Week-3

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```
#Loading the libraries
library(ggplot2)
library(ggthemes)

## Warning: package 'ggthemes' was built under R version 3.5.2

library(dplyr)

## Warning: package 'dplyr' was built under R version 3.5.2

##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union

library(gridExtra)

## Warning: package 'gridExtra' was built under R version 3.5.2

##
## Attaching package: 'gridExtra'

## The following object is masked from 'package:dplyr':
##
##     combine

library(corrplot)

## Warning: package 'corrplot' was built under R version 3.5.2

## corrplot 0.84 loaded

library(GGally)

## Warning: package 'GGally' was built under R version 3.5.2

##
## Attaching package: 'GGally'
```

```
## The following object is masked from 'package:dplyr':
##
##     nasa
```

```
library(data.table)
```

```
## Warning: package 'data.table' was built under R version 3.5.2
```

```
##
## Attaching package: 'data.table'
```

```
## The following objects are masked from 'package:dplyr':
##
##     between, first, last
```

```
library(scales)
library(MVA)
```

```
## Warning: package 'MVA' was built under R version 3.5.2
```

```
## Loading required package: HSAUR2
```

```
## Warning: package 'HSAUR2' was built under R version 3.5.2
```

```
## Loading required package: tools
```

```
library(Rmisc)
```

```
## Warning: package 'Rmisc' was built under R version 3.5.2
```

```
## Loading required package: lattice
```

```
## Warning: package 'lattice' was built under R version 3.5.2
```

```
## Loading required package: plyr
```

```
## ------------------------------------------------------------------------------
```

```
## You have loaded plyr after dplyr - this is likely to cause problems.
## If you need functions from both plyr and dplyr, please load plyr first,
then dplyr:
## library(plyr); library(dplyr)
```

```
## ------------------------------------------------------------------------------
```

```
##
## Attaching package: 'plyr'
```

```
## The following objects are masked from 'package:dplyr':
##
##     arrange, count, desc, failwith, id, mutate, rename, summarise,
##     summarize
```

```r
# loading the dataset
training <- read.csv("D:/MultiAnalysis/Project/house-prices-advanced-regression-techniques/Data.csv.csv")
View(training)
View(training)
```

UNDERSTANDING THE DATA

```r
dim(training) # checking the dimensions
```

```
## [1] 1460   81
```

```r
str(training)# checking the structure of dataset
```

```
## 'data.frame':    1460 obs. of  81 variables:
##  $ Id           : int  1 2 3 4 5 6 7 8 9 10 ...
##  $ MSSubClass   : int  60 20 60 70 60 50 20 60 50 190 ...
##  $ MSZoning     : Factor w/ 5 levels "C (all)","FV",..: 4 4 4 4 4 4 4 4 5 4 ...
##  $ LotFrontage  : int  65 80 68 60 84 85 75 NA 51 50 ...
##  $ LotArea      : int  8450 9600 11250 9550 14260 14115 10084 10382 6120 7420 ...
##  $ Street       : Factor w/ 2 levels "Grvl","Pave": 2 2 2 2 2 2 2 2 2 2 ...
##  $ Alley        : Factor w/ 2 levels "Grvl","Pave": NA NA NA NA NA NA NA NA NA NA ...
##  $ LotShape     : Factor w/ 4 levels "IR1","IR2","IR3",..: 4 4 1 1 1 1 4 1 4 4 ...
##  $ LandContour  : Factor w/ 4 levels "Bnk","HLS","Low",..: 4 4 4 4 4 4 4 4 4 4 ...
##  $ Utilities    : Factor w/ 2 levels "AllPub","NoSeWa": 1 1 1 1 1 1 1 1 1 1 ...
##  $ LotConfig    : Factor w/ 5 levels "Corner","CulDSac",..: 5 3 5 1 3 5 5 1 5 1 ...
##  $ LandSlope    : Factor w/ 3 levels "Gtl","Mod","Sev": 1 1 1 1 1 1 1 1 1 1 ...
##  $ Neighborhood : Factor w/ 25 levels "Blmngtn","Blueste",..: 6 25 6 7 14 12 21 17 18 4 ...
##  $ Condition1   : Factor w/ 9 levels "Artery","Feedr",..: 3 2 3 3 3 3 3 5 1 1 ...
##  $ Condition2   : Factor w/ 8 levels "Artery","Feedr",..: 3 3 3 3 3 3 3 3 3 1 ...
##  $ BldgType     : Factor w/ 5 levels "1Fam","2fmCon",..: 1 1 1 1 1 1 1 1 1 2 ...
##  $ HouseStyle   : Factor w/ 8 levels "1.5Fin","1.5Unf",..: 6 3 6 6 6 1 3 6 1 2 ...
##  $ OverallQual  : int  7 6 7 7 8 5 8 7 7 5 ...
##  $ OverallCond  : int  5 8 5 5 5 5 5 6 5 6 ...
##  $ YearBuilt    : int  2003 1976 2001 1915 2000 1993 2004 1973 1931 1939 ...
##  $ YearRemodAdd : int  2003 1976 2002 1970 2000 1995 2005 1973 1950 1950
```

```
...
##  $ RoofStyle    : Factor w/ 6 levels "Flat","Gable",..: 2 2 2 2 2 2 2 2 2
2 ...
##  $ RoofMatl     : Factor w/ 8 levels "ClyTile","CompShg",..: 2 2 2 2 2 2 2
2 2 2 ...
##  $ Exterior1st  : Factor w/ 15 levels "AsbShng","AsphShn",..: 13 9 13 14
13 13 13 7 4 9 ...
##  $ Exterior2nd  : Factor w/ 16 levels "AsbShng","AsphShn",..: 14 9 14 16
14 14 14 7 16 9 ...
##  $ MasVnrType   : Factor w/ 4 levels "BrkCmn","BrkFace",..: 2 3 2 3 2 3 4
4 3 3 ...
##  $ MasVnrArea   : int  196 0 162 0 350 0 186 240 0 0 ...
##  $ ExterQual    : Factor w/ 4 levels "Ex","Fa","Gd",..: 3 4 3 4 3 4 3 4 4
4 ...
##  $ ExterCond    : Factor w/ 5 levels "Ex","Fa","Gd",..: 5 5 5 5 5 5 5 5 5
5 ...
##  $ Foundation   : Factor w/ 6 levels "BrkTil","CBlock",..: 3 2 3 1 3 6 3 2
1 1 ...
##  $ BsmtQual     : Factor w/ 4 levels "Ex","Fa","Gd",..: 3 3 3 4 3 3 1 3 4
4 ...
##  $ BsmtCond     : Factor w/ 4 levels "Fa","Gd","Po",..: 4 4 4 2 4 4 4 4 4
4 ...
##  $ BsmtExposure : Factor w/ 4 levels "Av","Gd","Mn",..: 4 2 3 4 1 4 1 3 4
4 ...
##  $ BsmtFinType1 : Factor w/ 6 levels "ALQ","BLQ","GLQ",..: 3 1 3 1 3 3 3 1
6 3 ...
##  $ BsmtFinSF1   : int  706 978 486 216 655 732 1369 859 0 851 ...
##  $ BsmtFinType2 : Factor w/ 6 levels "ALQ","BLQ","GLQ",..: 6 6 6 6 6 6 6 2
6 6 ...
##  $ BsmtFinSF2   : int  0 0 0 0 0 0 0 32 0 0 ...
##  $ BsmtUnfSF    : int  150 284 434 540 490 64 317 216 952 140 ...
##  $ TotalBsmtSF  : int  856 1262 920 756 1145 796 1686 1107 952 991 ...
##  $ Heating      : Factor w/ 6 levels "Floor","GasA",..: 2 2 2 2 2 2 2 2 2
2 ...
##  $ HeatingQC    : Factor w/ 5 levels "Ex","Fa","Gd",..: 1 1 1 3 1 1 1 1 3
1 ...
##  $ CentralAir   : Factor w/ 2 levels "N","Y": 2 2 2 2 2 2 2 2 2 2 ...
##  $ Electrical   : Factor w/ 5 levels "FuseA","FuseF",..: 5 5 5 5 5 5 5 5 2
5 ...
##  $ X1stFlrSF    : int  856 1262 920 961 1145 796 1694 1107 1022 1077 ...
##  $ X2ndFlrSF    : int  854 0 866 756 1053 566 0 983 752 0 ...
##  $ LowQualFinSF : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ GrLivArea    : int  1710 1262 1786 1717 2198 1362 1694 2090 1774 1077
...
##  $ BsmtFullBath : int  1 0 1 1 1 1 1 1 0 1 ...
##  $ BsmtHalfBath : int  0 1 0 0 0 0 0 0 0 0 ...
##  $ FullBath     : int  2 2 2 1 2 1 2 2 2 1 ...
##  $ HalfBath     : int  1 0 1 0 1 1 0 1 0 0 ...
##  $ BedroomAbvGr : int  3 3 3 3 4 1 3 3 2 2 ...
##  $ KitchenAbvGr : int  1 1 1 1 1 1 1 1 2 2 ...
```

```
##  $ KitchenQual  : Factor w/ 4 levels "Ex","Fa","Gd",..: 3 4 3 3 3 4 3 4 4
4 ...
##  $ TotRmsAbvGrd : int  8 6 6 7 9 5 7 7 8 5 ...
##  $ Functional   : Factor w/ 7 levels "Maj1","Maj2",..: 7 7 7 7 7 7 7 7 3 7
...
##  $ Fireplaces   : int  0 1 1 1 1 0 1 2 2 2 ...
##  $ FireplaceQu  : Factor w/ 5 levels "Ex","Fa","Gd",..: NA 5 5 3 5 NA 3 5
5 5 ...
##  $ GarageType   : Factor w/ 6 levels "2Types","Attchd",..: 2 2 2 6 2 2 2 2
6 2 ...
##  $ GarageYrBlt  : int  2003 1976 2001 1998 2000 1993 2004 1973 1931 1939
...
##  $ GarageFinish : Factor w/ 3 levels "Fin","RFn","Unf": 2 2 2 3 2 3 2 2 3
2 ...
##  $ GarageCars   : int  2 2 2 3 3 2 2 2 2 1 ...
##  $ GarageArea   : int  548 460 608 642 836 480 636 484 468 205 ...
##  $ GarageQual   : Factor w/ 5 levels "Ex","Fa","Gd",..: 5 5 5 5 5 5 5 5 2
3 ...
##  $ GarageCond   : Factor w/ 5 levels "Ex","Fa","Gd",..: 5 5 5 5 5 5 5 5 5
5 ...
##  $ PavedDrive   : Factor w/ 3 levels "N","P","Y": 3 3 3 3 3 3 3 3 3 3 ...
##  $ WoodDeckSF   : int  0 298 0 0 192 40 255 235 90 0 ...
##  $ OpenPorchSF  : int  61 0 42 35 84 30 57 204 0 4 ...
##  $ EnclosedPorch: int  0 0 0 272 0 0 0 228 205 0 ...
##  $ X3SsnPorch   : int  0 0 0 0 0 320 0 0 0 0 ...
##  $ ScreenPorch  : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ PoolArea     : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ PoolQC       : Factor w/ 3 levels "Ex","Fa","Gd": NA NA NA NA NA NA NA
NA NA NA ...
##  $ Fence        : Factor w/ 4 levels "GdPrv","GdWo",..: NA NA NA NA NA 3
NA NA NA NA ...
##  $ MiscFeature  : Factor w/ 4 levels "Gar2","Othr",..: NA NA NA NA NA 3 NA
3 NA NA ...
##  $ MiscVal      : int  0 0 0 0 0 700 0 350 0 0 ...
##  $ MoSold       : int  2 5 9 2 12 10 8 11 4 1 ...
##  $ YrSold       : int  2008 2007 2008 2006 2008 2009 2007 2009 2008 2008
...
##  $ SaleType     : Factor w/ 9 levels "COD","Con","ConLD",..: 9 9 9 9 9 9 9
9 9 9 ...
##  $ SaleCondition: Factor w/ 6 levels "Abnorml","AdjLand",..: 5 5 5 1 5 5 5
5 1 5 ...
##  $ SalePrice    : int  208500 181500 223500 140000 250000 143000 307000
200000 129900 118000 ...
```

```
summary(training)# checking the summary of dataset
```

```
##        Id           MSSubClass       MSZoning     LotFrontage
##  Min.   :   1.0   Min.   : 20.0   C (all):  10   Min.   : 21.00
##  1st Qu.: 365.8   1st Qu.: 20.0   FV     :  65   1st Qu.: 59.00
##  Median : 730.5   Median : 50.0   RH     :  16   Median : 69.00
```

```
##  Mean   : 730.5   Mean   : 56.9   RL     :1151   Mean   : 70.05
##  3rd Qu.:1095.2   3rd Qu.: 70.0   RM     : 218   3rd Qu.: 80.00
##  Max.   :1460.0   Max.   :190.0                  Max.   :313.00
##                                                 NA's   :259
##     LotArea        Street      Alley      LotShape  LandContour
##  Min.   :  1300   Grvl:   6   Grvl:  50   IR1:484   Bnk:  63
##  1st Qu.:  7554   Pave:1454   Pave:  41   IR2: 41   HLS:  50
##  Median :  9478               NA's:1369   IR3: 10   Low:  36
##  Mean   : 10517                           Reg:925   Lvl:1311
##  3rd Qu.: 11602
##  Max.   :215245
##
##   Utilities      LotConfig    LandSlope   Neighborhood   Condition1
##  AllPub:1459   Corner : 263   Gtl:1382   NAmes  :225   Norm   :1260
##  NoSeWa:   1   CulDSac:  94   Mod:  65   CollgCr:150   Feedr  :  81
##                FR2    :  47   Sev:  13   OldTown:113   Artery :  48
##                FR3    :   4              Edwards:100   RRAn   :  26
##                Inside :1052              Somerst: 86   PosN   :  19
##                                          Gilbert: 79   RRAe   :  11
##                                          (Other):707   (Other):  15
##    Condition2     BldgType      HouseStyle   OverallQual
##  Norm   :1445   1Fam  :1220   1Story :726   Min.   : 1.000
##  Feedr  :   6   2fmCon:  31   2Story :445   1st Qu.: 5.000
##  Artery :   2   Duplex:  52   1.5Fin :154   Median : 6.000
##  PosN   :   2   Twnhs :  43   SLvl   : 65   Mean   : 6.099
##  RRNn   :   2   TwnhsE: 114   SFoyer : 37   3rd Qu.: 7.000
##  PosA   :   1                 1.5Unf : 14   Max.   :10.000
##  (Other):   2                 (Other): 19
##   OverallCond      YearBuilt     YearRemodAdd    RoofStyle
##  Min.   :1.000   Min.   :1872   Min.   :1950   Flat   :  13
##  1st Qu.:5.000   1st Qu.:1954   1st Qu.:1967   Gable  :1141
##  Median :5.000   Median :1973   Median :1994   Gambrel:  11
##  Mean   :5.575   Mean   :1971   Mean   :1985   Hip    : 286
##  3rd Qu.:6.000   3rd Qu.:2000   3rd Qu.:2004   Mansard:   7
##  Max.   :9.000   Max.   :2010   Max.   :2010   Shed   :   2
##
##     RoofMatl     Exterior1st   Exterior2nd    MasVnrType    MasVnrArea
##  CompShg:1434   VinylSd:515   VinylSd:504   BrkCmn : 15   Min.   :   0.0
##  Tar&Grv:  11   HdBoard:222   MetalSd:214   BrkFace:445   1st Qu.:   0.0
##  WdShngl:   6   MetalSd:220   HdBoard:207   None   :864   Median :   0.0
##  WdShake:   5   Wd Sdng:206   Wd Sdng:197   Stone  :128   Mean   : 103.7
##  ClyTile:   1   Plywood:108   Plywood:142   NA's   :  8   3rd Qu.: 166.0
##  Membran:   1   CemntBd: 61   CmentBd: 60                 Max.   :1600.0
##  (Other):   2   (Other):128   (Other):136                 NA's   :8
##  ExterQual ExterCond  Foundation  BsmtQual   BsmtCond    BsmtExposure
##  Ex: 52    Ex:   3   BrkTil:146   Ex  :121   Fa  :  45   Av  :221
##  Fa: 14    Fa:  28   CBlock:634   Fa  : 35   Gd  :  65   Gd  :134
##  Gd:488    Gd: 146   PConc :647   Gd  :618   Po  :   2   Mn  :114
##  TA:906    Po:   1   Slab  : 24   TA  :649   TA  :1311   No  :953
##            TA:1282   Stone :  6   NA's: 37   NA's:  37   NA's: 38
```

```
##                     Wood  :  3
##
##  BsmtFinType1   BsmtFinSF1     BsmtFinType2   BsmtFinSF2
##  ALQ :220     Min.   :   0.0   ALQ :  19    Min.   :   0.00
##  BLQ :148     1st Qu.:   0.0   BLQ :  33    1st Qu.:   0.00
##  GLQ :418     Median : 383.5   GLQ :  14    Median :   0.00
##  LwQ : 74     Mean   : 443.6   LwQ :  46    Mean   :  46.55
##  Rec :133     3rd Qu.: 712.2   Rec :  54    3rd Qu.:   0.00
##  Unf :430     Max.   :5644.0   Unf :1256    Max.   :1474.00
##  NA's: 37                      NA's:  38
##    BsmtUnfSF       TotalBsmtSF      Heating     HeatingQC CentralAir
##  Min.   :   0.0   Min.   :   0.0   Floor:   1   Ex:741    N:  95
##  1st Qu.: 223.0   1st Qu.: 795.8   GasA :1428   Fa: 49    Y:1365
##  Median : 477.5   Median : 991.5   GasW :  18   Gd:241
##  Mean   : 567.2   Mean   :1057.4   Grav :   7   Po:  1
##  3rd Qu.: 808.0   3rd Qu.:1298.2   OthW :   2   TA:428
##  Max.   :2336.0   Max.   :6110.0   Wall :   4
##
##  Electrical     X1stFlrSF      X2ndFlrSF     LowQualFinSF
##  FuseA:  94   Min.   : 334   Min.   :   0   Min.   :  0.000
##  FuseF:  27   1st Qu.: 882   1st Qu.:   0   1st Qu.:  0.000
##  FuseP:   3   Median :1087   Median :   0   Median :  0.000
##  Mix  :   1   Mean   :1163   Mean   : 347   Mean   :  5.845
##  SBrkr:1334   3rd Qu.:1391   3rd Qu.: 728   3rd Qu.:  0.000
##  NA's :   1   Max.   :4692   Max.   :2065   Max.   :572.000
##
##    GrLivArea     BsmtFullBath     BsmtHalfBath        FullBath
##  Min.   : 334   Min.   :0.0000   Min.   :0.00000   Min.   :0.000
##  1st Qu.:1130   1st Qu.:0.0000   1st Qu.:0.00000   1st Qu.:1.000
##  Median :1464   Median :0.0000   Median :0.00000   Median :2.000
##  Mean   :1515   Mean   :0.4253   Mean   :0.05753   Mean   :1.565
##  3rd Qu.:1777   3rd Qu.:1.0000   3rd Qu.:0.00000   3rd Qu.:2.000
##  Max.   :5642   Max.   :3.0000   Max.   :2.00000   Max.   :3.000
##
##     HalfBath       BedroomAbvGr    KitchenAbvGr   KitchenQual
##  Min.   :0.0000   Min.   :0.000   Min.   :0.000   Ex:100
##  1st Qu.:0.0000   1st Qu.:2.000   1st Qu.:1.000   Fa: 39
##  Median :0.0000   Median :3.000   Median :1.000   Gd:586
##  Mean   :0.3829   Mean   :2.866   Mean   :1.047   TA:735
##  3rd Qu.:1.0000   3rd Qu.:3.000   3rd Qu.:1.000
##  Max.   :2.0000   Max.   :8.000   Max.   :3.000
##
##   TotRmsAbvGrd    Functional    Fireplaces    FireplaceQu   GarageType
##  Min.   : 2.000   Maj1:  14   Min.   :0.000   Ex  : 24    2Types :  6
##  1st Qu.: 5.000   Maj2:   5   1st Qu.:0.000   Fa  : 33    Attchd :870
##  Median : 6.000   Min1:  31   Median :1.000   Gd  :380    Basment: 19
##  Mean   : 6.518   Min2:  34   Mean   :0.613   Po  : 20    BuiltIn: 88
##  3rd Qu.: 7.000   Mod :  15   3rd Qu.:1.000   TA  :313    CarPort:  9
##  Max.   :14.000   Sev :   1   Max.   :3.000   NA's:690    Detchd :387
##                   Typ :1360                               NA's   : 81
```

```
##   GarageYrBlt   GarageFinish   GarageCars      GarageArea     GarageQual
##  Min.   :1900   Fin :352     Min.   :0.000   Min.   :   0.0   Ex  :   3
##  1st Qu.:1961   RFn :422     1st Qu.:1.000   1st Qu.: 334.5   Fa  :  48
##  Median :1980   Unf :605     Median :2.000   Median : 480.0   Gd  :  14
##  Mean   :1979   NA's: 81     Mean   :1.767   Mean   : 473.0   Po  :   3
##  3rd Qu.:2002                3rd Qu.:2.000   3rd Qu.: 576.0   TA  :1311
##  Max.   :2010                Max.   :4.000   Max.   :1418.0   NA's:  81
##  NA's   :81
##  GarageCond  PavedDrive   WoodDeckSF      OpenPorchSF     EnclosedPorch
##  Ex  :   2   N:  90     Min.   :  0.00   Min.   :  0.00   Min.   :  0.00
##  Fa  :  35   P:  30     1st Qu.:  0.00   1st Qu.:  0.00   1st Qu.:  0.00
##  Gd  :   9   Y:1340     Median :  0.00   Median : 25.00   Median :  0.00
##  Po  :   7              Mean   : 94.24   Mean   : 46.66   Mean   : 21.95
##  TA  :1326              3rd Qu.:168.00   3rd Qu.: 68.00   3rd Qu.:  0.00
##  NA's:  81              Max.   :857.00   Max.   :547.00   Max.   :552.00
##
##    X3SsnPorch      ScreenPorch        PoolArea        PoolQC
##  Min.   :  0.00   Min.   :  0.00   Min.   :  0.000   Ex  :   2
##  1st Qu.:  0.00   1st Qu.:  0.00   1st Qu.:  0.000   Fa  :   2
##  Median :  0.00   Median :  0.00   Median :  0.000   Gd  :   3
##  Mean   :  3.41   Mean   : 15.06   Mean   :  2.759   NA's:1453
##  3rd Qu.:  0.00   3rd Qu.:  0.00   3rd Qu.:  0.000
##  Max.   :508.00   Max.   :480.00   Max.   :738.000
##
##    Fence      MiscFeature    MiscVal             MoSold
##  GdPrv:  59   Gar2:   2   Min.   :    0.00   Min.   : 1.000
##  GdWo :  54   Othr:   2   1st Qu.:    0.00   1st Qu.: 5.000
##  MnPrv: 157   Shed:  49   Median :    0.00   Median : 6.000
##  MnWw :  11   TenC:   1   Mean   :   43.49   Mean   : 6.322
##  NA's :1179   NA's:1406   3rd Qu.:    0.00   3rd Qu.: 8.000
##                           Max.   :15500.00   Max.   :12.000
##
##      YrSold        SaleType    SaleCondition    SalePrice
##  Min.   :2006   WD     :1267   Abnorml: 101   Min.   : 34900
##  1st Qu.:2007   New    : 122   AdjLand:   4   1st Qu.:129975
##  Median :2008   COD    :  43   Alloca :  12   Median :163000
##  Mean   :2008   ConLD  :   9   Family :  20   Mean   :180921
##  3rd Qu.:2009   ConLI  :   5   Normal :1198   3rd Qu.:214000
##  Max.   :2010   ConLw  :   5   Partial: 125   Max.   :755000
##                 (Other):   9
```

Checking for MISSING VALUES

```
#Missing data
sum(is.na(training)/(nrow(training)*nrow(training)))# printing percentage of
missing data

## [1] 0.003267499

unique(nrow(training)) # printing all the unique values
```

```
## [1] 1460
```

```
colSums(sapply(training,is.na))# prinitng number of missing values in each
column
```

```
##            Id    MSSubClass      MSZoning   LotFrontage       LotArea
##             0             0             0           259             0
##        Street         Alley      LotShape   LandContour     Utilities
##             0          1369             0             0             0
##     LotConfig     LandSlope  Neighborhood    Condition1    Condition2
##             0             0             0             0             0
##      BldgType    HouseStyle   OverallQual   OverallCond     YearBuilt
##             0             0             0             0             0
##  YearRemodAdd     RoofStyle      RoofMatl   Exterior1st   Exterior2nd
##             0             0             0             0             0
##    MasVnrType    MasVnrArea     ExterQual     ExterCond    Foundation
##             8             8             0             0             0
##      BsmtQual      BsmtCond  BsmtExposure  BsmtFinType1    BsmtFinSF1
##            37            37            38            37             0
##  BsmtFinType2    BsmtFinSF2     BsmtUnfSF   TotalBsmtSF       Heating
##            38             0             0             0             0
##     HeatingQC    CentralAir    Electrical     X1stFlrSF     X2ndFlrSF
##             0             0             1             0             0
##  LowQualFinSF     GrLivArea  BsmtFullBath  BsmtHalfBath      FullBath
##             0             0             0             0             0
##      HalfBath  BedroomAbvGr  KitchenAbvGr   KitchenQual  TotRmsAbvGrd
##             0             0             0             0             0
##    Functional    Fireplaces   FireplaceQu    GarageType   GarageYrBlt
##             0             0           690            81            81
##  GarageFinish    GarageCars    GarageArea    GarageQual    GarageCond
##            81             0             0            81            81
##    PavedDrive    WoodDeckSF   OpenPorchSF EnclosedPorch    X3SsnPorch
##             0             0             0             0             0
##   ScreenPorch      PoolArea        PoolQC         Fence   MiscFeature
##             0             0          1453          1179          1406
##       MiscVal        MoSold        YrSold      SaleType SaleCondition
##             0             0             0             0             0
##     SalePrice
##             0
```

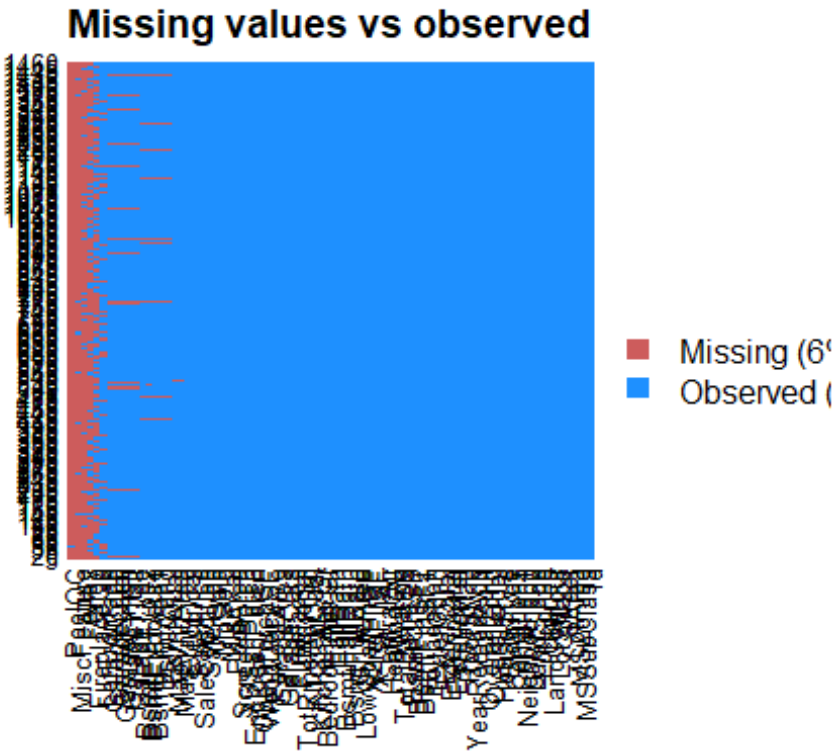
```
library(Amelia)
```

```
## Warning: package 'Amelia' was built under R version 3.5.2
```

```
## Loading required package: Rcpp
```

```
## ##
## ## Amelia II: Multiple Imputation
## ## (Version 1.7.5, built: 2018-05-07)
## ## Copyright (C) 2005-2019 James Honaker, Gary King and Matthew Blackwell
```

```
## ## Refer to http://gking.harvard.edu/amelia/ for more information
## ##

missmap(training, main ="Missing values vs observed")
```




```
# creating dataframe of categorical and numerical variables
catvar <- c('MSZoning','Street', 'Neighborhood', 'LandContour','BldgType',
'LandSlope', 'RoofStyle',

'HouseStyle','CentralAir','PavedDrive','SaleCondition','OverallCond' )
numvar<-
c('SalePrice','LotArea','TotalBsmtSF','GrLivArea','BedroomAbvGr','TotRmsAbvGr
d','GarageCars','GarageArea'
          ,'OpenPorchSF','EnclosedPorch','WoodDeckSF','PoolArea')

unique(nrow(training$SalePrice))

## NULL
```

Removing columns with NA values

```
training$Alley = NULL
training$LotFrontage = NULL
training$FireplaceQu = NULL
training$Fence = NULL
training$PoolQC = NULL
training$MiscFeature = NULL
training$BsmtQual = NULL
```

```
training$BsmtCond = NULL
training$BsmtExposure = NULL
training$BsmtFinType1 = NULL
training$BsmtFinType2 = NULL
training$GarageType = NULL
training$GarageYrBlt = NULL
training$MasVnrType = NULL
training$MasVnrArea = NULL
training$GarageQual = NULL
training$GarageFinish = NULL
training$GarageCond = NULL

training[!complete.cases(training),]

##        Id MSSubClass MSZoning LotArea Street LotShape LandContour
## 1380 1380         80       RL    9735   Pave      Reg         Lvl
##      Utilities LotConfig LandSlope Neighborhood Condition1 Condition2
## 1380    AllPub    Inside       Gtl       Timber       Norm       Norm
##      BldgType HouseStyle OverallQual OverallCond YearBuilt YearRemodAdd
## 1380     1Fam       SLvl           5           5      2006         2007
##      RoofStyle RoofMatl Exterior1st Exterior2nd ExterQual ExterCond
## 1380     Gable  CompShg     VinylSd     VinylSd        TA        TA
##      Foundation BsmtFinSF1 BsmtFinSF2 BsmtUnfSF TotalBsmtSF Heating
## 1380      PConc          0          0       384         384    GasA
##      HeatingQC CentralAir Electrical X1stFlrSF X2ndFlrSF LowQualFinSF
## 1380        Gd          Y       <NA>       754       640            0
##      GrLivArea BsmtFullBath BsmtHalfBath FullBath HalfBath BedroomAbvGr
## 1380      1394            0            0        2        1            3
##      KitchenAbvGr KitchenQual TotRmsAbvGrd Functional Fireplaces
## 1380            1          Gd            7        Typ          0
##      GarageCars GarageArea PavedDrive WoodDeckSF OpenPorchSF EnclosedPorch
## 1380          2        400          Y        100           0             0
##      X3SsnPorch ScreenPorch PoolArea MiscVal MoSold YrSold SaleType
## 1380          0           0        0       0      5   2008       WD
##      SaleCondition SalePrice
## 1380        Normal    167500

head(training)

##   Id MSSubClass MSZoning LotArea Street LotShape LandContour Utilities
## 1  1         60       RL    8450   Pave      Reg         Lvl    AllPub
## 2  2         20       RL    9600   Pave      Reg         Lvl    AllPub
## 3  3         60       RL   11250   Pave      IR1         Lvl    AllPub
## 4  4         70       RL    9550   Pave      IR1         Lvl    AllPub
## 5  5         60       RL   14260   Pave      IR1         Lvl    AllPub
## 6  6         50       RL   14115   Pave      IR1         Lvl    AllPub
##   LotConfig LandSlope Neighborhood Condition1 Condition2 BldgType
## 1    Inside       Gtl      CollgCr       Norm       Norm     1Fam
## 2       FR2       Gtl      Veenker      Feedr       Norm     1Fam
## 3    Inside       Gtl      CollgCr       Norm       Norm     1Fam
## 4    Corner       Gtl      Crawfor       Norm       Norm     1Fam
```

```
## 5       FR2       Gtl      NoRidge       Norm       Norm     1Fam
## 6    Inside       Gtl      Mitchel       Norm       Norm     1Fam
##   HouseStyle OverallQual OverallCond YearBuilt YearRemodAdd RoofStyle
## 1     2Story           7           5      2003         2003     Gable
## 2     1Story           6           8      1976         1976     Gable
## 3     2Story           7           5      2001         2002     Gable
## 4     2Story           7           5      1915         1970     Gable
## 5     2Story           8           5      2000         2000     Gable
## 6     1.5Fin           5           5      1993         1995     Gable
##   RoofMatl Exterior1st Exterior2nd ExterQual ExterCond Foundation
## 1  CompShg     VinylSd     VinylSd        Gd        TA      PConc
## 2  CompShg     MetalSd     MetalSd        TA        TA     CBlock
## 3  CompShg     VinylSd     VinylSd        Gd        TA      PConc
## 4  CompShg     Wd Sdng     Wd Shng        TA        TA     BrkTil
## 5  CompShg     VinylSd     VinylSd        Gd        TA      PConc
## 6  CompShg     VinylSd     VinylSd        TA        TA       Wood
##   BsmtFinSF1 BsmtFinSF2 BsmtUnfSF TotalBsmtSF Heating HeatingQC CentralAir
## 1        706          0       150         856    GasA        Ex          Y
## 2        978          0       284        1262    GasA        Ex          Y
## 3        486          0       434         920    GasA        Ex          Y
## 4        216          0       540         756    GasA        Gd          Y
## 5        655          0       490        1145    GasA        Ex          Y
## 6        732          0        64         796    GasA        Ex          Y
##   Electrical X1stFlrSF X2ndFlrSF LowQualFinSF GrLivArea BsmtFullBath
## 1      SBrkr       856       854            0      1710            1
## 2      SBrkr      1262         0            0      1262            0
## 3      SBrkr       920       866            0      1786            1
## 4      SBrkr       961       756            0      1717            1
## 5      SBrkr      1145      1053            0      2198            1
## 6      SBrkr       796       566            0      1362            1
##   BsmtHalfBath FullBath HalfBath BedroomAbvGr KitchenAbvGr KitchenQual
## 1            0        2        1            3            1          Gd
## 2            1        2        0            3            1          TA
## 3            0        2        1            3            1          Gd
## 4            0        1        0            3            1          Gd
## 5            0        2        1            4            1          Gd
## 6            0        1        1            1            1          TA
##   TotRmsAbvGrd Functional Fireplaces GarageCars GarageArea PavedDrive
## 1            8        Typ          0          2        548          Y
## 2            6        Typ          1          2        460          Y
## 3            6        Typ          1          2        608          Y
## 4            7        Typ          1          3        642          Y
## 5            9        Typ          1          3        836          Y
## 6            5        Typ          0          2        480          Y
##   WoodDeckSF OpenPorchSF EnclosedPorch X3SsnPorch ScreenPorch PoolArea
## 1          0          61             0          0           0        0
## 2        298           0             0          0           0        0
## 3          0          42             0          0           0        0
## 4          0          35           272          0           0        0
## 5        192          84             0          0           0        0
```

```
## 6         40          30              0        320           0        0
##   MiscVal MoSold YrSold SaleType SaleCondition SalePrice
## 1       0      2   2008       WD        Normal    208500
## 2       0      5   2007       WD        Normal    181500
## 3       0      9   2008       WD        Normal    223500
## 4       0      2   2006       WD       Abnorml    140000
## 5       0     12   2008       WD        Normal    250000
## 6     700     10   2009       WD        Normal    143000
```

```
#Missing data
sum(is.na(training)/(nrow(training)*nrow(training)))# printing percentage of
missing data
```

```
## [1] 4.691312e-07
```

```
unique(nrow(training)) # printing all the unique values
```

```
## [1] 1460
```

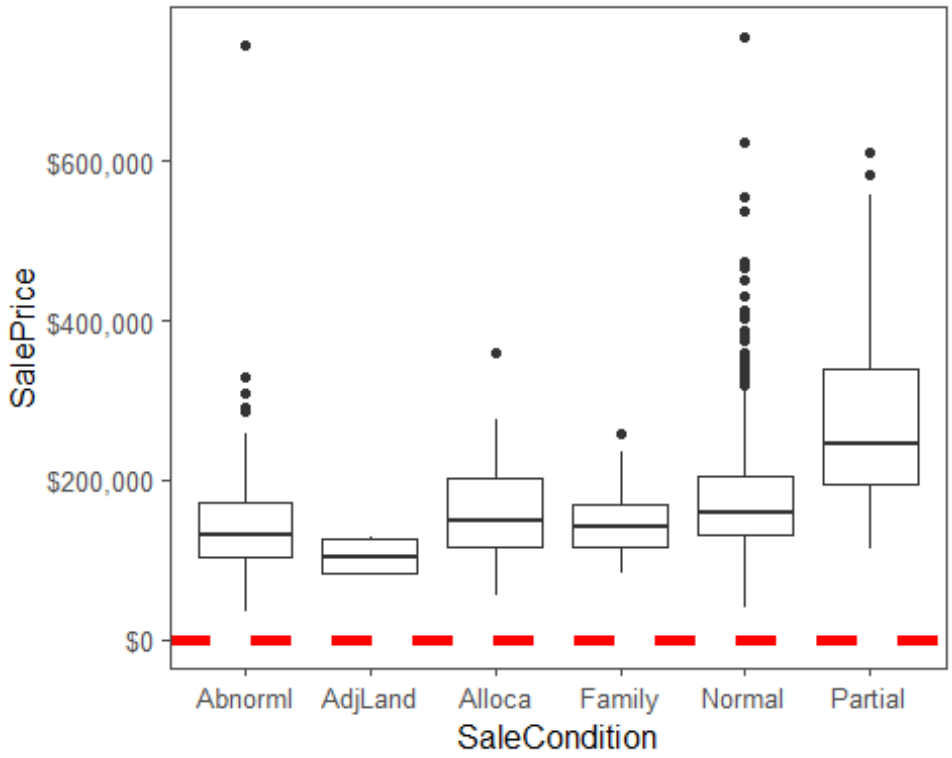
```
colSums(sapply(training,is.na))# prinitng number of missing values in each
column
```

```
##            Id    MSSubClass      MSZoning       LotArea        Street
##             0             0             0             0             0
##      LotShape   LandContour     Utilities     LotConfig     LandSlope
##             0             0             0             0             0
##  Neighborhood    Condition1    Condition2      BldgType    HouseStyle
##             0             0             0             0             0
##   OverallQual   OverallCond     YearBuilt  YearRemodAdd     RoofStyle
##             0             0             0             0             0
##      RoofMatl   Exterior1st   Exterior2nd     ExterQual     ExterCond
##             0             0             0             0             0
##    Foundation    BsmtFinSF1    BsmtFinSF2     BsmtUnfSF   TotalBsmtSF
##             0             0             0             0             0
##       Heating     HeatingQC    CentralAir    Electrical     X1stFlrSF
##             0             0             0             1             0
##     X2ndFlrSF  LowQualFinSF     GrLivArea  BsmtFullBath  BsmtHalfBath
##             0             0             0             0             0
##      FullBath      HalfBath  BedroomAbvGr  KitchenAbvGr   KitchenQual
##             0             0             0             0             0
##  TotRmsAbvGrd    Functional    Fireplaces    GarageCars    GarageArea
##             0             0             0             0             0
##    PavedDrive    WoodDeckSF   OpenPorchSF EnclosedPorch    X3SsnPorch
##             0             0             0             0             0
##   ScreenPorch      PoolArea       MiscVal        MoSold        YrSold
##             0             0             0             0             0
##      SaleType SaleCondition     SalePrice
##             0             0             0
```

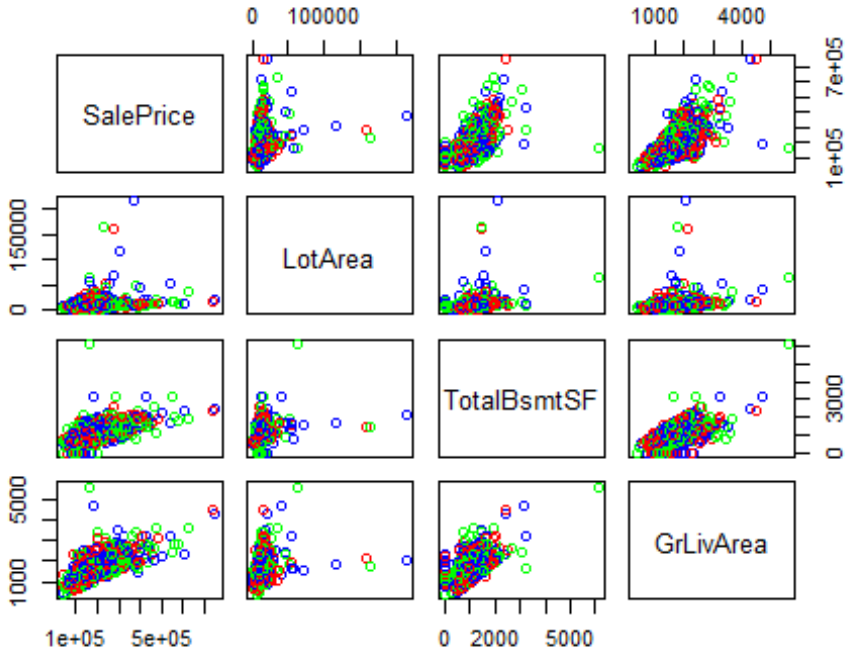
```
attach(training)
catdf<-training[,catvar]
numdf<-training[,numvar]
```

VISUALIZING THE DATA

```
ggplot(training, aes(x = SaleCondition, y = SalePrice)) +geom_boxplot() +
  geom_hline(aes(yintercept=80),
             colour='red', linetype='dashed', lwd=2) +
  scale_y_continuous(labels=dollar_format()) +
  theme_few()
```




```
pairs(~SalePrice+LotArea+TotalBsmtSF+GrLivArea,
data=training,col=c('red','blue','green'))
```




```
as.factor(training$SalePrice)
```

```
##    [1] 208500 181500 223500 140000 250000 143000 307000 200000 129900
##   [10] 118000 129500 345000 144000 279500 157000 132000 149000 90000
##   [19] 159000 139000 325300 139400 230000 129900 154000 256300 134800
##   [28] 306000 207500 68500  40000  149350 179900 165500 277500 309000
##   [37] 145000 153000 109000 82000  160000 170000 144000 130250 141000
##   [46] 319900 239686 249700 113000 127000 177000 114500 110000 385000
##   [55] 130000 180500 172500 196500 438780 124900 158000 101000 202500
##   [64] 140000 219500 317000 180000 226000 80000  225000 244000 129500
##   [73] 185000 144900 107400 91000  135750 127000 136500 110000 193500
##   [82] 153500 245000 126500 168500 260000 174000 164500 85000  123600
##   [91] 109900 98600  163500 133900 204750 185000 214000 94750  83000
##  [100] 128950 205000 178000 118964 198900 169500 250000 100000 115000
##  [109] 115000 190000 136900 180000 383970 217000 259500 176000 139000
##  [118] 155000 320000 163990 180000 100000 136000 153900 181000 84500
##  [127] 128000 87000  155000 150000 226000 244000 150750 220000 180000
##  [136] 174000 143000 171000 230000 231500 115000 260000 166000 204000
##  [145] 125000 130000 105000 222500 141000 115000 122000 372402 190000
##  [154] 235000 125000 79000  109500 269500 254900 320000 162500 412500
##  [163] 220000 103200 152000 127500 190000 325624 183500 228000 128500
##  [172] 215000 239000 163000 184000 243000 211000 172500 501837 100000
##  [181] 177000 200100 120000 200000 127000 475000 173000 135000 153337
##  [190] 286000 315000 184000 192000 130000 127000 148500 311872 235000
##  [199] 104000 274900 140000 171500 112000 149000 110000 180500 143900
##  [208] 141000 277000 145000 98000  186000 252678 156000 161750 134450
##  [217] 210000 107000 311500 167240 204900 200000 179900 97000  386250
```

```
##  [226] 112000 290000 106000 125000 192500 148000 403000 94500  128200
##  [235] 216500 89500  185500 194500 318000 113000 262500 110500 79000
##  [244] 120000 205000 241500 137000 140000 180000 277000 76500  235000
##  [253] 173000 158000 145000 230000 207500 220000 231500 97000  176000
##  [262] 276000 151000 130000 73000  175500 185000 179500 120500 148000
##  [271] 266000 241500 290000 139000 124500 205000 201000 141000 415298
##  [280] 192000 228500 185000 207500 244600 179200 164700 159000 88000
##  [289] 122000 153575 233230 135900 131000 235000 167000 142500 152000
##  [298] 239000 175000 158500 157000 267000 205000 149900 295000 305900
##  [307] 225000 89500  82500  360000 165600 132000 119900 375000 178000
##  [316] 188500 260000 270000 260000 187500 342643 354000 301000 126175
##  [325] 242000 87000  324000 145250 214500 78000  119000 139000 284000
##  [334] 207000 192000 228950 377426 214000 202500 155000 202900 82000
##  [343] 87500  266000 85000  140200 151500 157500 154000 437154 318061
##  [352] 190000 95000  105900 140000 177500 173000 134000 130000 280000
##  [361] 156000 145000 198500 118000 190000 147000 159000 165000 132000
##  [370] 162000 172400 134432 125000 123000 219500 61000  148000 340000
##  [379] 394432 179000 127000 187750 213500 76000  240000 192000 81000
##  [388] 125000 191000 426000 119000 215000 106500 100000 109000 129000
##  [397] 123000 169500 67000  241000 245500 164990 108000 258000 168000
##  [406] 150000 115000 177000 280000 339750 60000  145000 222000 115000
##  [415] 228000 181134 149500 239000 126000 142000 206300 215000 113000
##  [424] 315000 139000 135000 275000 109008 195400 175000 85400  79900
##  [433] 122500 181000 81000  212000 116000 119000 90350  110000 555000
##  [442] 118000 162900 172500 210000 127500 190000 199900 119500 120000
##  [451] 110000 280000 204000 210000 188000 175500 98000  256000 161000
##  [460] 110000 263435 155000 62383  188700 124000 178740 167000 146500
##  [469] 250000 187000 212000 190000 148000 440000 251000 132500 208900
##  [478] 380000 297000 89471  326000 374000 155000 164000 132500 147000
##  [487] 156000 175000 160000 86000  115000 133000 172785 155000 91300
##  [496] 34900  430000 184000 130000 120000 113000 226700 140000 289000
##  [505] 147000 124500 215000 208300 161000 124500 164900 202665 129900
##  [514] 134000 96500  402861 158000 265000 211000 234000 106250 150000
##  [523] 159000 184750 315750 176000 132000 446261 86000  200624 175000
##  [532] 128000 107500 39300  178000 107500 188000 111250 158000 272000
##  [541] 315000 248000 213250 133000 179665 229000 210000 129500 125000
##  [550] 263000 140000 112500 255500 108000 284000 113000 141000 108000
##  [559] 175000 234000 121500 170000 108000 185000 268000 128000 325000
##  [568] 214000 316600 135960 142600 120000 224500 170000 139000 118500
##  [577] 145000 164500 146000 131500 181900 253293 118500 325000 133000
##  [586] 369900 130000 137000 143000 79500  185900 451950 138000 140000
##  [595] 110000 319000 114504 194201 217500 151000 275000 141000 220000
##  [604] 151000 221000 205000 152000 225000 359100 118500 313000 148000
##  [613] 261500 147000 75500  137500 183200 105500 314813 305000 67000
##  [622] 240000 135000 168500 165150 160000 139900 153000 135000 168500
##  [631] 124000 209500 82500  139400 144000 200000 60000  93000  85000
##  [640] 264561 274000 226000 345000 152000 370878 143250 98300  155000
##  [649] 155000 84500  205950 108000 191000 135000 350000 88000  145500
##  [658] 149000 97500  167000 197900 402000 110000 137500 423000 230500
##  [667] 129000 193500 168000 137500 173500 103600 165000 257500 140000
```

```
##  [676] 148500 87000  109500 372500 128500 143000 159434 173000 285000
##  [685] 221000 207500 227875 148800 392000 194700 141000 755000 335000
##  [694] 108480 141500 176000 89000  123500 138500 196000 312500 140000
##  [703] 361919 140000 213000 55000  302000 254000 179540 109900 52000
##  [712] 102776 189000 129000 130500 165000 159500 157000 341000 128500
##  [721] 275000 143000 124500 135000 320000 120500 222000 194500 110000
##  [730] 103000 236500 187500 222500 131400 108000 163000 93500  239900
##  [739] 179000 190000 132000 142000 179000 175000 180000 299800 236000
##  [748] 265979 260400 98000  96500  162000 217000 275500 156000 172500
##  [757] 212000 158900 179400 290000 127500 100000 215200 337000 270000
##  [766] 264132 196500 160000 216837 538000 134900 102000 107000 114500
##  [775] 395000 162000 221500 142500 144000 135000 176000 175900 187100
##  [784] 165500 128000 161500 139000 233000 107900 187500 160200 146800
##  [793] 269790 225000 194500 171000 143500 110000 485000 175000 200000
##  [802] 109900 189000 582933 118000 227680 135500 223500 159950 106000
##  [811] 181000 144500 55993  157900 116000 224900 137000 271000 155000
##  [820] 224000 183000 93000  225000 139500 232600 385000 109500 189000
##  [829] 185000 147400 166000 151000 237000 167000 139950 128000 153500
##  [838] 100000 144000 130500 140000 157500 174900 141000 153900 171000
##  [847] 213000 133500 240000 187000 131500 215000 164000 158000 170000
##  [856] 127000 147000 174000 152000 250000 189950 131500 152000 132500
##  [865] 250580 148500 248900 129000 169000 236000 109500 200500 116000
##  [874] 133000 66500  303477 132250 350000 148000 136500 157000 187500
##  [883] 178000 118500 100000 328900 145000 135500 268000 149500 122900
##  [892] 172500 154500 165000 118858 140000 106500 142953 611657 135000
##  [901] 110000 153000 180000 240000 125500 128000 255000 250000 131000
##  [910] 174000 154300 143500 88000  145000 173733 75000  35311  135000
##  [919] 238000 176500 201000 145900 169990 193000 207500 175000 285000
##  [928] 176000 236500 222000 201000 117500 320000 190000 242000 79900
##  [937] 184900 253000 239799 244400 150900 214000 150000 143000 137500
##  [946] 124900 143000 270000 192500 197500 129000 119900 133900 172000
##  [955] 127500 145000 124000 132000 185000 155000 116500 272000 155000
##  [964] 239000 214900 178900 160000 135000 37900  140000 135000 173000
##  [973] 99500  182000 167500 165000 85500  199900 110000 139000 178400
##  [982] 336000 159895 255900 126000 125000 117000 395192 195000 197000
##  [991] 348000 168000 187000 173900 337500 121600 136500 185000 91000
## [1000] 206000 82000  86000  232000 136905 181000 149900 163500 88000
## [1009] 240000 102000 135000 100000 165000 85000  119200 227000 203000
## [1018] 187500 160000 213490 176000 194000 87000  191000 287000 112500
## [1027] 167500 293077 105000 118000 160000 197000 310000 230000 119750
## [1036] 84000  315500 287000 97000  80000  155000 173000 196000 262280
## [1045] 278000 139600 556581 145000 115000 84900  176485 200141 165000
## [1054] 144500 255000 180000 185850 248000 335000 220000 213500 81000
## [1063] 90000  110500 154000 328000 178000 167900 151400 135000 135000
## [1072] 154000 91500  159500 194000 219500 170000 138800 155900 126000
## [1081] 145000 133000 192000 160000 187500 147000 83500  252000 137500
## [1090] 197000 92900  160000 136500 146000 129000 176432 127000 170000
## [1099] 128000 157000 60000  119500 135000 159500 106000 325000 179900
## [1108] 274725 181000 280000 188000 205000 129900 134500 117000 318000
## [1117] 184100 130000 140000 133700 118400 212900 112000 118000 163900
```

```
## [1126] 115000 174000 259000 215000 140000 135000 93500  117500 239500
## [1135] 169000 102000 119000 94000  196000 144000 139000 197500 424870
## [1144] 80000  80000  149000 180000 174500 116900 143000 124000 149900
## [1153] 230000 120500 201800 218000 179900 230000 235128 185000 146000
## [1162] 224000 129000 108959 194000 233170 245350 173000 235000 625000
## [1171] 171000 163000 171900 200500 239000 285000 119500 115000 154900
## [1180] 93000  250000 392500 745000 120000 186700 104900 95000  262000
## [1189] 195000 189000 168000 174000 125000 165000 158000 176000 219210
## [1198] 144000 178000 148000 116050 197900 117000 213000 153500 271900
## [1207] 107000 200000 140000 290000 189000 164000 113000 145000 134500
## [1216] 125000 112000 229456 80500  91500  115000 134000 143000 137900
## [1225] 184000 145000 214000 147000 367294 127000 190000 132500 101800
## [1234] 142000 130000 138887 175500 195000 142500 265900 224900 248328
## [1243] 170000 465000 230000 178000 186500 169900 129500 119000 244000
## [1252] 171750 130000 294000 165400 127500 301500 99900  190000 151000
## [1261] 181000 128900 161500 180500 181000 183900 122000 378500 381000
## [1270] 144000 260000 185750 137000 177000 139000 137000 162000 197900
## [1279] 237000 68400  227000 180000 150500 139000 169000 132500 143000
## [1288] 190000 278000 281000 180500 119500 107500 162900 115000 138500
## [1297] 155000 140000 160000 154000 225000 177500 290000 232000 130000
## [1306] 325000 202500 138000 147000 179200 335000 203000 302000 333168
## [1315] 119000 206900 295493 208900 275000 111000 156500 72500  190000
## [1324] 82500  147000 55000  79000  130500 256000 176500 227000 132500
## [1333] 100000 125500 125000 167900 135000 52500  200000 128500 123000
## [1342] 155000 228500 177000 155835 108500 262500 283463 215000 122000
## [1351] 200000 171000 134900 410000 235000 170000 110000 149900 177500
## [1360] 315000 189000 260000 104900 156932 144152 216000 193000 127000
## [1369] 144000 232000 105000 165500 274300 466500 250000 239000 91000
## [1378] 117000 83000  167500 58500  237500 157000 112000 105000 125500
## [1387] 250000 136000 377500 131000 235000 124000 123000 163000 246578
## [1396] 281213 160000 137500 138000 137450 120000 193000 193879 282922
## [1405] 105000 275000 133000 112000 125500 215000 230000 140000 90000
## [1414] 257000 207000 175900 122500 340000 124000 223000 179900 127500
## [1423] 136500 274970 144000 142000 271000 140000 119000 182900 192140
## [1432] 143750 64500  186500 160000 174000 120500 394617 149700 197000
## [1441] 191000 149300 310000 121000 179600 129000 157900 240000 112000
## [1450] 92000  136000 287090 145000 84500  185000 175000 210000 266500
## [1459] 142125 147500
## 663 Levels: 34900 35311 37900 39300 40000 52000 52500 55000 55993 ...
755000

hist(training$SalePrice / 1000, xlab = "Saleprice in thousands")
```

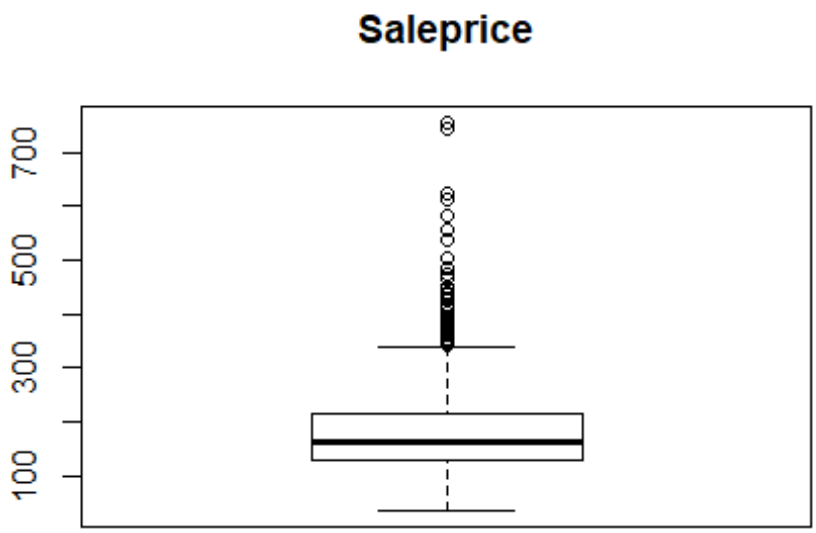

```
library(moments)
```

```
## Warning: package 'moments' was built under R version 3.5.2
```

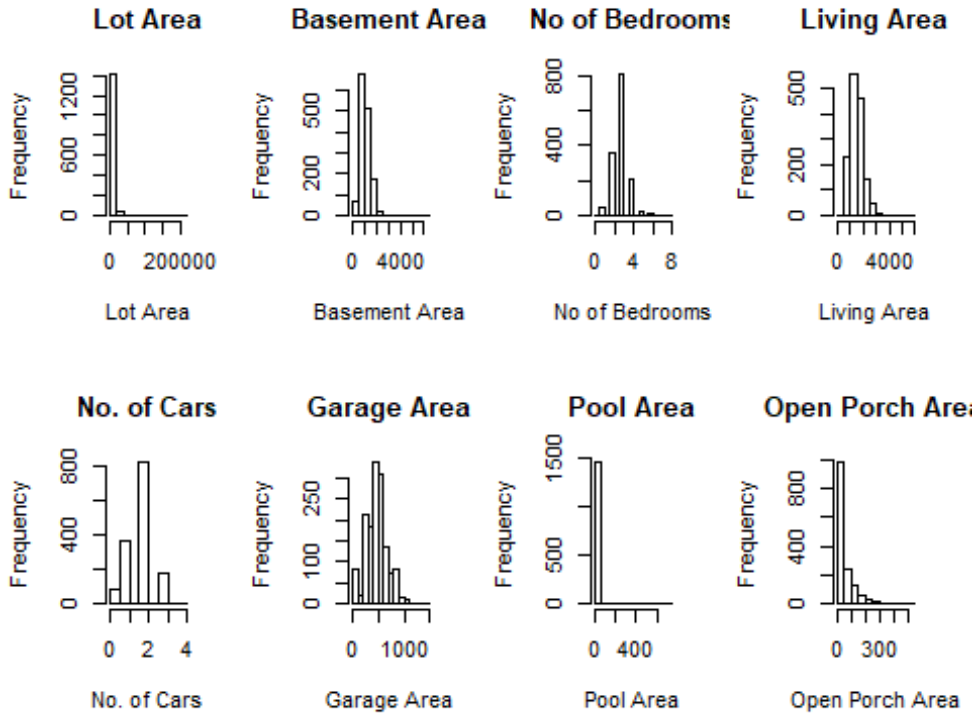
```
skewness(SalePrice)
```

```
## [1] 1.880941
```

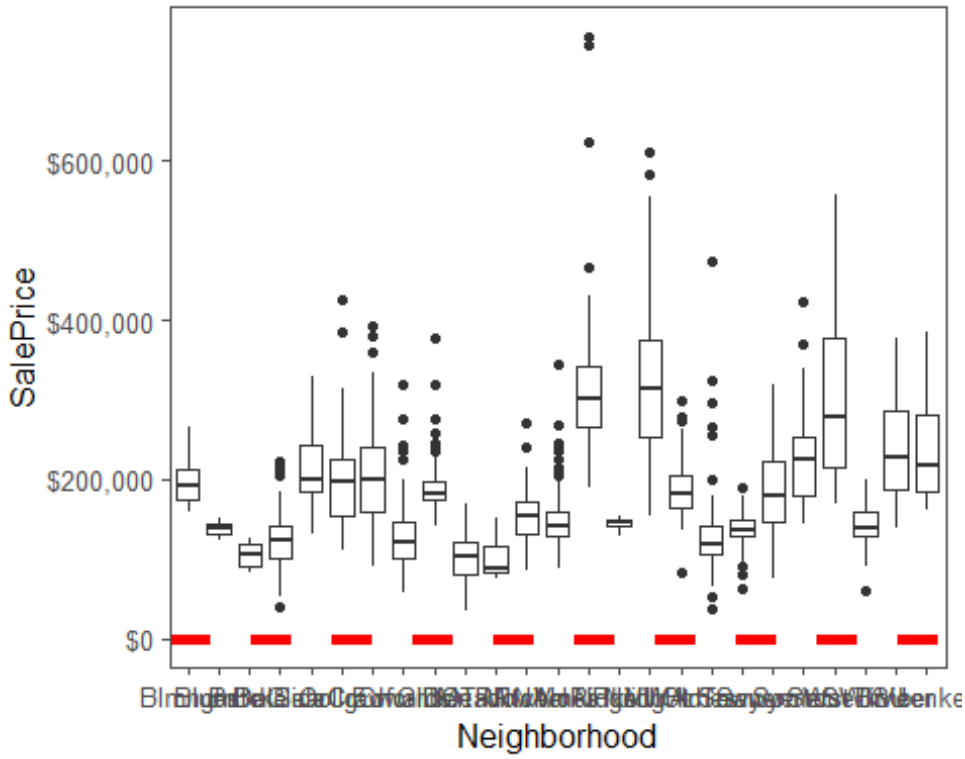
```
boxplot(training$SalePrice/ 1000, main = "Saleprice")
```



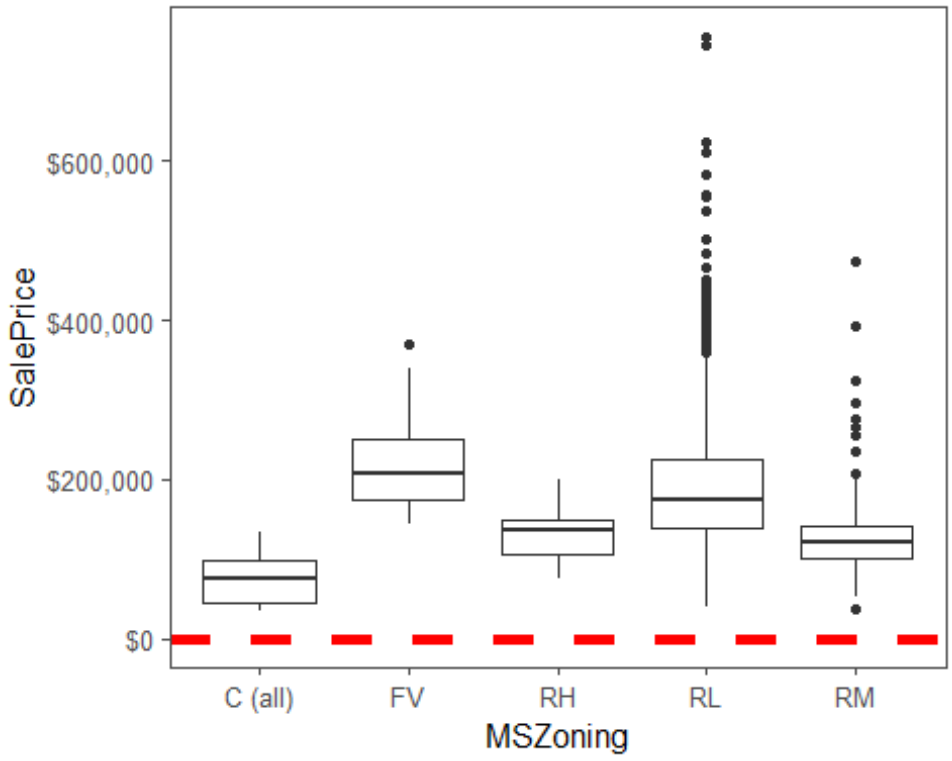

```
par(mfrow=c(2,4))
hist(training$LotArea,xlab="Lot Area", main="Lot Area")
hist(training$TotalBsmtSF, xlab="Basement Area", main="Basement Area")
hist(training$BedroomAbvGr, xlab="No of Bedrooms", main="No of Bedrooms")
hist(training$GrLivArea, xlab="Living Area",main="Living Area")
hist(training$GarageCars, xlab="No. of Cars",main="No. of Cars")
hist(training$GarageArea, xlab="Garage Area",main="Garage Area")
hist(training$PoolArea, xlab="Pool Area",main="Pool Area")
hist(training$OpenPorchSF, xlab="Open Porch Area",main="Open Porch Area")
```



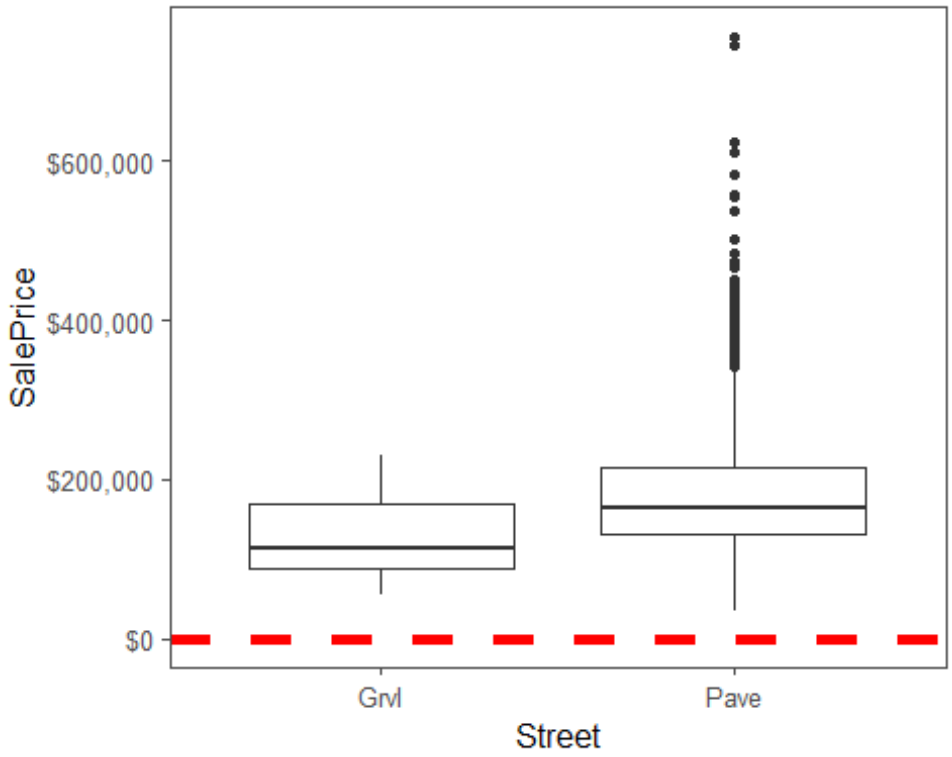

```
ggplot(training, aes(x = Neighborhood, y = SalePrice)) +
  geom_boxplot() +
  geom_hline(aes(yintercept=80),
             colour='red', linetype='dashed', lwd=2) +
  scale_y_continuous(labels=dollar_format()) +
  theme_few()
```



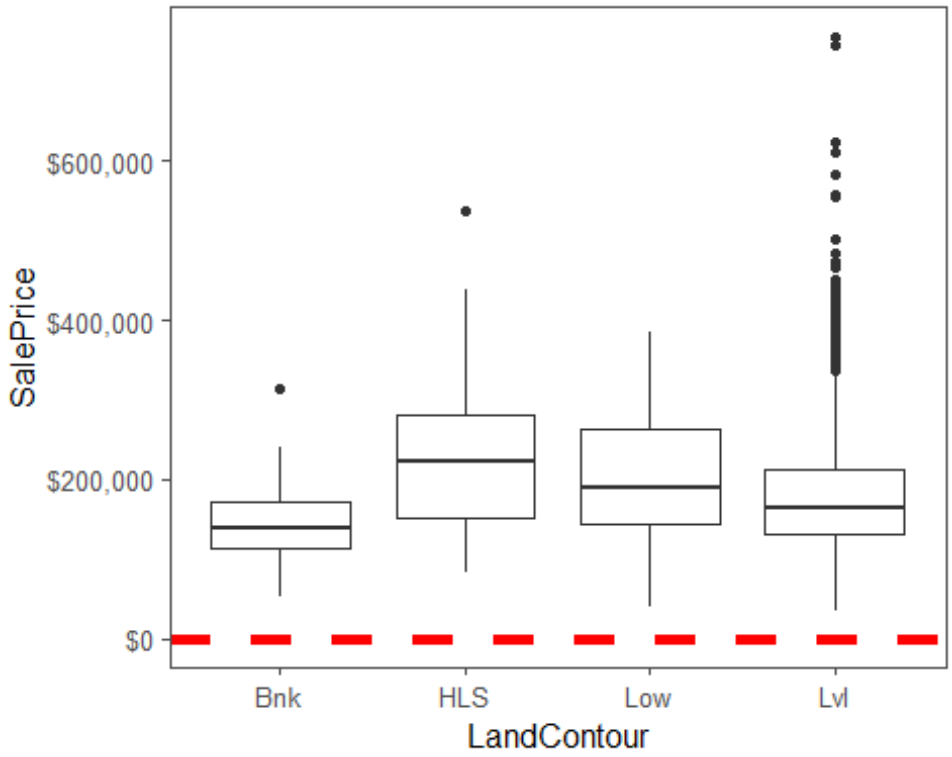

```
ggplot(training, aes(x = MSZoning, y = SalePrice)) +geom_boxplot() +
  geom_hline(aes(yintercept=80),
             colour='red', linetype='dashed', lwd=2) +
  scale_y_continuous(labels=dollar_format()) +
  theme_few()
```



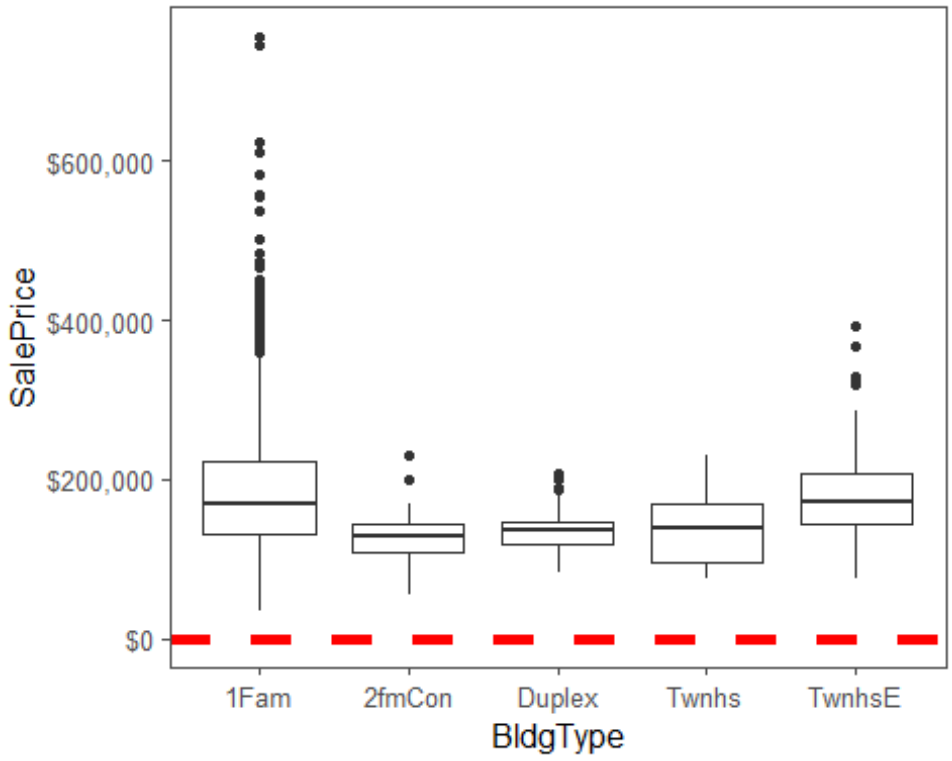

```
ggplot(training, aes(x = Street, y = SalePrice)) +geom_boxplot() +
  geom_hline(aes(yintercept=80),
             colour='red', linetype='dashed', lwd=2) +
  scale_y_continuous(labels=dollar_format()) +
  theme_few()
```



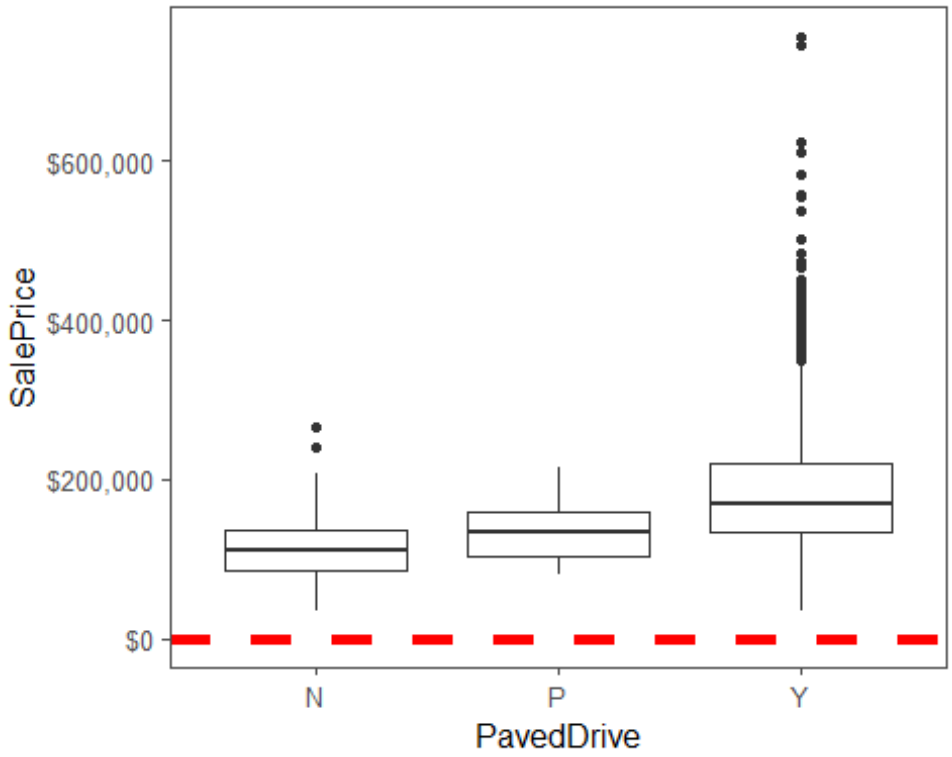

```
ggplot(training, aes(x = LandContour, y = SalePrice)) +geom_boxplot() +
  geom_hline(aes(yintercept=80),
             colour='red', linetype='dashed', lwd=2) +
  scale_y_continuous(labels=dollar_format()) +
  theme_few()
```



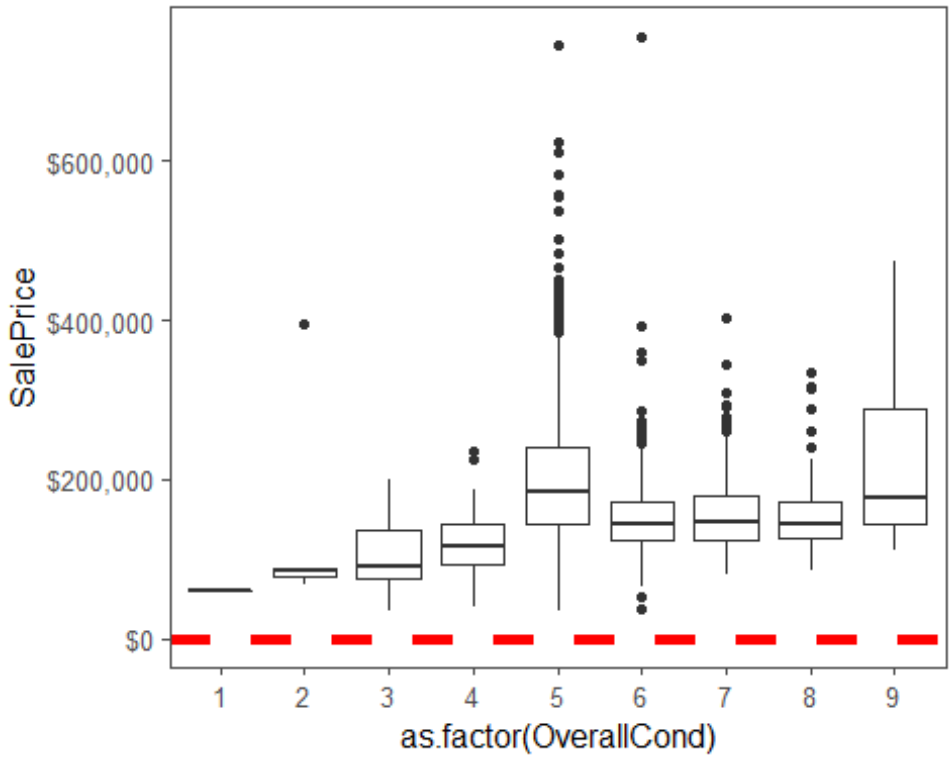

```
ggplot(training, aes(x = BldgType, y = SalePrice)) +geom_boxplot() +
  geom_hline(aes(yintercept=80),
             colour='red', linetype='dashed', lwd=2) +
  scale_y_continuous(labels=dollar_format()) +
  theme_few()
```



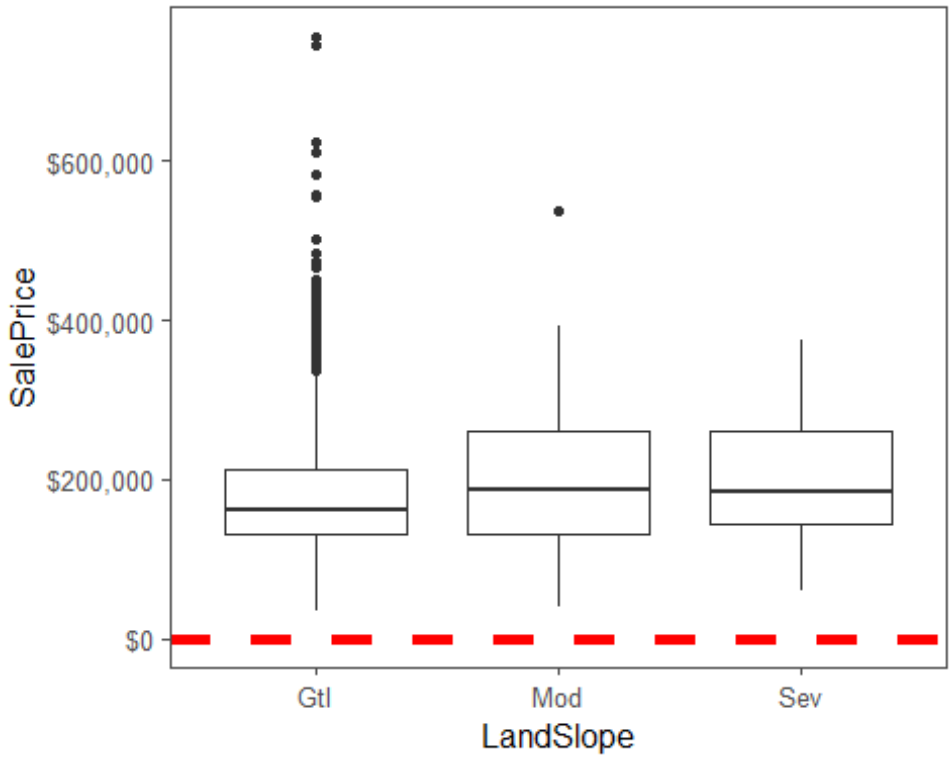

```
ggplot(training, aes(x = PavedDrive, y = SalePrice)) +geom_boxplot() +
  geom_hline(aes(yintercept=80),
             colour='red', linetype='dashed', lwd=2) +
  scale_y_continuous(labels=dollar_format()) +
  theme_few()
```



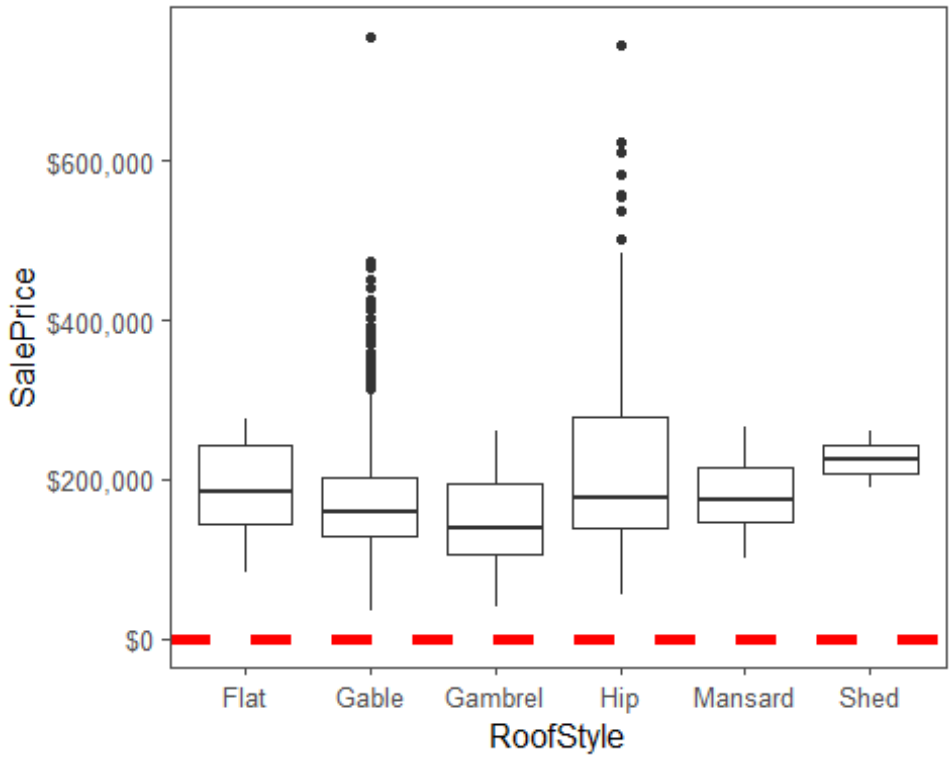

```
ggplot(training, aes(x = as.factor(OverallCond), y = SalePrice))
+geom_boxplot() +
  geom_hline(aes(yintercept=80),
             colour='red', linetype='dashed', lwd=2) +
  scale_y_continuous(labels=dollar_format()) +
  theme_few()
```



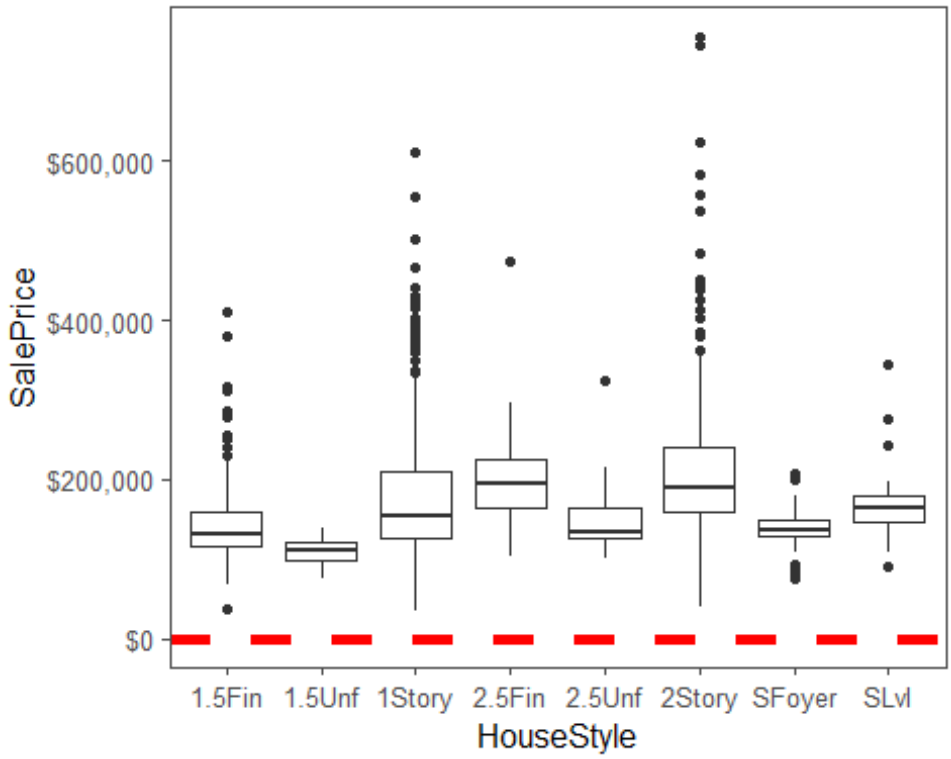

```
ggplot(training, aes(x = LandSlope, y = SalePrice)) +geom_boxplot() +
  geom_hline(aes(yintercept=80),
             colour='red', linetype='dashed', lwd=2) +
  scale_y_continuous(labels=dollar_format()) +
  theme_few()
```



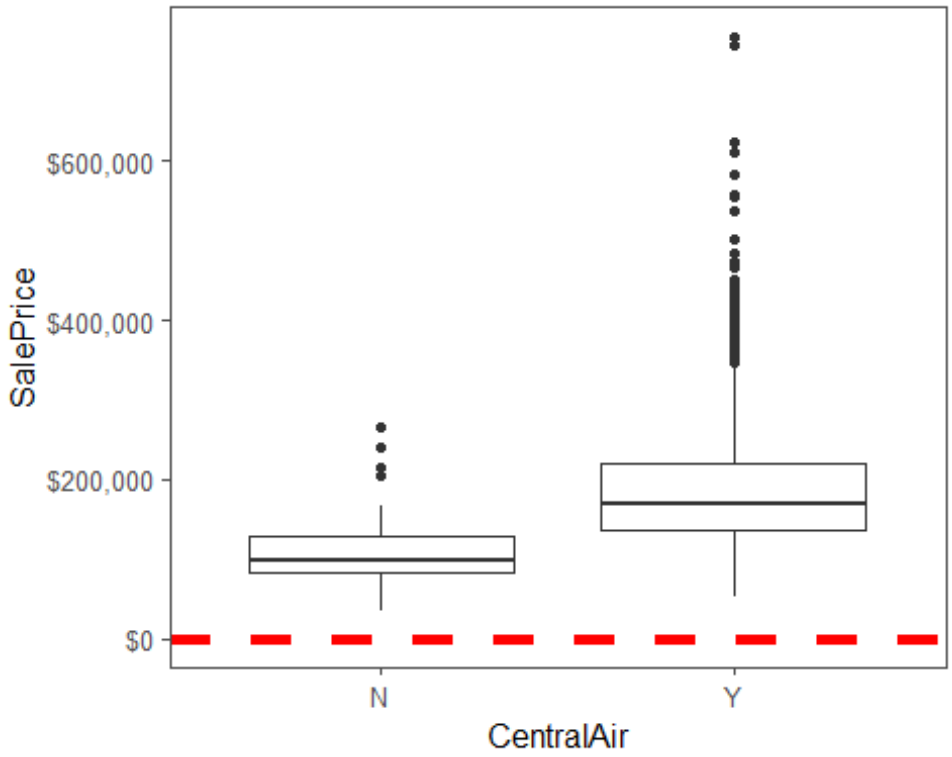

```
ggplot(training, aes(x = RoofStyle, y = SalePrice)) +geom_boxplot() +
  geom_hline(aes(yintercept=80),
             colour='red', linetype='dashed', lwd=2) +
  scale_y_continuous(labels=dollar_format()) +
  theme_few()
```




```
ggplot(training, aes(x = HouseStyle, y = SalePrice)) +geom_boxplot() +
  geom_hline(aes(yintercept=80),
             colour='red', linetype='dashed', lwd=2) +
  scale_y_continuous(labels=dollar_format()) +
  theme_few()
```




```
ggplot(training, aes(x = CentralAir, y = SalePrice)) +geom_boxplot() +
  geom_hline(aes(yintercept=80),
             colour='red', linetype='dashed', lwd=2) +
  scale_y_continuous(labels=dollar_format()) +
  theme_few()
```




```
library(PerformanceAnalytics)
```

```
## Warning: package 'PerformanceAnalytics' was built under R version 3.5.2
```

```
## Loading required package: xts
```

```
## Loading required package: zoo
```

```
##
## Attaching package: 'zoo'
```

```
## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
```

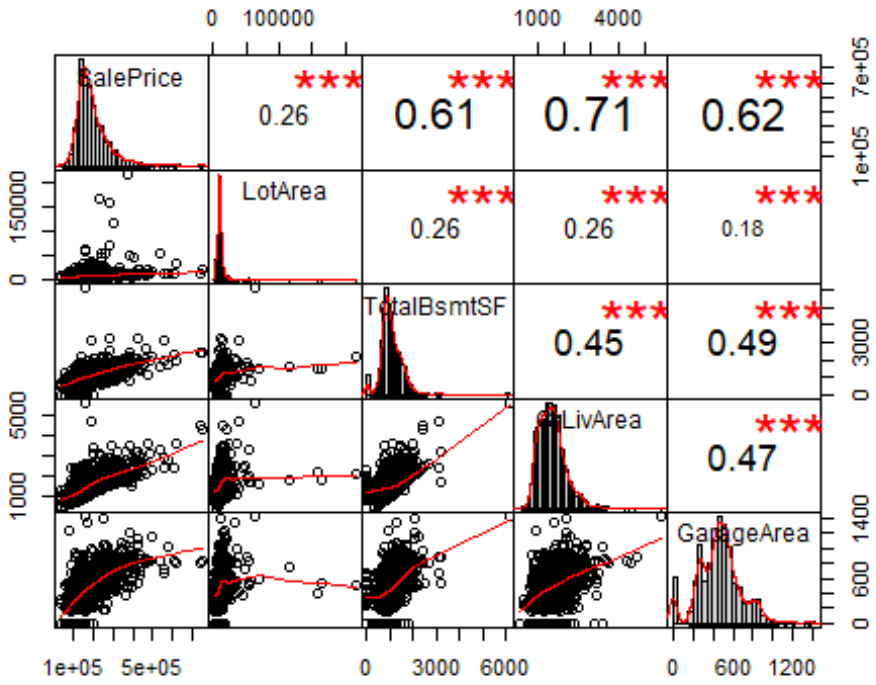
```
##
## Attaching package: 'xts'
```

```
## The following objects are masked from 'package:data.table':
##
##     first, last
```

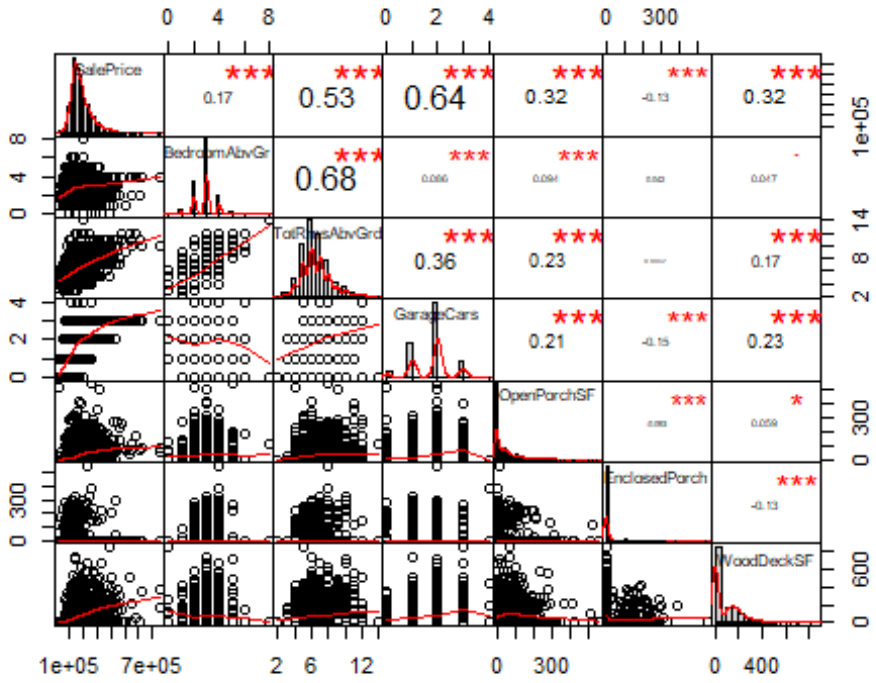
```
## The following objects are masked from 'package:dplyr':
##
##     first, last
```

```
##
## Attaching package: 'PerformanceAnalytics'
```

```
## The following objects are masked from 'package:moments':
##
##     kurtosis, skewness

## The following object is masked from 'package:graphics':
##
##     legend

my_data <- training[,
c('SalePrice','LotArea','TotalBsmtSF','GrLivArea','GarageArea')]

chart.Correlation(my_data, histogram=TRUE, pch=19)
```




```
my_data <- training[,
c('SalePrice','BedroomAbvGr','TotRmsAbvGrd','GarageCars','OpenPorchSF','Enclo
sedPorch','WoodDeckSF')]

chart.Correlation(my_data, histogram=TRUE, pch=19)
```




```
library(forecast)
linear <- lm(SalePrice~., data=training, metric="RMSE", maximize=FALSE)

## Warning: In lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...)
:
##  extra arguments 'metric', 'maximize' will be disregarded

summary(linear)

##
## Call:
## lm(formula = SalePrice ~ ., data = training, metric = "RMSE",
##     maximize = FALSE)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -174309  -10535       0    9742  174309
##
## Coefficients: (3 not defined because of singularities)
##                         Estimate Std. Error t value Pr(>|t|)
## (Intercept)          -1.199e+06  1.066e+06  -1.125 0.260855
## Id                    6.358e-01  1.603e+00   0.397 0.691694
## MSSubClass           -7.830e+00  8.553e+01  -0.092 0.927077
## MSZoningFV            3.101e+04  1.225e+04   2.532 0.011470 *
## MSZoningRH            2.371e+04  1.232e+04   1.925 0.054412 .
## MSZoningRL            2.588e+04  1.051e+04   2.463 0.013909 *
## MSZoningRM            2.503e+04  9.852e+03   2.541 0.011174 *
```

```
## LotArea                7.006e-01  1.083e-01   6.470 1.40e-10 ***
## StreetPave             3.867e+04  1.229e+04   3.148 0.001685 **
## LotShapeIR2            4.618e+03  4.323e+03   1.068 0.285624
## LotShapeIR3            4.584e+03  9.063e+03   0.506 0.613065
## LotShapeReg            5.589e+02  1.667e+03   0.335 0.737481
## LandContourHLS         1.350e+04  5.308e+03   2.543 0.011098 *
## LandContourLow        -4.241e+03  6.530e+03  -0.650 0.516119
## LandContourLvl         7.073e+03  3.822e+03   1.851 0.064427 .
## UtilitiesNoSeWa       -3.037e+04  2.663e+04  -1.141 0.254268
## LotConfigCulDSac       7.629e+03  3.328e+03   2.293 0.022033 *
## LotConfigFR2          -5.847e+03  4.160e+03  -1.406 0.160105
## LotConfigFR3          -1.349e+04  1.309e+04  -1.031 0.302943
## LotConfigInside       -1.241e+03  1.811e+03  -0.685 0.493217
## LandSlopeMod           1.046e+04  4.044e+03   2.586 0.009824 **
## LandSlopeSev          -2.560e+04  1.111e+04  -2.305 0.021326 *
## NeighborhoodBlueste   -2.735e+03  1.935e+04  -0.141 0.887666
## NeighborhoodBrDale     8.372e+03  1.113e+04   0.752 0.452231
## NeighborhoodBrkSide   -2.092e+03  9.509e+03  -0.220 0.825905
## NeighborhoodClearCr   -1.277e+04  9.432e+03  -1.354 0.176093
## NeighborhoodCollgCr   -9.717e+03  7.337e+03  -1.324 0.185610
## NeighborhoodCrawfor    9.596e+03  8.674e+03   1.106 0.268795
## NeighborhoodEdwards   -1.675e+04  8.085e+03  -2.072 0.038477 *
## NeighborhoodGilbert   -1.388e+04  7.854e+03  -1.767 0.077484 .
## NeighborhoodIDOTRR    -7.806e+03  1.087e+04  -0.718 0.472893
## NeighborhoodMeadowV   -1.365e+03  1.141e+04  -0.120 0.904805
## NeighborhoodMitchel   -2.038e+04  8.281e+03  -2.461 0.013996 *
## NeighborhoodNAmes     -1.447e+04  7.905e+03  -1.831 0.067377 .
## NeighborhoodNoRidge    2.877e+04  8.406e+03   3.423 0.000640 ***
## NeighborhoodNPkVill    8.163e+03  1.434e+04   0.569 0.569256
## NeighborhoodNridgHt    2.459e+04  7.383e+03   3.330 0.000893 ***
## NeighborhoodNWAmes    -2.053e+04  8.154e+03  -2.517 0.011950 *
## NeighborhoodOldTown   -1.301e+04  9.681e+03  -1.344 0.179263
## NeighborhoodSawyer    -1.005e+04  8.236e+03  -1.221 0.222449
## NeighborhoodSawyerW   -6.145e+03  7.857e+03  -0.782 0.434278
## NeighborhoodSomerst   -1.607e+01  8.984e+03  -0.002 0.998573
## NeighborhoodStoneBr    3.896e+04  8.390e+03   4.643 3.78e-06 ***
## NeighborhoodSWISU     -9.589e+03  9.837e+03  -0.975 0.329853
## NeighborhoodTimber    -6.108e+03  8.419e+03  -0.726 0.468254
## NeighborhoodVeenker    3.134e+03  1.074e+04   0.292 0.770436
## Condition1Feedr        2.827e+03  5.118e+03   0.552 0.580839
## Condition1Norm         1.210e+04  4.226e+03   2.862 0.004278 **
## Condition1PosA         7.386e+03  1.031e+04   0.716 0.473947
## Condition1PosN         7.856e+03  7.634e+03   1.029 0.303635
## Condition1RRAe        -1.708e+04  9.381e+03  -1.820 0.068945 .
## Condition1RRAn         6.184e+03  7.041e+03   0.878 0.379890
## Condition1RRNe        -7.318e+03  1.839e+04  -0.398 0.690706
## Condition1RRNn         3.829e+03  1.312e+04   0.292 0.770531
## Condition2Feedr       -9.499e+03  2.307e+04  -0.412 0.680617
## Condition2Norm        -7.535e+03  1.967e+04  -0.383 0.701655
## Condition2PosA         2.022e+04  3.803e+04   0.532 0.594962
```

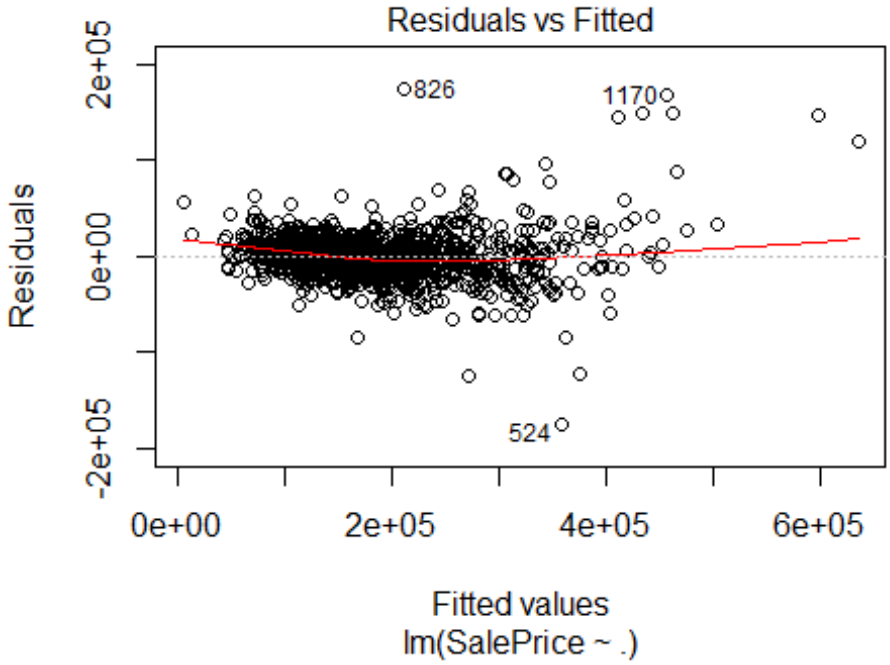
```
## Condition2PosN       -2.303e+05  2.764e+04  -8.331  < 2e-16 ***
## Condition2RRAe       -1.288e+05  4.688e+04  -2.747 0.006091 **
## Condition2RRAn       -1.208e+04  3.197e+04  -0.378 0.705522
## Condition2RRNn       -8.718e+03  2.713e+04  -0.321 0.747988
## BldgType2fmCon       -6.293e+03  1.288e+04  -0.489 0.625255
## BldgTypeDuplex       -1.020e+03  7.466e+03  -0.137 0.891399
## BldgTypeTwnhs        -2.560e+04  1.017e+04  -2.517 0.011949 *
## BldgTypeTwnhsE       -2.342e+04  9.215e+03  -2.542 0.011144 *
## HouseStyle1.5Unf      1.116e+04  7.941e+03   1.405 0.160212
## HouseStyle1Story      8.915e+03  4.365e+03   2.042 0.041324 *
## HouseStyle2.5Fin     -1.711e+04  1.232e+04  -1.388 0.165250
## HouseStyle2.5Unf     -1.188e+04  9.396e+03  -1.265 0.206181
## HouseStyle2Story     -6.353e+03  3.558e+03  -1.785 0.074426 .
## HouseStyleSFoyer      7.609e+03  6.207e+03   1.226 0.220443
## HouseStyleSLvl        7.253e+03  5.500e+03   1.319 0.187483
## OverallQual           8.042e+03  1.022e+03   7.867 7.70e-15 ***
## OverallCond           5.439e+03  8.759e+02   6.210 7.18e-10 ***
## YearBuilt             3.307e+02  7.400e+01   4.469 8.58e-06 ***
## YearRemodAdd          1.065e+02  5.571e+01   1.911 0.056168 .
## RoofStyleGable        1.518e+03  1.877e+04   0.081 0.935529
## RoofStyleGambrel      4.328e+03  2.052e+04   0.211 0.832985
## RoofStyleHip          3.112e+03  1.882e+04   0.165 0.868667
## RoofStyleMansard      1.724e+04  2.186e+04   0.789 0.430398
## RoofStyleShed         8.755e+04  3.554e+04   2.463 0.013905 *
## RoofMatlCompShg       6.504e+05  3.306e+04  19.672  < 2e-16 ***
## RoofMatlMembran       7.377e+05  4.782e+04  15.427  < 2e-16 ***
## RoofMatlMetal         6.978e+05  4.724e+04  14.770  < 2e-16 ***
## RoofMatlRoll          6.496e+05  4.168e+04  15.583  < 2e-16 ***
## RoofMatlTar&Grv       6.558e+05  3.801e+04  17.257  < 2e-16 ***
## RoofMatlWdShake       6.309e+05  3.683e+04  17.132  < 2e-16 ***
## RoofMatlWdShngl       7.282e+05  3.430e+04  21.229  < 2e-16 ***
## Exterior1stAsphShn   -1.265e+04  3.422e+04  -0.370 0.711798
## Exterior1stBrkComm   -1.327e+04  2.869e+04  -0.463 0.643757
## Exterior1stBrkFace    5.438e+03  1.287e+04   0.422 0.672763
## Exterior1stCBlock    -2.812e+04  2.761e+04  -1.018 0.308705
## Exterior1stCemntBd   -1.490e+04  1.947e+04  -0.765 0.444353
## Exterior1stHdBoard   -1.379e+04  1.299e+04  -1.062 0.288621
## Exterior1stImStucc   -6.922e+04  2.863e+04  -2.418 0.015758 *
## Exterior1stMetalSd   -3.215e+03  1.483e+04  -0.217 0.828473
## Exterior1stPlywood   -1.796e+04  1.288e+04  -1.395 0.163280
## Exterior1stStone     -1.511e+04  2.438e+04  -0.620 0.535573
## Exterior1stStucco    -4.992e+03  1.418e+04  -0.352 0.724787
## Exterior1stVinylSd   -1.764e+04  1.347e+04  -1.310 0.190513
## Exterior1stWd Sdng   -1.358e+04  1.243e+04  -1.092 0.274945
## Exterior1stWdShing   -6.428e+03  1.344e+04  -0.478 0.632616
## Exterior2ndAsphShn    8.090e+03  2.282e+04   0.354 0.723059
## Exterior2ndBrk Cmn    1.496e+04  2.075e+04   0.721 0.470967
## Exterior2ndBrkFace   -8.279e+02  1.331e+04  -0.062 0.950396
## Exterior2ndCBlock            NA         NA      NA       NA
## Exterior2ndCmentBd    1.303e+04  1.920e+04   0.678 0.497621
```

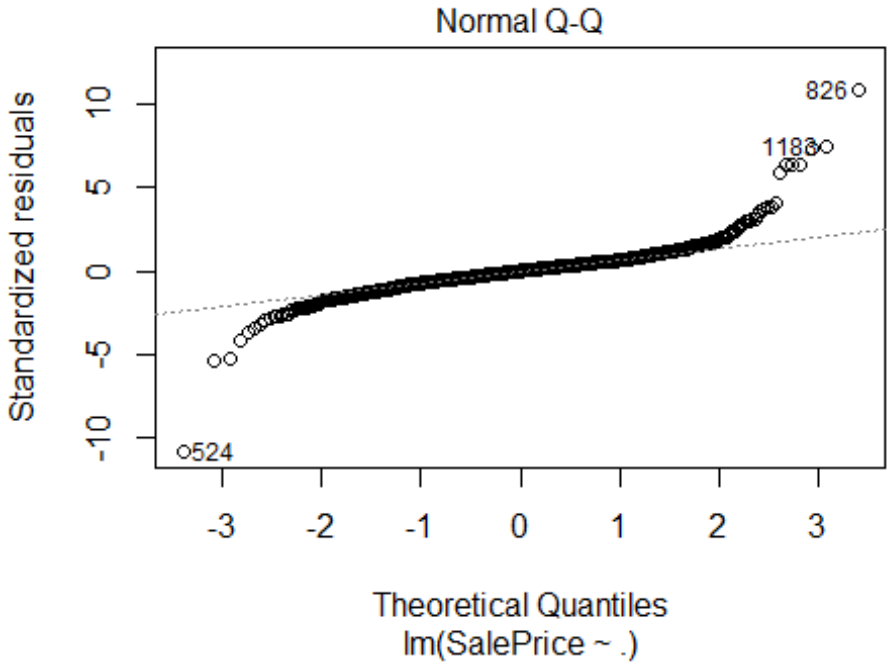
```
## Exterior2ndHdBoard    8.081e+03  1.251e+04   0.646 0.518448
## Exterior2ndImStucc    3.368e+04  1.447e+04   2.327 0.020112 *
## Exterior2ndMetalSd    2.897e+03  1.448e+04   0.200 0.841498
## Exterior2ndOther     -6.218e+03  2.822e+04  -0.220 0.825635
## Exterior2ndPlywood    9.189e+03  1.215e+04   0.756 0.449761
## Exterior2ndStone     -1.015e+04  1.738e+04  -0.584 0.559203
## Exterior2ndStucco     2.426e+03  1.366e+04   0.178 0.859056
## Exterior2ndVinylSd    1.646e+04  1.301e+04   1.266 0.205865
## Exterior2ndWd Sdng    1.052e+04  1.200e+04   0.877 0.380774
## Exterior2ndWd Shng    3.419e+03  1.251e+04   0.273 0.784665
## ExterQualFa          -8.622e+03  1.089e+04  -0.792 0.428642
## ExterQualGd          -3.080e+04  4.794e+03  -6.425 1.86e-10 ***
## ExterQualTA          -3.069e+04  5.365e+03  -5.720 1.33e-08 ***
## ExterCondFa          -2.614e+03  1.888e+04  -0.138 0.889928
## ExterCondGd          -7.990e+03  1.802e+04  -0.443 0.657627
## ExterCondPo           1.218e+04  3.286e+04   0.371 0.711022
## ExterCondTA          -5.344e+03  1.799e+04  -0.297 0.766449
## FoundationCBlock      1.760e+03  3.200e+03   0.550 0.582379
## FoundationPConc       4.829e+03  3.509e+03   1.376 0.169008
## FoundationSlab        8.498e+03  7.864e+03   1.081 0.280108
## FoundationStone       2.503e+03  1.118e+04   0.224 0.822878
## FoundationWood       -3.336e+04  1.513e+04  -2.205 0.027642 *
## BsmtFinSF1            3.710e+01  4.424e+00   8.386  < 2e-16 ***
## BsmtFinSF2            2.458e+01  5.800e+00   4.238 2.42e-05 ***
## BsmtUnfSF             1.497e+01  4.072e+00   3.676 0.000247 ***
## TotalBsmtSF                  NA         NA      NA       NA
## HeatingGasA          -7.036e+03  2.547e+04  -0.276 0.782451
## HeatingGasW          -1.559e+04  2.627e+04  -0.594 0.552905
## HeatingGrav          -1.540e+04  2.765e+04  -0.557 0.577754
## HeatingOthW          -4.575e+04  3.174e+04  -1.442 0.149665
## HeatingWall           8.292e+03  2.951e+04   0.281 0.778794
## HeatingQCFa          -1.594e+03  4.832e+03  -0.330 0.741498
## HeatingQCGd          -3.627e+03  2.153e+03  -1.685 0.092279 .
## HeatingQCPo           8.341e+03  2.775e+04   0.301 0.763758
## HeatingQCTA          -4.402e+03  2.123e+03  -2.074 0.038305 *
## CentralAirY          -3.675e+03  3.999e+03  -0.919 0.358319
## ElectricalFuseF      -1.221e+03  5.993e+03  -0.204 0.838579
## ElectricalFuseP      -1.003e+04  1.745e+04  -0.574 0.565821
## ElectricalMix         3.604e+03  2.893e+04   0.125 0.900860
## ElectricalSBrkr      -1.335e+03  3.028e+03  -0.441 0.659257
## X1stFlrSF             5.503e+01  5.337e+00  10.311  < 2e-16 ***
## X2ndFlrSF             6.998e+01  5.279e+00  13.257  < 2e-16 ***
## LowQualFinSF          2.514e+01  1.873e+01   1.342 0.179809
## GrLivArea                    NA         NA      NA       NA
## BsmtFullBath          1.551e+03  1.969e+03   0.788 0.431109
## BsmtHalfBath          3.517e+02  3.118e+03   0.113 0.910199
## FullBath              2.601e+03  2.247e+03   1.158 0.247210
## HalfBath             -1.508e+02  2.141e+03  -0.070 0.943878
## BedroomAbvGr         -5.506e+03  1.385e+03  -3.975 7.45e-05 ***
## KitchenAbvGr         -1.576e+04  5.776e+03  -2.729 0.006432 **
```

```
## KitchenQualFa        -2.065e+04  6.417e+03  -3.218 0.001324 **
## KitchenQualGd        -2.775e+04  3.490e+03  -7.953 4.01e-15 ***
## KitchenQualTA        -2.522e+04  3.999e+03  -6.307 3.93e-10 ***
## TotRmsAbvGrd          1.343e+03  9.765e+02   1.375 0.169414
## FunctionalMaj2       -5.309e+02  1.480e+04  -0.036 0.971397
## FunctionalMin1        4.452e+03  8.670e+03   0.514 0.607659
## FunctionalMin2        8.559e+03  8.584e+03   0.997 0.318926
## FunctionalMod        -7.249e+03  1.057e+04  -0.686 0.492877
## FunctionalSev        -5.986e+04  2.759e+04  -2.169 0.030236 *
## FunctionalTyp         1.970e+04  7.422e+03   2.654 0.008048 **
## Fireplaces            2.821e+03  1.374e+03   2.052 0.040326 *
## GarageCars            4.257e+03  2.222e+03   1.916 0.055637 .
## GarageArea            1.337e+01  7.653e+00   1.748 0.080774 .
## PavedDriveP          -3.332e+03  5.577e+03  -0.598 0.550237
## PavedDriveY          -2.109e+03  3.459e+03  -0.610 0.542108
## WoodDeckSF            1.370e+01  5.958e+00   2.300 0.021622 *
## OpenPorchSF           1.212e+01  1.185e+01   1.023 0.306696
## EnclosedPorch         5.632e+00  1.285e+01   0.438 0.661311
## X3SsnPorch            2.423e+01  2.316e+01   1.046 0.295536
## ScreenPorch           3.717e+01  1.260e+01   2.950 0.003238 **
## PoolArea              7.127e+01  1.836e+01   3.883 0.000109 ***
## MiscVal              -3.146e-01  1.470e+00  -0.214 0.830518
## MoSold               -6.394e+02  2.542e+02  -2.516 0.011996 *
## YrSold               -1.758e+02  5.250e+02  -0.335 0.737816
## SaleTypeCon           3.537e+04  1.839e+04   1.923 0.054645 .
## SaleTypeConLD         1.673e+04  1.002e+04   1.669 0.095317 .
## SaleTypeConLI         9.984e+03  1.192e+04   0.837 0.402591
## SaleTypeConLw        -2.443e+03  1.243e+04  -0.197 0.844222
## SaleTypeCWD           2.316e+04  1.337e+04   1.732 0.083534 .
## SaleTypeNew           3.440e+04  1.606e+04   2.142 0.032353 *
## SaleTypeOth           1.856e+04  1.504e+04   1.234 0.217488
## SaleTypeWD            4.603e+02  4.344e+03   0.106 0.915627
## SaleConditionAdjLand  1.047e+04  1.506e+04   0.696 0.486792
## SaleConditionAlloca   5.064e+03  8.787e+03   0.576 0.564546
## SaleConditionFamily  -1.338e+03  6.330e+03  -0.211 0.832625
## SaleConditionNormal   6.618e+03  2.994e+03   2.210 0.027273 *
## SaleConditionPartial -9.139e+03  1.547e+04  -0.591 0.554858
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 24010 on 1268 degrees of freedom
##   (1 observation deleted due to missingness)
## Multiple R-squared:  0.9206, Adjusted R-squared:  0.9087
## F-statistic: 77.37 on 190 and 1268 DF,  p-value: < 2.2e-16

accuracy(linear)

##                        ME     RMSE      MAE       MPE     MAPE     MASE
## Training set 6.955399e-13 22385.97 14532.91 -0.589762 8.495274 0.252891
```

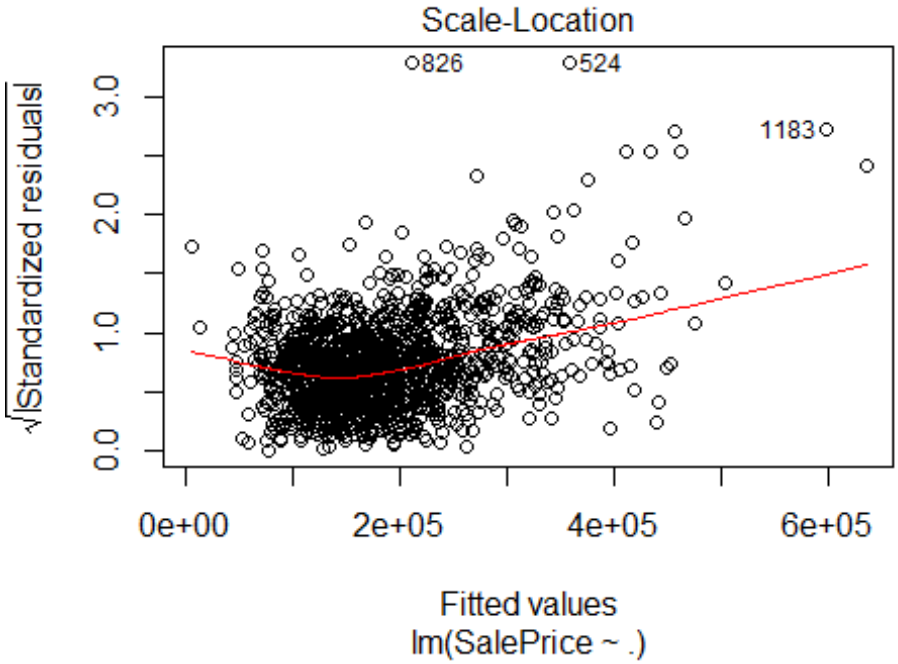
```r
plot(linear)
```

```
## Warning: not plotting observations with leverage one:
##   121, 272, 326, 399, 584, 596, 667, 945, 1004, 1012, 1188, 1231, 1271,
1276, 1299, 1322, 1371
```

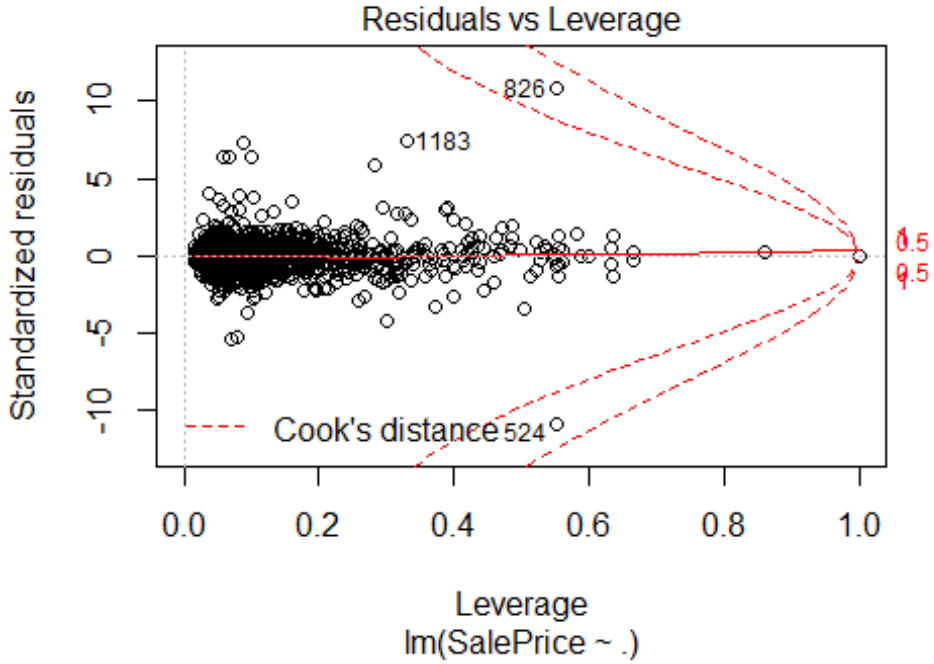





```
## Warning: not plotting observations with leverage one:
##   121, 272, 326, 399, 584, 596, 667, 945, 1004, 1012, 1188, 1231, 1271,
1276, 1299, 1322, 1371
```




```
## Warning in sqrt(crit * p * (1 - hh)/hh): NaNs produced

## Warning in sqrt(crit * p * (1 - hh)/hh): NaNs produced
```



```r
library(car)
```

```
## Warning: package 'car' was built under R version 3.5.2
```

```
## Loading required package: carData
```

```
## Warning: package 'carData' was built under R version 3.5.2
```

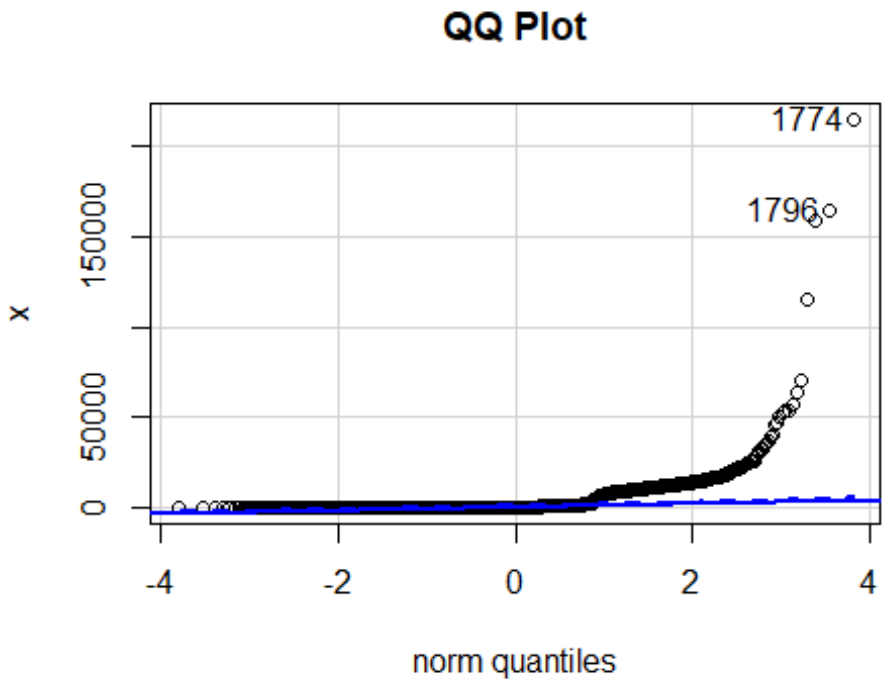
```
##
## Attaching package: 'car'
```

```
## The following object is masked from 'package:dplyr':
##
##     recode
```

```r
outlierTest(linear)
```

```
##        rstudent unadjusted p-value Bonferonni p
## 524  -11.362257         1.4735e-28   2.1248e-25
## 826   11.362257         1.4735e-28   2.1248e-25
## 1183   7.599255         5.7672e-14   8.3164e-11
## 1170   7.462093         1.5764e-13   2.2731e-10
## 899    6.528493         9.5889e-11   1.3827e-07
## 1047   6.511430         1.0705e-10   1.5436e-07
## 804    6.507672         1.0967e-10   1.5814e-07
## 692    5.942391         3.6254e-09   5.2278e-06
## 1325  -5.459095         5.7525e-08   8.2952e-05
## 582   -5.335961         1.1249e-07   1.6221e-04
```

```r
x <- c( BedroomAbvGr, LotArea, PoolArea, TotalBsmtSF, TotRmsAbvGrd)
qqPlot(x , main="QQ Plot")
```




```
## [1] 1774 1796
```

```
library(ggpubr)
```

```
## Warning: package 'ggpubr' was built under R version 3.5.2
```

```
## Loading required package: magrittr
```

```
##
## Attaching package: 'ggpubr'
```

```
## The following object is masked from 'package:forecast':
##
##     gghistogram
```

```
## The following object is masked from 'package:plyr':
##
##     mutate
```

```
t.test(SalePrice, x, data = training)
```

```
##
##  Welch Two Sample t-test
##
## data:  SalePrice and x
## t = 85.854, df = 1462.4, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
```

```
##  174523.2 182684.6
## sample estimates:
## mean of x mean of y
## 180921.20   2317.28
```