In [1]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

In [2]:

```
%matplotlib inline
import seaborn as sns
```

In [3]:

```
Data_Frame = pd.read_csv("PEP1.csv")
```

1. Understand the dataset:

a. Identify the shape of the dataset

In [4]:

```
Data_Frame.shape
```

Out[4]:

```
(1460, 81)
```

b. Identify variables with null values

In [5]:

```
Data_Null= Data_Frame.columns[Data_Frame.isnull().any()].to_list()
Data_Null
```

Out[5]:

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

c. Identify variables with unique values

In [6]:

```
for i in Data_Frame.columns:
    print (i , ":", Data_Frame[i].unique())
    print (" _ "*40)
    print (" _ "*40)
```

```
Id : [   1    2    3 ... 1458 1459 1460]
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MSSubClass : [ 60  20  70  50 190  45  90 120  30  85  80 160  75 180  40]
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MSZoning : ['RL' 'RM' 'C (all)' 'FV' 'RH']
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LotFrontage : [ 65.  80.  68.  60.  84.  85.  75.  nan  51.  50.  70.  91.  7
2.  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.]
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LotArea : [ 8450  9600 11250 ... 17217 13175  9717]
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Street : ['Pave' 'Grvl']
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Alley : [nan 'Grvl' 'Pave']
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LotShape : ['Reg' 'IR1' 'IR2' 'IR3']
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LandContour : ['Lvl' 'Bnk' 'Low' 'HLS']
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Utilities : ['AllPub' 'NoSeWa']
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LotConfig : ['Inside' 'FR2' 'Corner' 'CulDSac' 'FR3']
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 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]
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 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
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 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  73
7  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
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  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]
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BsmtFinType2 : ['Unf' 'BLQ' nan 'ALQ' 'Rec' 'LwQ' 'GLQ']
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BsmtFinSF2 : [   0   32  668  486   93  491  506  712  362   41  169  869  15
0  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   40  117  239   80  472   64 1057
  127  630  128  377  764  345 1085  435  823  500  290  324  634  411
  841 1061  466  396  354  149  193  273  465  400  682  557  230  106
  791  240  547  469  177  108  600  492  211  168 1031  438  375  144
   81  906  608  276  661   68  173  972  105  420  546  334  352  872
  110  627  163 1029]
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BsmtUnfSF : [ 150  284  434  540  490   64  317  216  952  140  134  177  175
1494
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 1296   83 1632  736  192  612  816   32  935  321  860 1410  148  217
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  176  370  350  381  410  741 1226 1053  641  516  793 1139  550  905
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  970  506  884  400  896  253  409   93 1200  572  774  769 1335  340
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 1390  594 1694  488  357  626  916 1020 1367  798  452  392  975  361
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  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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CentralAir : ['Y' 'N']
 _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _
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_  _  _  _  _  _  _  _  _  _  _  _  _  _
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Electrical : ['SBrkr' 'FuseF' 'FuseA' 'FuseP' 'Mix' nan]
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_  _  _  _  _  _  _  _  _  _  _  _  _  _
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_  _  _  _  _  _  _  _  _  _  _  _  _  _
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1494
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 1014  798 1566  866  889  626 1222 1872  908 1375 1444 1306 1625 1302
 1314 1005 1604  963 1382 1482  926  764 1422  802 1052  778 1113 1095
 1363 1632 1560 2121 1156 1175 1468 1575  625 1085  858  698 1079 1148
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 2018 1968 1332  935 1357  661 1724 1573 1582 1659 4692 1246  753 1203
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 1078 1980 1281 814 2633 1571 984 754 2117 998 1416 1746 1525 1221
  741 1569 1223 962 1537 1932 1423 913 1578 2073 1256]
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_ _ _ _ _ _ _ _ _ _ _ _ _ _
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  561 979 701 332 368 883 1336 1141 634 912 798 985 826 831
  750 456 602 855 336 408 980 998 1168 1208 797 850 898 1054
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  580 1112 653 220 240 1362 534 539 650 918 933 712 1796 971
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  587 994 950 1323 732 1357 557 1296 390 1185 873 1611 457 796
  908 550 989 932 358 1392 349 691 1349 768 208 622 857 556
 1044 708 626 904 510 1104 830 981 870 694 1152]
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LowQualFinSF : [0 360 513 234 528 572 144 392 371 390 420 473 156 515 80
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 1150 1752 2149 1656 1452 955 1470 1176 816 1842 1360 1425 1739 1720
 2945 780 1158 1111 1370 2034 2473 2207 1479 747 2287 2223 845 1718
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 1224 1526 990 1235 964 2291 1588 960 835 1225 1610 1732 1535 1226

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1355 1867 2161 1707 1382 1767 1651 2158 2060 1920 2234  968 1525 1802
1340 2082 3608 1217 1593 2727 1431 1726 3112 2229 1713 1121 1279 1310
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2574 1316  764 1422 1511 2192  778 1113 1939 1363 2270 1632 1548 2121
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2646 1472 2596 2468 2730 1163 2978  803 1719 1383 2134 1192 1056 1629
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1869 1453  720 1595 1167 1142 1352 1924 1505 1574 1394 1268 1287 1664
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2332 1367 1961  788 1034 1144 1812 1550 1288  672 1572 1620 1639 1680
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1412 1198 1365  630 1661  694 2402 1573 1258 1689 1888 1886 1376 1183
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1969 1072 1976 1652  970 1493 2643 1131 1850 1826 1216  999 1073 1484
2414 1304 1578  886 3228 1820  899 1218 1801 1322 1911 1378 1041 1368
2020 2119 2344 1796 2080 1294 1244 4676 2398 1266  928 2713  605 2515
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2715 2256 2640 1529 1140 2098 1026 1471 1386 2531 1547 2365 1506 1714
1836 3279 1220 1117 1973 1204 1614 1603 1110 1342 2084  901 2087 1145
1062 2013 1895 1564  773 3140 1688 2822 1128 1428 1576 2138 1309 1044
1008 1052  936 1733 1489 1434 2126 1223 1829 1516 1067 1559 1099 1482
1165 1416 1701 1775 2358 1646 1445 1779 1481 2654 1426 1039 1372 1002
1949  910 2610 2224 1155 1090 2230  892 1712 1393 2217 1683 1068  951
2240 2364 1670  902 1063 1636 2057 2274 1015 2002  480 1229 2127 2200
1617 1686 2374 1978 1788 2236 1466  925 1905 1500 2069 1971 1962 2403
1381  965 1958 2872 1894 1308 1098 1095  918 2019  869 1241 2612 2290
1940 2030 1851 1050  944  691 1504  985 1657 1522 1271 1022 1082 1132
2898 1264 3082 1654  954 1803 2329 2524 2868 1771  930 1977 1989 1523
1364 2184 1991 1338 2337 1103 1154 2260 1571 1611 2521  893 1240 1740
1459 1251 1247 1088  438  950 2622 2021 1690 1658 1964  833 1012  698
1005 1530 1981  974 2210  986 1020 1868 2828 1006 1298  932 1811 1265
1580 1876 1671 2108 3627 1261 3086 2345 1343 1124 2514 4476 1130 1221
1699 1624 1804 1622 1863 1630 1074 2196 1283 1845 1902 1211 1846 2136
1490 1138 1933 1702 1507 2620 1190 1188 1784 1948 1141 1173 2076 1553
2058 1405  874 2167 1987 1166 1675 1889 2018 3447 1524 1357 1395 2447
1659 1970 2372 5642 1246 1983 2526 1708 1122 1274 2810 2599 2112 1787
1923  708  774 2792 1334  693 1861  872 2169 1913 2156 2634 3238 1865
1078 1980 2601 1738 1475 1374 2633  790 2117 1762 2784 1746 1584 1912
2482 1687 1513 1608 2093 1840 1848 1569 2450 2201  804 1537 1932 1725
2555 2007  913 1346 2073 2340 1256]
```

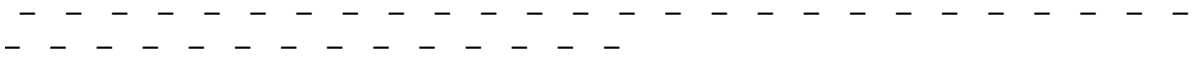

 _ _ _

```
GarageType : ['Attchd' 'Detchd' 'BuiltIn' 'CarPort' nan 'Basment' '2Types']
 –  –  –  
```

```
  254  712  719  862  928  782  466  714 1052  225  234  324  306  830
  807  358  186  693  482  813  995  757 1356  459  701  322  315  668
  404  543  954  850  477  276  518 1014  753 1418  213  844  860  748
  248  287  825  647  342  770  663  377  804  936  722  208  662  754
  622  620  370 1069  372  923  192]
 _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _
_  _  _  _  _  _  _  _  _  _  _  _  _
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_  _  _  _  _  _  _  _  _  _  _  _  _
GarageQual : ['TA' 'Fa' 'Gd' nan 'Ex' 'Po']
 _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _
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_  _  _  _  _  _  _  _  _  _  _  _  _
GarageCond : ['TA' 'Fa' nan 'Gd' 'Po' 'Ex']
 _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _
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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]
 _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _
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_  _  _  _  _  _  _  _  _  _  _  _  _
OpenPorchSF : [ 61   0  42  35  84  30  57 204   4  21  33 213 112 102 154 15
9 110  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]
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```
 _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _
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MoSold : [ 2  5  9 12 10  8 11  4  1  7  3  6]
 _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _
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YrSold : [2008 2007 2006 2009 2010]
 _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _
_  _  _  _  _  _  _  _  _  _  _  _  _
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_  _  _  _  _  _  _  _  _  _  _  _  _  _
SaleType : ['WD' 'New' 'COD' 'ConLD' 'ConLI' 'CWD' 'ConLw' 'Con' 'Oth']
 _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _
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_  _  _  _  _  _  _  _  _  _  _  _  _  _
SaleCondition : ['Normal' 'Abnorml' 'Partial' 'AdjLand' 'Alloca' 'Family']
 _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _
_  _  _  _  _  _  _  _  _  _  _  _  _
 _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _  _
_  _  _  _  _  _  _  _  _  _  _  _  _  _
SalePrice : [208500 181500 223500 140000 250000 143000 307000 200000 129900 1
18000
 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]
```

```
 –  –  –  –  –  –  –  –  –  –  –  –  –  –  –  –  –  –  –  –  –  –  –  –
–  –  –  –  –  –  –  –  –  –  –  –  –
 –  –  –  –  –  –  –  –  –  –  –  –  –  –  –  –  –  –  –  –  –  –  –  –
–  –  –  –  –  –  –  –  –  –  –  –  –
```

1. Generate a separate dataset for numerical and categorical variables

In [7]:

```
# dataset with numerical variables
numerics = ['int16', 'int32', 'int64','float16','float32','float64']
Data_numeric = Data_Frame.select_dtypes(include=numerics)
Data_numeric
```

Out[7]:

	Id	MSSubClass	LotFrontage	LotArea	OverallQual	OverallCond	YearBuilt	YearRemodA
0	1	60	65.0	8450	7	5	2003	2(
1	2	20	80.0	9600	6	8	1976	1!
2	3	60	68.0	11250	7	5	2001	2(
3	4	70	60.0	9550	7	5	1915	1!
4	5	60	84.0	14260	8	5	2000	2(
...	...	...	...	...	...	...	...	
1455	1456	60	62.0	7917	6	5	1999	2(
1456	1457	20	85.0	13175	6	6	1978	1!
1457	1458	70	66.0	9042	7	9	1941	2(
1458	1459	20	68.0	9717	5	6	1950	1!
1459	1460	20	75.0	9937	5	6	1965	1!

1460 rows × 38 columns

In [8]:

```
# dataset with categorical variables
Data_Category = Data_Frame.select_dtypes(include=['object'])
Data_Category
```

Out[8]:

	MSZoning	Street	Alley	LotShape	LandContour	Utilities	LotConfig	LandSlope	Neighbor
0	RL	Pave	NaN	Reg	Lvl	AllPub	Inside	Gtl	C
1	RL	Pave	NaN	Reg	Lvl	AllPub	FR2	Gtl	Ve
2	RL	Pave	NaN	IR1	Lvl	AllPub	Inside	Gtl	C
3	RL	Pave	NaN	IR1	Lvl	AllPub	Corner	Gtl	Cr
4	RL	Pave	NaN	IR1	Lvl	AllPub	FR2	Gtl	Nol
...	...	...	...	...	...	...	...	...	
1455	RL	Pave	NaN	Reg	Lvl	AllPub	Inside	Gtl	C
1456	RL	Pave	NaN	Reg	Lvl	AllPub	Inside	Gtl	NW
1457	RL	Pave	NaN	Reg	Lvl	AllPub	Inside	Gtl	Cr
1458	RL	Pave	NaN	Reg	Lvl	AllPub	Inside	Gtl	
1459	RL	Pave	NaN	Reg	Lvl	AllPub	Inside	Gtl	Edv

1460 rows × 43 columns

1. EDA of numerical variables:

a. Missing value treatment

In [9]:

```
Data_numeric_null = Data_numeric.isnull().sum()
Data_numeric_null
```

Out[9]:

```
Id                0
MSSubClass        0
LotFrontage     259
LotArea           0
OverallQual       0
OverallCond       0
YearBuilt         0
YearRemodAdd      0
MasVnrArea        8
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      81
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
```

In [10]:

```
Data_numeric["LotFrontage"].fillna(Data_numeric["LotFrontage"].mean(),inplace=True)
Data_numeric
```

```
/usr/local/lib/python3.7/site-packages/pandas/core/series.py:4536: SettingWit
hCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/s
table/user_guide/indexing.html#returning-a-view-versus-a-copy
  downcast=downcast,
```

Out[10]:

	Id	MSSubClass	LotFrontage	LotArea	OverallQual	OverallCond	YearBuilt	YearRemodA
0	1	60	65.0	8450	7	5	2003	2(
1	2	20	80.0	9600	6	8	1976	1(
2	3	60	68.0	11250	7	5	2001	2(
3	4	70	60.0	9550	7	5	1915	1(
4	5	60	84.0	14260	8	5	2000	2(
...	...	...	...	...	...	...	...	
1455	1456	60	62.0	7917	6	5	1999	2(
1456	1457	20	85.0	13175	6	6	1978	1(
1457	1458	70	66.0	9042	7	9	1941	2(
1458	1459	20	68.0	9717	5	6	1950	1(
1459	1460	20	75.0	9937	5	6	1965	1(

1460 rows × 38 columns

In [11]:

```
Data_numeric["GarageYrBlt"].fillna(Data_numeric["GarageYrBlt"].mean(),inplace=True)
Data_numeric
```

```
/usr/local/lib/python3.7/site-packages/pandas/core/series.py:4536: SettingWit
hCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/s
table/user_guide/indexing.html#returning-a-view-versus-a-copy
  downcast=downcast,
```

Out[11]:

	Id	MSSubClass	LotFrontage	LotArea	OverallQual	OverallCond	YearBuilt	YearRemodA
0	1	60	65.0	8450	7	5	2003	2(
1	2	20	80.0	9600	6	8	1976	1(
2	3	60	68.0	11250	7	5	2001	2(
3	4	70	60.0	9550	7	5	1915	1(
4	5	60	84.0	14260	8	5	2000	2(
...	...	...	...	...	...	...	...	
1455	1456	60	62.0	7917	6	5	1999	2(
1456	1457	20	85.0	13175	6	6	1978	1(
1457	1458	70	66.0	9042	7	9	1941	2(
1458	1459	20	68.0	9717	5	6	1950	1(
1459	1460	20	75.0	9937	5	6	1965	1(

1460 rows × 38 columns

In [12]:

```
Data_numeric["MasVnrArea"].fillna(Data_numeric["MasVnrArea"].mean(),inplace=True)
Data_numeric
```

```
/usr/local/lib/python3.7/site-packages/pandas/core/series.py:4536: SettingWit
hCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/s
table/user_guide/indexing.html#returning-a-view-versus-a-copy
  downcast=downcast,
```

Out[12]:

	Id	MSSubClass	LotFrontage	LotArea	OverallQual	OverallCond	YearBuilt	YearRemodA
0	1	60	65.0	8450	7	5	2003	2(
1	2	20	80.0	9600	6	8	1976	1(
2	3	60	68.0	11250	7	5	2001	2(
3	4	70	60.0	9550	7	5	1915	1(
4	5	60	84.0	14260	8	5	2000	2(
...	...	...	...	...	...	...	...	
1455	1456	60	62.0	7917	6	5	1999	2(
1456	1457	20	85.0	13175	6	6	1978	1(
1457	1458	70	66.0	9042	7	9	1941	2(
1458	1459	20	68.0	9717	5	6	1950	1(
1459	1460	20	75.0	9937	5	6	1965	1(

1460 rows × 38 columns

In [13]:

```
#check any null value
Data_numeric.isna().any().sum()
```

Out[13]:

```
0
```

b. Identify the skewness and distribution

In [14]:

```
Data_Skew = Data_numeric.skew()
Data_Skew
```

Out[14]:

```
Id               0.000000
MSSubClass       1.407657
LotFrontage      2.384950
LotArea         12.207688
OverallQual      0.216944
OverallCond      0.693067
YearBuilt       -0.613461
YearRemodAdd    -0.503562
MasVnrArea       2.676412
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     -0.668175
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
```

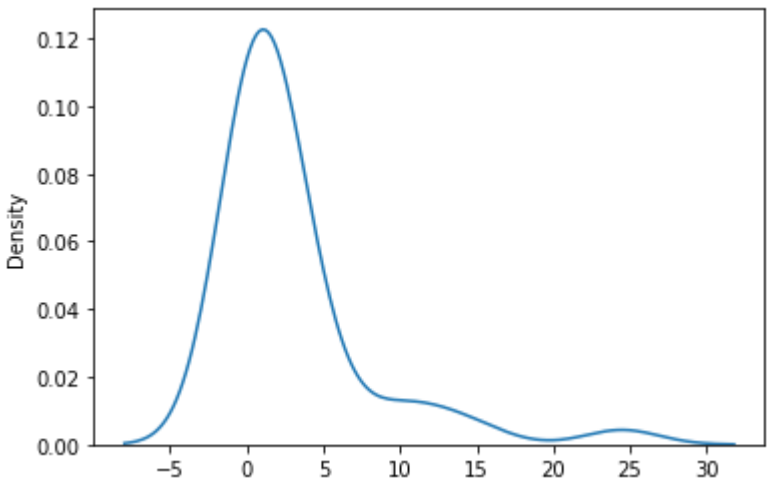
In [15]:

```
# Distributaion
import seaborn as sns
sns.distplot(Data_Skew,hist=False)
```

```
/usr/local/lib/python3.7/site-packages/seaborn/distributions.py:2619: FutureW
arning: `distplot` is a deprecated function and will be removed in a future v
ersion. Please adapt your code to use either `displot` (a figure-level functi
on with similar flexibility) or `kdeplot` (an axes-level function for kernel
density plots).
  warnings.warn(msg, FutureWarning)
```

Out[15]:

```
<AxesSubplot:ylabel='Density'>
```



c. Identify significant variables using a correlation matrix

In [16]:

```
Data_numeric_corr = Data_numeric.corr()
Data_numeric_corr
Data_numeric_corr.style.background_gradient(cmap='coolwarm')
```

Out[16]:

	Id	MSSubClass	LotFrontage	LotArea	OverallQual	OverallCond	YearB
Id	1.000000	0.011156	-0.009601	-0.033226	-0.028365	0.012609	-0.012
MSSubClass	0.011156	1.000000	-0.357056	-0.139781	0.032628	-0.059316	0.027
LotFrontage	-0.009601	-0.357056	1.000000	0.306795	0.234196	-0.052820	0.117
LotArea	-0.033226	-0.139781	0.306795	1.000000	0.105806	-0.005636	0.014
OverallQual	-0.028365	0.032628	0.234196	0.105806	1.000000	-0.091932	0.572
OverallCond	0.012609	-0.059316	-0.052820	-0.005636	-0.091932	1.000000	-0.375
YearBuilt	-0.012713	0.027850	0.117598	0.014228	0.572323	-0.375983	1.000
YearRemodAdd	-0.021998	0.040581	0.082746	0.013788	0.550684	0.073741	0.592
MasVnrArea	-0.050199	0.022895	0.179283	0.103960	0.410238	-0.127788	0.314
BsmtFinSF1	-0.005024	-0.069836	0.215828	0.214103	0.239666	-0.046231	0.249
BsmtFinSF2	-0.005968	-0.065649	0.043340	0.111170	-0.059119	0.040229	-0.049
BsmtUnfSF	-0.007940	-0.140759	0.122156	-0.002618	0.308159	-0.136841	0.149
TotalBsmtSF	-0.015415	-0.238518	0.363358	0.260833	0.537808	-0.171098	0.391
1stFlrSF	0.010496	-0.251758	0.414266	0.299475	0.476224	-0.144203	0.281
2ndFlrSF	0.005590	0.307886	0.072483	0.050986	0.295493	0.028942	0.010
LowQualFinSF	-0.044230	0.046474	0.036849	0.004779	-0.030429	0.025494	-0.183
GrLivArea	0.008273	0.074853	0.368392	0.263116	0.593007	-0.079686	0.199
BsmtFullBath	0.002289	0.003491	0.091481	0.158155	0.111098	-0.054942	0.187
BsmtHalfBath	-0.020155	-0.002333	-0.006419	0.048046	-0.040150	0.117821	-0.038
FullBath	0.005587	0.131608	0.180424	0.126031	0.550600	-0.194149	0.468
HalfBath	0.006784	0.177354	0.048258	0.014259	0.273458	-0.060769	0.242
BedroomAbvGr	0.037719	-0.023438	0.237023	0.119690	0.101676	0.012980	-0.070
KitchebvGr	0.002951	0.281721	-0.005805	-0.017784	-0.183882	-0.087001	-0.174
TotRmsAbvGrd	0.027239	0.040380	0.320146	0.190015	0.427452	-0.057583	0.095
Fireplaces	-0.019772	-0.045569	0.235755	0.271364	0.396765	-0.023820	0.147
GarageYrBlt	0.000070	0.080187	0.064324	-0.024812	0.518018	-0.306169	0.780
GarageCars	0.016570	-0.040110	0.269729	0.154871	0.600671	-0.185758	0.537
GarageArea	0.017634	-0.098672	0.323663	0.180403	0.562022	-0.151521	0.478
WoodDeckSF	-0.029643	-0.012579	0.077106	0.171698	0.238923	-0.003334	0.224
OpenPorchSF	-0.000477	-0.006100	0.137454	0.084774	0.308819	-0.032589	0.188
EnclosedPorch	0.002889	-0.012037	0.009790	-0.018340	-0.113937	0.070356	-0.387
3SsnPorch	-0.046635	-0.043825	0.062335	0.020423	0.030371	0.025504	0.031
ScreenPorch	0.001330	-0.026030	0.037684	0.043160	0.064886	0.054811	-0.050
PoolArea	0.057044	0.008283	0.180868	0.077672	0.065166	-0.001985	0.004

	Id	MSSubClass	LotFrontage	LotArea	OverallQual	OverallCond	YearB
MiscVal	-0.006242	-0.007683	0.001168	0.038068	-0.031406	0.068777	-0.034
MoSold	0.021172	-0.013585	0.010158	0.001205	0.070815	-0.003511	0.012
YrSold	0.000712	-0.021407	0.006768	-0.014261	-0.027347	0.043950	-0.013
SalePrice	-0.021917	-0.084284	0.334901	0.263843	0.790982	-0.077856	0.522

Variables which have >=0.5 correction with Saleprice

1. OverallQual (Overall material and finish quality)
2. YearBuilt (Original construction date)
3. YearRemodAdd (Remodel date)
4. TotalBsmtSF (Total square feet of basement area)
5. 1stFlrSF (First Floor square feet)
6. GrLivArea (Above grade (ground) living area square feet)
7. FullBath (Full bathrooms above grade)
8. TotRmsAbvGrd (Total rooms above grade (does not include bathrooms))
9. GarageCars (Size of the garage in car capacity)
10. GarageArea (Size of the garage in square feet)

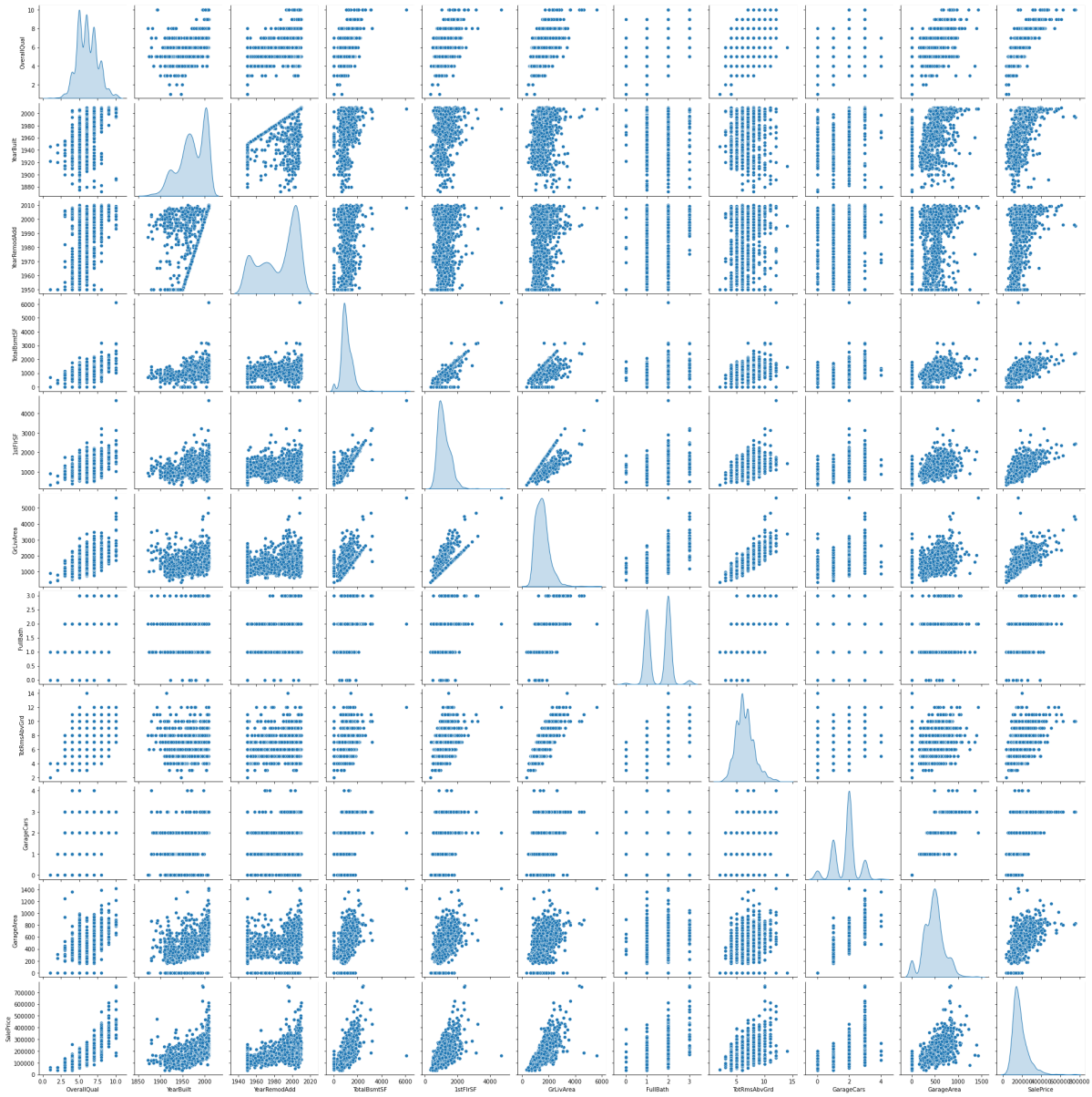
d. Pair plot for distribution and density

In [17]:

```
sns.pairplot(Data_numeric, vars=['OverallQual', 'YearBuilt', 'YearRemodAdd', 'TotalBsmtSF', '1stFlrSF','GrLivArea', 'FullBath', 'TotRmsAbvGrd', 'GarageCars', 'GarageArea','SalePrice'],diag_kind="kde")
```

Out[17]:

```
<seaborn.axisgrid.PairGrid at 0x7fbbe6a7ac90>
```



As we can see in pairplot many variables match themself

1. YearRemodAdd with SalePrice has a high resemblance to that of YearBuilt with SalePrice.
2. 1stFlrSF with SalePrice has a high resemblance to that of TotalBsmtSF with SalePrice.
3. TotRmsAbvGrd is highly correlated to GrLivArea.
4. GarageArea is highly correlated to GarageCars.

So, creating new numeric data which affect Saleprice

In [18]:

```
Data_numeric_new = Data_numeric[['OverallQual', 'YearBuilt', 'TotalBsmtSF', 'GrLivArea',
'FullBath', 'GarageCars','SalePrice']]
Data_numeric_new
```

Out[18]:

	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
...	...	...	...	...	...	...	...
1455	6	1999	953	1647	2	2	175000
1456	6	1978	1542	2073	2	2	210000
1457	7	1941	1152	2340	2	1	266500
1458	5	1950	1078	1078	1	1	142125
1459	5	1965	1256	1256	1	1	147500

1460 rows × 7 columns

1. EDA of categorical variables

a. Missing value treatment

In [19]:

```
Data_Category.isna().sum()
```

Out[19]:

```
MSZoning           0
Street             0
Alley           1369
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         8
ExterQual          0
ExterCond          0
Foundation         0
BsmtQual          37
BsmtCond          37
BsmtExposure      38
BsmtFinType1      37
BsmtFinType2      38
Heating            0
HeatingQC          0
CentralAir         0
Electrical         1
KitchenQual        0
Functiol           0
FireplaceQu      690
GarageType        81
GarageFinish      81
GarageQual        81
GarageCond        81
PavedDrive         0
PoolQC          1453
Fence           1179
MiscFeature     1406
SaleType           0
SaleCondition      0
dtype: int64
```

As we can see the data with larger null value is not related to sale price we can drop them. So, we can drop Alley, PoolQC, Fence, MiscFeature and FireplaceQu

In [20]:

```
Data_Category = Data_Category.drop(['Alley','PoolQC','Fence','MiscFeature','FireplaceQu'],
axis=1)
```

In [21]:

```
Data_Category.isna().sum()
```

Out[21]:

```
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        8
ExterQual         0
ExterCond         0
Foundation        0
BsmtQual         37
BsmtCond         37
BsmtExposure     38
BsmtFinType1     37
BsmtFinType2     38
Heating           0
HeatingQC         0
CentralAir        0
Electrical        1
KitchenQual       0
Functiol          0
GarageType       81
GarageFinish     81
GarageQual       81
GarageCond       81
PavedDrive        0
SaleType          0
SaleCondition     0
dtype: int64
```

As we can see still we have null values but they are very less number we can drop the same too.

In [22]:

```
Data_Category.dropna(inplace=True)
```

In [23]:

```
Data_Category.isna().sum()
```

Out[23]:

```
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
```

In [24]:

```
Data_Category
```

Out[24]:

	MSZoning	Street	LotShape	LandContour	Utilities	LotConfig	LandSlope	Neighborhood
0	RL	Pave	Reg	Lvl	AllPub	Inside	Gtl	CollgCr
1	RL	Pave	Reg	Lvl	AllPub	FR2	Gtl	Veenker
2	RL	Pave	IR1	Lvl	AllPub	Inside	Gtl	CollgCr
3	RL	Pave	IR1	Lvl	AllPub	Corner	Gtl	Crawfor
4	RL	Pave	IR1	Lvl	AllPub	FR2	Gtl	NoRidge
...	...	...	...	...	...	...	...	...
1455	RL	Pave	Reg	Lvl	AllPub	Inside	Gtl	Gilbert
1456	RL	Pave	Reg	Lvl	AllPub	Inside	Gtl	NWAmes
1457	RL	Pave	Reg	Lvl	AllPub	Inside	Gtl	Crawfor
1458	RL	Pave	Reg	Lvl	AllPub	Inside	Gtl	mes
1459	RL	Pave	Reg	Lvl	AllPub	Inside	Gtl	Edwards

1338 rows × 38 columns

In [25]:

```
#Adding SalePrice to the category data frame
Data_Category['SalePrice'] = Data_Frame.loc[Data_Category.index, 'SalePrice'].copy()
Data_Category.head(2)
```

Out[25]:

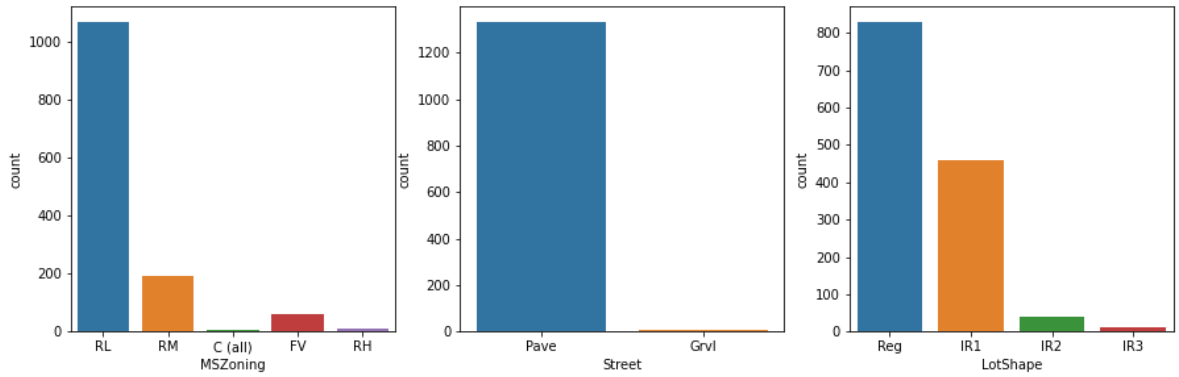
	MSZoning	Street	LotShape	LandContour	Utilities	LotConfig	LandSlope	Neighborhood	Co
0	RL	Pave	Reg	Lvl	AllPub	Inside	Gtl	CollgCr	
1	RL	Pave	Reg	Lvl	AllPub	FR2	Gtl	Veenker	

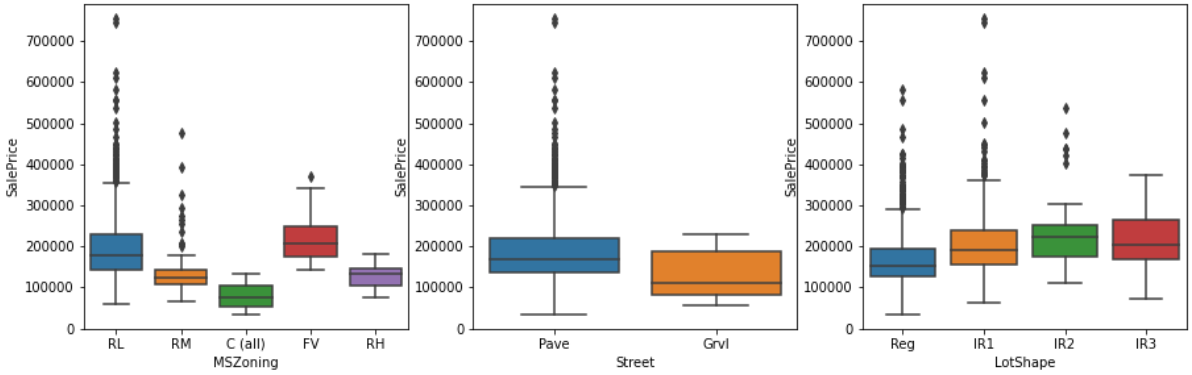
2 rows × 39 columns

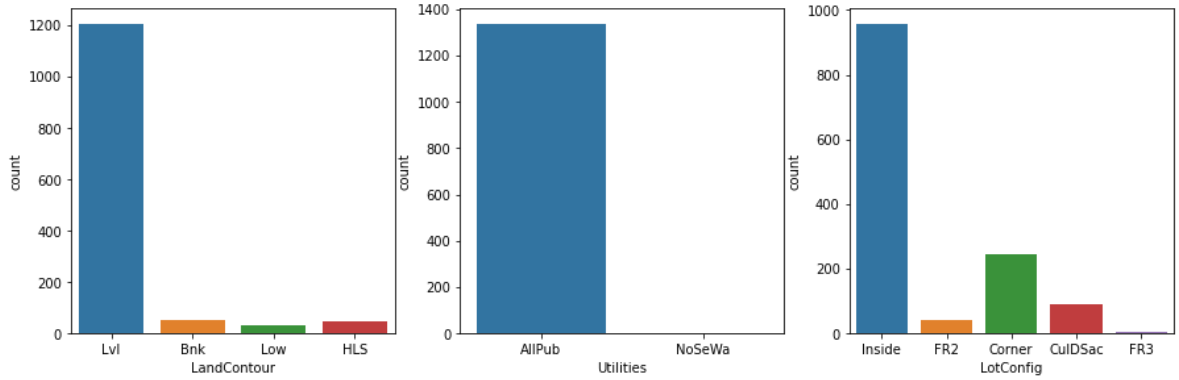
b. Count plot and box plot for bivariate analysis

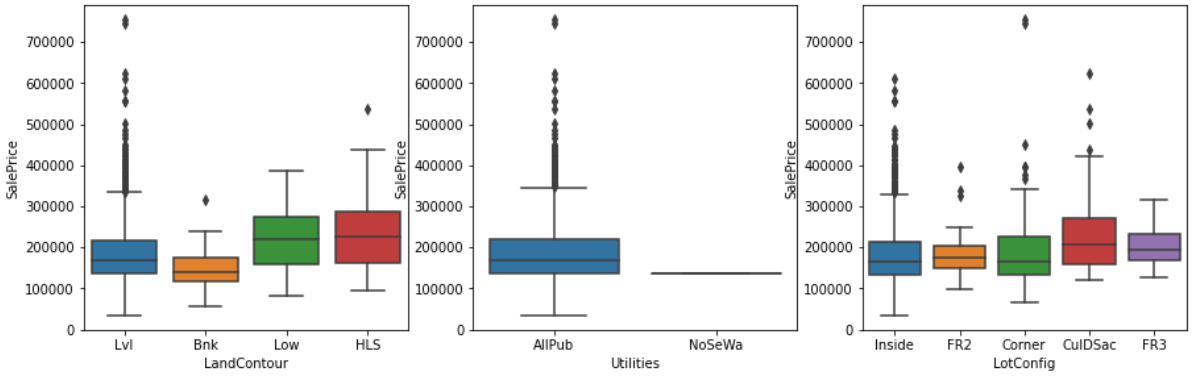
In [26]:

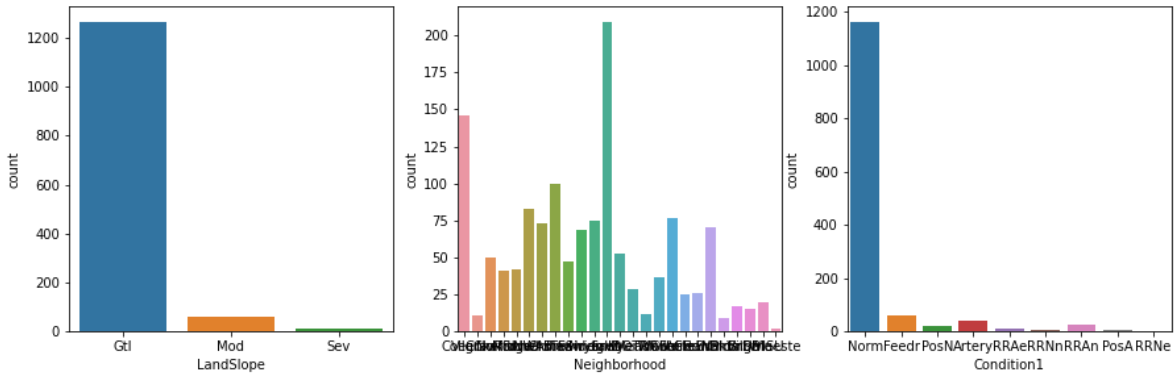
```
i = 1
fig = plt.figure(figsize = (15,10))
for c in list(Data_Category.columns):
    if i <= 3:
        if c != 'SalePrice':
            ax1 = fig.add_subplot(2,3,i)
            sns.countplot(data = Data_Category, x=c, ax = ax1) #For countplot
            ax2 = fig.add_subplot(2,3,i+3)
            sns.boxplot(data = Data_Category, x=c, y='SalePrice', ax=ax2) #For boxplot

    i = i +1
    if i == 4:
        fig = plt.figure(figsize = (15,10))
        i = 1
```

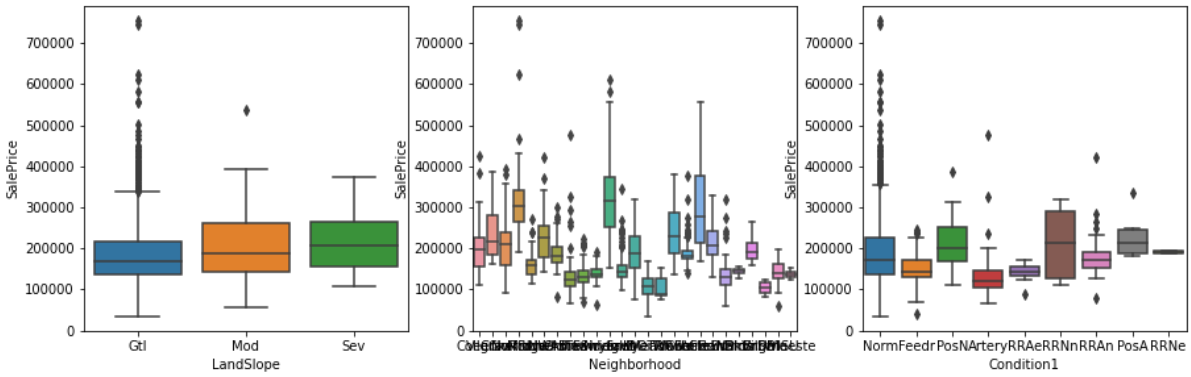

count
MSZoning
RL
RM
C (all)
FV
RH
Street
Pave
Grvl
LotShape
Reg
IR1
IR2
IR3

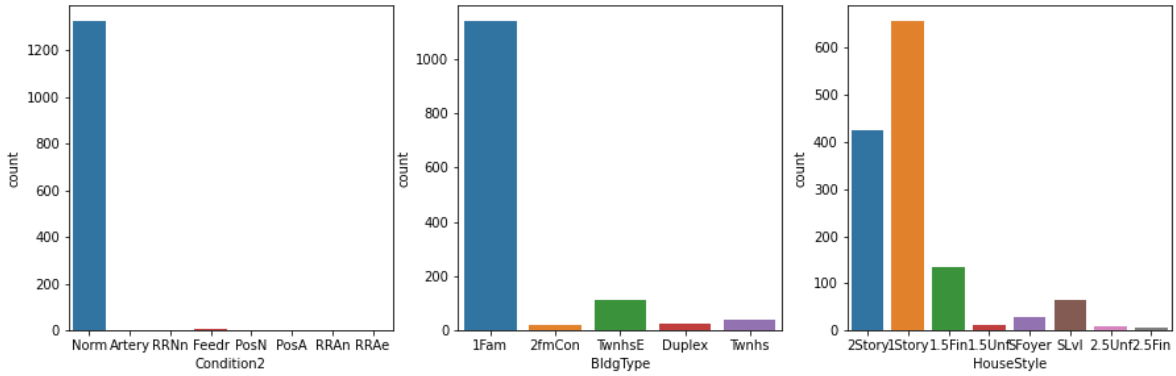

SalePrice
MSZoning
RL
RM
C (all)
FV
RH
Street
Pave
Grvl
LotShape
Reg
IR1
IR2
IR3

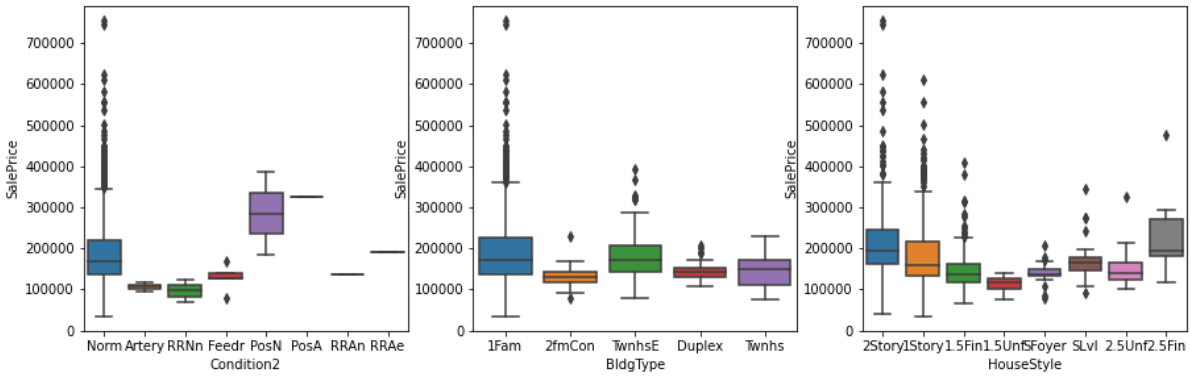

count
LandContour
Lvl
Bnk
Low
HLS
Utilities
AllPub
NoSeWa
LotConfig
Inside
FR2
Corner
CulDSac
FR3

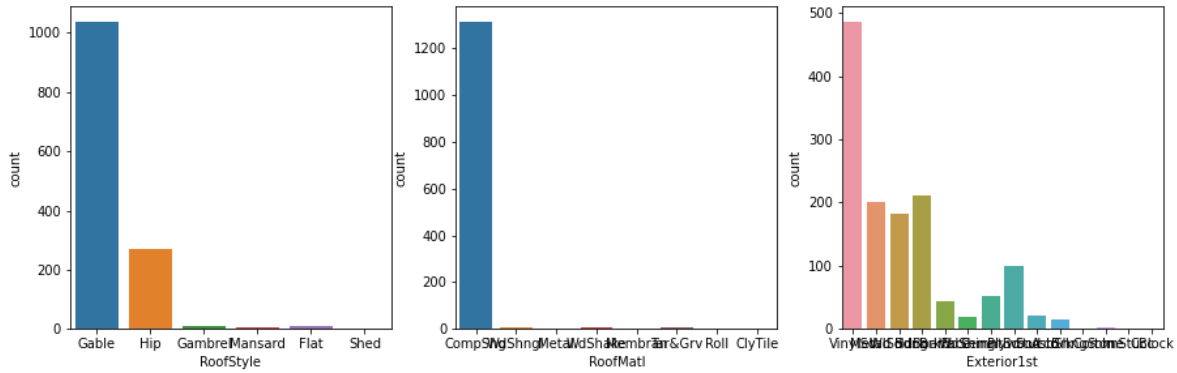

SalePrice
LandContour
Lvl
Bnk
Low
HLS
Utilities
AllPub
NoSeWa
LotConfig
Inside
FR2
Corner
CulDSac
FR3

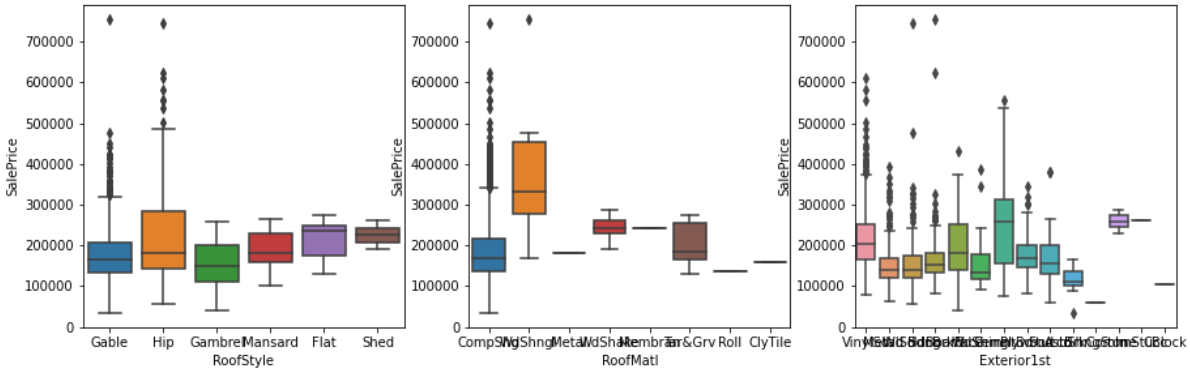

count
LandSlope
Gtl
Mod
Sev
Neighborhood
Condition1
NormFeedrPosNArteryRRAeRRNnRRAnPosARRNe

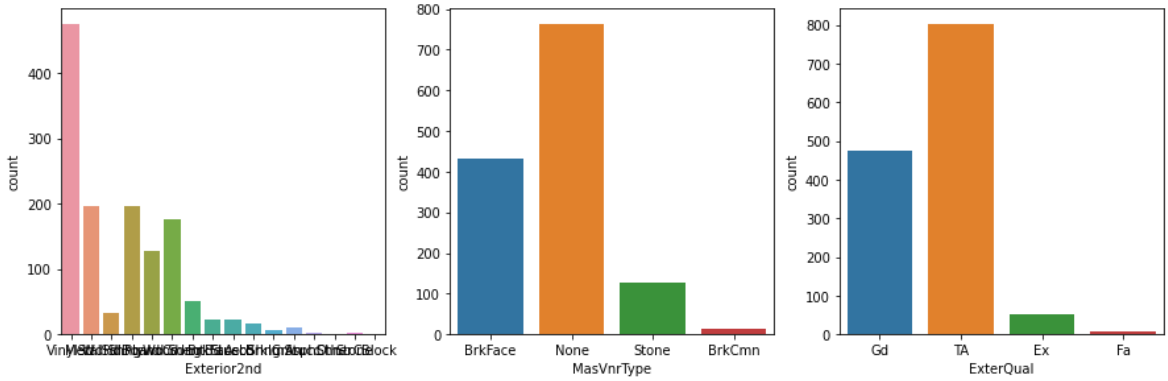

SalePrice
LandSlope
Gtl
Mod
Sev
Neighborhood
Condition1
NormFeedrPosNArteryRRAeRRNnRRAnPosARRNe

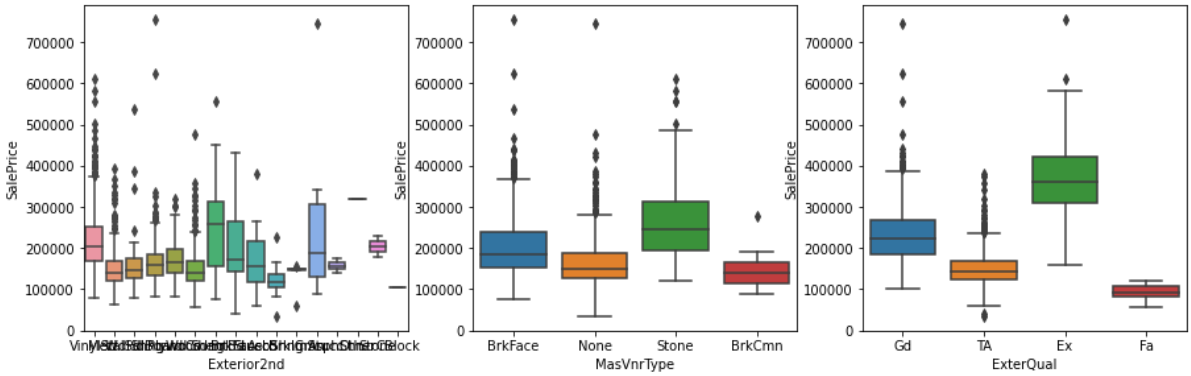

count
Condition2
Norm Artery RRNn Feedr PosN PosA RRAn RRAe
BldgType
1Fam 2fmCon TwnhsE Duplex Twnhs
HouseStyle
2Story1Story1.5Fin1.5UnfSFoyer SLvl 2.5Unf2.5Fin

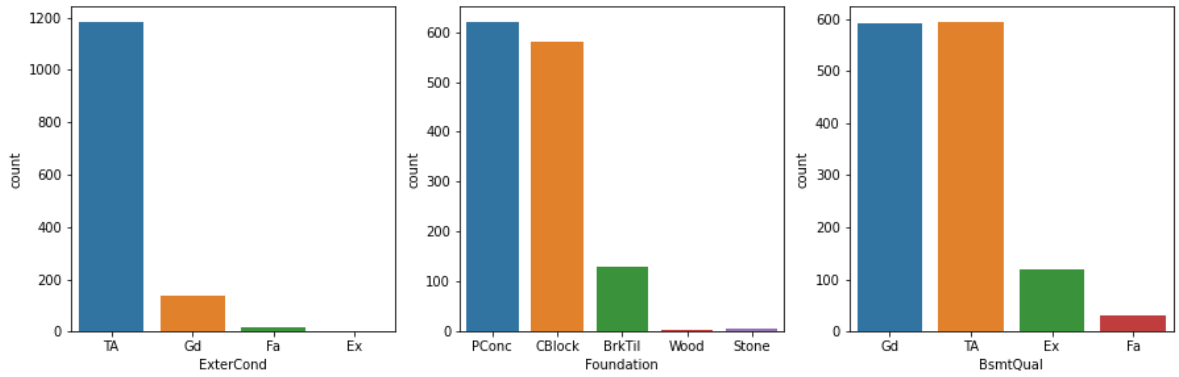

SalePrice
Condition2
Norm Artery RRNn Feedr PosN PosA RRAn RRAe
BldgType
1Fam 2fmCon TwnhsE Duplex Twnhs
HouseStyle
2Story1Story1.5Fin1.5UnfSFoyer SLvl 2.5Unf2.5Fin

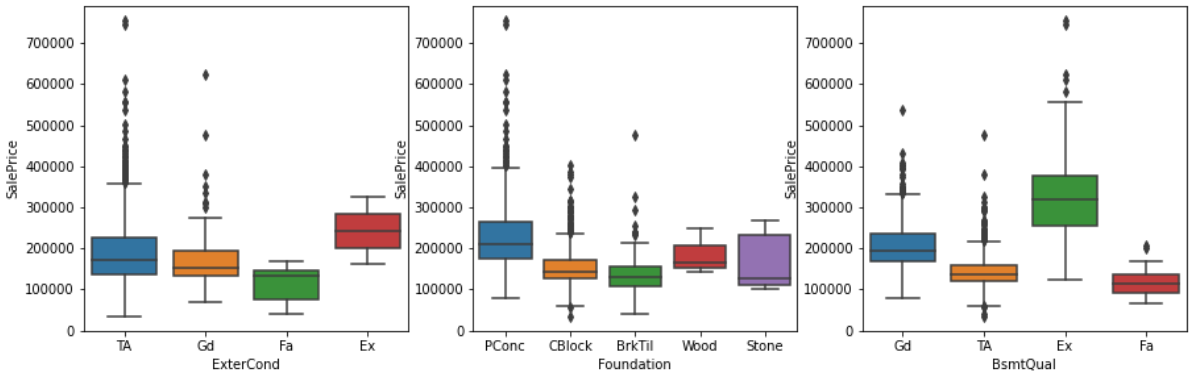

count
RoofStyle
Gable
Hip
Gambrel
Mansard
Flat
Shed
RoofMatl
CompShg
WdShngl
Metal
WdShake
Membran
Tar&Grv
Roll
ClyTile
Exterior1st

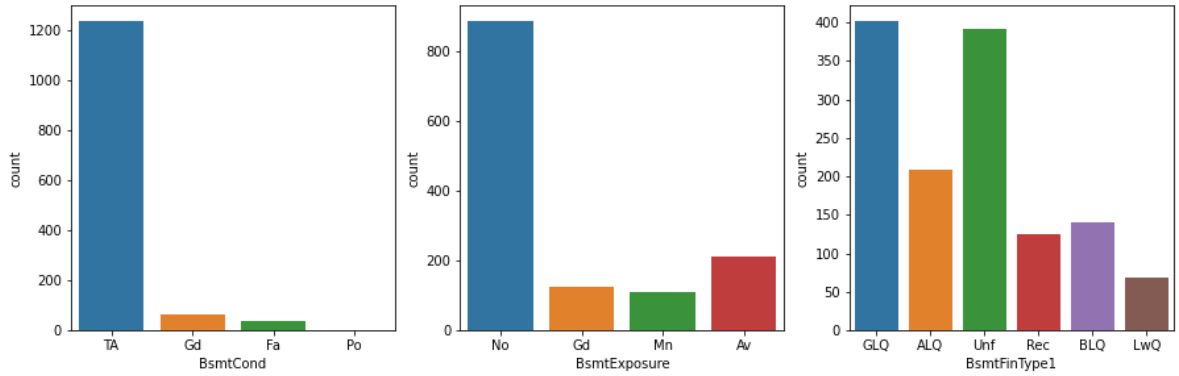

SalePrice
RoofStyle
Gable
Hip
Gambrel
Mansard
Flat
Shed
RoofMatl
CompShg
WdShngl
Metal
WdShake
Membran
Tar&Grv
Roll
ClyTile
Exterior1st

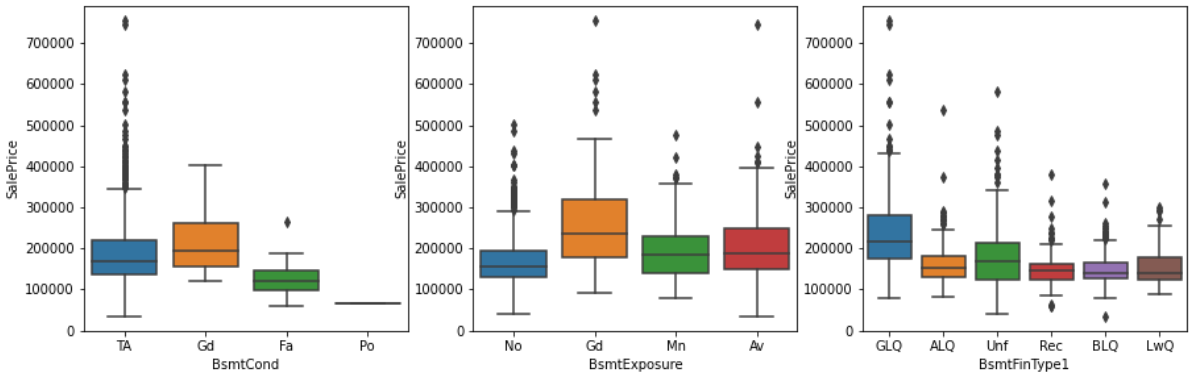

count
Exterior2nd
BrkFace
None
Stone
BrkCmn
MasVnrType
Gd
TA
Ex
Fa
ExterQual


SalePrice
Exterior2nd
BrkFace
None
Stone
BrkCmn
MasVnrType
Gd
TA
Ex
Fa
ExterQual


count
ExterCond
TA
Gd
Fa
Ex
Foundation
PConc
CBlock
BrkTil
Wood
Stone
BsmtQual
Gd
TA
Ex
Fa


SalePrice
ExterCond
TA
Gd
Fa
Ex
Foundation
PConc
CBlock
BrkTil
Wood
Stone
BsmtQual
Gd
TA
Ex
Fa


count
BsmtCond
TA
Gd
Fa
Po
BsmtExposure
No
Gd
Mn
Av
BsmtFinType1
GLQ
ALQ
Unf
Rec
BLQ
LwQ


SalePrice
BsmtCond
TA
Gd
Fa
Po
BsmtExposure
No
Gd
Mn
Av
BsmtFinType1
GLQ
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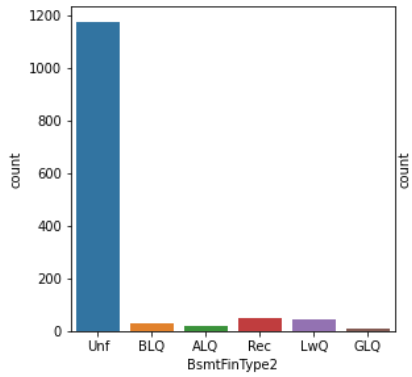
Unf
Rec
BLQ
LwQ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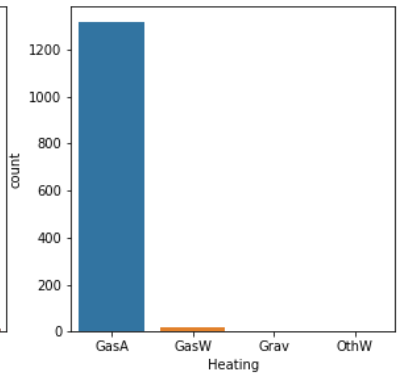
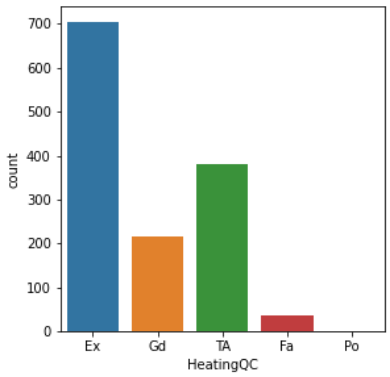
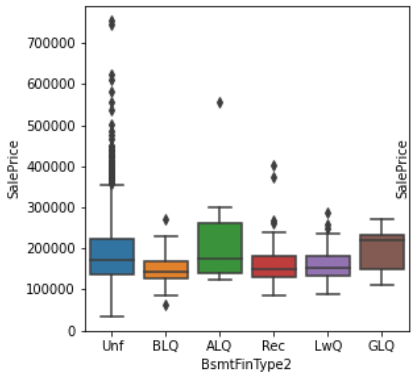
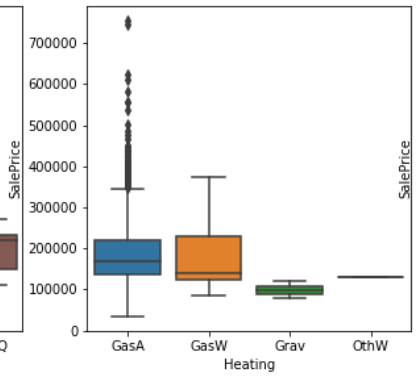
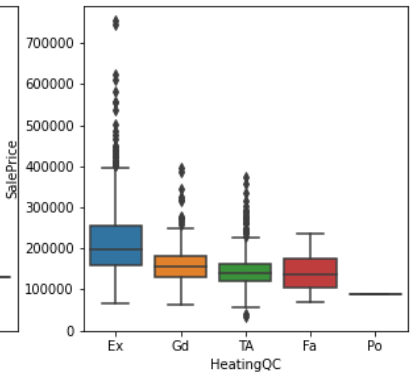
BsmtFinType2
Unf
BLQ
ALQ
Rec
LwQ
GLQ

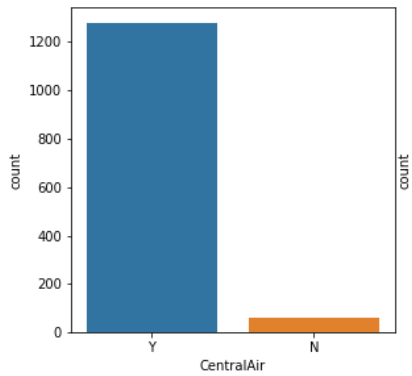

count
Heating
GasA
GasW
Grav
OthW


count
HeatingQC
Ex
Gd
TA
Fa
Po


SalePrice
BsmtFinType2
Unf
BLQ
ALQ
Rec
LwQ
GLQ


SalePrice
Heating
GasA
GasW
Grav
OthW


SalePrice
HeatingQC
Ex
Gd
TA
Fa
Po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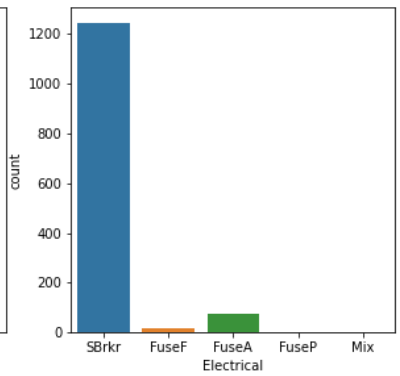
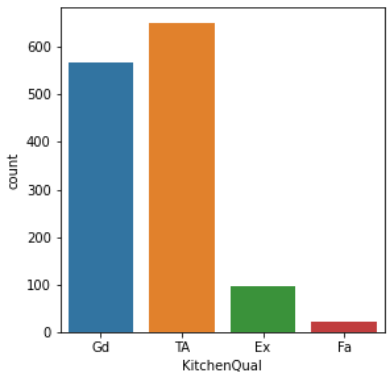
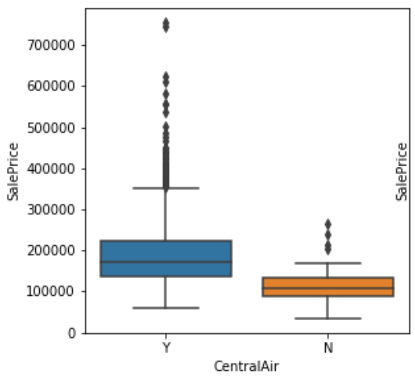
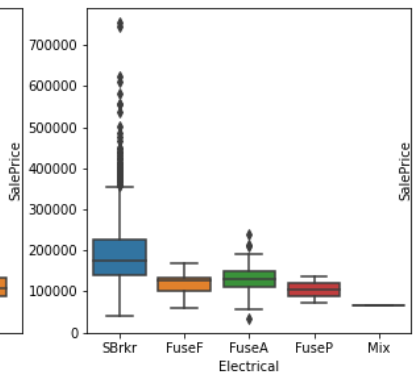
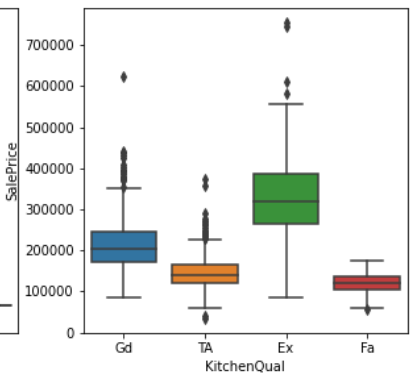
CentralAir
Y
N

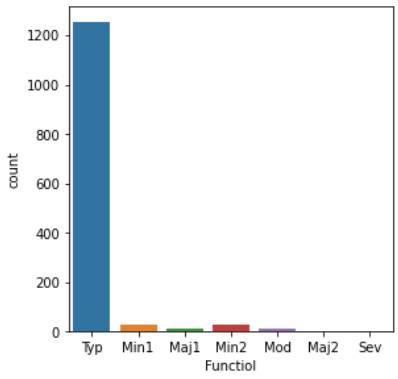

count
Electrical
SBrkr
FuseF
FuseA
FuseP
Mix

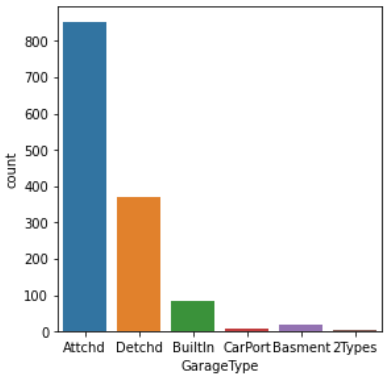

count
KitchenQual
Gd
TA
Ex
Fa

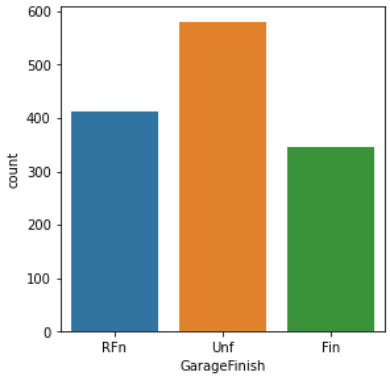

SalePrice
CentralAir
Y
N

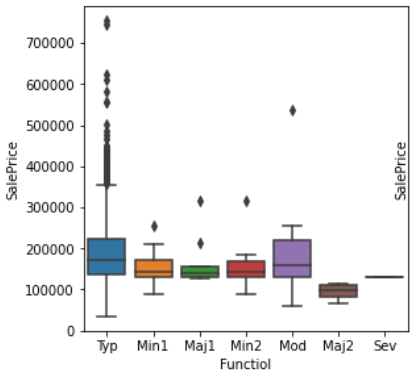

SalePrice
Electrical
SBrkr
FuseF
FuseA
FuseP
Mix

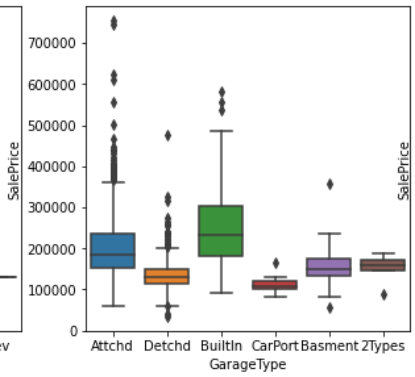

SalePrice
KitchenQual
Gd
TA
Ex
Fa

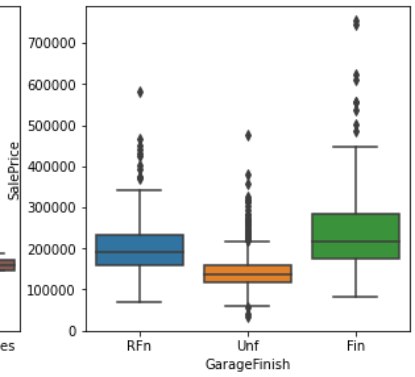

count
Typ
Min1
Maj1
Min2
Mod
Maj2
Sev
Functiol

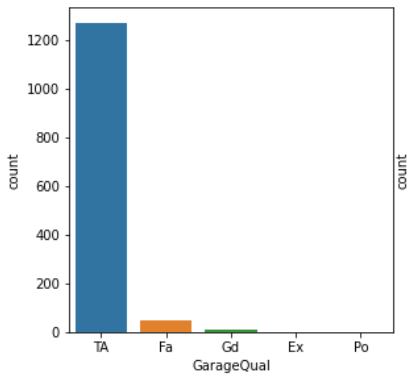

count
Attchd
Detchd
BuiltIn
CarPort
Basment
2Types
GarageType

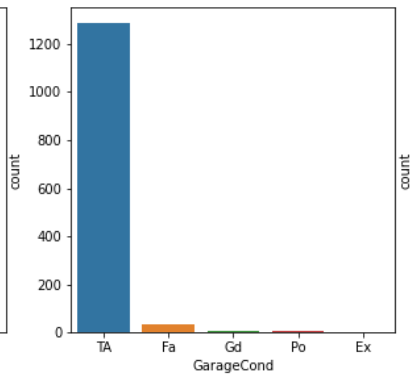

count
RFn
Unf
Fin
GarageFinish

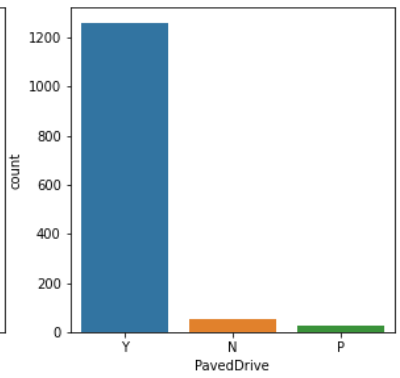

SalePrice
Typ
Min1
Maj1
Min2
Mod
Maj2
Sev
Functiol

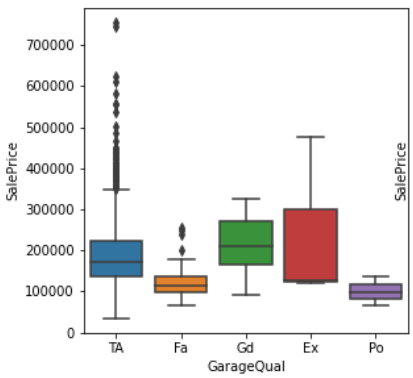

SalePrice
Attchd
Detchd
BuiltIn
CarPort
Basment
2Types
GarageType

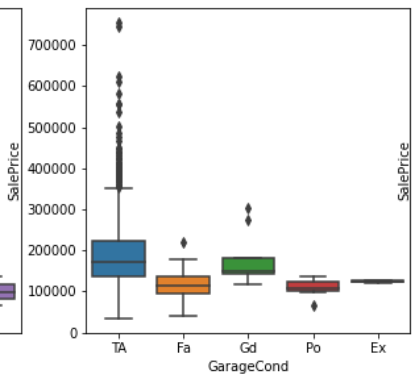

SalePrice
RFn
Unf
Fin
GarageFinish

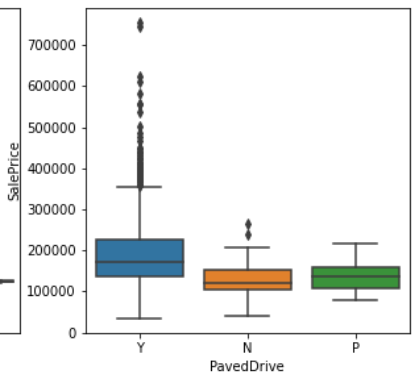

count
TA
Fa
Gd
Ex
Po
GarageQual

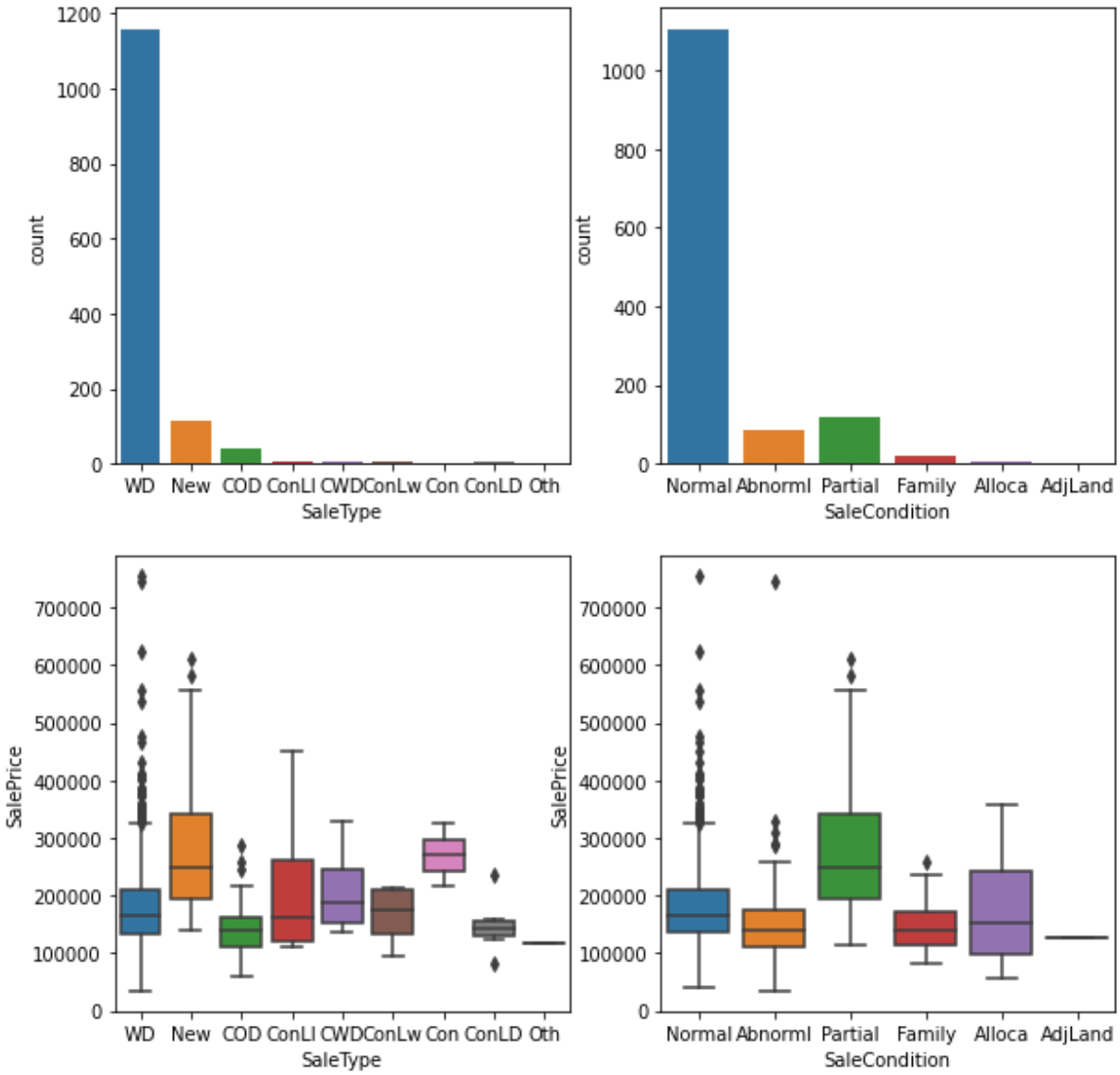

count
TA
Fa
Gd
Po
Ex
GarageCond


count
Y
N
P
PavedDrive


SalePrice
TA
Fa
Gd
Ex
Po
GarageQual


SalePrice
TA
Fa
Gd
Po
Ex
GarageCond


SalePrice
Y
N
P
PavedDrive



<Figure size 1080x720 with 0 Axes>

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

In [27]:

```
import numpy as np
import scipy.stats as stats
from scipy.stats import chi2_contingency
class ChiSquare:
#Function to determine p-value and perform chi-square test
    def __init__(self, dataframe):
        self.df = dataframe
        self.p = None #P-Value
        self.chi2 = None #Chi-square Test Statistic
        self.dof = None

        self.dfObserved = None
        self.dfExpected = None

#Function to print the results of p-value and chi-square test
    def _print_chisquare_result(self, colX, alpha):
        result = ""
        if self.p<alpha:
            result="{0} is IMPORTANT for Prediction".format(colX)
        else:
            result="{0} is NOT an important predictor. (Discard {0} from model)".format(co
lX)
        print(result)
#Function to determine 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)


#Initializing ChiSquare Class
cT = ChiSquare(Data_Category)
#Perform Feature Selection
testColumns = ['MSZoning', 'Street', 'LotShape', 'LandContour', 'Utilities', 'LotConfig',
'LandSlope', 'Neighborhood', 'Condition1', 'Condition2', 'BldgType', 'HouseStyle', 'RoofSt
yle', 'RoofMatl', 'Exterior1st', 'Exterior2nd', 'MasVnrType', 'ExterQual', 'ExterCond', 'F
oundation', 'BsmtQual', 'BsmtCond', 'BsmtExposure', 'BsmtFinType1', 'BsmtFinType2', 'Heati
ng', 'HeatingQC', 'CentralAir', 'Electrical', 'KitchenQual', 'Functiol', 'GarageType', 'Ga
rageFinish', 'GarageQual', 'GarageCond', 'PavedDrive', 'SaleType', 'SaleCondition','SalePr
ice']
for var in testColumns:
    cT.TestIndependence(colX=var,colY="SalePrice" )
```

MSZoning is IMPORTANT for Prediction
Street is IMPORTANT for Prediction
LotShape is IMPORTANT for Prediction
LandContour is NOT an important predictor. (Discard LandContour from model)
Utilities is NOT an important predictor. (Discard Utilities from model)
LotConfig is NOT an important predictor. (Discard LotConfig from model)
LandSlope is NOT an important predictor. (Discard LandSlope from model)
Neighborhood is IMPORTANT for Prediction
Condition1 is NOT an important predictor. (Discard Condition1 from model)
Condition2 is IMPORTANT for Prediction
BldgType is NOT an important predictor. (Discard BldgType from model)
HouseStyle is NOT an important predictor. (Discard HouseStyle from model)
RoofStyle is NOT an important predictor. (Discard RoofStyle from model)
RoofMatl is NOT an important predictor. (Discard RoofMatl from model)
Exterior1st is NOT an important predictor. (Discard Exterior1st from model)
Exterior2nd is NOT an important predictor. (Discard Exterior2nd from model)
MasVnrType is IMPORTANT for Prediction
ExterQual is IMPORTANT for Prediction
ExterCond is NOT an important predictor. (Discard ExterCond from model)
Foundation is IMPORTANT for Prediction
BsmtQual is IMPORTANT for Prediction
BsmtCond is IMPORTANT for Prediction
BsmtExposure is IMPORTANT for Prediction
BsmtFinType1 is NOT an important predictor. (Discard BsmtFinType1 from model)
BsmtFinType2 is NOT an important predictor. (Discard BsmtFinType2 from model)
Heating is NOT an important predictor. (Discard Heating from model)
HeatingQC is NOT an important predictor. (Discard HeatingQC from model)
CentralAir is IMPORTANT for Prediction
Electrical is IMPORTANT for Prediction
KitchenQual is IMPORTANT for Prediction
Functiol is NOT an important predictor. (Discard Functiol from model)
GarageType is IMPORTANT for Prediction
GarageFinish is IMPORTANT for Prediction
GarageQual is IMPORTANT for Prediction
GarageCond is NOT an important predictor. (Discard GarageCond from model)
PavedDrive is NOT an important predictor. (Discard PavedDrive from model)
SaleType is IMPORTANT for Prediction
SaleCondition is IMPORTANT for Prediction
SalePrice is IMPORTANT for Prediction

In [28]:

```
Data_Category = Data_Category[['MSZoning','Street','LotShape','Neighborhood','Condition
2','MasVnrType','ExterQual','Foundation','BsmtQual','BsmtCond','BsmtExposure','CentralAi
r','Electrical','KitchenQual','GarageType','GarageFinish','GarageQual','SaleType','SaleCon
dition','SalePrice']]
Data_Category
```

Out[28]:

	MSZoning	Street	LotShape	Neighborhood	Condition2	MasVnrType	ExterQual	Foundatio
0	RL	Pave	Reg	CollgCr	Norm	BrkFace	Gd	PCon
1	RL	Pave	Reg	Veenker	Norm	None	TA	CBloc
2	RL	Pave	IR1	CollgCr	Norm	BrkFace	Gd	PCon
3	RL	Pave	IR1	Crawfor	Norm	None	TA	Brk1
4	RL	Pave	IR1	NoRidge	Norm	BrkFace	Gd	PCon
...	...	...	...	...	...	...	...	.
1455	RL	Pave	Reg	Gilbert	Norm	None	TA	PCon
1456	RL	Pave	Reg	NWAmes	Norm	Stone	TA	CBloc
1457	RL	Pave	Reg	Crawfor	Norm	None	Ex	Ston
1458	RL	Pave	Reg	mes	Norm	None	TA	CBloc
1459	RL	Pave	Reg	Edwards	Norm	None	Gd	CBloc

1338 rows × 20 columns

1. Combine all the significant categorical and numerical variables

In [29]:

```
DataFrame_New = pd.merge(Data_Category , Data_numeric , how="outer", on=["SalePrice"])
DataFrame_New
```

Out[29]:

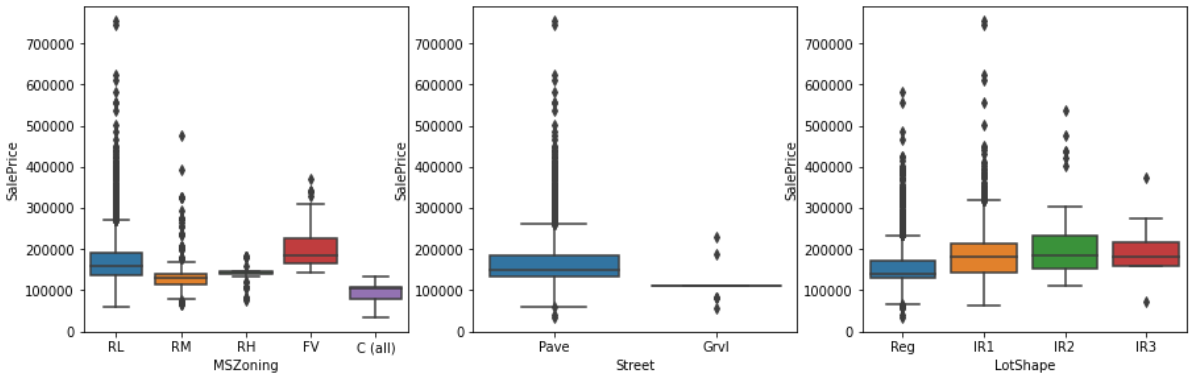
	MSZoning	Street	LotShape	Neighborhood	Condition2	MasVnrType	ExterQual	Foundatio
0	RL	Pave	Reg	CollgCr	Norm	BrkFace	Gd	PCon
1	RL	Pave	Reg	Veenker	Norm	None	TA	CBloc
2	RL	Pave	IR1	CollgCr	Norm	BrkFace	Gd	PCon
3	RL	Pave	IR1	CollgCr	Norm	BrkFace	Gd	PCon
4	RL	Pave	Reg	BrkSide	Norm	None	TA	CBloc
...	...	...	...	...	...	...	...	.
6378	NaN	NaN	NaN	NaN	NaN	NaN	NaN	Na
6379	NaN	NaN	NaN	NaN	NaN	NaN	NaN	Na
6380	NaN	NaN	NaN	NaN	NaN	NaN	NaN	Na
6381	NaN	NaN	NaN	NaN	NaN	NaN	NaN	Na
6382	NaN	NaN	NaN	NaN	NaN	NaN	NaN	Na

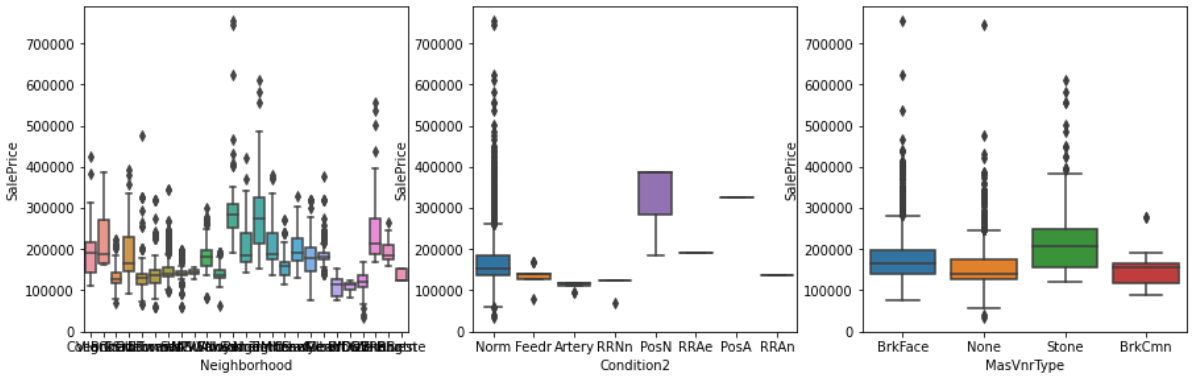
6383 rows × 57 columns

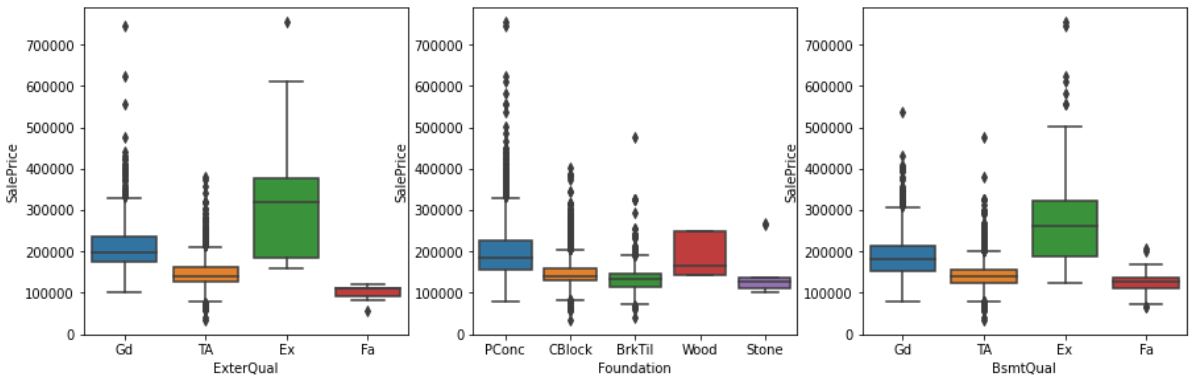
a. Plot box plot for the new dataset to find the variables with outliers

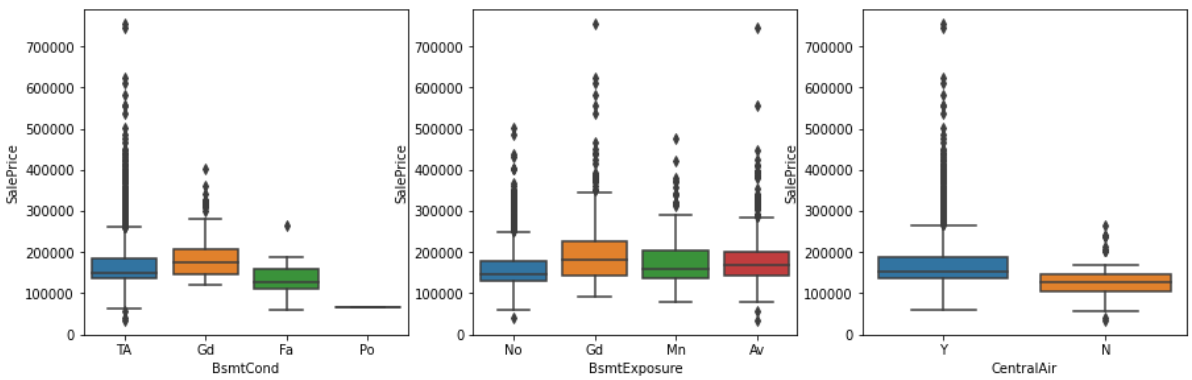
In [ ]:

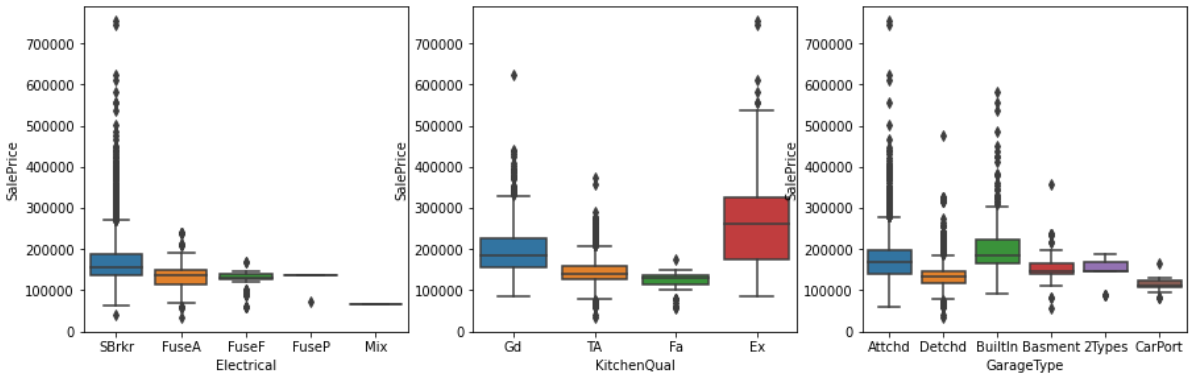
```
#Function to plot all independent categorical variables with SalePrice and count plot
i = 1
fig = plt.figure(figsize = (15,10))
for c in list(DataFrame_New.columns):
    if i <= 3:
        if c != 'SalePrice':
            ax2 = fig.add_subplot(2,3,i+3)
            sns.boxplot(data=DataFrame_New, x=c, y='SalePrice', ax=ax2) #for boxplot

    i = i +1
    if i == 4:
        fig = plt.figure(figsize = (15,10))
        i =1
```

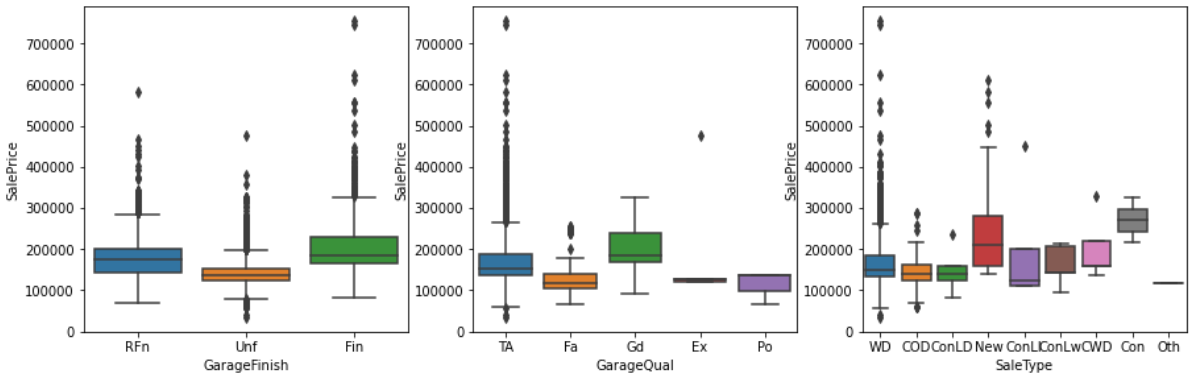

SalePrice
MSZoning
RL
RM
RH
FV
C (all)
Street
Pave
Grvl
LotShape
Reg
IR1
IR2
IR3


SalePrice
Neighborhood
Condition2
Norm
Feedr
Artery
RRNn
PosN
RRAe
PosA
RRAn
MasVnrType
BrkFace
None
Stone
BrkCmn

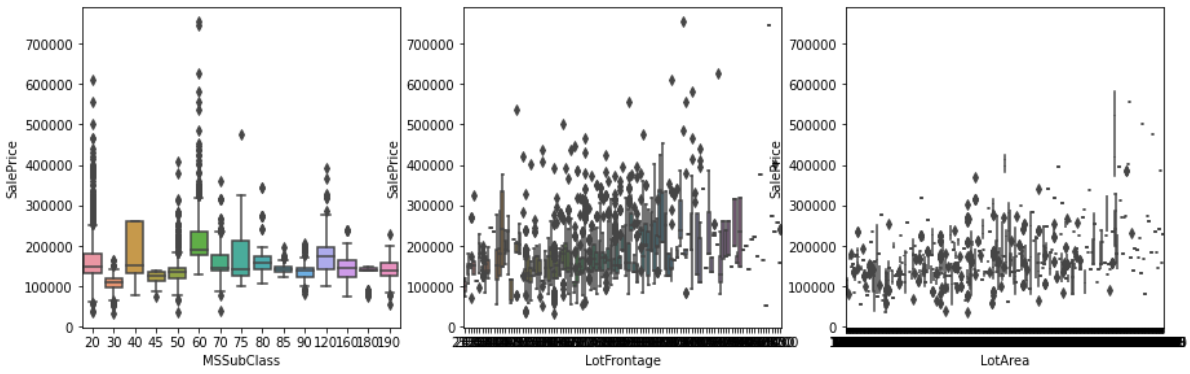

SalePrice
ExterQual
Gd
TA
Ex
Fa
Foundation
PConc
CBlock
BrkTil
Wood
Stone
BsmtQual


SalePrice
BsmtCond
TA
Gd
Fa
Po
BsmtExposure
No
Gd
Mn
Av
CentralAir
Y
N


SalePrice
Electrical
SBrkr FuseA FuseF FuseP Mix
KitchenQual
Gd TA Fa Ex
GarageType
Attchd Detchd BuiltIn Basment 2Types CarPort


SalePrice
GarageFinish
RFn Unf Fin
GarageQual
TA Fa Gd Ex Po
SaleType
WD COD ConLD New ConLI ConLw CWD Con Oth

SalePrice
SaleCondition
Normal Abnorml Partial Family Alloca AdjLand
Id


SalePrice
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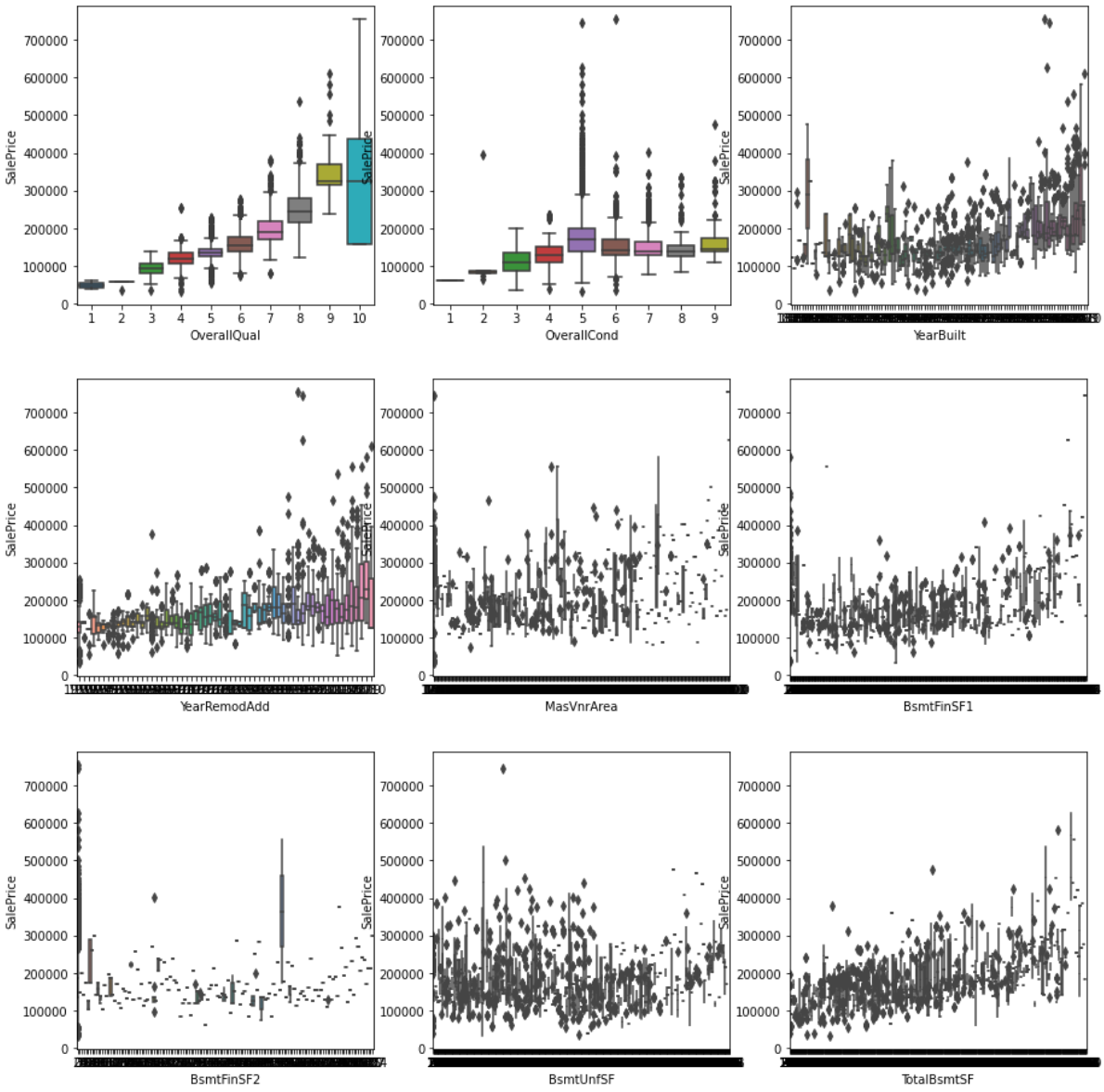
LotFrontage
LotArea


SalePrice
OverallQual
OverallCond
YearBuilt
YearRemodAdd
MasVnrArea
BsmtFinSF1
BsmtFinSF2
BsmtUnfSF
TotalBsmtSF

In [ ]: