Project_Feature Engineering

November 21, 2022

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

[2]:
```
# Import essential libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
import seaborn as sns
from sklearn.impute import SimpleImputer
from sklearn.base import TransformerMixin
```

[3]:
```
# import dataset
data = pd.read_csv('PEP1.csv')
data.head()
```

[3]:
```
   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  … PoolArea PoolQC Fence MiscFeature MiscVal MoSold  \
0         Lvl    AllPub  …        0    NaN   NaN         NaN       0      2
1         Lvl    AllPub  …        0    NaN   NaN         NaN       0      5
2         Lvl    AllPub  …        0    NaN   NaN         NaN       0      9
3         Lvl    AllPub  …        0    NaN   NaN         NaN       0      2
4         Lvl    AllPub  …        0    NaN   NaN         NaN       0     12

  YrSold SaleType  SaleCondition  SalePrice
0   2008       WD         Normal     208500
1   2007       WD         Normal     181500
2   2008       WD         Normal     223500
3   2006       WD        Abnorml     140000
4   2008       WD         Normal     250000
```

```
[5 rows x 81 columns]
```

1 1. Understand the dataset:

a. Identify the shape of the dataset

b. Identify variables with null values

c. Identify variables with unique values

[4]:

```
# a. Identify the shape of the dataset
print('Shape of the dataset :',data.shape)
```

```
Shape of the dataset : (1460, 81)
```

[5]:

```
# b. Identify variables with null values

data_null = pd.DataFrame(data[data.columns[data.isna().any()]].isna().sum())
data_null['percentage'] = data.isna().sum() / data.shape[0]*100
data_null = data_null.reset_index()
data_null = data_null.rename(columns={'index':'Variables',0:'Count'})
data_null = data_null.sort_values(by='Count',ascending=False)
data_null
```

[5]:

```
        Variables  Count  percentage
16         PoolQC   1453   99.520548
18    MiscFeature   1406   96.301370
1           Alley   1369   93.767123
17          Fence   1179   80.753425
10    FireplaceQu    690   47.260274
0     LotFrontage    259   17.739726
11     GarageType     81    5.547945
12    GarageYrBlt     81    5.547945
13   GarageFinish     81    5.547945
14     GarageQual     81    5.547945
15     GarageCond     81    5.547945
6    BsmtExposure     38    2.602740
8    BsmtFinType2     38    2.602740
7    BsmtFinType1     37    2.534247
5        BsmtCond     37    2.534247
4        BsmtQual     37    2.534247
3      MasVnrArea      8    0.547945
2      MasVnrType      8    0.547945
9      Electrical      1    0.068493
```

[6]:

```
# c. Identify variables with unique values

for i in data.columns:
    print({i : data[i].unique()})
```

```
{'Id': array([   1,    2,    3, …, 1458, 1459, 1460], dtype=int64)}
{'MSSubClass': array([ 60,  20,  70,  50, 190,  45,  90, 120,  30,  85,  80,
160,  75,
       180,  40], dtype=int64)}
{'MSZoning': array(['RL', 'RM', 'C (all)', 'FV', 'RH'], dtype=object)}
{'LotFrontage': array([ 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': array([ 8450,  9600, 11250, …, 17217, 13175,  9717], dtype=int64)}
{'Street': array(['Pave', 'Grvl'], dtype=object)}
{'Alley': array([nan, 'Grvl', 'Pave'], dtype=object)}
{'LotShape': array(['Reg', 'IR1', 'IR2', 'IR3'], dtype=object)}
{'LandContour': array(['Lvl', 'Bnk', 'Low', 'HLS'], dtype=object)}
{'Utilities': array(['AllPub', 'NoSeWa'], dtype=object)}
{'LotConfig': array(['Inside', 'FR2', 'Corner', 'CulDSac', 'FR3'],
dtype=object)}
{'LandSlope': array(['Gtl', 'Mod', 'Sev'], dtype=object)}
{'Neighborhood': array(['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'], dtype=object)}
{'Condition1': array(['Norm', 'Feedr', 'PosN', 'Artery', 'RRAe', 'RRNn', 'RRAn',
'PosA',
       'RRNe'], dtype=object)}
{'Condition2': array(['Norm', 'Artery', 'RRNn', 'Feedr', 'PosN', 'PosA', 'RRAn',
'RRAe'],
      dtype=object)}
{'BldgType': array(['1Fam', '2fmCon', 'Duplex', 'TwnhsE', 'Twnhs'],
dtype=object)}
{'HouseStyle': array(['2Story', '1Story', '1.5Fin', '1.5Unf', 'SFoyer', 'SLvl',
'2.5Unf',
       '2.5Fin'], dtype=object)}
{'OverallQual': array([ 7,  6,  8,  5,  9,  4, 10,  3,  1,  2], dtype=int64)}
{'OverallCond': array([5, 8, 6, 7, 4, 2, 3, 9, 1], dtype=int64)}
```

```
{'YearBuilt': array([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], dtype=int64)}
{'YearRemodAdd': array([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], dtype=int64)}
{'RoofStyle': array(['Gable', 'Hip', 'Gambrel', 'Mansard', 'Flat', 'Shed'],
dtype=object)}
{'RoofMatl': array(['CompShg', 'WdShngl', 'Metal', 'WdShake', 'Membran',
'Tar&Grv',
       'Roll', 'ClyTile'], dtype=object)}
{'Exterior1st': array(['VinylSd', 'MetalSd', 'Wd Sdng', 'HdBoard', 'BrkFace',
'WdShing',
       'CemntBd', 'Plywood', 'AsbShng', 'Stucco', 'BrkComm', 'AsphShn',
       'Stone', 'ImStucc', 'CBlock'], dtype=object)}
{'Exterior2nd': array(['VinylSd', 'MetalSd', 'Wd Shng', 'HdBoard', 'Plywood',
'Wd Sdng',
       'CmentBd', 'BrkFace', 'Stucco', 'AsbShng', 'Brk Cmn', 'ImStucc',
       'AsphShn', 'Stone', 'Other', 'CBlock'], dtype=object)}
{'MasVnrType': array(['BrkFace', 'None', 'Stone', 'BrkCmn', nan], dtype=object)}
{'MasVnrArea': array([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,
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       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])}
{'ExterQual': array(['Gd', 'TA', 'Ex', 'Fa'], dtype=object)}
{'ExterCond': array(['TA', 'Gd', 'Fa', 'Po', 'Ex'], dtype=object)}
{'Foundation': array(['PConc', 'CBlock', 'BrkTil', 'Wood', 'Slab', 'Stone'],
dtype=object)}
{'BsmtQual': array(['Gd', 'TA', 'Ex', nan, 'Fa'], dtype=object)}
{'BsmtCond': array(['TA', 'Gd', nan, 'Fa', 'Po'], dtype=object)}
{'BsmtExposure': array(['No', 'Gd', 'Mn', 'Av', nan], dtype=object)}
```

```
{'BsmtFinType1': array(['GLQ', 'ALQ', 'Unf', 'Rec', 'BLQ', nan, 'LwQ'],
dtype=object)}
{'BsmtFinSF1': array([ 706,  978,  486,  216,  655,  732, 1369,  859,    0,
851,  906,
        998,  737,  733,  578,  646,  504,  840,  188,  234, 1218, 1277,
       1018, 1153, 1213,  731,  643,  967,  747,  280,  179,  456, 1351,
         24,  763,  182,  104, 1810,  384,  490,  649,  632,  941,  739,
        912, 1013,  603, 1880,  565,  320,  462,  228,  336,  448, 1201,
         33,  588,  600,  713, 1046,  648,  310, 1162,  520,  108,  569,
       1200,  224,  705,  444,  250,  984,   35,  774,  419,  170, 1470,
        938,  570,  300,  120,  116,  512,  567,  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,  288, 1398,  477,  831, 1904,  436,  352,  611, 1086,
        297,  626,  560,  390,  566, 1126, 1036, 1088,  641,  617,  662,
        312, 1065,  787,  468,   36,  822,  378,  946,  341,   16,  550,
        524,   56,  321,  842,  689,  625,  358,  402,   94, 1078,  329,
        929,  697, 1573,  270,  922,  503, 1334,  361,  672,  506,  714,
        403,  751,  226,  620,  546,  392,  421,  905,  904,  430,  614,
        450,  210,  292,  795, 1285,  819,  420,  841,  281,  894, 1464,
        700,  262, 1274,  518, 1236,  425,  692,  987,  970,   28,  256,
       1619,   40,  846, 1124,  720,  828, 1249,  810,  213,  585,  129,
        498, 1270,  573, 1410, 1082,  236,  388,  334,  874,  956,  773,
        399,  162,  712,  609,  371,  540,   72,  623,  428,  350,  298,
       1445,  218,  985,  631, 1280,  241,  690,  266,  777,  812,  786,
       1116,  789, 1056,   50, 1128,  775, 1309, 1246,  986,  616, 1518,
        664,  387,  471,  385,  365, 1767,  133,  642,  247,  331,  742,
       1606,  916,  185,  544,  553,  326,  778,  386,  426,  368,  459,
       1350, 1196,  630,  994,  168, 1261, 1567,  299,  897,  607,  836,
        515,  374, 1231,  111,  356,  400,  698, 1247,  257,  380,   27,
        141,  991,  650,  521, 1436, 2260,  719,  377, 1330,  348, 1219,
        783,  969,  673, 1358, 1260,  144,  584,  554, 1002,  619,  180,
        559,  308,  866,  895,  637,  604, 1302, 1071,  290,  728,    2,
       1441,  943,  231,  414,  349,  442,  328,  594,  816, 1460, 1324,
       1338,  685, 1422, 1283,   81,  454,  903,  605,  990,  206,  150,
        457,   48,  871,   41,  674,  624,  480, 1154,  738,  493, 1121,
        282,  500,  131, 1696,  806, 1361,  920, 1721,  187, 1138,  988,
        193,  551,  767, 1186,  892,  311,  827,  543, 1003, 1059,  239,
        945,   20, 1455,  965,  980,  863,  533, 1084, 1173,  523, 1148,
        191, 1234,  375,  808,  724,  152, 1180,  252,  832,  575,  919,
        439,  381,  438,  549,  612, 1163,  437,  394, 1416,  422,  762,
        975, 1097,  251,  686,  656,  568,  539,  862,  197,  516,  663,
        608, 1636,  784,  249, 1040,  483,  196,  572,  338,  330,  156,
       1390,  513,  460,  659,  364,  564,  306,  505,  932,  750,   64,
        633, 1170,  899,  902, 1238,  528, 1024, 1064,  285, 2188,  465,
        322,  860,  599,  354,   63,  223,  301,  443,  489,  284,  294,
        814,  165,  552,  833,  464,  936,  772, 1440,  748,  982,  398,
        562,  484,  417,  699,  696,  896,  556, 1106,  651,  867,  854,
       1646, 1074,  536, 1172,  915,  595, 1237,  273,  684,  324, 1165,
        138, 1513,  317, 1012, 1022,  509,  900, 1085, 1104,  240,  383,
        644,  397,  740,  837,  220,  586,  535,  410,   75,  824,  592,
       1039,  510,  423,  661,  248,  704,  412, 1032,  219,  708,  415,
       1004,  353,  702,  369,  622,  212,  645,  852, 1150, 1258,  275,
        176,  296,  538, 1157,  492, 1198, 1387,  522,  658, 1216, 1480,
       2096, 1159,  440, 1456,  883,  547,  788,  485,  340, 1220,  427,
        344,  756, 1540,  666,  803, 1000,  885, 1386,  319,  534,  125,
       1314,  602,  192,  593,  804, 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,
        865,  204,  790, 1320,  769, 1070,  264,  759, 1373,  976,  781,
         25, 1110,  404,  580,  678,  958, 1336, 1079,   49,  830],
      dtype=int64)}
{'BsmtFinType2': array(['Unf', 'BLQ', nan, 'ALQ', 'Rec', 'LwQ', 'GLQ'],
dtype=object)}
{'BsmtFinSF2': array([   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,  692,  228,  125, 1063,  620,
        175,  820, 1474,  264,  479,  147,  232,  380,  544,  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,  336,  468,  287,   35,  499,  723,  119,
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{'MoSold': array([ 2,  5,  9, 12, 10,  8, 11,  4,  1,  7,  3,  6], dtype=int64)}
{'YrSold': array([2008, 2007, 2006, 2009, 2010], dtype=int64)}
{'SaleType': array(['WD', 'New', 'COD', 'ConLD', 'ConLI', 'CWD', 'ConLw', 'Con',
'Oth'],
      dtype=object)}
{'SaleCondition': array(['Normal', 'Abnorml', 'Partial', 'AdjLand', 'Alloca',
'Family'],
      dtype=object)}
{'SalePrice': array([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,
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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,
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 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],
       dtype=int64)}
```

2 2. 2. Generate a separate dataset for numerical and categorical variables

[7]:

```
data_categorical = data.select_dtypes(exclude=np.number)
data_numerical = data.select_dtypes(include=np.number)
```

[8]:

```
data_categorical.head()
```

[8]:

```
  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]
```

```
[9]: data_numerical.head()
```

```
[9]:    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]
```

3 3. EDA of numerical variables:

a. Missing value treatment

b. Identify the skewness and distribution

c. Identify significant variables using a correlation matrix

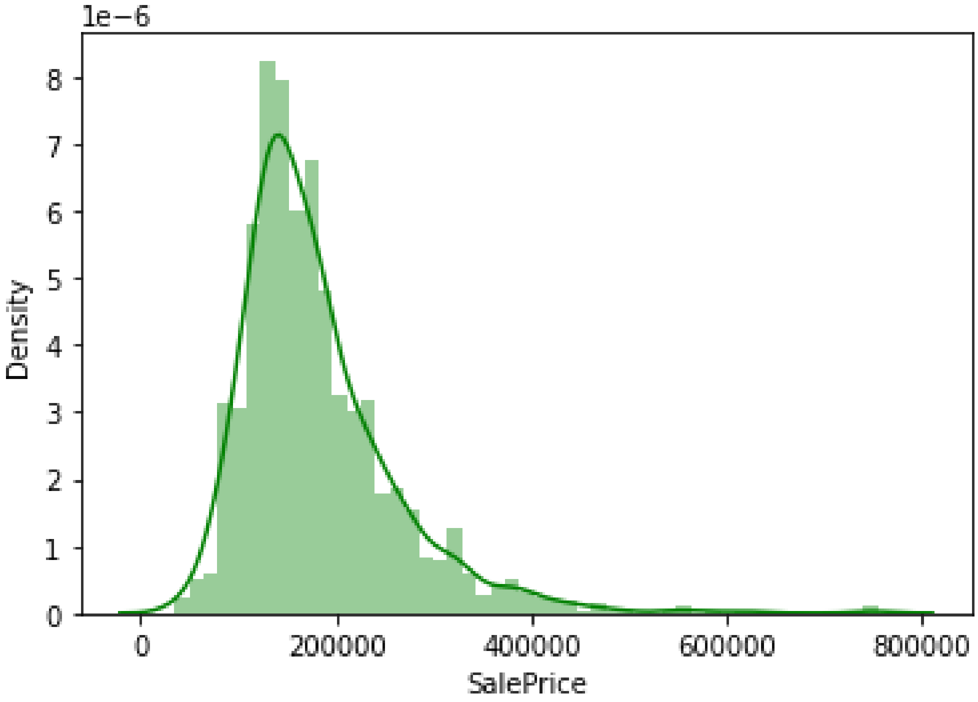
d. Pair plot for distribution and density

[10]:
```
# a. Missing value treatment

class SimpleImputerLookup(SimpleImputer):
    def __init__(self, fill_values=None, **kwargs):
        kwargs["strategy"] = "constant"
        super().__init__(**kwargs)
        self.fill_values = fill_values
    def fit(self, X):
        super().fit(X)
        if isinstance(self.fill_values, dict) and hasattr(X, "columns"):
            self.statistics_ = np.array([self.fill_values[c] for c in X.
 ↪columns])
        else:
            self.statistics_ = np.array(self.fill_values)
        return self

numeric_cols = [data.select_dtypes(exclude=['object']).columns]
impute_numeric_data = []
for col in numeric_cols:
    imp = SimpleImputerLookup(fill_values=data_numerical[col].mean())
    impute_numeric_data = pd.DataFrame(imp.fit_transform(data_numerical))
    impute_numeric_data.columns = data_numerical.columns
    impute_numeric_data.append(impute_numeric_data)
```

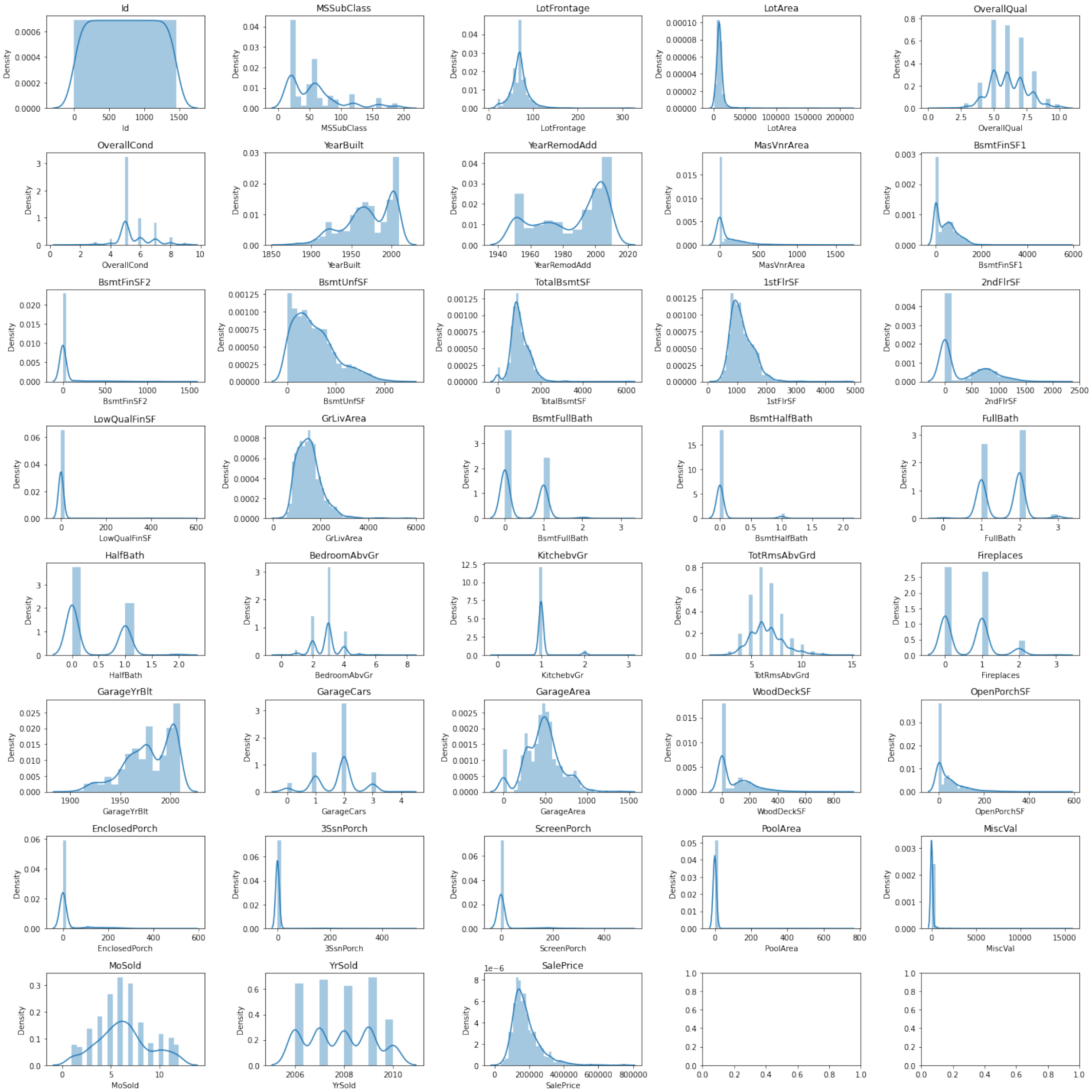
[11]:
```
print('Before implementation of Simple Imputer on numeric data :',data.isna().
 ↪sum().any())
print('After implementation of Simple Imputer on numeric data :
 ↪',impute_numeric_data.isna().sum().any())
```

```
Before implementation of Simple Imputer on numeric data : True
After implementation of Simple Imputer on numeric data : False
```

[12]:
```
# b. Identify the skewness and distribution
sns.distplot(impute_numeric_data['SalePrice'],color='g')
plt.show()
```



[13]:
```
fig,axes = plt.subplots(nrows=8,ncols=5)
axes = axes.flatten()
fig.set_size_inches(20,20)

for ax, col in zip(axes,impute_numeric_data.columns):
    sns.distplot(impute_numeric_data[col],ax=ax)
    ax.set_title(col)
plt.tight_layout()
```



[14]:
```
# c. Identify significant variables using a correlation matrix
data.corr()
```

[14]:
```
                     Id  MSSubClass  LotFrontage   LotArea  OverallQual  \
Id             1.000000    0.011156    -0.010601 -0.033226    -0.028365
MSSubClass     0.011156    1.000000    -0.386347 -0.139781     0.032628
LotFrontage   -0.010601   -0.386347     1.000000  0.426095     0.251646
LotArea       -0.033226   -0.139781     0.426095  1.000000     0.105806
OverallQual   -0.028365    0.032628     0.251646  0.105806     1.000000
OverallCond    0.012609   -0.059316    -0.059213 -0.005636    -0.091932
YearBuilt     -0.012713    0.027850     0.123349  0.014228     0.572323
YearRemodAdd  -0.021998    0.040581     0.088866  0.013788     0.550684
MasVnrArea    -0.050298    0.022936     0.193458  0.104160     0.411876
```

```
BsmtFinSF1    -0.005024   -0.069836     0.233633  0.214103     0.239666
BsmtFinSF2    -0.005968   -0.065649     0.049900  0.111170    -0.059119
BsmtUnfSF     -0.007940   -0.140759     0.132644 -0.002618     0.308159
TotalBsmtSF   -0.015415   -0.238518     0.392075  0.260833     0.537808
1stFlrSF       0.010496   -0.251758     0.457181  0.299475     0.476224
2ndFlrSF       0.005590    0.307886     0.080177  0.050986     0.295493
LowQualFinSF  -0.044230    0.046474     0.038469  0.004779    -0.030429
GrLivArea      0.008273    0.074853     0.402797  0.263116     0.593007
BsmtFullBath   0.002289    0.003491     0.100949  0.158155     0.111098
BsmtHalfBath  -0.020155   -0.002333    -0.007234  0.048046    -0.040150
FullBath       0.005587    0.131608     0.198769  0.126031     0.550600
HalfBath       0.006784    0.177354     0.053532  0.014259     0.273458
BedroomAbvGr   0.037719   -0.023438     0.263170  0.119690     0.101676
KitchebvGr     0.002951    0.281721    -0.006069 -0.017784    -0.183882
TotRmsAbvGrd   0.027239    0.040380     0.352096  0.190015     0.427452
Fireplaces    -0.019772   -0.045569     0.266639  0.271364     0.396765
GarageYrBlt    0.000072    0.085072     0.070250 -0.024947     0.547766
GarageCars     0.016570   -0.040110     0.285691  0.154871     0.600671
GarageArea     0.017634   -0.098672     0.344997  0.180403     0.562022
WoodDeckSF    -0.029643   -0.012579     0.088521  0.171698     0.238923
OpenPorchSF   -0.000477   -0.006100     0.151972  0.084774     0.308819
EnclosedPorch  0.002889   -0.012037     0.010700 -0.018340    -0.113937
3SsnPorch     -0.046635   -0.043825     0.070029  0.020423     0.030371
ScreenPorch    0.001330   -0.026030     0.041383  0.043160     0.064886
PoolArea       0.057044    0.008283     0.206167  0.077672     0.065166
MiscVal       -0.006242   -0.007683     0.003368  0.038068    -0.031406
MoSold         0.021172   -0.013585     0.011200  0.001205     0.070815
YrSold         0.000712   -0.021407     0.007450 -0.014261    -0.027347
SalePrice     -0.021917   -0.084284     0.351799  0.263843     0.790982

               OverallCond  YearBuilt  YearRemodAdd  MasVnrArea  BsmtFinSF1  \
Id                0.012609  -0.012713     -0.021998   -0.050298   -0.005024
MSSubClass       -0.059316   0.027850      0.040581    0.022936   -0.069836
LotFrontage      -0.059213   0.123349      0.088866    0.193458    0.233633
LotArea          -0.005636   0.014228      0.013788    0.104160    0.214103
OverallQual      -0.091932   0.572323      0.550684    0.411876    0.239666
OverallCond       1.000000  -0.375983      0.073741   -0.128101   -0.046231
YearBuilt        -0.375983   1.000000      0.592855    0.315707    0.249503
YearRemodAdd      0.073741   0.592855      1.000000    0.179618    0.128451
MasVnrArea       -0.128101   0.315707      0.179618    1.000000    0.264736
BsmtFinSF1       -0.046231   0.249503      0.128451    0.264736    1.000000
BsmtFinSF2        0.040229  -0.049107     -0.067759   -0.072319   -0.050117
BsmtUnfSF        -0.136841   0.149040      0.181133    0.114442   -0.495251
TotalBsmtSF      -0.171098   0.391452      0.291066    0.363936    0.522396
1stFlrSF         -0.144203   0.281986      0.240379    0.344501    0.445863
2ndFlrSF          0.028942   0.010308      0.140024    0.174561   -0.137079
LowQualFinSF      0.025494  -0.183784     -0.062419   -0.069071   -0.064503
```

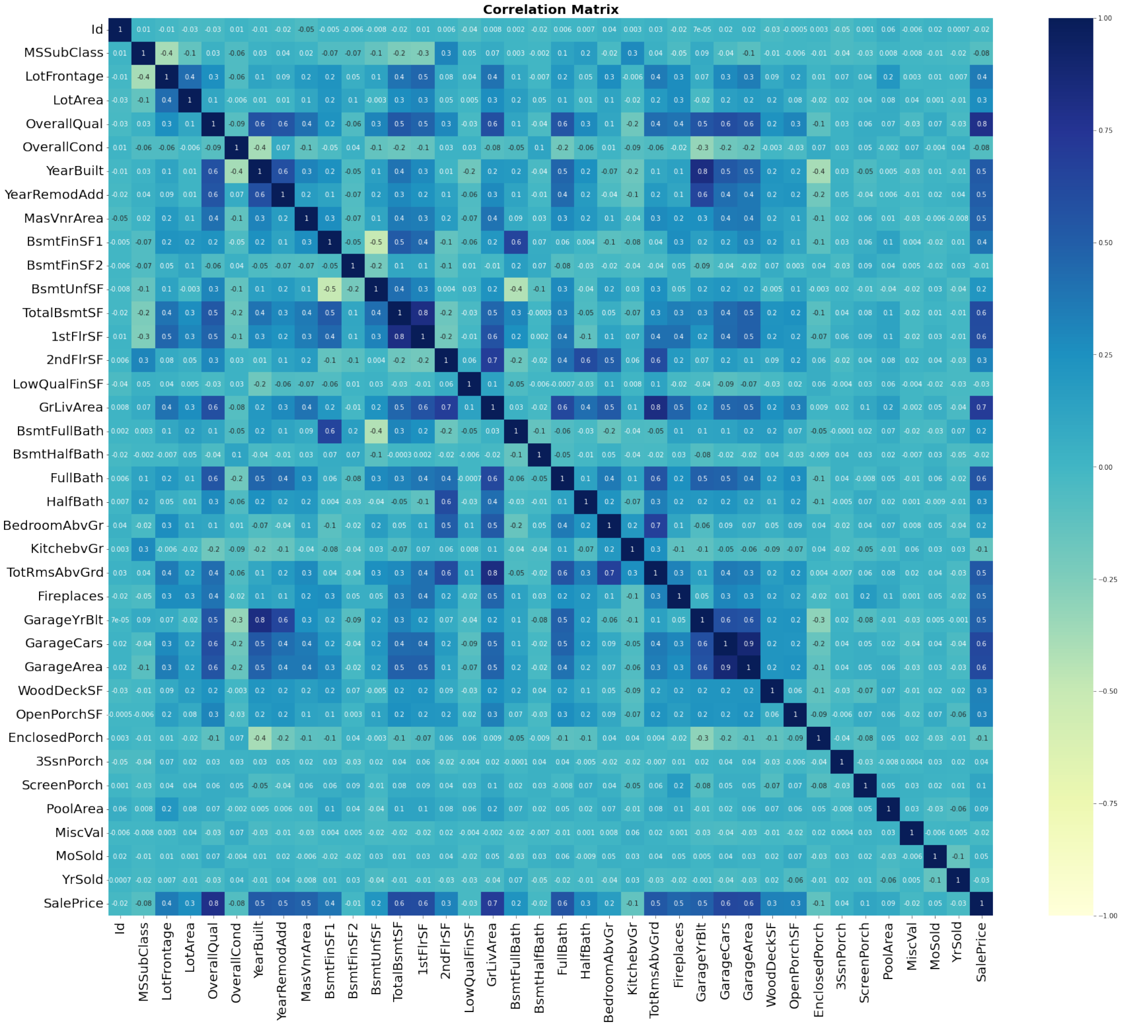
```
GrLivArea        -0.079686   0.199010      0.287389    0.390857    0.208171
BsmtFullBath     -0.054942   0.187599      0.119470    0.085310    0.649212
BsmtHalfBath      0.117821  -0.038162     -0.012337    0.026673    0.067418
FullBath         -0.194149   0.468271      0.439046    0.276833    0.058543
HalfBath         -0.060769   0.242656      0.183331    0.201444    0.004262
BedroomAbvGr      0.012980  -0.070651     -0.040581    0.102821   -0.107355
KitchebvGr       -0.087001  -0.174800     -0.149598   -0.037610   -0.081007
TotRmsAbvGrd     -0.057583   0.095589      0.191740    0.280682    0.044316
Fireplaces       -0.023820   0.147716      0.112581    0.249070    0.260011
GarageYrBlt      -0.324297   0.825667      0.642277    0.252691    0.153484
GarageCars       -0.185758   0.537850      0.420622    0.364204    0.224054
GarageArea       -0.151521   0.478954      0.371600    0.373066    0.296970
WoodDeckSF       -0.003334   0.224880      0.205726    0.159718    0.204306
OpenPorchSF      -0.032589   0.188686      0.226298    0.125703    0.111761
EnclosedPorch     0.070356  -0.387268     -0.193919   -0.110204   -0.102303
3SsnPorch         0.025504   0.031355      0.045286    0.018796    0.026451
ScreenPorch       0.054811  -0.050364     -0.038740    0.061466    0.062021
PoolArea         -0.001985   0.004950      0.005829    0.011723    0.140491
MiscVal           0.068777  -0.034383     -0.010286   -0.029815    0.003571
MoSold           -0.003511   0.012398      0.021490   -0.005965   -0.015727
YrSold            0.043950  -0.013618      0.035743   -0.008201    0.014359
SalePrice        -0.077856   0.522897      0.507101    0.477493    0.386420

              …  WoodDeckSF  OpenPorchSF  EnclosedPorch  3SsnPorch  \
Id            …   -0.029643    -0.000477       0.002889  -0.046635
MSSubClass    …   -0.012579    -0.006100      -0.012037  -0.043825
LotFrontage   …    0.088521     0.151972       0.010700   0.070029
LotArea       …    0.171698     0.084774      -0.018340   0.020423
OverallQual   …    0.238923     0.308819      -0.113937   0.030371
OverallCond   …   -0.003334    -0.032589       0.070356   0.025504
YearBuilt     …    0.224880     0.188686      -0.387268   0.031355
YearRemodAdd  …    0.205726     0.226298      -0.193919   0.045286
MasVnrArea    …    0.159718     0.125703      -0.110204   0.018796
BsmtFinSF1    …    0.204306     0.111761      -0.102303   0.026451
BsmtFinSF2    …    0.067898     0.003093       0.036543  -0.029993
BsmtUnfSF     …   -0.005316     0.129005      -0.002538   0.020764
TotalBsmtSF   …    0.232019     0.247264      -0.095478   0.037384
1stFlrSF      …    0.235459     0.211671      -0.065292   0.056104
2ndFlrSF      …    0.092165     0.208026       0.061989  -0.024358
LowQualFinSF  …   -0.025444     0.018251       0.061081  -0.004296
GrLivArea     …    0.247433     0.330224       0.009113   0.020643
BsmtFullBath  …    0.175315     0.067341      -0.049911  -0.000106
BsmtHalfBath  …    0.040161    -0.025324      -0.008555   0.035114
FullBath      …    0.187703     0.259977      -0.115093   0.035353
HalfBath      …    0.108080     0.199740      -0.095317  -0.004972
BedroomAbvGr  …    0.046854     0.093810       0.041570  -0.024478
KitchebvGr    …   -0.090130    -0.070091       0.037312  -0.024600
```

```
TotRmsAbvGrd   …    0.165984     0.234192       0.004151  -0.006683
Fireplaces     …    0.200019     0.169405      -0.024822   0.011257
GarageYrBlt    …    0.224577     0.228425      -0.297003   0.023544
GarageCars     …    0.226342     0.213569      -0.151434   0.035765
GarageArea     …    0.224666     0.241435      -0.121777   0.035087
WoodDeckSF     …    1.000000     0.058661      -0.125989  -0.032771
OpenPorchSF    …    0.058661     1.000000      -0.093079  -0.005842
EnclosedPorch  …   -0.125989    -0.093079       1.000000  -0.037305
3SsnPorch      …   -0.032771    -0.005842      -0.037305   1.000000
ScreenPorch    …   -0.074181     0.074304      -0.082864  -0.031436
PoolArea       …    0.073378     0.060762       0.054203  -0.007992
MiscVal        …   -0.009551    -0.018584       0.018361   0.000354
MoSold         …    0.021011     0.071255      -0.028887   0.029474
YrSold         …    0.022270    -0.057619      -0.009916   0.018645
SalePrice      …    0.324413     0.315856      -0.128578   0.044584

               ScreenPorch  PoolArea   MiscVal    MoSold    YrSold  SalePrice
Id                0.001330  0.057044 -0.006242  0.021172  0.000712  -0.021917
MSSubClass       -0.026030  0.008283 -0.007683 -0.013585 -0.021407  -0.084284
LotFrontage       0.041383  0.206167  0.003368  0.011200  0.007450   0.351799
LotArea           0.043160  0.077672  0.038068  0.001205 -0.014261   0.263843
OverallQual       0.064886  0.065166 -0.031406  0.070815 -0.027347   0.790982
OverallCond       0.054811 -0.001985  0.068777 -0.003511  0.043950  -0.077856
YearBuilt        -0.050364  0.004950 -0.034383  0.012398 -0.013618   0.522897
YearRemodAdd     -0.038740  0.005829 -0.010286  0.021490  0.035743   0.507101
MasVnrArea        0.061466  0.011723 -0.029815 -0.005965 -0.008201   0.477493
BsmtFinSF1        0.062021  0.140491  0.003571 -0.015727  0.014359   0.386420
BsmtFinSF2        0.088871  0.041709  0.004940 -0.015211  0.031706  -0.011378
BsmtUnfSF        -0.012579 -0.035092 -0.023837  0.034888 -0.041258   0.214479
TotalBsmtSF       0.084489  0.126053 -0.018479  0.013196 -0.014969   0.613581
1stFlrSF          0.088758  0.131525 -0.021096  0.031372 -0.013604   0.605852
2ndFlrSF          0.040606  0.081487  0.016197  0.035164 -0.028700   0.319334
LowQualFinSF      0.026799  0.062157 -0.003793 -0.022174 -0.028921  -0.025606
GrLivArea         0.101510  0.170205 -0.002416  0.050240 -0.036526   0.708624
BsmtFullBath      0.023148  0.067616 -0.023047 -0.025361  0.067049   0.227122
BsmtHalfBath      0.032121  0.020025 -0.007367  0.032873 -0.046524  -0.016844
FullBath         -0.008106  0.049604 -0.014290  0.055872 -0.019669   0.560664
HalfBath          0.072426  0.022381  0.001290 -0.009050 -0.010269   0.284108
BedroomAbvGr      0.044300  0.070703  0.007767  0.046544 -0.036014   0.168213
KitchebvGr       -0.051613 -0.014525  0.062341  0.026589  0.031687  -0.135907
TotRmsAbvGrd      0.059383  0.083757  0.024763  0.036907 -0.034516   0.533723
Fireplaces        0.184530  0.095074  0.001409  0.046357 -0.024096   0.466929
GarageYrBlt      -0.075418 -0.014501 -0.032417  0.005337 -0.001014   0.486362
GarageCars        0.050494  0.020934 -0.043080  0.040522 -0.039117   0.640409
GarageArea        0.051412  0.061047 -0.027400  0.027974 -0.027378   0.623431
WoodDeckSF       -0.074181  0.073378 -0.009551  0.021011  0.022270   0.324413
OpenPorchSF       0.074304  0.060762 -0.018584  0.071255 -0.057619   0.315856
```

```
EnclosedPorch    -0.082864  0.054203  0.018361 -0.028887 -0.009916  -0.128578
3SsnPorch        -0.031436 -0.007992  0.000354  0.029474  0.018645   0.044584
ScreenPorch       1.000000  0.051307  0.031946  0.023217  0.010694   0.111447
PoolArea          0.051307  1.000000  0.029669 -0.033737 -0.059689   0.092404
MiscVal           0.031946  0.029669  1.000000 -0.006495  0.004906  -0.021190
MoSold            0.023217 -0.033737 -0.006495  1.000000 -0.145721   0.046432
YrSold            0.010694 -0.059689  0.004906 -0.145721  1.000000  -0.028923
SalePrice         0.111447  0.092404 -0.021190  0.046432 -0.028923   1.000000

[38 rows x 38 columns]
```

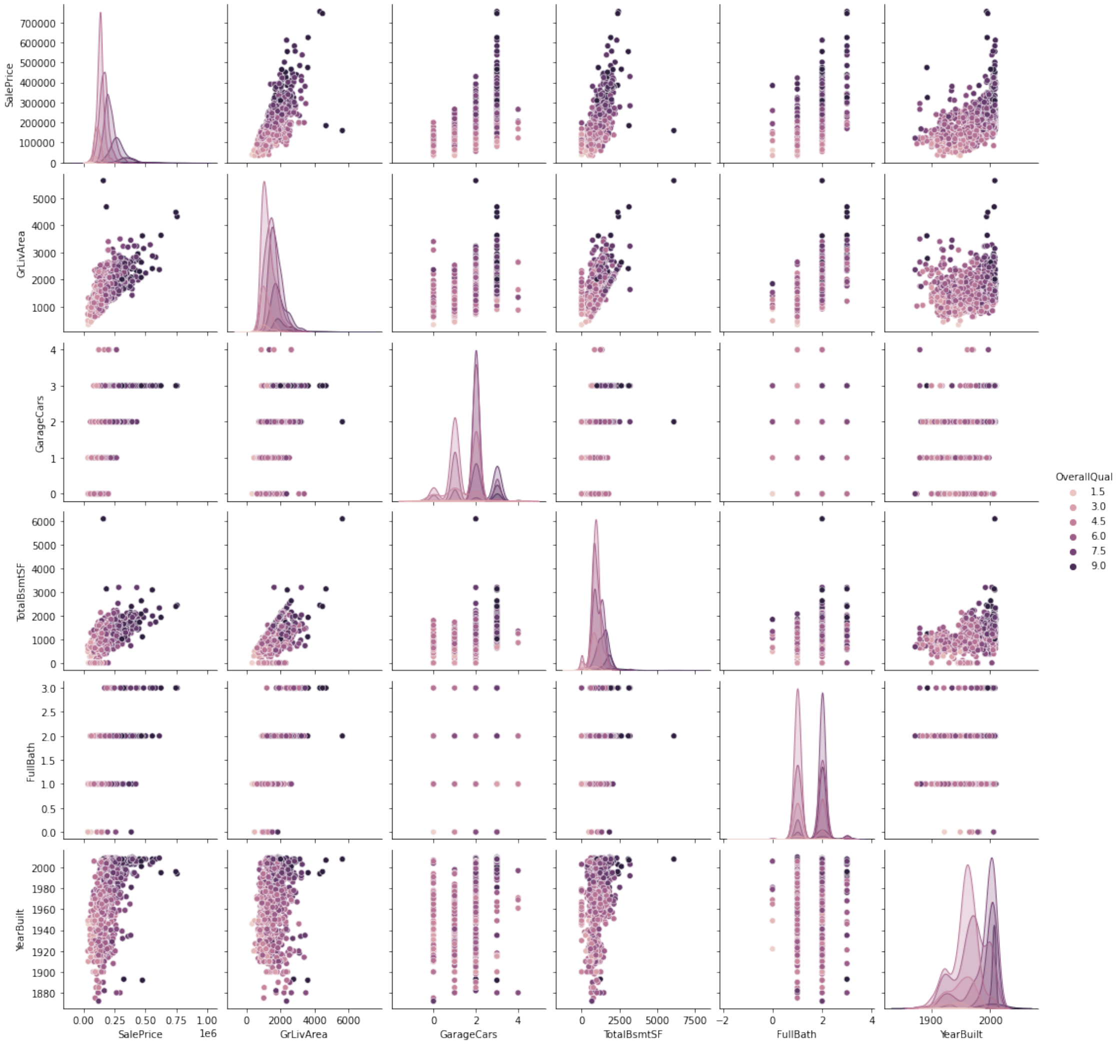
[15]:

```
plt.figure(figsize=(30,25))
sns.heatmap(data.corr(),cmap='YlGnBu',annot=True,fmt='.1g',vmax=1,vmin=-1)
plt.tick_params(labelsize=20)
plt.title('Correlation Matrix', fontsize=20,weight='bold')
plt.show()
```



```
[16]: # d. Pair plot for distribution and density

      cols = ['SalePrice', 'OverallQual', 'GrLivArea', 'GarageCars', 'TotalBsmtSF',␣
       ↪'FullBath', 'YearBuilt']
      sns.pairplot(impute_numeric_data[cols],hue='OverallQual')
```

```
[16]: <seaborn.axisgrid.PairGrid at 0x2e5abff69a0>
```



4 4. EDA of categorical variables

a. Missing value treatment

b. Count plot and box plot for bivariate analysis

c. Identify significant variables using p-values and Chi-Square values

[17]:
```
# a. Missing value treatment.

class DataFrameImputer(TransformerMixin):

    def __init__(self):
        """Impute missing values.

        Columns of dtype object are imputed with the most frequent value
        in column.

        Columns of other types are imputed with mean of column.

        """
    def fit(self, X, y=None):

        self.fill = pd.Series([X[c].value_counts().index[0]
            if X[c].dtype == np.dtype('O') else X[c].mode() for c in X],
            index=X.columns)

        return self

    def transform(self, X, y=None):
        return X.fillna(self.fill)

impute_categoric_data = pd.DataFrame(data_categorical)
impute_categoric_data = DataFrameImputer().fit_transform(impute_categoric_data)
```

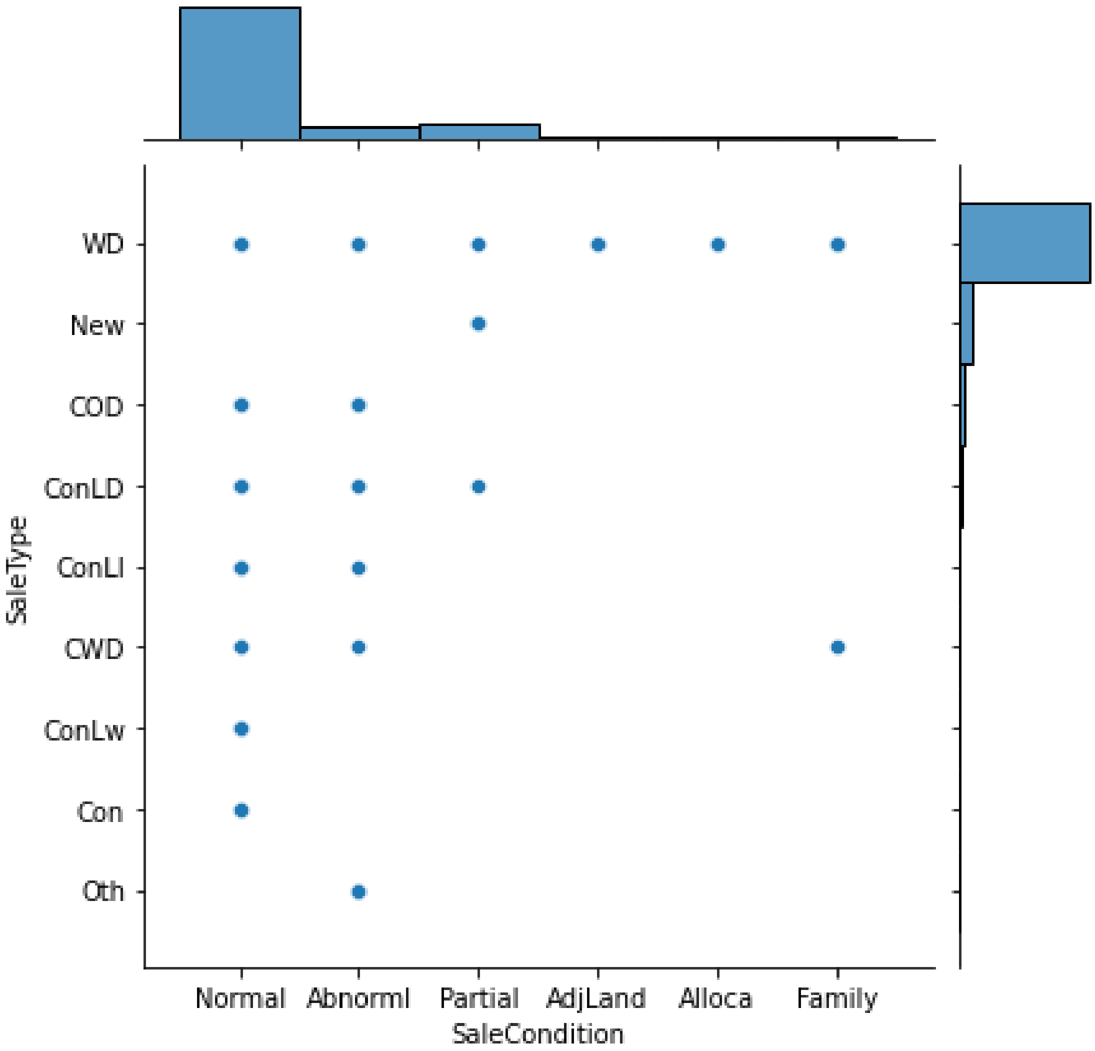
[18]:
```
print('Before implementation of Simple Imputer on categorical data :
 ↪',data_categorical.isna().sum().any())
print('After implementation of Simple Imputer on categorical data :
 ↪',impute_categoric_data.isna().sum().any())
```

```
Before implementation of Simple Imputer on categorical data : True
After implementation of Simple Imputer on categorical data : False
```

[19]:
```
# b. Count plot and box plot for bivariate analysis

plt.figure(figsize=(10,5))
sns.
 ↪jointplot('SaleCondition','SaleType',data=impute_categoric_data,kind='scatter')
```

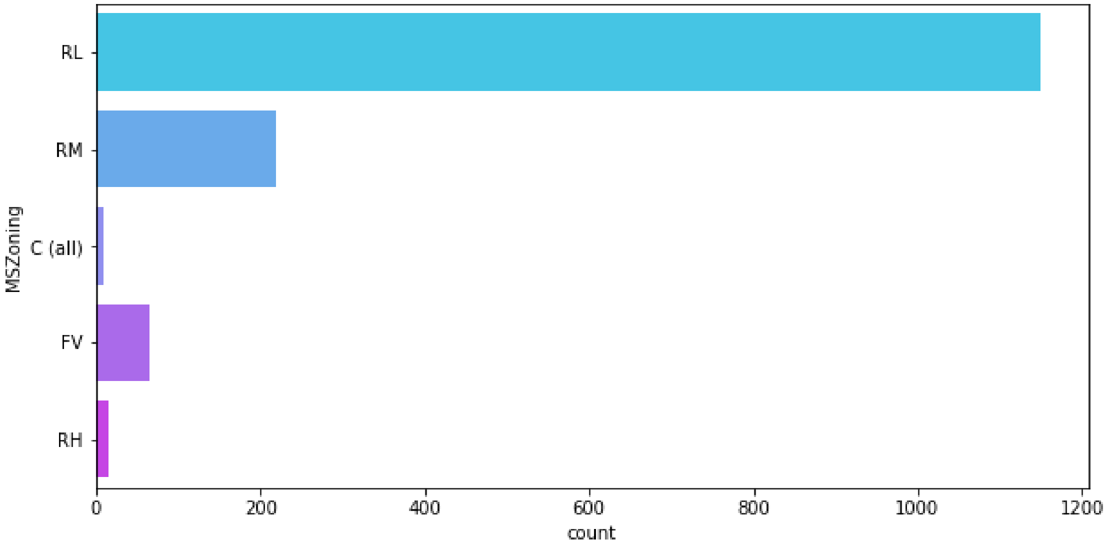
[19]:
```
<seaborn.axisgrid.JointGrid at 0x2e5ab6b6340>
```

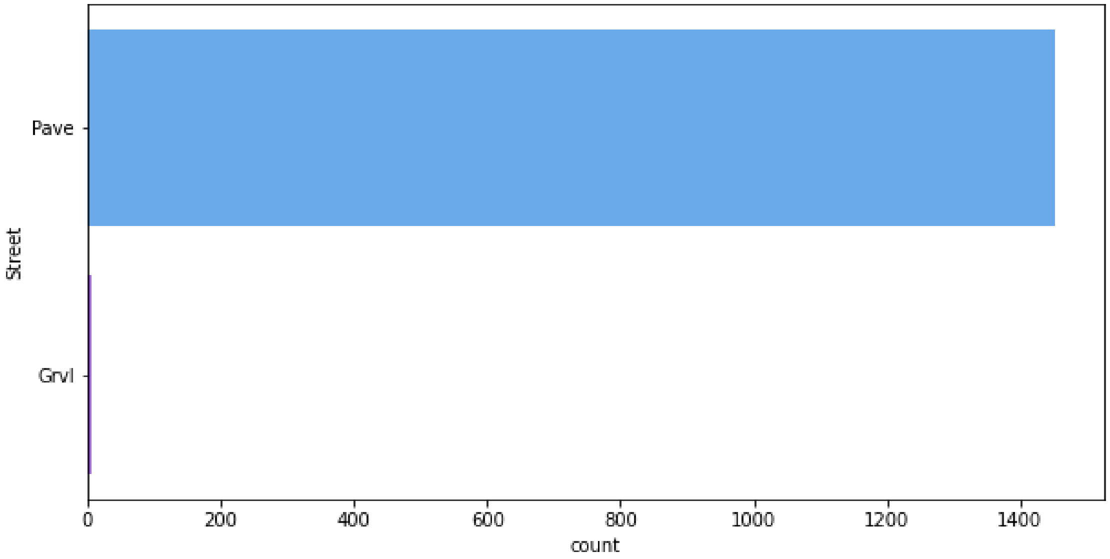
```
<Figure size 720x360 with 0 Axes>
```

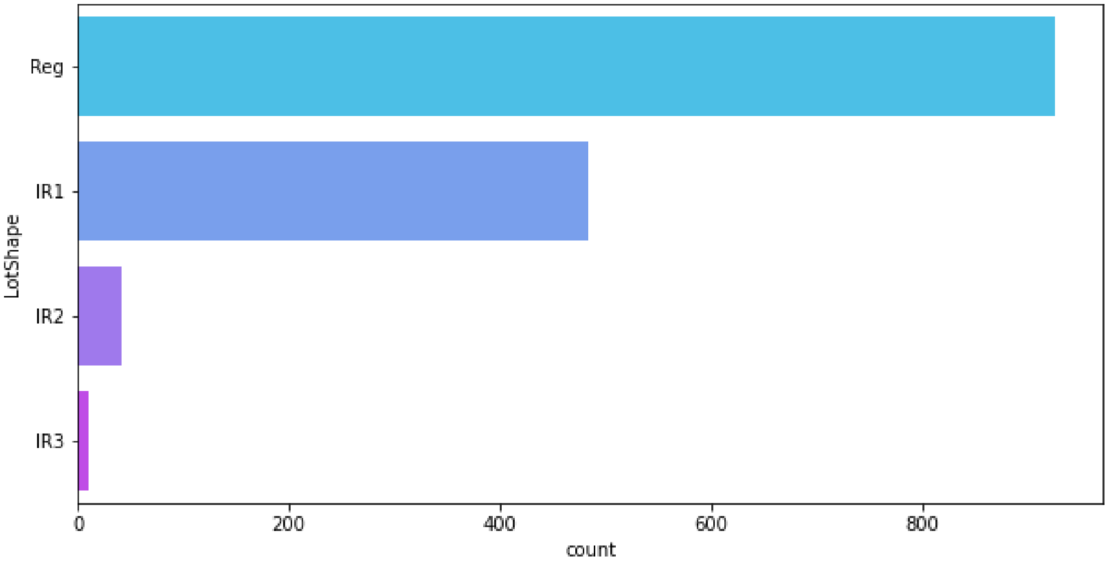


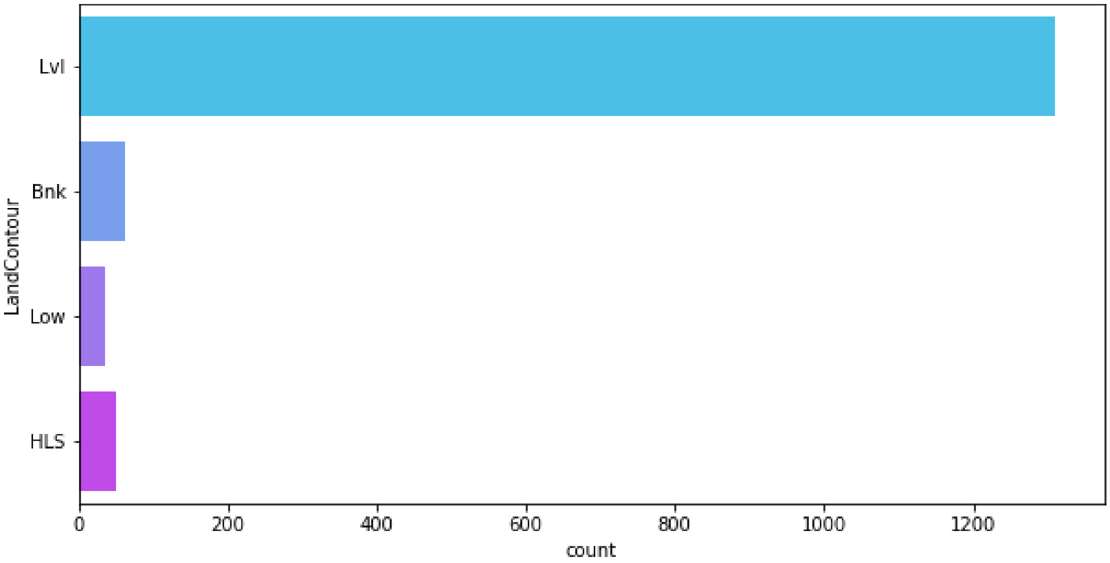
```
[20]: cols = [ 'MSZoning', 'Street', 'LotShape', 'LandContour',␣
       ↪'Utilities','LotConfig', 'LandSlope', 'Neighborhood',
              'Condition1', 'Condition2','BldgType', 'HouseStyle', 'RoofStyle',␣
       ↪'RoofMatl', 'Exterior1st','Exterior2nd',
              'MasVnrType', 'ExterQual', 'ExterCond', 'Foundation','BsmtQual',␣
       ↪'BsmtCond', 'BsmtExposure', 'BsmtFinType1',
              'BsmtFinType2','Heating', 'HeatingQC', 'CentralAir', 'Electrical',␣
       ↪'KitchenQual','Functiol', 'FireplaceQu',
              'GarageType', 'GarageFinish', 'GarageQual','GarageCond', 'PavedDrive',␣
       ↪'SaleType', 'SaleCondition']

      for i in cols:
          fig, ax = plt.subplots(1,1, figsize=(10,5))
```

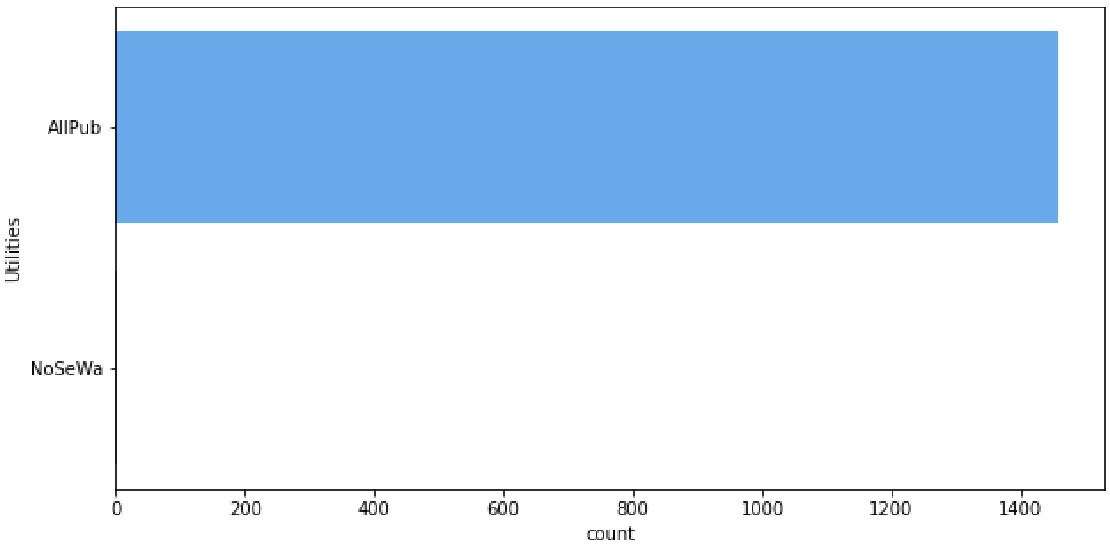
```
    sns.countplot(data=impute_categoric_data, y=impute_categoric_data[i][1:],␣
↪palette='cool')
```

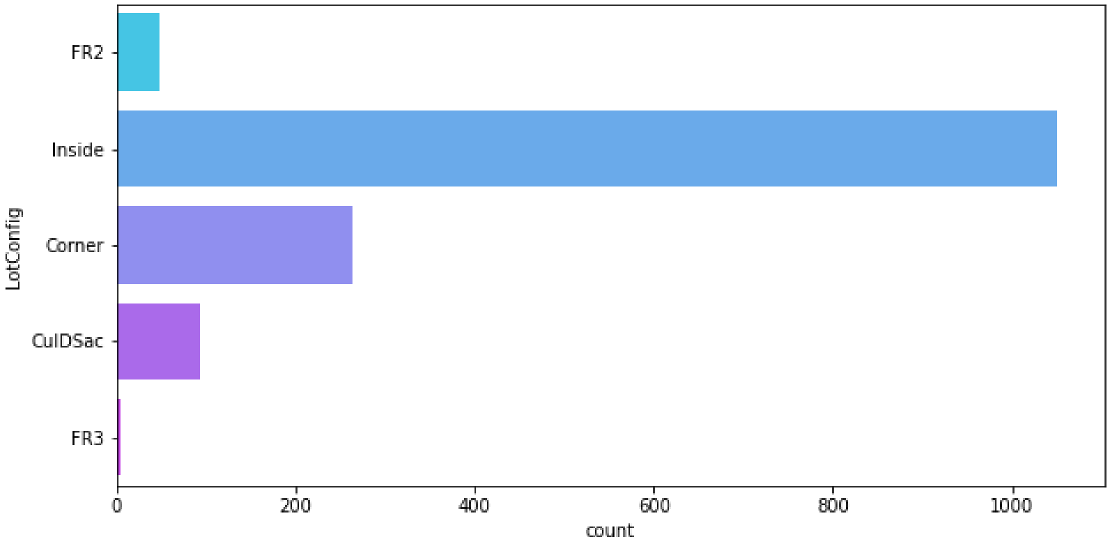


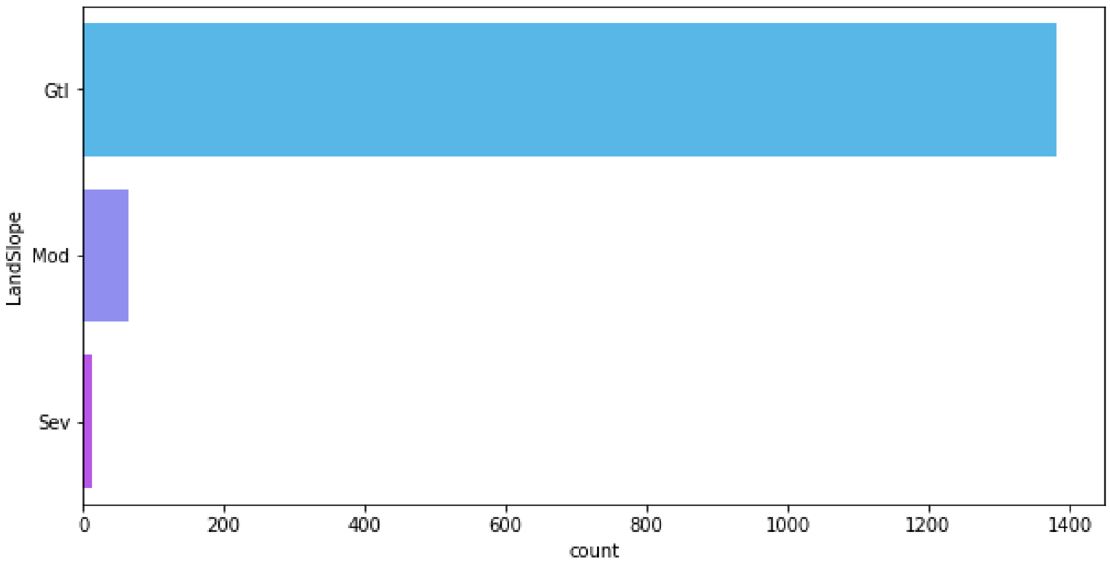


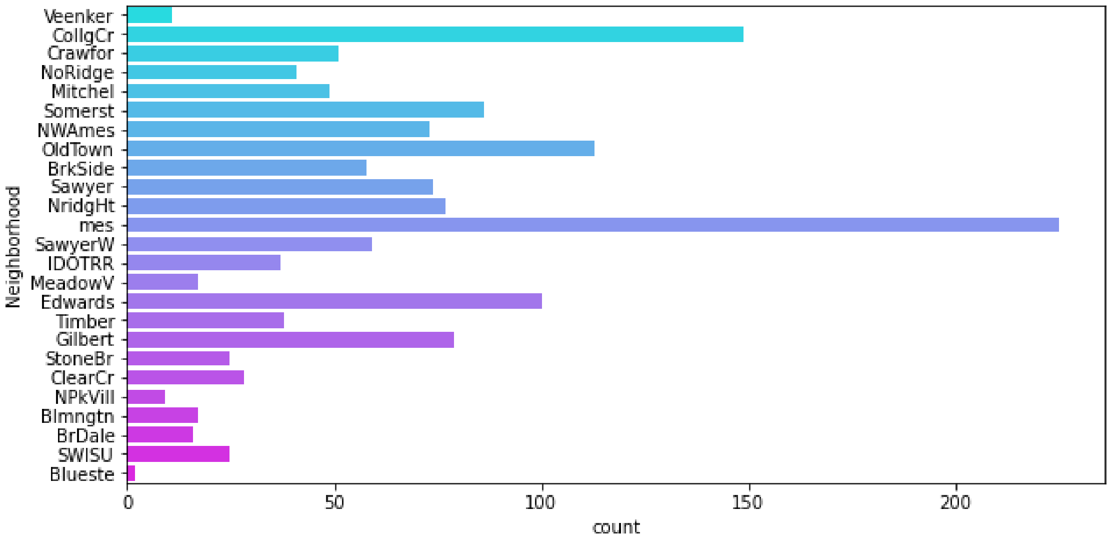

Reg
IR1
IR2
IR3
LotShape
0
200
400
600
800
count

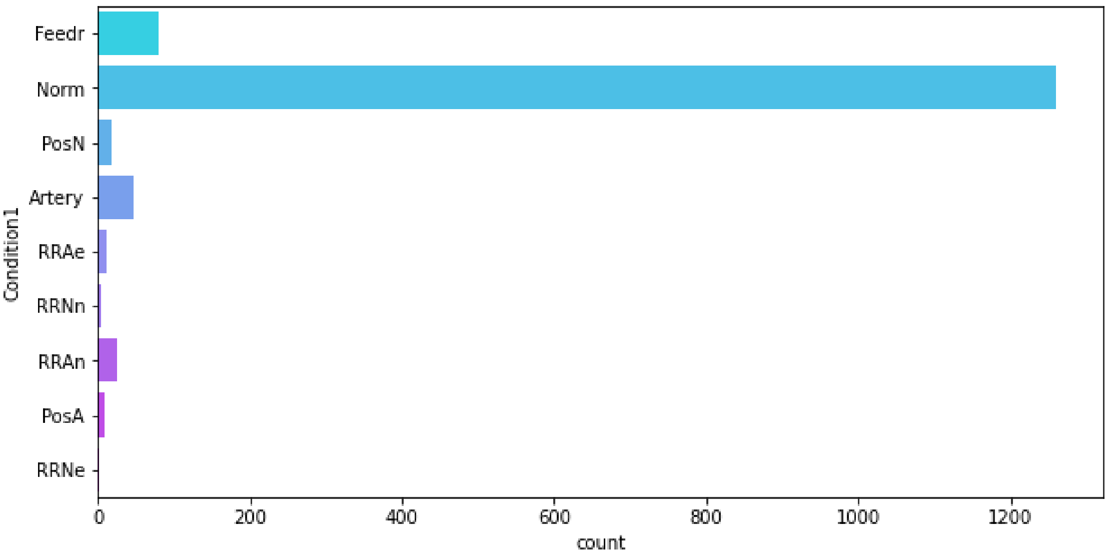

Lvl
Bnk
Low
HLS
LandContour
0
200
400
600
800
1000
1200
count

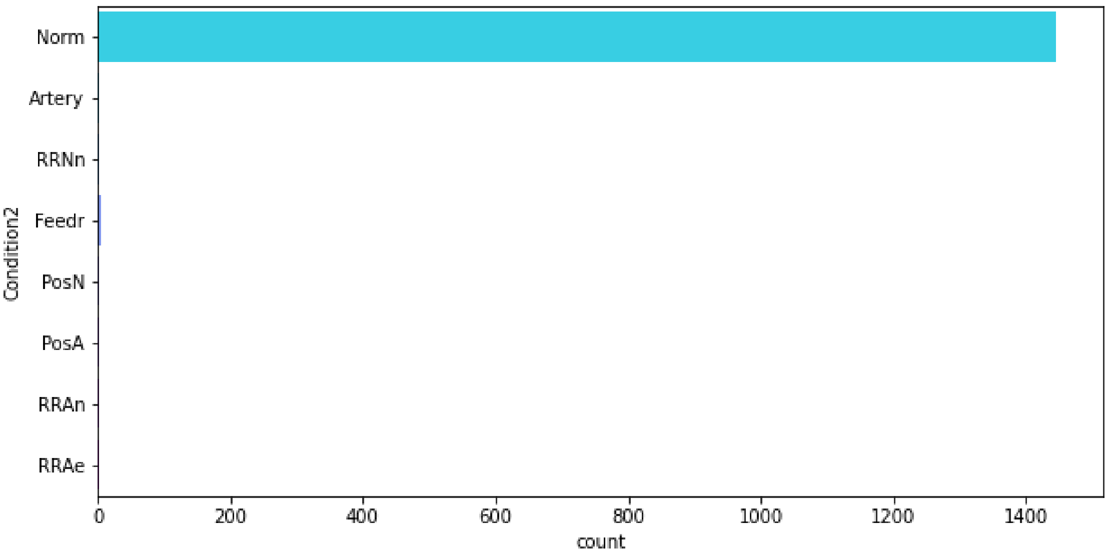

AllPub
NoSeWa
Utilities
0
200
400
600
800
1000
1200
1400
count

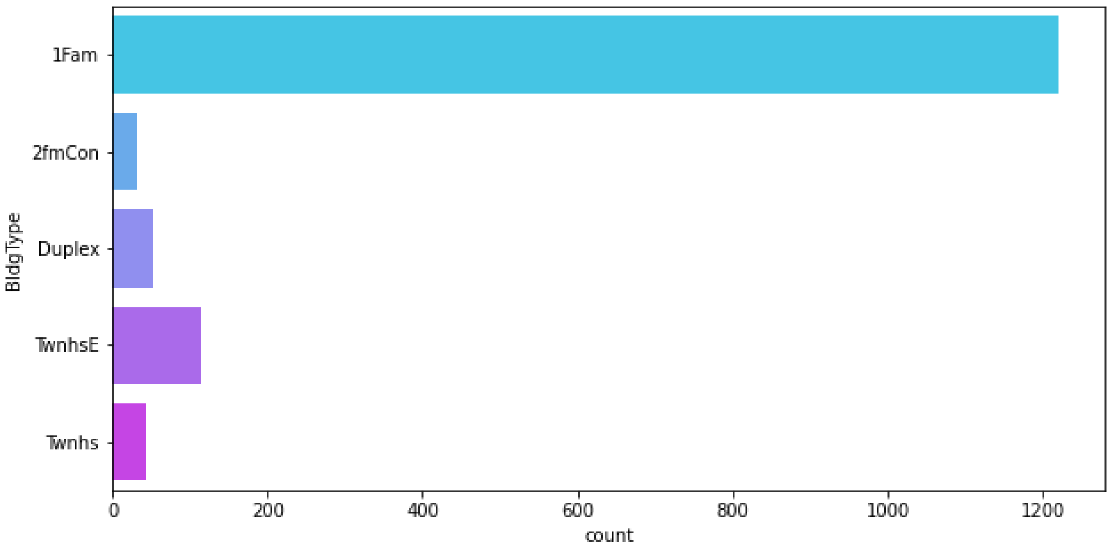

FR2
Inside
Corner
CulDSac
FR3
LotConfig
0
200
400
600
800
1000
count

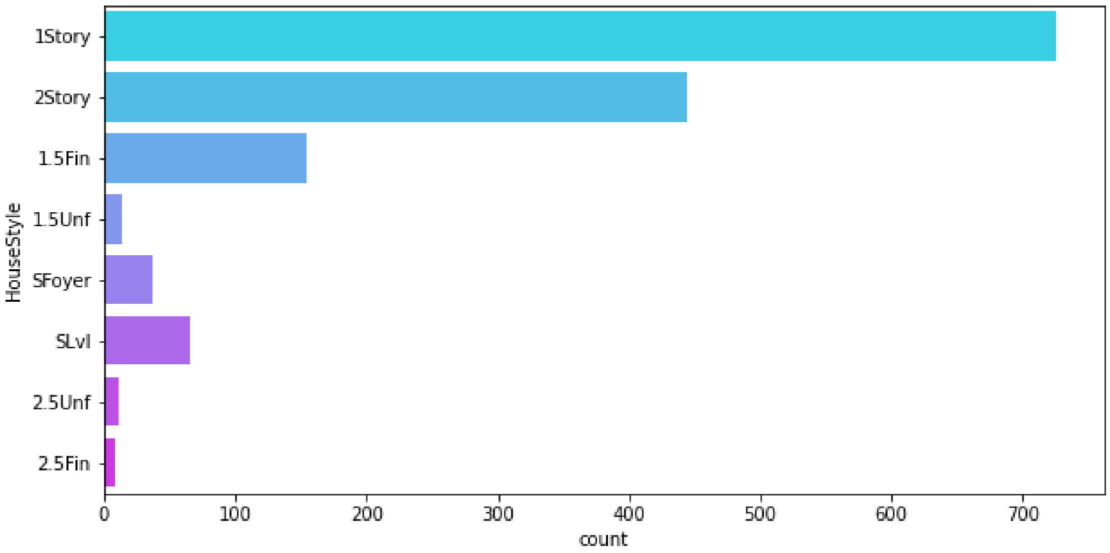

LandSlope
Gtl
Mod
Sev
0
200
400
600
800
1000
1200
1400
count

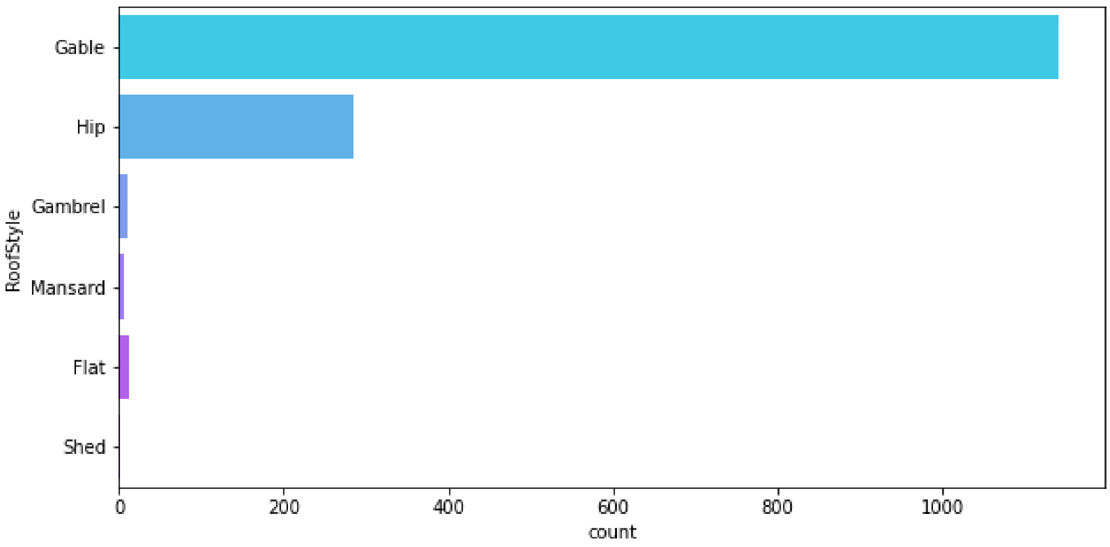

Neighborhood
Veenker
CollgCr
Crawfor
NoRidge
Mitchel
Somerst
NWAmes
OldTown
BrkSide
Sawyer
NridgHt
mes
SawyerW
IDOTRR
MeadowV
Edwards
Timber
Gilbert
StoneBr
ClearCr
NPkVill
Blmngtn
BrDale
SWISU
Blueste
0
50
100
150
200
count

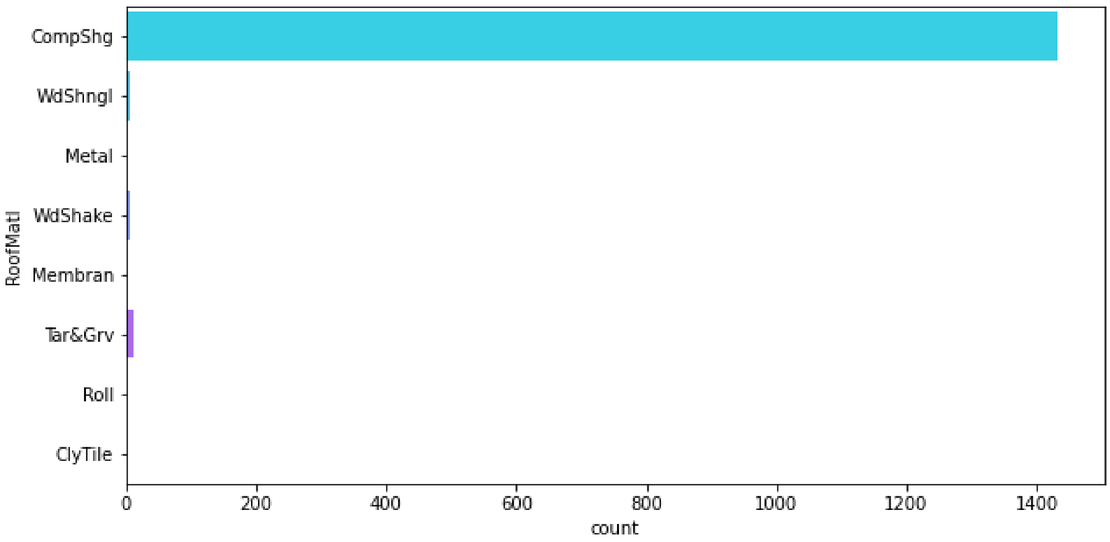

Feedr
Norm
PosN
Artery
RRAe
RRNn
RRAn
PosA
RRNe
Condition1
0
200
400
600
800
1000
1200
count

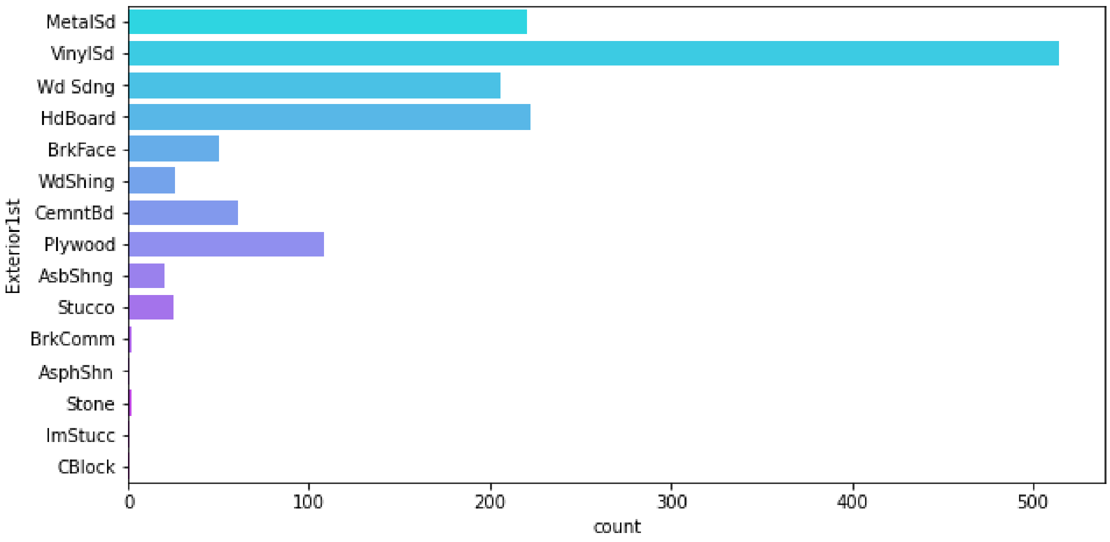

Norm
Artery
RRNn
Feedr
PosN
PosA
RRAn
RRAe
Condition2
0
200
400
600
800
1000
1200
1400
count

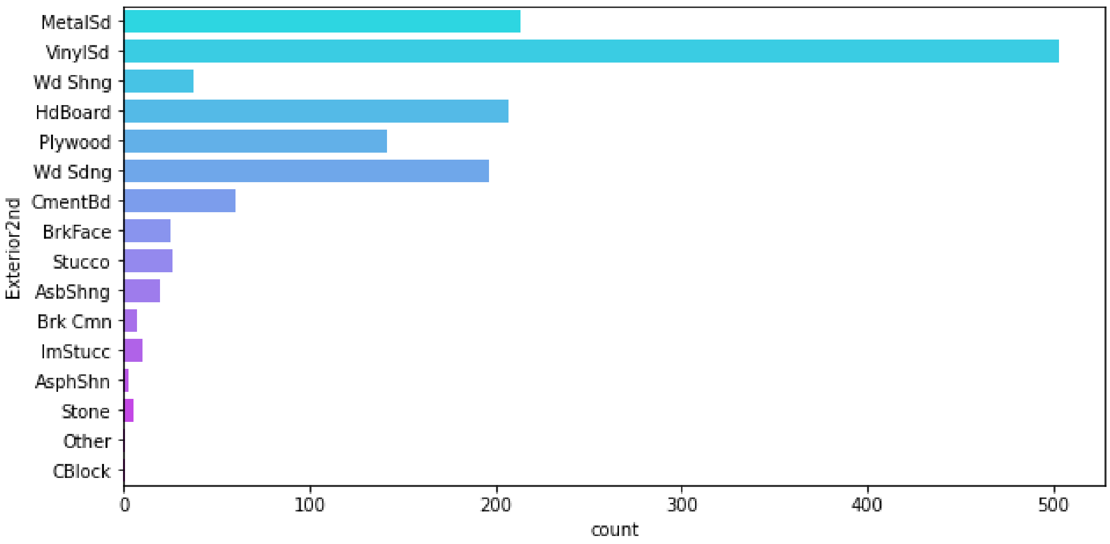

1Fam
2fmCon
Duplex
TwnhsE
Twnhs
BldgType
0
200
400
600
800
1000
1200
count

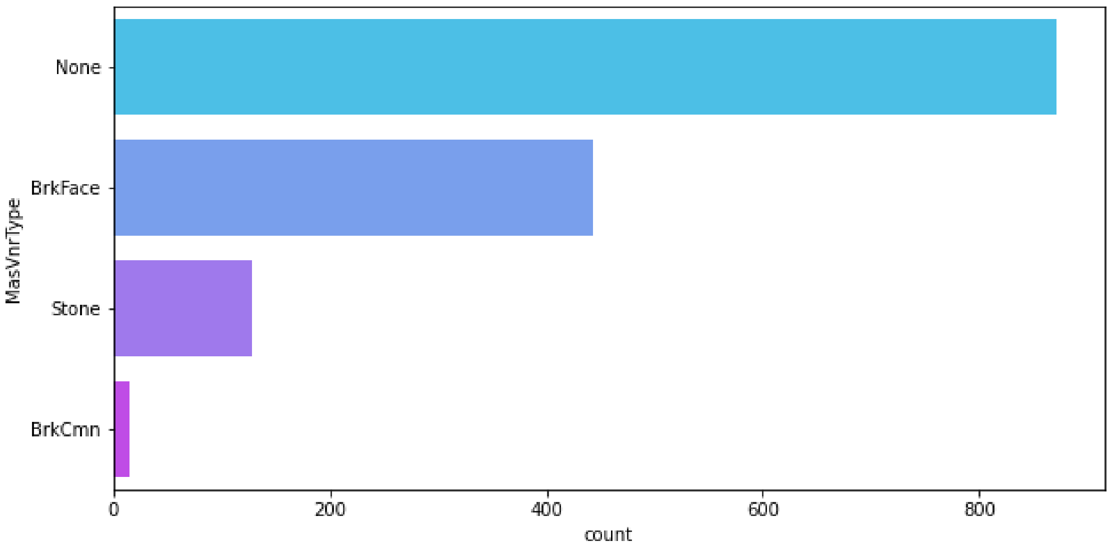

1Story
2Story
1.5Fin
1.5Unf
SFoyer
SLvl
2.5Unf
2.5Fin
HouseStyle
0
100
200
300
400
500
600
700
count

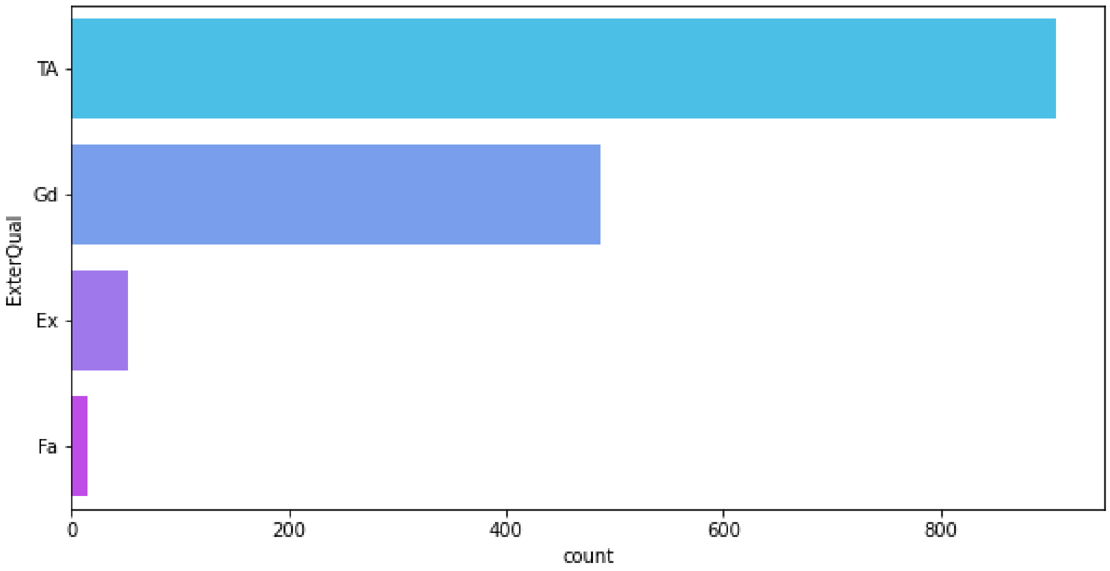

Gable
Hip
Gambrel
Mansard
Flat
Shed
RoofStyle
0
200
400
600
800
1000
count

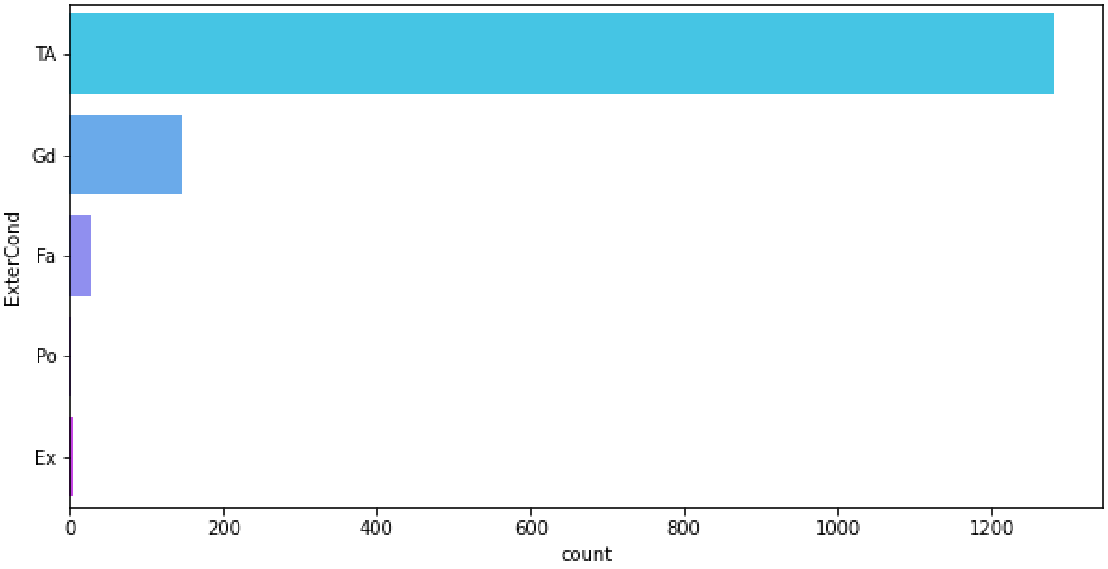

CompShg
WdShngl
Metal
WdShake
Membran
Tar&Grv
Roll
ClyTile
RoofMatl
0
200
400
600
800
1000
1200
1400
count

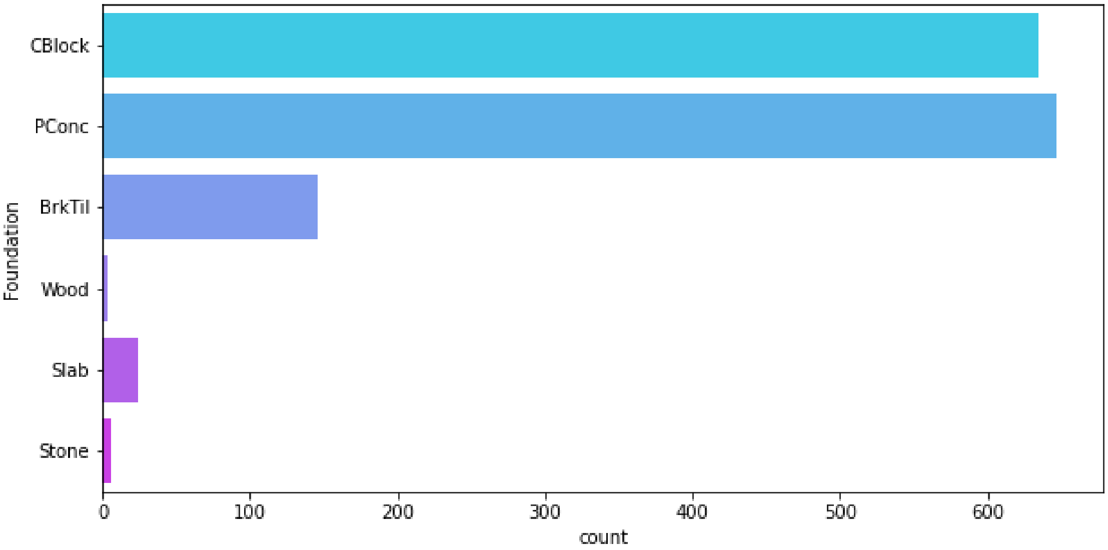

MetalSd
VinylSd
Wd Sdng
HdBoard
BrkFace
WdShing
CemntBd
Plywood
AsbShng
Stucco
BrkComm
AsphShn
Stone
ImStucc
CBlock
Exterior1st
0
100
200
300
400
500
count

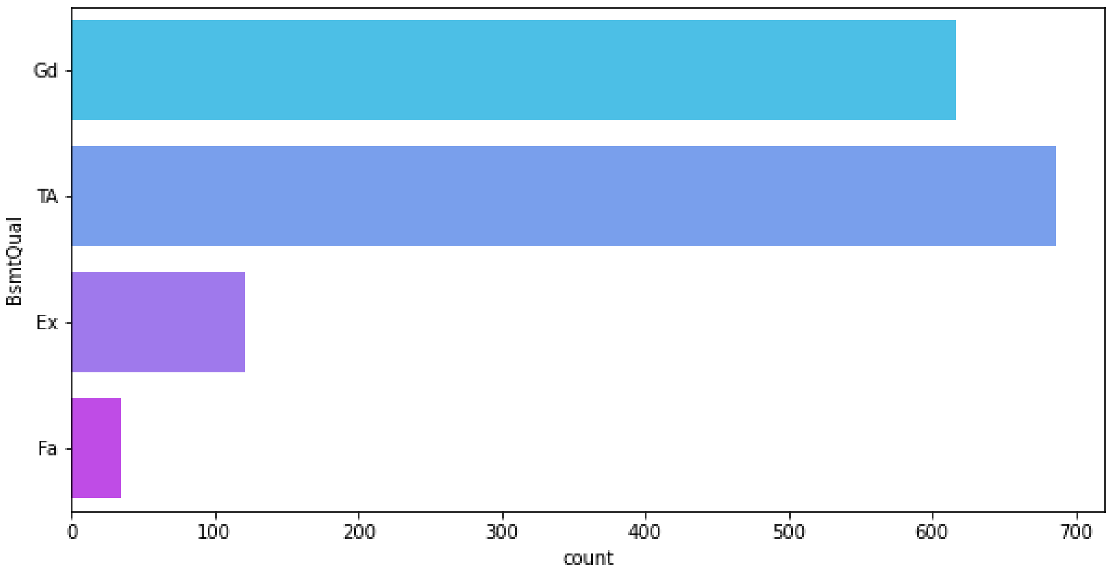

MetalSd
VinylSd
Wd Shng
HdBoard
Plywood
Wd Sdng
CmentBd
BrkFace
Stucco
AsbShng
Brk Cmn
ImStucc
AsphShn
Stone
Other
CBlock
Exterior2nd
0
100
200
300
400
500
count

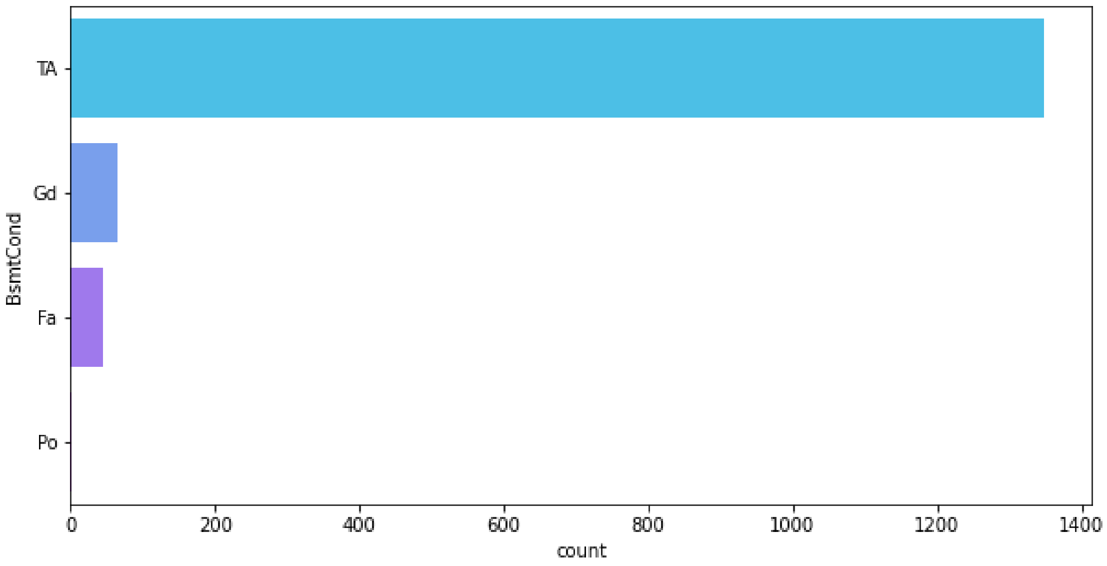

None
BrkFace
Stone
BrkCmn
MasVnrType
0
200
400
600
800
count

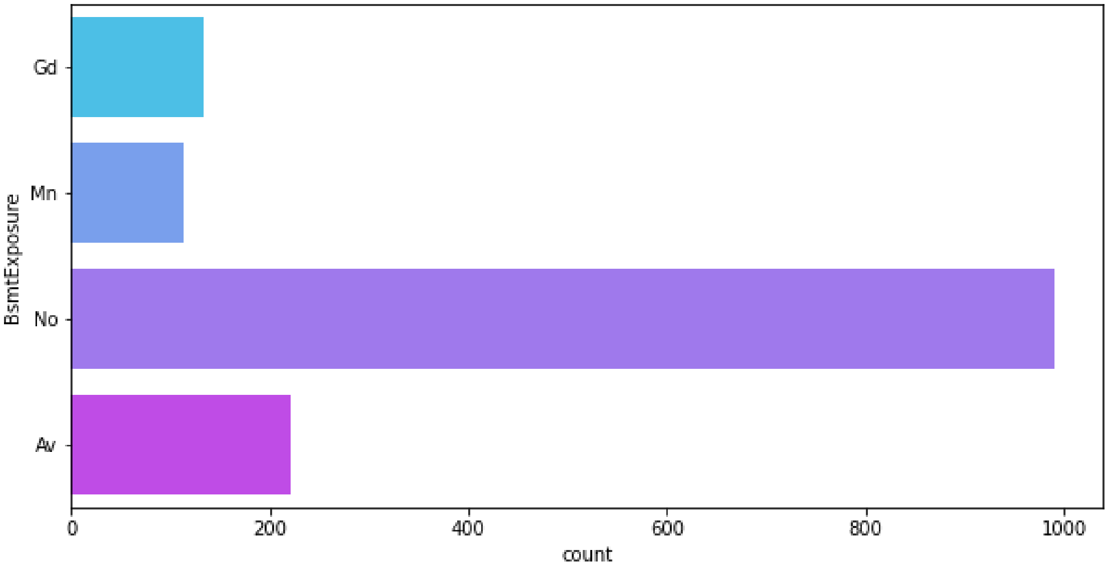

TA
Gd
Ex
Fa
ExterQual
0
200
400
600
800
count

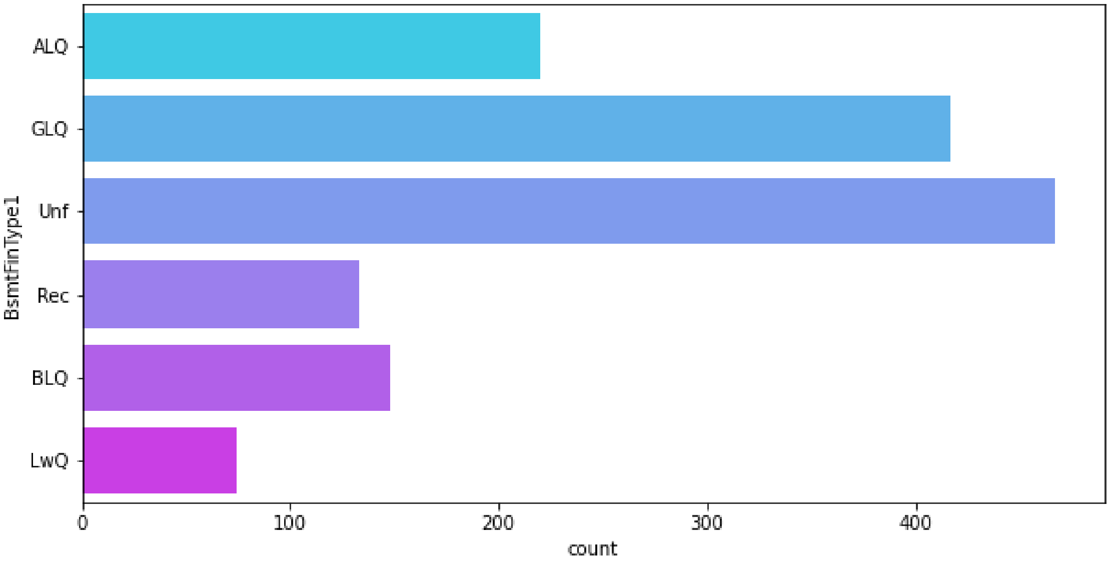

TA
Gd
Fa
Po
Ex
ExterCond
0
200
400
600
800
1000
1200
count

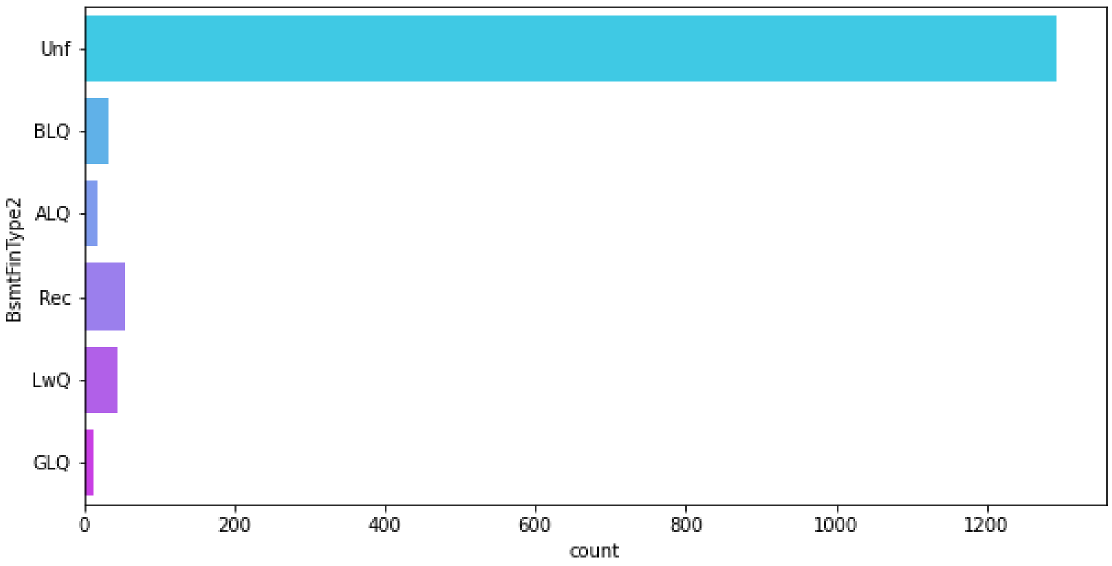

CBlock
PConc
BrkTil
Wood
Slab
Stone
Foundation
0
100
200
300
400
500
600
count

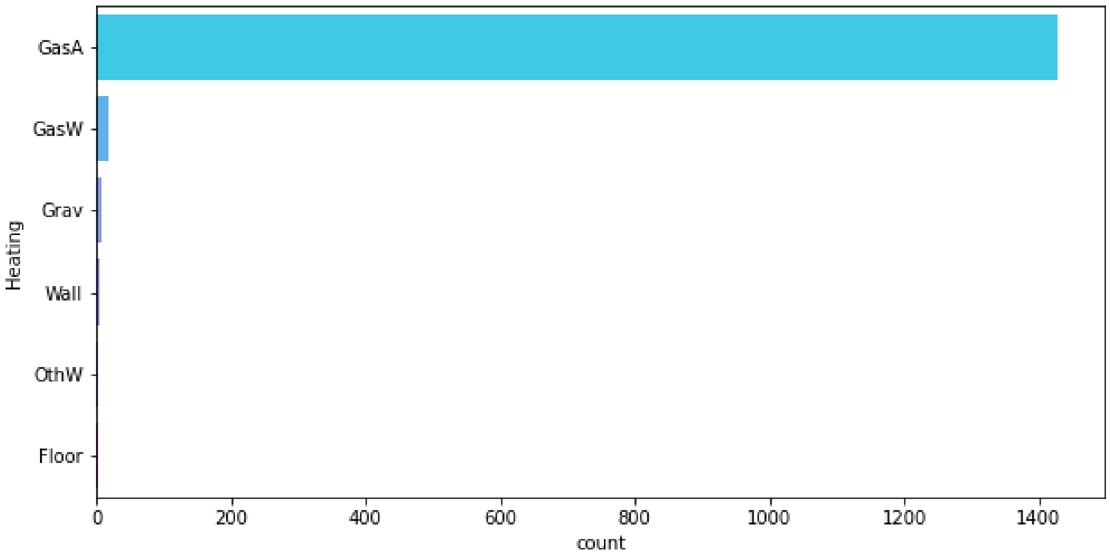

BsmtQual
Gd
TA
Ex
Fa
0
100
200
300
400
500
600
700
count

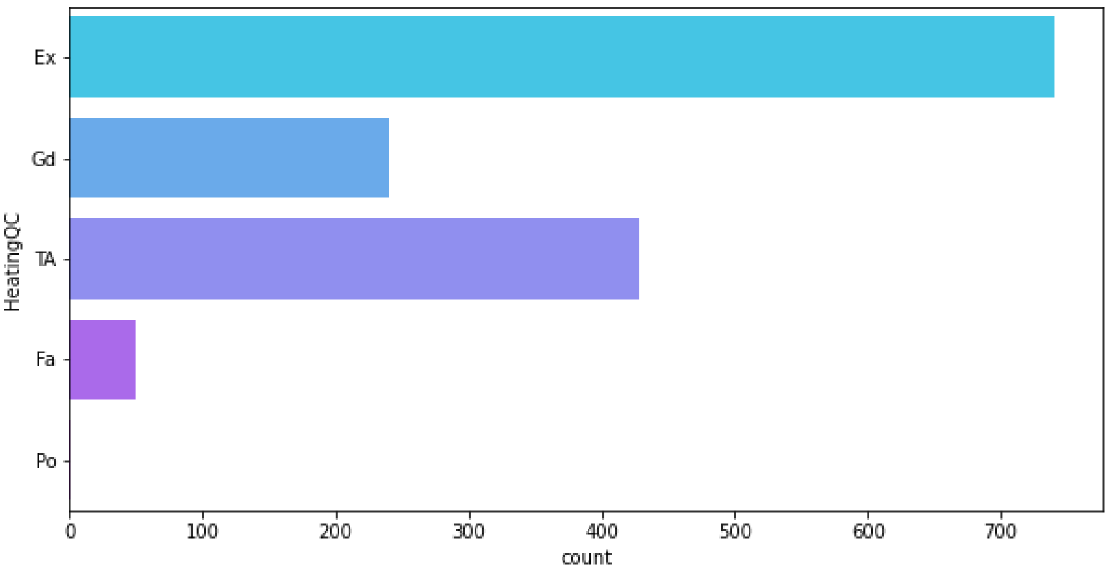

BsmtCond
TA
Gd
Fa
Po
0
200
400
600
800
1000
1200
1400
count

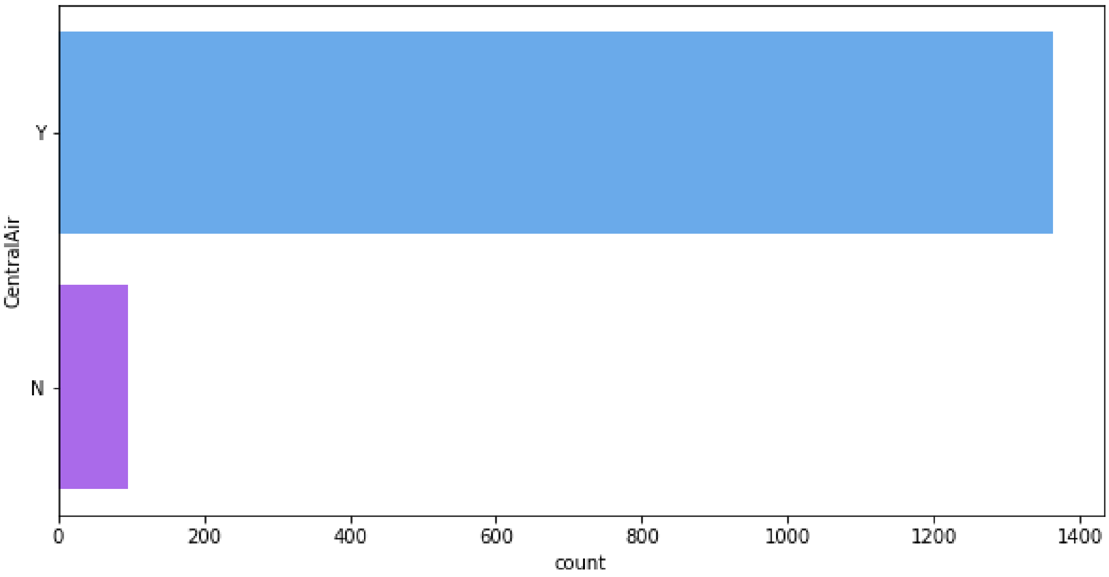

Gd
Mn
No
Av
BsmtExposure
0
200
400
600
800
1000
count

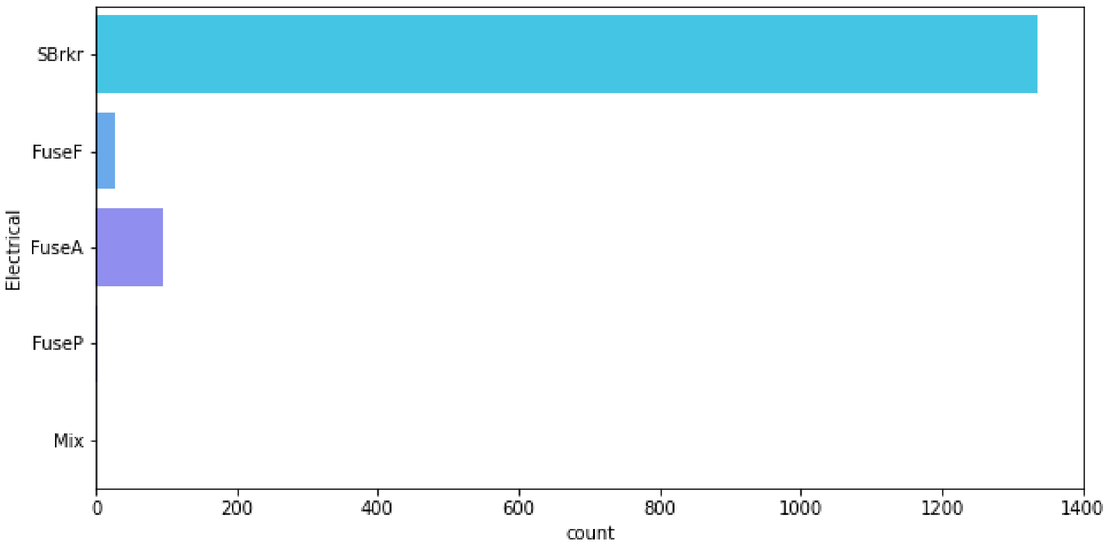

ALQ
GLQ
Unf
Rec
BLQ
LwQ
BsmtFinType1
0
100
200
300
400
count

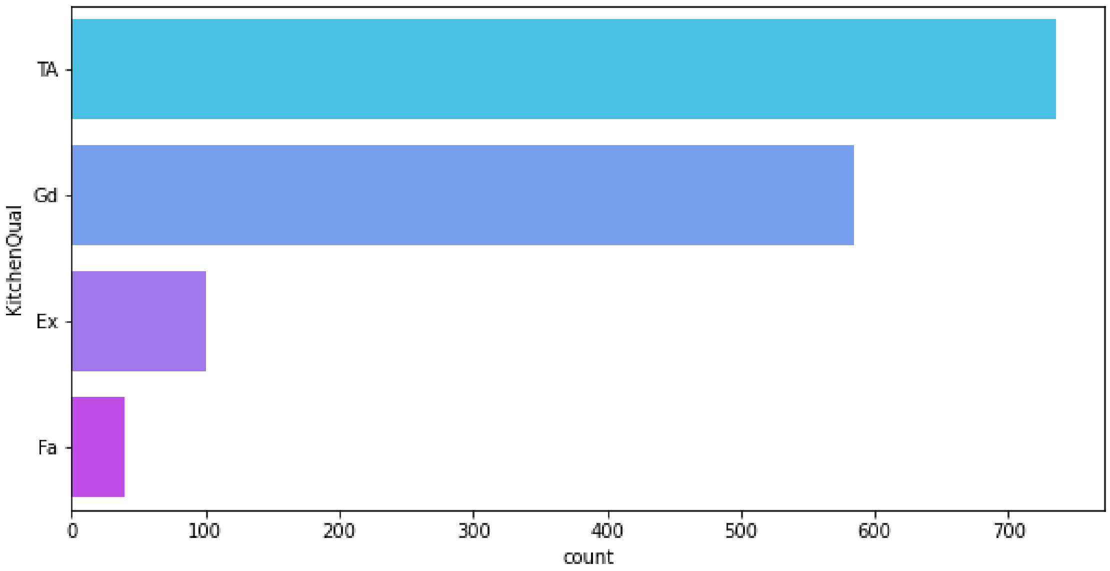

BsmtFinType2
Unf
BLQ
ALQ
Rec
LwQ
GLQ
0
200
400
600
800
1000
1200
count

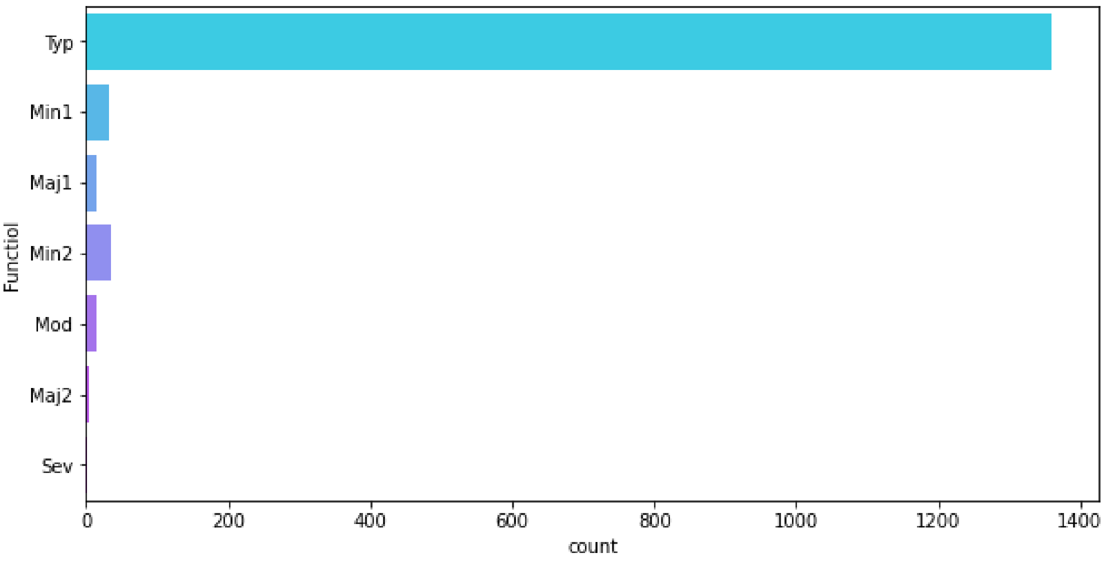

Heating
GasA
GasW
Grav
Wall
OthW
Floor
0
200
400
600
800
1000
1200
1400
count

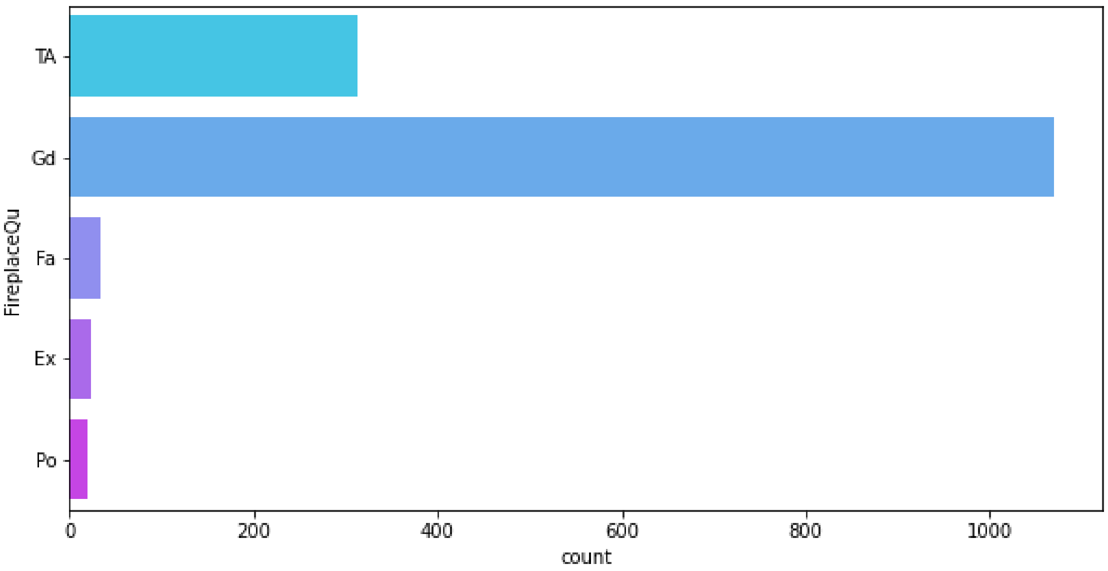

Ex
Gd
TA
Fa
Po
HeatingQC
0
100
200
300
400
500
600
700
count

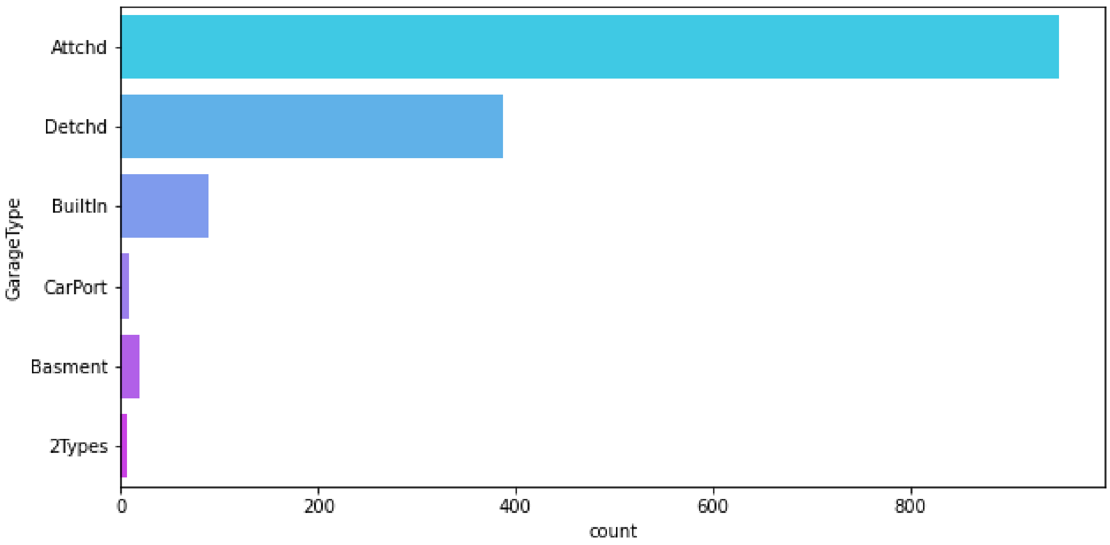

Y
N
CentralAir
0
200
400
600
800
1000
1200
1400
count

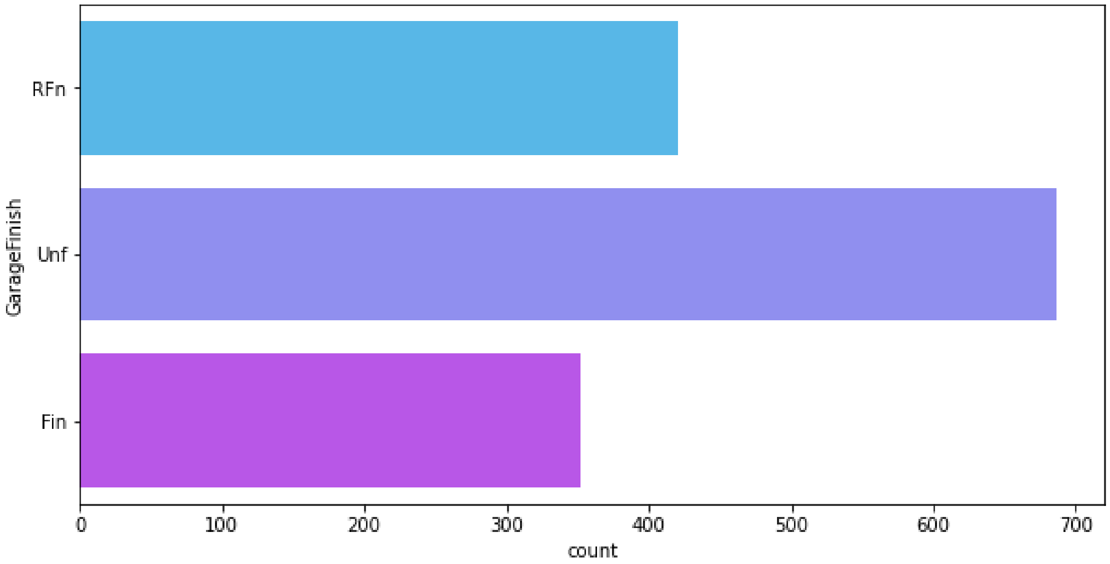

SBrkr
FuseF
FuseA
FuseP
Mix
Electrical
0
200
400
600
800
1000
1200
1400
count

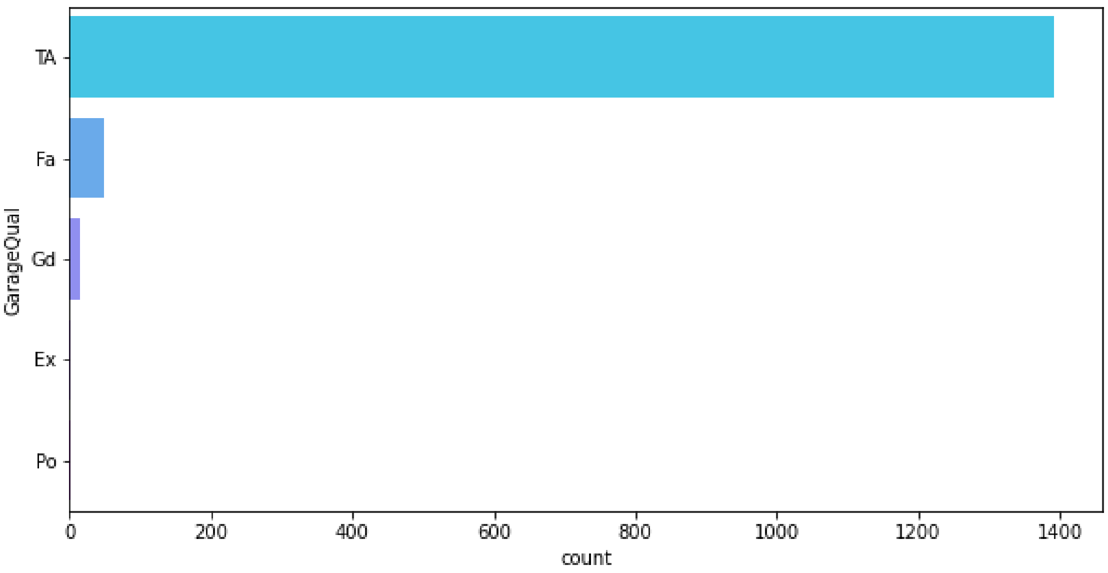

TA
Gd
Ex
Fa
KitchenQual
0
100
200
300
400
500
600
700
count

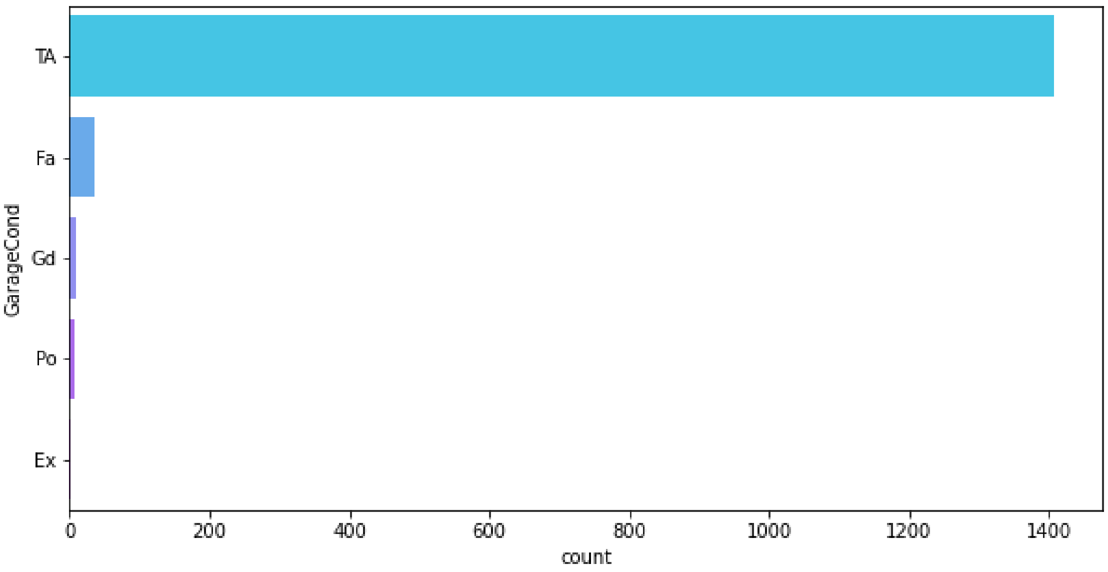

Typ
Min1
Maj1
Min2
Mod
Maj2
Sev
Functiol
0
200
400
600
800
1000
1200
1400
count

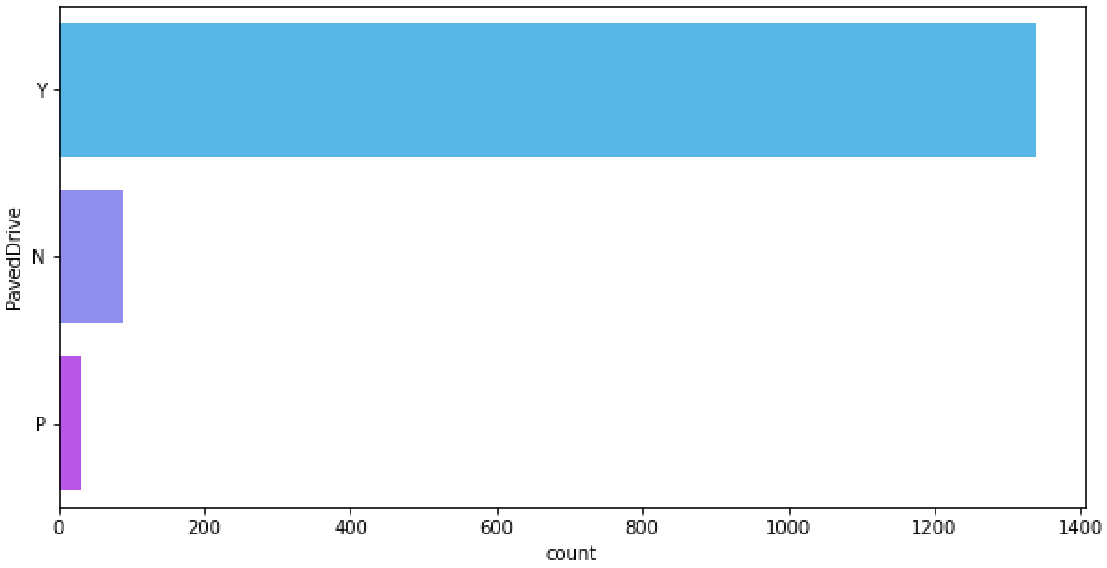

TA
Gd
Fa
Ex
Po
FireplaceQu
0
200
400
600
800
1000
count

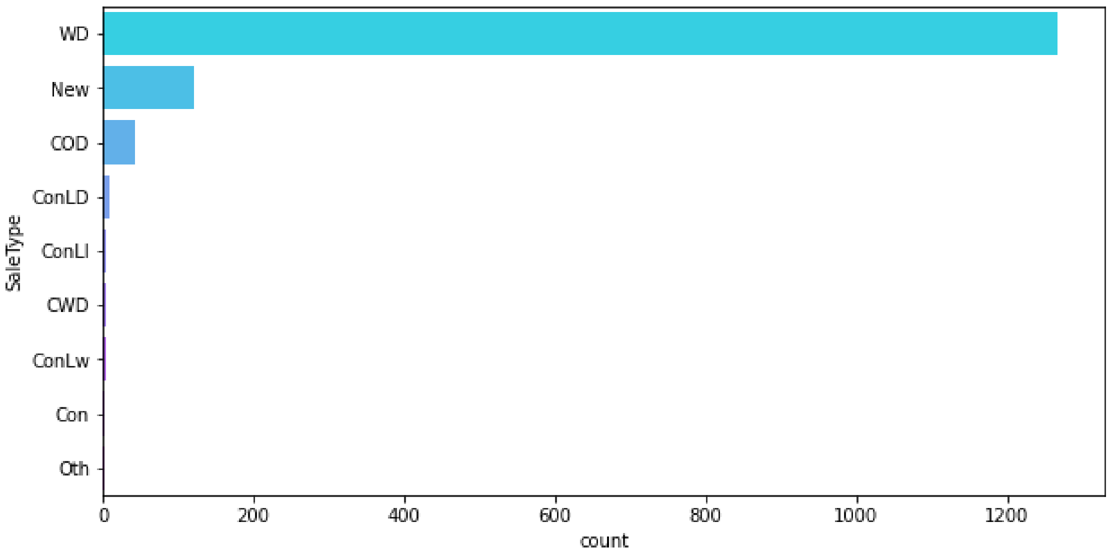

Attchd
Detchd
BuiltIn
CarPort
Basment
2Types
GarageType
0
200
400
600
800
count

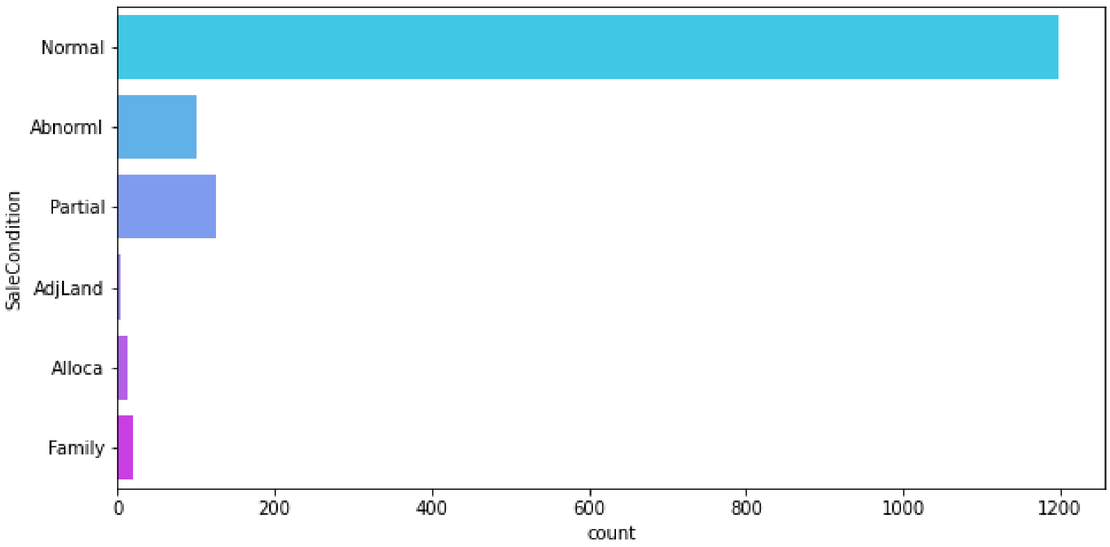

RFn
Unf
Fin
GarageFinish
0
100
200
300
400
500
600
700
count


TA
Fa
Gd
Ex
Po
GarageQual
0
200
400
600
800
1000
1200
1400
count


TA
Fa
Gd
Po
Ex
GarageCond
0
200
400
600
800
1000
1200
1400
count

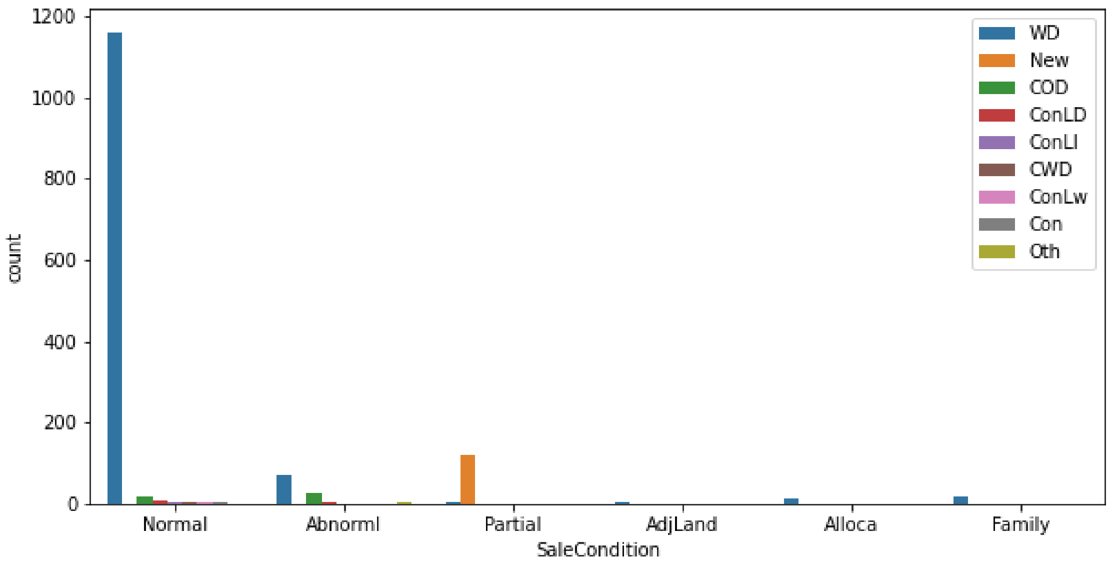

Y
N
P
PavedDrive
0
200
400
600
800
1000
1200
1400
count


WD
New
COD
ConLD
ConLI
CWD
ConLw
Con
Oth
SaleType
0
200
400
600
800
1000
1200
count



[21]:
```
plt.figure(figsize=(10,5))
sns.countplot(impute_categoric_data.SaleCondition, hue = 'SaleType',␣
 ↪data=impute_categoric_data)
plt.legend(loc='upper right')
```

[21]:
```
<matplotlib.legend.Legend at 0x2e5ab90c460>
```



[23]:
```
# c. Identify significant variables using p-values and Chi-Square values
```

```
from scipy import stats

data_cross = pd.
 ↪crosstab(impute_categoric_data['SaleType'],impute_categoric_data['SaleCondition'])
coff,pval,dof,expec=stats.chi2_contingency(data_cross)
print("chisquare",coff)
print("Pvalue",pval)
print("DOF",dof)
print("Expected",expec)
```

```
chisquare 1652.6750772643866
Pvalue 0.0
DOF 40
Expected [[2.97465753e+00 1.17808219e-01 3.53424658e-01 5.89041096e-01
  3.52835616e+01 3.68150685e+00]
 [2.76712329e-01 1.09589041e-02 3.28767123e-02 5.47945205e-02
  3.28219178e+00 3.42465753e-01]
 [1.38356164e-01 5.47945205e-03 1.64383562e-02 2.73972603e-02
  1.64109589e+00 1.71232877e-01]
 [6.22602740e-01 2.46575342e-02 7.39726027e-02 1.23287671e-01
  7.38493151e+00 7.70547945e-01]
 [3.45890411e-01 1.36986301e-02 4.10958904e-02 6.84931507e-02
  4.10273973e+00 4.28082192e-01]
 [3.45890411e-01 1.36986301e-02 4.10958904e-02 6.84931507e-02
  4.10273973e+00 4.28082192e-01]
 [8.43972603e+00 3.34246575e-01 1.00273973e+00 1.67123288e+00
  1.00106849e+02 1.04452055e+01]
 [2.07534247e-01 8.21917808e-03 2.46575342e-02 4.10958904e-02
  2.46164384e+00 2.56849315e-01]
 [8.76486301e+01 3.47123288e+00 1.04136986e+01 1.73561644e+01
  1.03963425e+03 1.08476027e+02]]
```

[24]:
```
if pval<0.05:
    print("Alter Hypo----->relation exist")
else:
    print("Null Hypo---->No relation")
```

```
Alter Hypo----->relation exist
```

5 5. Combine all the significant categorical and numerical variables

[25]:
```
df_combine = pd.concat([impute_numeric_data,impute_categoric_data],axis=1)
df_combine.
 ↪drop(['Id','LotFrontage','LotArea','TotRmsAbvGrd','YearBuilt','MasVnrArea','BsmtFinSF1','Bs
                    ␣
↪'TotalBsmtSF','EnclosedPorch','YearRemodAdd','GarageYrBlt','BsmtFullBath','BsmtUnfSF','MSSu
                    ␣
↪'1stFlrSF','2ndFlrSF','PoolQC','MiscFeature','Fence','Alley','GrLivArea','GarageArea',
                     'WoodDeckSF', 'OpenPorchSF','ScreenPorch'], axis=1,␣
↪inplace=True)
df_combine.head()
```

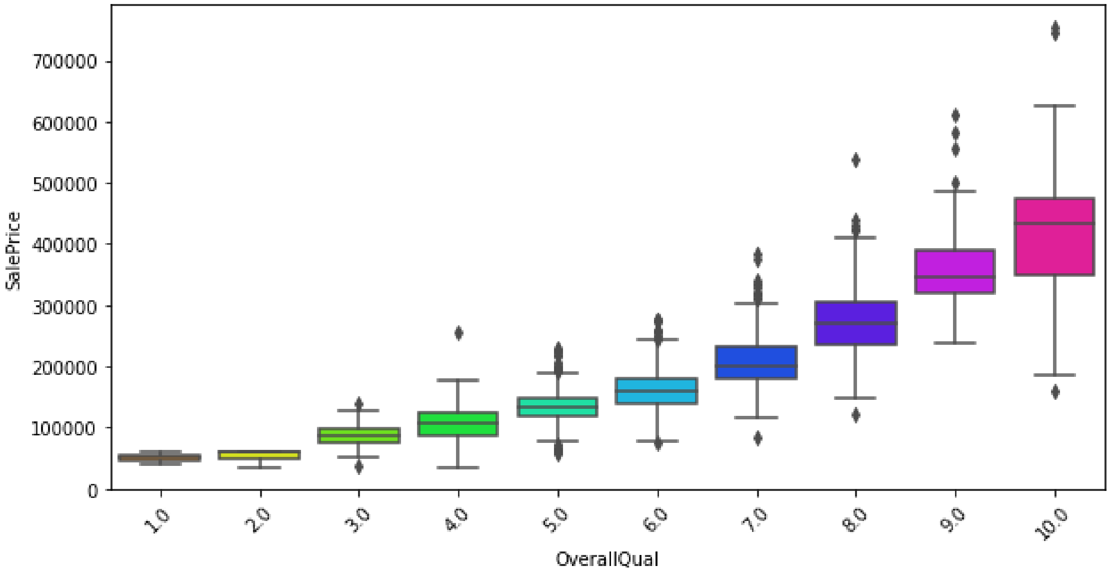
[25]:

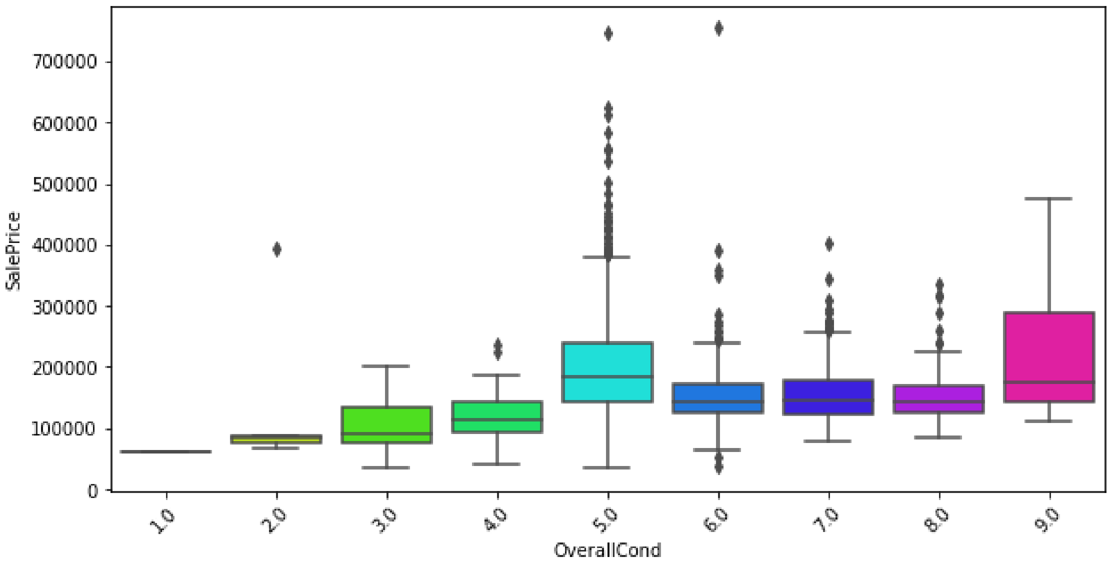
```
   OverallQual  OverallCond  LowQualFinSF  BsmtHalfBath  FullBath  HalfBath  \
0          7.0          5.0           0.0           0.0       2.0       1.0
1          6.0          8.0           0.0           1.0       2.0       0.0
2          7.0          5.0           0.0           0.0       2.0       1.0
3          7.0          5.0           0.0           0.0       1.0       0.0
4          8.0          5.0           0.0           0.0       2.0       1.0

   BedroomAbvGr  KitchebvGr  Fireplaces  GarageCars  …  KitchenQual  \
0           3.0         1.0         0.0         2.0  …           Gd
1           3.0         1.0         1.0         2.0  …           TA
2           3.0         1.0         1.0         2.0  …           Gd
3           3.0         1.0         1.0         3.0  …           Gd
4           4.0         1.0         1.0         3.0  …           Gd

   Functiol  FireplaceQu  GarageType  GarageFinish  GarageQual GarageCond  \
0       Typ           Gd      Attchd           RFn          TA         TA
1       Typ           TA      Attchd           RFn          TA         TA
2       Typ           TA      Attchd           RFn          TA         TA
3       Typ           Gd      Detchd           Unf          TA         TA
4       Typ           TA      Attchd           RFn          TA         TA

  PavedDrive SaleType SaleCondition
0          Y       WD        Normal
1          Y       WD        Normal
2          Y       WD        Normal
3          Y       WD       Abnorml
4          Y       WD        Normal

[5 rows x 55 columns]
```

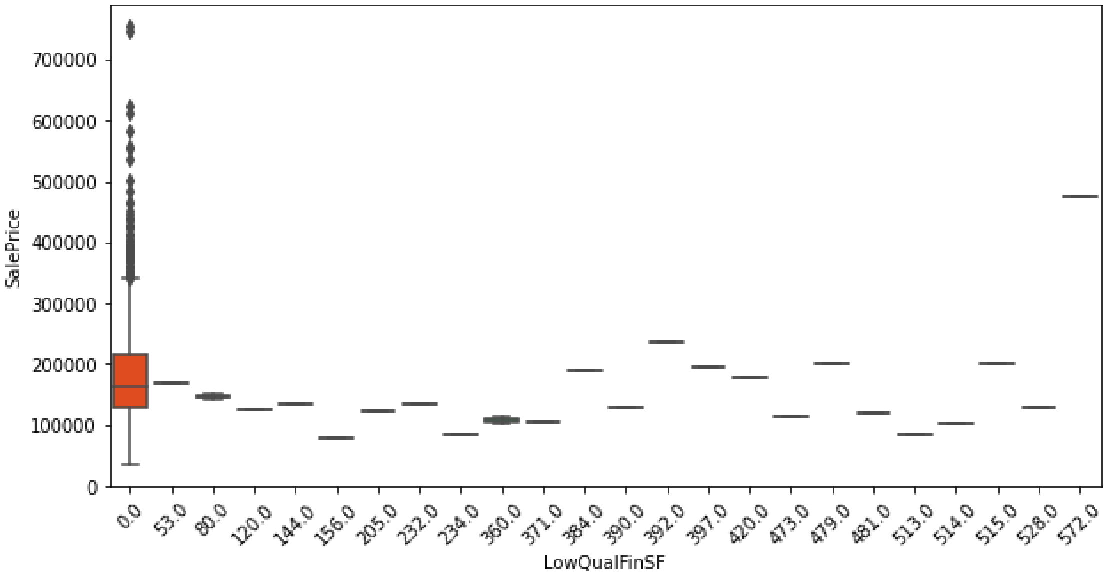
6 6. Plot box plot for the new dataset to find the variables with outliers

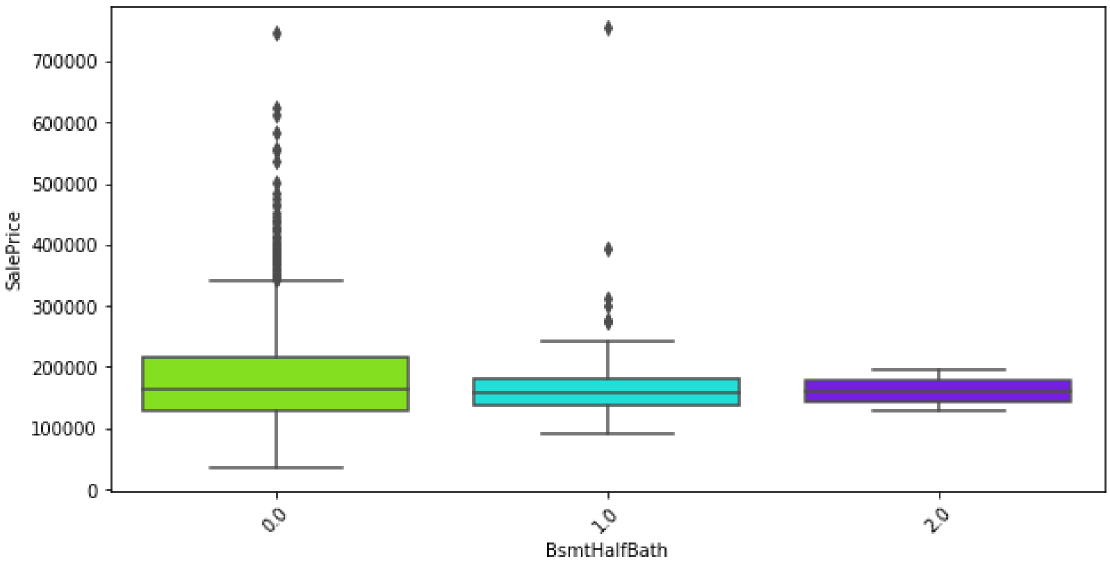
[26]:

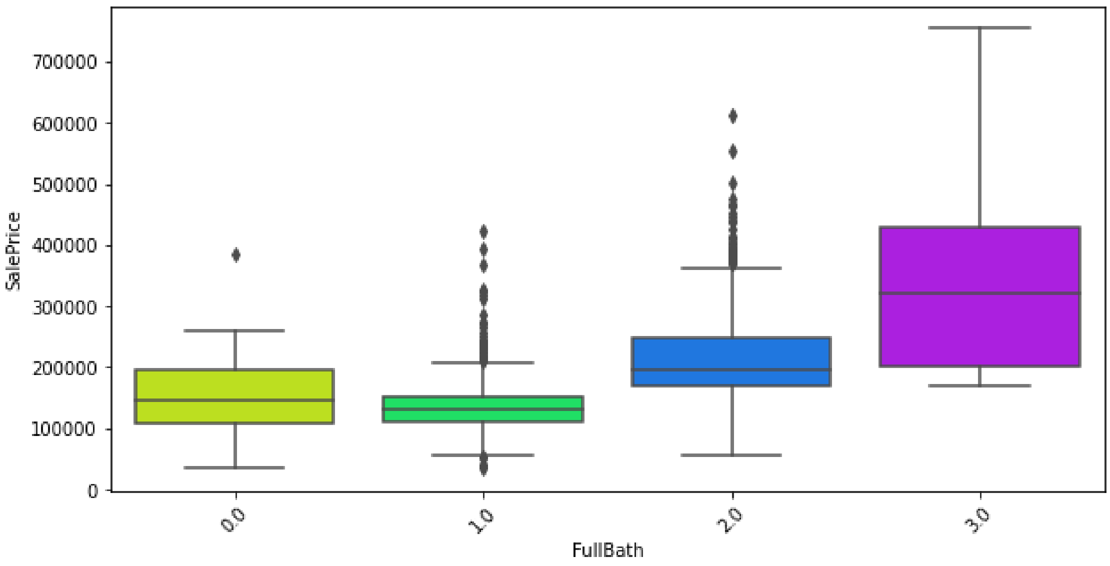
```
cols =['OverallQual','OverallCond','LowQualFinSF','BsmtHalfBath',␣
↪'FullBath','HalfBath','BedroomAbvGr','KitchebvGr',
      'Fireplaces','GarageCars','3SsnPorch','PoolArea', 'MiscVal','MoSold',␣
↪'YrSold','MSZoning','Street','LotShape',
        'LandContour','Utilities','LotConfig','LandSlope','Neighborhood',␣
 ↪'Condition1', 'Condition2', 'BldgType',
        'HouseStyle', 'RoofStyle', 'RoofMatl', 'Exterior1st',␣
 ↪'Exterior2nd','MasVnrType', 'ExterQual', 'ExterCond',
        'Foundation', 'BsmtQual','BsmtCond', 'BsmtExposure', 'BsmtFinType1',␣
 ↪'BsmtFinType2', 'Heating','HeatingQC',
        'CentralAir', 'Electrical', 'KitchenQual', 'Functiol','FireplaceQu',␣
 ↪'GarageType', 'GarageFinish', 'GarageQual',
        'GarageCond','PavedDrive', 'SaleType', 'SaleCondition']

for i in cols:
    fig, ax = plt.subplots(1,1, figsize=(10,5))
    plt.xticks(rotation = 45)
    sns.boxplot(df_combine[i][1:], 'SalePrice', data=df_combine,palette='hsv')
```

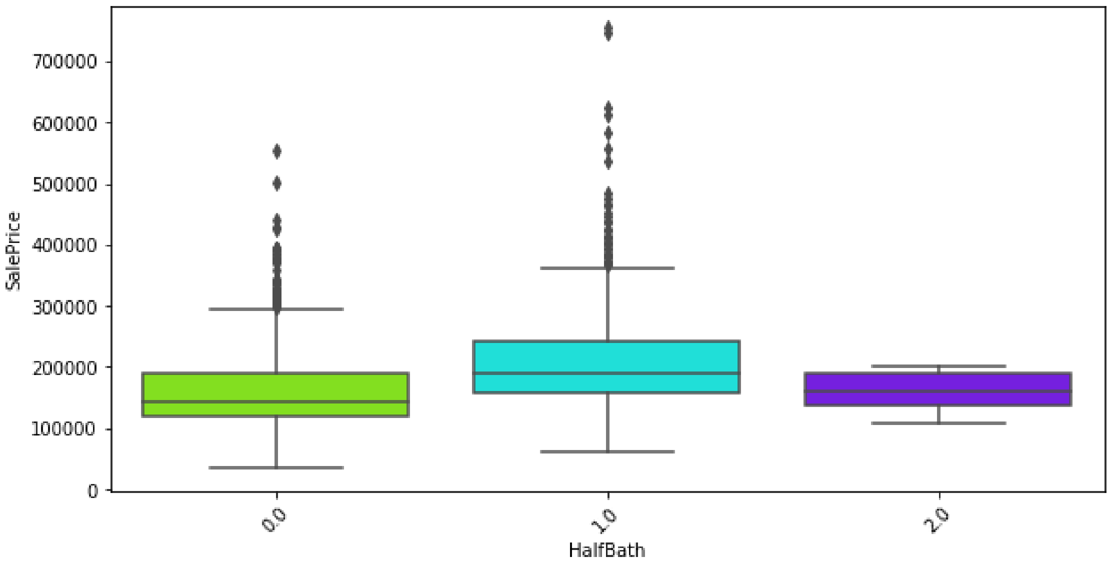



SalePrice
0
100000
200000
300000
400000
500000
600000
700000
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
OverallCond

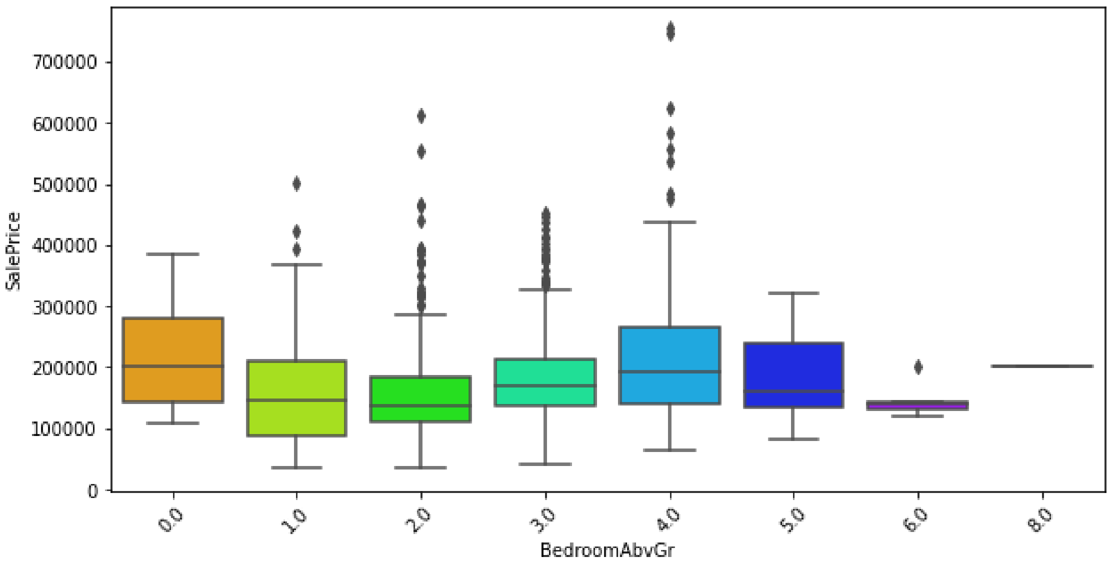

SalePrice
0
100000
200000
300000
400000
500000
600000
700000
0.0
53.0
80.0
120.0
144.0
156.0
205.0
232.0
234.0
360.0
371.0
384.0
390.0
392.0
397.0
420.0
473.0
479.0
481.0
513.0
514.0
515.0
528.0
572.0
LowQualFinSF


SalePrice
0
100000
200000
300000
400000
500000
600000
700000
0.0
1.0
2.0
BsmtHalfBath

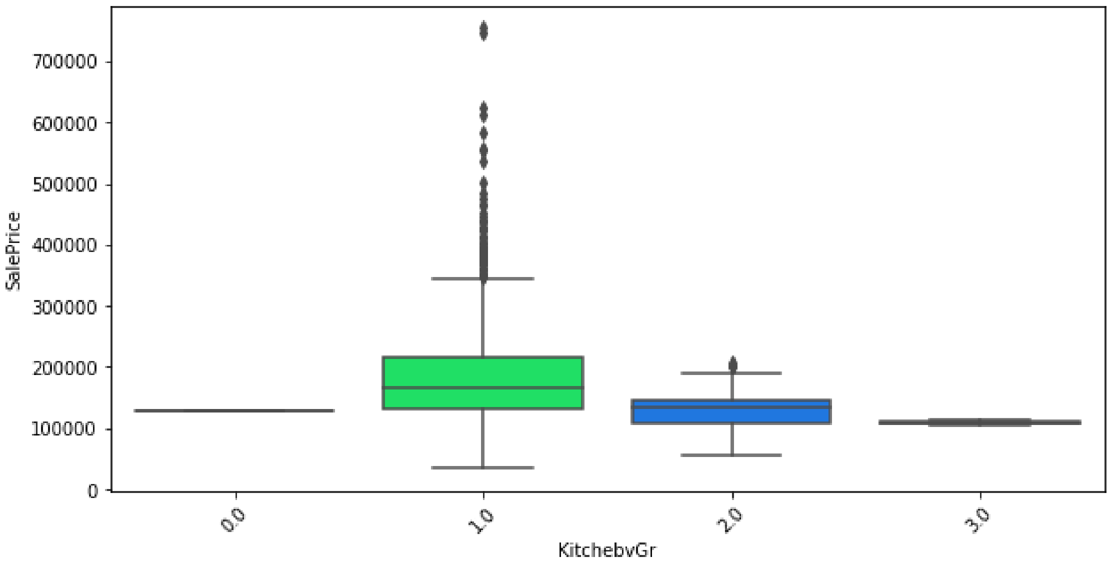

SalePrice
0
100000
200000
300000
400000
500000
600000
700000
0.0
1.0
2.0
3.0
FullBath

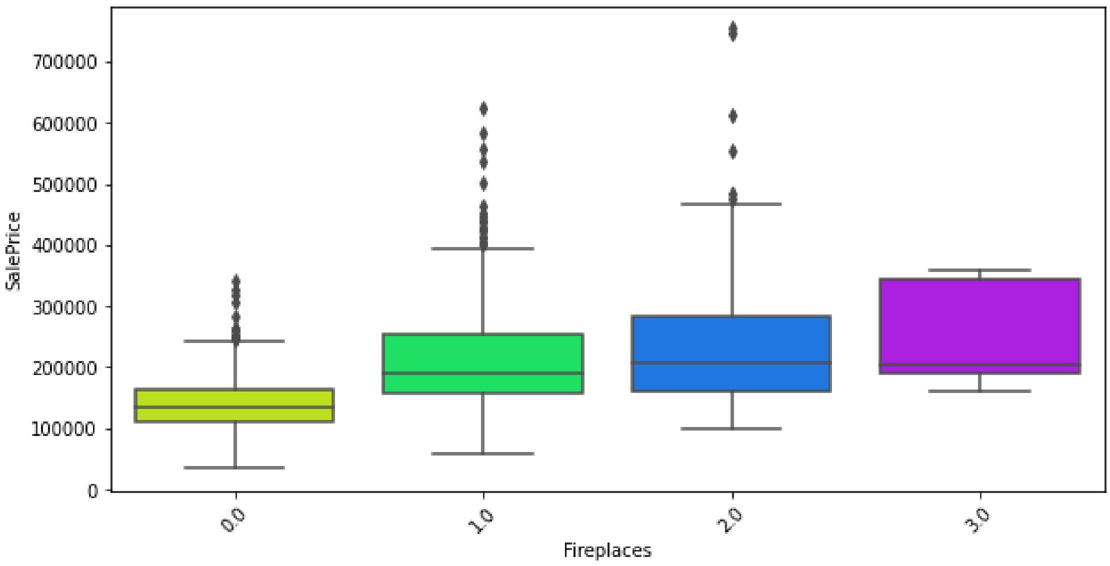


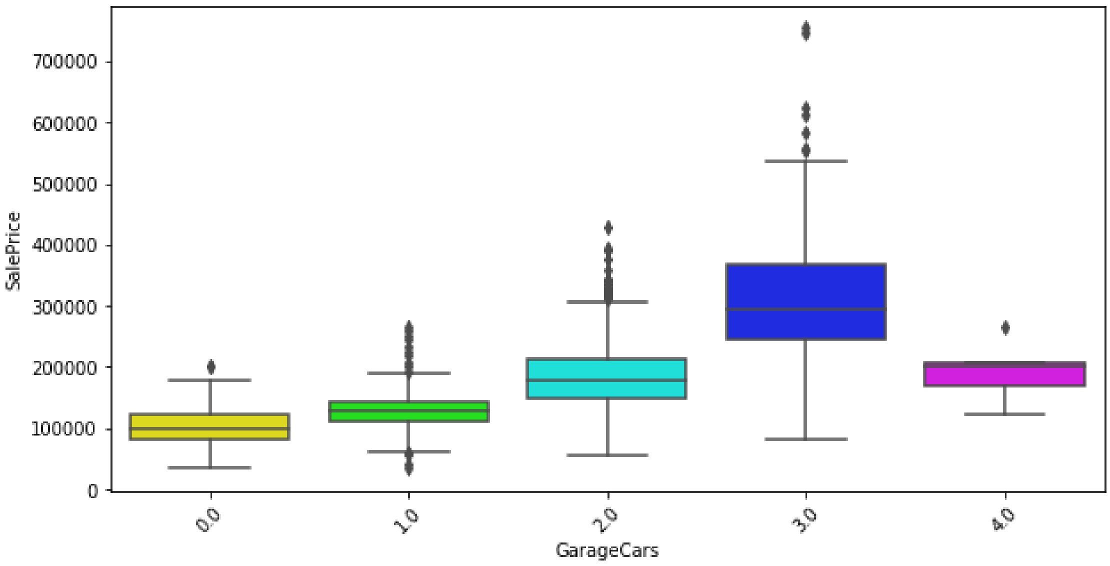
SalePrice
0
100000
200000
300000
400000
500000
600000
700000
0.0
1.0
2.0
HalfBath

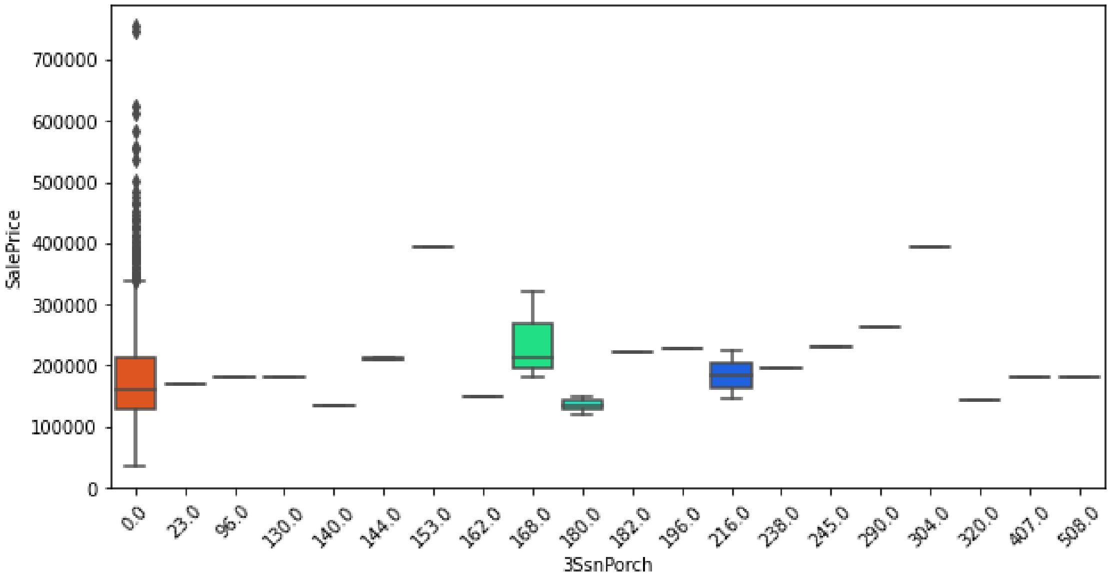


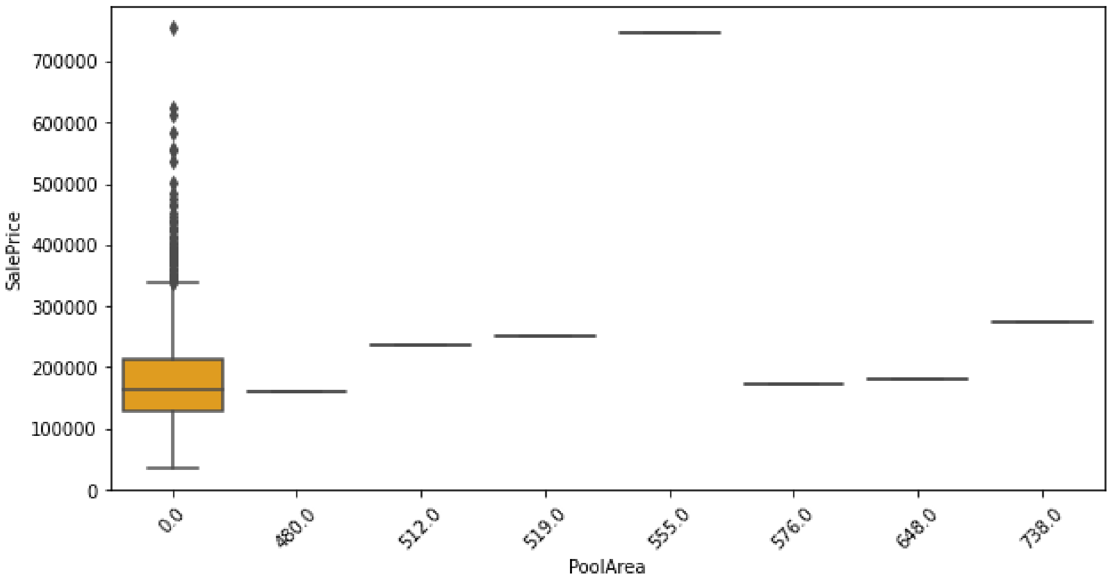
SalePrice
0
100000
200000
300000
400000
500000
600000
700000
0.0
1.0
2.0
3.0
4.0
5.0
6.0
8.0
BedroomAbvGr

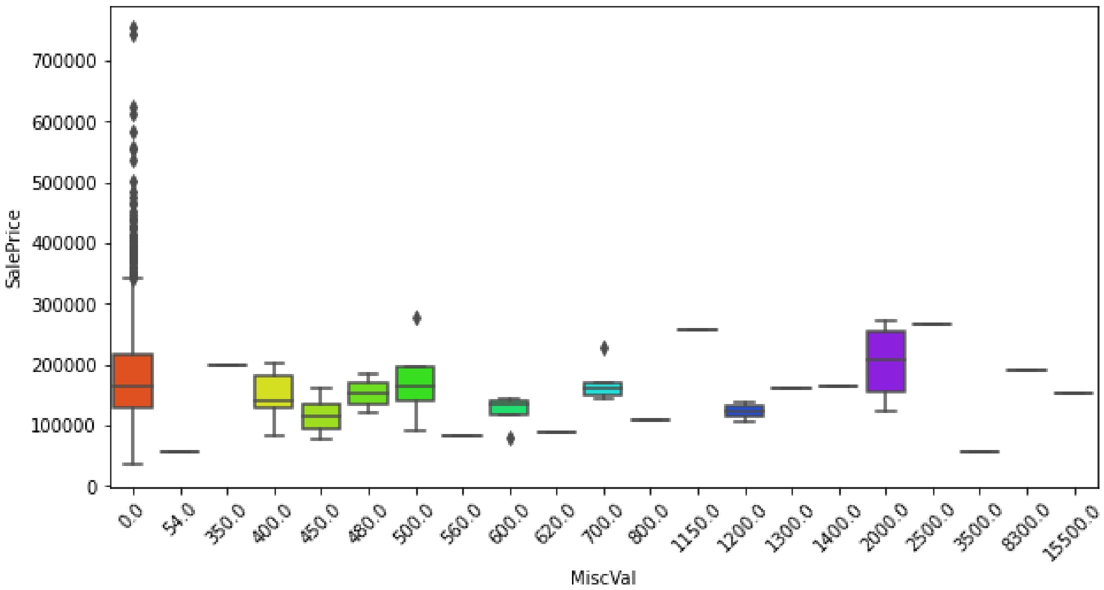

700000
600000
500000
400000
300000
200000
100000
0
SalePrice
0.0
1.0
2.0
3.0
KitchebvGr

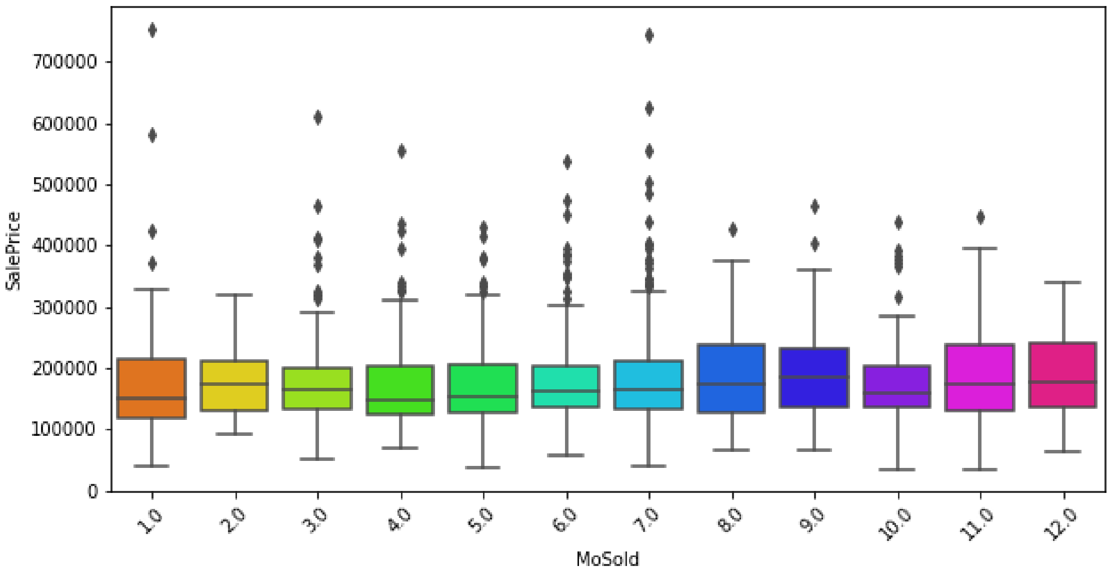

700000
600000
500000
400000
300000
200000
100000
0
SalePrice
0.0
1.0
2.0
3.0
Fireplaces

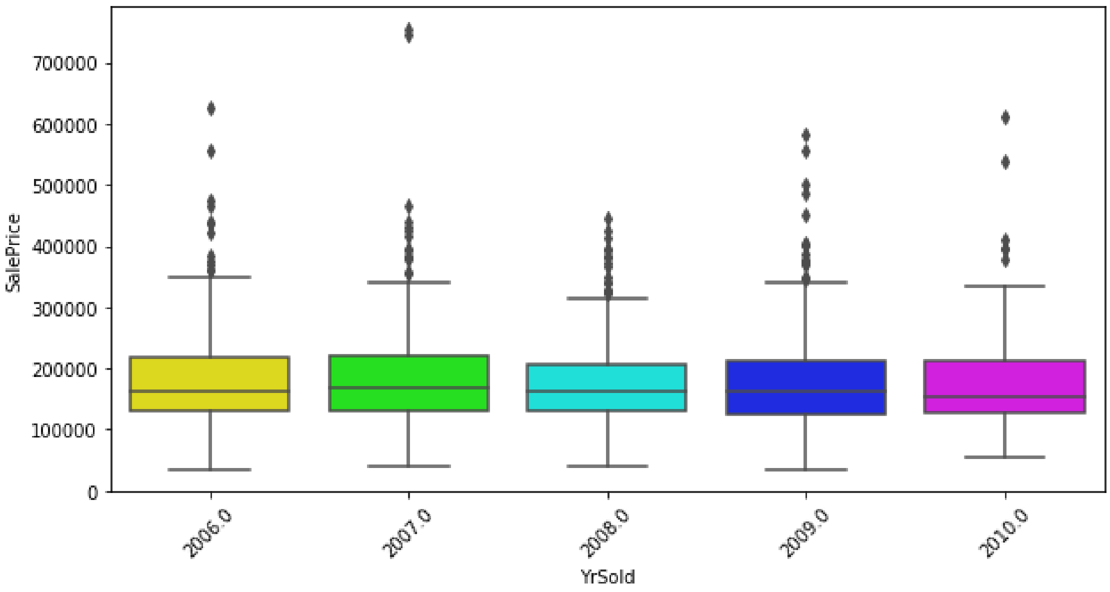

SalePrice
0
100000
200000
300000
400000
500000
600000
700000
0.0
1.0
2.0
3.0
4.0
GarageCars

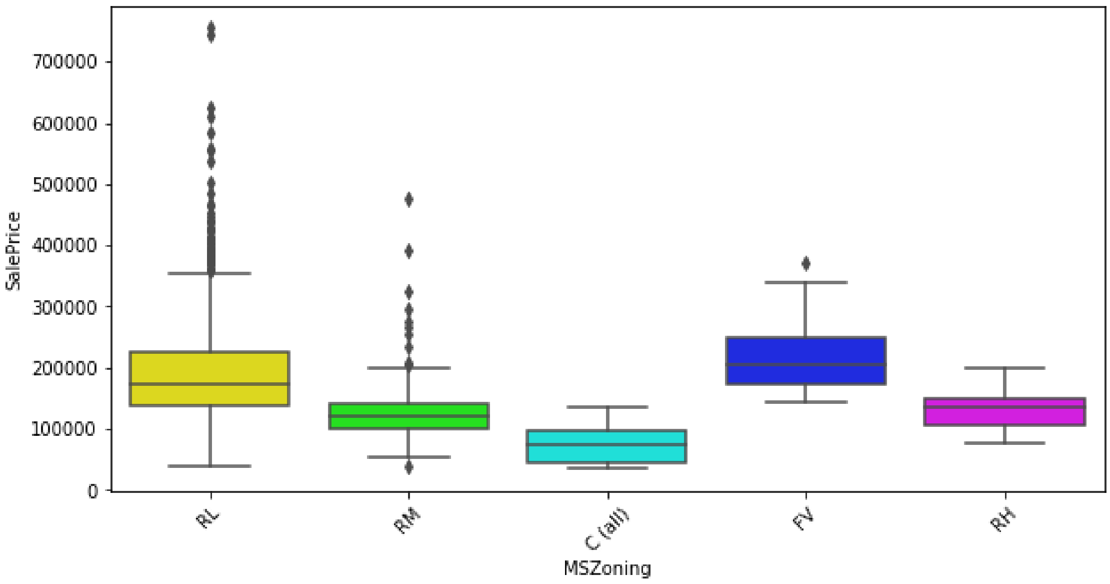

SalePrice
0
100000
200000
300000
400000
500000
600000
700000
0.0
23.0
96.0
130.0
140.0
144.0
153.0
162.0
168.0
180.0
182.0
196.0
216.0
238.0
245.0
290.0
304.0
320.0
407.0
508.0
3SsnPorch

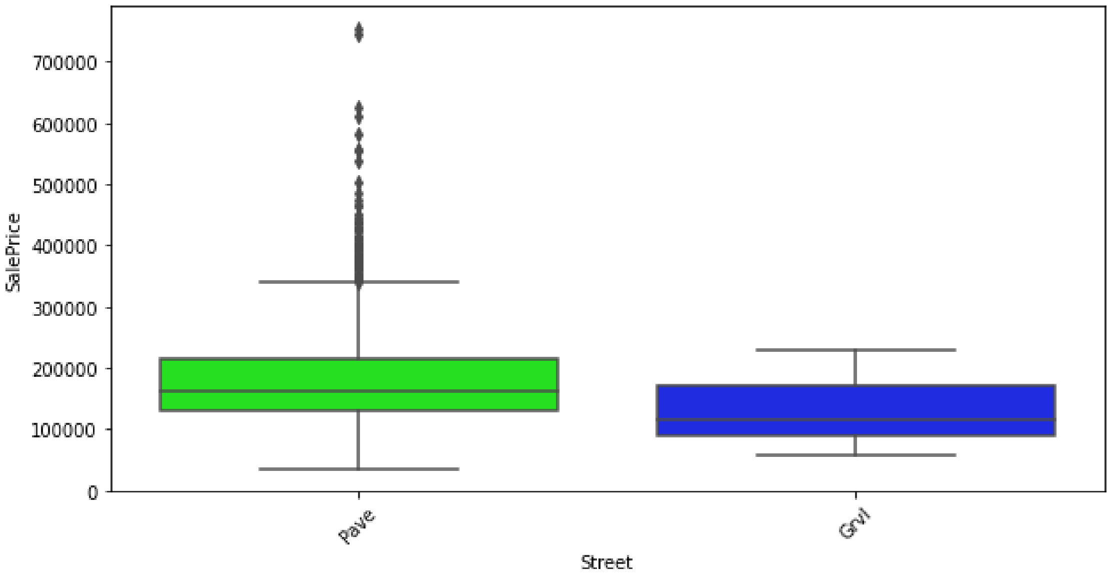

SalePrice
0
100000
200000
300000
400000
500000
600000
700000
0.0
480.0
512.0
519.0
555.0
576.0
648.0
738.0
PoolArea

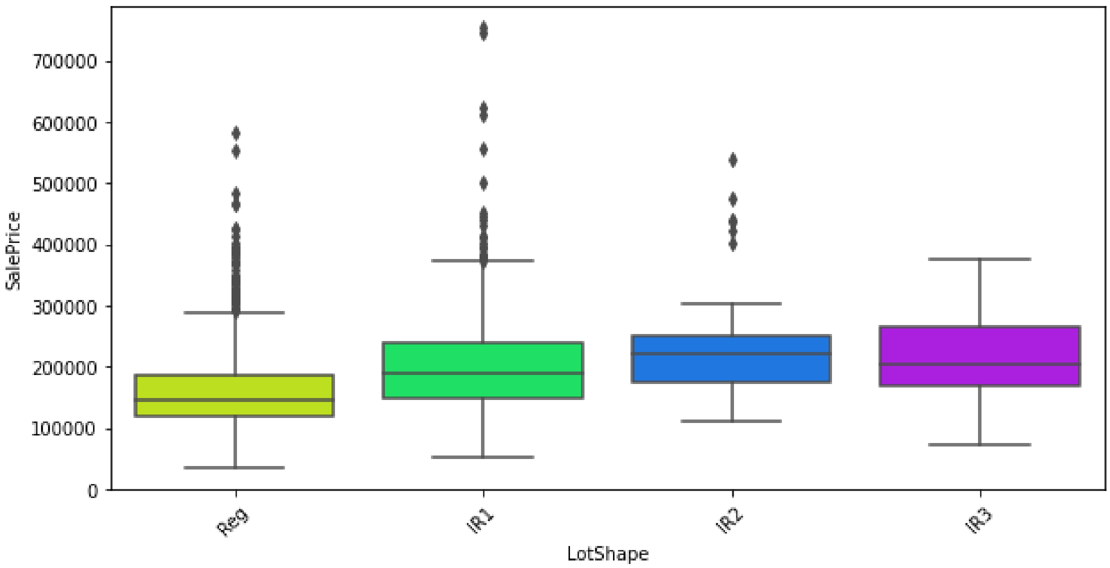

SalePrice
0
100000
200000
300000
400000
500000
600000
700000
0.0
54.0
350.0
400.0
450.0
480.0
500.0
560.0
600.0
620.0
700.0
800.0
1150.0
1200.0
1300.0
1400.0
2000.0
2500.0
3500.0
8300.0
15500.0
MiscVal


SalePrice
0
100000
200000
300000
400000
500000
600000
700000
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
12.0
MoSold


SalePrice
0
100000
200000
300000
400000
500000
600000
700000
2006.0
2007.0
2008.0
2009.0
2010.0
YrSold


SalePrice
0
100000
200000
300000
400000
500000
600000
700000
RL
RM
C (all)
FV
RH
MSZoning


SalePrice
0
100000
200000
300000
400000
500000
600000
700000
Pave
Grvl
Street


SalePrice
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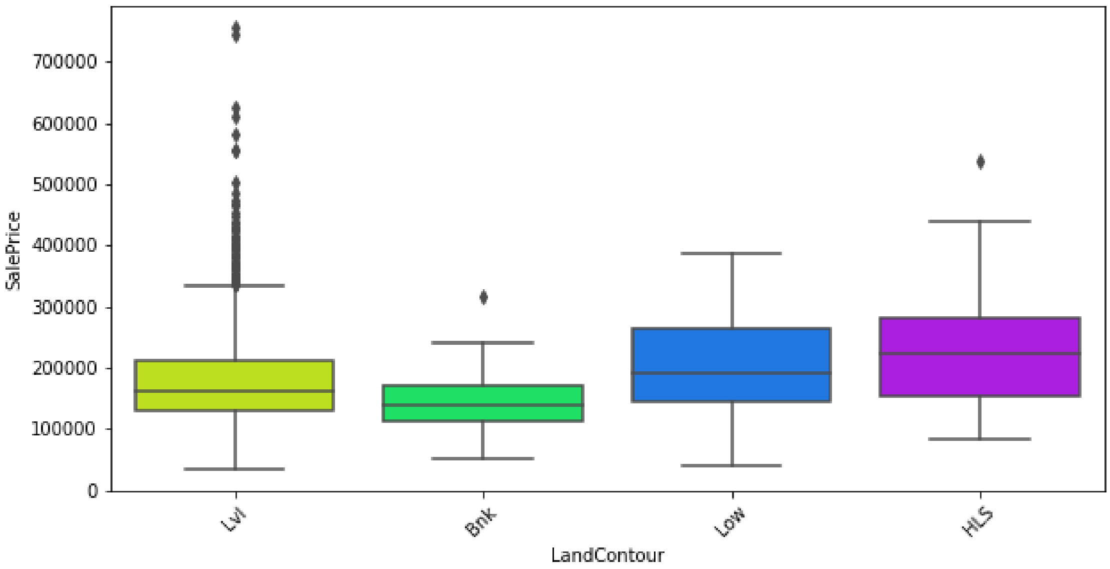
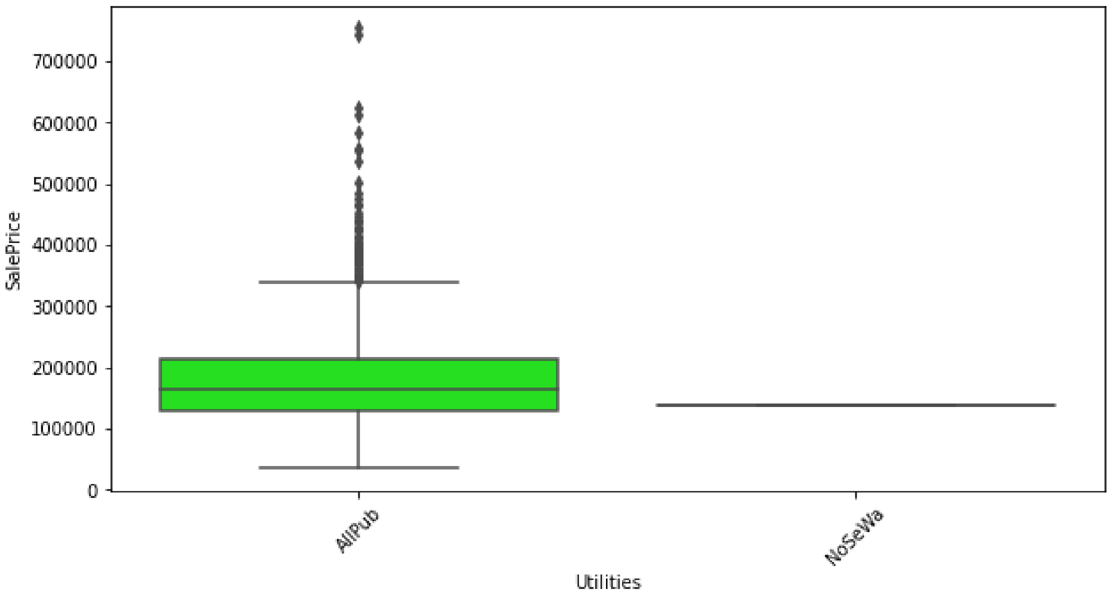
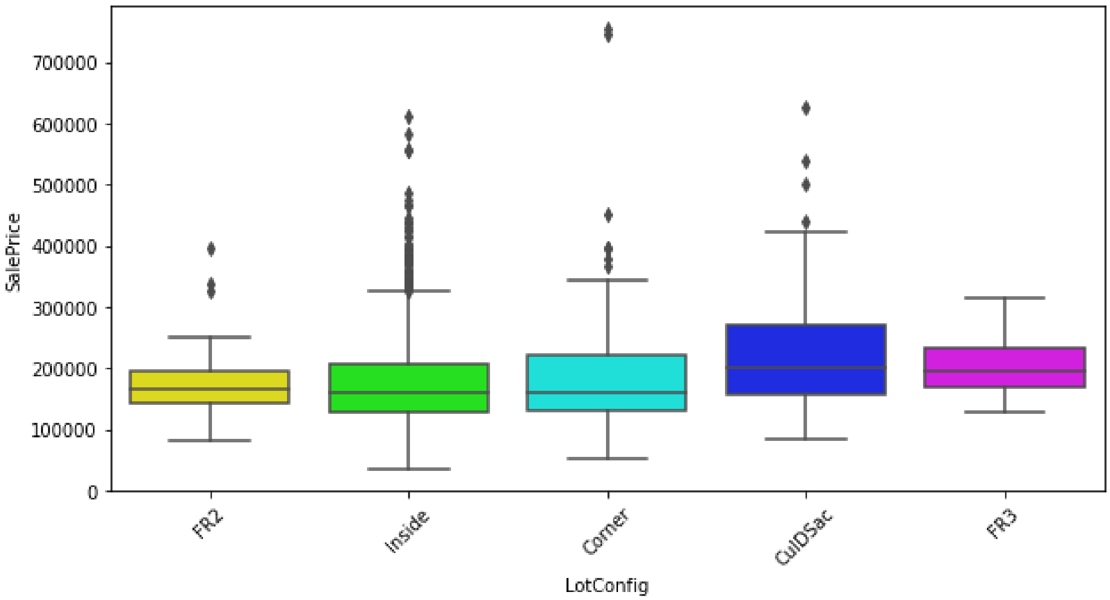
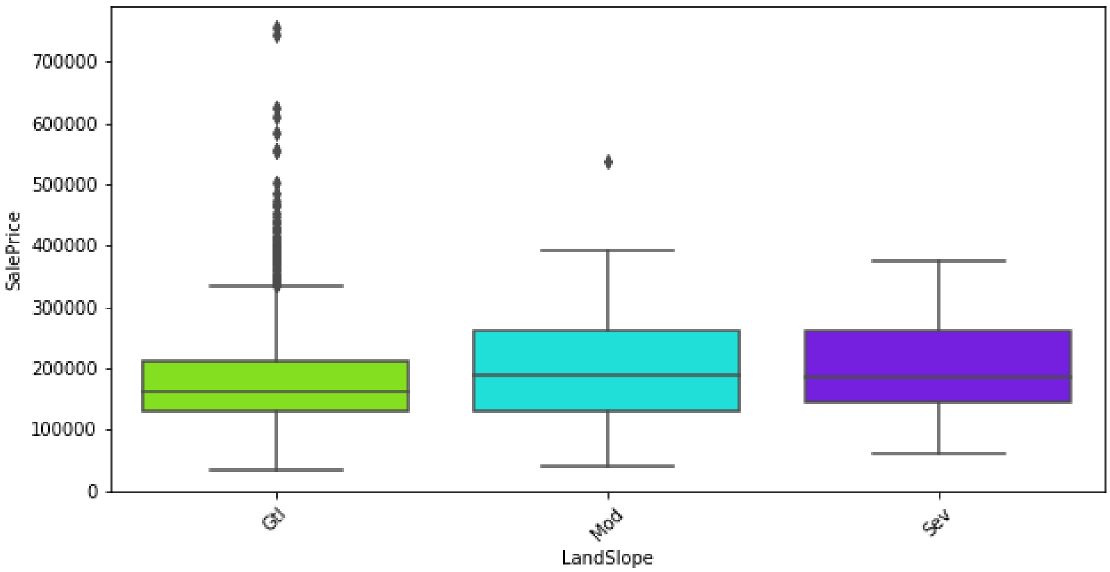
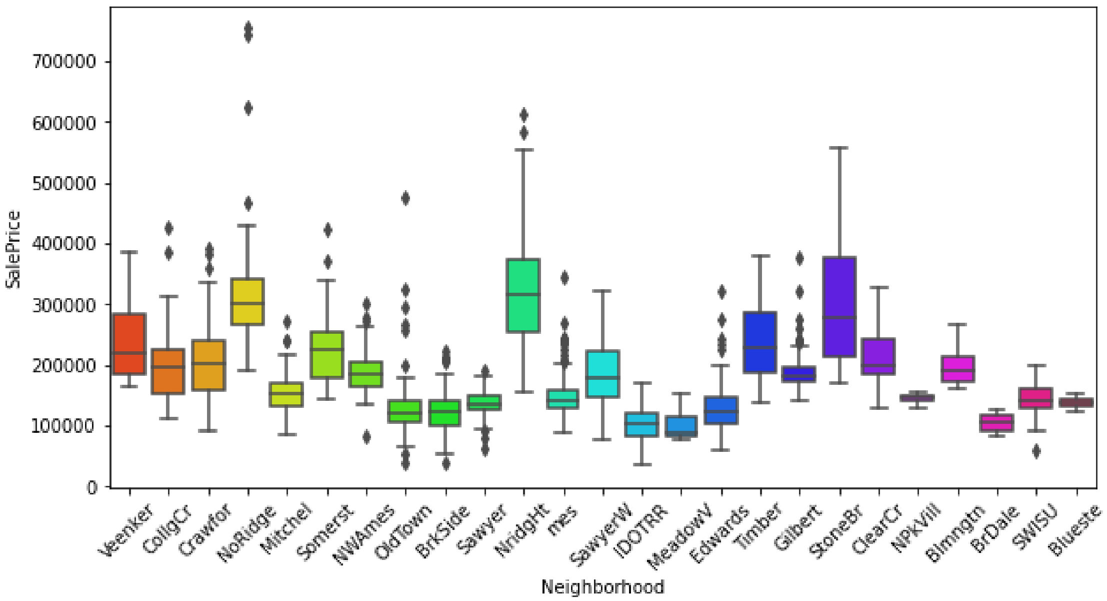
600000
500000
400000
300000
200000
100000
0
Reg
IR1
IR2
IR3
LotShape

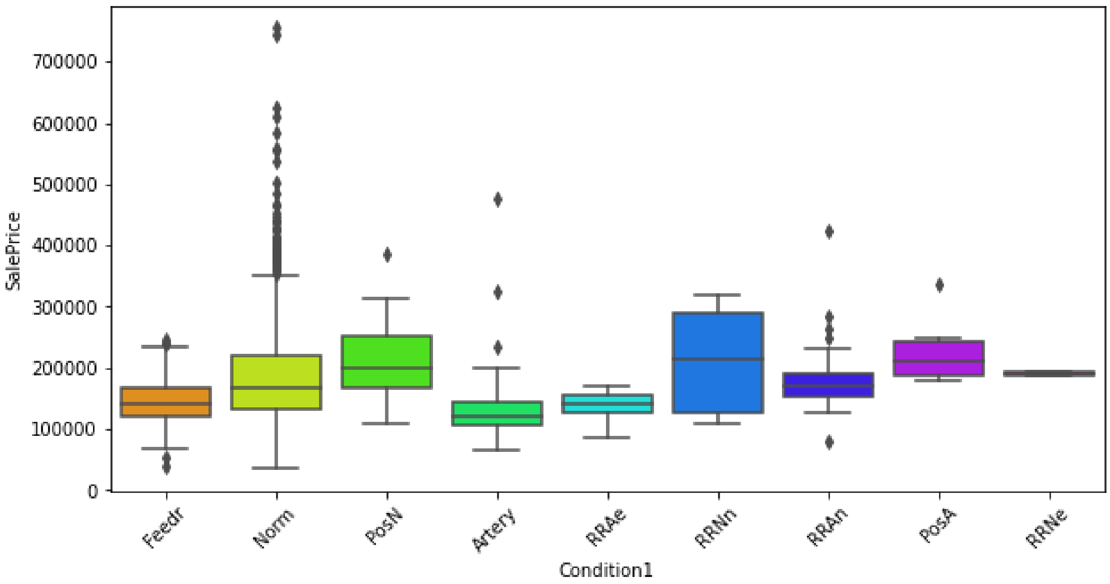

SalePrice
700000
600000
500000
400000
300000
200000
100000
0
Lvl
Bnk
Low
HLS
LandContour

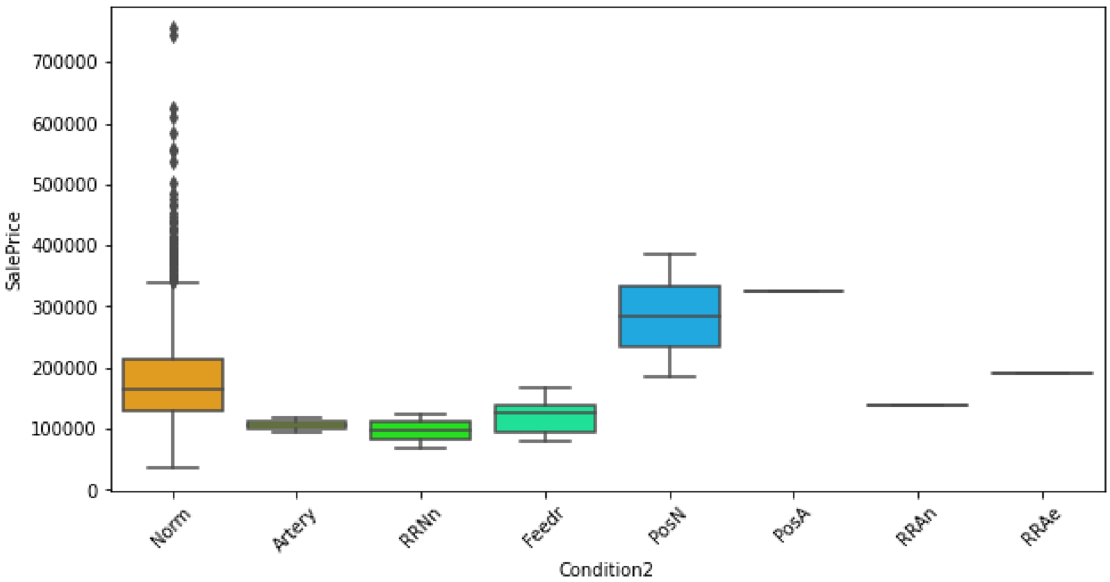

SalePrice
0
100000
200000
300000
400000
500000
600000
700000
AllPub
NoSeWa
Utilities

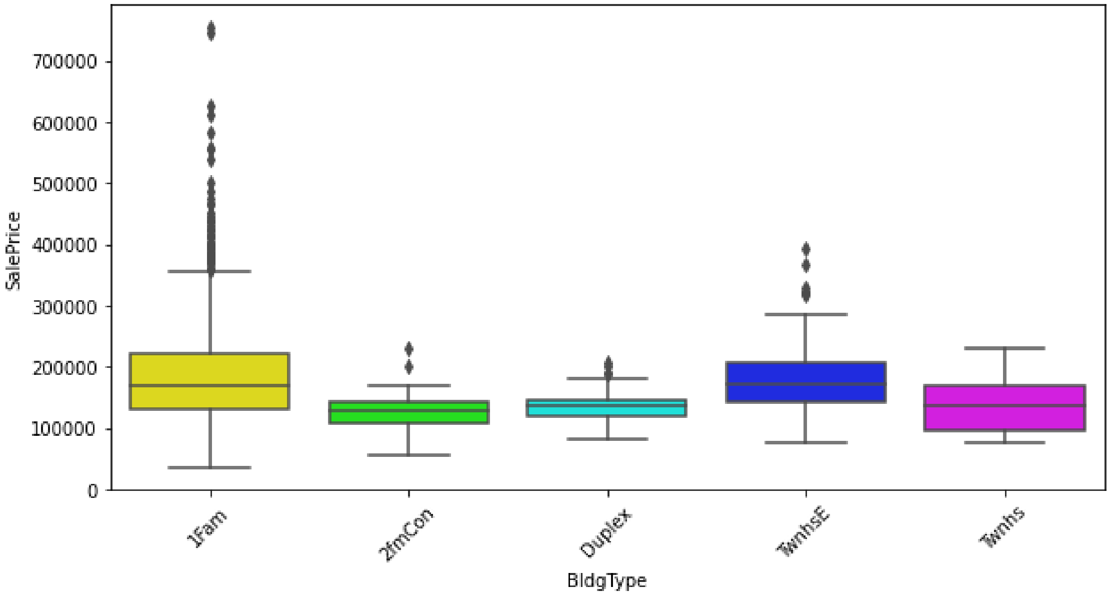

SalePrice
0
100000
200000
300000
400000
500000
600000
700000
FR2
Inside
Corner
CulDSac
FR3
LotConfig

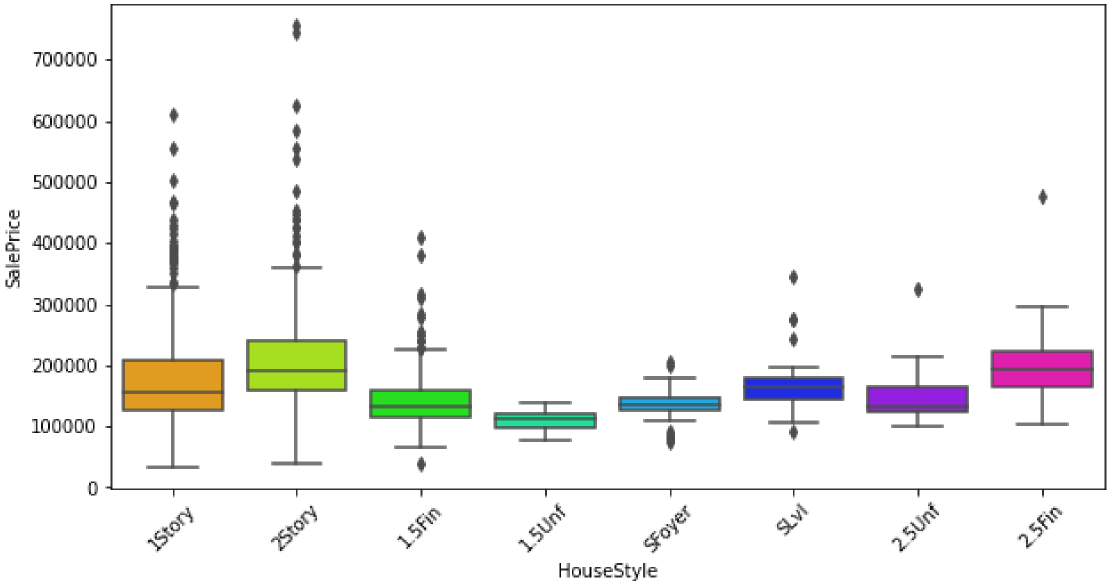

700000
600000
500000
400000
300000
200000
100000
0
SalePrice
Gtl
Mod
Sev
LandSlope


700000
600000
500000
400000
300000
200000
100000
0
SalePrice
Veenker
CollgCr
Crawfor
NoRidge
Mitchel
Somerst
NWAmes
OldTown
BrkSide
Sawyer
NridgHt
mes
SawyerW
IDOTRR
MeadowV
Edwards
Timber
Gilbert
StoneBr
ClearCr
NPkVill
Blmngtn
BrDale
SWISU
Blueste
Neighborhood


SalePrice
700000
600000
500000
400000
300000
200000
100000
0
Feedr
Norm
PosN
Artery
RRAe
RRNn
RRAn
PosA
RRNe
Condition1


SalePrice
700000
600000
500000
400000
300000
200000
100000
0
Norm
Artery
RRNn
Feedr
PosN
PosA
RRAn
RRAe
Condition2


SalePrice
0
100000
200000
300000
400000
500000
600000
700000
1Fam
2fmCon
Duplex
TwnhsE
Twnhs
BldgType


SalePrice
0
100000
200000
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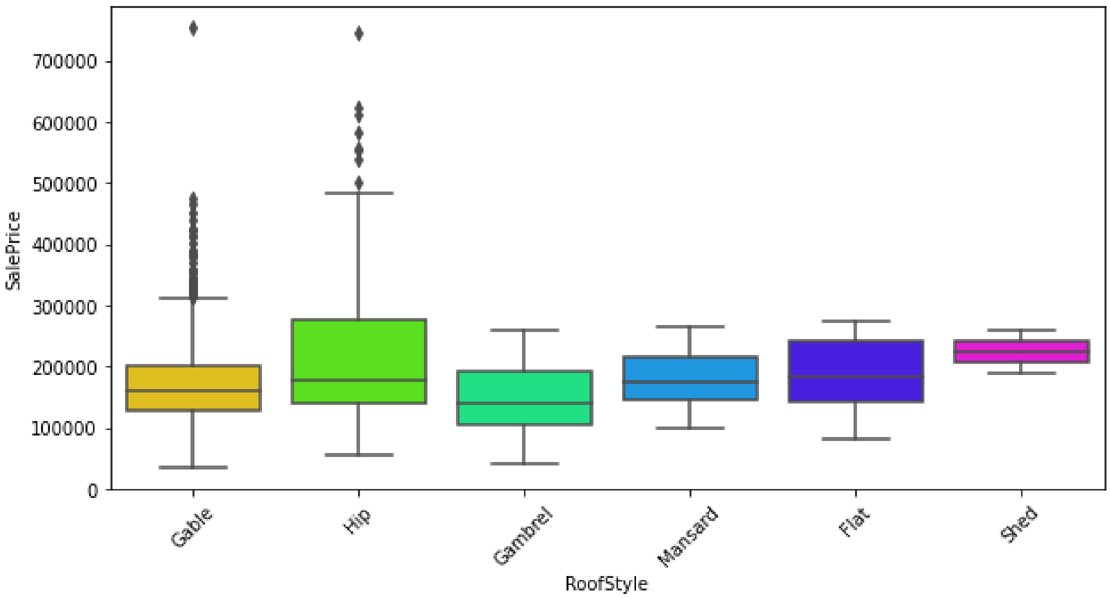
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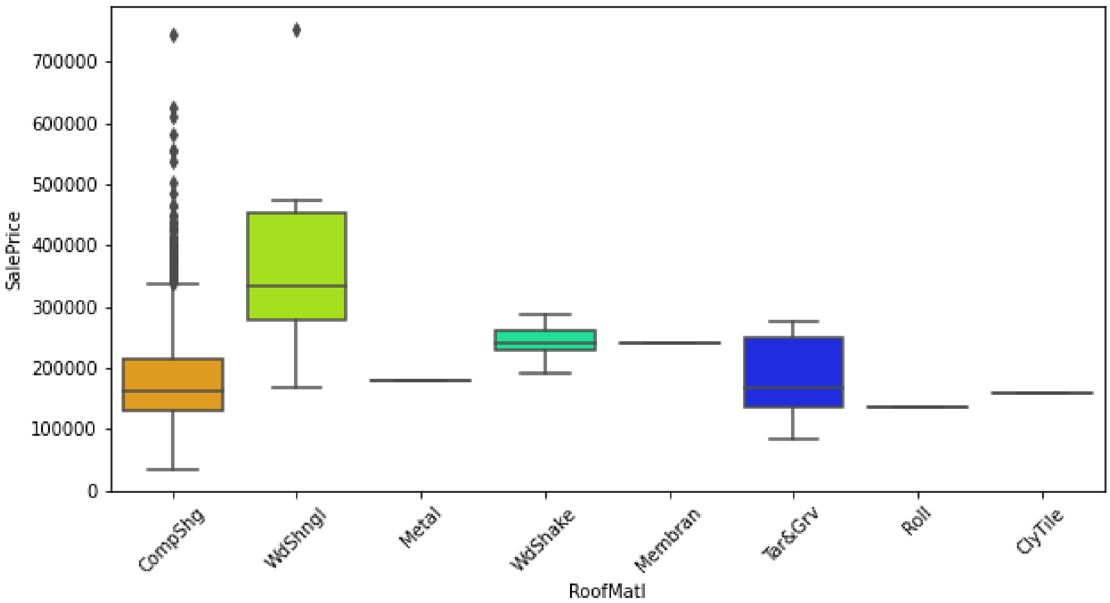
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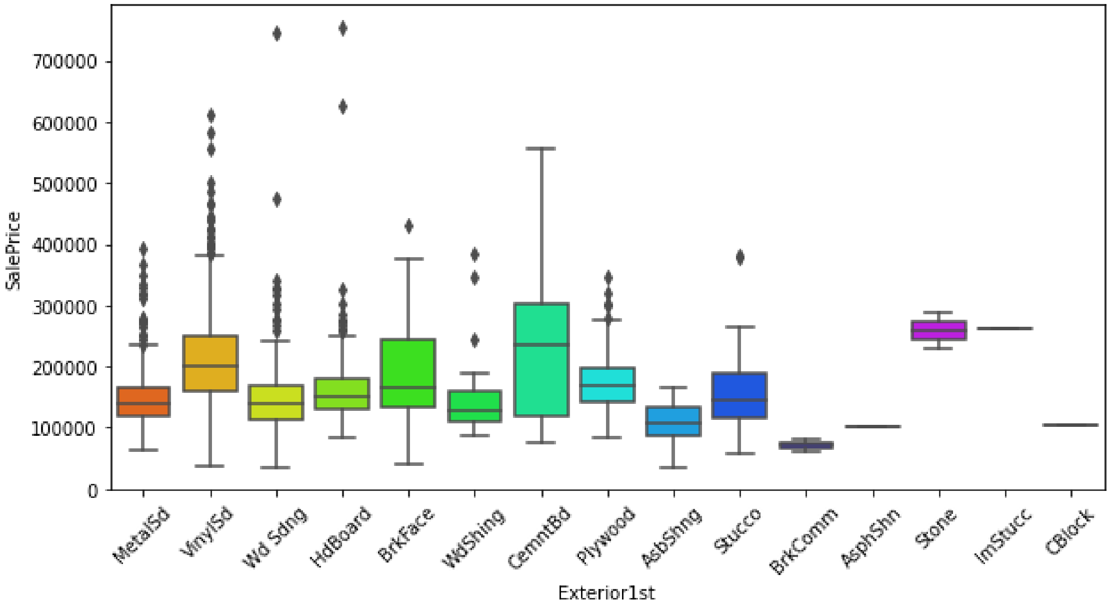
RoofMatl



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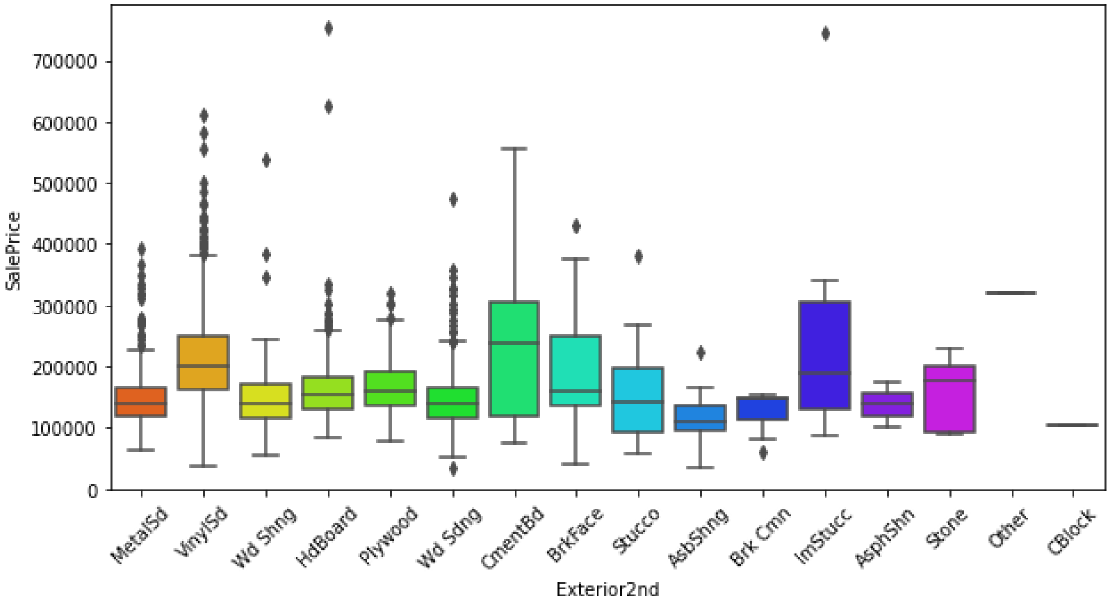
CBlock
Exterior1st



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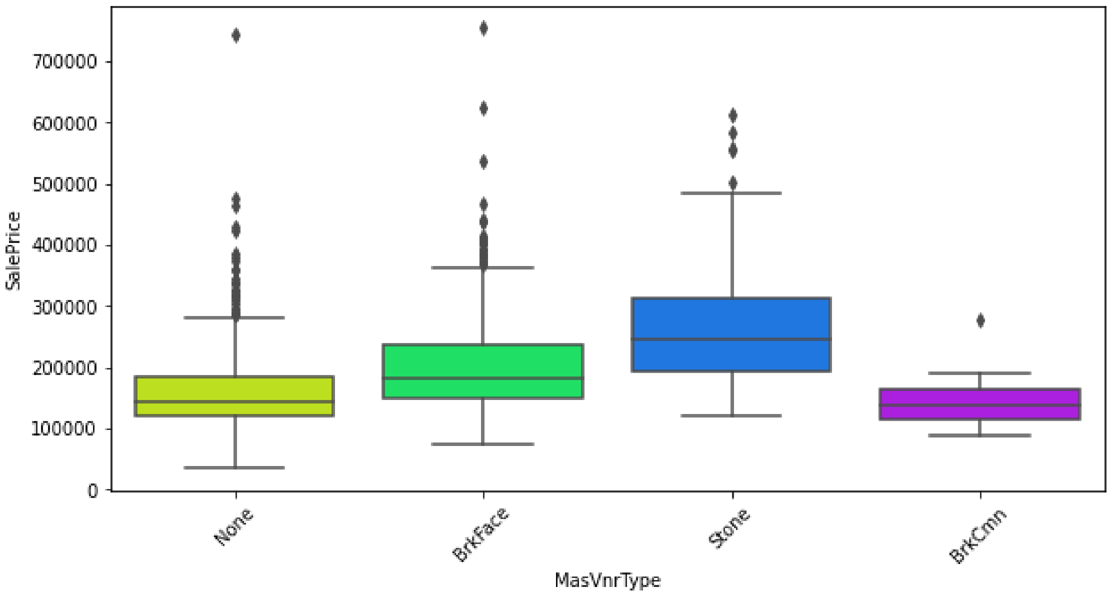

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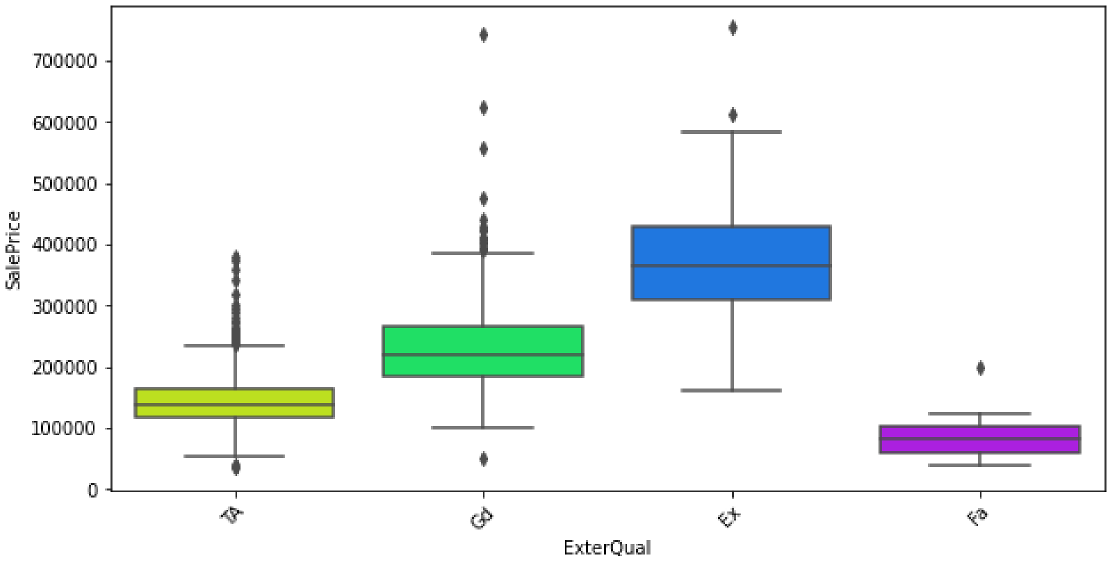

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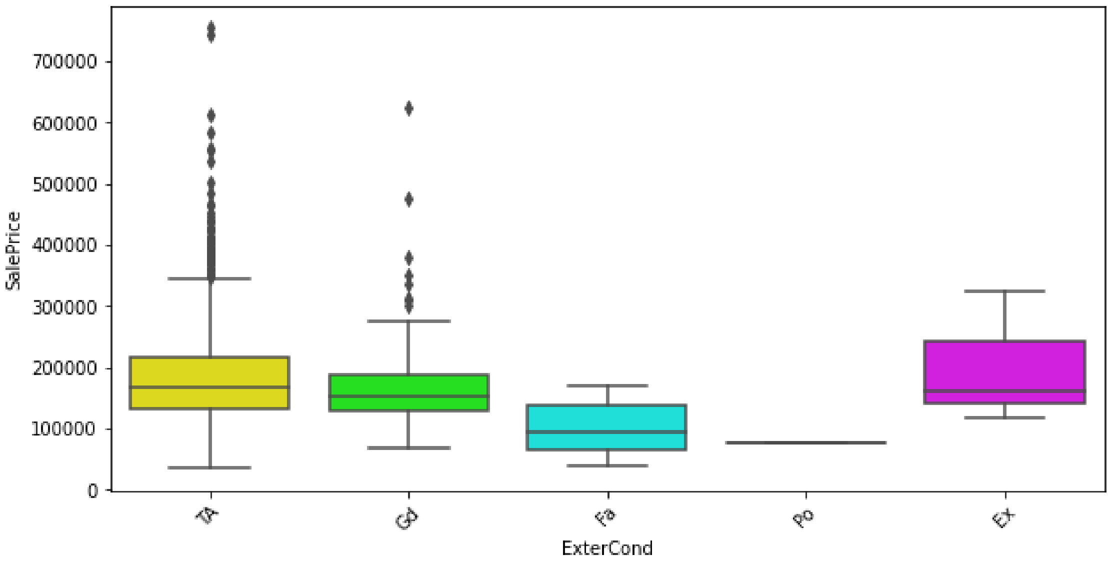
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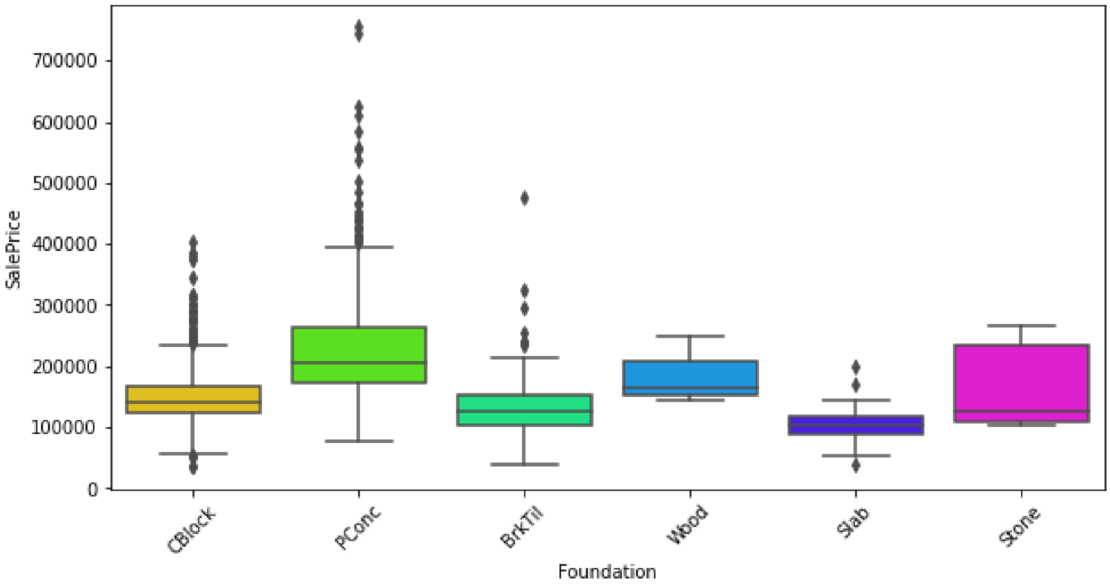
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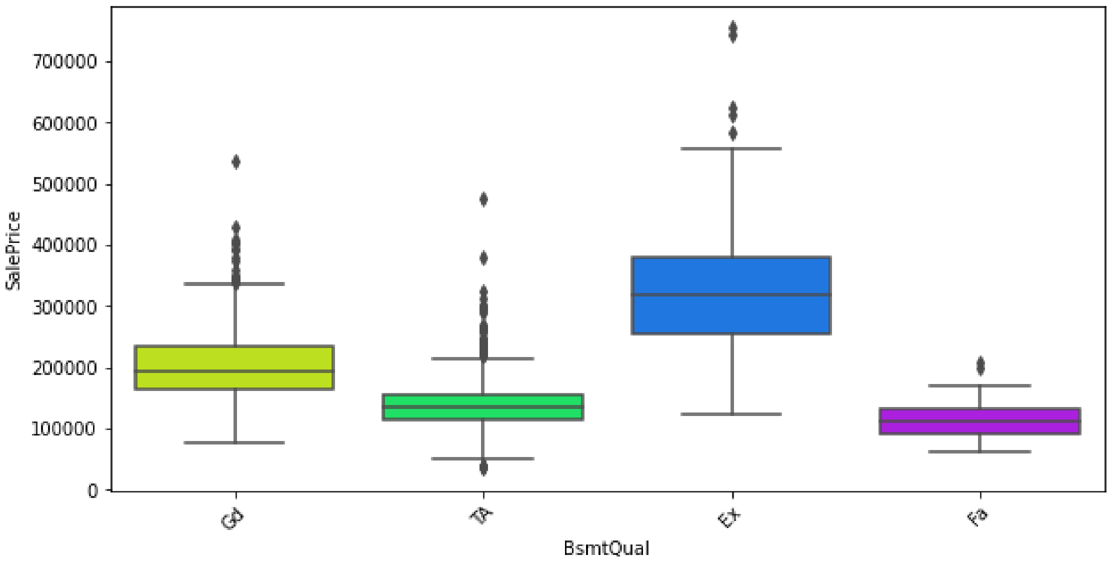
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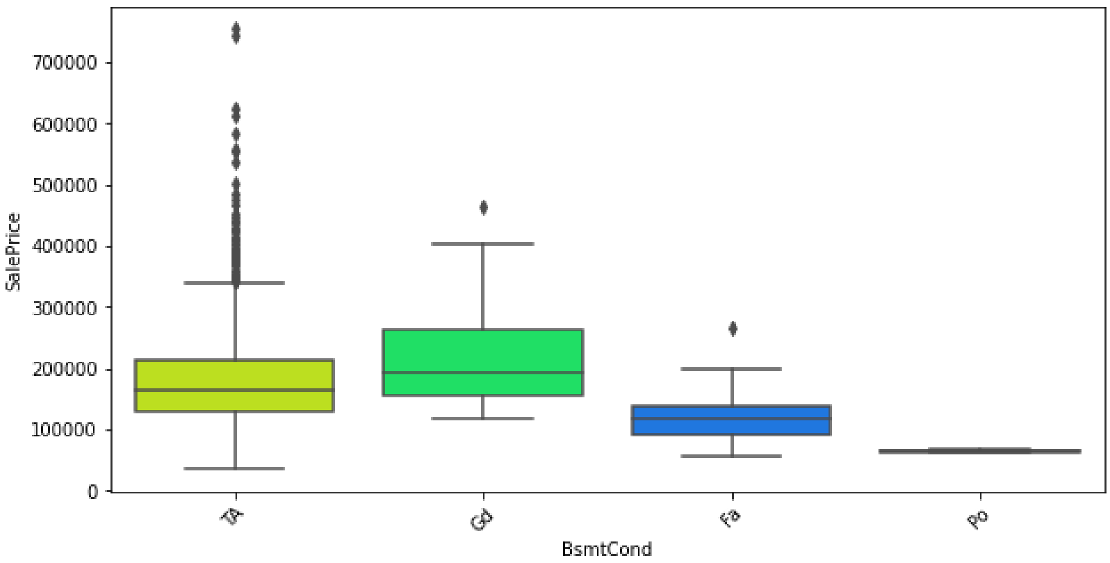
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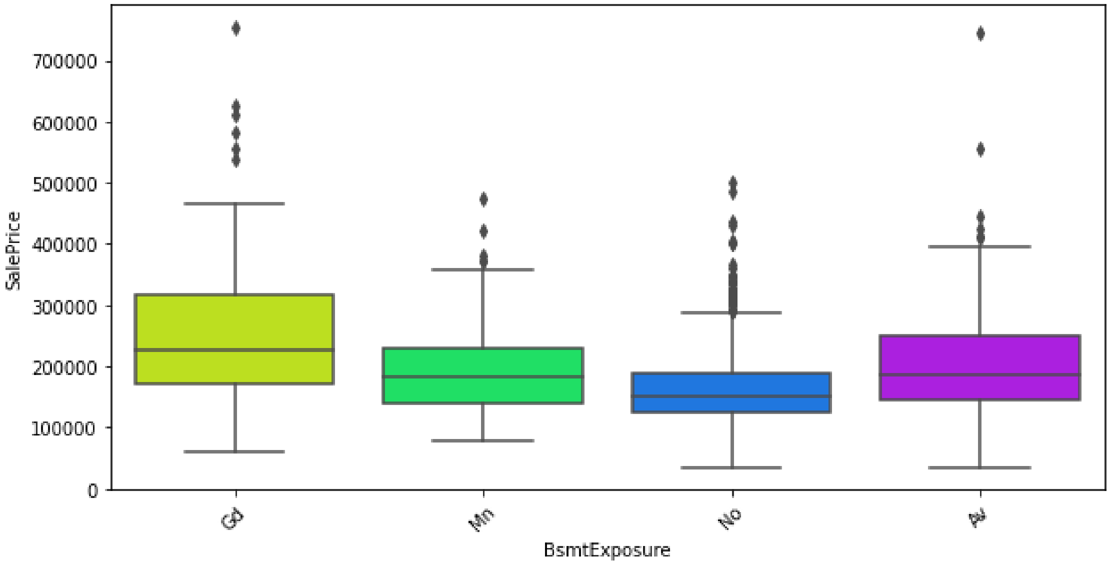
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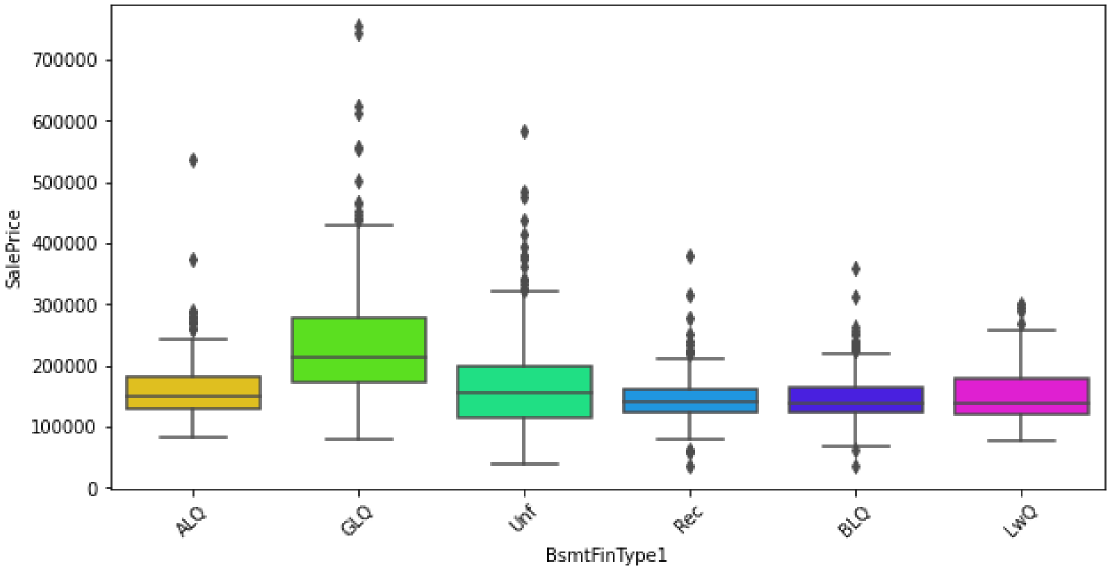
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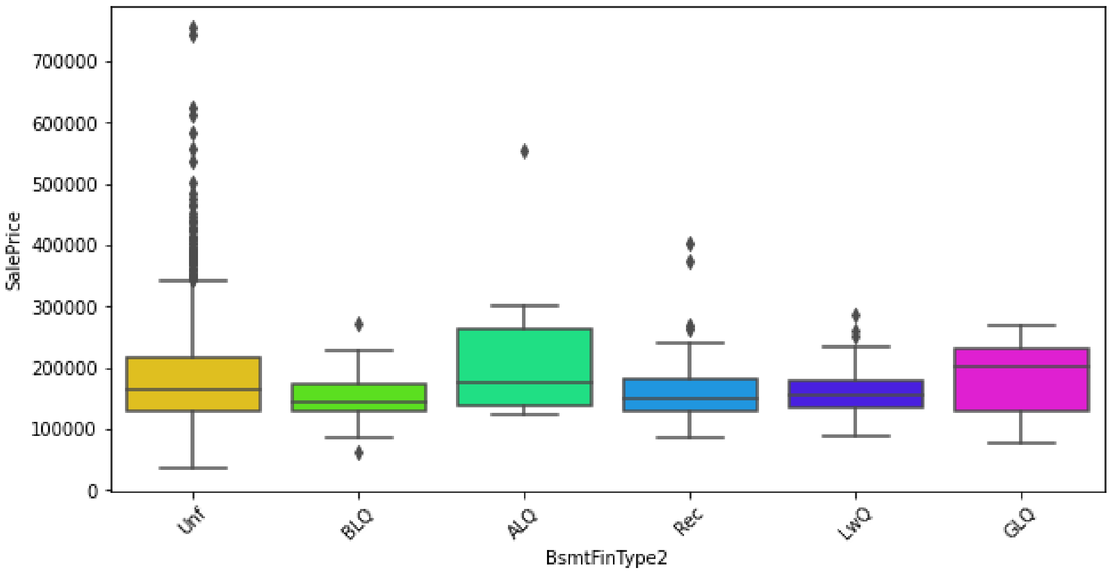
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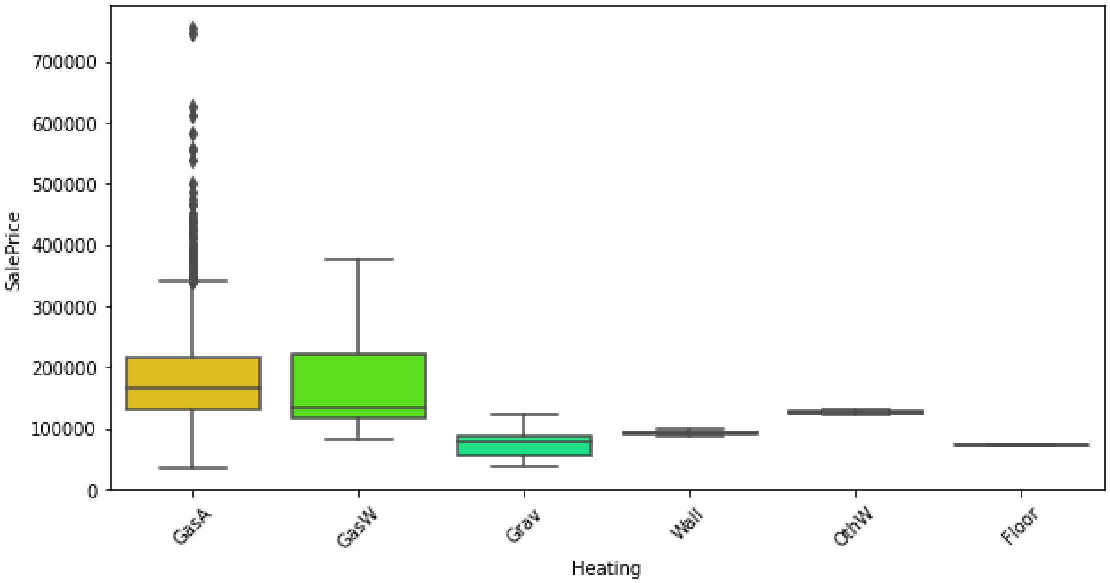
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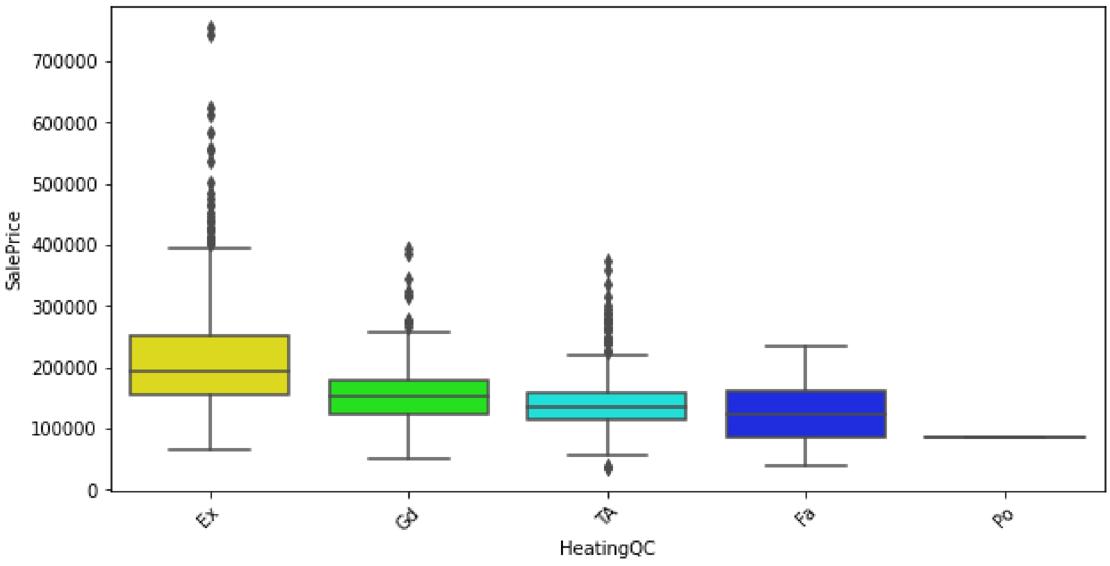
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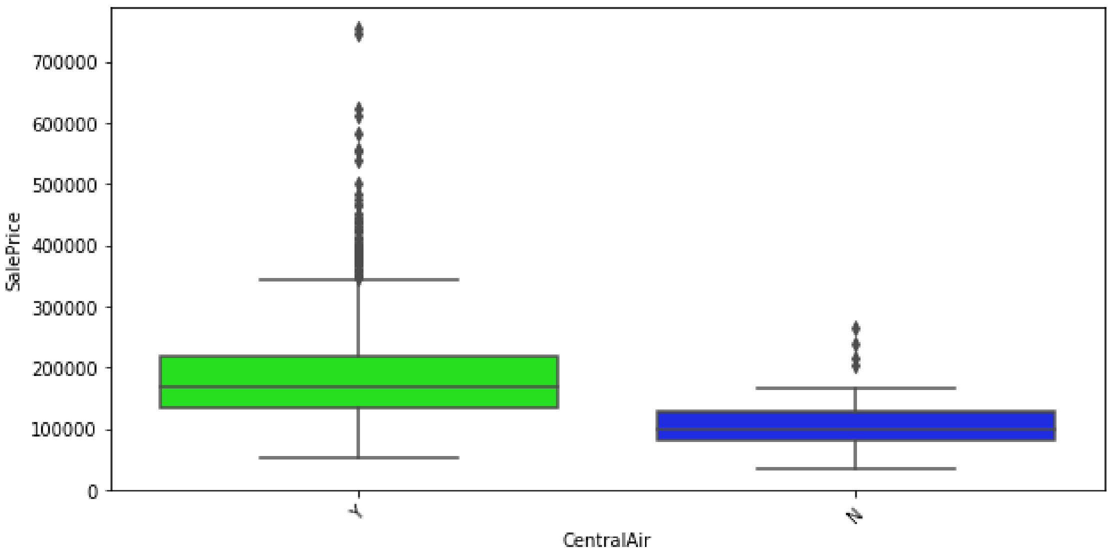
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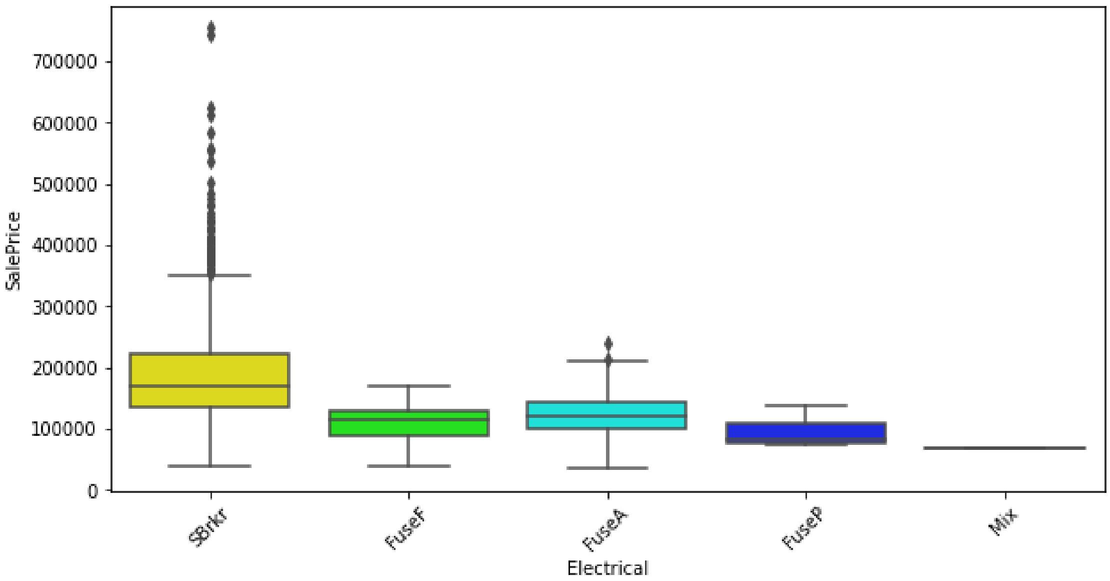
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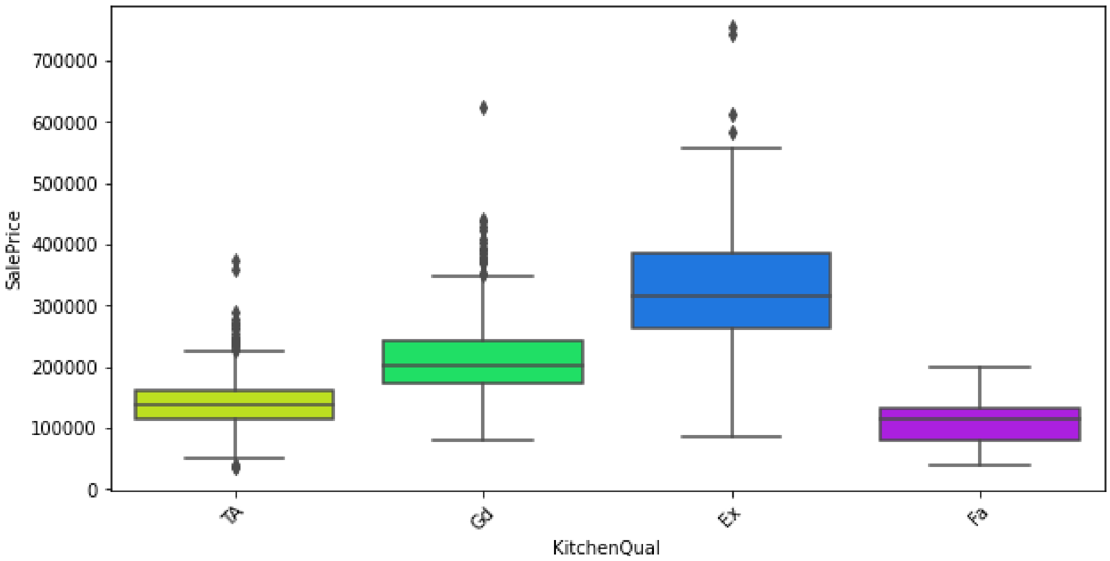
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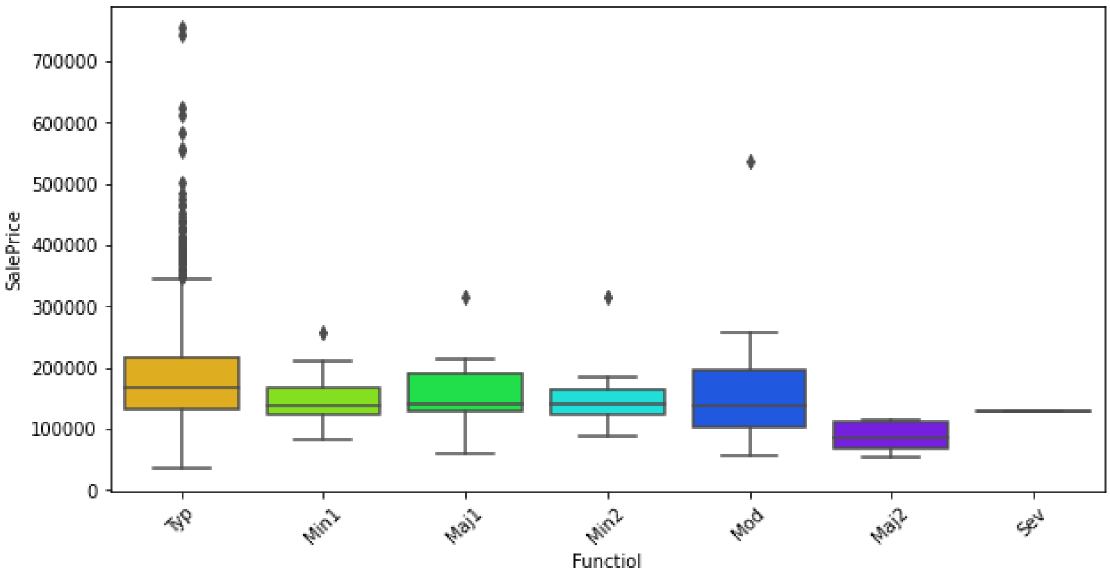
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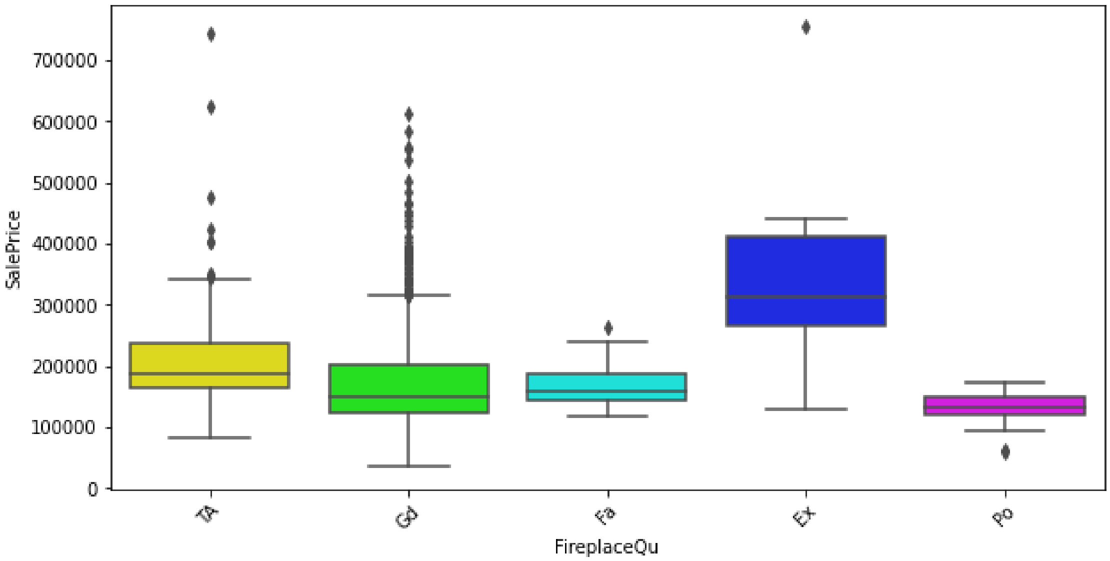
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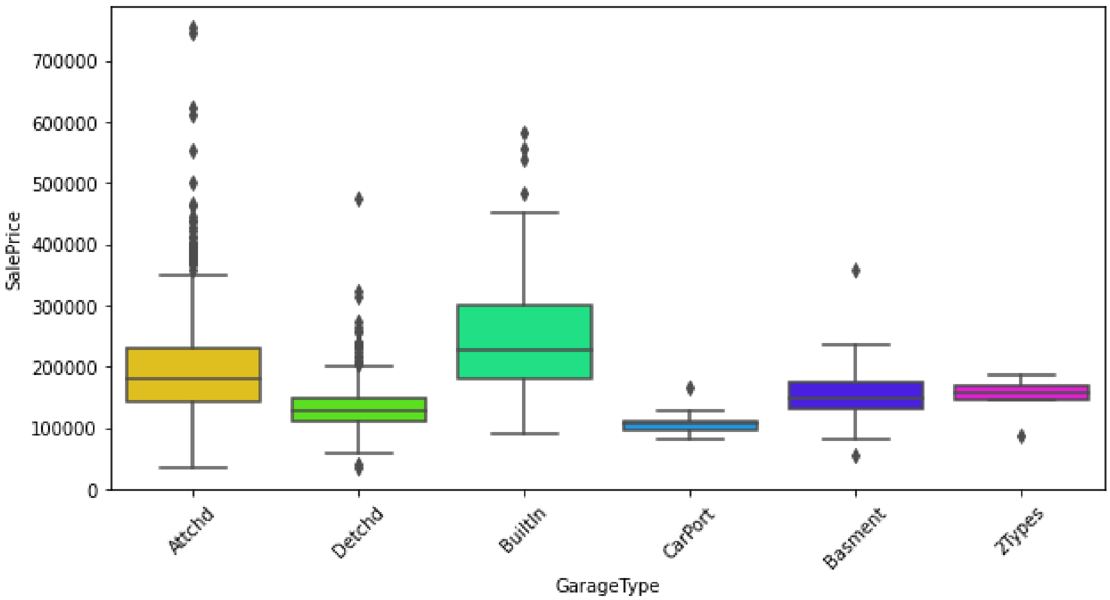
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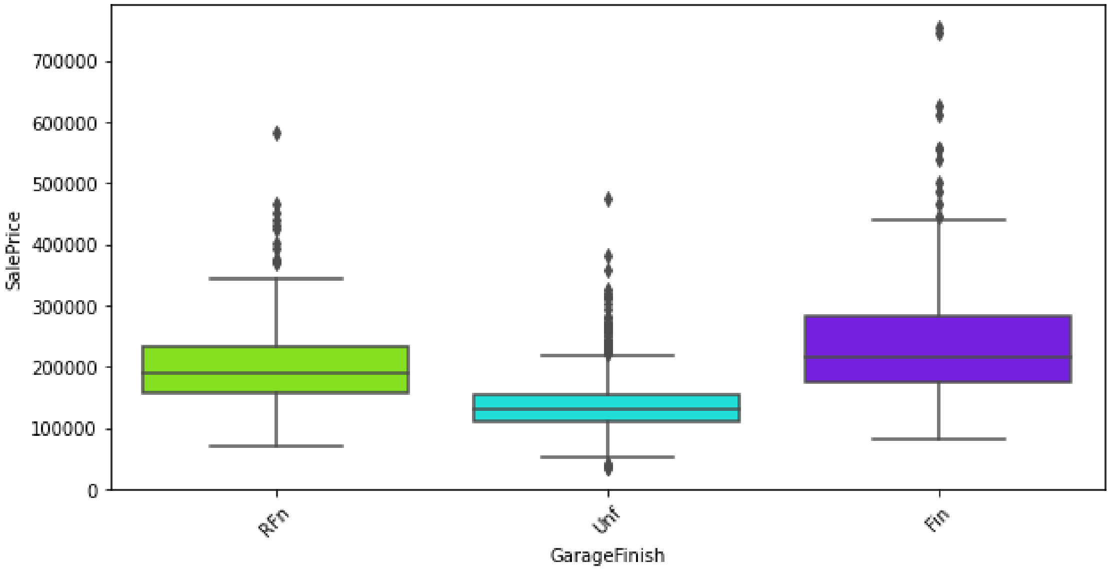
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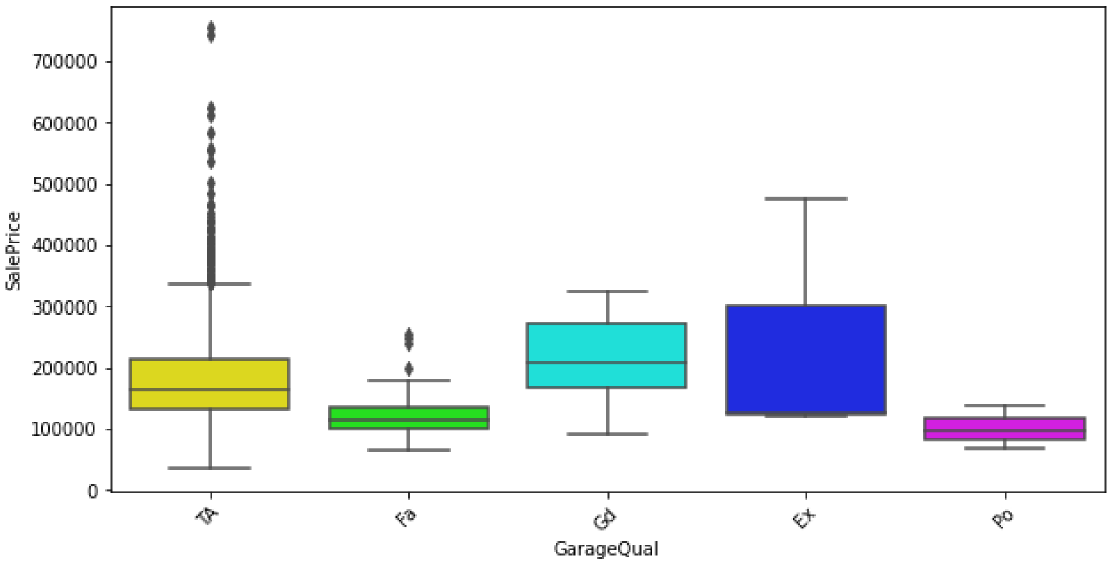
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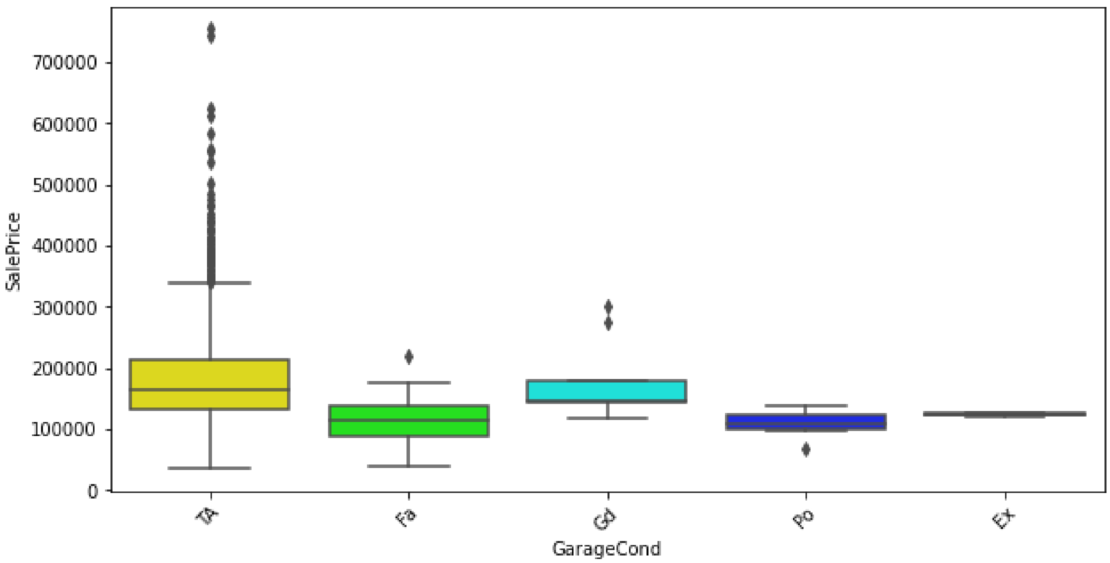
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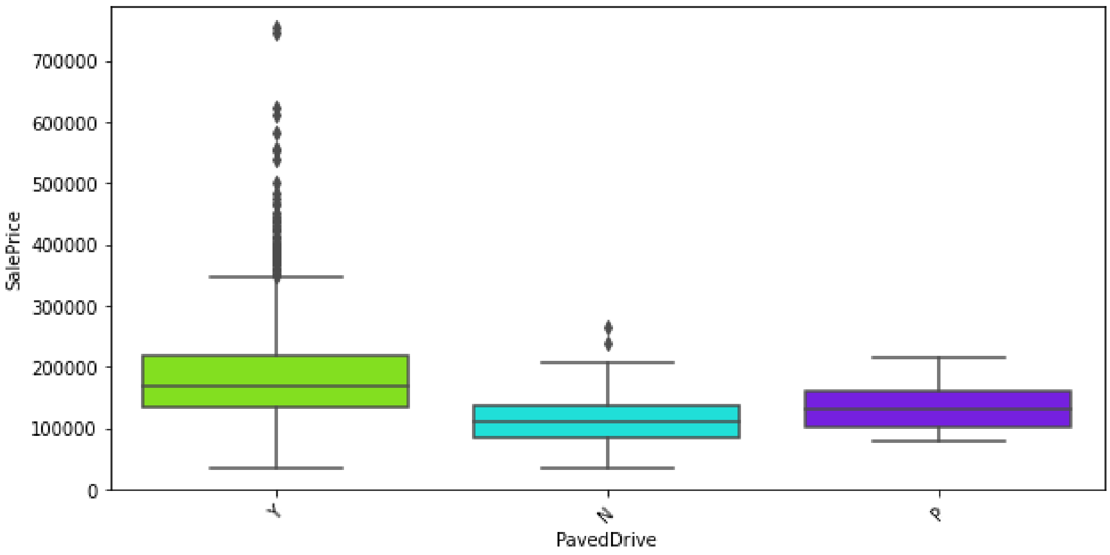
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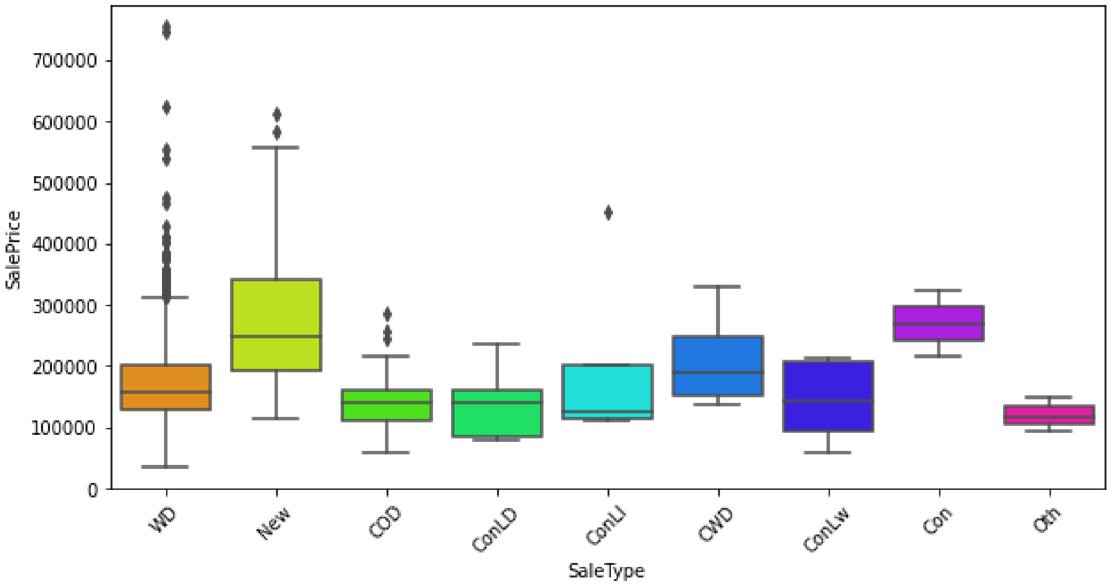
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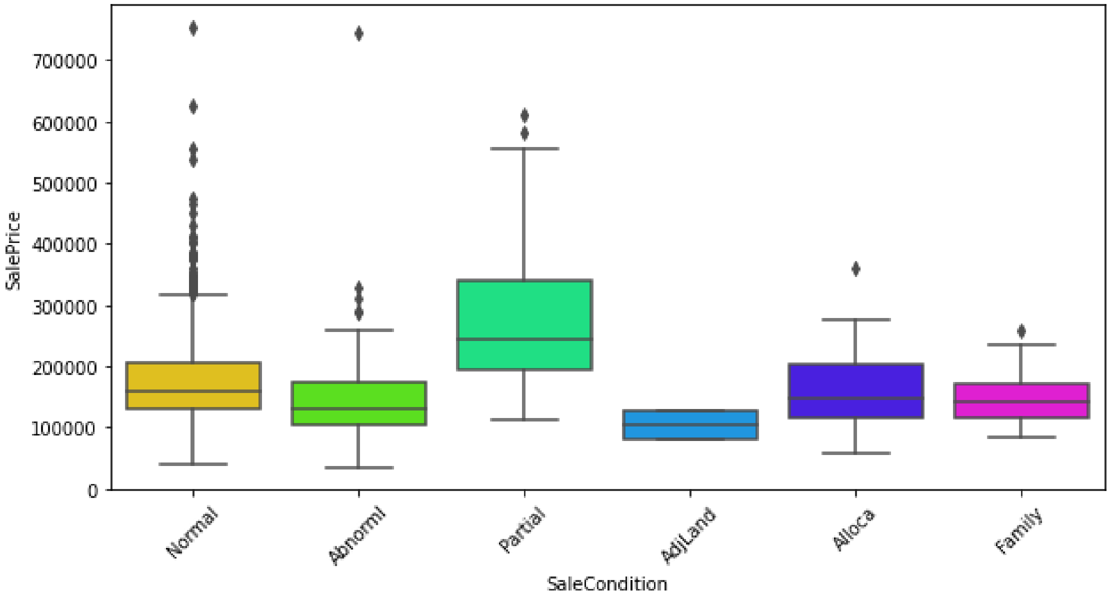
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