# sample-submission.R

Submitted by:

Tejaswini Nutalapati

Aditi Bhargava

```
#Loading the libraries

library(reshape2)
library(dplyr)

##
## 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(ggplot2)
library(lattice)
library(caret)
library(scales)
library(dummies)

## dummies-1.5.6 provided by Decision Patterns

library(fmsb)

## Registered S3 methods overwritten by 'fmsb':
##   method    from
##   print.roc pROC
##   plot.roc  pROC

library(randomForest)

## randomForest 4.6-14

## Type rfNews() to see new features/changes/bug fixes.

##
## Attaching package: 'randomForest'
## The following object is masked from 'package:ggplot2':
##
##     margin
```

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

```
library(DescTools)
```

```
##
## Attaching package: 'DescTools'
```

```
## The following objects are masked from 'package:fmsb':
##
##     CronbachAlpha, VIF
```

```
## The following objects are masked from 'package:caret':
##
##     MAE, RMSE
```

```
library(outliers)
```

```
##
## Attaching package: 'outliers'
```

```
## The following object is masked from 'package:randomForest':
##
##     outlier
```

```
library(VIM)
```

```
## Loading required package: colorspace
```

```
## Loading required package: grid
```

```
## Loading required package: data.table
```

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

```
## The following object is masked from 'package:DescTools':
##
##     %like%
```

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

```
## The following objects are masked from 'package:reshape2':
##
##     dcast, melt
## VIM is ready to use.
##  Since version 4.0.0 the GUI is in its own package VIMGUI.
##
##           Please use the package to use the new (and old) GUI.
```

```
## Suggestions and bug-reports can be submitted at:
https://github.com/alexkowa/VIM/issues
```

```
##
## Attaching package: 'VIM'
```

```
## The following object is masked from 'package:datasets':
##
##     sleep
```

```
library(GGally)
```

```
## Registered S3 method overwritten by 'GGally':
##   method from
##   +.gg   ggplot2
```

```
library(corrplot)
```

```
## corrplot 0.84 loaded
```

```
# Loading the dataset

list.files("../input")
```

```
## character(0)
```

```
Train<-read.csv("C:/Users/aditi/OneDrive/Desktop/MVA/train.csv")
Test<-read.csv("C:/Users/aditi/OneDrive/Desktop/MVA/test.csv")

# Add sale price new column in test dataset
Test["SalePrice"] <- NA

# Let's explore the structure of the data
dim(Train)
```

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

```
str(Train)
```

```
## '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 ...
```

```
dim(Test)
```

```
## [1] 1459   81
```

```
str(Test)
```

```
## 'data.frame':    1459 obs. of  81 variables:
##  $ Id           : int  1461 1462 1463 1464 1465 1466 1467 1468 1469 1470
...
##  $ MSSubClass   : int  20 20 60 60 120 60 20 60 20 20 ...
##  $ MSZoning     : Factor w/ 5 levels "C (all)","FV",..: 3 4 4 4 4 4 4 4 4
4 ...
##  $ LotFrontage  : int  80 81 74 78 43 75 NA 63 85 70 ...
##  $ LotArea      : int  11622 14267 13830 9978 5005 10000 7980 8402 10176
8400 ...
##  $ 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 1 1 1 1 1 1 1
4 4 ...
##  $ LandContour  : Factor w/ 4 levels "Bnk","HLS","Low",..: 4 4 4 4 2 4 4 4
4 4 ...
##  $ Utilities    : Factor w/ 1 level "AllPub": 1 1 1 1 1 1 1 1 1 1 ...
##  $ LotConfig    : Factor w/ 5 levels "Corner","CulDSac",..: 5 1 5 5 5 1 5
5 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",..: 13 13 9 9 22
9 9 9 9 13 ...
##  $ Condition1   : Factor w/ 9 levels "Artery","Feedr",..: 2 3 3 3 3 3 3 3
3 3 ...
##  $ Condition2   : Factor w/ 5 levels "Artery","Feedr",..: 3 3 3 3 3 3 3 3
3 3 ...
##  $ BldgType     : Factor w/ 5 levels "1Fam","2fmCon",..: 1 1 1 1 5 1 1 1 1
1 ...
##  $ HouseStyle   : Factor w/ 7 levels "1.5Fin","1.5Unf",..: 3 3 5 5 3 5 3 5
3 3 ...
##  $ OverallQual  : int  5 6 5 6 8 6 6 6 7 4 ...
##  $ OverallCond  : int  6 6 5 6 5 5 7 5 5 5 ...
##  $ YearBuilt    : int  1961 1958 1997 1998 1992 1993 1992 1998 1990 1970
...
##  $ YearRemodAdd : int  1961 1958 1998 1998 1992 1994 2007 1998 1990 1970
...
##  $ RoofStyle    : Factor w/ 6 levels "Flat","Gable",..: 2 4 2 2 2 2 2 2 2
2 ...
##  $ RoofMatl     : Factor w/ 4 levels "CompShg","Tar&Grv",..: 1 1 1 1 1 1 1
1 1 1 ...
##  $ Exterior1st  : Factor w/ 13 levels "AsbShng","AsphShn",..: 11 12 11 11
7 7 7 11 7 9 ...
##  $ Exterior2nd  : Factor w/ 15 levels "AsbShng","AsphShn",..: 13 14 13 13
7 7 7 13 7 10 ...
##  $ MasVnrType   : Factor w/ 4 levels "BrkCmn","BrkFace",..: 3 2 3 2 3 3 3
3 3 3 ...
##  $ MasVnrArea   : int  0 108 0 20 0 0 0 0 0 0 ...
##  $ ExterQual    : Factor w/ 4 levels "Ex","Fa","Gd",..: 4 4 4 4 3 4 4 4 4
4 ...
##  $ ExterCond    : Factor w/ 5 levels "Ex","Fa","Gd",..: 5 5 5 5 5 5 3 5 5
5 ...
##  $ Foundation   : Factor w/ 6 levels "BrkTil","CBlock",..: 2 2 3 3 3 3 3 3
3 2 ...
##  $ BsmtQual     : Factor w/ 4 levels "Ex","Fa","Gd",..: 4 4 3 4 3 3 3 3 3
4 ...
##  $ BsmtCond     : Factor w/ 4 levels "Fa","Gd","Po",..: 4 4 4 4 4 4 4 4 4
4 ...
##  $ BsmtExposure : Factor w/ 4 levels "Av","Gd","Mn",..: 4 4 4 4 4 4 4 4 2
4 ...
##  $ BsmtFinType1 : Factor w/ 6 levels "ALQ","BLQ","GLQ",..: 5 1 3 3 1 6 1 6
3 1 ...
##  $ BsmtFinSF1   : int  468 923 791 602 263 0 935 0 637 804 ...
##  $ BsmtFinType2 : Factor w/ 6 levels "ALQ","BLQ","GLQ",..: 4 6 6 6 6 6 6 6
6 5 ...
##  $ BsmtFinSF2   : int  144 0 0 0 0 0 0 0 0 78 ...
##  $ BsmtUnfSF    : int  270 406 137 324 1017 763 233 789 663 0 ...
##  $ TotalBsmtSF  : int  882 1329 928 926 1280 763 1168 789 1300 882 ...
##  $ Heating      : Factor w/ 4 levels "GasA","GasW",..: 1 1 1 1 1 1 1 1 1 1
...
##  $ HeatingQC    : Factor w/ 5 levels "Ex","Fa","Gd",..: 5 5 3 1 1 3 1 3 3
```

```
5 ...
##  $ CentralAir   : Factor w/ 2 levels "N","Y": 2 2 2 2 2 2 2 2 2 2 ...
##  $ Electrical   : Factor w/ 4 levels "FuseA","FuseF",..: 4 4 4 4 4 4 4 4 4
4 ...
##  $ X1stFlrSF    : int  896 1329 928 926 1280 763 1187 789 1341 882 ...
##  $ X2ndFlrSF    : int  0 0 701 678 0 892 0 676 0 0 ...
##  $ LowQualFinSF : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ GrLivArea    : int  896 1329 1629 1604 1280 1655 1187 1465 1341 882 ...
##  $ BsmtFullBath : int  0 0 0 0 0 0 1 0 1 1 ...
##  $ BsmtHalfBath : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ FullBath     : int  1 1 2 2 2 2 2 2 1 1 ...
##  $ HalfBath     : int  0 1 1 1 0 1 0 1 1 0 ...
##  $ BedroomAbvGr : int  2 3 3 3 2 3 3 3 2 2 ...
##  $ KitchenAbvGr : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ KitchenQual  : Factor w/ 4 levels "Ex","Fa","Gd",..: 4 3 4 3 3 4 4 4 3
4 ...
##  $ TotRmsAbvGrd : int  5 6 6 7 5 7 6 7 5 4 ...
##  $ Functional   : Factor w/ 7 levels "Maj1","Maj2",..: 7 7 7 7 7 7 7 7 7 7
...
##  $ Fireplaces   : int  0 0 1 1 0 1 0 1 1 0 ...
##  $ FireplaceQu  : Factor w/ 5 levels "Ex","Fa","Gd",..: NA NA 5 3 NA 5 NA
3 4 NA ...
##  $ GarageType   : Factor w/ 6 levels "2Types","Attchd",..: 2 2 2 2 2 2 2 2
2 2 ...
##  $ GarageYrBlt  : int  1961 1958 1997 1998 1992 1993 1992 1998 1990 1970
...
##  $ GarageFinish : Factor w/ 3 levels "Fin","RFn","Unf": 3 3 1 1 2 1 1 1 3
1 ...
##  $ GarageCars   : int  1 1 2 2 2 2 2 2 2 2 ...
##  $ GarageArea   : int  730 312 482 470 506 440 420 393 506 525 ...
##  $ GarageQual   : Factor w/ 4 levels "Fa","Gd","Po",..: 4 4 4 4 4 4 4 4 4
4 ...
##  $ 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  140 393 212 360 0 157 483 0 192 240 ...
##  $ OpenPorchSF  : int  0 36 34 36 82 84 21 75 0 0 ...
##  $ EnclosedPorch: int  0 0 0 0 0 0 0 0 0 0 ...
##  $ X3SsnPorch   : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ ScreenPorch  : int  120 0 0 0 144 0 0 0 0 0 ...
##  $ PoolArea     : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ PoolQC       : Factor w/ 2 levels "Ex","Gd": NA NA NA NA NA NA NA NA NA
NA ...
##  $ Fence        : Factor w/ 4 levels "GdPrv","GdWo",..: 3 NA 3 NA NA NA 1
NA NA 3 ...
##  $ MiscFeature  : Factor w/ 3 levels "Gar2","Othr",..: NA 1 NA NA NA NA 3
NA NA NA ...
##  $ MiscVal      : int  0 12500 0 0 0 0 500 0 0 0 ...
##  $ MoSold       : int  6 6 3 6 1 4 3 5 2 4 ...
##  $ YrSold       : int  2010 2010 2010 2010 2010 2010 2010 2010 2010 2010
```

```
...
##  $ 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 5 5 5 5
5 5 5 ...
##  $ SalePrice    : logi  NA NA NA NA NA NA ...
```

```
#The categorical variables are stored as factors in our dataframe.

# Combining the dataset
Test$SalePrice <- -1
df <- rbind(Train,Test)
str(df)
```

```
## 'data.frame':    2919 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    : num  208500 181500 223500 140000 250000 ...
```

```
summary(df)
```

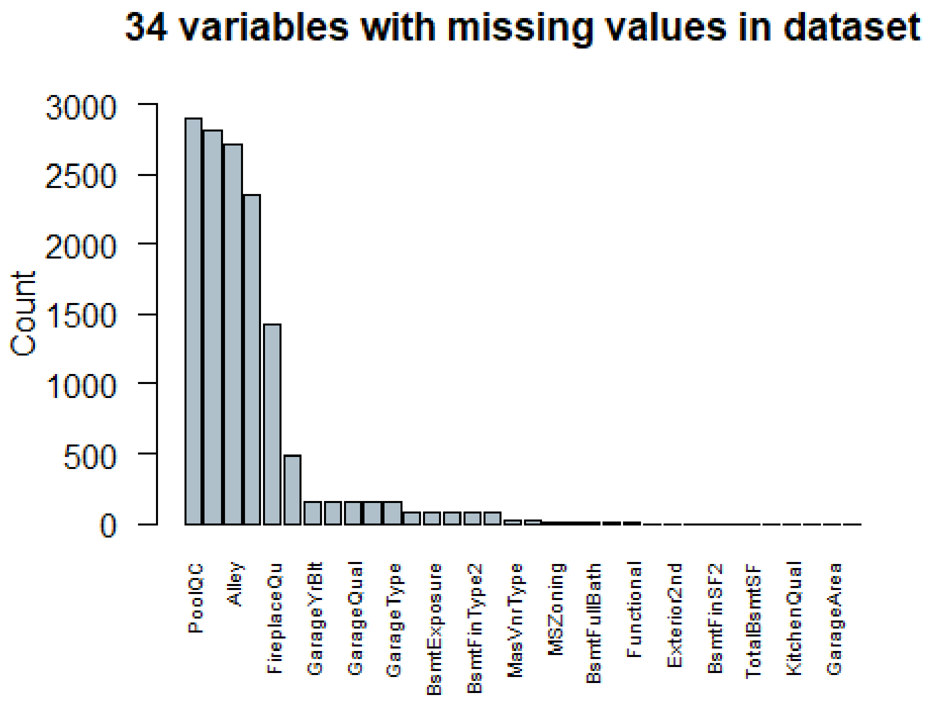
```
##        Id           MSSubClass        MSZoning     LotFrontage
##  Min.   :   1.0   Min.   : 20.00   C (all):  25   Min.   : 21.00
##  1st Qu.: 730.5   1st Qu.: 20.00   FV     : 139   1st Qu.: 59.00
##  Median :1460.0   Median : 50.00   RH     :  26   Median : 68.00
##  Mean   :1460.0   Mean   : 57.14   RL      :2265   Mean   : 69.31  
##  3rd Qu.:2189.5   3rd Qu.: 70.00   RM      : 460   3rd Qu.: 80.00  
##  Max.   :2919.0   Max.   :190.00   NA's    :   4   Max.   :313.00  
##                                                    NA's   :486     
##     LotArea        Street      Alley      LotShape   LandContour 
Utilities   
##  Min.   :  1300   Grvl:  12   Grvl: 120   IR1: 968   Bnk: 117    
AllPub:2916  
##  1st Qu.:  7478   Pave:2907   Pave:  78   IR2:  76   HLS: 120    NoSeWa:   
1  
##  Median :  9453               NA's:2721   IR3:  16   Low:  60    NA's  :   
2  
##  Mean   : 10168                           Reg:1859   Lvl:2622                
##  3rd Qu.: 11570                                                              
##  Max.   :215245                                                              
##                                                                              
##    LotConfig    LandSlope   Neighborhood    Condition1     Condition2  
##  Corner : 511   Gtl:2778   NAmes  : 443   Norm   :2511   Norm   :2889  
##  CulDSac: 176   Mod: 125   CollgCr: 267   Feedr  : 164   Feedr  :  13  
##  FR2    :  85   Sev:  16   OldTown: 239   Artery :  92   Artery :   5  
##  FR3    :  14              Edwards: 194   RRAn   :  50   PosA   :   4  
##  Inside :2133              Somerst: 182   PosN   :  39   PosN   :   4  
##                            NridgHt: 166   RRAe   :  28   RRNn   :   2  
##                            (Other):1428   (Other):  35   (Other):   2  
##    BldgType      HouseStyle    OverallQual      OverallCond      YearBuilt   
##  1Fam  :2425   1Story :1471   Min.   : 1.000   Min.   :1.000   Min.   
:1872  
##  2fmCon:  62   2Story : 872   1st Qu.: 5.000   1st Qu.:5.000   1st 
Qu.:1954  
##  Duplex: 109   1.5Fin : 314   Median : 6.000   Median :5.000   Median 
:1973  
##  Twnhs :  96   SLvl   : 128   Mean   : 6.089   Mean   :5.565   Mean   
:1971  
##  TwnhsE: 227   SFoyer :  83   3rd Qu.: 7.000   3rd Qu.:6.000   3rd 
Qu.:2001  
##                2.5Unf :  24   Max.   :10.000   Max.   :9.000   Max.   
:2010  
##                (Other):  27                                                  
##   YearRemodAdd    RoofStyle       RoofMatl     Exterior1st    Exterior2nd  
##  Min.   :1950   Flat   :  20   CompShg:2876   VinylSd:1025   VinylSd:1014  
##  1st Qu.:1965   Gable  :2310   Tar&Grv:  23   MetalSd: 450   MetalSd: 447  
##  Median :1993   Gambrel:  22   WdShake:   9   HdBoard: 442   HdBoard: 406  
##  Mean   :1984   Hip    : 551   WdShngl:   7   Wd Sdng: 411   Wd Sdng: 391  
##  3rd Qu.:2004   Mansard:  11   ClyTile:   1   Plywood: 221   Plywood: 270  
##  Max.   :2010   Shed   :   5   Membran:   1   (Other): 369   (Other): 390  
##                                (Other):   2   NA's   :   1   NA's   :   1  
##    MasVnrType     MasVnrArea     ExterQual ExterCond  Foundation   
BsmtQual   
##  BrkCmn :  25   Min.   :   0.0   Ex: 107   Ex:  12   BrkTil: 311   Ex  :
258  
```

```
##  BrkFace: 879   1st Qu.:   0.0   Fa:  35   Fa:  67   CBlock:1235   Fa  :
88
##  None   :1742   Median :   0.0   Gd: 979   Gd: 299   PConc :1308   Gd
:1209
##  Stone  : 249   Mean   : 102.2   TA:1798   Po:   3   Slab  :  49   TA
:1283
##  NA's   :  24   3rd Qu.: 164.0             TA:2538   Stone :  11   NA's:
81
##                 Max.   :1600.0                       Wood  :   5
##                 NA's   :23
##  BsmtCond    BsmtExposure BsmtFinType1   BsmtFinSF1     BsmtFinType2
##  Fa  : 104   Av  : 418    ALQ :429     Min.   :   0.0   ALQ :  52
##  Gd  : 122   Gd  : 276    BLQ :269     1st Qu.:   0.0   BLQ :  68
##  Po  :   5   Mn  : 239    GLQ :849     Median : 368.5   GLQ :  34
##  TA  :2606   No  :1904    LwQ :154     Mean   : 441.4   LwQ :  87
##  NA's:  82   NA's:  82    Rec :288     3rd Qu.: 733.0   Rec : 105
##                           Unf :851     Max.   :5644.0   Unf :2493
##                           NA's: 79     NA's   :1        NA's:  80
##    BsmtFinSF2        BsmtUnfSF       TotalBsmtSF      Heating
HeatingQC
##  Min.   :   0.00   Min.   :   0.0   Min.   :   0.0   Floor:   1   Ex:1493
##  1st Qu.:   0.00   1st Qu.: 220.0   1st Qu.: 793.0   GasA :2874   Fa:  92
##  Median :   0.00   Median : 467.0   Median : 989.5   GasW :  27   Gd: 474
##  Mean   :  49.58   Mean   : 560.8   Mean   :1051.8   Grav :   9   Po:   3
##  3rd Qu.:   0.00   3rd Qu.: 805.5   3rd Qu.:1302.0   OthW :   2   TA: 857
##  Max.   :1526.00   Max.   :2336.0   Max.   :6110.0   Wall :   6
##  NA's   :1         NA's   :1         NA's   :1
##  CentralAir Electrical     X1stFlrSF      X2ndFlrSF       LowQualFinSF
##  N: 196     FuseA: 188   Min.   : 334   Min.   :   0.0   Min.   :   0.000
##  Y:2723     FuseF:  50   1st Qu.: 876   1st Qu.:   0.0   1st Qu.:   0.000
##             FuseP:   8   Median :1082   Median :   0.0   Median :   0.000
##             Mix  :   1   Mean   :1160   Mean   : 336.5   Mean   :   4.694
##             SBrkr:2671   3rd Qu.:1388   3rd Qu.: 704.0   3rd Qu.:   0.000
##             NA's :   1   Max.   :5095   Max.   :2065.0   Max.   :1064.000
##
##    GrLivArea     BsmtFullBath     BsmtHalfBath       FullBath
##  Min.   : 334   Min.   :0.0000   Min.   :0.00000   Min.   :0.000
##  1st Qu.:1126   1st Qu.:0.0000   1st Qu.:0.00000   1st Qu.:1.000
##  Median :1444   Median :0.0000   Median :0.00000   Median :2.000
##  Mean   :1501   Mean   :0.4299   Mean   :0.06136   Mean   :1.568
##  3rd Qu.:1744   3rd Qu.:1.0000   3rd Qu.:0.00000   3rd Qu.:2.000
##  Max.   :5642   Max.   :3.0000   Max.   :2.00000   Max.   :4.000
##                 NA's   :2        NA's   :2
##     HalfBath       BedroomAbvGr   KitchenAbvGr   KitchenQual  TotRmsAbvGrd
##  Min.   :0.0000   Min.   :0.00   Min.   :0.000   Ex  : 205   Min.   :
2.000
##  1st Qu.:0.0000   1st Qu.:2.00   1st Qu.:1.000   Fa  :  70   1st Qu.:
5.000
##  Median :0.0000   Median :3.00   Median :1.000   Gd  :1151   Median :
6.000
```

```
##  Mean   :0.3803   Mean   :2.86   Mean   :1.045   TA  :1492   Mean   :
6.452
##  3rd Qu.:1.0000   3rd Qu.:3.00   3rd Qu.:1.000   NA's:   1   3rd Qu.:
7.000
##  Max.   :2.0000   Max.   :8.00   Max.   :3.000               Max.
:15.000
##
##    Functional     Fireplaces     FireplaceQu   GarageType    GarageYrBlt
##  Typ    :2717   Min.   :0.0000   Ex  :  43   2Types :  23   Min.   :1895
##  Min2   :  70   1st Qu.:0.0000   Fa  :  74   Attchd :1723   1st Qu.:1960
##  Min1   :  65   Median :1.0000   Gd  : 744   Basment:  36   Median :1979
##  Mod    :  35   Mean   :0.5971   Po  :  46   BuiltIn: 186   Mean   :1978
##  Maj1   :  19   3rd Qu.:1.0000   TA  : 592   CarPort:  15   3rd Qu.:2002
##  (Other):  11   Max.   :4.0000   NA's:1420   Detchd : 779   Max.   :2207
##  NA's   :   2                                NA's   : 157   NA's   :159
##  GarageFinish   GarageCars      GarageArea     GarageQual  GarageCond
##  Fin : 719    Min.   :0.000   Min.   :   0.0   Ex  :   3   Ex  :   3
##  RFn : 811    1st Qu.:1.000   1st Qu.: 320.0   Fa  : 124   Fa  :  74
##  Unf :1230    Median :2.000   Median : 480.0   Gd  :  24   Gd  :  15
##  NA's: 159    Mean   :1.767   Mean   : 472.9   Po  :   5   Po  :  14
##               3rd Qu.:2.000   3rd Qu.: 576.0   TA  :2604   TA  :2654
##               Max.   :5.000   Max.   :1488.0   NA's: 159   NA's: 159
##               NA's   :1       NA's   :1
##  PavedDrive   WoodDeckSF       OpenPorchSF     EnclosedPorch
##  N: 216     Min.   :   0.00   Min.   :  0.00   Min.   :   0.0
##  P:  62     1st Qu.:   0.00   1st Qu.:  0.00   1st Qu.:   0.0
##  Y:2641     Median :   0.00   Median : 26.00   Median :   0.0
##             Mean   :  93.71   Mean   : 47.49   Mean   :  23.1
##             3rd Qu.: 168.00   3rd Qu.: 70.00   3rd Qu.:   0.0
##             Max.   :1424.00   Max.   :742.00   Max.   :1012.0
##
##    X3SsnPorch       ScreenPorch        PoolArea        PoolQC       Fence
##  Min.   :  0.000   Min.   :  0.00   Min.   :  0.000   Ex  :   4   GdPrv:
118
##  1st Qu.:  0.000   1st Qu.:  0.00   1st Qu.:  0.000   Fa  :   2   GdWo :
112
##  Median :  0.000   Median :  0.00   Median :  0.000   Gd  :   4   MnPrv:
329
##  Mean   :  2.602   Mean   : 16.06   Mean   :  2.252   NA's:2909   MnWw :
12
##  3rd Qu.:  0.000   3rd Qu.:  0.00   3rd Qu.:  0.000               NA's
:2348
##  Max.   :508.000   Max.   :576.00   Max.   :800.000
##
##  MiscFeature    MiscVal             MoSold          YrSold
SaleType
##  Gar2:   5   Min.   :    0.00   Min.   : 1.000   Min.   :2006   WD
:2525
##  Othr:   4   1st Qu.:    0.00   1st Qu.: 4.000   1st Qu.:2007   New    :
239
```

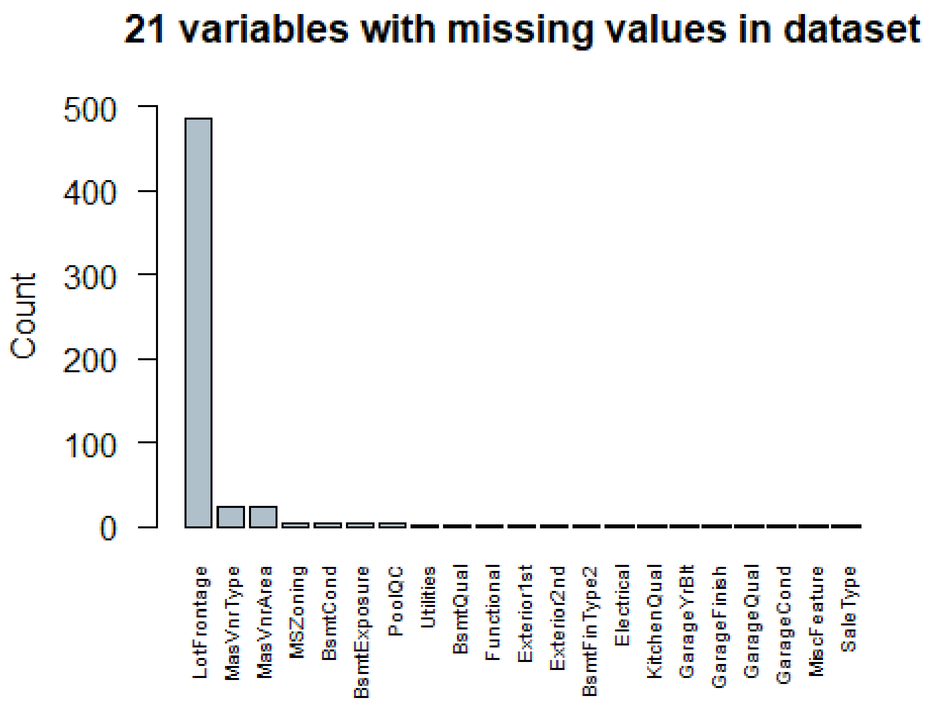
```
##  Shed:  95   Median :     0.00   Median : 6.000   Median :2008   COD     :
87
##  TenC:   1   Mean   :    50.83   Mean   : 6.213   Mean   :2008   ConLD   :
26
##  NA's:2814   3rd Qu.:     0.00   3rd Qu.: 8.000   3rd Qu.:2009   CWD     :
12
##              Max.   :17000.00   Max.   :12.000   Max.   :2010   (Other):
29
##                                                                 NA's    :
1
##  SaleCondition    SalePrice
##  Abnorml: 190   Min.   :    -1
##  AdjLand:  12   1st Qu.:    -1
##  Alloca :  24   Median : 34900
##  Family :  46   Mean   : 90491
##  Normal :2402   3rd Qu.:163000
##  Partial: 245   Max.   :755000
##
```

```
#finding how many variables with missing values are in the dataset
options(repr.plot.width=6, repr.plot.height=5)
cMiss = function(x){sum(is.na(x))}
CM <- sort(apply(df,2,cMiss),decreasing=T);
barplot(CM[CM!=0],
        las=2,
        cex.names=0.6,
        ylab="Count",
        ylim=c(0,3000),
        horiz=F,
        col="#AFC0CB",
        main=paste(toString(sum(CM!=0)), "variables with missing values in
dataset"))
```

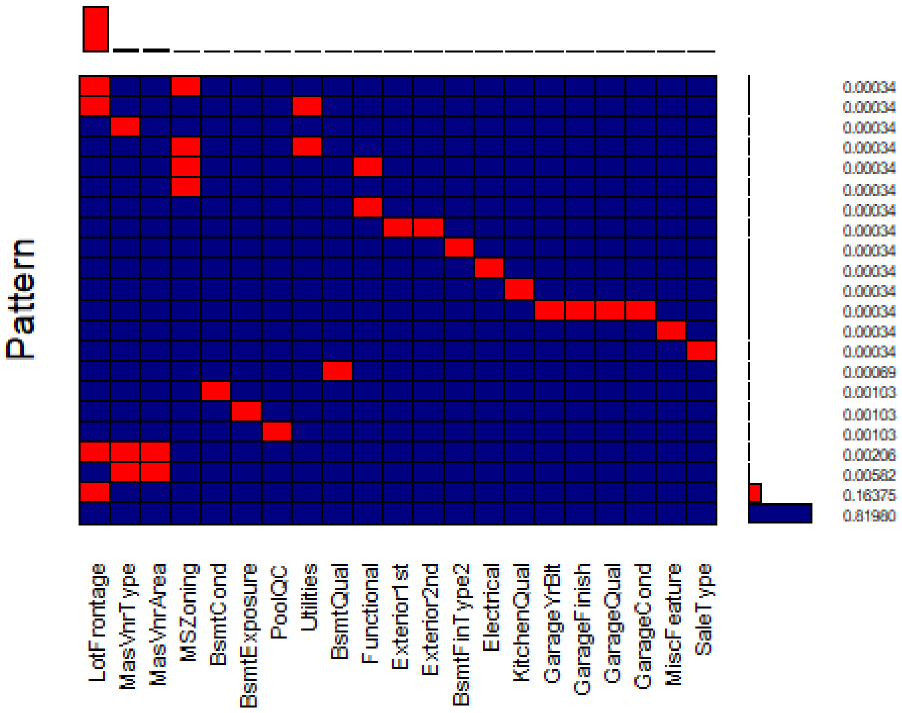


```
dfClean <-function(df)
{
  # Pool Variable: If PoolQC = NA and PoolArea = 0 , assign factor NoPool
  df$PoolQC <- as.character(df$PoolQC)
  df$PoolQC[df$PoolArea %in% c(0,NA) & is.na(df$PoolQC)] <- "NoPool"
  df$PoolQC <- as.factor(df$PoolQC)

  # MiscFeature Variable: If MiscFeature = NA and MiscVal = 0, assign factor
None
  df$MiscFeature <- as.character(df$MiscFeature)
  df$MiscFeature[df$MiscVal %in% c(0,NA) & is.na(df$MiscFeature)] <- "None"
  df$MiscFeature <- as.factor(df$MiscFeature)

  # Alley Variable: If Alley = NA, assign factor NoAccess
  df$Alley <- as.character(df$Alley)
  df$Alley[is.na(df$Alley)] <- "NoAccess"
  df$Alley <- as.factor(df$Alley)

  # Fence Variable: If Fence = NA, assign factor NoFence
  df$Fence <- as.character(df$Fence)
  df$Fence[is.na(df$Fence)] <- "NoFence"
  df$Fence <- as.factor(df$Fence)

  # FireplaceQu Variable: If FireplaceQu = NA and Fireplaces = 0 , assign
factor NoFirePlace
  df$FireplaceQu <- as.character(df$FireplaceQu)
  df$FireplaceQu[df$Fireplaces %in% c(0,NA) & is.na(df$FireplaceQu)] <-
"NoFirePlace"
  df$FireplaceQu <- as.factor(df$FireplaceQu)

  # GarageYrBlt Variable: If GarageYrBlt = NA and GarageArea = 0 assign
factor NoGarage
  df$GarageYrBlt <- as.character(df$GarageYrBlt)
  df$GarageYrBlt[df$GarageArea %in% c(0,NA) & is.na(df$GarageYrBlt)] <-
"NoGarage"
  df$GarageYrBlt <- as.factor(df$GarageYrBlt)

  # GarageFinish Variable: If GarageFinish = NA and GarageArea = 0 assign
factor NoGarage
  df$GarageFinish <- as.character(df$GarageFinish)
  df$GarageFinish[df$GarageArea %in% c(0,NA) & is.na(df$GarageFinish)] <-
"NoGarage"
  df$GarageFinish <- as.factor(df$GarageFinish)

  # GarageQual Variable: If GarageQual = NA and GarageArea = 0 assign factor
NoGarage
  df$GarageQual <- as.character(df$GarageQual)
  df$GarageQual[df$GarageArea %in% c(0,NA) & is.na(df$GarageQual)] <-
"NoGarage"
  df$GarageQual <- as.factor(df$GarageQual)

  # GarageCond Variable: If GarageCond = NA and GarageArea = 0 assign factor
NoGarage
  df$GarageCond <- as.character(df$GarageCond)
  df$GarageCond[df$GarageArea %in% c(0,NA) & is.na(df$GarageCond)] <-
"NoGarage"
  df$GarageCond <- as.factor(df$GarageCond)

  # GarageType Variable: If GarageType = NA and GarageArea = 0 assign factor
NoGarage
  df$GarageType <- as.character(df$GarageType)
  df$GarageType[df$GarageArea %in% c(0,NA) & is.na(df$GarageType)] <-
"NoGarage"
  df$GarageType <- as.factor(df$GarageType)
  df$GarageArea[is.na(df$GarageArea) & df$GarageCars %in% c(0,NA)] <- 0
  df$GarageCars[is.na(df$GarageCars) & df$GarageArea %in% c(0,NA)] <- 0

  # BsmtFullBath Variable: If BsmtFullBath = NA and TotalBsmtSF = 0 assign 0
  df$BsmtFullBath[df$TotalBsmtSF %in% c(0,NA) & is.na(df$BsmtFullBath)] <- 0

  # BsmtHalfBath Variable: If BsmtHalfBath = NA and TotalBsmtSF = 0 assign 0
  df$BsmtHalfBath[df$TotalBsmtSF %in% c(0,NA) & is.na(df$BsmtHalfBath)] <- 0

  # BsmtFinSF1 Variable: If BsmtFinSF1 = NA and TotalBsmtSF = 0 assign 0
  df$BsmtFinSF1[df$TotalBsmtSF %in% c(0,NA) & is.na(df$BsmtFinSF1)] <- 0
  # BsmtFinSF2 Variable: If BsmtFinSF2 = NA and TotalBsmtSF = 0 assign 0
  df$BsmtFinSF2[df$TotalBsmtSF %in% c(0,NA) & is.na(df$BsmtFinSF2)] <- 0

  # BsmtUnfSF Variable: If BsmtUnfSF = NA and TotalBsmtSF = 0 assign 0
  df$BsmtUnfSF[df$TotalBsmtSF %in% c(0,NA) & is.na(df$BsmtUnfSF)] <- 0

  # TotalBsmtSF Variable: If TotalBsmtSF = NA and TotalBsmtSF = 0 assign 0
  df$TotalBsmtSF[df$TotalBsmtSF %in% c(0,NA) & is.na(df$TotalBsmtSF)] <- 0

  # BsmtQual Variable: If BsmtQual = NA and TotalBsmtSF = 0 assign factor
NoBasement
  df$BsmtQual <- as.character(df$BsmtQual)
  df$BsmtQual[df$TotalBsmtSF %in% c(0,NA) & is.na(df$BsmtQual)] <-
"NoBasement"
  df$BsmtQual <- as.factor(df$BsmtQual)

  # BsmtFinType1 Variable: If BsmtFinType1 = NA and TotalBsmtSF = 0 assign
factor NoBasement
  df$BsmtFinType1 <- as.character(df$BsmtFinType1)
  df$BsmtFinType1[df$TotalBsmtSF %in% c(0,NA) & is.na(df$BsmtFinType1)] <-
"NoBasement"
  df$BsmtFinType1 <- as.factor(df$BsmtFinType1)

  # BsmtFinType2 Variable: If BsmtFinType2 = NA and TotalBsmtSF = 0 assign
factor NoBasement
  df$BsmtFinType2 <- as.character(df$BsmtFinType2)
  df$BsmtFinType2[df$TotalBsmtSF %in% c(0,NA) & is.na(df$BsmtFinType2)] <-
"NoBasement"
  df$BsmtFinType2 <- as.factor(df$BsmtFinType2)

  # BsmtExposure Variable: If BsmtExposure = NA and TotalBsmtSF = 0 assign
factor NoBasement
  df$BsmtExposure <- as.character(df$BsmtExposure)
  df$BsmtExposure[df$TotalBsmtSF %in% c(0,NA) & is.na(df$BsmtExposure)] <-
"NoBasement"
  df$BsmtExposure <- as.factor(df$BsmtExposure)

  # BsmtCond Variable: If BsmtCond = NA and TotalBsmtSF = 0 assign factor
NoBasement
  df$BsmtCond <- as.character(df$BsmtCond)
  df$BsmtCond[df$TotalBsmtSF %in% c(0,NA) & is.na(df$BsmtCond)] <-
"NoBasement"
  df$BsmtCond <- as.factor(df$BsmtCond)
  return(df)
}
df <- dfClean(df)

PM <- sort(apply(df,2,cMiss),decreasing=T);
```

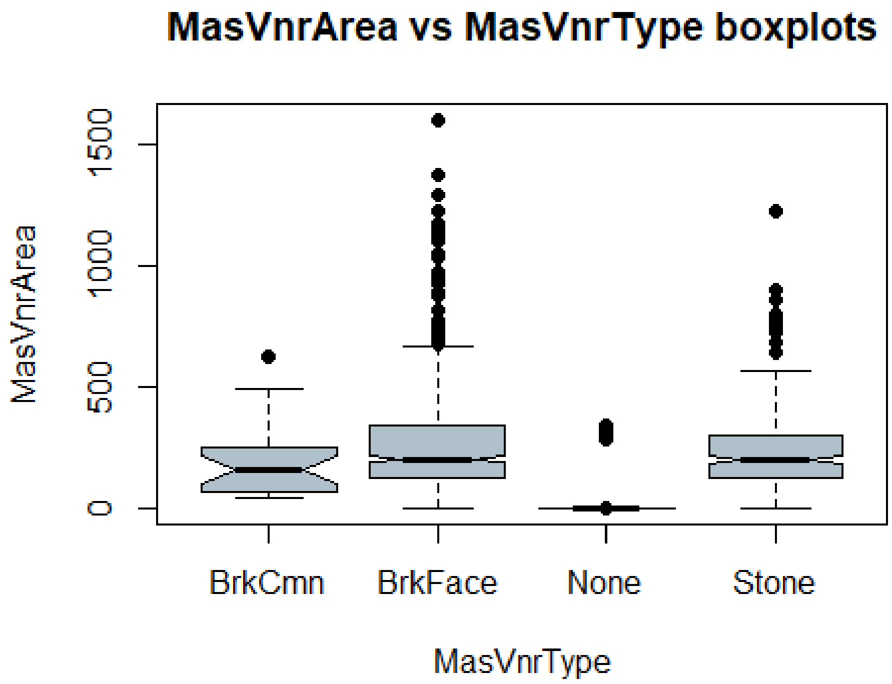
```
barplot(PM[PM!=0],
        las=2,
        cex.names=0.6,
        ylab="Count",
        ylim=c(0,500),
        horiz=F,
        col="#AFC0CB",
        main=paste(toString(sum(PM!=0)), "variables with missing values in 
dataset"))
```



```
#That certainly helped a little bit. Let's see if there's a pattern to the 
remaining missing data.
data = df[, names(PM[PM!=0])];
aggr_plot <- aggr(data,
                  col=c('navyblue','red'),
                  bars=T,
                  numbers=T,
                  combined = T,
                  labels=names(data),
                  cex.axis=.7,
                  gap=3,
                  ylab=c("Pattern"),
                  cex.numbers=0.51)
```



```
#MasVnrType and MasVnrArea
plot(df[,c("MasVnrType","MasVnrArea")],
     pch=16,
     notch=TRUE,
     main="MasVnrArea vs MasVnrType boxplots",
     col="#AFC0CB")
```

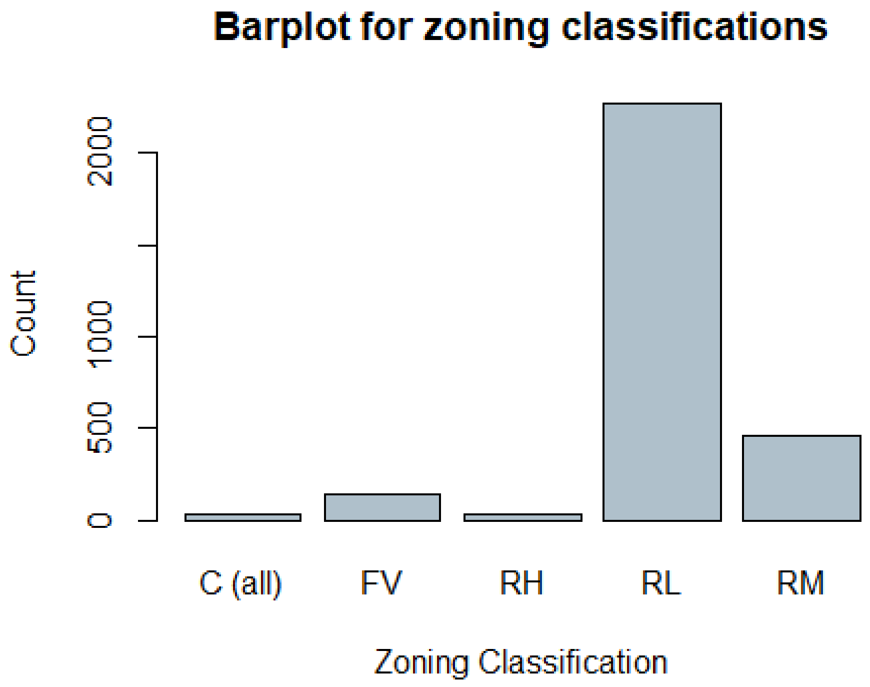


```
df[ (is.na(df$MasVnrType) | is.na(df$MasVnrArea))
,c("MasVnrType","MasVnrArea")]

##      MasVnrType MasVnrArea
## 235        <NA>         NA
## 530        <NA>         NA
## 651        <NA>         NA
## 937        <NA>         NA
## 974        <NA>         NA
## 978        <NA>         NA
## 1244       <NA>         NA
## 1279       <NA>         NA
## 1692       <NA>         NA
## 1707       <NA>         NA
## 1883       <NA>         NA
## 1993       <NA>         NA
## 2005       <NA>         NA
## 2042       <NA>         NA
## 2312       <NA>         NA
## 2326       <NA>         NA
## 2341       <NA>         NA
## 2350       <NA>         NA
## 2369       <NA>         NA
## 2593       <NA>         NA
## 2611       <NA>        198
## 2658       <NA>         NA
## 2687       <NA>         NA
## 2863       <NA>         NA
```

```
summary(df[ !(is.na(df$MasVnrType) | is.na(df$MasVnrArea))
,c("MasVnrType","MasVnrArea")])
```

```
##    MasVnrType     MasVnrArea
##  BrkCmn :  25   Min.   :   0.0
##  BrkFace: 879   1st Qu.:   0.0
##  None   :1742   Median :   0.0
##  Stone  : 249   Mean   : 102.2
##                 3rd Qu.: 164.0
##                 Max.   :1600.0
```

```
df$MasVnrType <- as.character(df$MasVnrType)
df$MasVnrType[is.na(df$MasVnrType)] <- "None"
df$MasVnrType <- as.factor(df$MasVnrType)
df$MasVnrArea[is.na(df$MasVnrArea)] <- 0

#MSZoning
plot(df$MSZoning,
     col="#AFC0CB",
     xlab="Zoning Classification",
     ylab = "Count",
     main = "Barplot for zoning classifications")
```



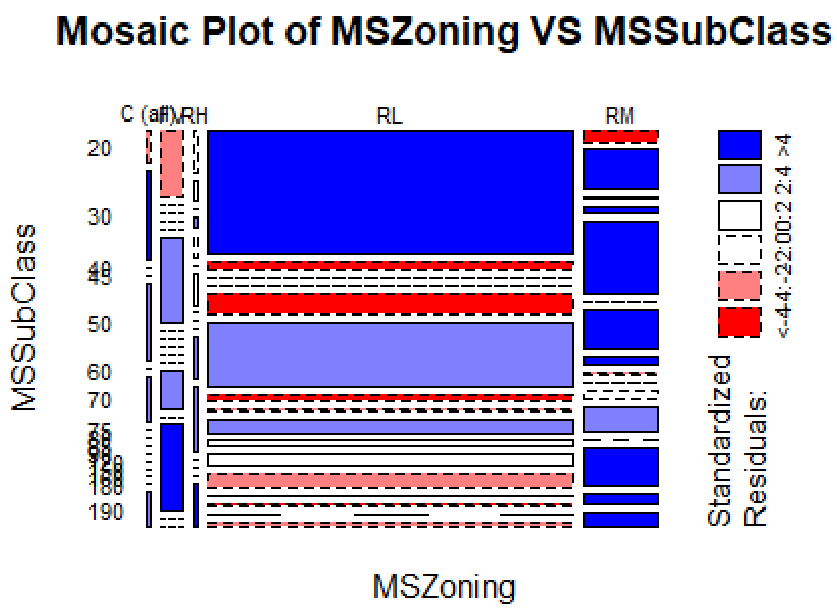
```
df[ is.na(df$MSZoning) ,c("MSZoning","MSSubClass")]
```

```
##      MSZoning MSSubClass
## 1916     <NA>         30
## 2217     <NA>         20
## 2251     <NA>         70
## 2905     <NA>         20
```

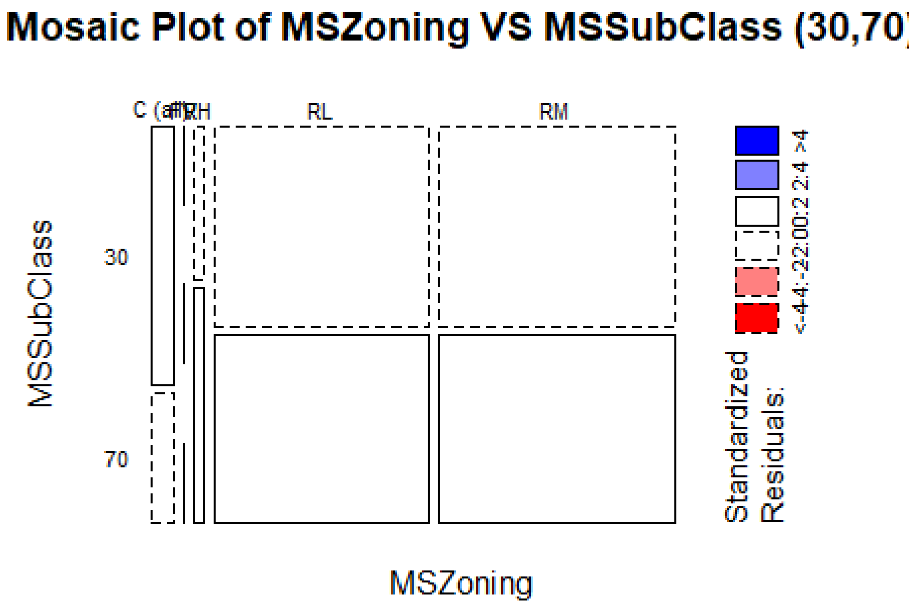
```
ZoneClassTable <- table(df[ ,c("MSZoning","MSSubClass")])
ZoneClassTable
```

```
##          MSSubClass
## MSZoning    20   30   40   45   50   60   70   75   80   85   90  120  150
160
##   C (all)    3    8    0    0    7    0    4    0    0    0    0    0    0
0
##   FV        34    0    0    0    0   43    0    0    0    0    0   19    0
43
##   RH         4    2    0    1    2    0    3    0    0    0    4    6    0
0
##   RL      1016   61    4    6  159  529   57    9  115   47   92  117    1
21
##   RM        20   67    2   11  119    3   63   14    3    1   13   40    0
64
##          MSSubClass
## MSZoning   180  190
##   C (all)    0    3
##   FV         0    0
##   RH         0    4
##   RL         0   31
##   RM        17   23
```

```
mosaicplot(ZoneClassTable,
           main="Mosaic Plot of MSZoning VS MSSubClass",
           las=1,
           color=T,
           shade=T)
```



```
GTest(ZoneClassTable)

##
##  Log likelihood ratio (G-test) test of independence without correction
##
## data:  ZoneClassTable
## G = 1321.9, X-squared df = 60, p-value < 2.2e-16

Table<-table(df[ df$MSSubClass %in% c(30,70) ,c("MSZoning","MSSubClass")])
Table <- Table[ , colSums(Table != 0) > 0 ]
Table

##          MSSubClass
## MSZoning  30 70
##   C (all)  8  4
##   FV       0  0
##   RH       2  3
##   RL      61 57
##   RM      67 63

mosaicplot(Table,
           main="Mosaic Plot of MSZoning VS MSSubClass (30,70)",
           las=1,
           color=T,
           shade=T)
```



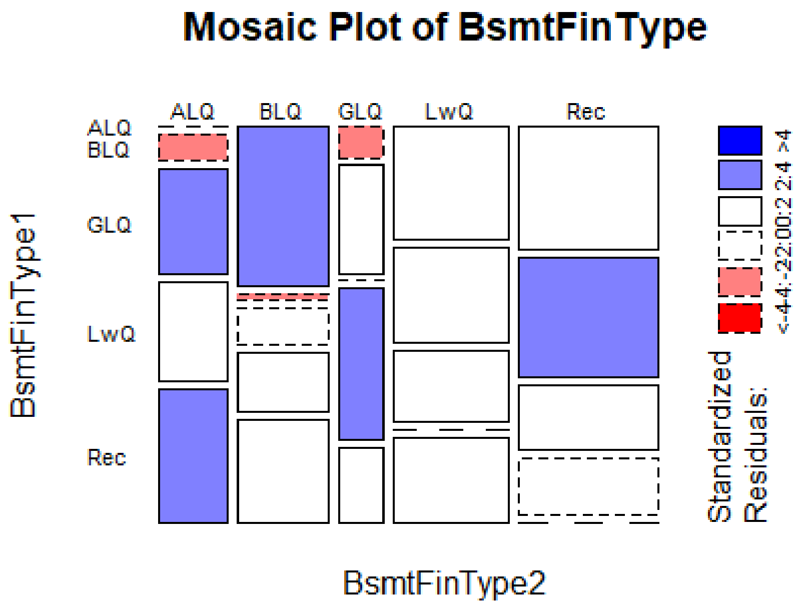
```
Test1<-GTest(Table)
Test1

##
##  Log likelihood ratio (G-test) test of independence without correction
##
## data:  Table
## G = 1.3625, X-squared df = 4, p-value = 0.8507

paste("At a 95% confidence level, since the p-value =",
as.character(round(Test1$p.value,2)),
      "> 0.05, we cannot reject the null hypothesis that MSZoning and
MSSubClass are independent when MSSubClass = 30 or 70.")

## [1] "At a 95% confidence level, since the p-value = 0.85 > 0.05, we cannot
reject the null hypothesis that MSZoning and MSSubClass are independent when
MSSubClass = 30 or 70."

df$MSZoning <- as.character(df$MSZoning)
df$MSZoning[is.na(df$MSZoning)] <- "RL"
df$MSZoning <- as.factor(df$MSZoning)

#Basement
MissBsmt = c('BsmtCond','BsmtExposure','BsmtQual','BsmtFinType2')
df[!complete.cases(df[,names(df) %in% MissBsmt]),names(df) %in%
names(df)[which(grepl("Bsmt",names(df)))]]
```

```
##      BsmtQual BsmtCond BsmtExposure BsmtFinType1 BsmtFinSF1 BsmtFinType2
## 333        Gd       TA           No          GLQ       1124         <NA>
## 949        Gd       TA         <NA>          Unf          0          Unf
## 1488       Gd       TA         <NA>          Unf          0          Unf
## 2041       Gd     <NA>           Mn          GLQ       1044          Rec
## 2186       TA     <NA>           No          BLQ       1033          Unf
## 2218     <NA>       Fa           No          Unf          0          Unf
## 2219     <NA>       TA           No          Unf          0          Unf
## 2349       Gd       TA         <NA>          Unf          0          Unf
## 2525       TA     <NA>           Av          ALQ        755          Unf
##      BsmtFinSF2 BsmtUnfSF TotalBsmtSF BsmtFullBath BsmtHalfBath
## 333         479      1603        3206            1            0
## 949           0       936         936            0            0
## 1488          0      1595        1595            0            0
## 2041        382         0        1426            1            0
## 2186          0        94        1127            0            1
## 2218          0       173         173            0            0
## 2219          0       356         356            0            0
## 2349          0       725         725            0            0
## 2525          0       240         995            0            0
```

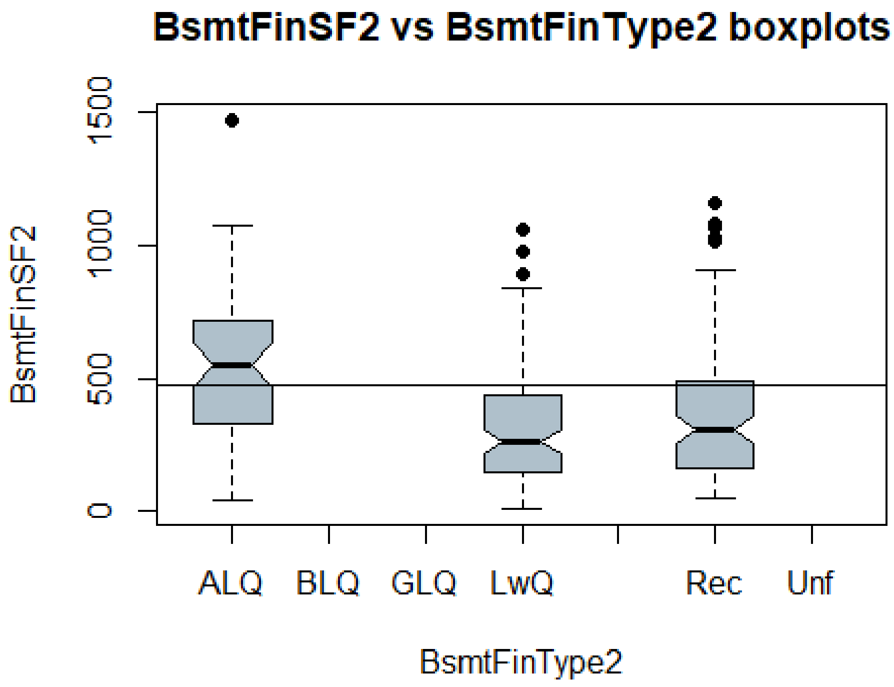
```
#BsmtExposure
df$BsmtExposure <- as.character(df$BsmtExposure)
df$BsmtExposure[is.na(df$BsmtExposure)]<-"No"
df$BsmtExposure <- as.factor(df$BsmtExposure)

#BsmtFinType2
BsmtFinQuality<-table(df[ !(df$BsmtFinType2 %in% c("NoBasement","Unf") |
df$BsmtFinType1 %in% c("NoBasement","Unf"))
,c("BsmtFinType2","BsmtFinType1")])
BsmtFinQuality<-BsmtFinQuality[rowSums(BsmtFinQuality != 0) > 0 ,
colSums(BsmtFinQuality != 0) > 0]
BsmtFinQuality
```

```
##              BsmtFinType1
## BsmtFinType2 ALQ BLQ GLQ LwQ Rec
##          ALQ   0   4  15  14  19
##          BLQ  30   1   7  11  19
##          GLQ   3  10   0  14   7
##          LwQ  27  23  17   0  20
##          Rec  36  34  19  16   0
```

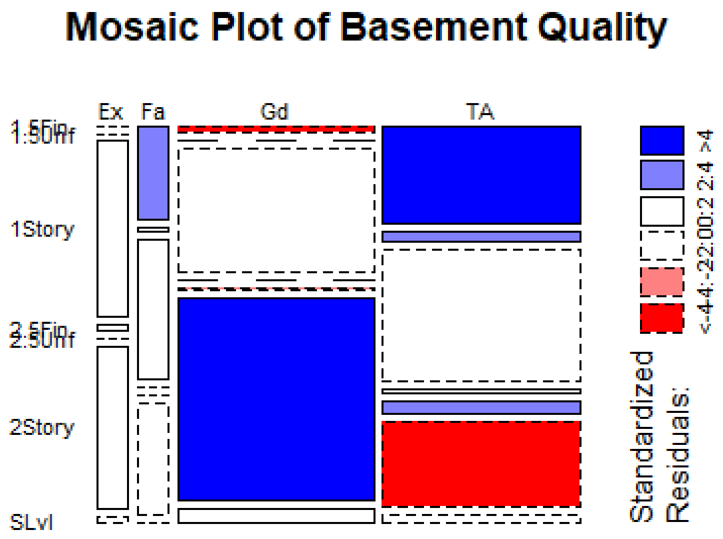
```
mosaicplot(BsmtFinQuality,
           main="Mosaic Plot of BsmtFinType",
           las=1,
           color=T,
           shade=T)
```



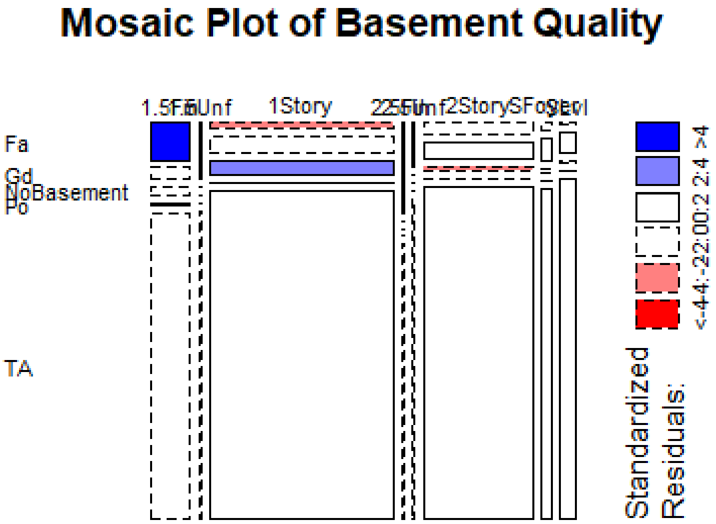
```
TestQ<-GTest(BsmtFinQuality)
TestQ

##
##  Log likelihood ratio (G-test) test of independence without correction
##
## data:  BsmtFinQuality
## G = 184.71, X-squared df = 16, p-value < 2.2e-16

plot(df[df$BsmtFinType2 %in% c("ALQ","LwQ",
"Rec"),c("BsmtFinType2","BsmtFinSF2")],
     pch=16,
     notch=TRUE,
     main="BsmtFinSF2 vs BsmtFinType2 boxplots",
     col="#AFC0CB")
abline(h=df[is.na(df$BsmtFinType2) ,c("BsmtFinSF2")])
```



```
df$BsmtFinType2 <- as.character(df$BsmtFinType2)
df$BsmtFinType2[is.na(df$BsmtFinType2)]<-"ALQ"
df$BsmtFinType2 <- as.factor(df$BsmtFinType2)

#BsmtQual
BsmtQualUnf<-table(df$BsmtQual[df$BsmtUnfSF==df$TotalBsmtSF &
df$TotalBsmtSF>0],df$HouseStyle[df$BsmtUnfSF==df$TotalBsmtSF &
df$TotalBsmtSF>0])
BsmtQualUnf<-BsmtQualUnf[rowSums(BsmtQualUnf != 0) > 0 , colSums(BsmtQualUnf
!= 0) > 0]
BsmtQualUnf

##
##      1.5Fin 1.5Unf 1Story 2.5Fin 2.5Unf 2Story SLvl
##   Ex      0      0     28      1      0     26    1
##   Fa     16      1     24      0      0     19    0
##   Gd      8      0    129      0      1    212   14
##   TA    103     12    139      4     13     89    9

mosaicplot(BsmtQualUnf,
           main="Mosaic Plot of Basement Quality",
           las=1,
           color=T,
           shade=T)
```

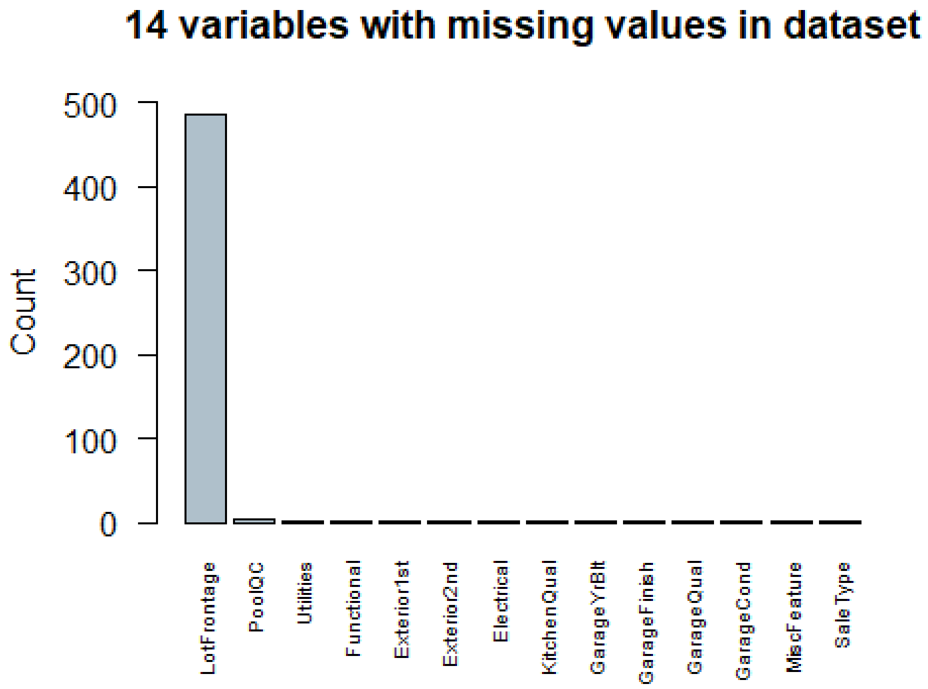


```
TestQ2<-GTest(BsmtQualUnf)
TestQ2

##
##  Log likelihood ratio (G-test) test of independence without correction
##
## data:  BsmtQualUnf
## G = 220.7, X-squared df = 18, p-value < 2.2e-16

df$HouseStyle[is.na(df$BsmtQual)]

## [1] 2Story 1.5Fin
## Levels: 1.5Fin 1.5Unf 1Story 2.5Fin 2.5Unf 2Story SFoyer SLvl

df$BsmtQual <- as.character(df$BsmtQual)
df$BsmtQual[is.na(df$BsmtQual) & df$HouseStyle == "2Story"]<-"Gd"
df$BsmtQual[is.na(df$BsmtQual) & df$HouseStyle == "1.5Fin"]<-"TA"
df$BsmtQual <- as.factor(df$BsmtQual)

#BsmtCond
TableBsmtCond<-table(df$HouseStyle,df$BsmtCond)
TableBsmtCond<-TableBsmtCond[rowSums(TableBsmtCond != 0) > 0 ,
colSums(TableBsmtCond != 0) > 0]
TableBsmtCond

##
##            Fa    Gd  NoBasement    Po    TA
##   1.5Fin   33     9           8     1   263
##   1.5Unf    3    0          0    0   16
##   1Story   31   60         59    3 1316
##   2.5Fin    2    0          0    0    6
##   2.5Unf    3    0          0    0   21
##   2Story   29   41         10    1  791
##   SFoyer    2    5          1    0   75
##   SLvl      1    7          1    0  118

mosaicplot(TableBsmtCond,
           main="Mosaic Plot of Basement Quality",
           las=1,
           color=T,
           shade=T)
```

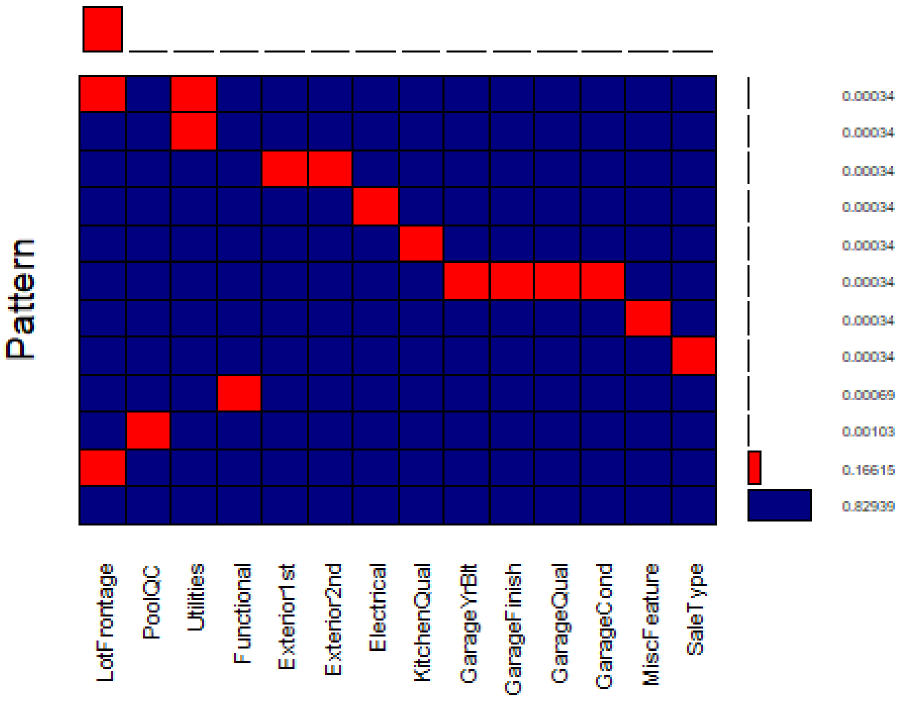


```
TestQ2<-GTest(TableBsmtCond)
TestQ2

##
##  Log likelihood ratio (G-test) test of independence without correction
##
## data:  TableBsmtCond
## G = 89.202, X-squared df = 28, p-value = 2.64e-08

df$HouseStyle[is.na(df$BsmtCond)]

## [1] 1Story 1Story SLvl
## Levels: 1.5Fin 1.5Unf 1Story 2.5Fin 2.5Unf 2Story SFoyer SLvl
```

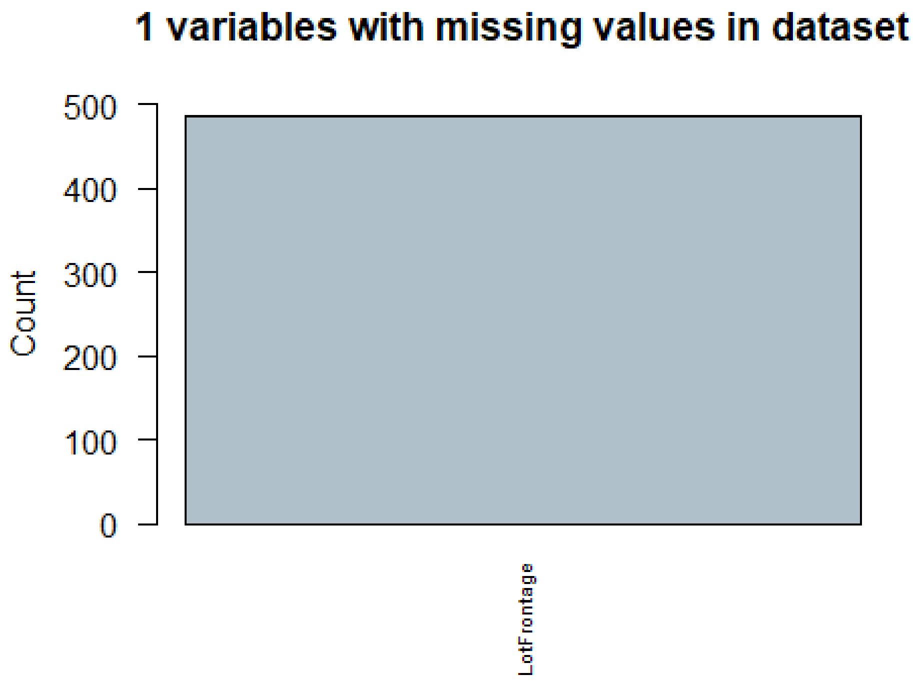
```
df$BsmtCond <- as.character(df$BsmtCond)
df$BsmtCond[is.na(df$BsmtCond)]<-"TA"
df$BsmtCond <- as.factor(df$BsmtCond)

PM <- sort(apply(df,2,cMiss),decreasing=T);
barplot(PM[PM!=0],
        las=2,
        cex.names=0.6,
        ylab="Count",
        ylim=c(0,500),
        horiz=F,
        col="#AFC0CB",
        main=paste(toString(sum(PM!=0)), "variables with missing values in
dataset"))
```



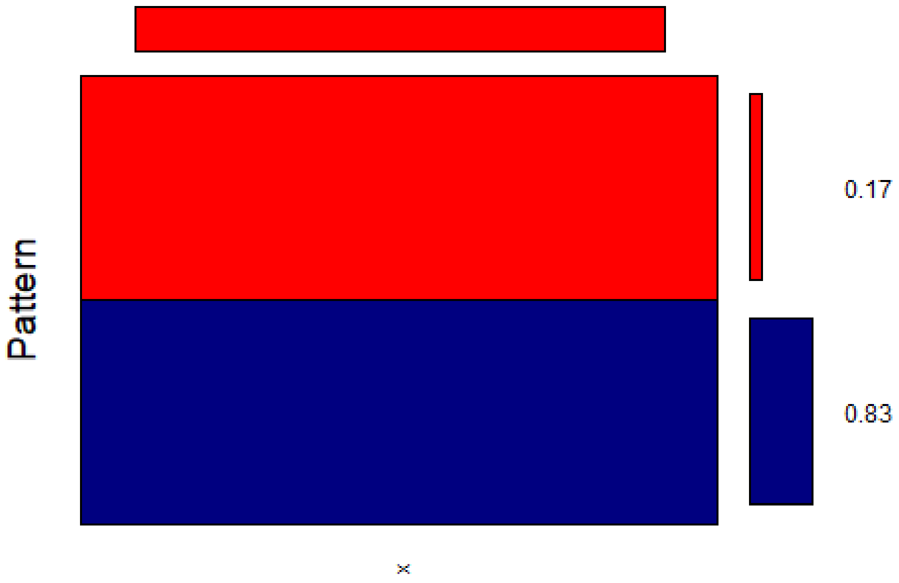
```
data = df[, names(PM[PM!=0])];
aggr_plot <- aggr(data,
                  col=c('navyblue','red'),
                  bars=T,
                  numbers=T,
                  combined = T,
                  labels=names(data),
                  cex.axis=.7,
                  gap=3,
                  ylab=c("Pattern"),
                  cex.numbers=0.44)
```



```
#The rest
fillMiss<- function(x)
{
  ux <- unique(x[!is.na(x)])
  x <- as.character(x)
  mode <- ux[which.max(tabulate(match(x[!is.na(x)], ux)))]
  x[is.na(x)] <- as.character(mode)
  x <- as.factor(x)
  return(x)
}
df[,sapply(df,function(x){!(is.numeric(x))}) ]<-
as.data.frame(apply(df[,sapply(df,function(x){!(is.numeric(x))})
],2,fillMiss))
PM <- sort(apply(df,2,cMiss),decreasing=T);
barplot(PM[PM!=0],
        las=2,
        cex.names=0.6,
        ylab="Count",
        ylim=c(0,500),
        horiz=F,
        col="#AFC0CB",
        main=paste(toString(sum(PM!=0)), "variables with missing values in
dataset"))
```



```
data = df[, names(PM[PM!=0])];
aggr_plot <- aggr(data,
                  col=c('navyblue','red'),
                  bars=T,
                  numbers=T,
                  combined = T,
                  labels=names(data),
                  cex.axis=.7,
                  gap=3,
                  ylab=c("Pattern"),
                  cex.numbers=0.74)
```



```
#splitting back to Test and Train
Traindata<-df[1:1460,]
Testdata<-df[(1461):nrow(df),]
#Testdata<- testdata[ , -which(names(Testdata) %in% c("SalePrice"))]

str(Testdata)

## 'data.frame':    1459 obs. of  81 variables:
##  $ Id           : int  1461 1462 1463 1464 1465 1466 1467 1468 1469 1470
...
##  $ MSSubClass   : int  20 20 60 60 120 60 20 60 20 20 ...
##  $ MSZoning     : Factor w/ 5 levels "C (all)","FV",..: 3 4 4 4 4 4 4 4 4
4 ...
##  $ LotFrontage  : int  80 81 74 78 43 75 NA 63 85 70 ...
##  $ LotArea      : int  11622 14267 13830 9978 5005 10000 7980 8402 10176
8400 ...
##  $ Street       : Factor w/ 2 levels "Grvl","Pave": 2 2 2 2 2 2 2 2 2 2
...
##  $ Alley        : Factor w/ 3 levels "Grvl","NoAccess",..: 2 2 2 2 2 2 2 2
2 2 ...
##  $ LotShape     : Factor w/ 4 levels "IR1","IR2","IR3",..: 4 1 1 1 1 1 1 1
4 4 ...
##  $ LandContour  : Factor w/ 4 levels "Bnk","HLS","Low",..: 4 4 4 4 2 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 1 5 5 5 1 5
```

```
5 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",..: 13 13 9 9 22
9 9 9 9 13 ...
##  $ Condition1   : Factor w/ 9 levels "Artery","Feedr",..: 2 3 3 3 3 3 3 3
3 3 ...
##  $ Condition2   : Factor w/ 8 levels "Artery","Feedr",..: 3 3 3 3 3 3 3 3
3 3 ...
##  $ BldgType     : Factor w/ 5 levels "1Fam","2fmCon",..: 1 1 1 1 5 1 1 1 1
1 ...
##  $ HouseStyle   : Factor w/ 8 levels "1.5Fin","1.5Unf",..: 3 3 6 6 3 6 3 6
3 3 ...
##  $ OverallQual  : int  5 6 5 6 8 6 6 6 7 4 ...
##  $ OverallCond  : int  6 6 5 6 5 5 7 5 5 5 ...
##  $ YearBuilt    : int  1961 1958 1997 1998 1992 1993 1992 1998 1990 1970
...
##  $ YearRemodAdd : int  1961 1958 1998 1998 1992 1994 2007 1998 1990 1970
...
##  $ RoofStyle    : Factor w/ 6 levels "Flat","Gable",..: 2 4 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 14 13 13
7 7 7 13 7 10 ...
##  $ Exterior2nd  : Factor w/ 16 levels "AsbShng","AsphShn",..: 14 15 14 14
7 7 7 14 7 11 ...
##  $ MasVnrType   : Factor w/ 4 levels "BrkCmn","BrkFace",..: 3 2 3 2 3 3 3
3 3 3 ...
##  $ MasVnrArea   : num  0 108 0 20 0 0 0 0 0 0 ...
##  $ ExterQual    : Factor w/ 4 levels "Ex","Fa","Gd",..: 4 4 4 4 3 4 4 4 4
4 ...
##  $ ExterCond    : Factor w/ 5 levels "Ex","Fa","Gd",..: 5 5 5 5 5 5 3 5 5
5 ...
##  $ Foundation   : Factor w/ 6 levels "BrkTil","CBlock",..: 2 2 3 3 3 3 3 3
3 2 ...
##  $ BsmtQual     : Factor w/ 5 levels "Ex","Fa","Gd",..: 5 5 3 5 3 3 3 3 3
5 ...
##  $ BsmtCond     : Factor w/ 5 levels "Fa","Gd","NoBasement",..: 5 5 5 5 5
5 5 5 5 5 ...
##  $ BsmtExposure : Factor w/ 5 levels "Av","Gd","Mn",..: 4 4 4 4 4 4 4 4 2
4 ...
##  $ BsmtFinType1 : Factor w/ 7 levels "ALQ","BLQ","GLQ",..: 6 1 3 3 1 7 1 7
3 1 ...
##  $ BsmtFinSF1   : num  468 923 791 602 263 0 935 0 637 804 ...
##  $ BsmtFinType2 : Factor w/ 7 levels "ALQ","BLQ","GLQ",..: 4 7 7 7 7 7 7 7
7 6 ...
##  $ BsmtFinSF2   : num  144 0 0 0 0 0 0 0 0 78 ...
##  $ BsmtUnfSF    : num  270 406 137 324 1017 ...
##  $ TotalBsmtSF  : num  882 1329 928 926 1280 ...
##  $ 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",..: 5 5 3 1 1 3 1 3 3
5 ...
##  $ 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 5
5 ...
##  $ X1stFlrSF    : int  896 1329 928 926 1280 763 1187 789 1341 882 ...
##  $ X2ndFlrSF    : int  0 0 701 678 0 892 0 676 0 0 ...
##  $ LowQualFinSF : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ GrLivArea    : int  896 1329 1629 1604 1280 1655 1187 1465 1341 882 ...
##  $ BsmtFullBath : num  0 0 0 0 0 0 1 0 1 1 ...
##  $ BsmtHalfBath : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ FullBath     : int  1 1 2 2 2 2 2 2 1 1 ...
##  $ HalfBath     : int  0 1 1 1 0 1 0 1 1 0 ...
##  $ BedroomAbvGr : int  2 3 3 3 2 3 3 3 2 2 ...
##  $ KitchenAbvGr : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ KitchenQual  : Factor w/ 4 levels "Ex","Fa","Gd",..: 4 3 4 3 3 4 4 4 3
4 ...
##  $ TotRmsAbvGrd : int  5 6 6 7 5 7 6 7 5 4 ...
##  $ Functional   : Factor w/ 7 levels "Maj1","Maj2",..: 7 7 7 7 7 7 7 7 7 7
...
##  $ Fireplaces   : int  0 0 1 1 0 1 0 1 1 0 ...
##  $ FireplaceQu  : Factor w/ 6 levels "Ex","Fa","Gd",..: 4 4 6 3 4 6 4 3 5
4 ...
##  $ GarageType   : Factor w/ 7 levels "2Types","Attchd",..: 2 2 2 2 2 2 2 2
2 2 ...
##  $ GarageYrBlt  : Factor w/ 104 levels "1895","1896",..: 53 50 89 90 84 85
84 90 82 62 ...
##  $ GarageFinish : Factor w/ 4 levels "Fin","NoGarage",..: 4 4 1 1 3 1 1 1
4 1 ...
##  $ GarageCars   : num  1 1 2 2 2 2 2 2 2 2 ...
##  $ GarageArea   : num  730 312 482 470 506 440 420 393 506 525 ...
##  $ GarageQual   : Factor w/ 6 levels "Ex","Fa","Gd",..: 6 6 6 6 6 6 6 6 6
6 ...
##  $ GarageCond   : Factor w/ 6 levels "Ex","Fa","Gd",..: 6 6 6 6 6 6 6 6 6
6 ...
##  $ PavedDrive   : Factor w/ 3 levels "N","P","Y": 3 3 3 3 3 3 3 3 3 3 ...
##  $ WoodDeckSF   : int  140 393 212 360 0 157 483 0 192 240 ...
##  $ OpenPorchSF  : int  0 36 34 36 82 84 21 75 0 0 ...
##  $ EnclosedPorch: int  0 0 0 0 0 0 0 0 0 0 ...
##  $ X3SsnPorch   : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ ScreenPorch  : int  120 0 0 0 144 0 0 0 0 0 ...
##  $ PoolArea     : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ PoolQC       : Factor w/ 4 levels "Ex","Fa","Gd",..: 4 4 4 4 4 4 4 4 4
4 ...
##  $ Fence        : Factor w/ 5 levels "GdPrv","GdWo",..: 3 5 3 5 5 5 1 5 5
3 ...
##  $ MiscFeature  : Factor w/ 5 levels "Gar2","None",..: 2 1 2 2 2 2 4 2 2 2
...
```

```
##  $ MiscVal      : int  0 12500 0 0 0 0 500 0 0 0 ...
##  $ MoSold       : int  6 6 3 6 1 4 3 5 2 4 ...
##  $ YrSold       : int  2010 2010 2010 2010 2010 2010 2010 2010 2010 2010
...
##  $ 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 5 5 5 5
5 5 5 ...
##  $ SalePrice    : num  -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 ...
```

```
str(Traindata)
```

```
## '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/ 3 levels "Grvl","NoAccess",..: 2 2 2 2 2 2 2 2
2 2 ...
##  $ 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   : num  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/ 5 levels "Ex","Fa","Gd",..: 3 3 3 5 3 3 1 3 5
5 ...
##  $ BsmtCond     : Factor w/ 5 levels "Fa","Gd","NoBasement",..: 5 5 5 2 5
5 5 5 5 5 ...
##  $ BsmtExposure : Factor w/ 5 levels "Av","Gd","Mn",..: 4 2 3 4 1 4 1 3 4
4 ...
##  $ BsmtFinType1 : Factor w/ 7 levels "ALQ","BLQ","GLQ",..: 3 1 3 1 3 3 3 1
7 3 ...
##  $ BsmtFinSF1   : num  706 978 486 216 655 ...
##  $ BsmtFinType2 : Factor w/ 7 levels "ALQ","BLQ","GLQ",..: 7 7 7 7 7 7 7 2
7 7 ...
##  $ BsmtFinSF2   : num  0 0 0 0 0 0 0 32 0 0 ...
##  $ BsmtUnfSF    : num  150 284 434 540 490 64 317 216 952 140 ...
##  $ TotalBsmtSF  : num  856 1262 920 756 1145 ...
##  $ 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 : num  1 0 1 1 1 1 1 1 0 1 ...
##  $ BsmtHalfBath : num  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/ 6 levels "Ex","Fa","Gd",..: 4 6 6 3 6 4 3 6 6
6 ...
##  $ GarageType   : Factor w/ 7 levels "2Types","Attchd",..: 2 2 2 6 2 2 2 2
6 2 ...
##  $ GarageYrBlt  : Factor w/ 104 levels "1895","1896",..: 95 68 93 90 92 85
96 65 24 32 ...
##  $ GarageFinish : Factor w/ 4 levels "Fin","NoGarage",..: 3 3 3 4 3 4 3 3
4 3 ...
##  $ GarageCars   : num  2 2 2 3 3 2 2 2 2 1 ...
##  $ GarageArea   : num  548 460 608 642 836 480 636 484 468 205 ...
##  $ GarageQual   : Factor w/ 6 levels "Ex","Fa","Gd",..: 6 6 6 6 6 6 6 6 2
3 ...
##  $ GarageCond   : Factor w/ 6 levels "Ex","Fa","Gd",..: 6 6 6 6 6 6 6 6 6
6 ...
##  $ 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/ 4 levels "Ex","Fa","Gd",..: 4 4 4 4 4 4 4 4 4
4 ...
##  $ Fence        : Factor w/ 5 levels "GdPrv","GdWo",..: 5 5 5 5 5 3 5 5 5
5 ...
##  $ MiscFeature  : Factor w/ 5 levels "Gar2","None",..: 2 2 2 2 2 4 2 4 2 2
...
##  $ 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    : num  208500 181500 223500 140000 250000 ...
```

```
# We have cleaned all of the data

#we are using the most
model.fit = lm(SalePrice ~ MSSubClass + LotArea + Street + LotConfig +
                 LandSlope + OverallQual + OverallCond + YearBuilt +
                 RoofStyle + RoofMatl + PoolArea + BedroomAbvGr +
KitchenAbvGr + SaleType ,data=Train)
summary(model.fit)
```

```
##
## Call:
## lm(formula = SalePrice ~ MSSubClass + LotArea + Street + LotConfig +
##     LandSlope + OverallQual + OverallCond + YearBuilt + RoofStyle +
##     RoofMatl + PoolArea + BedroomAbvGr + KitchenAbvGr + SaleType,
##     data = Train)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -231252  -24926   -2844   18481  318989
##
## Coefficients:
##                      Estimate Std. Error t value Pr(>|t|)
## (Intercept)        -1.242e+06  1.172e+05 -10.600  < 2e-16 ***
## MSSubClass         -1.231e+02  2.844e+01  -4.329 1.60e-05 ***
## LotArea             1.373e+00  1.490e-01   9.211  < 2e-16 ***
## StreetPave          4.476e+04  1.797e+04   2.491  0.01284 *
## LotConfigCulDSac    1.102e+04  5.255e+03   2.097  0.03619 *
## LotConfigFR2       -1.117e+04  6.738e+03  -1.658  0.09757 .
## LotConfigFR3       -1.350e+04  2.120e+04  -0.637  0.52452
## LotConfigInside    -3.327e+03  2.943e+03  -1.130  0.25850
## LandSlopeMod        2.829e+04  5.483e+03   5.159 2.84e-07 ***
## LandSlopeSev       -2.431e+04  1.662e+04  -1.463  0.14369
## OverallQual         3.613e+04  1.075e+03  33.604  < 2e-16 ***
## OverallCond         3.191e+03  1.106e+03   2.884  0.00399 **
## YearBuilt           3.900e+02  5.150e+01   7.573 6.54e-14 ***
## RoofStyleGable     -3.577e+04  3.050e+04  -1.173  0.24117
## RoofStyleGambrel   -2.500e+04  3.308e+04  -0.756  0.44988
## RoofStyleHip       -1.857e+04  3.059e+04  -0.607  0.54389
## RoofStyleMansard   -2.180e+04  3.504e+04  -0.622  0.53386
## RoofStyleShed       2.320e+04  4.420e+04   0.525  0.59975
## RoofMatlCompShg     3.519e+05  4.498e+04   7.825 9.82e-15 ***
## RoofMatlMembran     3.291e+05  7.069e+04   4.656 3.52e-06 ***
## RoofMatlMetal       3.444e+05  7.111e+04   4.843 1.42e-06 ***
## RoofMatlRoll        3.499e+05  6.168e+04   5.672 1.70e-08 ***
## RoofMatlTar&Grv     3.165e+05  5.415e+04   5.844 6.30e-09 ***
## RoofMatlWdShake     3.465e+05  4.979e+04   6.958 5.25e-12 ***
## RoofMatlWdShngl     4.541e+05  4.782e+04   9.497  < 2e-16 ***
## PoolArea            1.241e+02  2.927e+01   4.239 2.39e-05 ***
## BedroomAbvGr        8.439e+03  1.452e+03   5.810 7.68e-09 ***
## KitchenAbvGr        8.090e+03  5.638e+03   1.435  0.15156
## SaleTypeCon         5.250e+04  3.048e+04   1.722  0.08526 .
## SaleTypeConLD       1.821e+04  1.559e+04   1.168  0.24309
## SaleTypeConLI       2.445e+04  1.993e+04   1.227  0.22003
## SaleTypeConLw       1.080e+04  1.985e+04   0.544  0.58644
## SaleTypeCWD         1.410e+04  2.203e+04   0.640  0.52216
## SaleTypeNew         4.241e+04  7.749e+03   5.473 5.22e-08 ***
## SaleTypeOth         1.589e+04  2.517e+04   0.632  0.52781
## SaleTypeWD          9.666e+03  6.556e+03   1.474  0.14061
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 41900 on 1424 degrees of freedom
## Multiple R-squared:  0.7285, Adjusted R-squared:  0.7218
## F-statistic: 109.2 on 35 and 1424 DF,  p-value: < 2.2e-16

predictSales  = predict(model.fit,Test)
#see side by side
Actual<-read.csv("C:/Users/aditi/Downloads/sample_submission.csv")

Both = data.frame(cbind(Actual,predictSales))
View(Both)
```