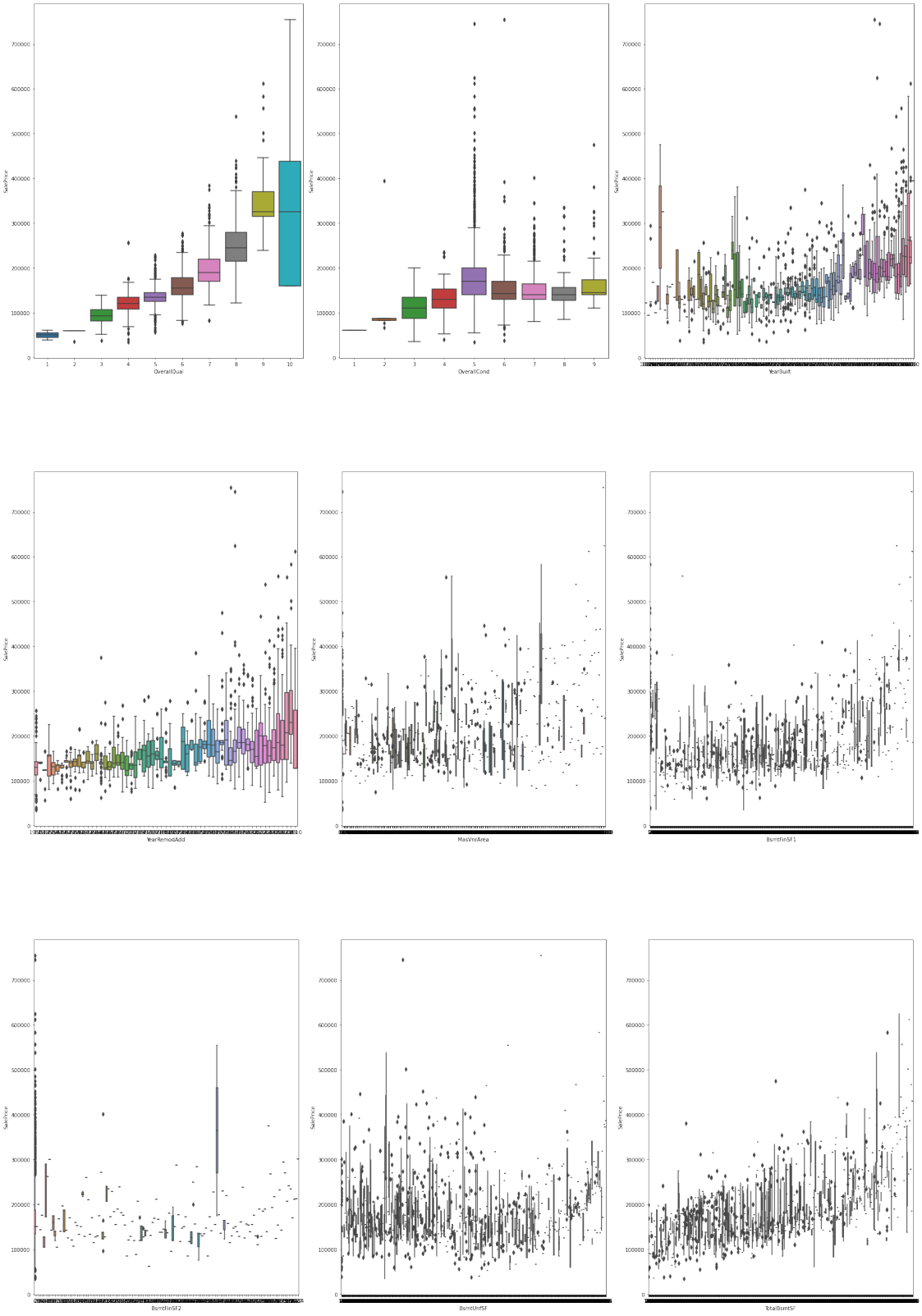

SalePrice
SaleCondition
Normal
Abnorml
Partial
Family
Alloca
AdjLand


SalePrice
Id


SalePrice
MSSubClass
20
30
40
45
50
60
70
75
80
85
90
120
160
180
190


SalePrice
LotFrontage


SalePrice
LotArea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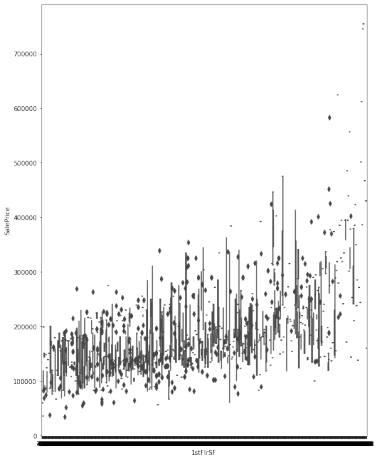
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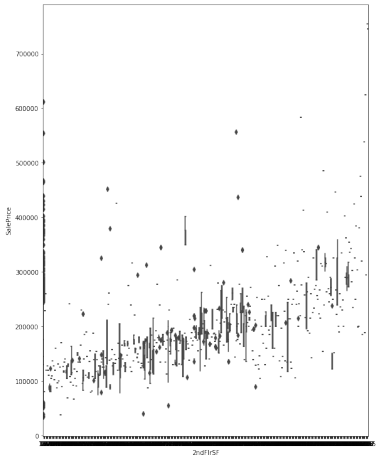
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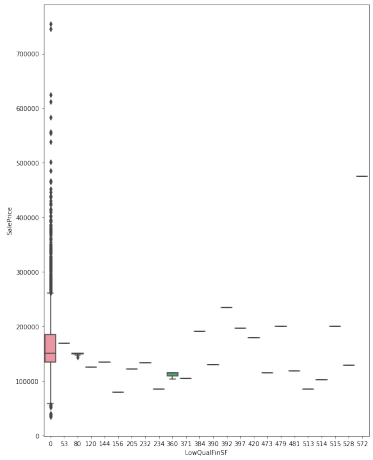
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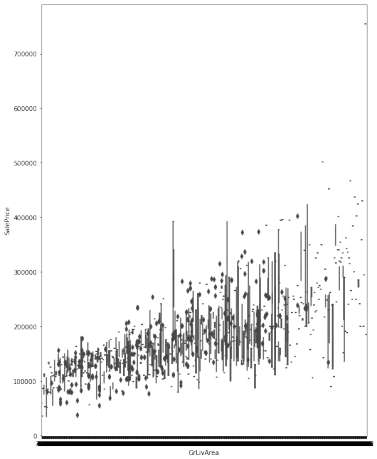
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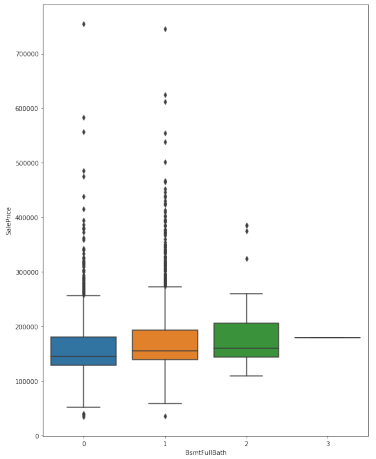
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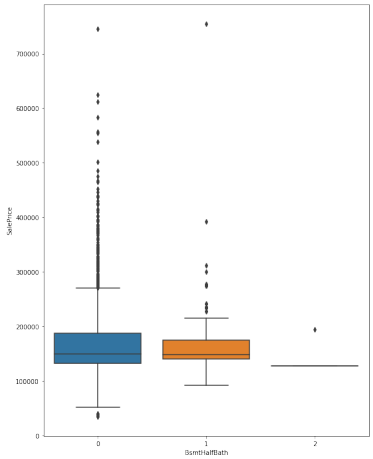
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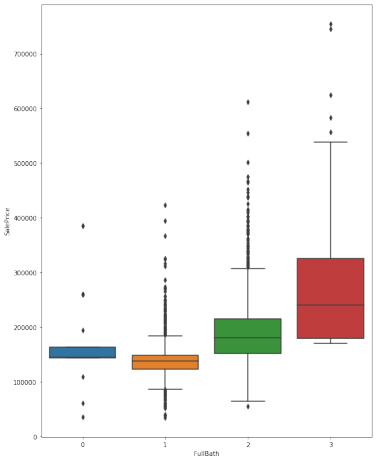
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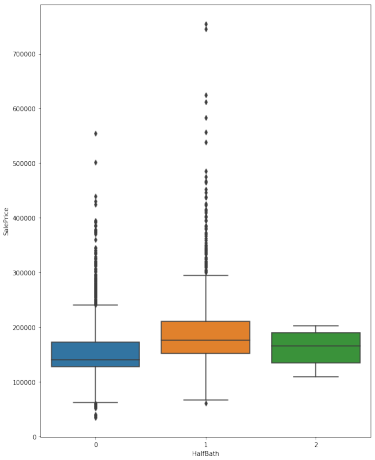
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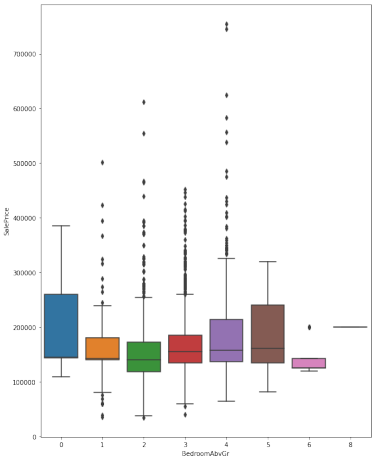
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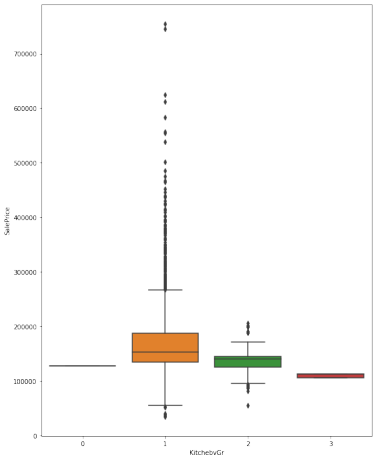
BedroomAbvGr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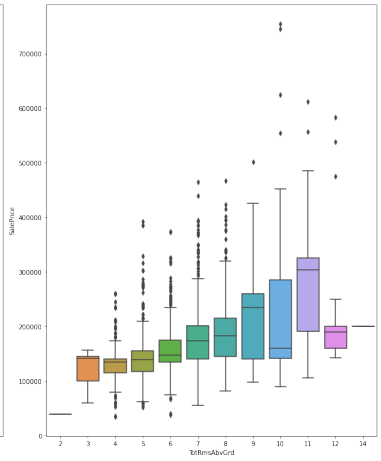
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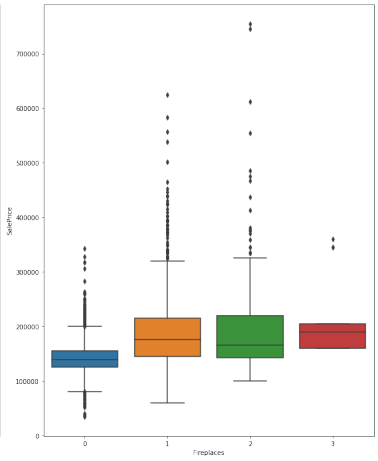
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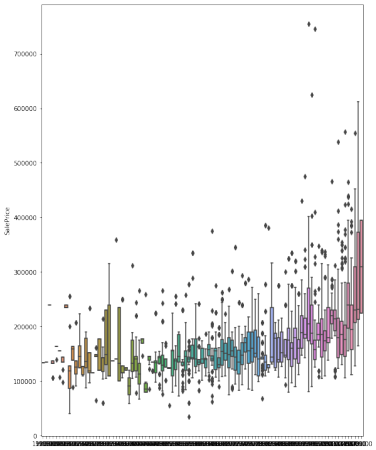
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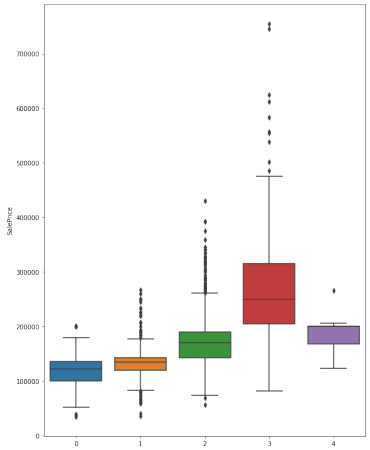
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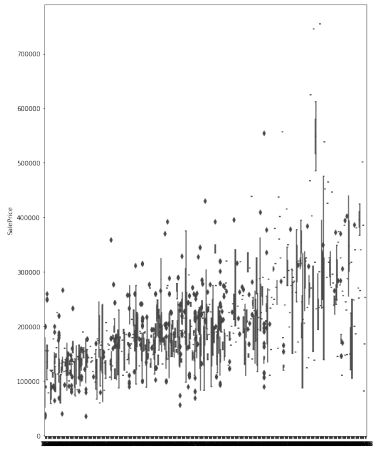
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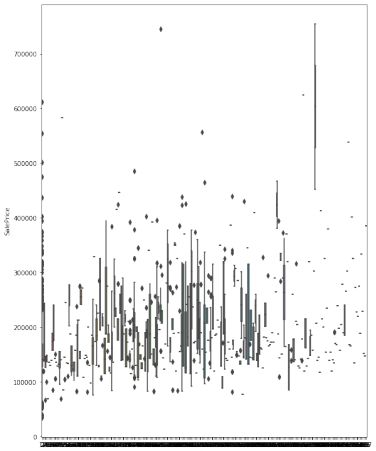
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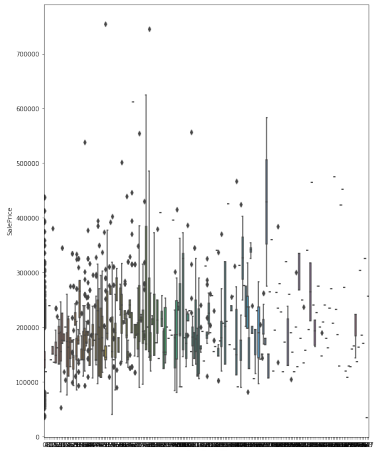
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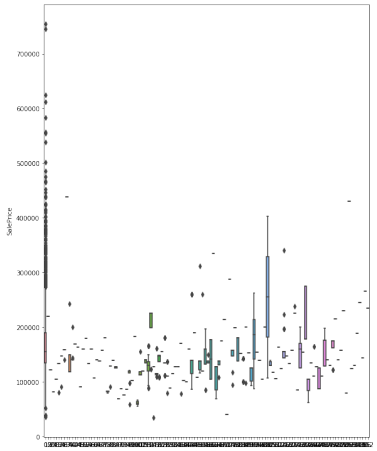
OpenPorchSF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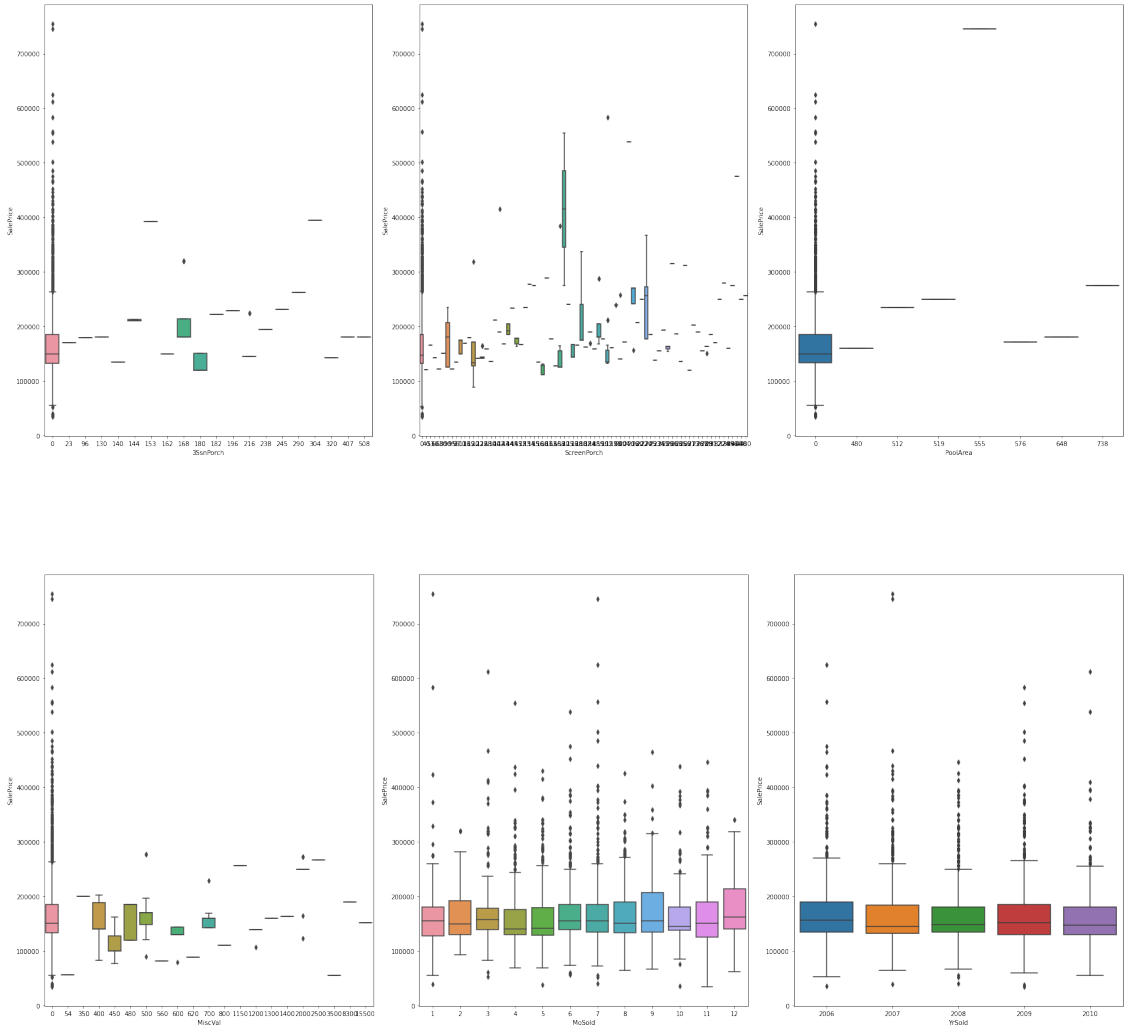
EnclosedPorch



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