Predicting House Prices

Loading and inspecting the train and test datasets

```
library(tidyverse)
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.1 --
```

```
## v ggplot2 3.3.5      v purrr   0.3.4
## v tibble  3.1.4      v dplyr   1.0.7
## v tidyr   1.1.3      v stringr 1.4.0
## v readr   2.0.1      v forcats 0.5.1
```

```
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
## Load Training Data
path_traindata <- 'D:\\Datos\\Documents\\Development\\R\\Advanced Statistics\\Project 1 House Prediction
train <- read_csv(path_traindata)
```

```
## Rows: 1460 Columns: 77
```

```
## -- Column specification -----------------------------------------------------
## Delimiter: ","
## chr (40): MSSubClass, MSZoning, Street, Alley, LotShape, LandContour, LotCon...
## dbl (35): Id, LotArea, OverallQual, OverallCond, YearBuilt, YearRemodAdd, Ma...
## lgl  (2): Exterior2nd, Functional
```

```
##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
#dim(train)
## Load Testing Data
path_testdata <- 'D:\\Datos\\Documents\\Development\\R\\Advanced Statistics\\Project 1 House Prediction'
test <- read_csv(path_testdata)
```

```
## Rows: 1459 Columns: 76
```

```
## -- Column specification -----------------------------------------------------
## Delimiter: ","
## chr (40): MSSubClass, MSZoning, Street, Alley, LotShape, LandContour, LotCon...
## dbl (34): Id, LotArea, OverallQual, OverallCond, YearBuilt, YearRemodAdd, Ma...
## lgl  (2): Exterior2nd, Functional
```

```
##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```r
#dim(test)
```
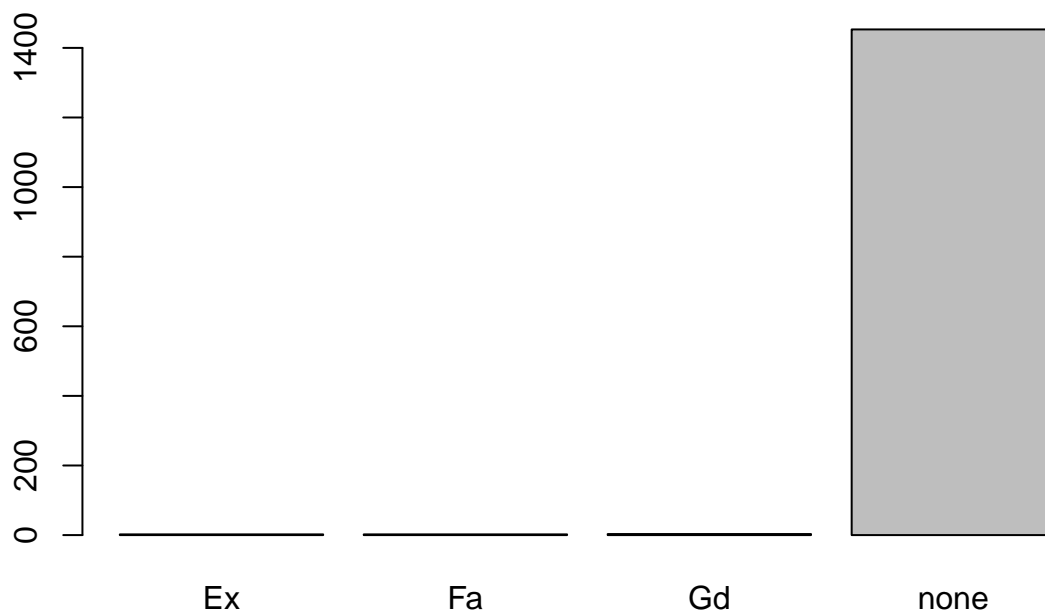
```r
#Remove id
train = train %>% select(-Id)
```

```r
#Rename columns
train <- train %>%
         rename(
           FirstFlrSF = '1stFlrSF',
           SectFlrSF = '2ndFlrSF',
           ThirdSsnPorch= '3SsnPorch'
           )

test <- test %>%
         rename(
           FirstFlrSF = '1stFlrSF',
           SectFlrSF = '2ndFlrSF',
           ThirdSsnPorch= '3SsnPorch'
           )
```

Explore PoolQC

PoolQC has different levels in train and test. Let's investigate it
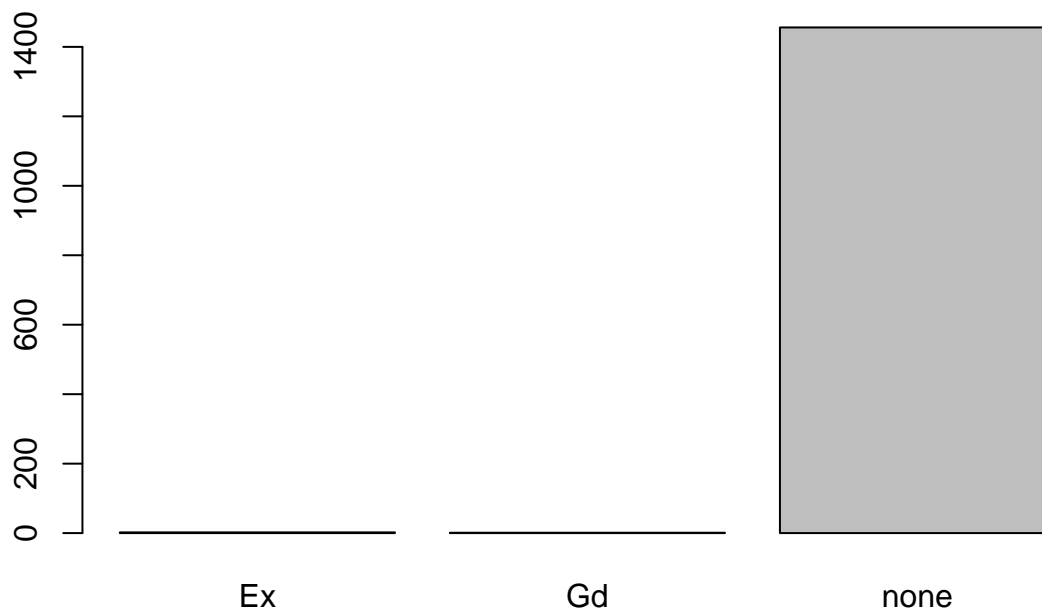
```r
counts <- table(train$PoolQC)
barplot(counts)
```

```
counts
```

```
##
##   Ex   Fa   Gd none
##    2    2    3 1453
```

```
counts <- table(test$PoolQC)
barplot(counts)
```

```
counts
```

```
##
##    Ex   Gd none
##     2    1 1456
```

Since there are not a lot of samples, we will just collapse PoolQC into Yes or None. Also, we will remove predictor PoolArea from the final model because we will see below that the rship with SalePrice doesnt look linear at all

```r
#Collapse PoolQC into yes or none
train$PoolQC = fct_collapse(train$PoolQC, yes=c("Ex", "Fa"))
test$PoolQC = fct_collapse(test$PoolQC, yes=c("Ex", "Gd"))
```

Numerical Variables

```r
#library(purrr)
train_num <- train %>% keep(is.numeric) %>% head()
num_cols <- unlist(lapply(train, is.numeric))        # Identify numeric columns
train_num <- train[ , num_cols]                       # Subset numeric columns of data
train_num
```

```
## # A tibble: 1,460 x 34
```

4

```
##      LotArea OverallQual OverallCond YearBuilt YearRemodAdd MasVnrArea BsmtFinSF1
##        <dbl>       <dbl>       <dbl>     <dbl>        <dbl>      <dbl>      <dbl>
##  1      8450           7           5      2003         2003        196        706
##  2      9600           6           8      1976         1976          0        978
##  3     11250           7           5      2001         2002        162        486
##  4      9550           7           5      1915         1970          0        216
##  5     14260           8           5      2000         2000        350        655
##  6     14115           5           5      1993         1995          0        732
##  7     10084           8           5      2004         2005        186       1369
##  8     10382           7           6      1973         1973        240        859
##  9      6120           7           5      1931         1950          0          0
## 10      7420           5           6      1939         1950          0        851
## # ... with 1,450 more rows, and 27 more variables: BsmtFinSF2 <dbl>,
## #   BsmtUnfSF <dbl>, TotalBsmtSF <dbl>, FirstFlrSF <dbl>, SectFlrSF <dbl>,
## #   LowQualFinSF <dbl>, GrLivArea <dbl>, BsmtFullBath <dbl>,
## #   BsmtHalfBath <dbl>, FullBath <dbl>, HalfBath <dbl>, BedroomAbvGr <dbl>,
## #   KitchenAbvGr <dbl>, TotRmsAbvGrd <dbl>, Fireplaces <dbl>, GarageCars <dbl>,
## #   GarageArea <dbl>, WoodDeckSF <dbl>, OpenPorchSF <dbl>, EnclosedPorch <dbl>,
## #   ThirdSsnPorch <dbl>, ScreenPorch <dbl>, PoolArea <dbl>, MiscVal <dbl>, ...
```

###Check linearity btw response and numerical predictors

```r
scatter_fun = function(x, y) {
    ggplot(train_num, aes_string(x = x, y = y ) ) +
        geom_point() +
        geom_smooth(method = "loess", se = FALSE, color = "grey74") +
        theme_bw()
}
```
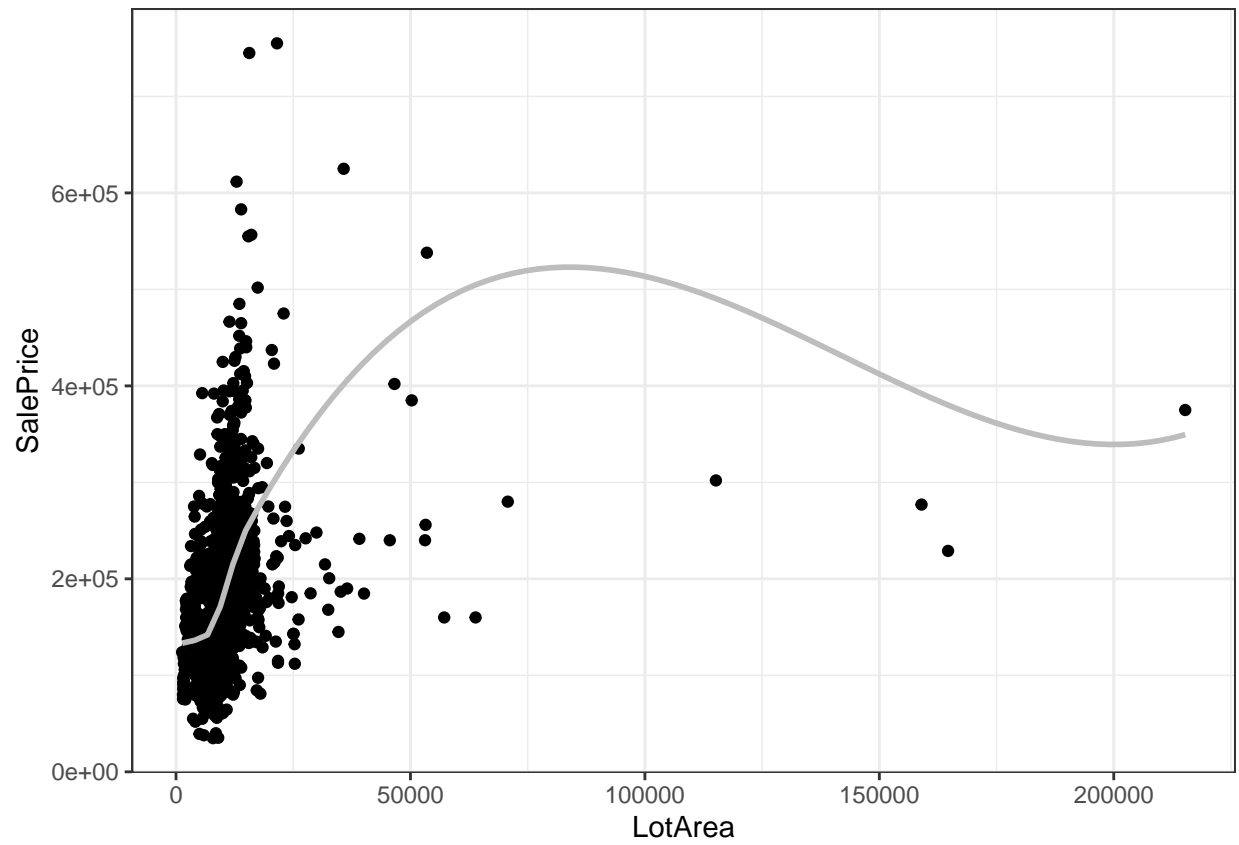
```r
library(purrr)
response = "SalePrice"
expl = names(train_num)[1:ncol(train_num)-1]
#expl = names(train)[1:5]

elev_plots = map(expl, ~scatter_fun(.x, "SalePrice") )
```
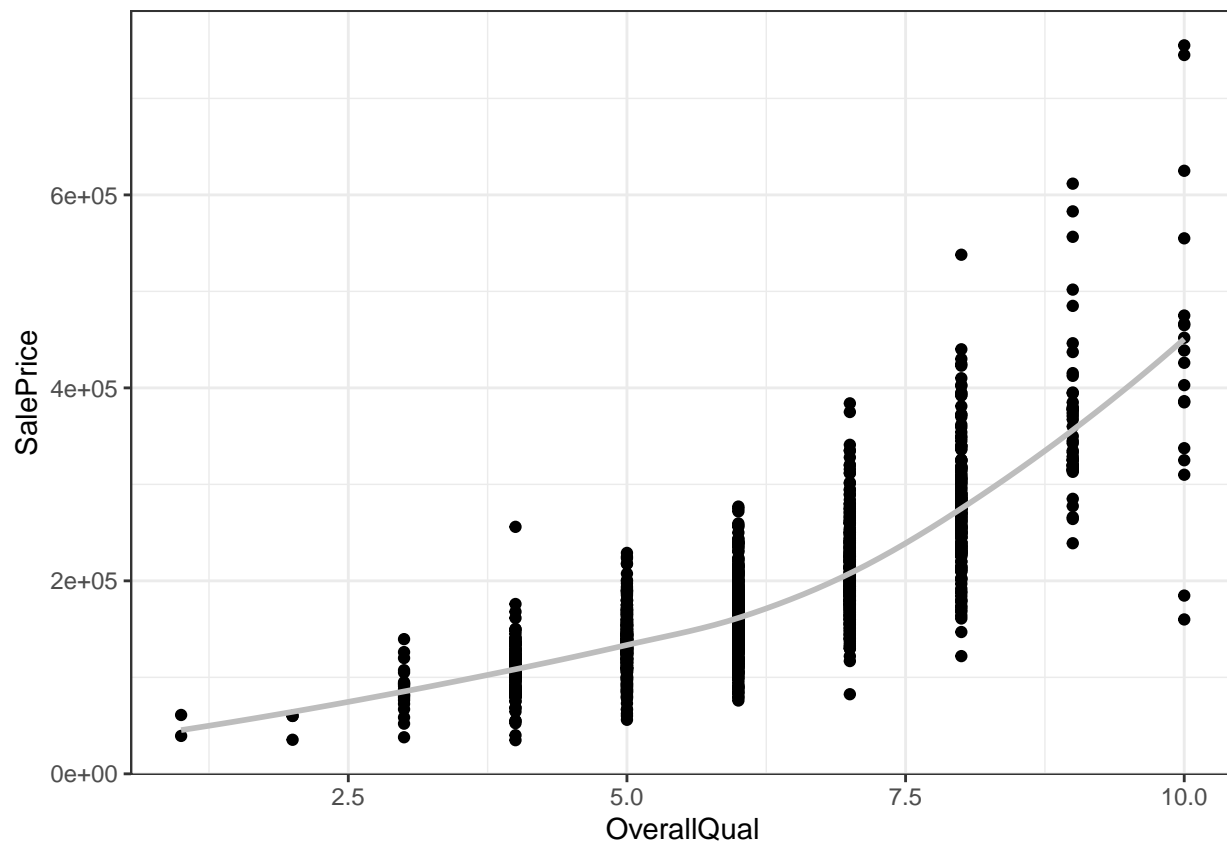
```r
elev_plots
```

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

```
## `geom_smooth()` using formula 'y ~ x'
```

```
##
## [[2]]

## `geom_smooth()` using formula 'y ~ x'
```
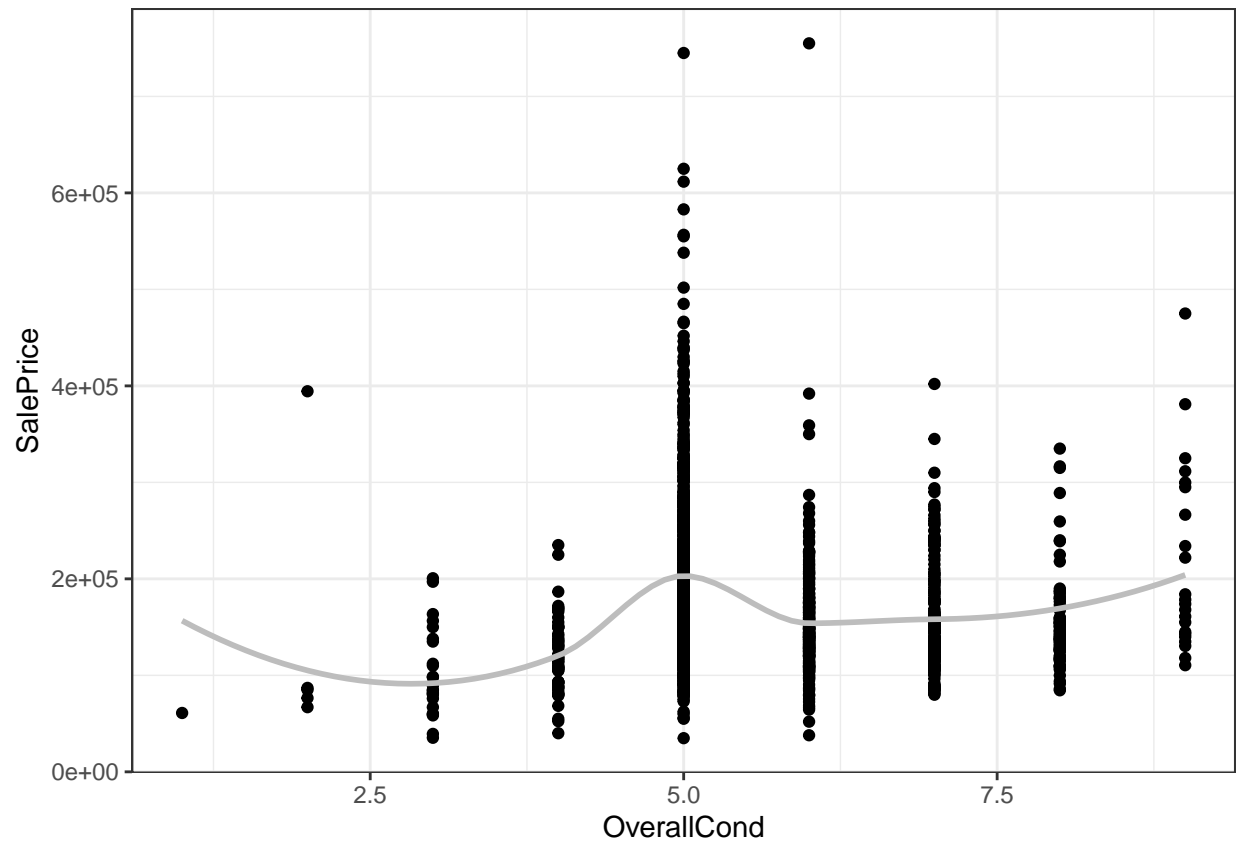
```
##
## [[3]]

## 'geom_smooth()' using formula 'y ~ x'

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : pseudoinverse used at 5

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : neighborhood radius 1

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : reciprocal condition number 0

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : There are other near singularities as well. 1
```
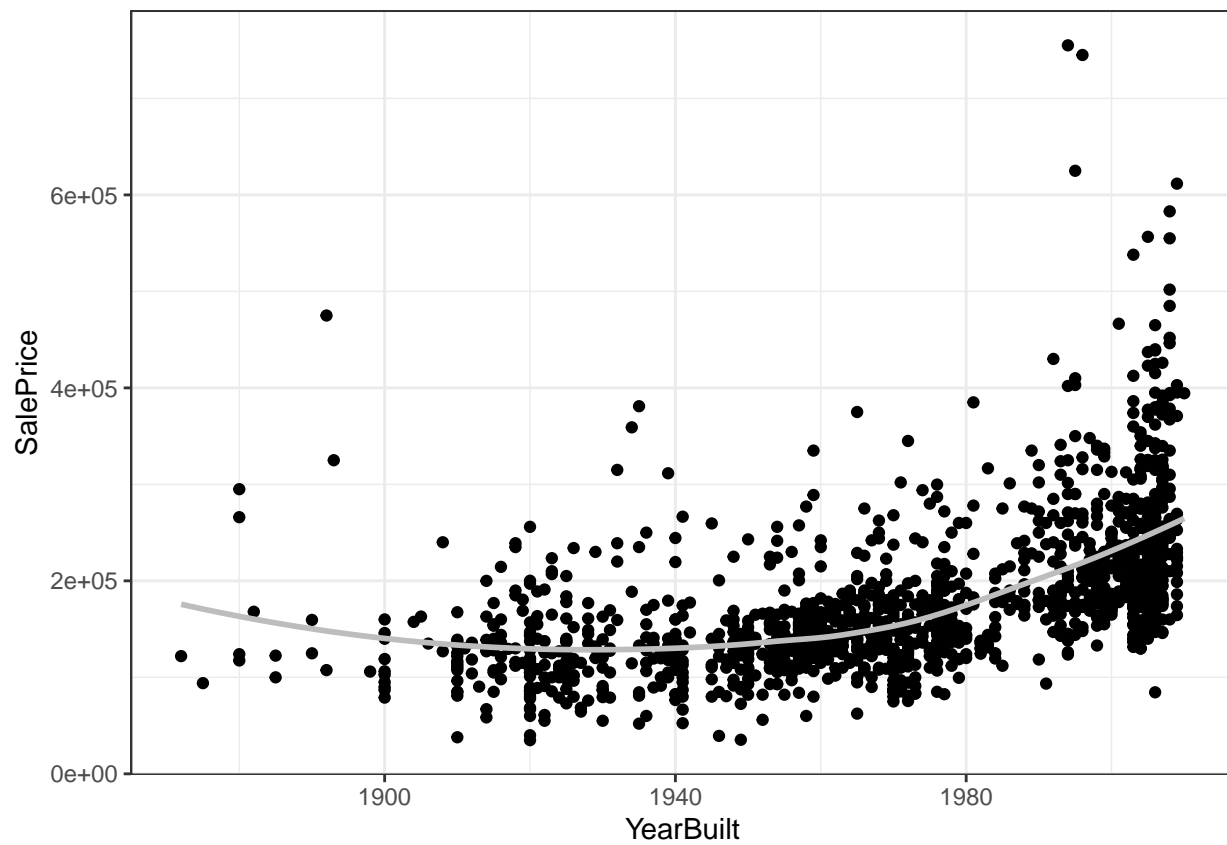
```
##
## [[4]]

## `geom_smooth()` using formula 'y ~ x'
```
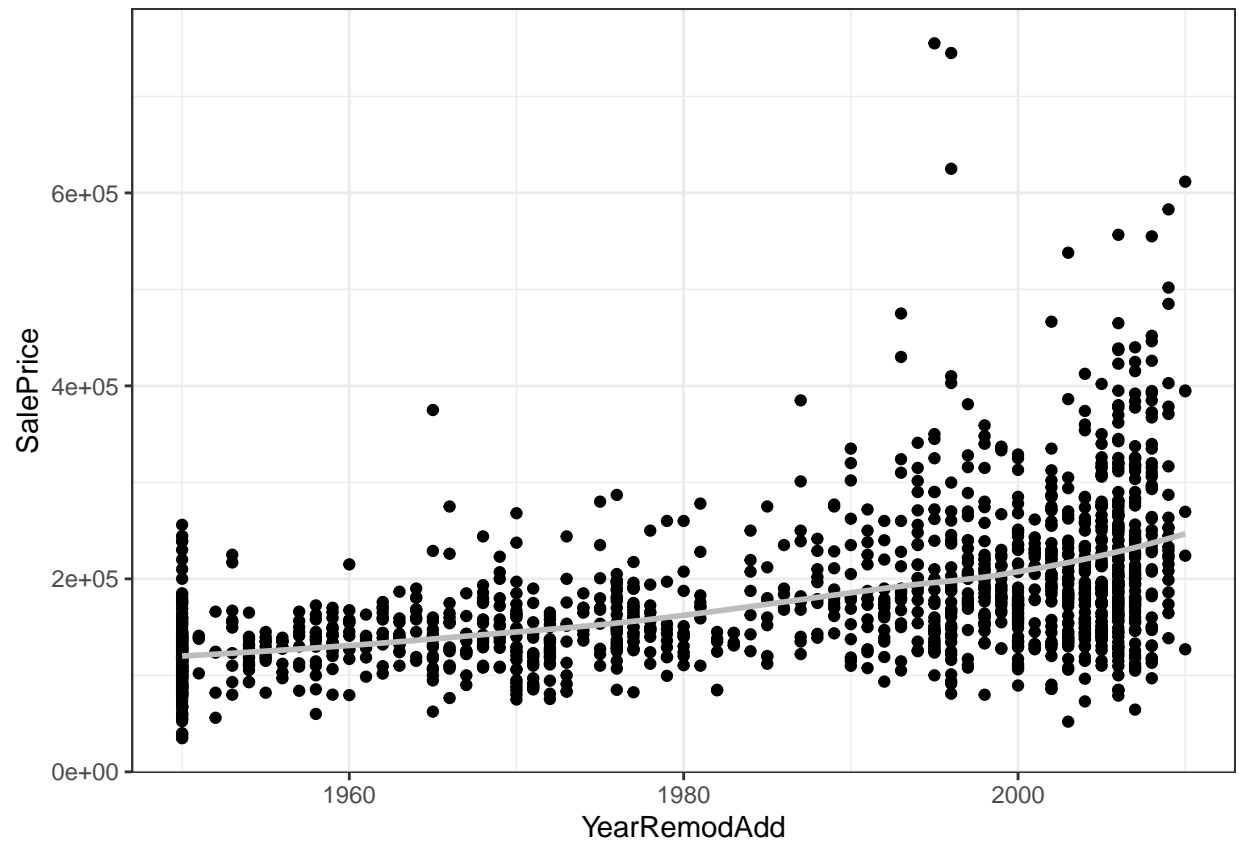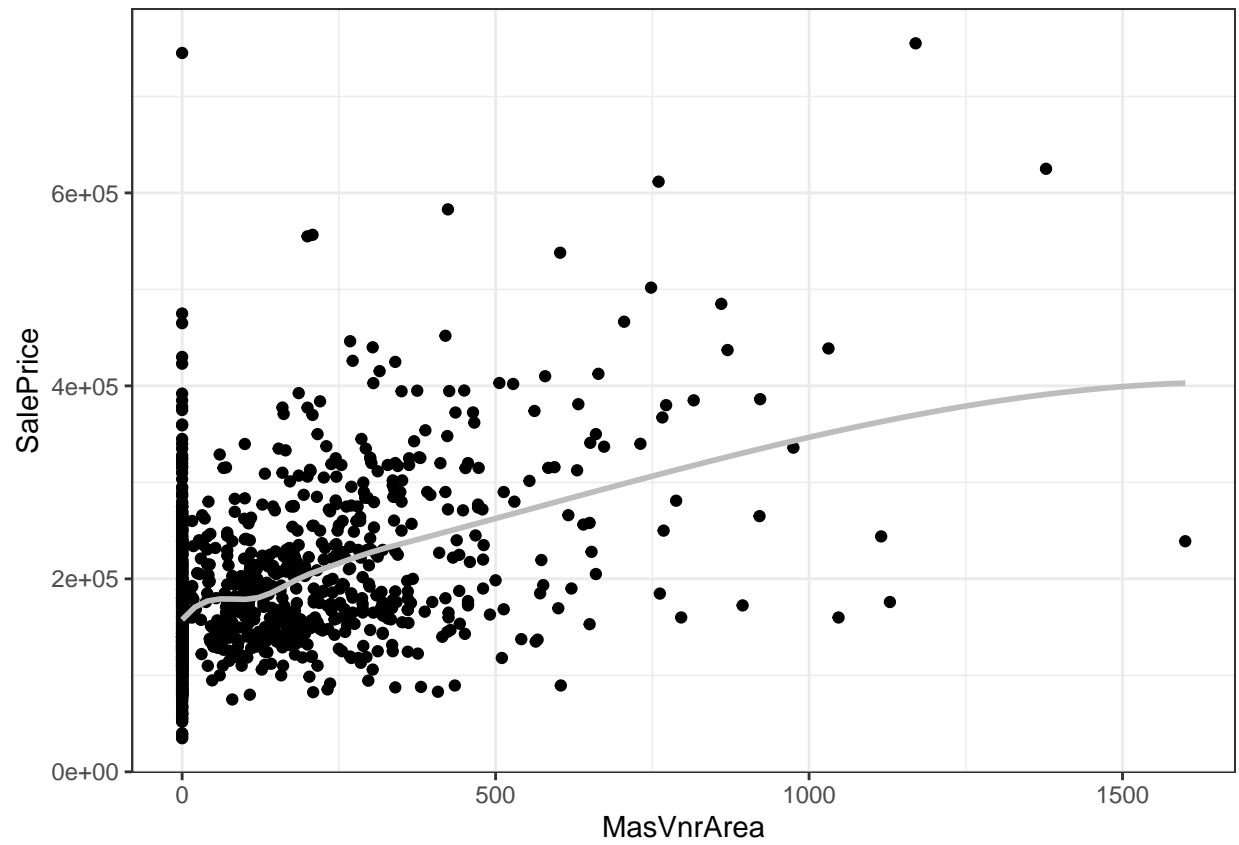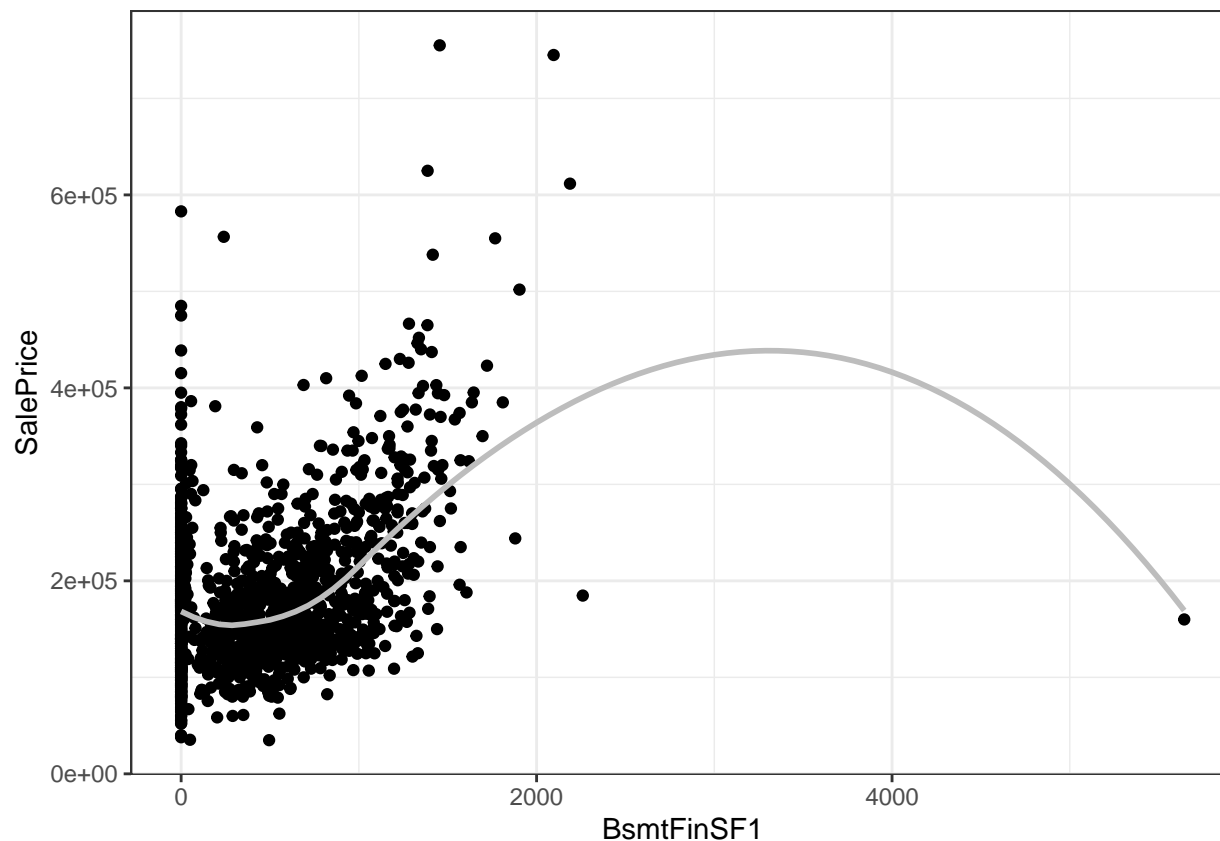
```
##
## [[5]]
```

```
## `geom_smooth()` using formula 'y ~ x'
```

```
##
## [[6]]

## `geom_smooth()` using formula 'y ~ x'
```

```
##
## [[7]]
```

```
## `geom_smooth()` using formula 'y ~ x'
```

```
##
## [[8]]

## `geom_smooth()` using formula 'y ~ x'

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : at -7.37

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : radius 54.317

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : all data on boundary of neighborhood. make span bigger

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : pseudoinverse used at -7.37

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : neighborhood radius 7.37

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : reciprocal condition number 1

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : zero-width neighborhood. make span bigger
```

```
## Warning: Computation failed in 'stat_smooth()':
## NA/NaN/Inf in foreign function call (arg 5)
```



```
##
## [[9]]
```
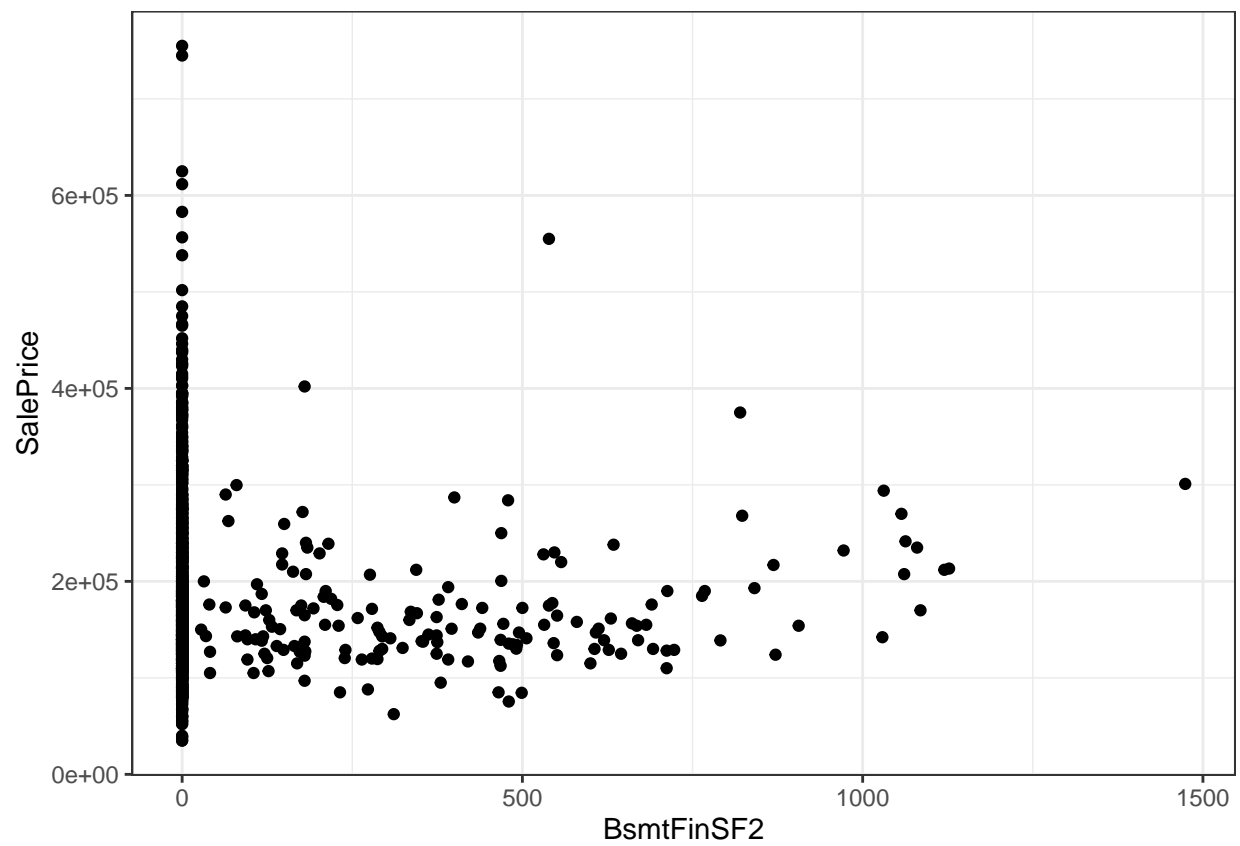
```
## 'geom_smooth()' using formula 'y ~ x'
```
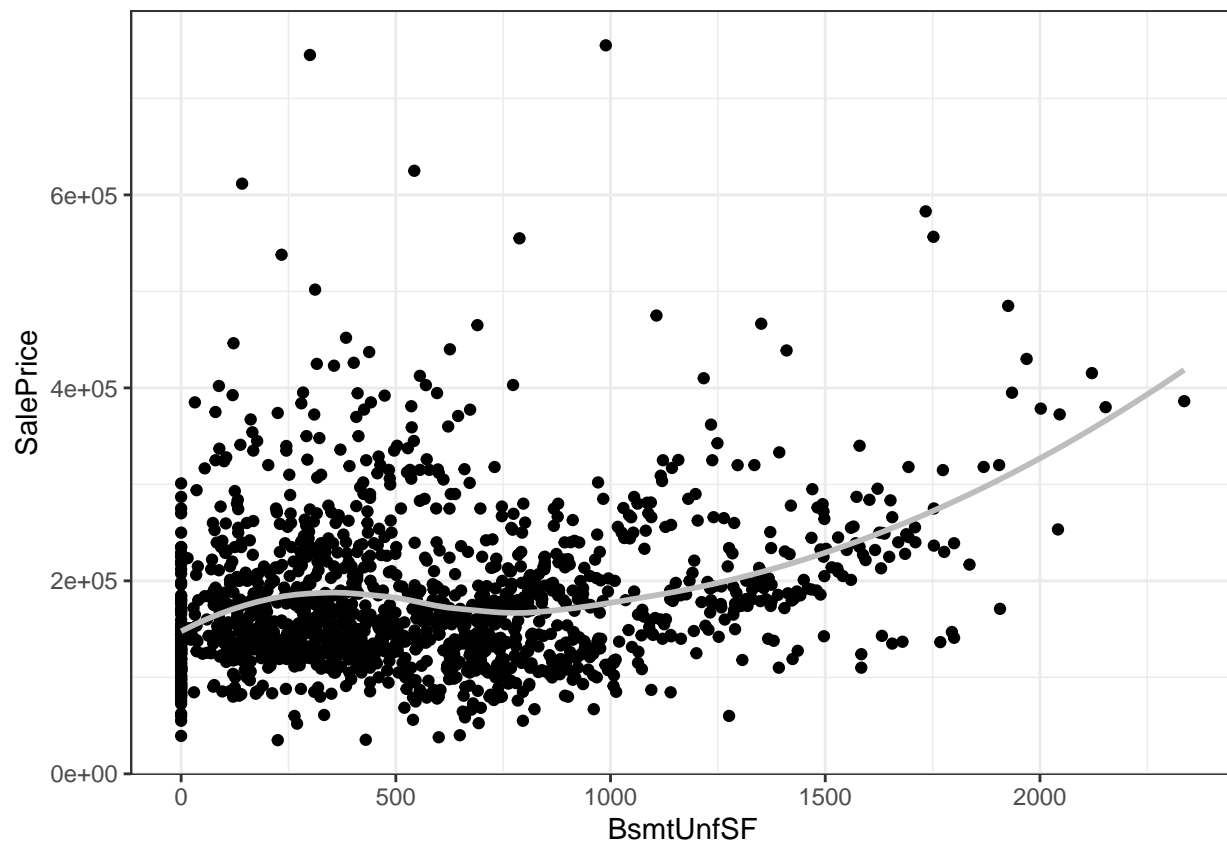
```
##
## [[10]]

## `geom_smooth()` using formula 'y ~ x'
```
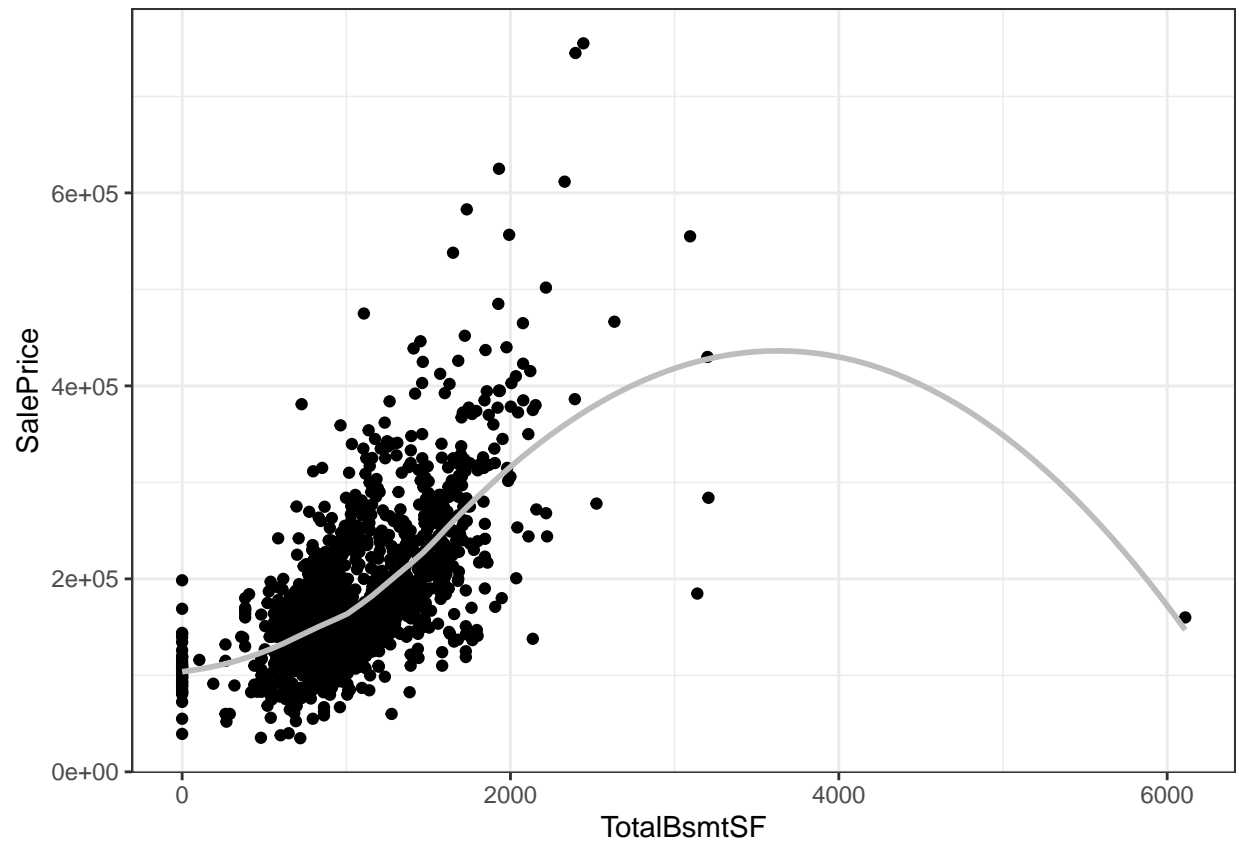
```
## 
## [[11]]
```

```
## `geom_smooth()` using formula 'y ~ x'
```

```
##
## [[12]]

## `geom_smooth()` using formula 'y ~ x'
```

```
##
## [[13]]

## `geom_smooth()` using formula 'y ~ x'

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : at -2.86

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : radius 8.1796

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : all data on boundary of neighborhood. make span bigger

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : pseudoinverse used at -2.86

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : neighborhood radius 2.86

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : reciprocal condition number 1

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : zero-width neighborhood. make span bigger
```

```
## Warning: Computation failed in 'stat_smooth()':
## NA/NaN/Inf in foreign function call (arg 5)
```
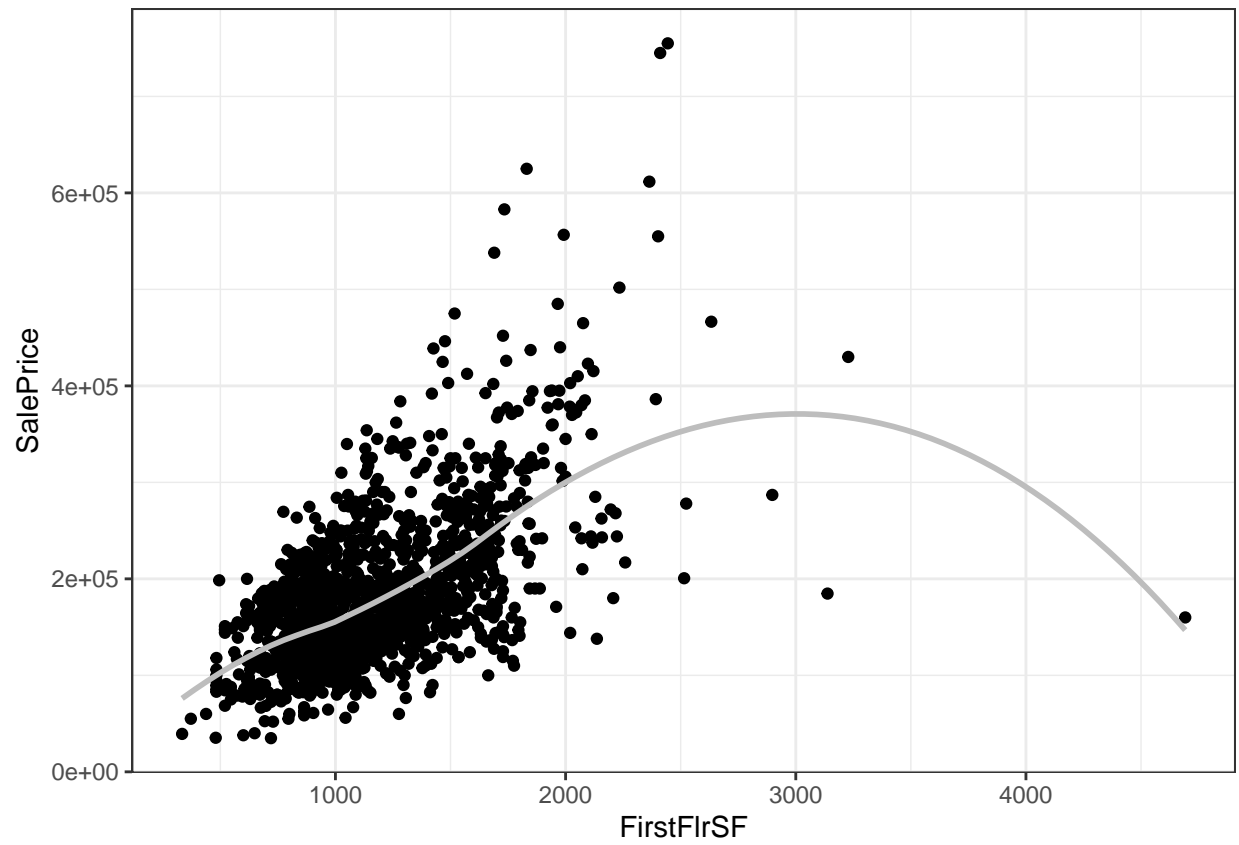


```
##
## [[14]]
```
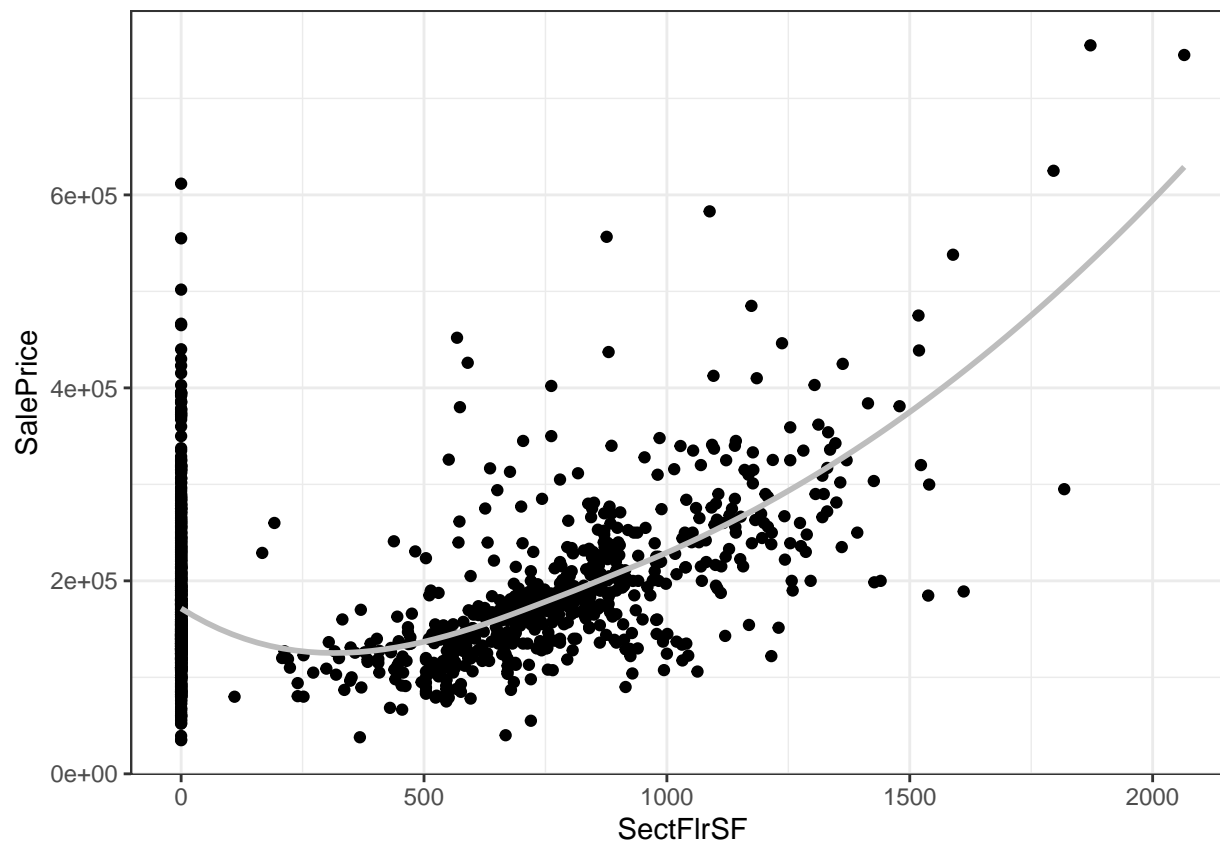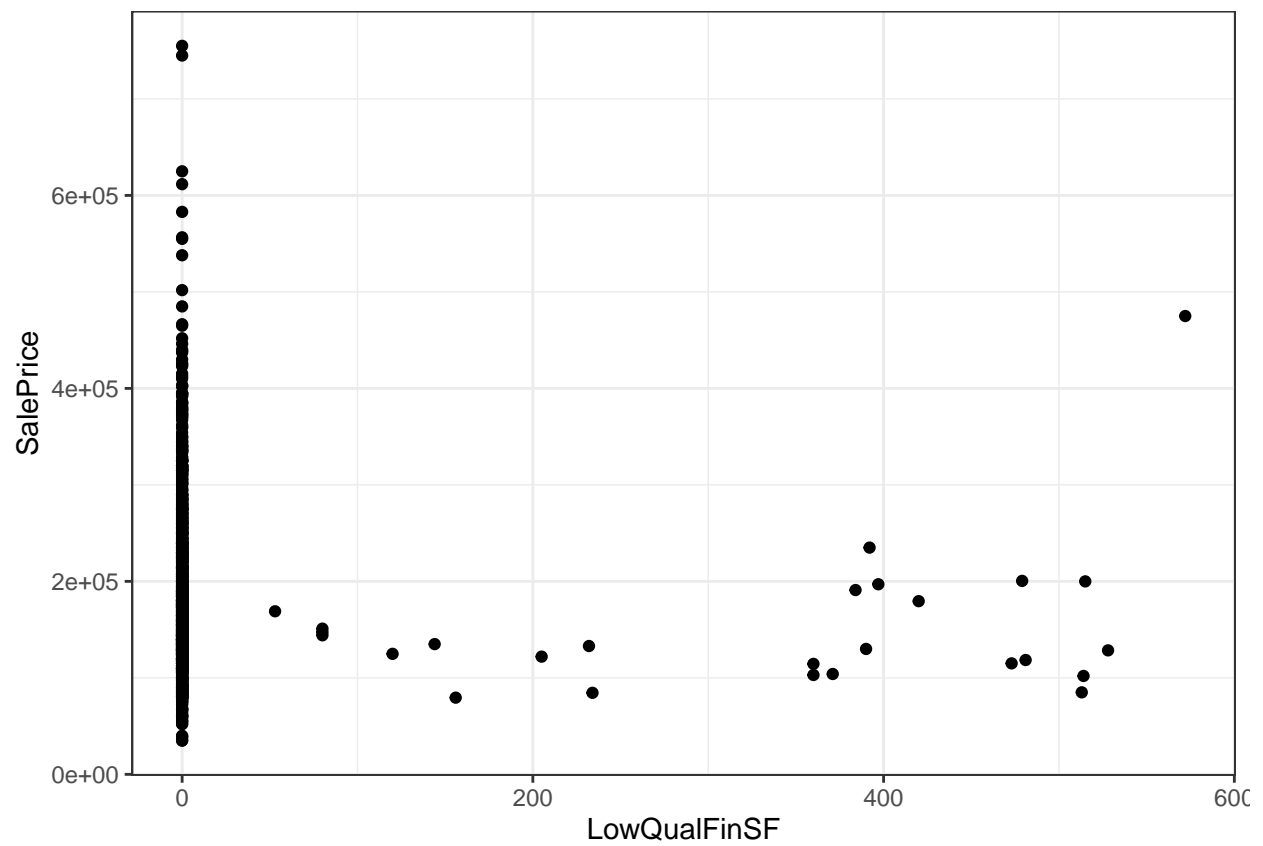
```
## 'geom_smooth()' using formula 'y ~ x'
```
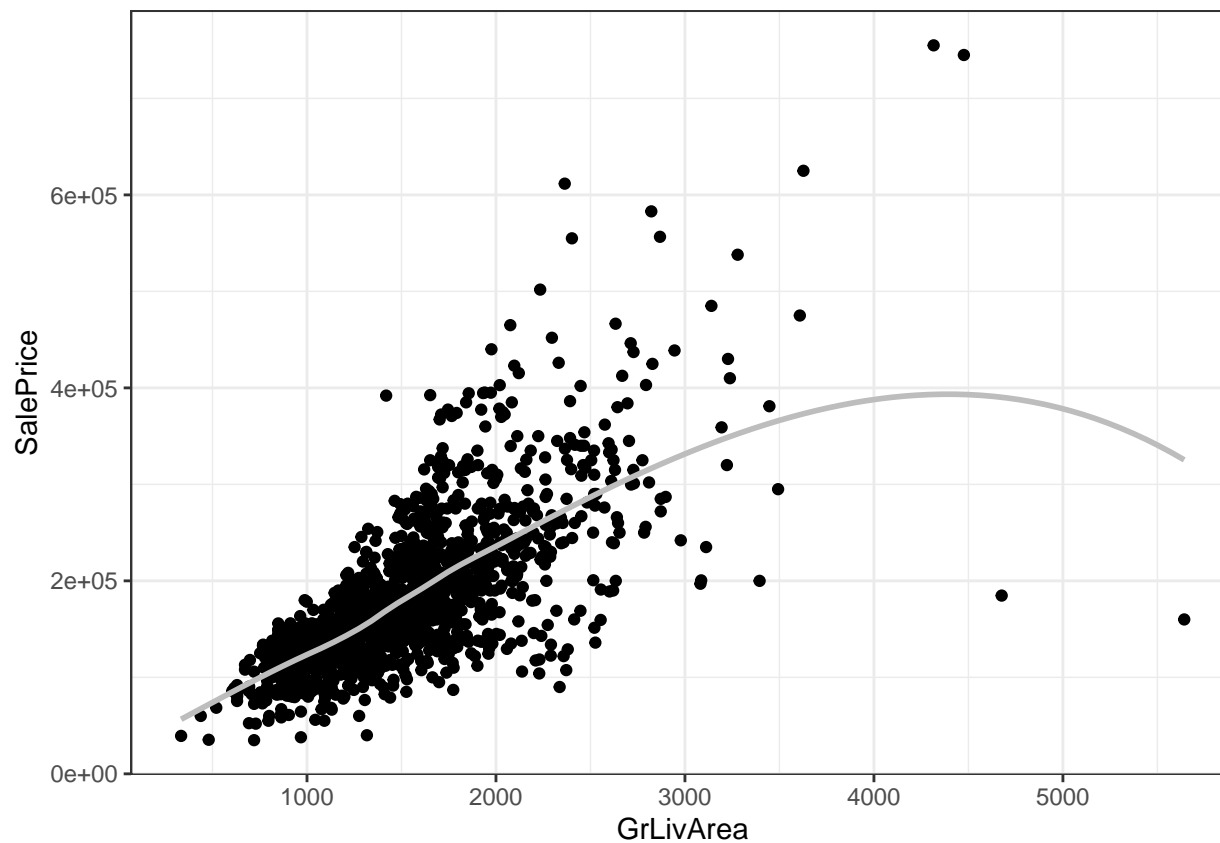
```
##
## [[15]]
```

```
## 'geom_smooth()' using formula 'y ~ x'
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : pseudoinverse used at -0.015
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : neighborhood radius 1.015
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : reciprocal condition number 1.294e-028
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : There are other near singularities as well. 1
```

```
##
## [[16]]

## `geom_smooth()` using formula 'y ~ x'

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : at -0.01

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : radius 0.0001

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : all data on boundary of neighborhood. make span bigger

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : pseudoinverse used at -0.01

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : neighborhood radius 0.01

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : reciprocal condition number 1

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : There are other near singularities as well. 4.0401
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : zero-width neighborhood. make span bigger
```

```
## Warning: Computation failed in 'stat_smooth()':
## NA/NaN/Inf in foreign function call (arg 5)
```



```
##
## [[17]]
```

```
## 'geom_smooth()' using formula 'y ~ x'
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : pseudoinverse used at -0.015
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : neighborhood radius 2.015
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : reciprocal condition number 1.9617e-015
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : There are other near singularities as well. 4.0602
```
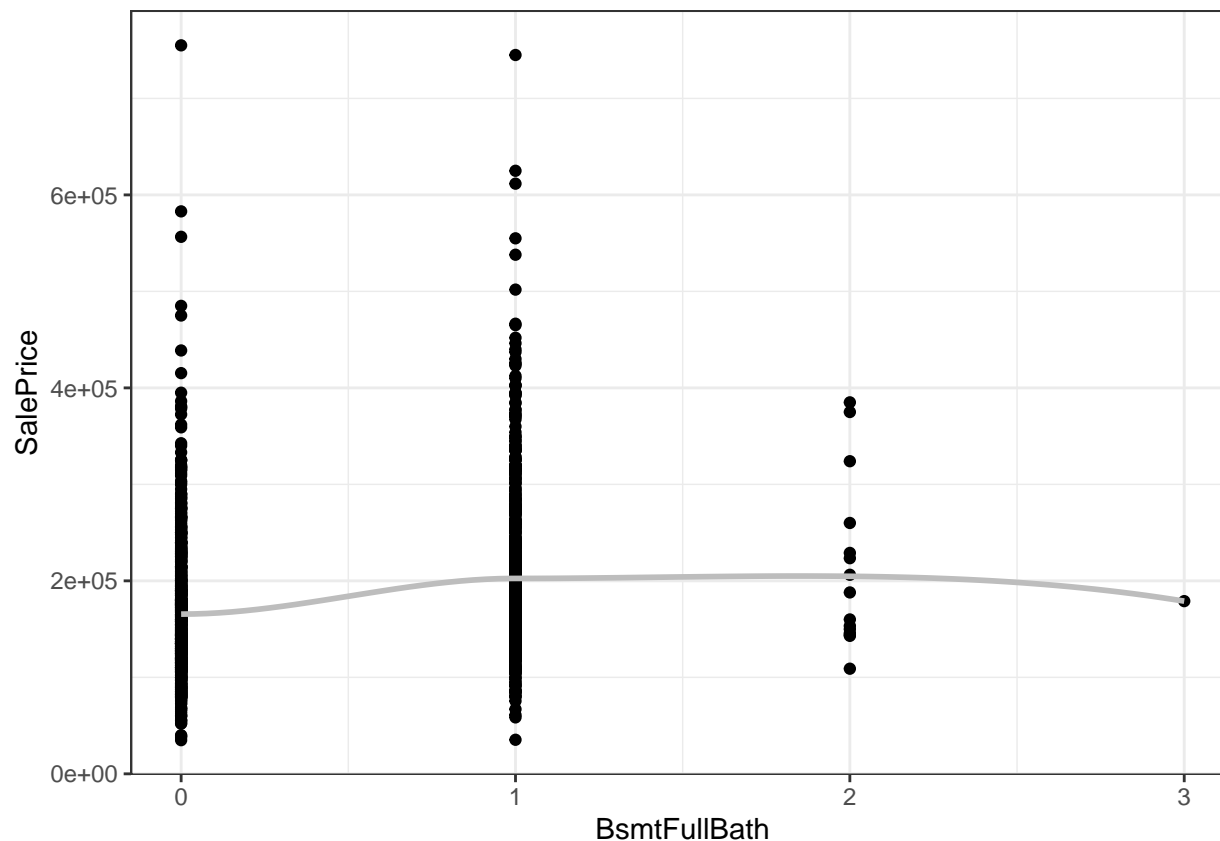
```
##
## [[18]]

## 'geom_smooth()' using formula 'y ~ x'

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : pseudoinverse used at -0.01

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : neighborhood radius 1.01

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : reciprocal condition number 1.9567e-029

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : There are other near singularities as well. 4.0401
```

```
##
## [[19]]

## `geom_smooth()` using formula 'y ~ x'

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : pseudoinverse used at 2

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : neighborhood radius 1

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : reciprocal condition number 0

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : There are other near singularities as well. 1
```

```
##
## [[20]]


## 'geom_smooth()' using formula 'y ~ x'


## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : pseudoinverse used at -0.015


## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : neighborhood radius 1.015


## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : reciprocal condition number 0


## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : There are other near singularities as well. 4.0602


## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : zero-width neighborhood. make span bigger


## Warning: Computation failed in 'stat_smooth()':
## NA/NaN/Inf in foreign function call (arg 5)
```
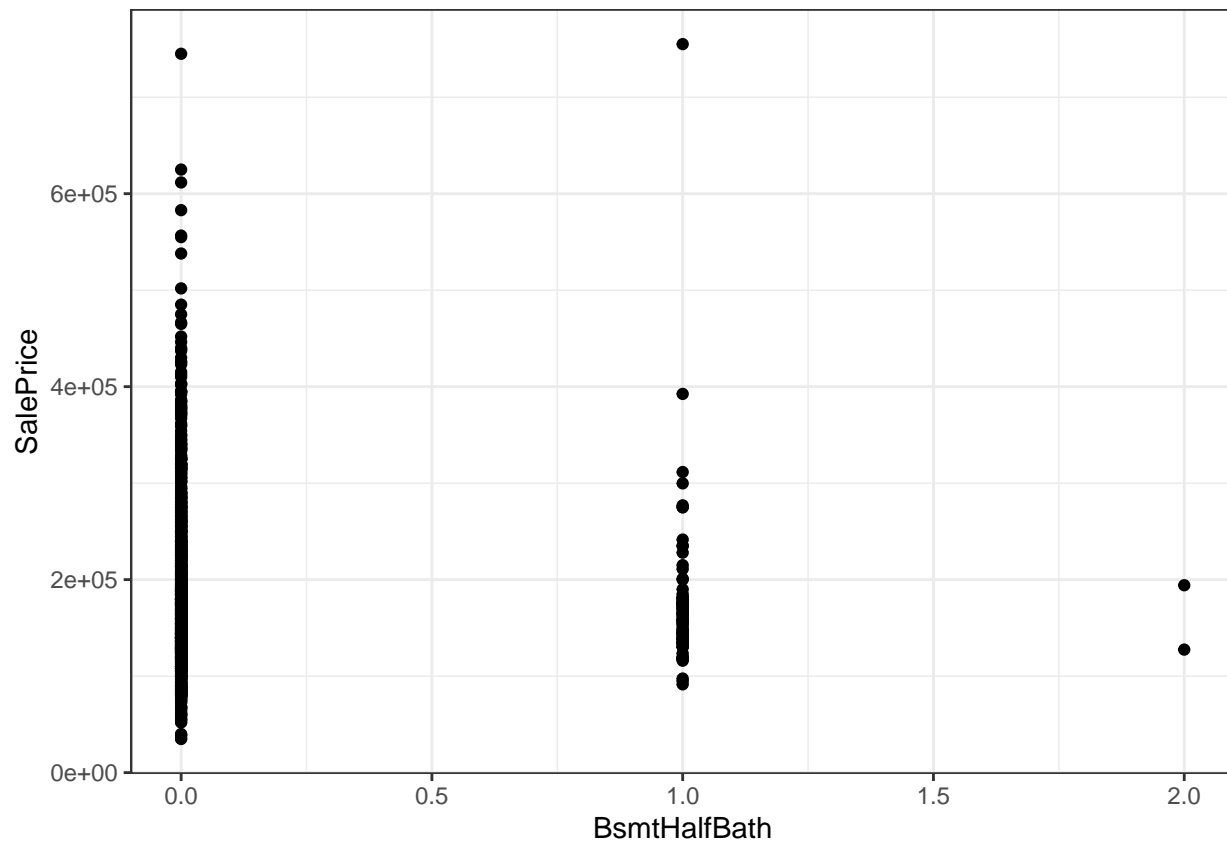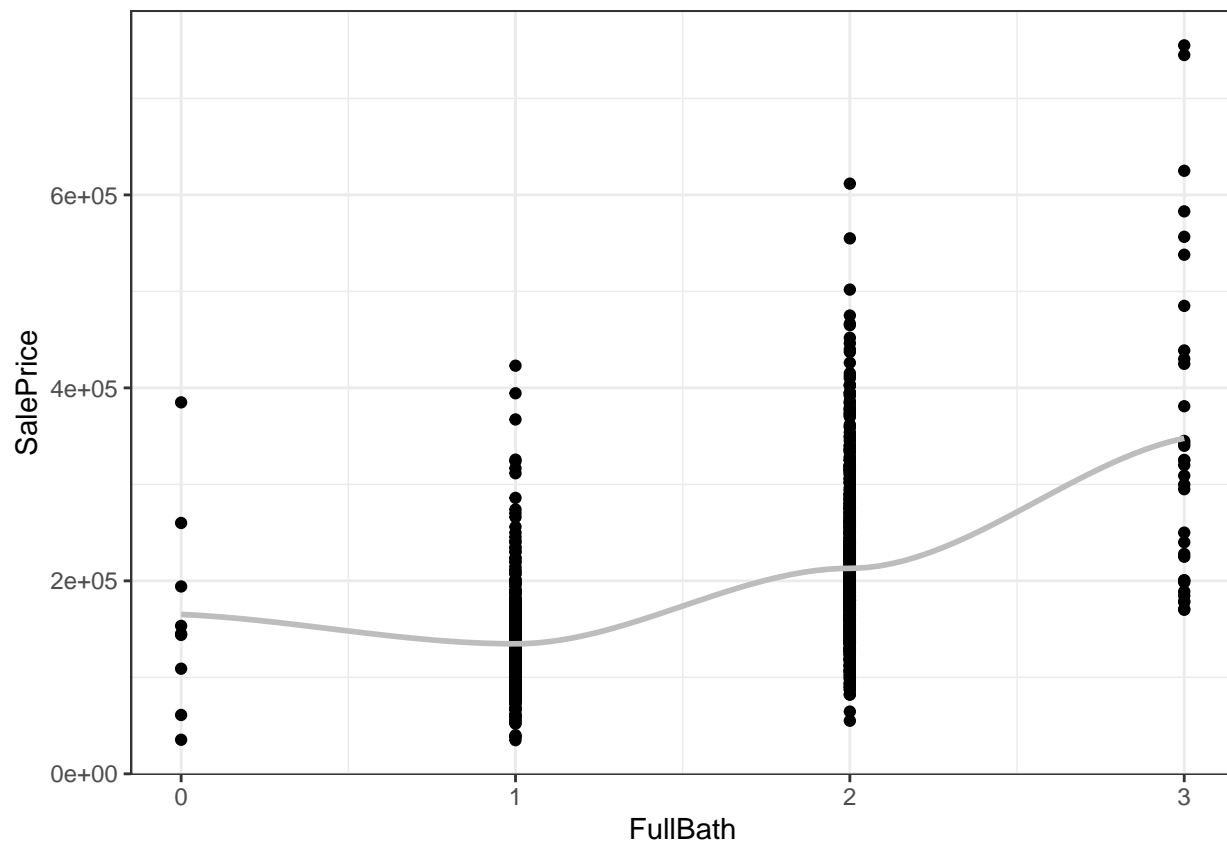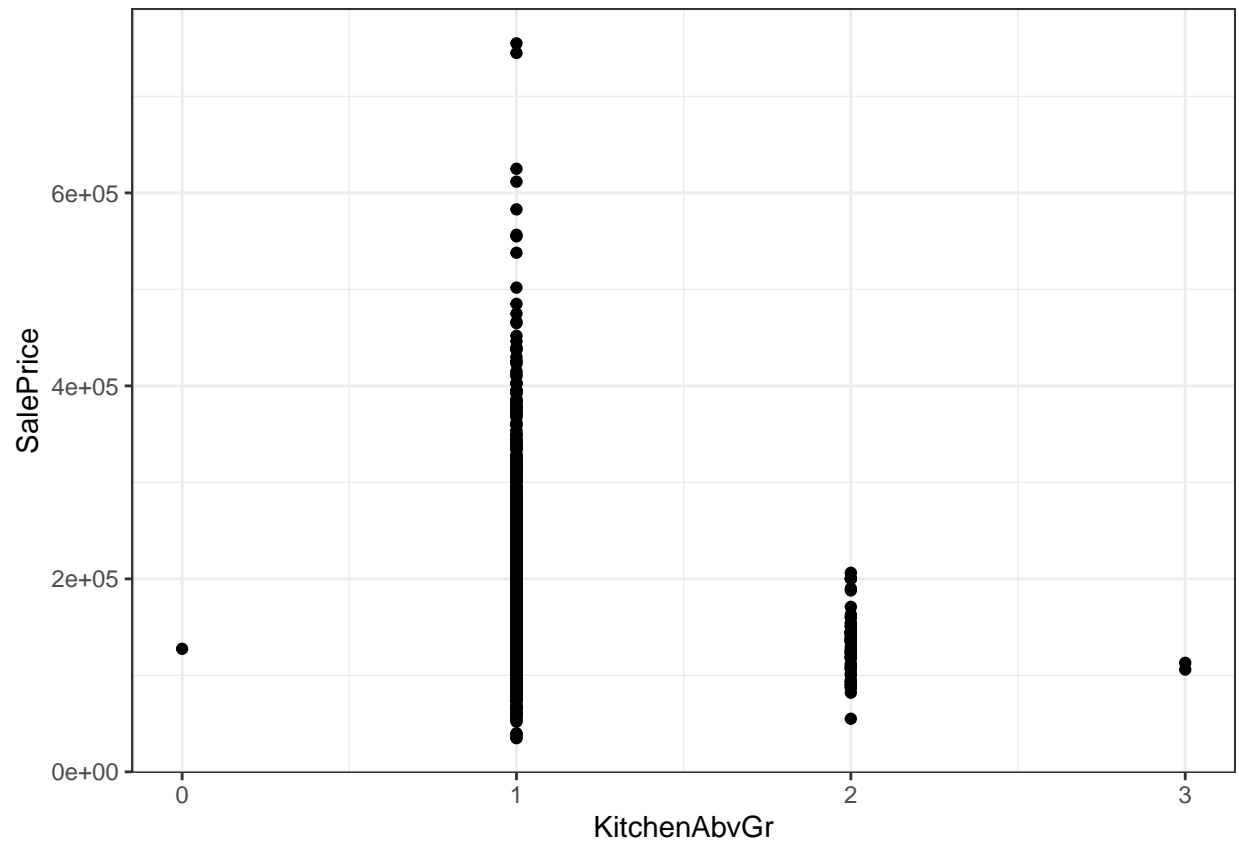
```
##
## [[21]]

## 'geom_smooth()' using formula 'y ~ x'
```

```
##
## [[22]]

## `geom_smooth()` using formula 'y ~ x'

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : pseudoinverse used at -0.015

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : neighborhood radius 1.015

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : reciprocal condition number 1.4557e-029

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : There are other near singularities as well. 1
```
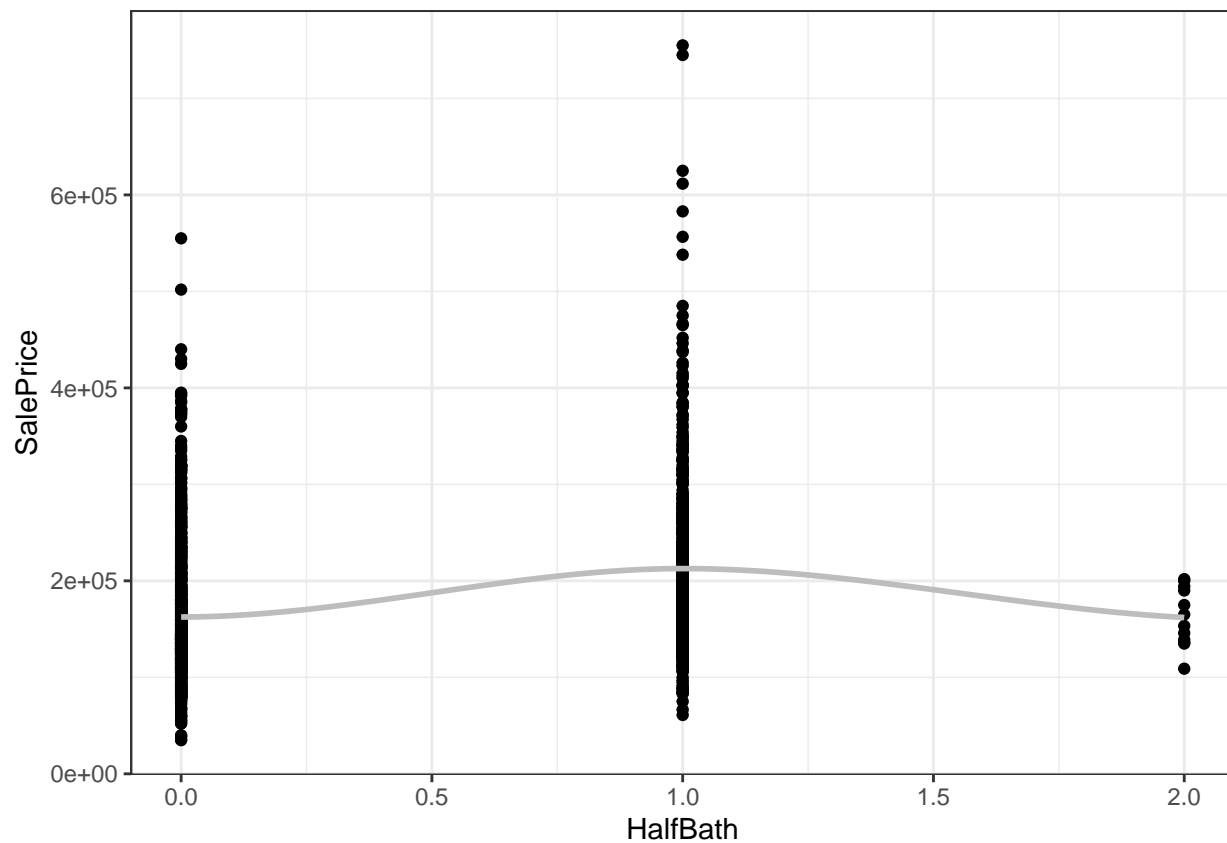
```
##
## [[23]]

## `geom_smooth()` using formula 'y ~ x'

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : pseudoinverse used at -0.02

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : neighborhood radius 2.02

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : reciprocal condition number 2.5528e-015

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : There are other near singularities as well. 1
```

```
##
## [[24]]
```
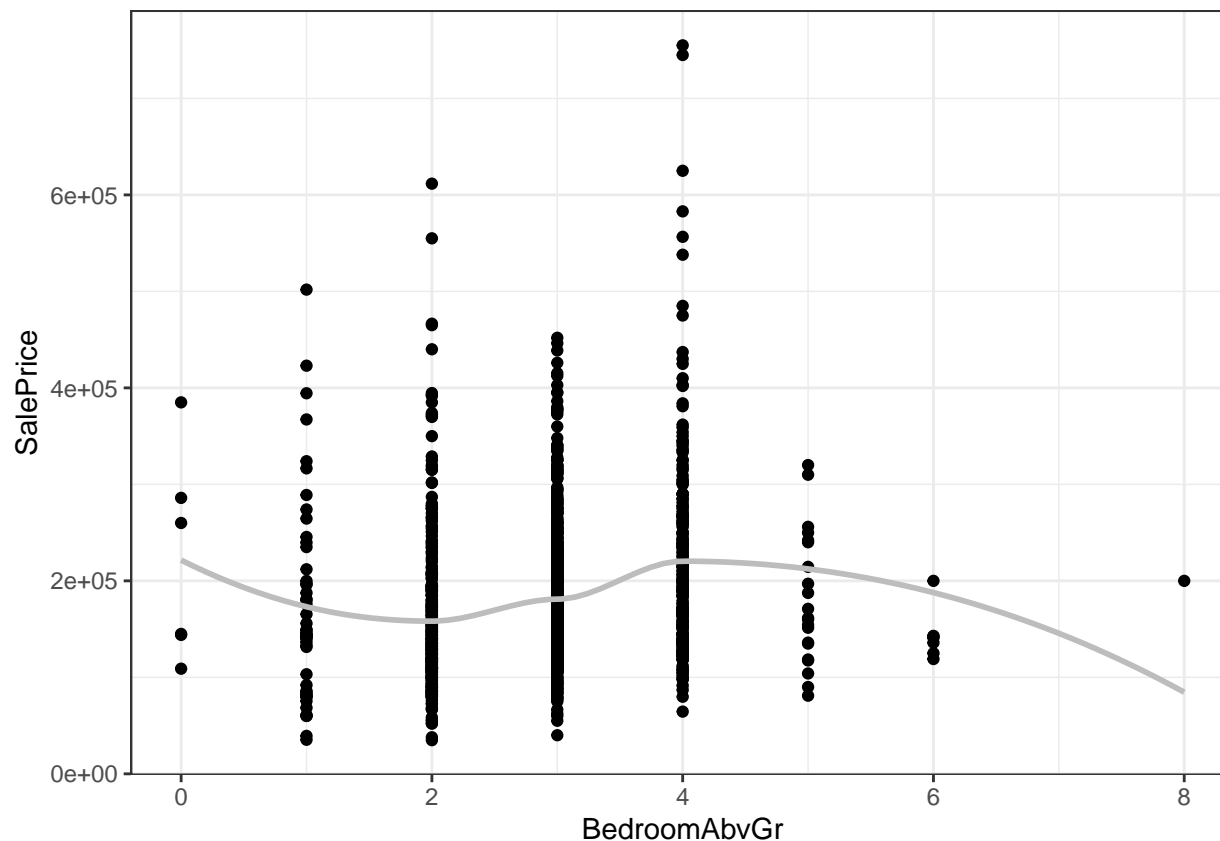
```
## `geom_smooth()` using formula 'y ~ x'
```

```
## 
## [[25]]
```

```
## `geom_smooth()` using formula 'y ~ x'
```
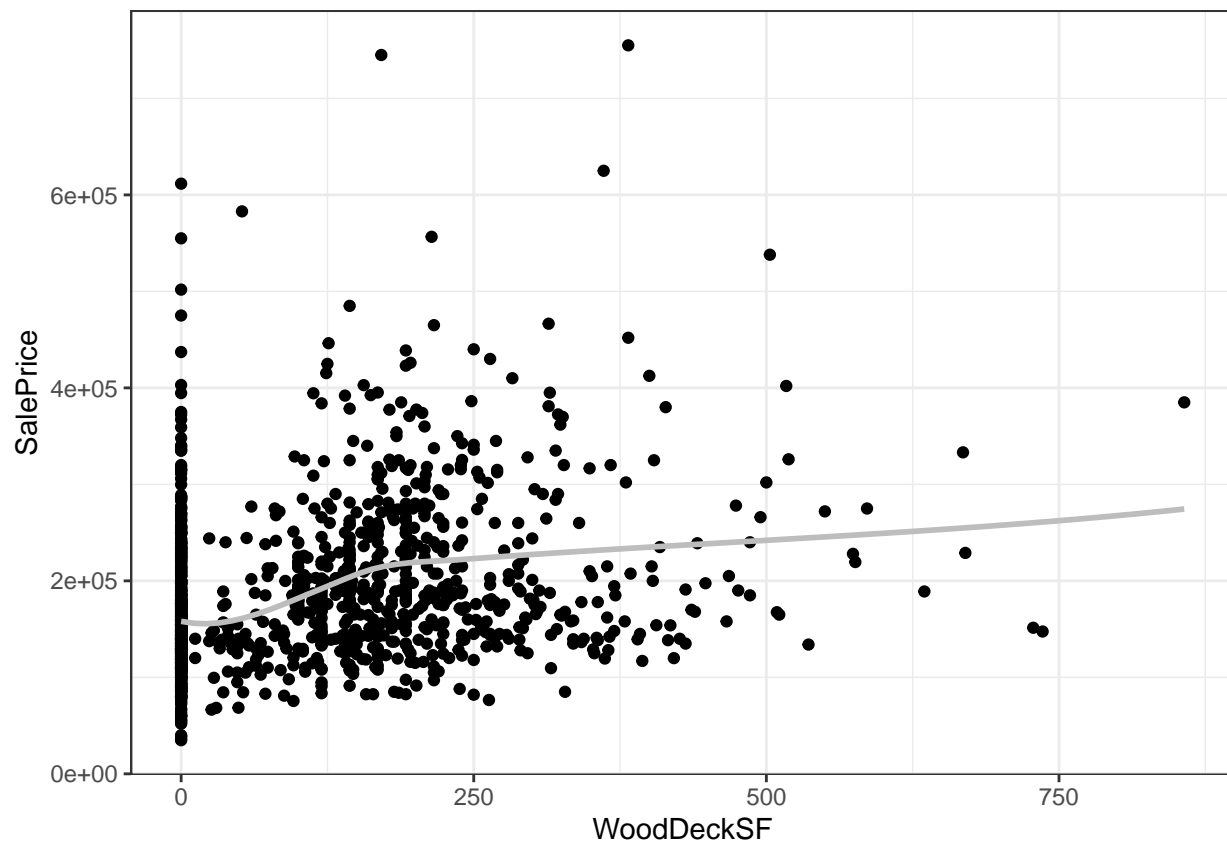
```
##
## [[26]]

## `geom_smooth()` using formula 'y ~ x'
```
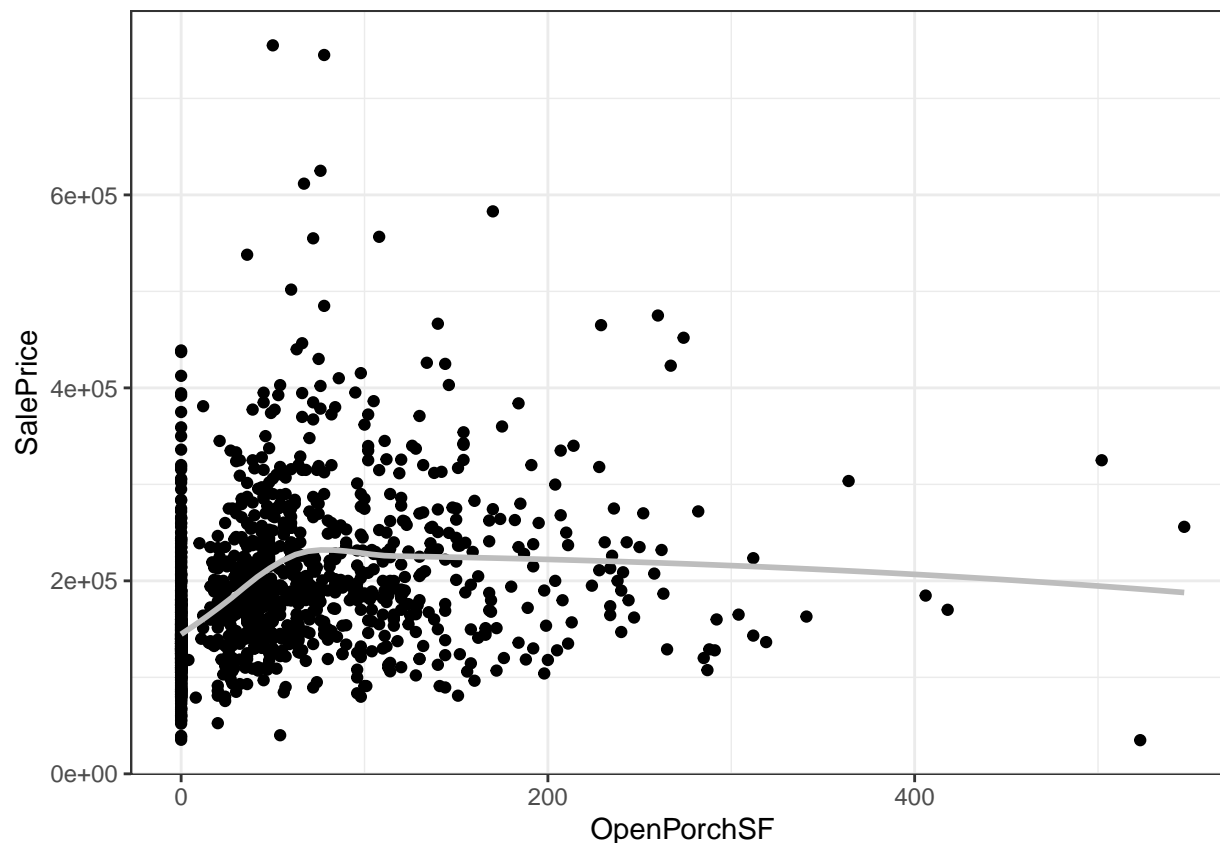
```
##
## [[27]]

## `geom_smooth()` using formula 'y ~ x'

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : at -2.76

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : radius 7.6176

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : all data on boundary of neighborhood. make span bigger

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : pseudoinverse used at -2.76

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : neighborhood radius 2.76

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : reciprocal condition number 1

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : zero-width neighborhood. make span bigger
```

```
## Warning: Computation failed in 'stat_smooth()':
## NA/NaN/Inf in foreign function call (arg 5)
```
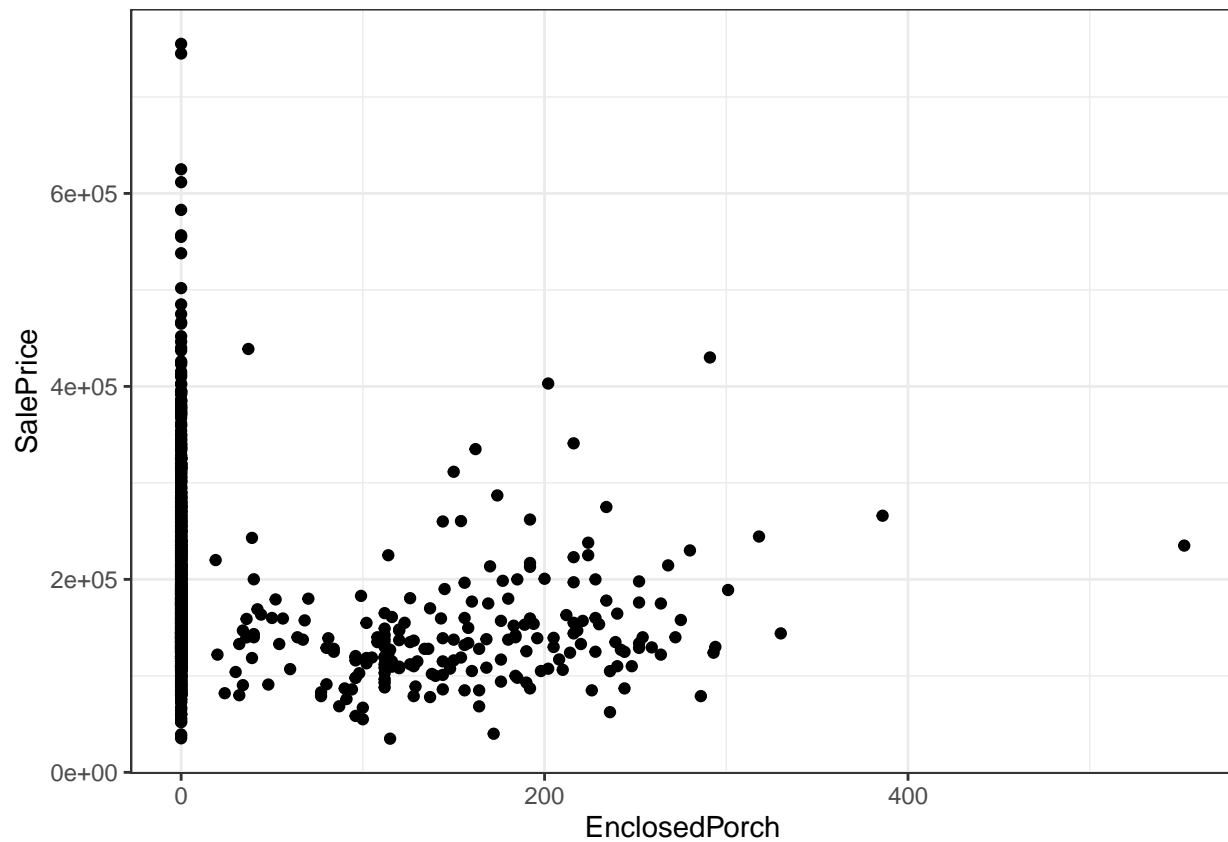


```
##
## [[28]]
```

```
## 'geom_smooth()' using formula 'y ~ x'
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : at -2.54
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : radius 6.4516
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : all data on boundary of neighborhood. make span bigger
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : pseudoinverse used at -2.54
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : neighborhood radius 2.54
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : reciprocal condition number 1

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : zero-width neighborhood. make span bigger

## Warning: Computation failed in 'stat_smooth()':
## NA/NaN/Inf in foreign function call (arg 5)
```
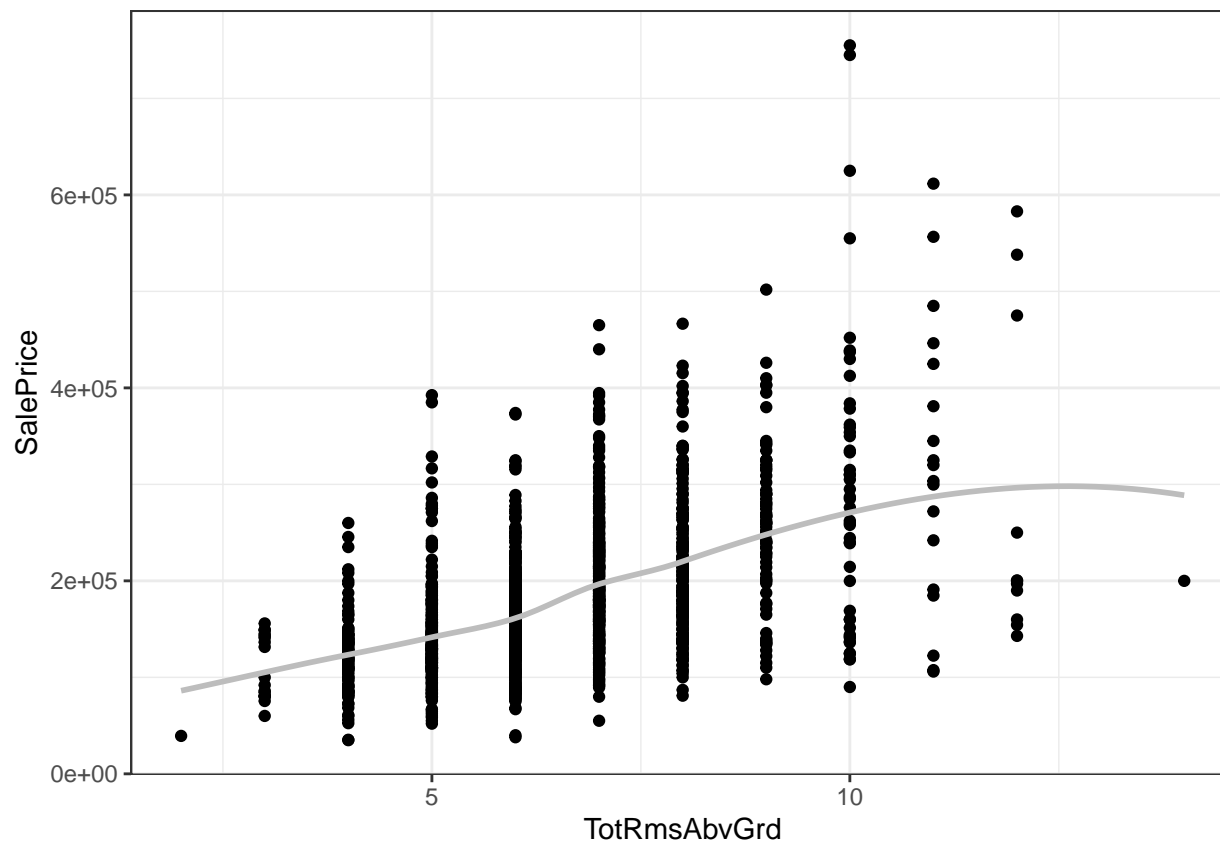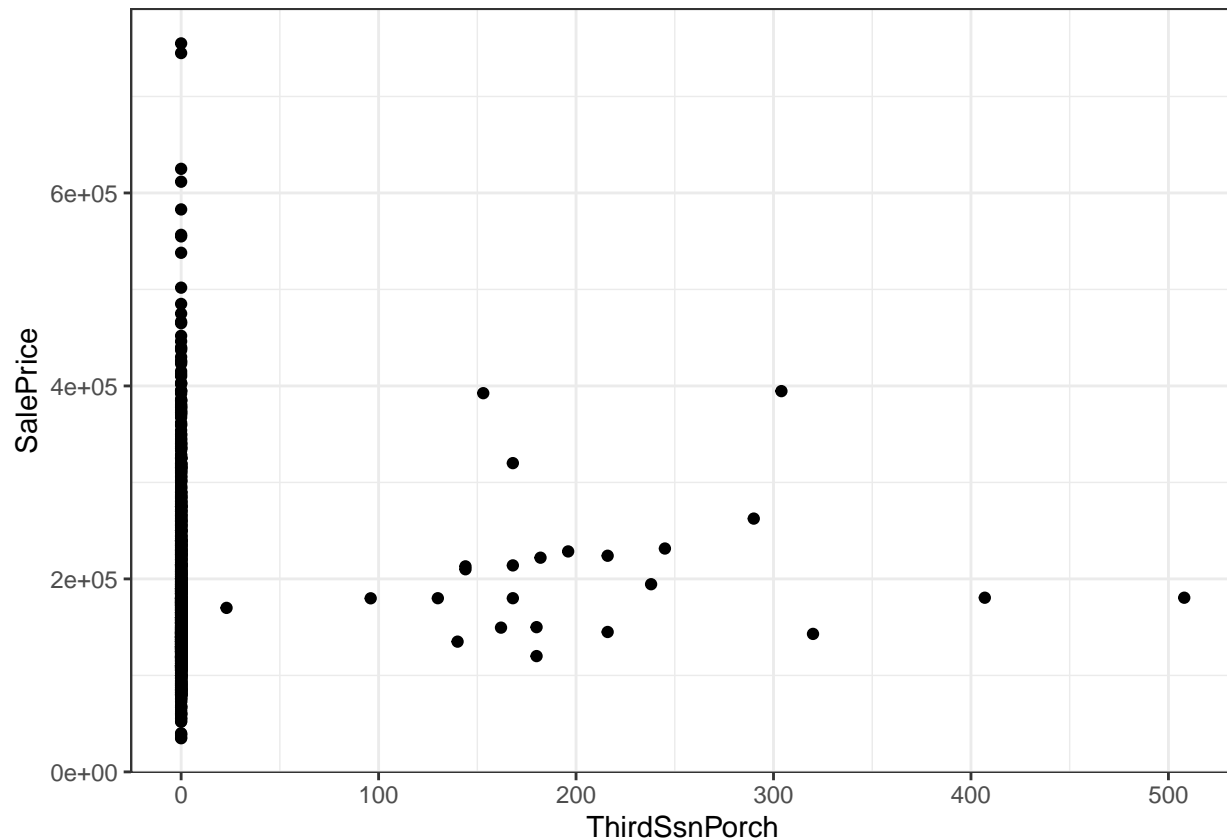


```
##
## [[29]]

## 'geom_smooth()' using formula 'y ~ x'

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : at -2.4

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : radius 5.76

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : all data on boundary of neighborhood. make span bigger
```
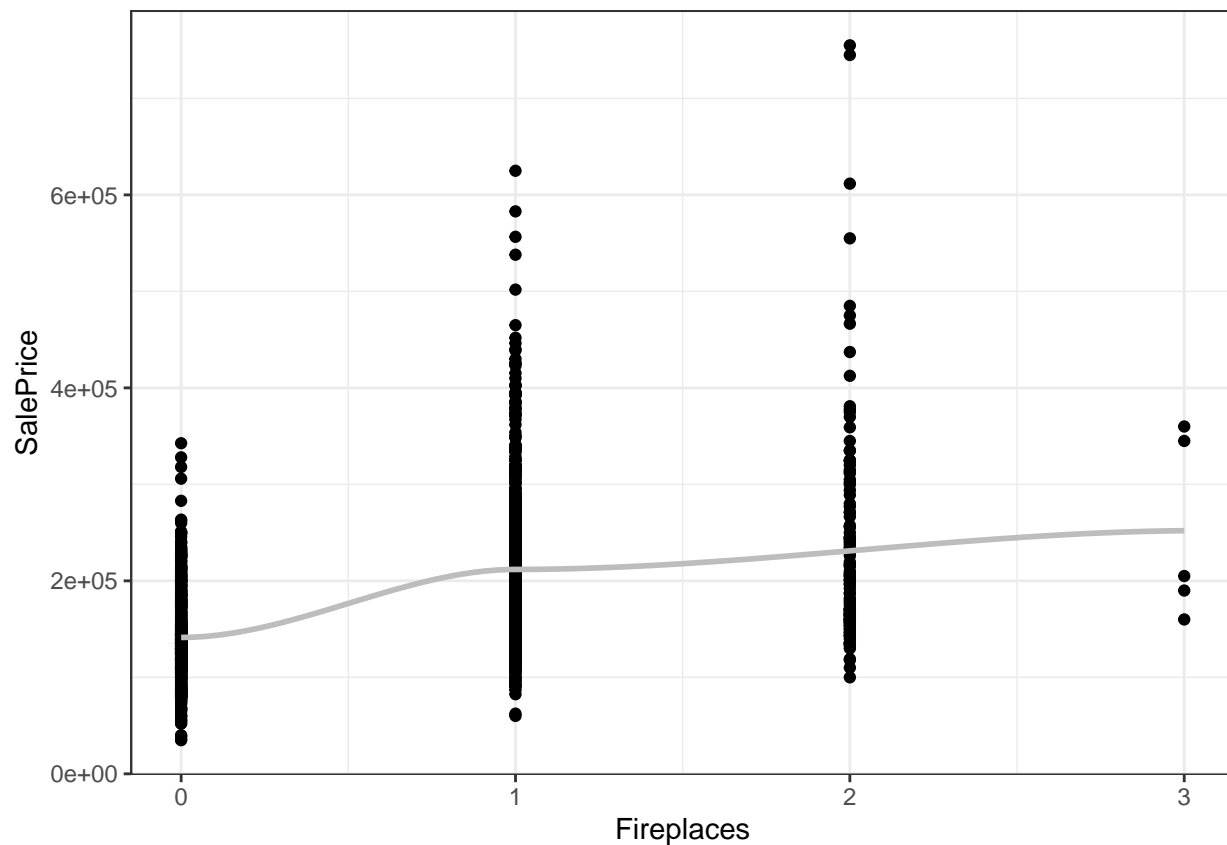
```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : pseudoinverse used at -2.4

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : neighborhood radius 2.4

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : reciprocal condition number 1

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : zero-width neighborhood. make span bigger

## Warning: Computation failed in 'stat_smooth()':
## NA/NaN/Inf in foreign function call (arg 5)
```
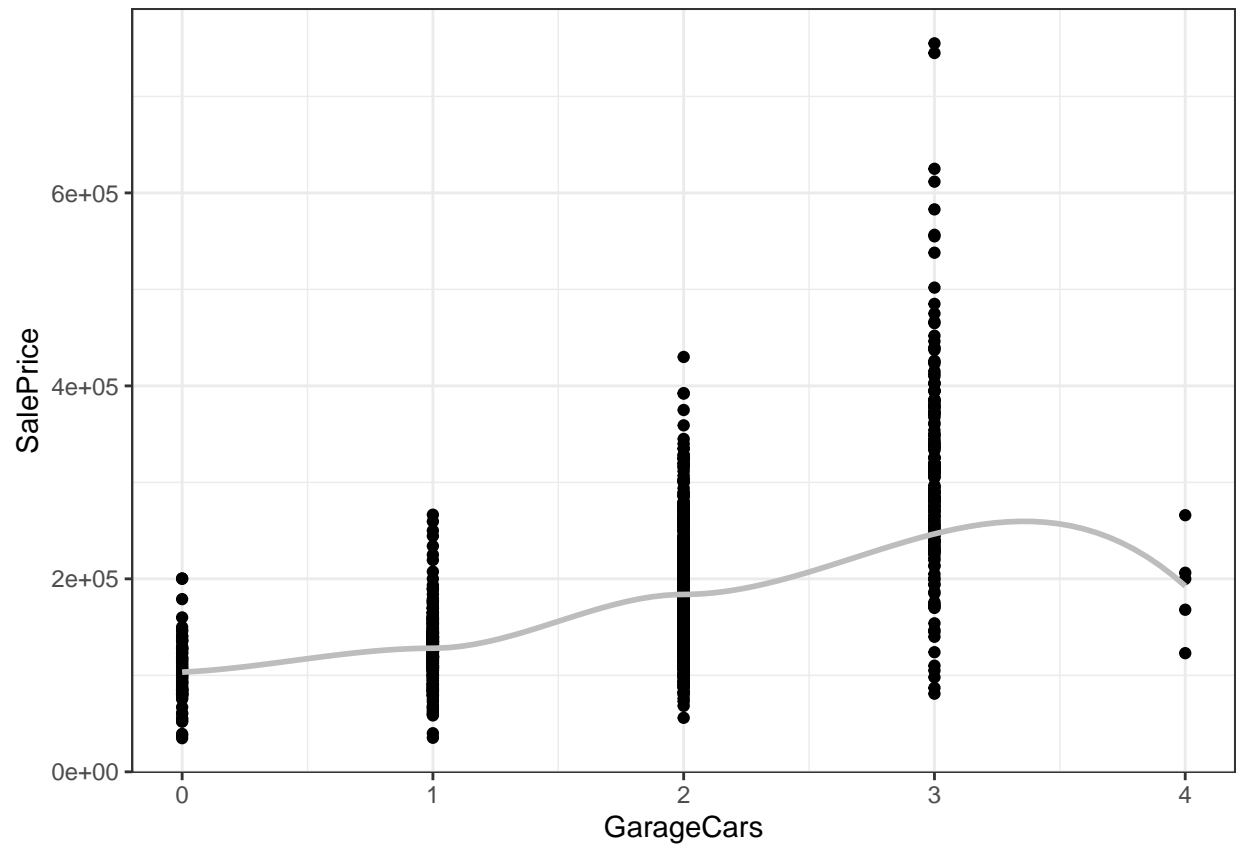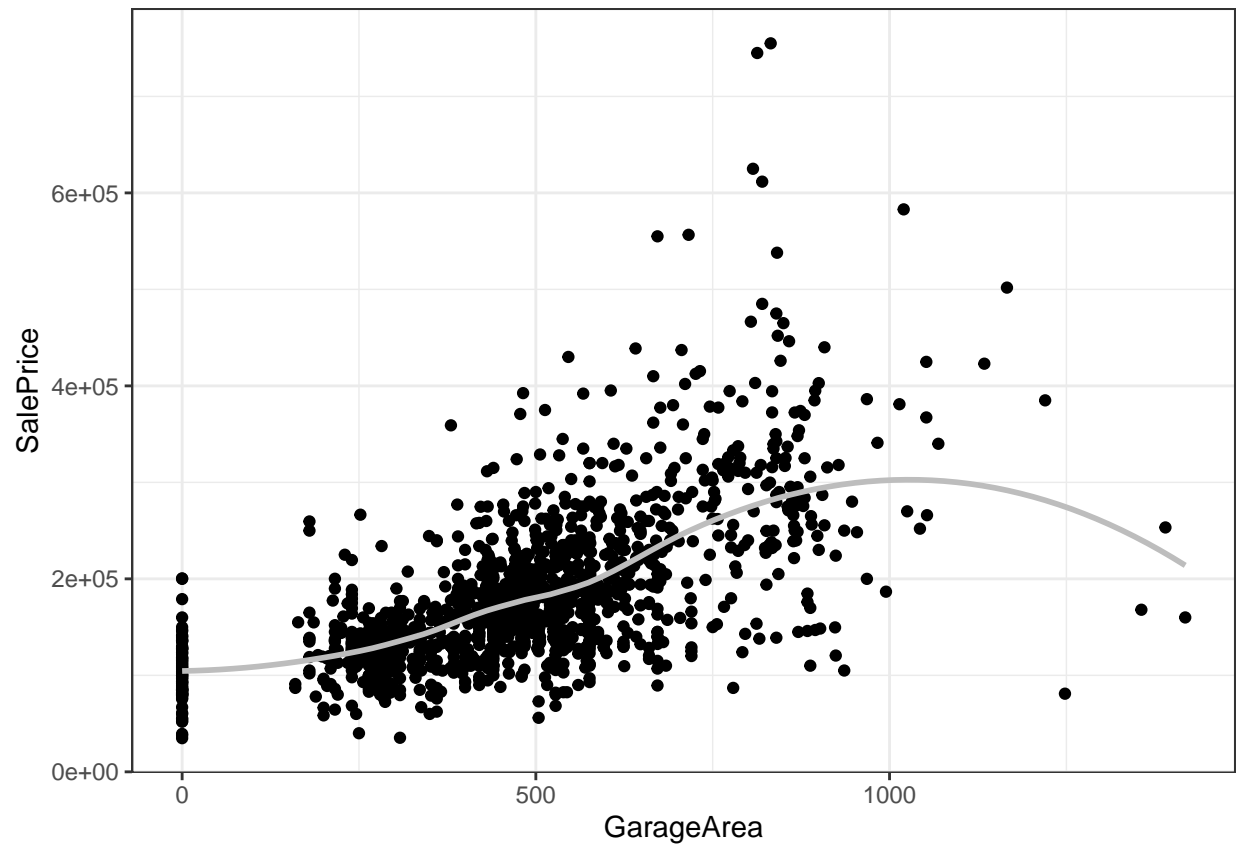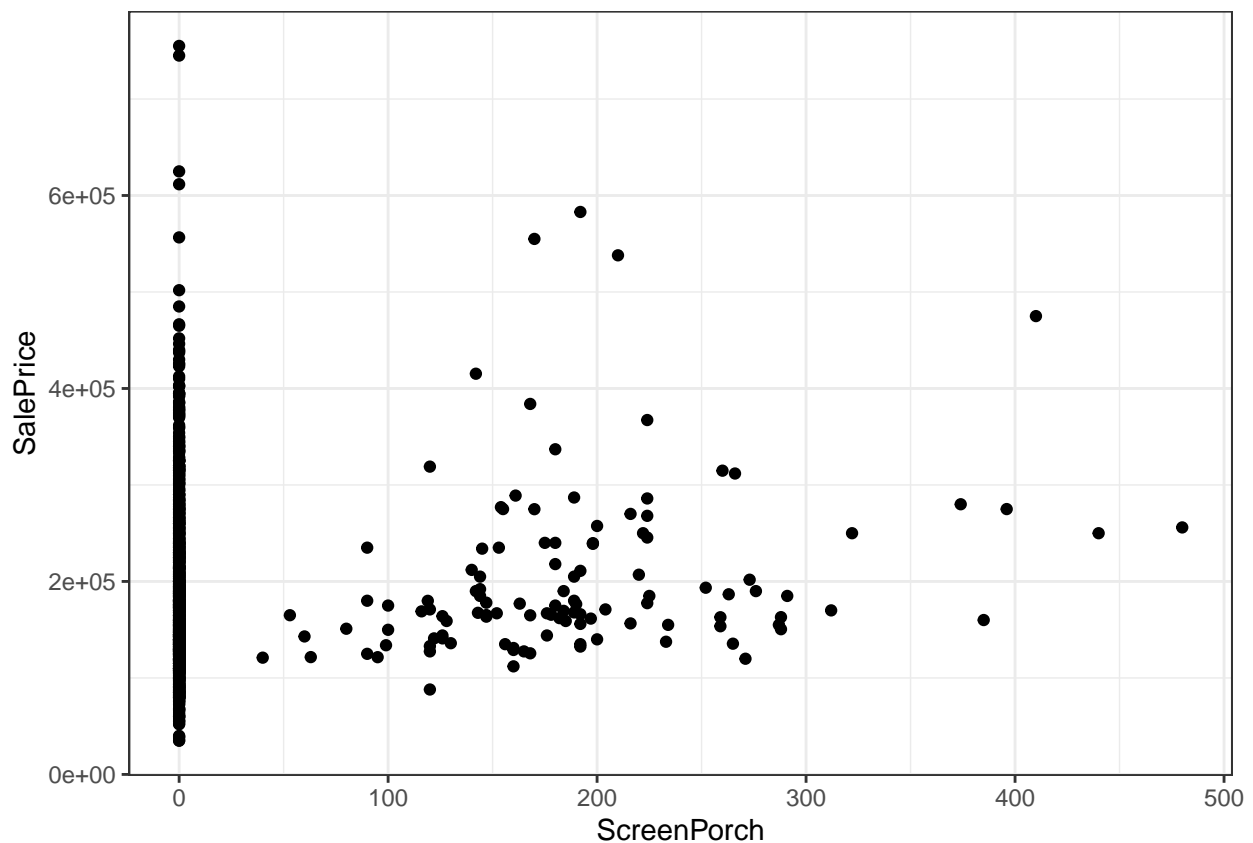


```
##
## [[30]]

## 'geom_smooth()' using formula 'y ~ x'

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : at -3.69
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : radius 13.616

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : all data on boundary of neighborhood. make span bigger

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : pseudoinverse used at -3.69

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : neighborhood radius 3.69

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : reciprocal condition number 1

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : zero-width neighborhood. make span bigger

## Warning: Computation failed in 'stat_smooth()':
## NA/NaN/Inf in foreign function call (arg 5)
```
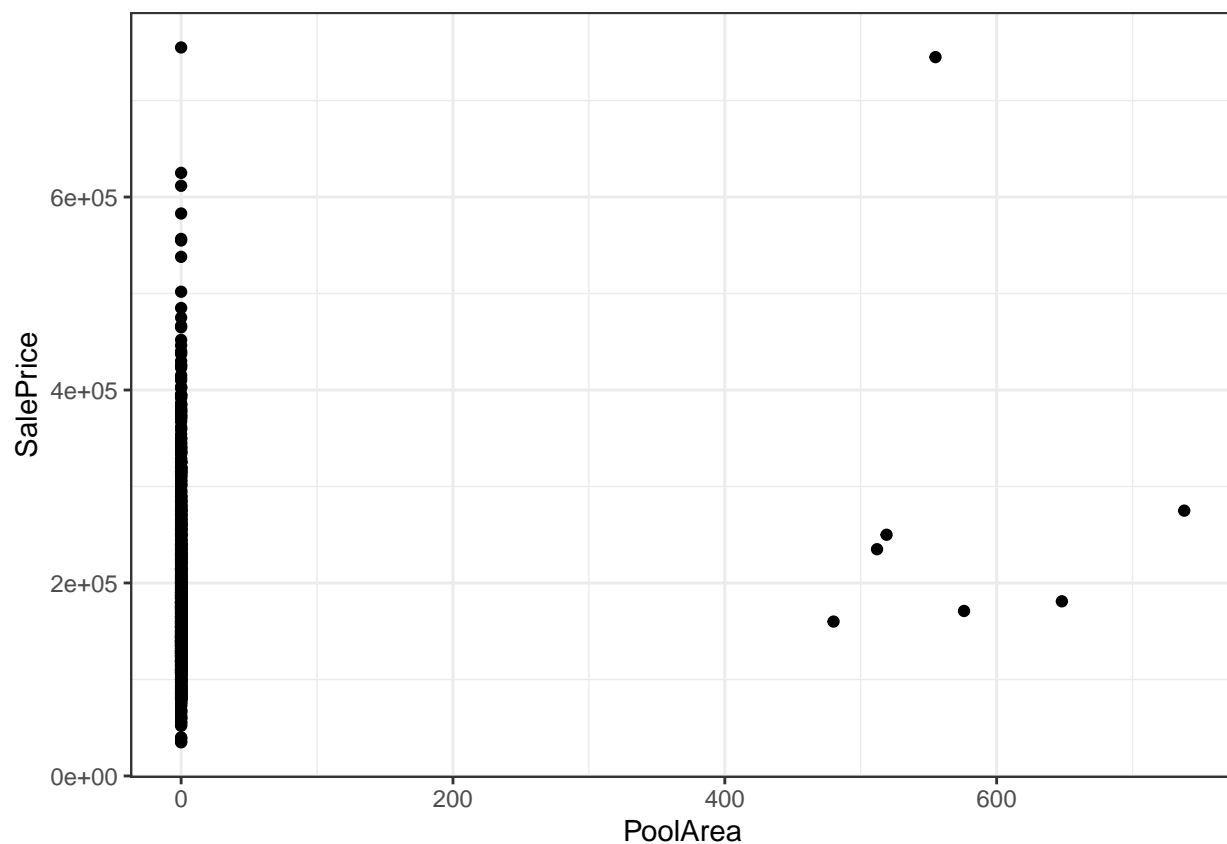


```
##
## [[31]]
```

```
## `geom_smooth()` using formula 'y ~ x'

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : at -77.5

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : radius 6006.3

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : all data on boundary of neighborhood. make span bigger

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : pseudoinverse used at -77.5

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : neighborhood radius 77.5

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : reciprocal condition number 1

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : zero-width neighborhood. make span bigger

## Warning: Computation failed in `stat_smooth()`:
## NA/NaN/Inf in foreign function call (arg 5)
```
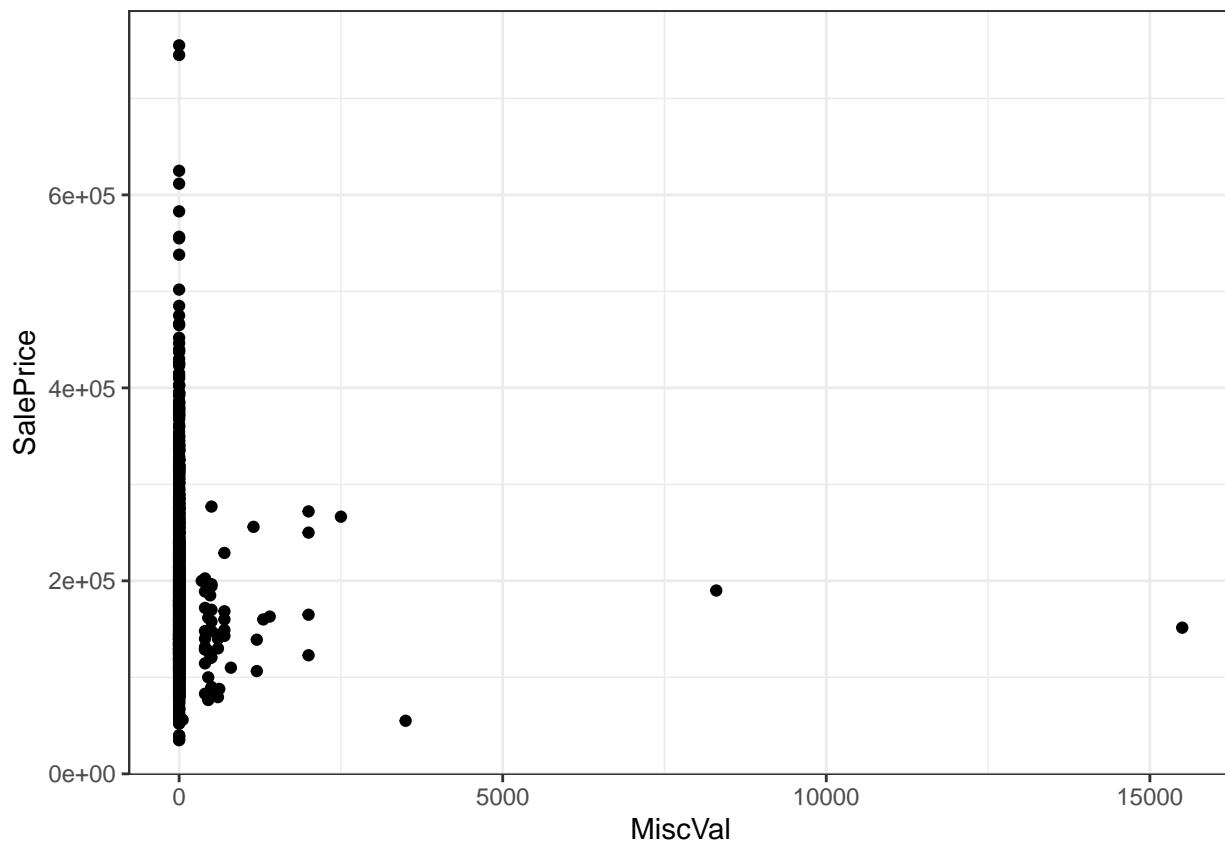
```
##
## [[32]]
```

```
## `geom_smooth()` using formula 'y ~ x'
```
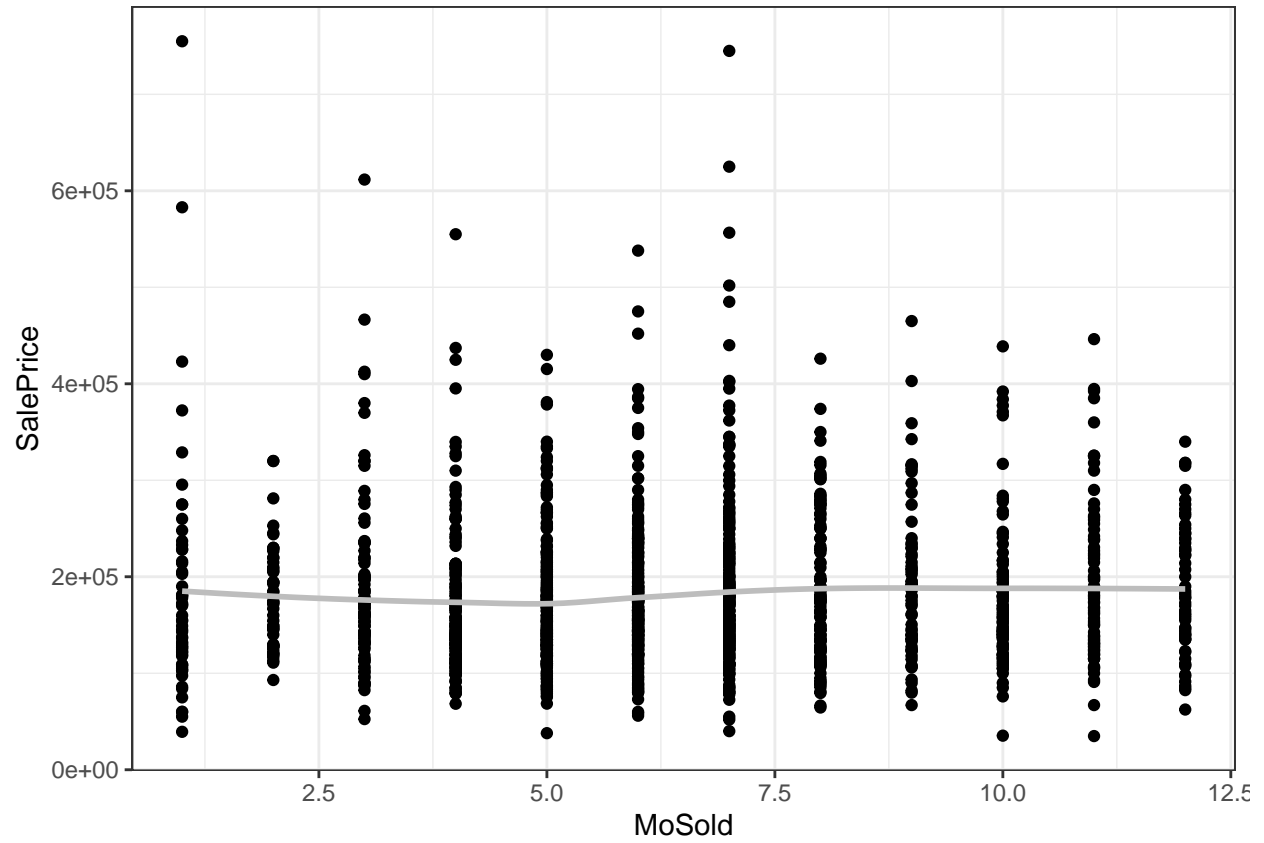


```
##
## [[33]]
```

```
## `geom_smooth()` using formula 'y ~ x'
```
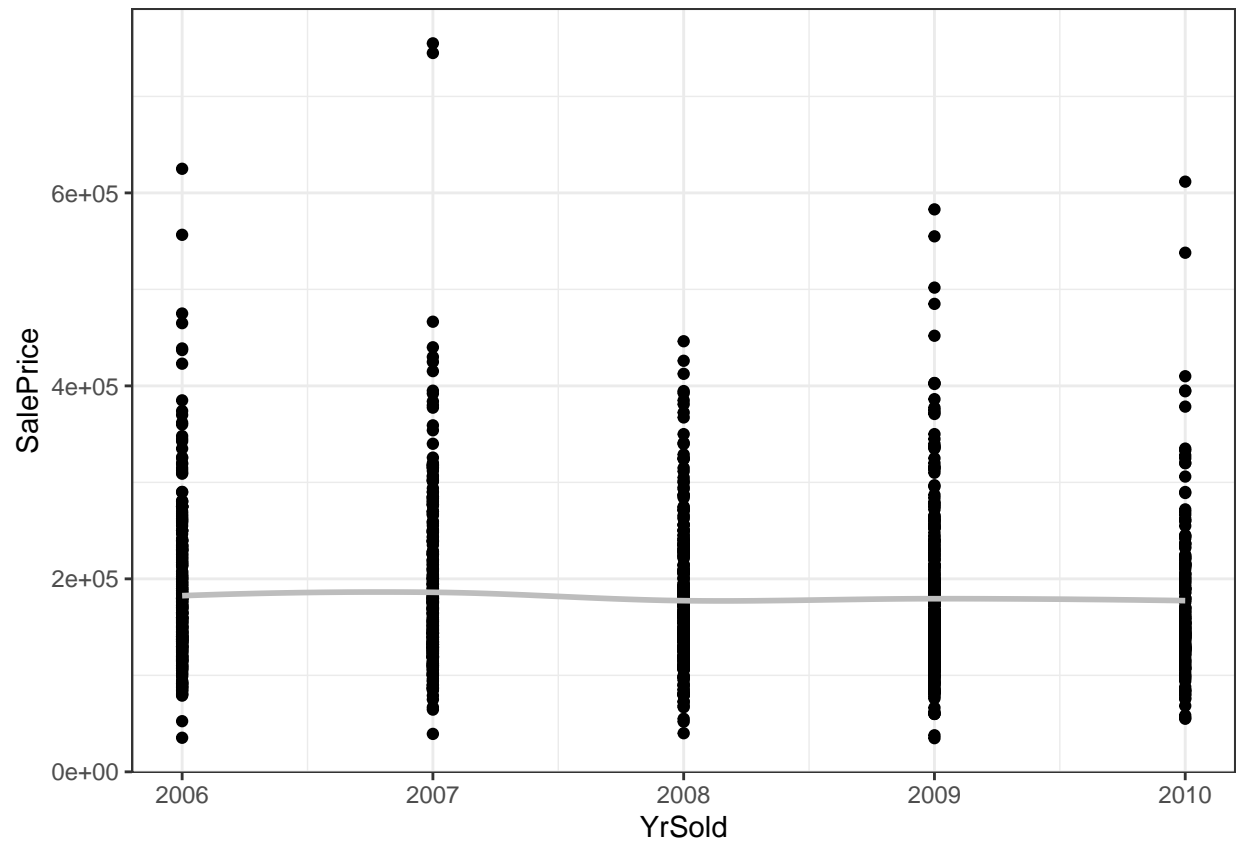
Boxplots

```
for(i in colnames(train_num)) {          # for-loop over columns
  print(i)
  boxplot(train_num[i], data=train_num, main=i)
}
```

```
## [1] "LotArea"
```

LotArea


```
## [1] "OverallQual"
```
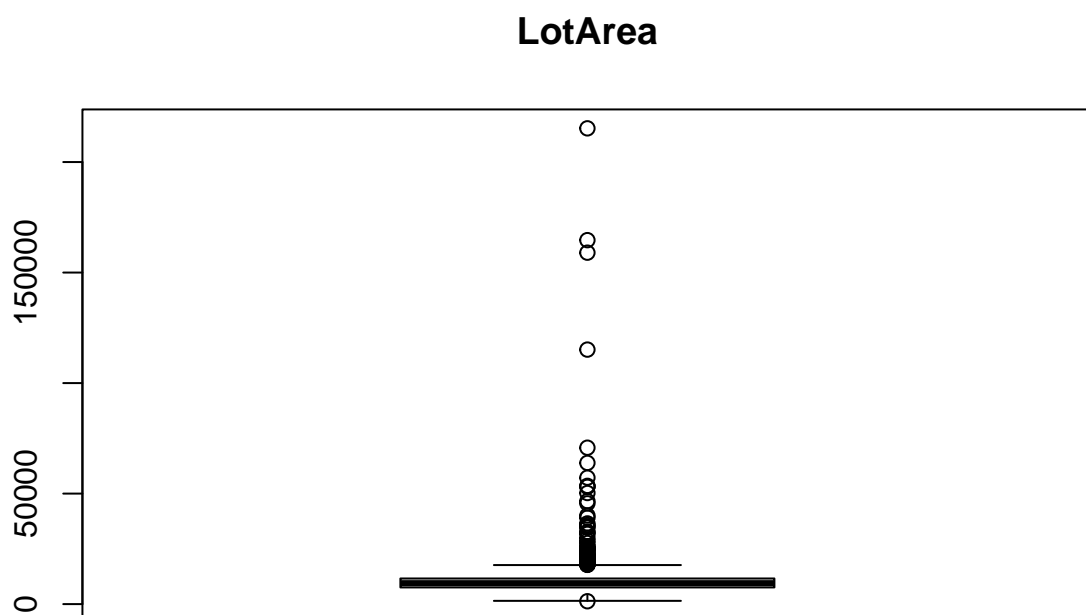
OverallQual


```
## [1] "OverallCond"
```
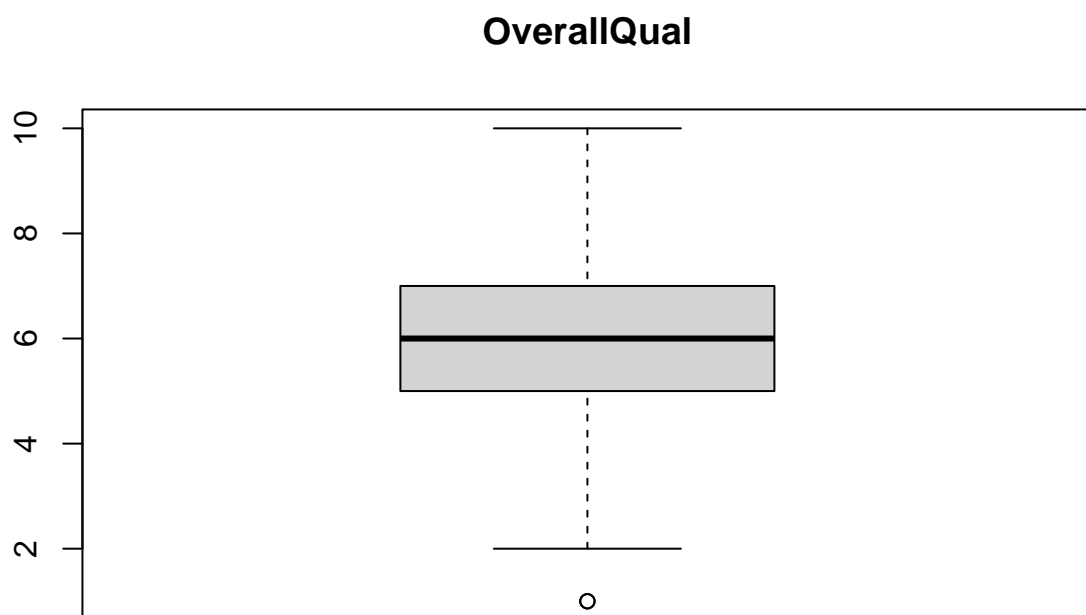
OverallCond


```
## [1] "YearBuilt"
```
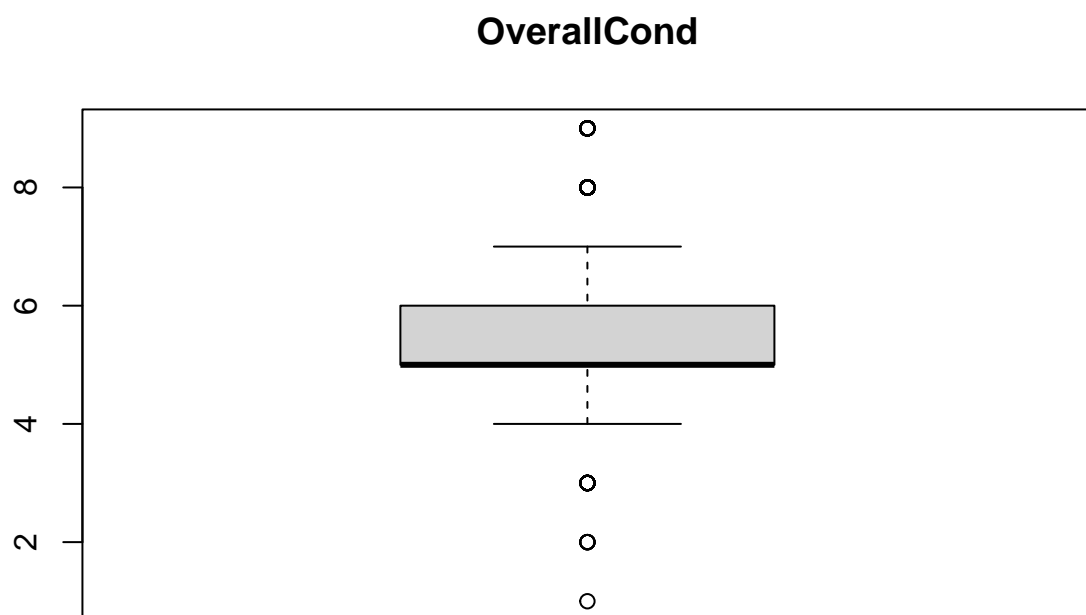
YearBuilt


```
## [1] "YearRemodAdd"
```
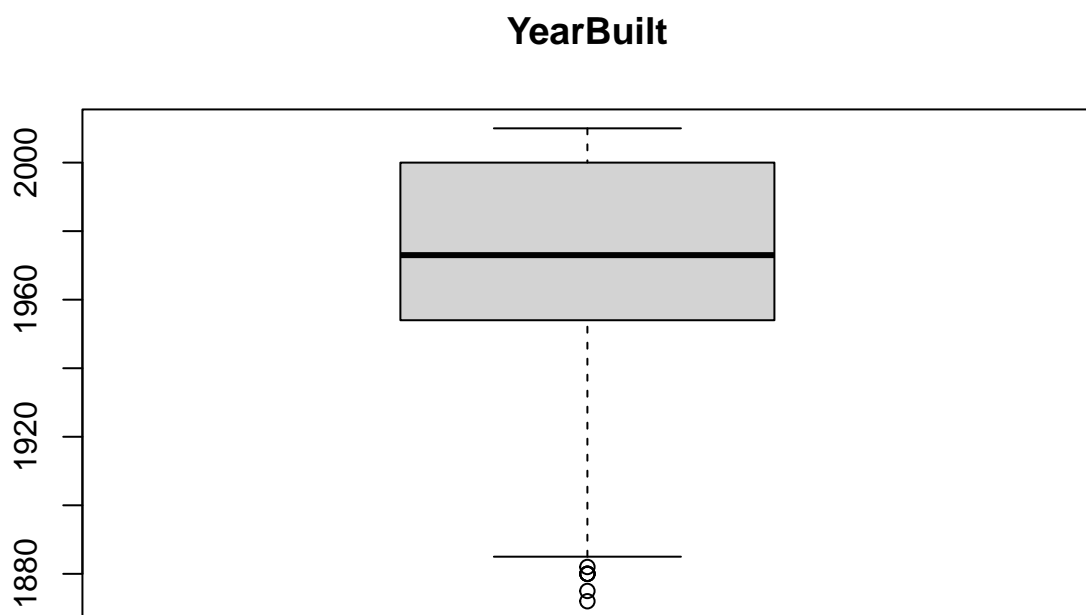
YearRemodAdd
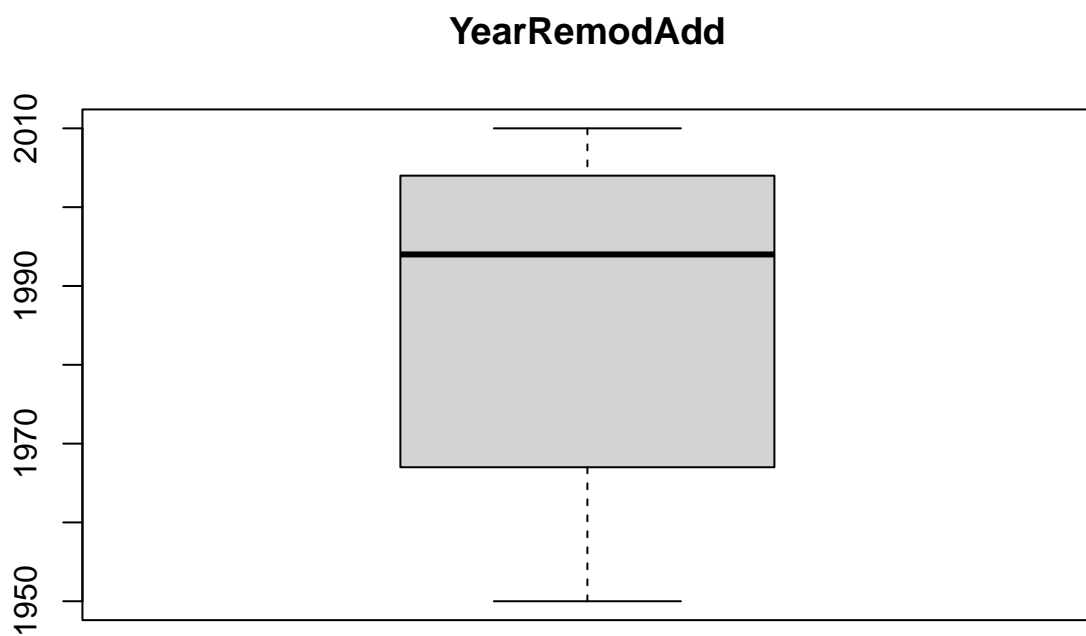

```
## [1] "MasVnrArea"
```

MasVnrArea
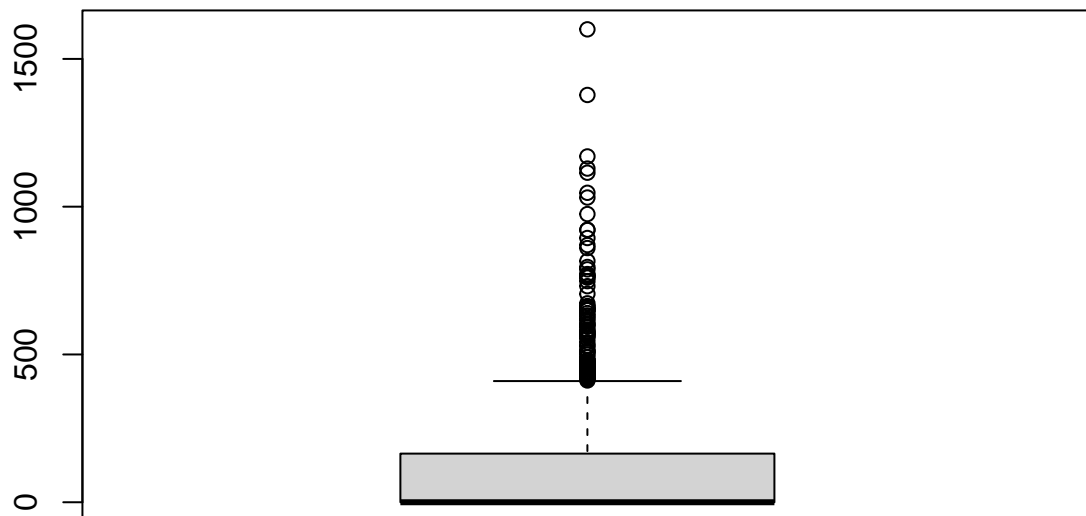

```
## [1] "BsmtFinSF1"
```

BsmtFinSF1
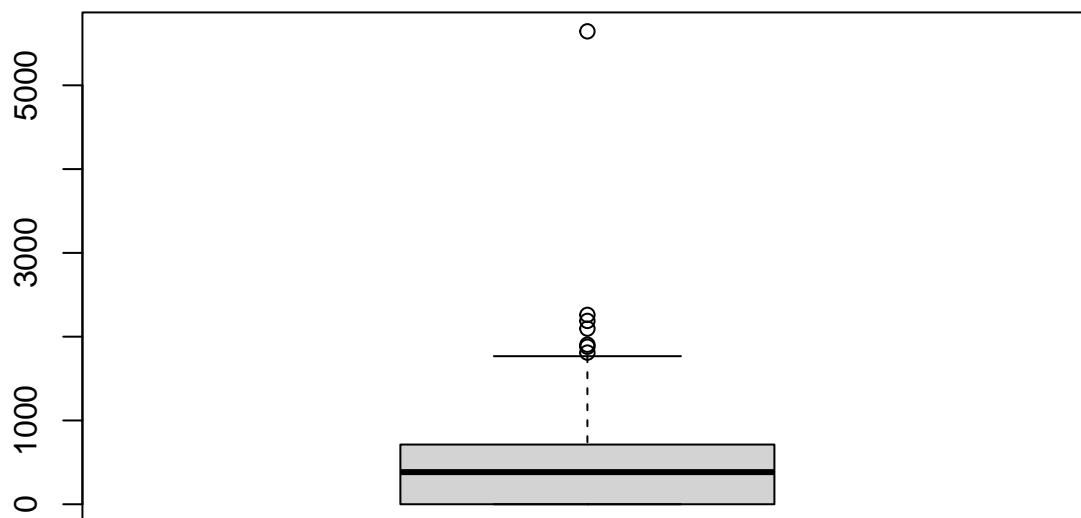

```
## [1] "BsmtFinSF2"
```

BsmtFinSF2
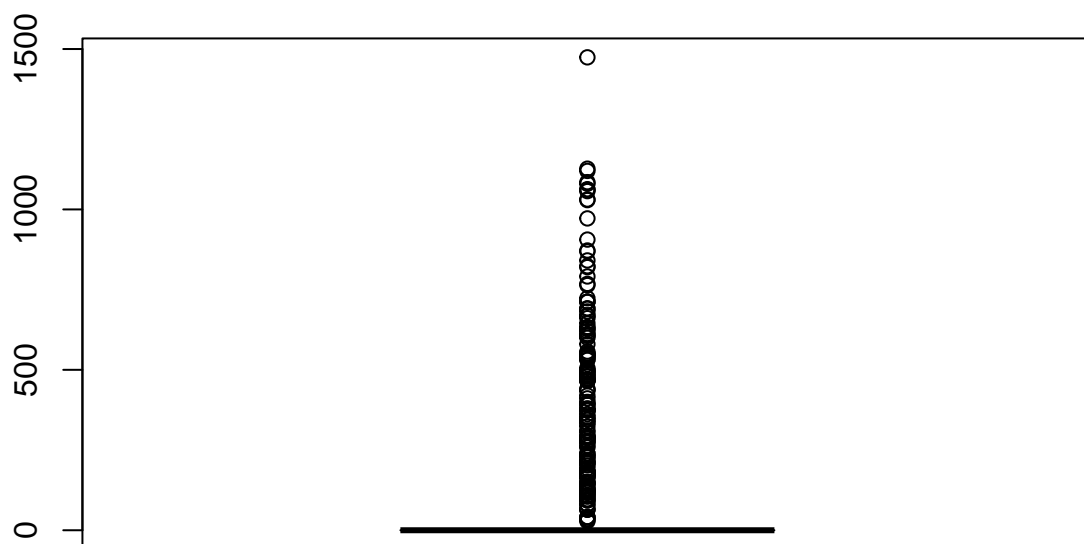

```
## [1] "BsmtUnfSF"
```

BsmtUnfSF
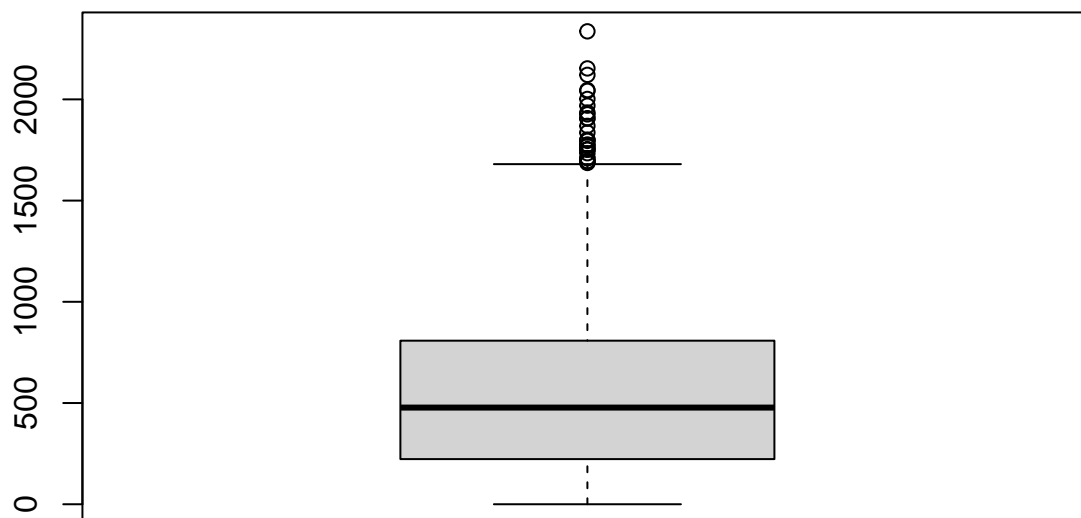

```
## [1] "TotalBsmtSF"
```

TotalBsmtSF
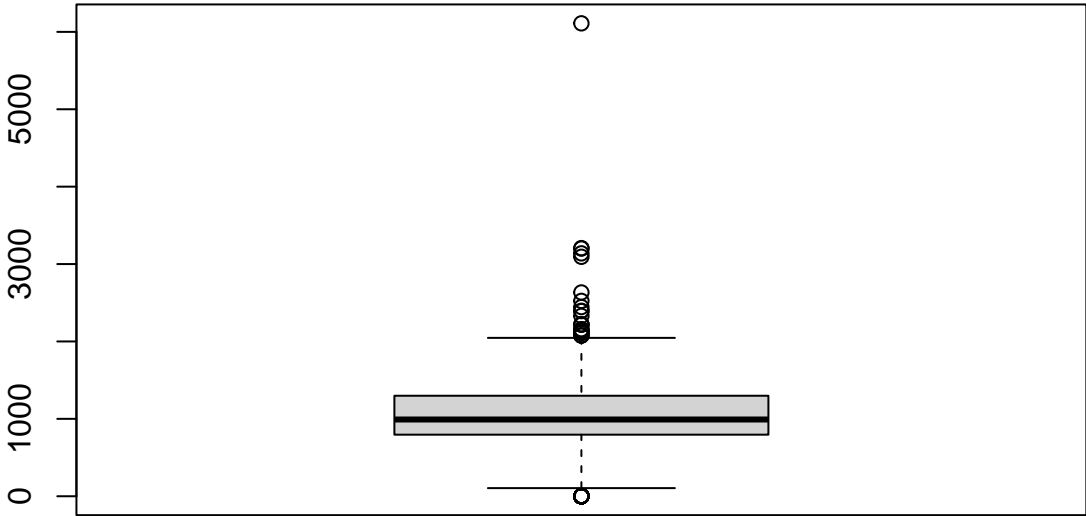

```
## [1] "FirstFlrSF"
```

FirstFlrSF


```
## [1] "SectFlrSF"
```
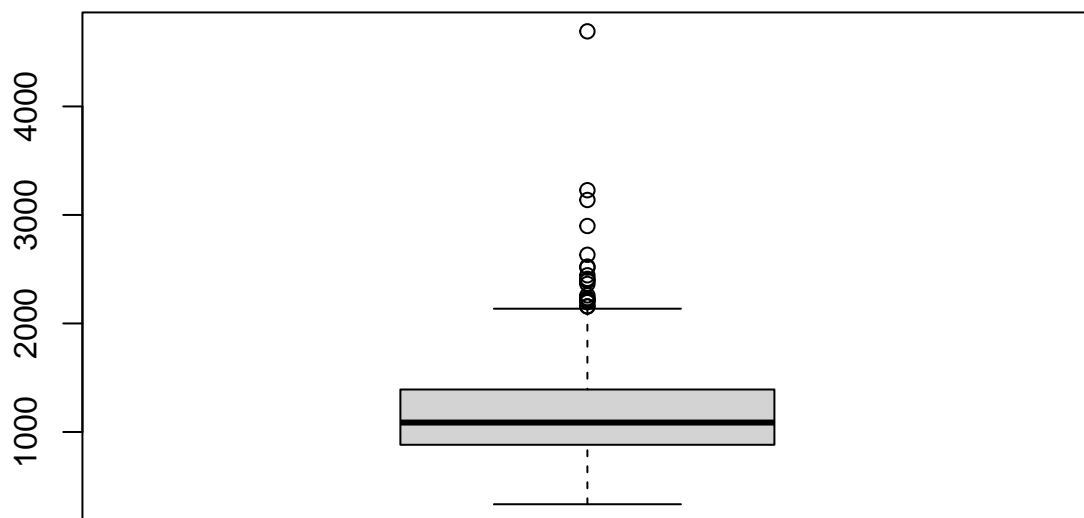
SectFlrSF
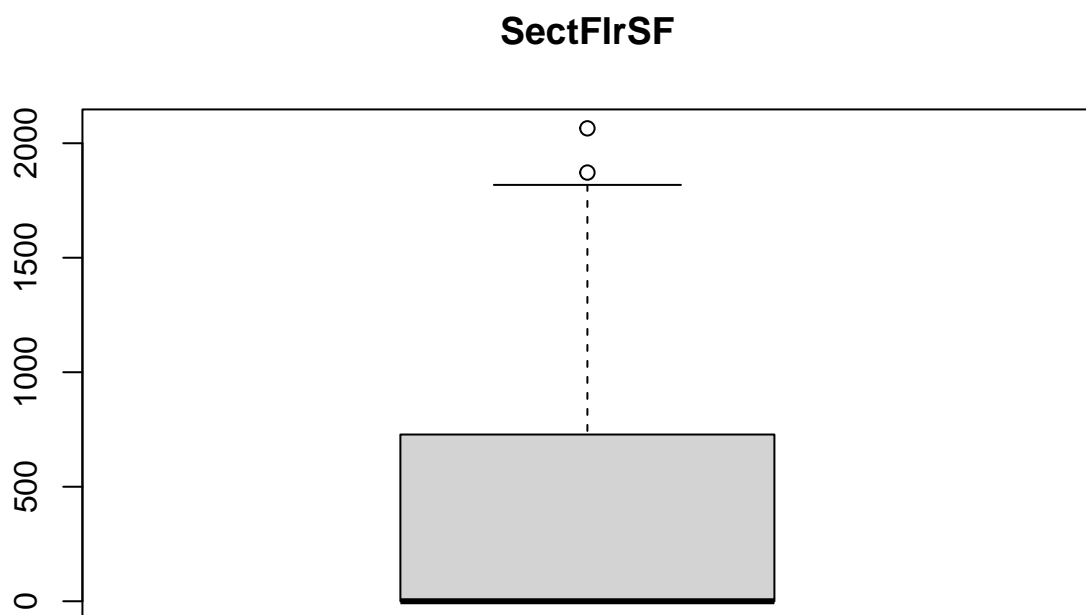

```
## [1] "LowQualFinSF"
```

LowQualFinSF


```
## [1] "GrLivArea"
```
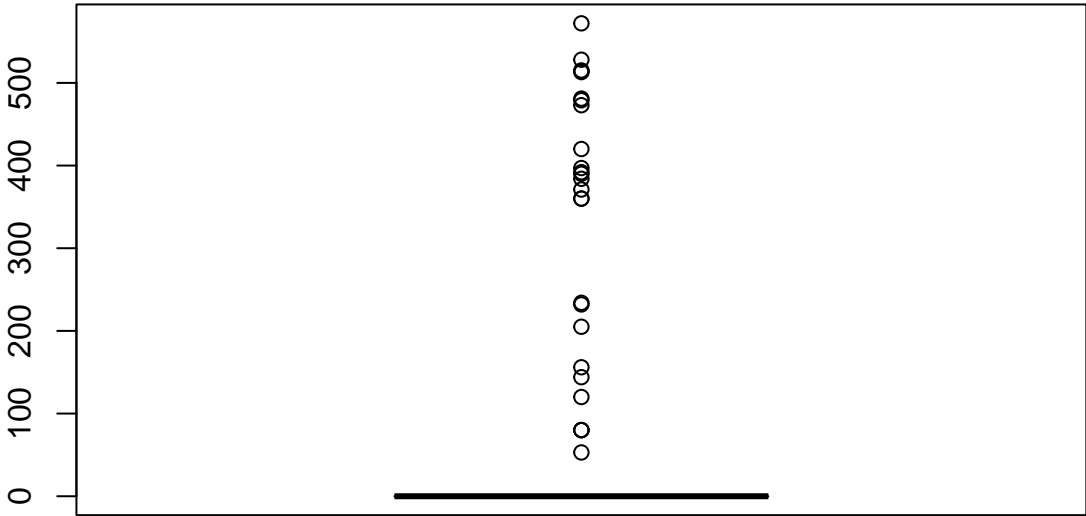
GrLivArea
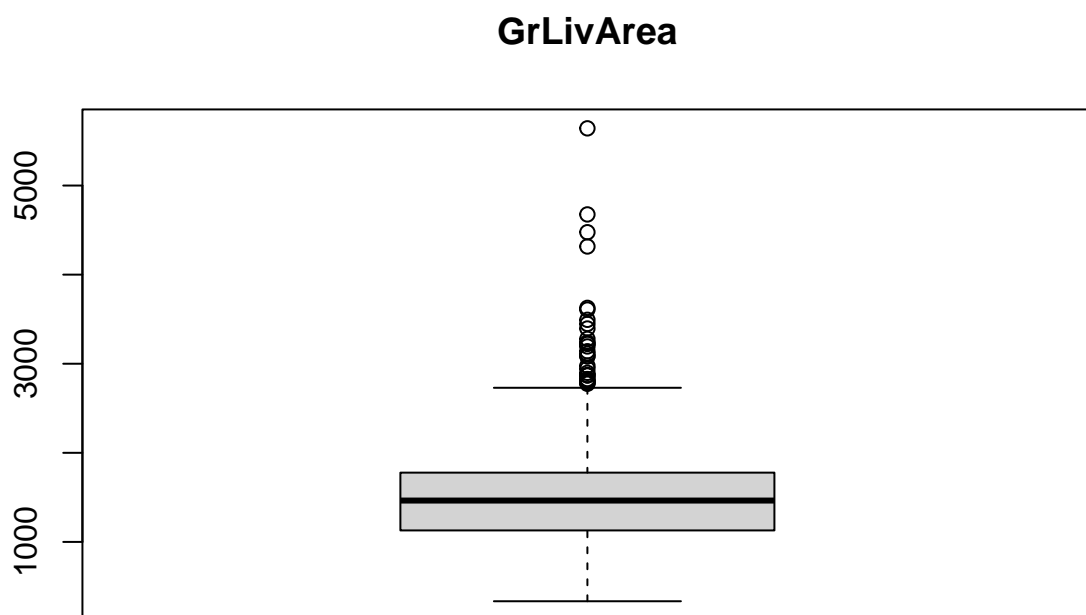

```
## [1] "BsmtFullBath"
```

BsmtFullBath
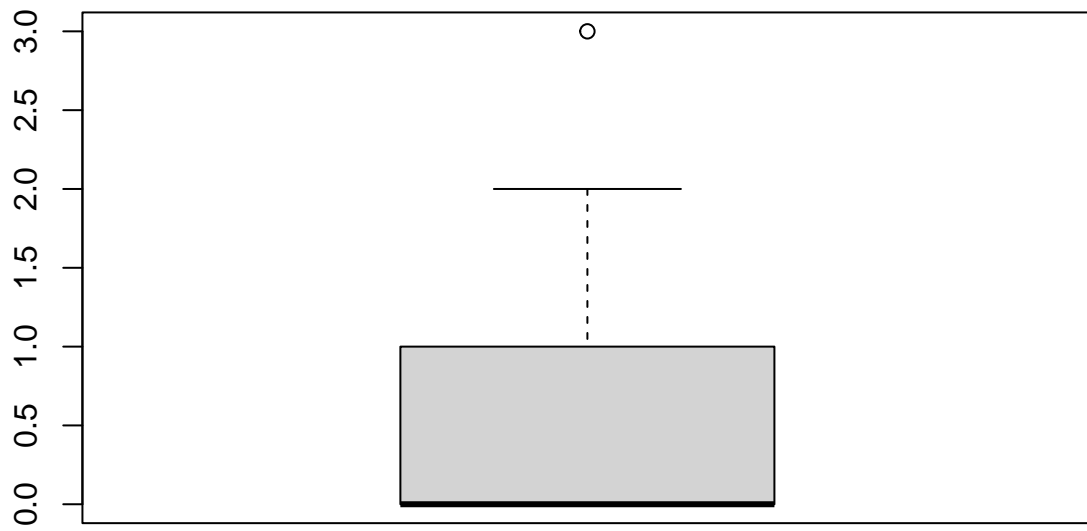

```
## [1] "BsmtHalfBath"
```

BsmtHalfBath

```
## [1] "FullBath"
```
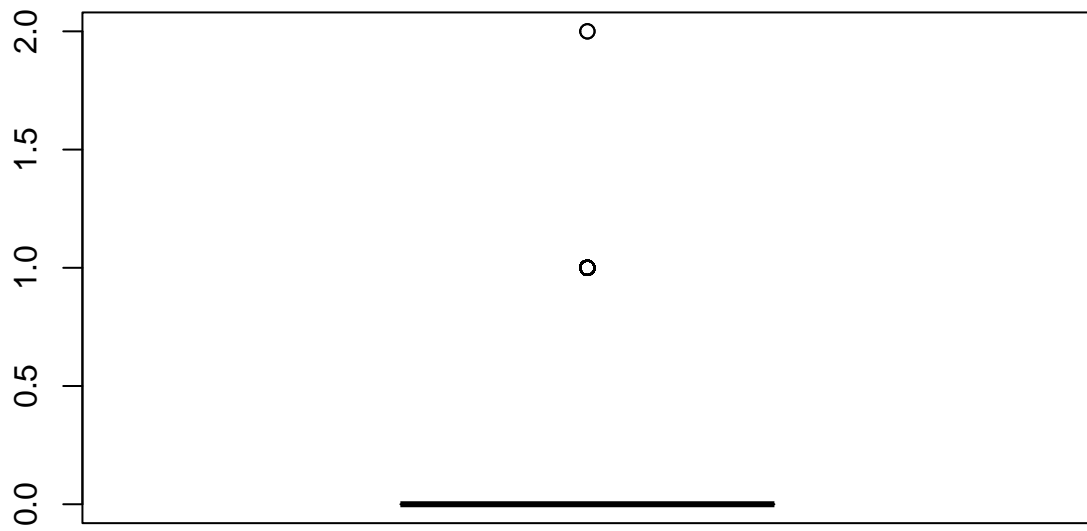
FullBath


```
## [1] "HalfBath"
```
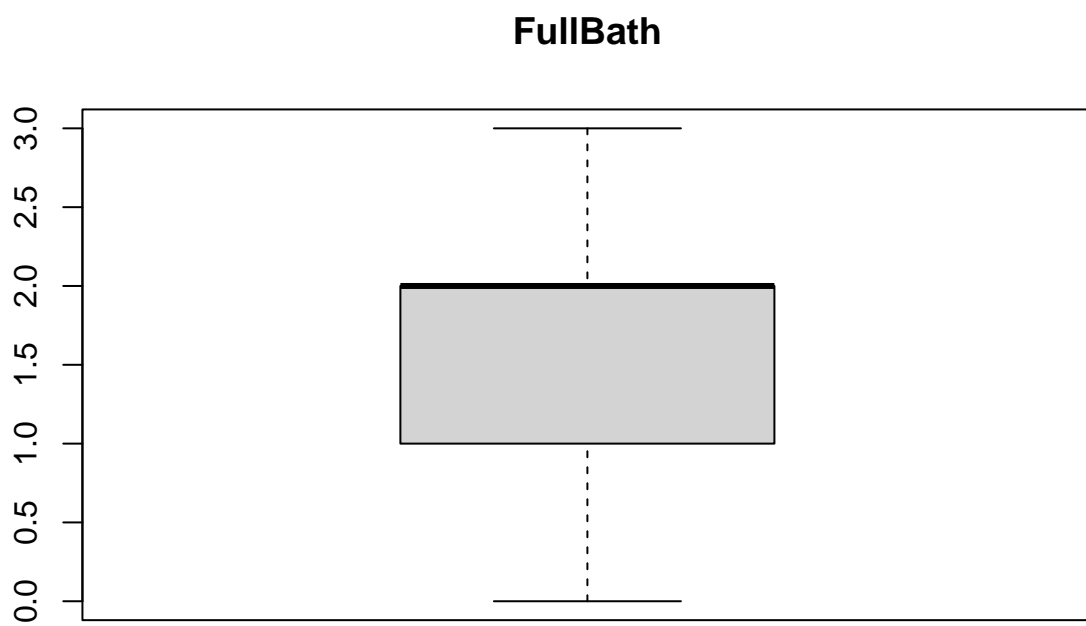
HalfBath
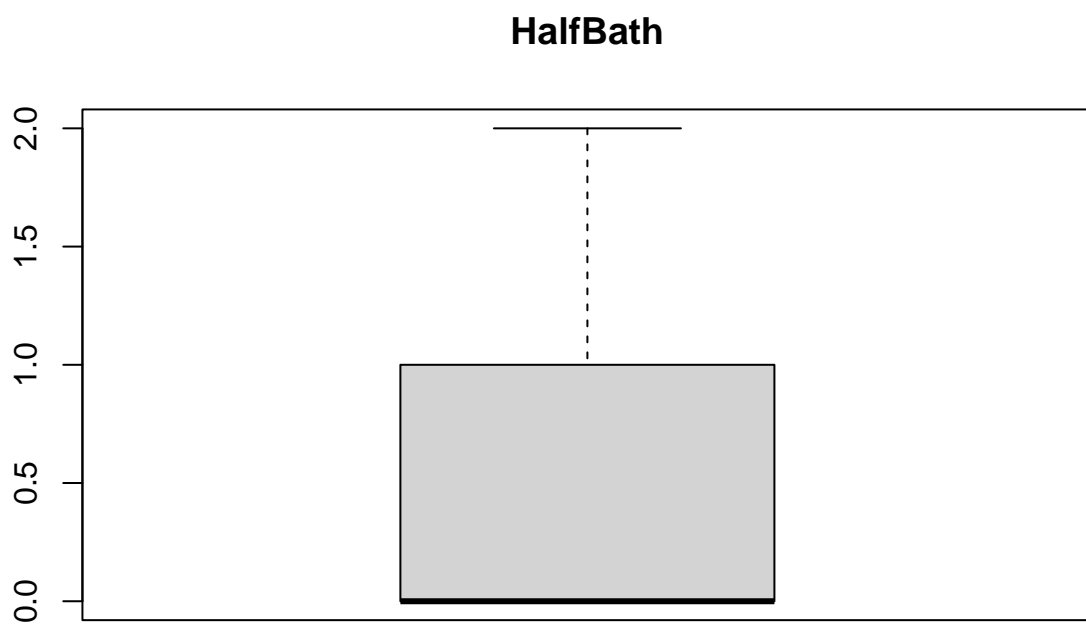

```
## [1] "BedroomAbvGr"
```

BedroomAbvGr
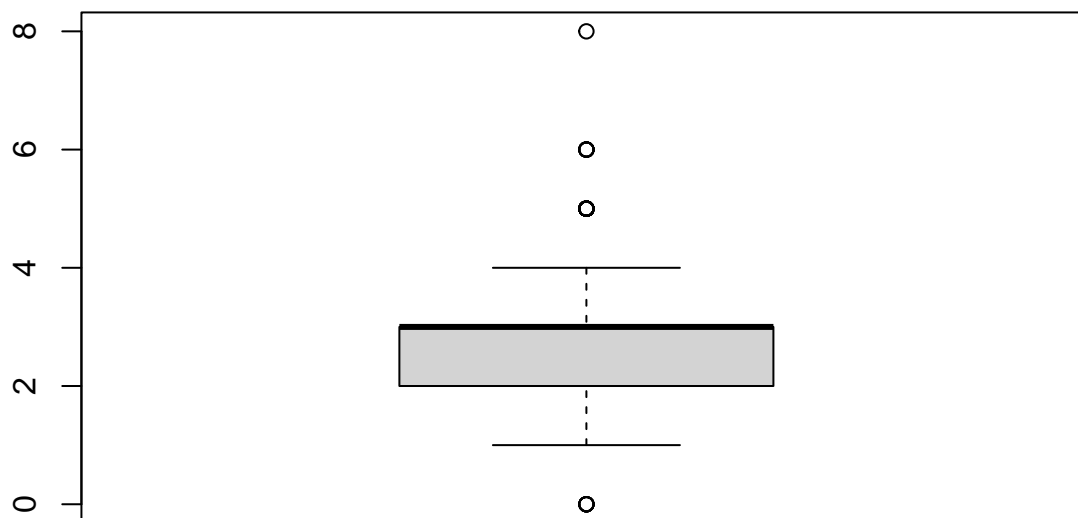

```
## [1] "KitchenAbvGr"
```

KitchenAbvGr


```
## [1] "TotRmsAbvGrd"
```
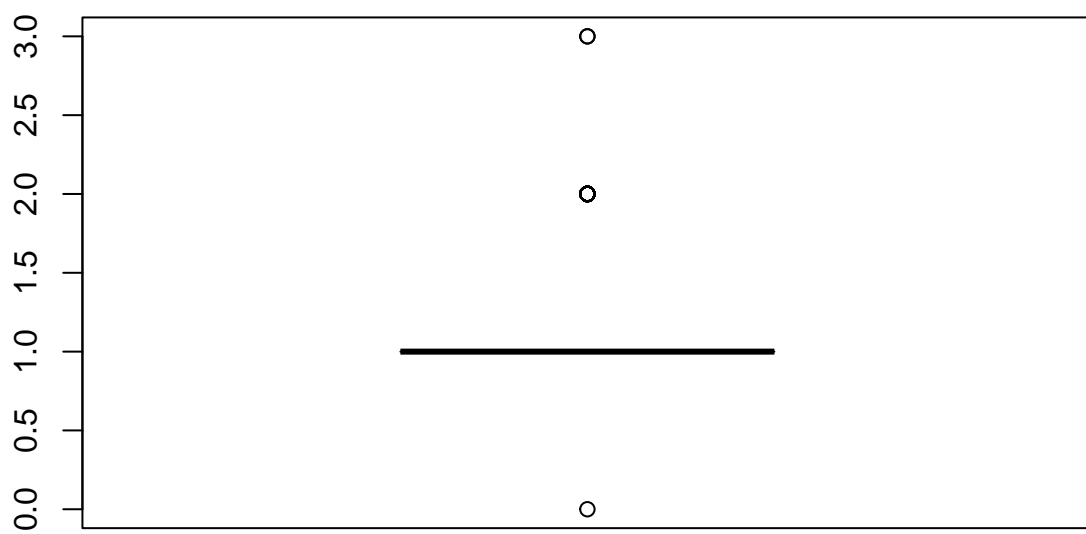
TotRmsAbvGrd


```
## [1] "Fireplaces"
```
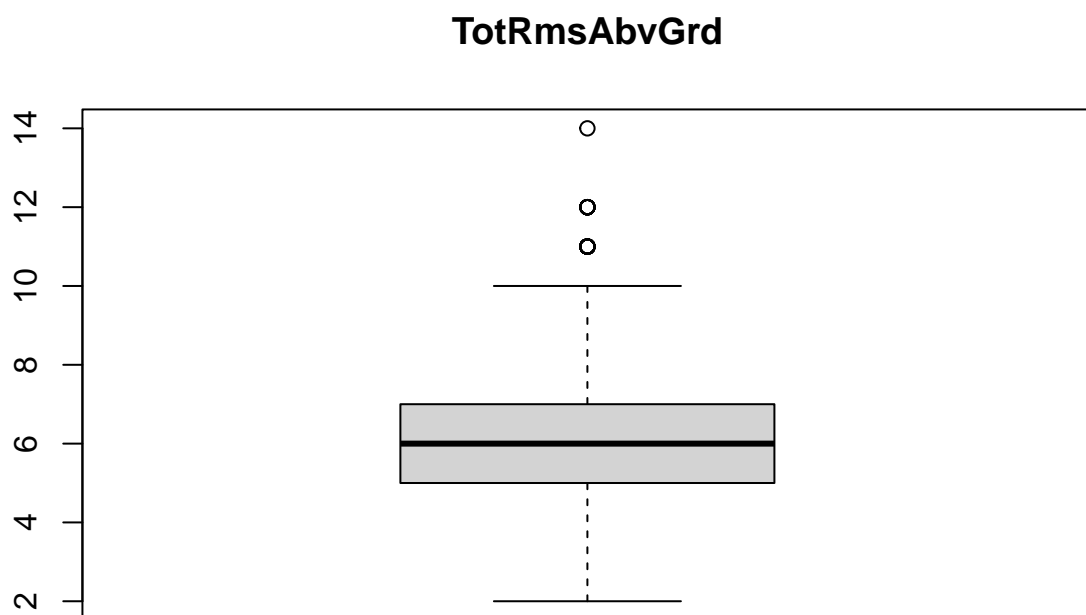
Fireplaces
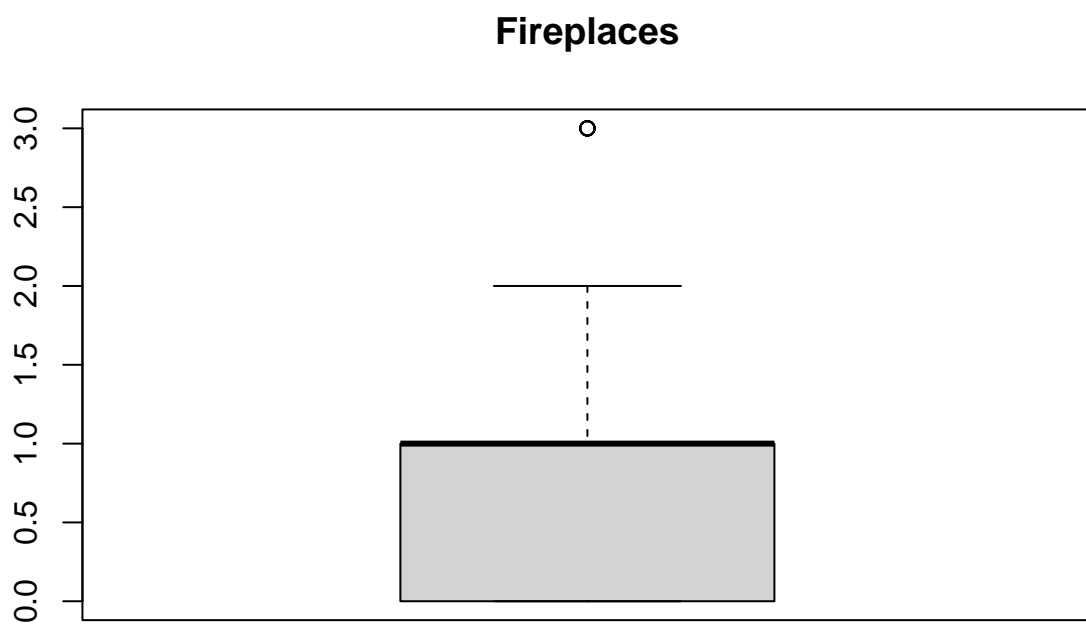

```
## [1] "GarageCars"
```

GarageCars
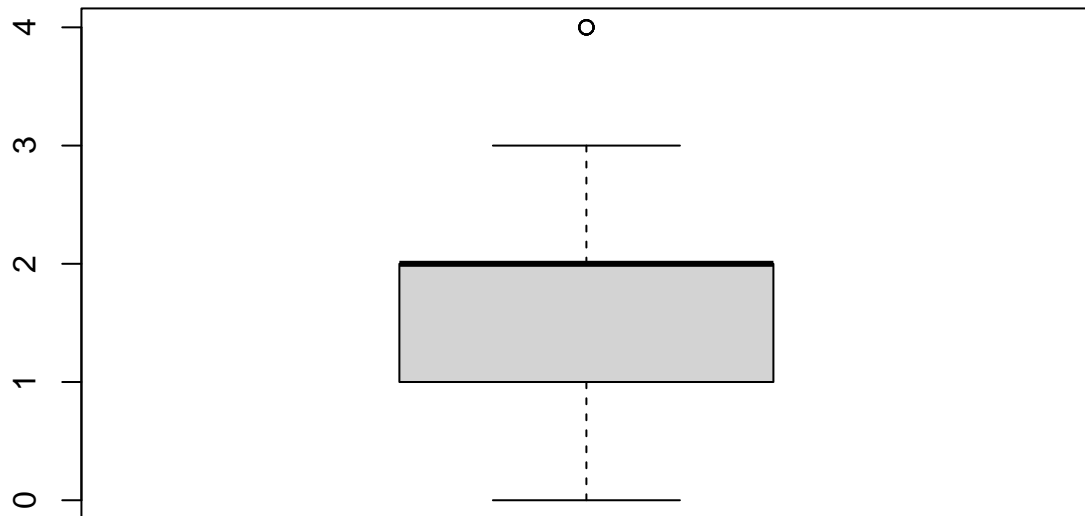

```
## [1] "GarageArea"
```

GarageArea
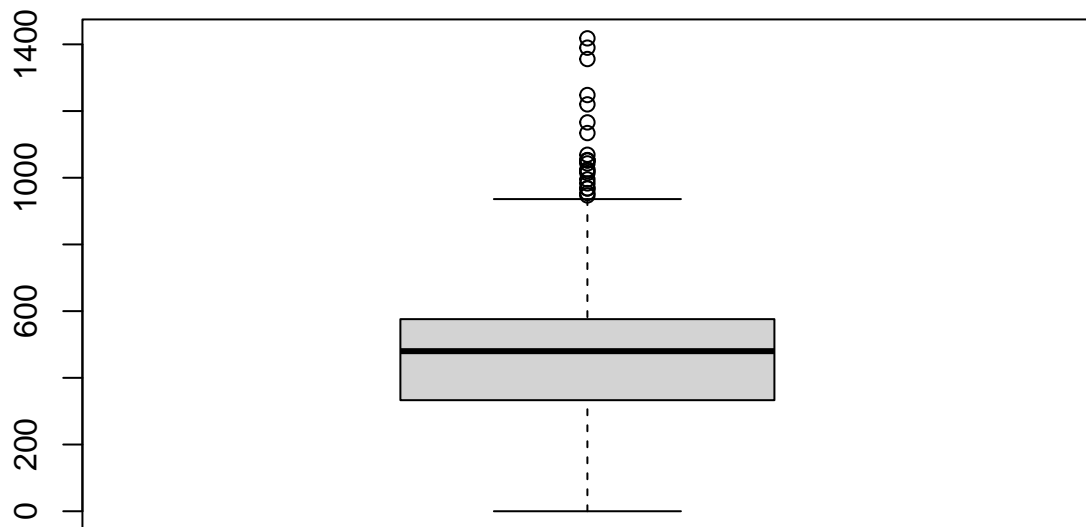

```
## [1] "WoodDeckSF"
```

WoodDeckSF
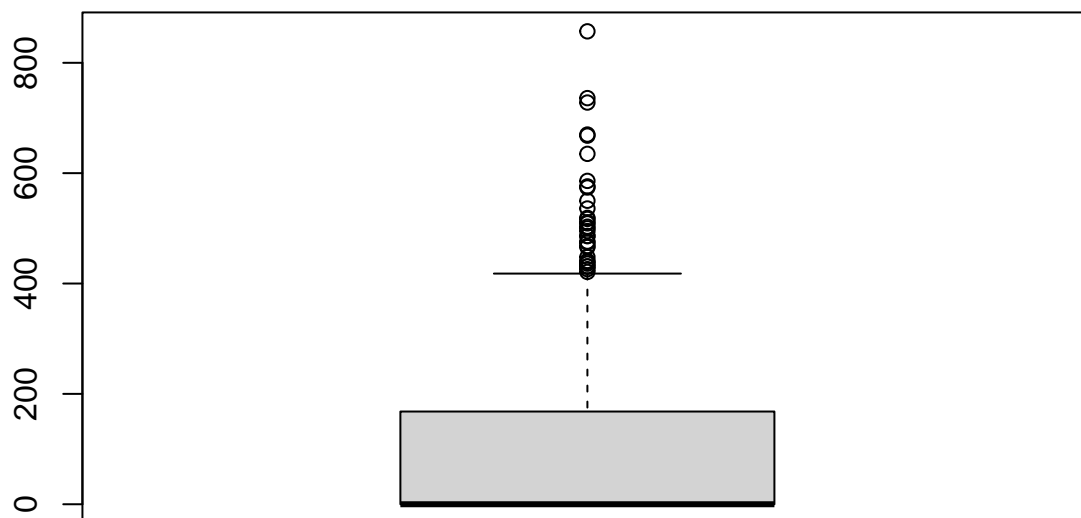

```
## [1] "OpenPorchSF"
```

OpenPorchSF
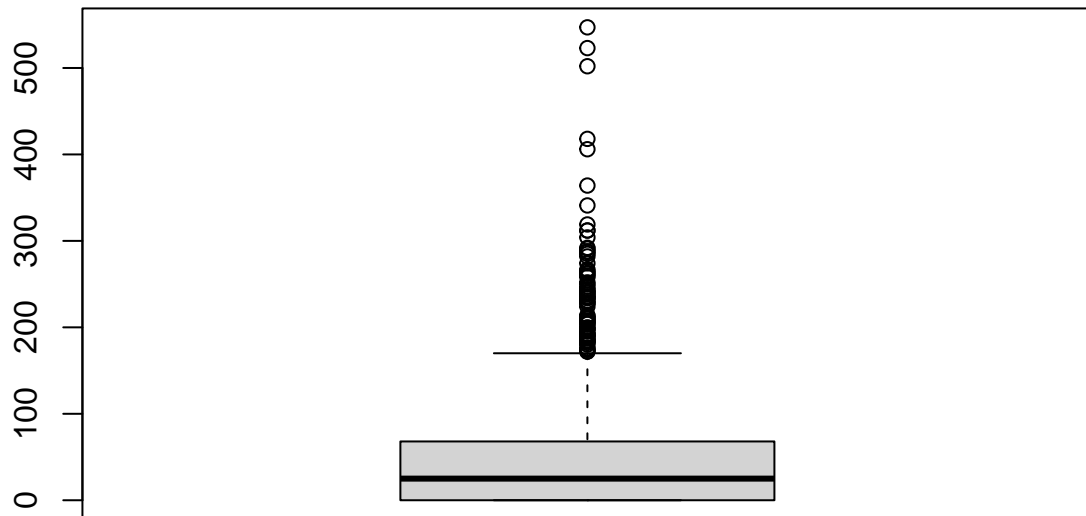

```
## [1] "EnclosedPorch"
```

EnclosedPorch
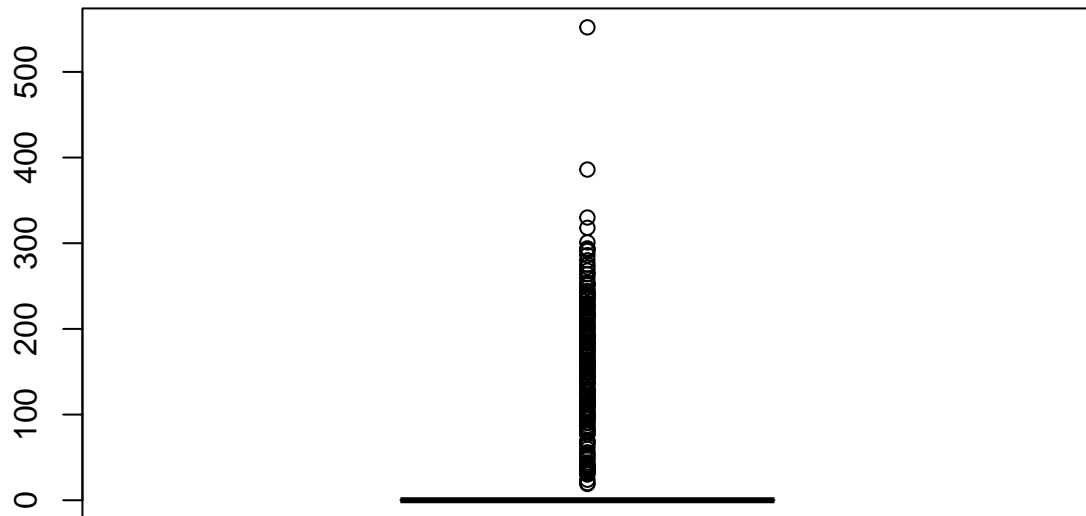

```
## [1] "ThirdSsnPorch"
```

ThirdSsnPorch
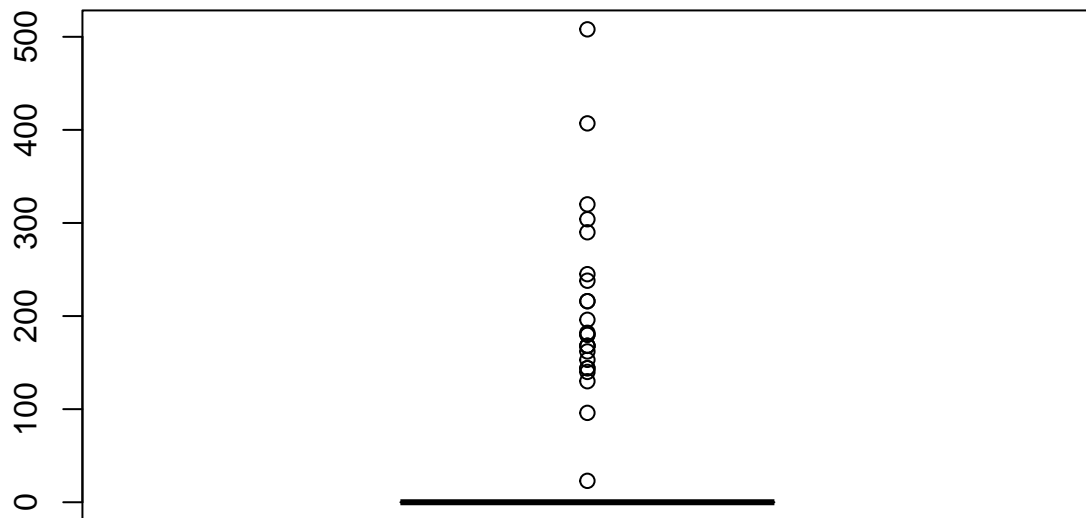

```
## [1] "ScreenPorch"
```

ScreenPorch
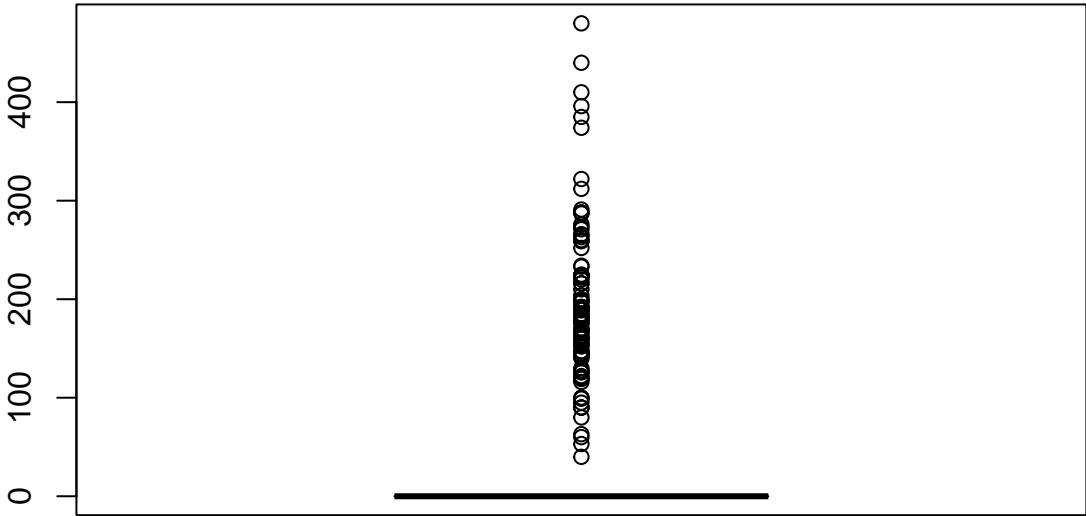

```
## [1] "PoolArea"
```

PoolArea
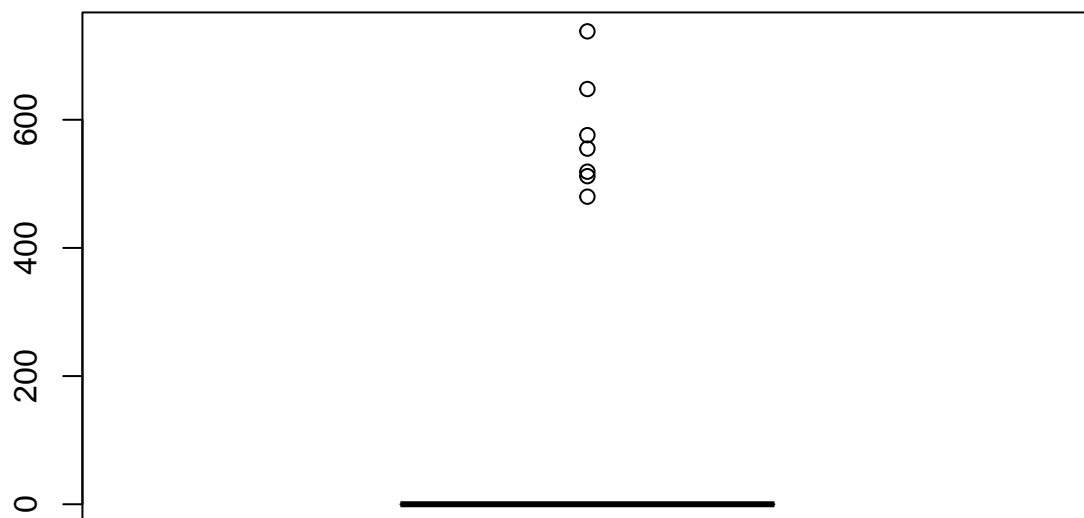

```
## [1] "MiscVal"
```

MiscVal


```
## [1] "MoSold"
```

MoSold


```
## [1] "YrSold"
```
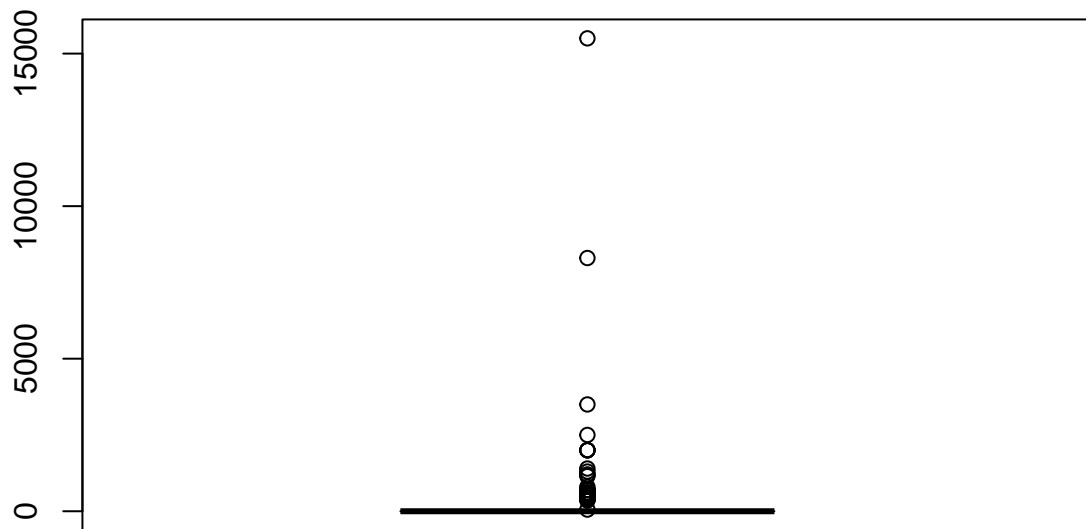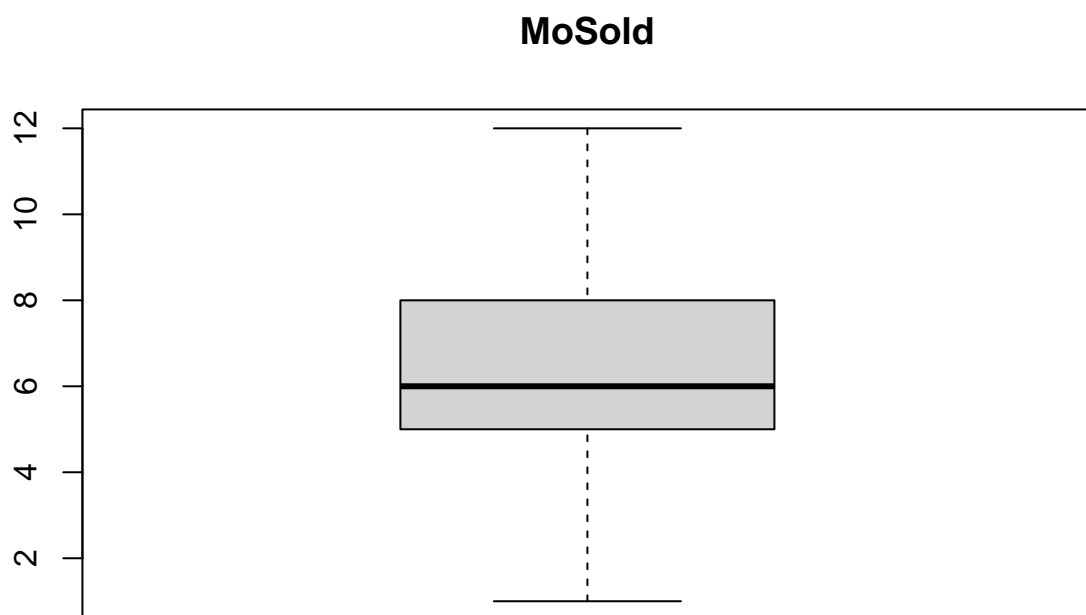
YrSold


```
## [1] "SalePrice"
```
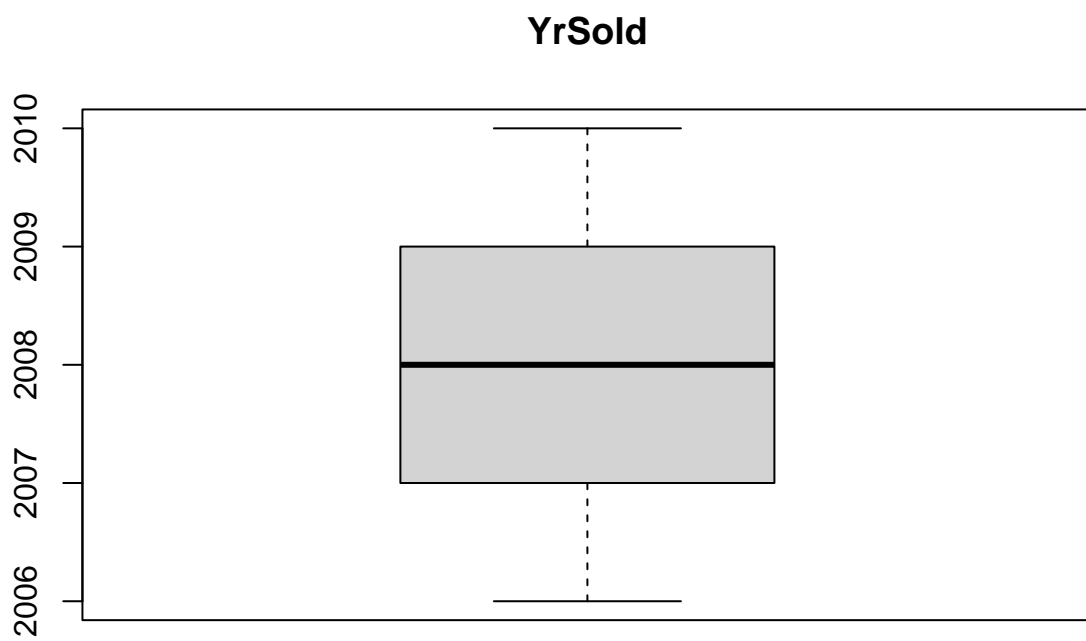
SalePrice

Multiple linear regression - All predictors

```r
#Multiple linear regression
mlr_obj <- lm(log(SalePrice) ~ .-PoolArea,
              data = train)
#summary(mlr_obj)
```

Residuals

```r
res <- resid(mlr_obj)

#produce residual vs. fitted plot
plot(fitted(mlr_obj), res)

#add a horizontal line at 0
abline(0,0)
```
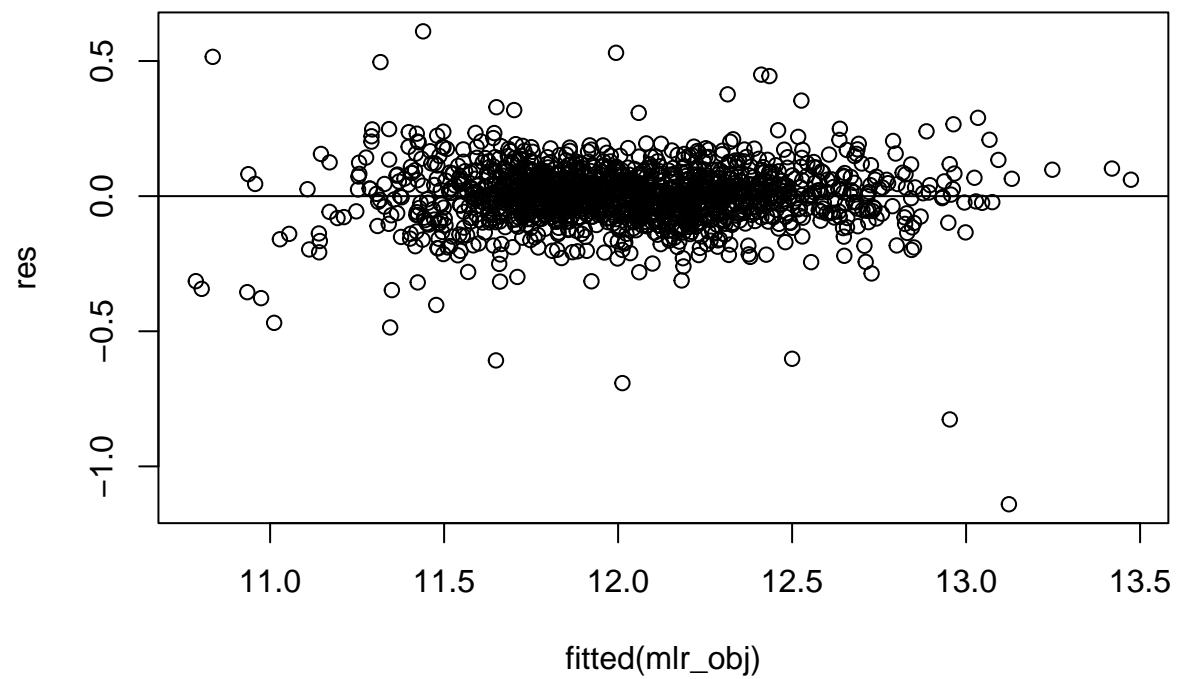
```
#create Q-Q plot for residuals
qqnorm(res)

#add a straight diagonal line to the plot
qqline(res)
```

Normal Q–Q Plot
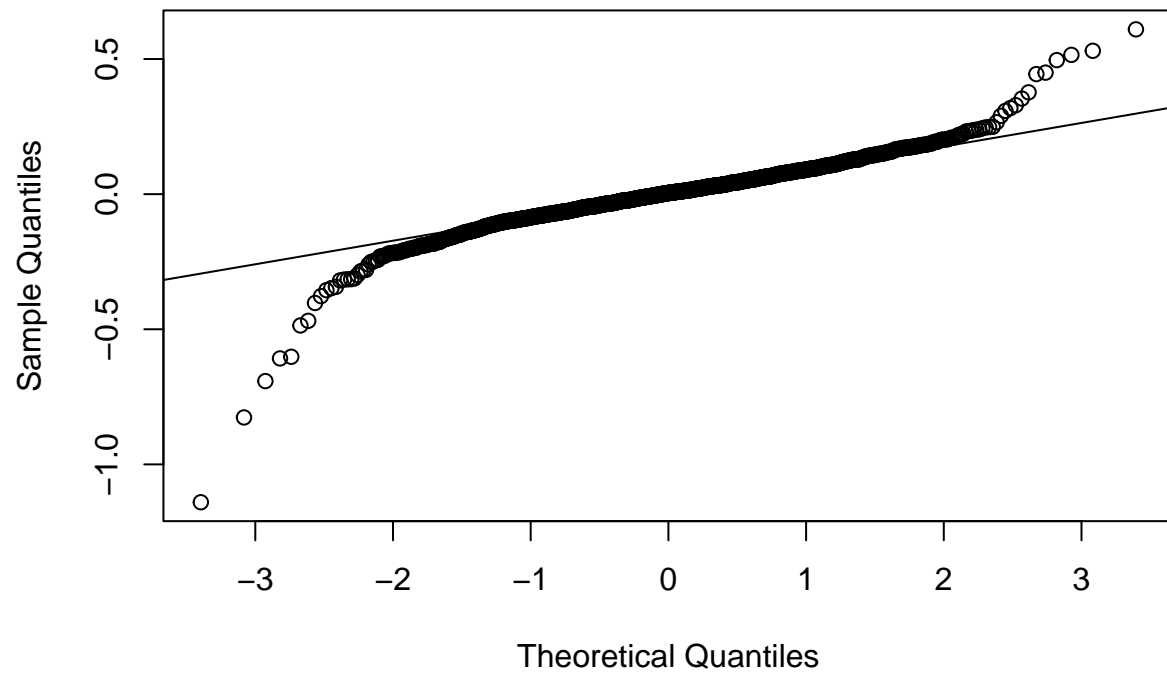

```
#Create density plot of residuals
plot(density(res))
```

density.default(x = res)

N = 1460   Bandwidth = 0.01839
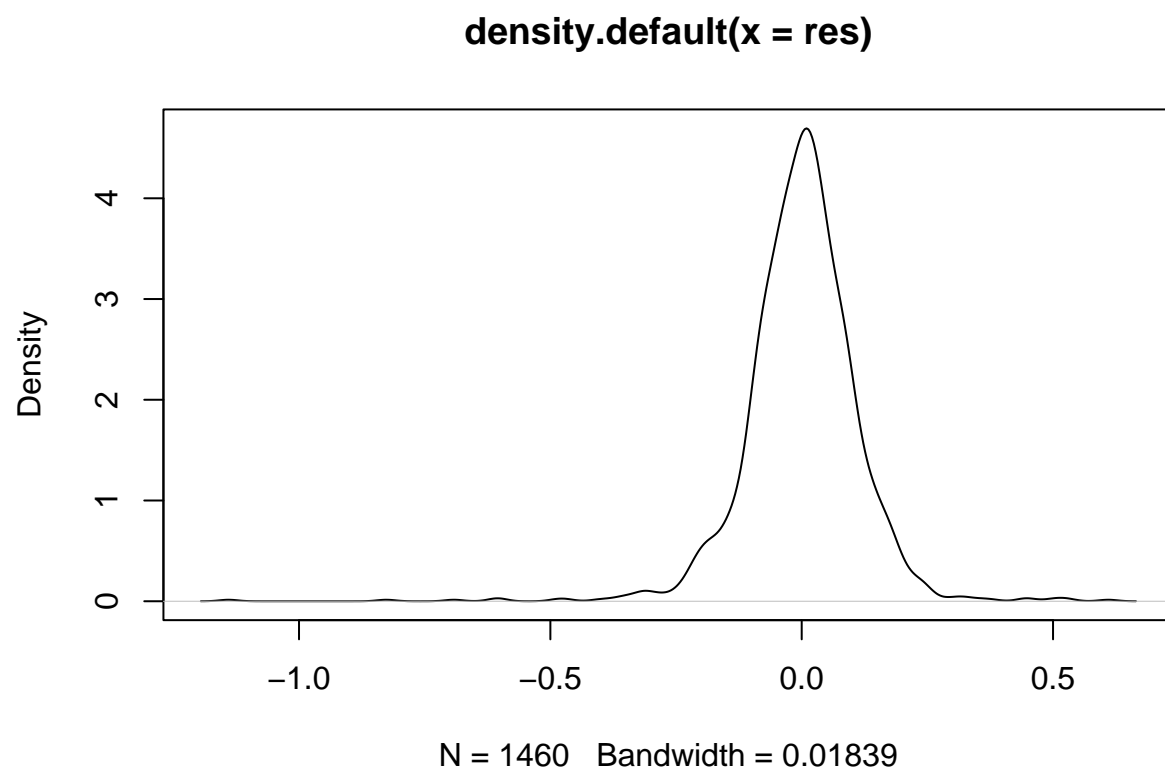
Check Outliers

```
plot(mlr_obj, which=3)
```

```
## Warning: not plotting observations with leverage one:
##    326, 333, 949, 1387
```

Scale−Location

Fitted values
lm(log(SalePrice) ~ . − PoolArea)
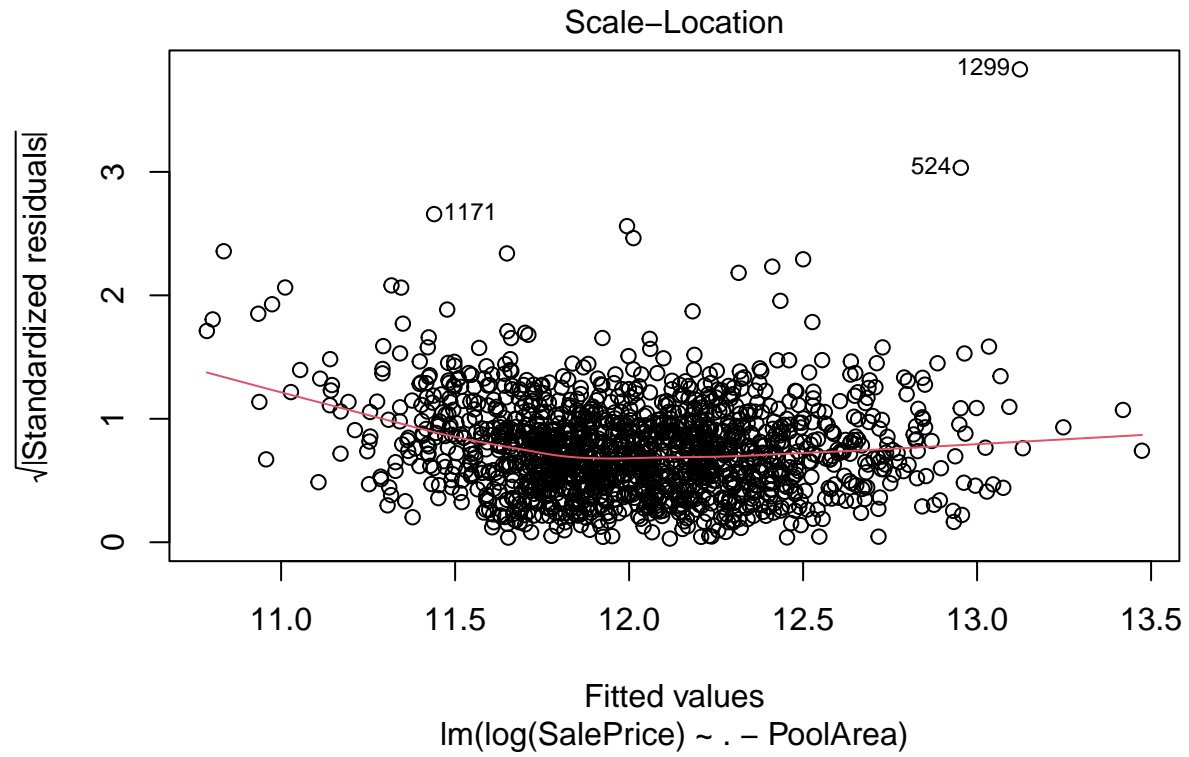
#Influenia Observations: Cook's Distance

```
#Influential Outliers
plot(mlr_obj, which=4)
```

Cook's distance
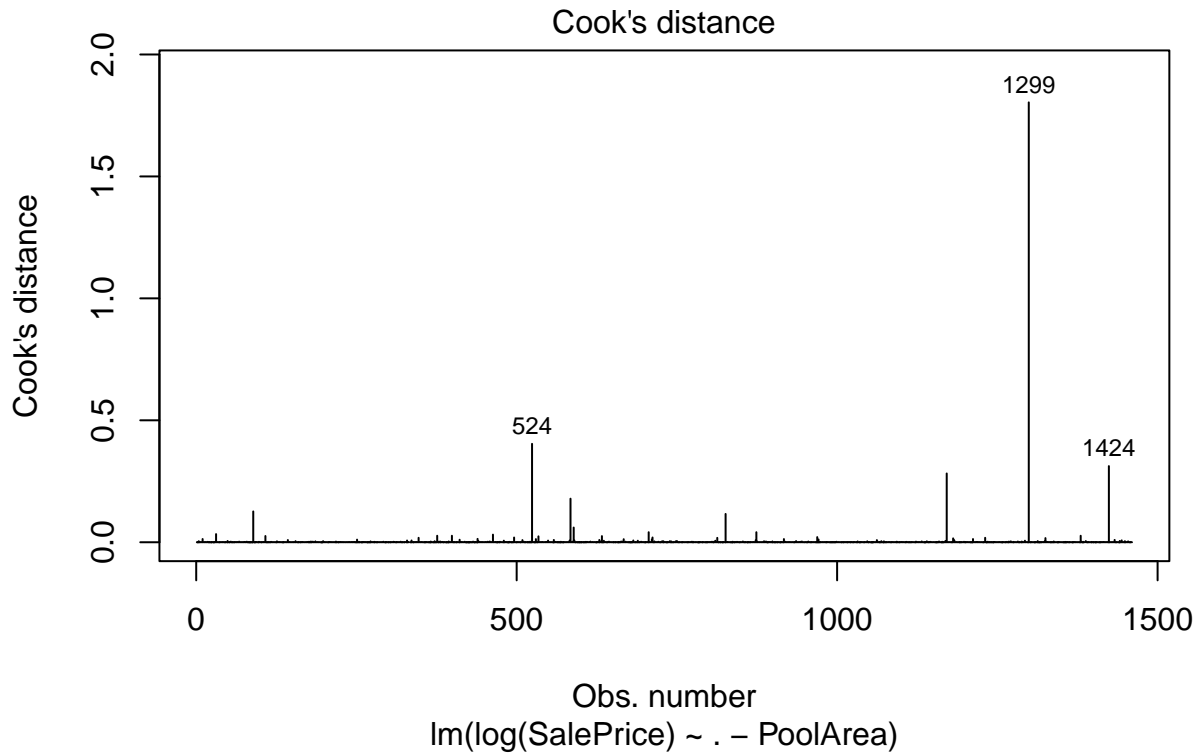

```r
#Removing influential observations
train <- train[-c(1171, 1299, 1424, 524), ] #Including PoolArea
#train <- train[-c(463, 632, 1322, 89, 588, 705), ] #Without PoolArea
```

Linear Reggression - without outliers

```r
mlr_obj2 <- lm(log(SalePrice) ~ .-PoolArea,
              data = train)
```

Residuals

```r
res2 <- resid(mlr_obj2)

#produce residual vs. fitted plot
plot(fitted(mlr_obj2), res2)

#add a horizontal line at 0
abline(0,0)
```
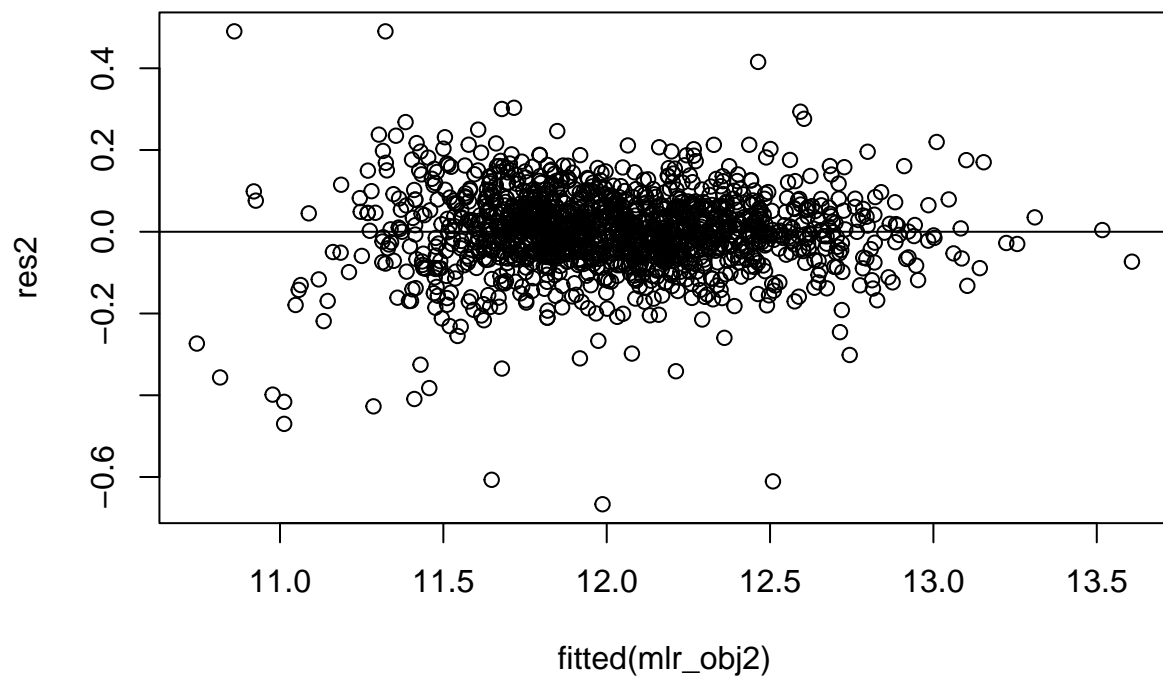
```
#create Q-Q plot for residuals
qqnorm(res2)

#add a straight diagonal line to the plot
qqline(res2)
```

Normal Q–Q Plot
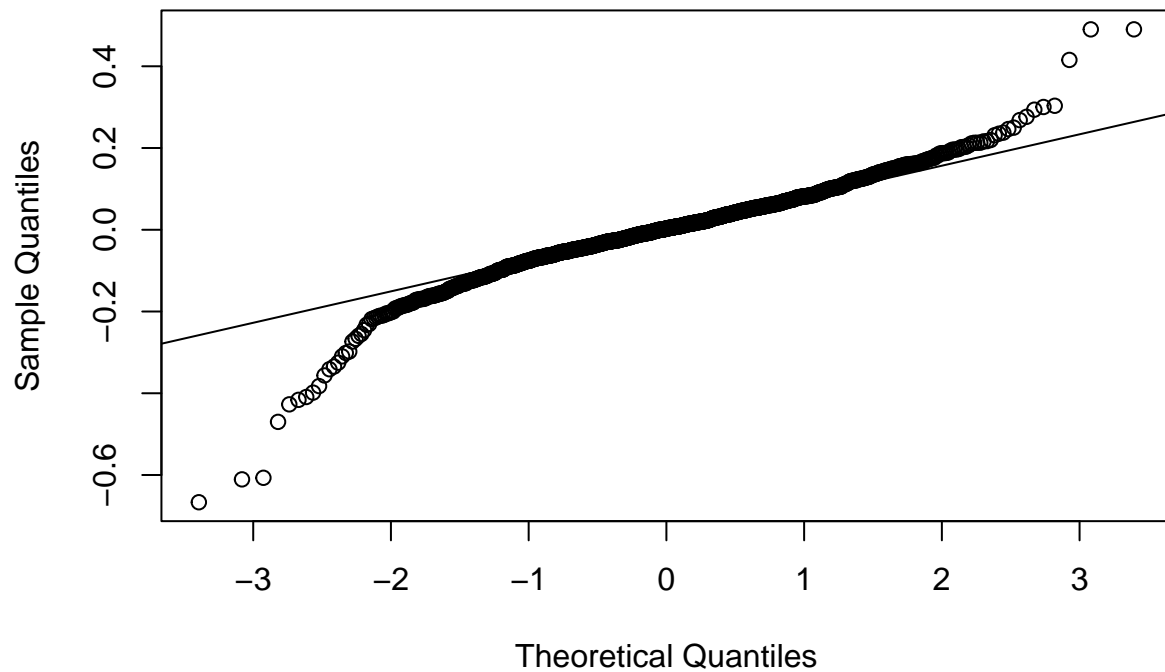
Collinearity

```r
num_cols <- unlist(lapply(train, is.numeric))      # Identify numeric columns
train_num <- train[ , num_cols]                     # Subset numeric columns of data
```

```r
library(corrplot)
```

Correlation Matrix

```
## corrplot 0.91 loaded
```

```r
cor.m <- cor(train_num)
corrplot(cor.m, type="lower")
```
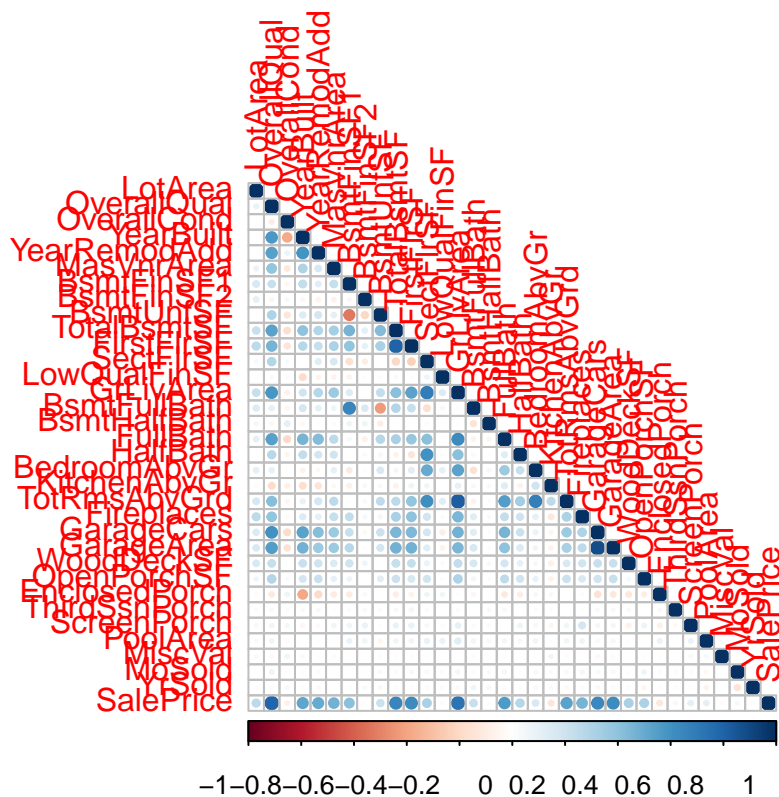
We can see many pairs of features that are highly correlated. Let's see the correlations above 0.7

```r
#Print the pairs of variables that are highly correlated.
corr_check <- function(Dataset, threshold){
  matriz_cor <- cor(Dataset)
  matriz_cor

  for (i in 1:nrow(matriz_cor)){
    correlations <-  which((abs(matriz_cor[i,i:ncol(matriz_cor)]) > threshold) & (matriz_cor[i,i:ncol(ma

    if(length(correlations)> 0){
      lapply(correlations,FUN =  function(x) (cat(paste(colnames(Dataset)[i], "with",colnames(Dataset)[:

    }
  }
}

corr_check(train_num, 0.8)
```

```
## TotalBsmtSF with OverallQual
## GrLivArea with BsmtFinSF2
## GarageCars with OverallQual
```

VIF   Let's use VIF to check for collinearity

```
library(car)
```

```
## Warning: package 'car' was built under R version 4.1.3
```

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

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

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

```
## The following object is masked from 'package:purrr':
##
##     some
```

#vif(mlr_obj2)

TotalBsmtSF and GrLivArea are removed from the model because we were getting the error "there are aliased coefficients in the model" which I think it is because they are a perfect function of other vars (perfect collinearity)

```
mlr_obj3 <- lm(log(SalePrice) ~ .-PoolArea -TotalBsmtSF -GrLivArea,
            data = train_num)
```

```
vif(mlr_obj3)
```

```
##          LotArea   OverallQual   OverallCond      YearBuilt   YearRemodAdd
##         1.183298      3.224559      1.563415       4.074480       2.246297
##        MasVnrArea     BsmtFinSF1     BsmtFinSF2       BsmtUnfSF      FirstFlrSF
##         1.355857      5.376825      1.584334       4.272054       5.664322
##        SectFlrSF   LowQualFinSF   BsmtFullBath   BsmtHalfBath        FullBath
##         5.605939      1.096672      2.240879       1.150441       2.901100
##         HalfBath   BedroomAbvGr   KitchenAbvGr   TotRmsAbvGrd      Fireplaces
##         2.162836      2.276094      1.387628       4.747065       1.564532
##        GarageCars     GarageArea     WoodDeckSF    OpenPorchSF  EnclosedPorch
##         5.636995      5.176754      1.208303       1.196187       1.278672
## ThirdSsnPorch    ScreenPorch        MiscVal         MoSold          YrSold
##         1.021048      1.111498      1.022306       1.044172       1.043597
```

Let's Remove the Variable with the biggest VIF and keep doing this until they are all below 5

```
mlr_obj3 <- lm(log(SalePrice) ~ . -PoolArea -TotalBsmtSF -GrLivArea -FirstFlrSF,
            data = train_num)
vif(mlr_obj3)
```

```
##          LotArea   OverallQual   OverallCond      YearBuilt   YearRemodAdd
##         1.175493      3.182182      1.554887       3.917484       2.236457
```

```
##      MasVnrArea      BsmtFinSF1      BsmtFinSF2       BsmtUnfSF        SectFlrSF
##        1.346045        4.114412        1.389842        3.294976        3.941633
##    LowQualFinSF    BsmtFullBath    BsmtHalfBath        FullBath        HalfBath
##        1.092152        2.237289        1.150247        2.741965        2.160464
##    BedroomAbvGr    KitchenAbvGr    TotRmsAbvGrd      Fireplaces      GarageCars
##        2.275939        1.379837        3.906131        1.469057        5.630845
##      GarageArea      WoodDeckSF     OpenPorchSF  EnclosedPorch  ThirdSsnPorch
##        5.085869        1.200935        1.195577        1.277538        1.017637
##     ScreenPorch         MiscVal          MoSold          YrSold
##        1.110395        1.021154        1.043944        1.043597
```

We still have values above 5. Let's remove GarageCars

```
mlr_obj3 <- lm(log(SalePrice) ~ . -PoolArea -TotalBsmtSF -GrLivArea -FirstFlrSF -GarageCars,
           data = train_num)
vif(mlr_obj3)
```

```
##         LotArea     OverallQual     OverallCond       YearBuilt   YearRemodAdd
##        1.175047        3.155752        1.551835        3.887100        2.231213
##      MasVnrArea      BsmtFinSF1      BsmtFinSF2       BsmtUnfSF        SectFlrSF
##        1.345979        4.102226        1.388111        3.293722        3.939968
##    LowQualFinSF    BsmtFullBath    BsmtHalfBath        FullBath        HalfBath
##        1.088190        2.237287        1.149570        2.726253        2.150450
##    BedroomAbvGr    KitchenAbvGr    TotRmsAbvGrd      Fireplaces      GarageArea
##        2.273901        1.377732        3.897555        1.456228        1.741816
##      WoodDeckSF     OpenPorchSF  EnclosedPorch  ThirdSsnPorch    ScreenPorch
##        1.200922        1.188222        1.277238        1.017629        1.110054
##         MiscVal          MoSold          YrSold
##        1.019357        1.043934        1.042570
```

All our values are below 5. We stop here. So we will remove TotalBsmtSF, GrLivArea, 'FirstFlrSF and GarageCars from our final model

More Influential Outliers

```
#Influential Outliers
plot(mlr_obj3, which=4)
```

Cook's distance

Obs. number
lm(log(SalePrice) ~ . – PoolArea – TotalBsmtSF – GrLivArea – FirstFlrSF – G ...
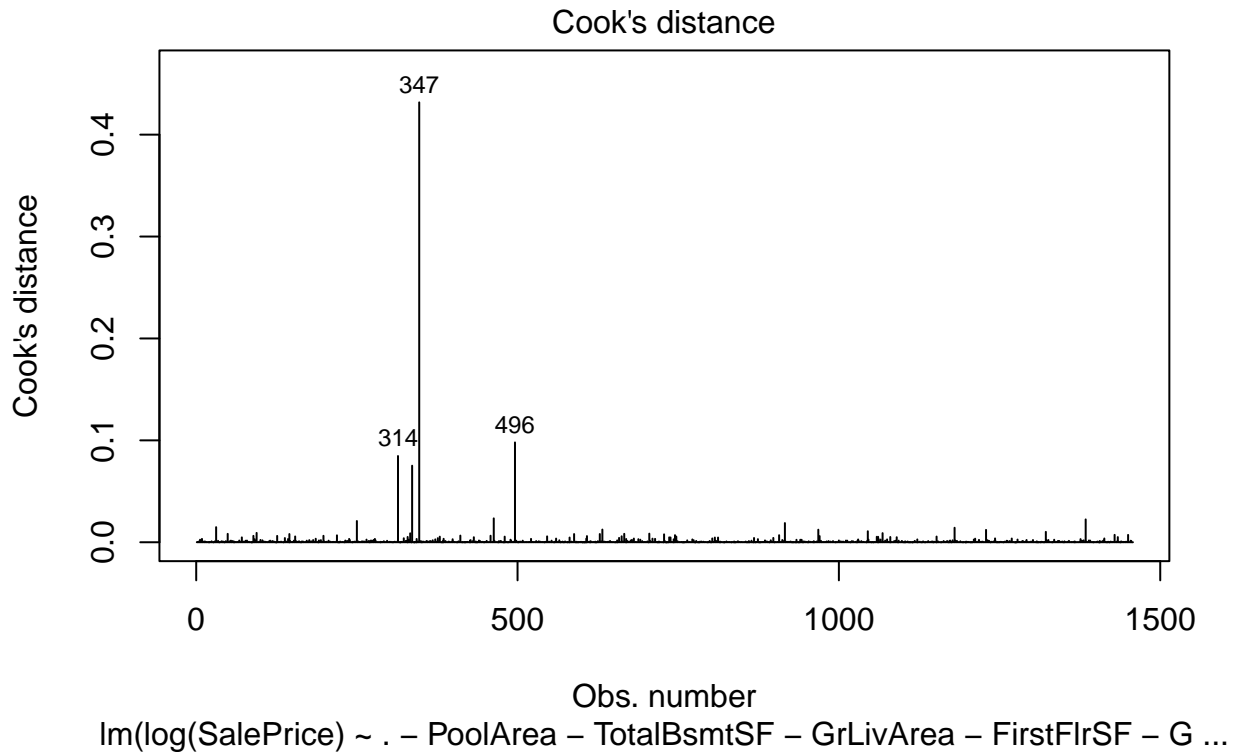
```r
#train <- train[-c(313, 346, 494), ]
train <- train[-c(347, 524, 1299), ]
```

Final Model (before AIC)

```r
#Fit with all predictors, including categorical
mlr_obj <- lm(log(SalePrice) ~ . -PoolArea -TotalBsmtSF -GrLivArea -FirstFlrSF -GarageCars,
              data = train)
```

Variable Selection: AIC

```r
step(mlr_obj)
```

```
## Start:  AIC=-6292.36
## log(SalePrice) ~ (MSSubClass + MSZoning + LotArea + Street +
##     Alley + LotShape + LandContour + LotConfig + LandSlope +
##     Neighborhood + Condition1 + Condition2 + BldgType + HouseStyle +
##     OverallQual + OverallCond + YearBuilt + YearRemodAdd + RoofStyle +
##     Exterior1st + Exterior2nd + MasVnrType + MasVnrArea + ExterQual +
##     ExterCond + Foundation + BsmtQual + BsmtCond + BsmtExposure +
##     BsmtFinType1 + BsmtFinSF1 + BsmtFinType2 + BsmtFinSF2 + BsmtUnfSF +
```

```
##      TotalBsmtSF + Heating + HeatingQC + CentralAir + Electrical +
##      FirstFlrSF + SectFlrSF + LowQualFinSF + GrLivArea + BsmtFullBath +
##      BsmtHalfBath + FullBath + HalfBath + BedroomAbvGr + KitchenAbvGr +
##      KitchenQual + TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu +
##      GarageType + GarageFinish + GarageCars + GarageArea + GarageQual +
##      GarageCond + PavedDrive + WoodDeckSF + OpenPorchSF + EnclosedPorch +
##      ThirdSsnPorch + ScreenPorch + PoolArea + PoolQC + Fence +
##      MiscFeature + MiscVal + MoSold + YrSold + SaleType + SaleCondition) -
##      PoolArea - TotalBsmtSF - GrLivArea - FirstFlrSF - GarageCars
##
##                     Df Sum of Sq    RSS      AIC
## - ExterQual          3   0.00213 15.259 -6298.2
## - FireplaceQu        5   0.04421 15.301 -6298.2
## - Fence              4   0.03618 15.293 -6296.9
## - Condition2         3   0.01694 15.274 -6296.7
## - GarageType         3   0.02221 15.279 -6296.2
## - BsmtFinType1       5   0.07073 15.328 -6295.6
## - GarageFinish       2   0.00800 15.265 -6295.6
## - BsmtCond           3   0.03215 15.289 -6295.3
## - MiscFeature        4   0.05722 15.314 -6294.9
## - PavedDrive         2   0.01514 15.272 -6294.9
## - Electrical         2   0.01673 15.274 -6294.8
## - RoofStyle          2   0.02075 15.278 -6294.4
## - LandContour        1   0.00001 15.257 -6294.4
## - BsmtHalfBath       1   0.00024 15.257 -6294.3
## - Exterior2nd        1   0.00246 15.260 -6294.1
## - LotShape           1   0.00290 15.260 -6294.1
## - MasVnrArea         1   0.00325 15.260 -6294.0
## - MoSold             1   0.00551 15.263 -6293.8
## - PoolQC             1   0.00689 15.264 -6293.7
## - BedroomAbvGr       1   0.00954 15.267 -6293.4
## - OpenPorchSF        1   0.01481 15.272 -6292.9
## - Fireplaces         1   0.01546 15.273 -6292.9
## - GarageQual         2   0.03948 15.297 -6292.6
## - Alley              2   0.03978 15.297 -6292.6
## <none>                          15.257 -6292.4
## - MasVnrType         4   0.08460 15.342 -6292.3
## - YrSold             1   0.02328 15.280 -6292.1
## - GarageCond         2   0.04511 15.302 -6292.1
## - MiscVal            1   0.02533 15.283 -6291.9
## - BsmtQual           3   0.06789 15.325 -6291.9
## - Street             1   0.03529 15.293 -6291.0
## - ThirdSsnPorch      1   0.03877 15.296 -6290.7
## - BsmtFinType2       6   0.15019 15.407 -6290.1
## - Heating            2   0.07004 15.327 -6289.7
## - BsmtFullBath       1   0.05162 15.309 -6289.4
## - EnclosedPorch      1   0.05196 15.309 -6289.4
## - ExterCond          3   0.09622 15.353 -6289.2
## - LandSlope          2   0.07992 15.337 -6288.8
## - KitchenAbvGr       1   0.06331 15.320 -6288.3
## - LowQualFinSF       1   0.06735 15.325 -6288.0
## - Foundation         5   0.16071 15.418 -6287.1
## - LotConfig          1   0.07879 15.336 -6286.9
## - HeatingQC          4   0.14722 15.404 -6286.4
```

```
## - Functional       1   0.09772 15.355 -6285.1
## - BldgType         3   0.14495 15.402 -6284.6
## - CentralAir       1   0.10817 15.365 -6284.1
## - YearBuilt        1   0.11952 15.377 -6283.0
## - WoodDeckSF        1   0.14467 15.402 -6280.6
## - MSSubClass        3   0.19372 15.451 -6280.0
## - SaleType         3   0.19757 15.455 -6279.7
## - BsmtExposure      4   0.22119 15.478 -6279.4
## - KitchenQual       3   0.20966 15.467 -6278.5
## - HalfBath          1   0.17442 15.432 -6277.8
## - Exterior1st       7   0.30677 15.564 -6277.4
## - FullBath          1   0.18402 15.441 -6276.9
## - Condition1        3   0.25137 15.508 -6274.6
## - YearRemodAdd      1   0.22413 15.481 -6273.2
## - ScreenPorch       1   0.24809 15.505 -6270.9
## - HouseStyle        3   0.33060 15.588 -6267.2
## - SaleCondition     5   0.46116 15.718 -6259.1
## - LotArea           1   0.45595 15.713 -6251.6
## - TotRmsAbvGrd      1   0.47092 15.728 -6250.2
## - GarageArea        1   0.53731 15.794 -6244.1
## - BsmtFinSF2        1   0.61862 15.876 -6236.6
## - Neighborhood     15   1.10418 16.361 -6220.8
## - OverallCond       1   1.02162 16.279 -6200.2
## - SectFlrSF         1   1.20882 16.466 -6183.6
## - MSZoning          3   1.30971 16.567 -6178.7
## - OverallQual       1   1.61003 16.867 -6148.6
## - BsmtUnfSF         1   2.26886 17.526 -6092.9
## - BsmtFinSF1        1   2.69998 17.957 -6057.6
##
## Step:  AIC=-6298.15
## log(SalePrice) ~ MSSubClass + MSZoning + LotArea + Street + Alley +
##     LotShape + LandContour + LotConfig + LandSlope + Neighborhood +
##     Condition1 + Condition2 + BldgType + HouseStyle + OverallQual +
##     OverallCond + YearBuilt + YearRemodAdd + RoofStyle + Exterior1st +
##     Exterior2nd + MasVnrType + MasVnrArea + ExterCond + Foundation +
##     BsmtQual + BsmtCond + BsmtExposure + BsmtFinType1 + BsmtFinSF1 +
##     BsmtFinType2 + BsmtFinSF2 + BsmtUnfSF + Heating + HeatingQC +
##     CentralAir + Electrical + SectFlrSF + LowQualFinSF + BsmtFullBath +
##     BsmtHalfBath + FullBath + HalfBath + BedroomAbvGr + KitchenAbvGr +
##     KitchenQual + TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu +
##     GarageType + GarageFinish + GarageArea + GarageQual + GarageCond +
##     PavedDrive + WoodDeckSF + OpenPorchSF + EnclosedPorch + ThirdSsnPorch +
##     ScreenPorch + PoolQC + Fence + MiscFeature + MiscVal + MoSold +
##     YrSold + SaleType + SaleCondition
##
##                 Df Sum of Sq    RSS     AIC
## - FireplaceQu    5   0.04440 15.304 -6303.9
## - Fence          4   0.03691 15.296 -6302.6
## - Condition2     3   0.01736 15.277 -6302.5
## - GarageType     3   0.02239 15.282 -6302.0
## - BsmtFinType1   5   0.07114 15.330 -6301.4
## - GarageFinish   2   0.00891 15.268 -6301.3
## - BsmtCond       3   0.03233 15.292 -6301.1
## - PavedDrive     2   0.01458 15.274 -6300.8
```

```
## - MiscFeature     4   0.05712 15.316 -6300.7
## - Electrical      2   0.01654 15.276 -6300.6
## - RoofStyle       2   0.02049 15.280 -6300.2
## - LandContour     1   0.00002 15.259 -6300.2
## - BsmtHalfBath    1   0.00026 15.260 -6300.1
## - Exterior2nd     1   0.00251 15.262 -6299.9
## - MasVnrArea      1   0.00287 15.262 -6299.9
## - LotShape        1   0.00322 15.262 -6299.8
## - MoSold          1   0.00568 15.265 -6299.6
## - PoolQC          1   0.00693 15.266 -6299.5
## - BedroomAbvGr    1   0.01009 15.269 -6299.2
## - OpenPorchSF     1   0.01462 15.274 -6298.8
## - Fireplaces      1   0.01523 15.274 -6298.7
## - GarageQual      2   0.03918 15.299 -6298.4
## - Alley           2   0.03985 15.299 -6298.4
## <none>                        15.259 -6298.2
## - MasVnrType      4   0.08497 15.344 -6298.1
## - YrSold          1   0.02353 15.283 -6297.9
## - MiscVal         1   0.02506 15.284 -6297.8
## - GarageCond      2   0.04628 15.306 -6297.8
## - BsmtQual        3   0.06896 15.328 -6297.6
## - Street          1   0.03603 15.295 -6296.7
## - ThirdSsnPorch   1   0.03892 15.298 -6296.5
## - BsmtFinType2    6   0.15059 15.410 -6295.9
## - Heating         2   0.07004 15.329 -6295.5
## - BsmtFullBath    1   0.05157 15.311 -6295.3
## - ExterCond       3   0.09504 15.354 -6295.1
## - EnclosedPorch   1   0.05340 15.313 -6295.1
## - LandSlope       2   0.07976 15.339 -6294.6
## - KitchenAbvGr    1   0.06278 15.322 -6294.2
## - LowQualFinSF    1   0.07084 15.330 -6293.4
## - Foundation      5   0.16337 15.423 -6292.7
## - LotConfig       1   0.07885 15.338 -6292.7
## - HeatingQC       4   0.15034 15.410 -6291.9
## - Functional      1   0.09719 15.357 -6290.9
## - BldgType        3   0.14451 15.404 -6290.5
## - CentralAir      1   0.10658 15.366 -6290.0
## - YearBuilt       1   0.12463 15.384 -6288.3
## - WoodDeckSF      1   0.14446 15.404 -6286.5
## - MSSubClass      3   0.19415 15.454 -6285.8
## - BsmtExposure    4   0.22027 15.480 -6285.3
## - SaleType        3   0.20114 15.460 -6285.1
## - HalfBath        1   0.17407 15.433 -6283.7
## - Exterior1st     7   0.30922 15.569 -6283.0
## - FullBath        1   0.18265 15.442 -6282.9
## - KitchenQual     3   0.22708 15.486 -6282.7
## - Condition1      3   0.25057 15.510 -6280.5
## - YearRemodAdd    1   0.22502 15.484 -6278.9
## - ScreenPorch     1   0.24865 15.508 -6276.7
## - HouseStyle      3   0.33112 15.590 -6273.0
## - SaleCondition   5   0.46298 15.722 -6264.7
## - LotArea         1   0.45541 15.715 -6257.4
## - TotRmsAbvGrd    1   0.47279 15.732 -6255.8
## - GarageArea      1   0.53918 15.799 -6249.7
```

```
## - BsmtFinSF2     1   0.62711 15.886 -6241.6
## - Neighborhood  15   1.11812 16.377 -6225.4
## - OverallCond    1   1.02451 16.284 -6205.7
## - SectFlrSF      1   1.22580 16.485 -6187.9
## - MSZoning       3   1.32160 16.581 -6183.5
## - OverallQual    1   1.69248 16.952 -6147.3
## - BsmtUnfSF      1   2.30738 17.567 -6095.5
## - BsmtFinSF1     1   2.72112 17.980 -6061.7
##
## Step:  AIC=-6303.93
## log(SalePrice) ~ MSSubClass + MSZoning + LotArea + Street + Alley +
##     LotShape + LandContour + LotConfig + LandSlope + Neighborhood +
##     Condition1 + Condition2 + BldgType + HouseStyle + OverallQual +
##     OverallCond + YearBuilt + YearRemodAdd + RoofStyle + Exterior1st +
##     Exterior2nd + MasVnrType + MasVnrArea + ExterCond + Foundation +
##     BsmtQual + BsmtCond + BsmtExposure + BsmtFinType1 + BsmtFinSF1 +
##     BsmtFinType2 + BsmtFinSF2 + BsmtUnfSF + Heating + HeatingQC +
##     CentralAir + Electrical + SectFlrSF + LowQualFinSF + BsmtFullBath +
##     BsmtHalfBath + FullBath + HalfBath + BedroomAbvGr + KitchenAbvGr +
##     KitchenQual + TotRmsAbvGrd + Functional + Fireplaces + GarageType +
##     GarageFinish + GarageArea + GarageQual + GarageCond + PavedDrive +
##     WoodDeckSF + OpenPorchSF + EnclosedPorch + ThirdSsnPorch +
##     ScreenPorch + PoolQC + Fence + MiscFeature + MiscVal + MoSold +
##     YrSold + SaleType + SaleCondition
##
##               Df Sum of Sq    RSS     AIC
## - Fence        4   0.03720 15.341 -6308.4
## - Condition2   3   0.01672 15.320 -6308.3
## - GarageType   3   0.02452 15.328 -6307.6
## - BsmtFinType1 5   0.07066 15.374 -6307.2
## - BsmtCond     3   0.03142 15.335 -6307.0
## - GarageFinish 2   0.01158 15.315 -6306.8
## - Electrical   2   0.01595 15.320 -6306.4
## - MiscFeature  4   0.05832 15.362 -6306.4
## - PavedDrive   2   0.01690 15.321 -6306.3
## - RoofStyle    2   0.01917 15.323 -6306.1
## - BsmtHalfBath 1   0.00013 15.304 -6305.9
## - LandContour  1   0.00019 15.304 -6305.9
## - Exterior2nd  1   0.00243 15.306 -6305.7
## - MasVnrArea   1   0.00296 15.307 -6305.7
## - LotShape     1   0.00336 15.307 -6305.6
## - MoSold       1   0.00486 15.309 -6305.5
## - PoolQC       1   0.00518 15.309 -6305.4
## - BedroomAbvGr 1   0.01207 15.316 -6304.8
## - OpenPorchSF  1   0.01503 15.319 -6304.5
## - GarageQual   2   0.03914 15.343 -6304.2
## - Alley        2   0.03960 15.343 -6304.2
## - MasVnrType   4   0.08297 15.387 -6304.1
## <none>                     15.304 -6303.9
## - GarageCond   2   0.04499 15.349 -6303.7
## - YrSold       1   0.02567 15.329 -6303.5
## - BsmtQual     3   0.06915 15.373 -6303.4
## - MiscVal      1   0.02782 15.332 -6303.3
## - Street       1   0.03752 15.341 -6302.4
```

```
## - ThirdSsnPorch   1    0.04285 15.347 -6301.9
## - BsmtFinType2    6    0.15286 15.457 -6301.5
## - Heating         2    0.07387 15.378 -6300.9
## - EnclosedPorch   1    0.05289 15.357 -6300.9
## - ExterCond       3    0.09764 15.401 -6300.7
## - BsmtFullBath    1    0.05610 15.360 -6300.6
## - LandSlope       2    0.08104 15.385 -6300.3
## - KitchenAbvGr    1    0.06683 15.370 -6299.6
## - LowQualFinSF    1    0.07018 15.374 -6299.3
## - Foundation      5    0.16309 15.467 -6298.5
## - LotConfig       1    0.07933 15.383 -6298.4
## - HeatingQC       4    0.14637 15.450 -6298.1
## - Functional      1    0.09446 15.398 -6297.0
## - BldgType        3    0.14750 15.451 -6296.0
## - CentralAir      1    0.10922 15.413 -6295.6
## - YearBuilt       1    0.12567 15.429 -6294.0
## - BsmtExposure    4    0.20756 15.511 -6292.4
## - WoodDeckSF      1    0.14600 15.450 -6292.1
## - MSSubClass      3    0.18982 15.493 -6292.0
## - SaleType        3    0.19927 15.503 -6291.1
## - HalfBath        1    0.16592 15.470 -6290.3
## - KitchenQual     3    0.21822 15.522 -6289.4
## - Exterior1st     7    0.30587 15.610 -6289.2
## - FullBath        1    0.18224 15.486 -6288.7
## - Condition1      3    0.24609 15.550 -6286.8
## - YearRemodAdd    1    0.21856 15.522 -6285.3
## - Fireplaces      1    0.24602 15.550 -6282.8
## - ScreenPorch     1    0.25487 15.559 -6281.9
## - HouseStyle      3    0.34153 15.645 -6277.9
## - SaleCondition   5    0.46481 15.768 -6270.5
## - LotArea         1    0.43463 15.738 -6265.2
## - TotRmsAbvGrd    1    0.49676 15.800 -6259.5
## - GarageArea      1    0.56343 15.867 -6253.4
## - BsmtFinSF2      1    0.63178 15.935 -6247.2
## - Neighborhood   15    1.12860 16.432 -6230.5
## - OverallCond     1    1.02428 16.328 -6211.8
## - SectFlrSF       1    1.26084 16.564 -6190.9
## - MSZoning        3    1.32445 16.628 -6189.3
## - OverallQual     1    1.74429 17.048 -6149.1
## - BsmtUnfSF       1    2.34303 17.647 -6098.9
## - BsmtFinSF1      1    2.71691 18.021 -6068.5
##
## Step:  AIC=-6308.4
## log(SalePrice) ~ MSSubClass + MSZoning + LotArea + Street + Alley +
##     LotShape + LandContour + LotConfig + LandSlope + Neighborhood +
##     Condition1 + Condition2 + BldgType + HouseStyle + OverallQual +
##     OverallCond + YearBuilt + YearRemodAdd + RoofStyle + Exterior1st +
##     Exterior2nd + MasVnrType + MasVnrArea + ExterCond + Foundation +
##     BsmtQual + BsmtCond + BsmtExposure + BsmtFinType1 + BsmtFinSF1 +
##     BsmtFinType2 + BsmtFinSF2 + BsmtUnfSF + Heating + HeatingQC +
##     CentralAir + Electrical + SectFlrSF + LowQualFinSF + BsmtFullBath +
##     BsmtHalfBath + FullBath + HalfBath + BedroomAbvGr + KitchenAbvGr +
##     KitchenQual + TotRmsAbvGrd + Functional + Fireplaces + GarageType +
##     GarageFinish + GarageArea + GarageQual + GarageCond + PavedDrive +
```

```
##        WoodDeckSF + OpenPorchSF + EnclosedPorch + ThirdSsnPorch +
##        ScreenPorch + PoolQC + MiscFeature + MiscVal + MoSold + YrSold +
##        SaleType + SaleCondition
##
##                    Df Sum of Sq     RSS      AIC
## - Condition2        3   0.01546  15.356  -6312.9
## - GarageType        3   0.02219  15.363  -6312.3
## - BsmtCond          3   0.02723  15.368  -6311.8
## - BsmtFinType1      5   0.07178  15.413  -6311.6
## - GarageFinish      2   0.01003  15.351  -6311.5
## - MiscFeature       4   0.05396  15.395  -6311.3
## - Electrical        2   0.01499  15.356  -6311.0
## - PavedDrive        2   0.01844  15.359  -6310.7
## - RoofStyle         2   0.01878  15.360  -6310.6
## - BsmtHalfBath      1   0.00014  15.341  -6310.4
## - LandContour       1   0.00052  15.341  -6310.4
## - Exterior2nd       1   0.00224  15.343  -6310.2
## - MasVnrArea        1   0.00285  15.344  -6310.1
## - PoolQC            1   0.00349  15.344  -6310.1
## - LotShape          1   0.00397  15.345  -6310.0
## - MoSold            1   0.00428  15.345  -6310.0
## - BedroomAbvGr      1   0.00941  15.350  -6309.5
## - OpenPorchSF       1   0.01322  15.354  -6309.2
## - Alley             2   0.03710  15.378  -6308.9
## - GarageQual        2   0.03877  15.380  -6308.7
## <none>                           15.341  -6308.4
## - MasVnrType        4   0.08495  15.426  -6308.4
## - YrSold            1   0.02409  15.365  -6308.1
## - GarageCond        2   0.04646  15.387  -6308.0
## - MiscVal           1   0.02781  15.369  -6307.8
## - BsmtQual          3   0.07573  15.417  -6307.2
## - Street            1   0.03580  15.377  -6307.0
## - ThirdSsnPorch     1   0.04193  15.383  -6306.4
## - EnclosedPorch     1   0.05116  15.392  -6305.6
## - Heating           2   0.07380  15.415  -6305.4
## - BsmtFinType2      6   0.15904  15.500  -6305.4
## - ExterCond         3   0.09695  15.438  -6305.2
## - BsmtFullBath      1   0.05726  15.398  -6305.0
## - LandSlope         2   0.07904  15.420  -6304.9
## - KitchenAbvGr      1   0.06419  15.405  -6304.3
## - LowQualFinSF      1   0.06983  15.411  -6303.8
## - LotConfig         1   0.07677  15.418  -6303.2
## - Foundation        5   0.16310  15.504  -6303.0
## - HeatingQC         4   0.15556  15.496  -6301.7
## - Functional        1   0.09706  15.438  -6301.2
## - BldgType          3   0.15095  15.492  -6300.2
## - CentralAir        1   0.10943  15.450  -6300.1
## - YearBuilt         1   0.12435  15.465  -6298.7
## - WoodDeckSF        1   0.13575  15.477  -6297.6
## - MSSubClass        3   0.18292  15.524  -6297.2
## - BsmtExposure      4   0.20549  15.546  -6297.1
## - SaleType          3   0.19909  15.540  -6295.7
## - HalfBath          1   0.16842  15.509  -6294.5
## - KitchenQual       3   0.21520  15.556  -6294.2
```

```
## - Exterior1st    7   0.30520 15.646 -6293.8
## - FullBath       1   0.18370 15.525 -6293.1
## - Condition1     3   0.24907 15.590 -6291.0
## - YearRemodAdd   1   0.21095 15.552 -6290.6
## - Fireplaces     1   0.25192 15.593 -6286.7
## - ScreenPorch    1   0.25693 15.598 -6286.3
## - HouseStyle     3   0.33131 15.672 -6283.4
## - SaleCondition  5   0.46955 15.810 -6274.6
## - LotArea        1   0.43279 15.774 -6270.0
## - TotRmsAbvGrd   1   0.48045 15.821 -6265.6
## - GarageArea     1   0.57589 15.917 -6256.9
## - BsmtFinSF2     1   0.65249 15.993 -6249.9
## - Neighborhood  15   1.13491 16.476 -6234.7
## - OverallCond    1   1.02720 16.368 -6216.2
## - SectFlrSF      1   1.24886 16.590 -6196.7
## - MSZoning       3   1.31874 16.660 -6194.6
## - OverallQual    1   1.75127 17.092 -6153.3
## - BsmtUnfSF      1   2.41431 17.755 -6098.0
## - BsmtFinSF1     1   2.75574 18.097 -6070.4
##
## Step:  AIC=-6312.94
## log(SalePrice) ~ MSSubClass + MSZoning + LotArea + Street + Alley +
##     LotShape + LandContour + LotConfig + LandSlope + Neighborhood +
##     Condition1 + BldgType + HouseStyle + OverallQual + OverallCond +
##     YearBuilt + YearRemodAdd + RoofStyle + Exterior1st + Exterior2nd +
##     MasVnrType + MasVnrArea + ExterCond + Foundation + BsmtQual +
##     BsmtCond + BsmtExposure + BsmtFinType1 + BsmtFinSF1 + BsmtFinType2 +
##     BsmtFinSF2 + BsmtUnfSF + Heating + HeatingQC + CentralAir +
##     Electrical + SectFlrSF + LowQualFinSF + BsmtFullBath + BsmtHalfBath +
##     FullBath + HalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual +
##     TotRmsAbvGrd + Functional + Fireplaces + GarageType + GarageFinish +
##     GarageArea + GarageQual + GarageCond + PavedDrive + WoodDeckSF +
##     OpenPorchSF + EnclosedPorch + ThirdSsnPorch + ScreenPorch +
##     PoolQC + MiscFeature + MiscVal + MoSold + YrSold + SaleType +
##     SaleCondition
##
##                 Df Sum of Sq    RSS     AIC
## - GarageType     3   0.02545 15.382 -6316.5
## - BsmtCond       3   0.02550 15.382 -6316.5
## - GarageFinish   2   0.00972 15.366 -6316.0
## - BsmtFinType1   5   0.07495 15.431 -6315.9
## - MiscFeature    4   0.05501 15.411 -6315.7
## - Electrical     2   0.01487 15.371 -6315.5
## - PavedDrive     2   0.01849 15.375 -6315.2
## - RoofStyle      2   0.01949 15.376 -6315.1
## - BsmtHalfBath   1   0.00010 15.357 -6314.9
## - LandContour    1   0.00054 15.357 -6314.9
## - Exterior2nd    1   0.00215 15.358 -6314.7
## - MasVnrArea     1   0.00281 15.359 -6314.7
## - PoolQC         1   0.00362 15.360 -6314.6
## - LotShape       1   0.00407 15.360 -6314.6
## - MoSold         1   0.00480 15.361 -6314.5
## - BedroomAbvGr   1   0.00941 15.366 -6314.0
## - OpenPorchSF    1   0.01283 15.369 -6313.7
```

```
## - Alley            2    0.03643 15.393 -6313.5
## <none>                          15.356 -6312.9
## - MasVnrType        4    0.08571 15.442 -6312.9
## - YrSold            1    0.02263 15.379 -6312.8
## - GarageCond        2    0.04419 15.401 -6312.8
## - GarageQual        2    0.04434 15.401 -6312.8
## - MiscVal           1    0.02696 15.383 -6312.4
## - Street            1    0.03690 15.393 -6311.5
## - BsmtQual          3    0.08078 15.437 -6311.3
## - ThirdSsnPorch     1    0.04115 15.398 -6311.1
## - EnclosedPorch     1    0.05018 15.406 -6310.2
## - Heating           2    0.07140 15.428 -6310.2
## - BsmtFinType2      6    0.15827 15.515 -6310.0
## - ExterCond         3    0.09592 15.452 -6309.9
## - BsmtFullBath      1    0.05745 15.414 -6309.5
## - LandSlope         2    0.08056 15.437 -6309.3
## - KitchenAbvGr      1    0.06300 15.419 -6309.0
## - Foundation        5    0.16102 15.517 -6307.8
## - LowQualFinSF      1    0.07603 15.432 -6307.8
## - LotConfig         1    0.07959 15.436 -6307.4
## - HeatingQC         4    0.15967 15.516 -6305.9
## - Functional        1    0.10063 15.457 -6305.4
## - BldgType          3    0.14913 15.505 -6304.9
## - CentralAir        1    0.11206 15.468 -6304.4
## - YearBuilt         1    0.11874 15.475 -6303.7
## - WoodDeckSF        1    0.13688 15.493 -6302.0
## - BsmtExposure      4    0.20735 15.564 -6301.5
## - MSSubClass        3    0.18670 15.543 -6301.4
## - SaleType          3    0.19997 15.556 -6300.1
## - HalfBath          1    0.16695 15.523 -6299.2
## - KitchenQual       3    0.21280 15.569 -6298.9
## - Exterior1st       7    0.30700 15.663 -6298.2
## - FullBath          1    0.18278 15.539 -6297.7
## - YearRemodAdd      1    0.21219 15.569 -6295.0
## - Condition1        3    0.26107 15.617 -6294.4
## - Fireplaces        1    0.25339 15.610 -6291.2
## - ScreenPorch       1    0.25649 15.613 -6290.9
## - HouseStyle        3    0.32940 15.686 -6288.1
## - SaleCondition     5    0.46502 15.821 -6279.6
## - LotArea           1    0.42963 15.786 -6274.8
## - TotRmsAbvGrd      1    0.48322 15.840 -6269.9
## - GarageArea        1    0.57292 15.929 -6261.7
## - BsmtFinSF2        1    0.64707 16.003 -6255.0
## - Neighborhood     15    1.13900 16.495 -6239.0
## - OverallCond       1    1.01684 16.373 -6221.8
## - SectFlrSF         1    1.25341 16.610 -6200.9
## - MSZoning          3    1.32054 16.677 -6199.1
## - OverallQual       1    1.75708 17.113 -6157.5
## - BsmtUnfSF         1    2.41193 17.768 -6103.0
## - BsmtFinSF1        1    2.74841 18.105 -6075.7
##
## Step:  AIC=-6316.53
## log(SalePrice) ~ MSSubClass + MSZoning + LotArea + Street + Alley +
##      LotShape + LandContour + LotConfig + LandSlope + Neighborhood +
```

91

```
##      Condition1 + BldgType + HouseStyle + OverallQual + OverallCond +
##      YearBuilt + YearRemodAdd + RoofStyle + Exterior1st + Exterior2nd +
##      MasVnrType + MasVnrArea + ExterCond + Foundation + BsmtQual +
##      BsmtCond + BsmtExposure + BsmtFinType1 + BsmtFinSF1 + BsmtFinType2 +
##      BsmtFinSF2 + BsmtUnfSF + Heating + HeatingQC + CentralAir +
##      Electrical + SectFlrSF + LowQualFinSF + BsmtFullBath + BsmtHalfBath +
##      FullBath + HalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual +
##      TotRmsAbvGrd + Functional + Fireplaces + GarageFinish + GarageArea +
##      GarageQual + GarageCond + PavedDrive + WoodDeckSF + OpenPorchSF +
##      EnclosedPorch + ThirdSsnPorch + ScreenPorch + PoolQC + MiscFeature +
##      MiscVal + MoSold + YrSold + SaleType + SaleCondition
##
##                    Df Sum of Sq    RSS     AIC
## - BsmtCond          3   0.02480 15.407 -6320.2
## - MiscFeature       4   0.05557 15.437 -6319.3
## - Electrical        2   0.01597 15.398 -6319.0
## - BsmtFinType1      5   0.08066 15.463 -6318.9
## - PavedDrive        2   0.01930 15.401 -6318.7
## - RoofStyle         2   0.02056 15.402 -6318.6
## - BsmtHalfBath      1   0.00011 15.382 -6318.5
## - LandContour       1   0.00071 15.383 -6318.5
## - GarageFinish      2   0.02309 15.405 -6318.4
## - MasVnrArea        1   0.00191 15.384 -6318.4
## - Exterior2nd       1   0.00279 15.385 -6318.3
## - PoolQC            1   0.00338 15.385 -6318.2
## - LotShape          1   0.00359 15.385 -6318.2
## - MoSold            1   0.00435 15.386 -6318.1
## - BedroomAbvGr      1   0.00922 15.391 -6317.7
## - Alley             2   0.03178 15.414 -6317.5
## - OpenPorchSF       1   0.01214 15.394 -6317.4
## - MasVnrType        4   0.08436 15.466 -6316.6
## <none>                          15.382 -6316.5
## - GarageQual        2   0.04385 15.426 -6316.4
## - YrSold            1   0.02434 15.406 -6316.2
## - GarageCond        2   0.04958 15.431 -6315.9
## - MiscVal           1   0.02948 15.411 -6315.8
## - Street            1   0.03786 15.420 -6315.0
## - BsmtQual          3   0.08167 15.463 -6314.8
## - ThirdSsnPorch     1   0.04123 15.423 -6314.6
## - Heating           2   0.07113 15.453 -6313.8
## - ExterCond         3   0.09349 15.475 -6313.7
## - EnclosedPorch     1   0.05156 15.433 -6313.7
## - BsmtFullBath      1   0.05649 15.438 -6313.2
## - BsmtFinType2      6   0.16325 15.545 -6313.2
## - LandSlope         2   0.07898 15.461 -6313.1
## - KitchenAbvGr      1   0.06282 15.445 -6312.6
## - LowQualFinSF      1   0.07118 15.453 -6311.8
## - LotConfig         1   0.07878 15.461 -6311.1
## - Foundation        5   0.16878 15.551 -6310.7
## - HeatingQC         4   0.16053 15.542 -6309.4
## - Functional        1   0.10099 15.483 -6309.0
## - CentralAir        1   0.11116 15.493 -6308.1
## - BldgType          3   0.15756 15.539 -6307.7
## - YearBuilt         1   0.12325 15.505 -6306.9
```

```
## - WoodDeckSF      1   0.14179 15.524 -6305.2
## - BsmtExposure    4   0.20795 15.590 -6305.0
## - MSSubClass      3   0.19449 15.576 -6304.3
## - SaleType        3   0.20122 15.583 -6303.6
## - KitchenQual     3   0.20709 15.589 -6303.1
## - Exterior1st     7   0.29396 15.676 -6303.0
## - HalfBath        1   0.17407 15.556 -6302.2
## - FullBath        1   0.19204 15.574 -6300.5
## - YearRemodAdd    1   0.21321 15.595 -6298.5
## - Condition1      3   0.26214 15.644 -6298.0
## - ScreenPorch     1   0.26153 15.643 -6294.0
## - Fireplaces      1   0.26918 15.651 -6293.3
## - HouseStyle      3   0.34096 15.723 -6290.7
## - SaleCondition   5   0.47306 15.855 -6282.5
## - LotArea         1   0.44118 15.823 -6277.4
## - TotRmsAbvGrd    1   0.48643 15.868 -6273.3
## - GarageArea      1   0.55919 15.941 -6266.6
## - BsmtFinSF2      1   0.66641 16.048 -6256.9
## - Neighborhood   15   1.12327 16.505 -6244.1
## - OverallCond     1   1.02001 16.402 -6225.2
## - MSZoning        3   1.33112 16.713 -6201.9
## - SectFlrSF       1   1.34301 16.725 -6196.9
## - OverallQual     1   1.79721 17.179 -6158.0
## - BsmtUnfSF       1   2.46628 17.848 -6102.5
## - BsmtFinSF1      1   2.83054 18.212 -6073.1
##
## Step:  AIC=-6320.19
## log(SalePrice) ~ MSSubClass + MSZoning + LotArea + Street + Alley +
##     LotShape + LandContour + LotConfig + LandSlope + Neighborhood +
##     Condition1 + BldgType + HouseStyle + OverallQual + OverallCond +
##     YearBuilt + YearRemodAdd + RoofStyle + Exterior1st + Exterior2nd +
##     MasVnrType + MasVnrArea + ExterCond + Foundation + BsmtQual +
##     BsmtExposure + BsmtFinType1 + BsmtFinSF1 + BsmtFinType2 +
##     BsmtFinSF2 + BsmtUnfSF + Heating + HeatingQC + CentralAir +
##     Electrical + SectFlrSF + LowQualFinSF + BsmtFullBath + BsmtHalfBath +
##     FullBath + HalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual +
##     TotRmsAbvGrd + Functional + Fireplaces + GarageFinish + GarageArea +
##     GarageQual + GarageCond + PavedDrive + WoodDeckSF + OpenPorchSF +
##     EnclosedPorch + ThirdSsnPorch + ScreenPorch + PoolQC + MiscFeature +
##     MiscVal + MoSold + YrSold + SaleType + SaleCondition
##
##                 Df Sum of Sq    RSS     AIC
## - Electrical     2   0.01271 15.419 -6323.0
## - MiscFeature    4   0.05658 15.463 -6322.9
## - RoofStyle      2   0.01948 15.426 -6322.4
## - PavedDrive     2   0.02110 15.428 -6322.2
## - BsmtHalfBath   1   0.00008 15.407 -6322.2
## - LandContour    1   0.00060 15.407 -6322.1
## - MasVnrArea     1   0.00205 15.409 -6322.0
## - GarageFinish   2   0.02388 15.431 -6321.9
## - Exterior2nd    1   0.00306 15.410 -6321.9
## - BsmtFinType1   5   0.08841 15.495 -6321.9
## - LotShape       1   0.00401 15.411 -6321.8
## - PoolQC         1   0.00405 15.411 -6321.8
```

```
## - MoSold            1    0.00488 15.412 -6321.7
## - Alley             2    0.03050 15.437 -6321.3
## - BedroomAbvGr      1    0.00985 15.416 -6321.3
## - OpenPorchSF       1    0.01219 15.419 -6321.0
## - MasVnrType        4    0.08217 15.489 -6320.5
## <none>                          15.407 -6320.2
## - GarageQual        2    0.04352 15.450 -6320.1
## - YrSold            1    0.02507 15.432 -6319.8
## - MiscVal           1    0.02832 15.435 -6319.5
## - GarageCond        2    0.05755 15.464 -6318.8
## - Street            1    0.03684 15.444 -6318.7
## - ThirdSsnPorch     1    0.03958 15.446 -6318.5
## - BsmtQual          3    0.08442 15.491 -6318.3
## - Heating           2    0.06996 15.477 -6317.6
## - EnclosedPorch     1    0.05121 15.458 -6317.4
## - BsmtFinType2      6    0.16151 15.568 -6317.0
## - ExterCond         3    0.09778 15.504 -6317.0
## - LandSlope         2    0.07752 15.484 -6316.9
## - BsmtFullBath      1    0.05909 15.466 -6316.6
## - KitchenAbvGr      1    0.06248 15.469 -6316.3
## - LowQualFinSF      1    0.06623 15.473 -6316.0
## - LotConfig         1    0.07973 15.486 -6314.7
## - Foundation        5    0.17225 15.579 -6314.0
## - Functional        1    0.10279 15.509 -6312.5
## - HeatingQC         4    0.16864 15.575 -6312.4
## - CentralAir        1    0.11679 15.523 -6311.2
## - BldgType          3    0.16024 15.567 -6311.2
## - YearBuilt         1    0.13367 15.540 -6309.6
## - WoodDeckSF        1    0.14026 15.547 -6309.0
## - MSSubClass        3    0.18597 15.593 -6308.8
## - BsmtExposure      4    0.21193 15.619 -6308.3
## - SaleType          3    0.19277 15.599 -6308.1
## - KitchenQual       3    0.20604 15.613 -6306.9
## - Exterior1st       7    0.29381 15.700 -6306.7
## - HalfBath          1    0.17696 15.584 -6305.6
## - FullBath          1    0.18954 15.596 -6304.4
## - YearRemodAdd      1    0.19972 15.606 -6303.5
## - Condition1        3    0.27037 15.677 -6300.9
## - ScreenPorch       1    0.25980 15.666 -6297.9
## - Fireplaces        1    0.26489 15.671 -6297.4
## - HouseStyle        3    0.33132 15.738 -6295.3
## - SaleCondition     5    0.46660 15.873 -6286.8
## - LotArea           1    0.43765 15.844 -6281.5
## - TotRmsAbvGrd      1    0.49577 15.902 -6276.2
## - GarageArea        1    0.57034 15.977 -6269.4
## - BsmtFinSF2        1    0.67154 16.078 -6260.2
## - Neighborhood     15    1.11615 16.523 -6248.6
## - OverallCond       1    1.08868 16.495 -6223.0
## - MSZoning          3    1.33784 16.744 -6205.2
## - SectFlrSF         1    1.32926 16.736 -6201.9
## - OverallQual       1    1.81114 17.218 -6160.7
## - BsmtUnfSF         1    2.47803 17.885 -6105.5
## - BsmtFinSF1        1    2.82074 18.227 -6077.9
##
```

```
## Step:  AIC=-6322.99
## log(SalePrice) ~ MSSubClass + MSZoning + LotArea + Street + Alley +
##     LotShape + LandContour + LotConfig + LandSlope + Neighborhood +
##     Condition1 + BldgType + HouseStyle + OverallQual + OverallCond +
##     YearBuilt + YearRemodAdd + RoofStyle + Exterior1st + Exterior2nd +
##     MasVnrType + MasVnrArea + ExterCond + Foundation + BsmtQual +
##     BsmtExposure + BsmtFinType1 + BsmtFinSF1 + BsmtFinType2 +
##     BsmtFinSF2 + BsmtUnfSF + Heating + HeatingQC + CentralAir +
##     SectFlrSF + LowQualFinSF + BsmtFullBath + BsmtHalfBath +
##     FullBath + HalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual +
##     TotRmsAbvGrd + Functional + Fireplaces + GarageFinish + GarageArea +
##     GarageQual + GarageCond + PavedDrive + WoodDeckSF + OpenPorchSF +
##     EnclosedPorch + ThirdSsnPorch + ScreenPorch + PoolQC + MiscFeature +
##     MiscVal + MoSold + YrSold + SaleType + SaleCondition
##
##                 Df Sum of Sq    RSS     AIC
## - MiscFeature    4   0.05638 15.476 -6325.7
## - RoofStyle      2   0.01932 15.439 -6325.2
## - PavedDrive     2   0.02002 15.439 -6325.1
## - BsmtHalfBath   1   0.00007 15.419 -6325.0
## - LandContour    1   0.00069 15.420 -6324.9
## - GarageFinish   2   0.02333 15.443 -6324.8
## - MasVnrArea     1   0.00216 15.421 -6324.8
## - Exterior2nd    1   0.00264 15.422 -6324.7
## - BsmtFinType1   5   0.08865 15.508 -6324.7
## - PoolQC         1   0.00404 15.423 -6324.6
## - LotShape       1   0.00450 15.424 -6324.6
## - MoSold         1   0.00499 15.424 -6324.5
## - Alley          2   0.03039 15.450 -6324.1
## - BedroomAbvGr   1   0.01098 15.430 -6324.0
## - OpenPorchSF    1   0.01237 15.432 -6323.8
## - MasVnrType     4   0.08486 15.504 -6323.0
## <none>                       15.419 -6323.0
## - GarageQual     2   0.04336 15.463 -6322.9
## - YrSold         1   0.02670 15.446 -6322.5
## - MiscVal        1   0.02864 15.448 -6322.3
## - GarageCond     2   0.05720 15.476 -6321.6
## - Street         1   0.03614 15.456 -6321.6
## - ThirdSsnPorch  1   0.04017 15.460 -6321.2
## - BsmtQual       3   0.08734 15.507 -6320.8
## - Heating        2   0.06613 15.486 -6320.8
## - EnclosedPorch  1   0.05197 15.471 -6320.1
## - BsmtFinType2   6   0.15940 15.579 -6320.1
## - LandSlope      2   0.07850 15.498 -6319.6
## - KitchenAbvGr   1   0.05799 15.477 -6319.5
## - BsmtFullBath   1   0.05859 15.478 -6319.5
## - ExterCond      3   0.10158 15.521 -6319.5
## - LowQualFinSF   1   0.06609 15.485 -6318.8
## - LotConfig      1   0.07790 15.497 -6317.7
## - Foundation     5   0.17100 15.590 -6317.0
## - Functional     1   0.10488 15.524 -6315.1
## - HeatingQC      4   0.16948 15.589 -6315.1
## - CentralAir     1   0.10952 15.529 -6314.7
## - BldgType       3   0.16069 15.580 -6313.9
```

```
## - YearBuilt      1   0.13174 15.551 -6312.6
## - WoodDeckSF     1   0.13996 15.559 -6311.9
## - MSSubClass     3   0.18414 15.604 -6311.7
## - BsmtExposure   4   0.20884 15.628 -6311.4
## - SaleType       3   0.19093 15.610 -6311.1
## - KitchenQual    3   0.20912 15.628 -6309.4
## - Exterior1st    7   0.30337 15.723 -6308.7
## - HalfBath       1   0.17489 15.594 -6308.6
## - FullBath       1   0.18531 15.605 -6307.6
## - YearRemodAdd   1   0.19260 15.612 -6307.0
## - Condition1     3   0.26719 15.687 -6304.0
## - ScreenPorch    1   0.25996 15.679 -6300.7
## - Fireplaces     1   0.26247 15.682 -6300.5
## - HouseStyle     3   0.33651 15.756 -6297.6
## - SaleCondition  5   0.46672 15.886 -6289.7
## - LotArea        1   0.43858 15.858 -6284.2
## - TotRmsAbvGrd   1   0.49703 15.916 -6278.9
## - GarageArea     1   0.56157 15.981 -6273.0
## - BsmtFinSF2     1   0.67397 16.093 -6262.8
## - Neighborhood  15   1.10957 16.529 -6252.0
## - OverallCond    1   1.08470 16.504 -6226.2
## - MSZoning       3   1.33324 16.753 -6208.5
## - SectFlrSF      1   1.34510 16.764 -6203.5
## - OverallQual    1   1.81110 17.230 -6163.6
## - BsmtUnfSF      1   2.49047 17.910 -6107.4
## - BsmtFinSF1     1   2.82169 18.241 -6080.8
##
## Step:  AIC=-6325.69
## log(SalePrice) ~ MSSubClass + MSZoning + LotArea + Street + Alley +
##     LotShape + LandContour + LotConfig + LandSlope + Neighborhood +
##     Condition1 + BldgType + HouseStyle + OverallQual + OverallCond +
##     YearBuilt + YearRemodAdd + RoofStyle + Exterior1st + Exterior2nd +
##     MasVnrType + MasVnrArea + ExterCond + Foundation + BsmtQual +
##     BsmtExposure + BsmtFinType1 + BsmtFinSF1 + BsmtFinType2 +
##     BsmtFinSF2 + BsmtUnfSF + Heating + HeatingQC + CentralAir +
##     SectFlrSF + LowQualFinSF + BsmtFullBath + BsmtHalfBath +
##     FullBath + HalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual +
##     TotRmsAbvGrd + Functional + Fireplaces + GarageFinish + GarageArea +
##     GarageQual + GarageCond + PavedDrive + WoodDeckSF + OpenPorchSF +
##     EnclosedPorch + ThirdSsnPorch + ScreenPorch + PoolQC + MiscVal +
##     MoSold + YrSold + SaleType + SaleCondition
##
##                Df Sum of Sq    RSS     AIC
## - RoofStyle     2   0.02066 15.496 -6327.8
## - BsmtHalfBath  1   0.00002 15.476 -6327.7
## - LandContour   1   0.00053 15.476 -6327.6
## - PavedDrive    2   0.02199 15.498 -6327.6
## - PoolQC        1   0.00111 15.477 -6327.6
## - MasVnrArea    1   0.00211 15.478 -6327.5
## - Exterior2nd   1   0.00239 15.478 -6327.5
## - GarageFinish  2   0.02426 15.500 -6327.4
## - MoSold        1   0.00383 15.479 -6327.3
## - LotShape      1   0.00416 15.480 -6327.3
## - BsmtFinType1  5   0.09117 15.567 -6327.2
```

```
## - Alley            2    0.02993 15.506 -6326.9
## - BedroomAbvGr     1    0.00995 15.486 -6326.8
## - OpenPorchSF      1    0.01409 15.490 -6326.4
## - GarageQual       2    0.04202 15.518 -6325.8
## - MasVnrType       4    0.08495 15.561 -6325.7
## <none>                          15.476 -6325.7
## - YrSold           1    0.02570 15.501 -6325.3
## - Street           1    0.03000 15.506 -6324.9
## - GarageCond       2    0.05607 15.532 -6324.4
## - ThirdSsnPorch    1    0.04085 15.517 -6323.9
## - BsmtQual         3    0.08729 15.563 -6323.5
## - Heating          2    0.06668 15.542 -6323.4
## - BsmtFinType2     6    0.15770 15.633 -6323.0
## - BsmtFullBath     1    0.05554 15.531 -6322.5
## - KitchenAbvGr     1    0.05556 15.531 -6322.5
## - LandSlope        2    0.07734 15.553 -6322.4
## - EnclosedPorch    1    0.05901 15.535 -6322.2
## - ExterCond        3    0.11024 15.586 -6321.4
## - LowQualFinSF     1    0.07638 15.552 -6320.5
## - LotConfig        1    0.07978 15.556 -6320.2
## - Foundation       5    0.17044 15.646 -6319.8
## - Functional       1    0.10092 15.577 -6318.2
## - HeatingQC        4    0.16877 15.645 -6317.9
## - CentralAir       1    0.11342 15.589 -6317.1
## - BldgType         3    0.15744 15.633 -6317.0
## - MiscVal          1    0.12833 15.604 -6315.7
## - YearBuilt        1    0.13272 15.608 -6315.3
## - BsmtExposure     4    0.20797 15.684 -6314.3
## - WoodDeckSF       1    0.14888 15.625 -6313.8
## - MSSubClass       3    0.19361 15.669 -6313.6
## - SaleType         3    0.19897 15.675 -6313.1
## - KitchenQual      3    0.20921 15.685 -6312.2
## - Exterior1st      7    0.30227 15.778 -6311.6
## - HalfBath         1    0.17910 15.655 -6311.0
## - FullBath         1    0.17936 15.655 -6310.9
## - YearRemodAdd     1    0.20173 15.677 -6308.9
## - ScreenPorch      1    0.23782 15.713 -6305.5
## - Condition1       3    0.28142 15.757 -6305.5
## - Fireplaces       1    0.26014 15.736 -6303.5
## - HouseStyle       3    0.35098 15.827 -6299.1
## - SaleCondition    5    0.45823 15.934 -6293.3
## - LotArea          1    0.45464 15.930 -6285.6
## - TotRmsAbvGrd     1    0.47669 15.952 -6283.6
## - GarageArea       1    0.56609 16.042 -6275.5
## - BsmtFinSF2       1    0.65824 16.134 -6267.2
## - Neighborhood    15    1.11984 16.596 -6254.2
## - OverallCond      1    1.08500 16.561 -6229.2
## - MSZoning         3    1.32748 16.803 -6212.1
## - SectFlrSF        1    1.38952 16.865 -6202.8
## - OverallQual      1    1.84565 17.321 -6164.0
## - BsmtUnfSF        1    2.51186 17.988 -6109.1
## - BsmtFinSF1       1    2.85378 18.329 -6081.8
##
## Step:  AIC=-6327.75
```

97

```
## log(SalePrice) ~ MSSubClass + MSZoning + LotArea + Street + Alley +
##     LotShape + LandContour + LotConfig + LandSlope + Neighborhood +
##     Condition1 + BldgType + HouseStyle + OverallQual + OverallCond +
##     YearBuilt + YearRemodAdd + Exterior1st + Exterior2nd + MasVnrType +
##     MasVnrArea + ExterCond + Foundation + BsmtQual + BsmtExposure +
##     BsmtFinType1 + BsmtFinSF1 + BsmtFinType2 + BsmtFinSF2 + BsmtUnfSF +
##     Heating + HeatingQC + CentralAir + SectFlrSF + LowQualFinSF +
##     BsmtFullBath + BsmtHalfBath + FullBath + HalfBath + BedroomAbvGr +
##     KitchenAbvGr + KitchenQual + TotRmsAbvGrd + Functional +
##     Fireplaces + GarageFinish + GarageArea + GarageQual + GarageCond +
##     PavedDrive + WoodDeckSF + OpenPorchSF + EnclosedPorch + ThirdSsnPorch +
##     ScreenPorch + PoolQC + MiscVal + MoSold + YrSold + SaleType +
##     SaleCondition
##
##                    Df Sum of Sq    RSS     AIC
## - BsmtHalfBath      1   0.00003 15.496 -6329.8
## - LandContour       1   0.00060 15.497 -6329.7
## - PavedDrive        2   0.02223 15.519 -6329.7
## - PoolQC            1   0.00110 15.498 -6329.7
## - Exterior2nd       1   0.00189 15.498 -6329.6
## - MasVnrArea        1   0.00240 15.499 -6329.5
## - GarageFinish      2   0.02408 15.520 -6329.5
## - MoSold            1   0.00398 15.500 -6329.4
## - LotShape          1   0.00424 15.501 -6329.4
## - BsmtFinType1      5   0.09162 15.588 -6329.2
## - Alley             2   0.02946 15.526 -6329.0
## - BedroomAbvGr      1   0.01143 15.508 -6328.7
## - OpenPorchSF       1   0.01457 15.511 -6328.4
## - MasVnrType        4   0.08100 15.577 -6328.2
## - GarageQual        2   0.04268 15.539 -6327.8
## <none>                         15.496 -6327.8
## - YrSold            1   0.02608 15.522 -6327.3
## - GarageCond        2   0.05140 15.548 -6326.9
## - Street            1   0.03264 15.529 -6326.7
## - ThirdSsnPorch     1   0.04248 15.539 -6325.8
## - BsmtQual          3   0.08683 15.583 -6325.6
## - LandSlope         2   0.06627 15.563 -6325.6
## - Heating           2   0.07040 15.567 -6325.2
## - BsmtFullBath      1   0.05418 15.551 -6324.7
## - EnclosedPorch     1   0.05764 15.554 -6324.4
## - BsmtFinType2      6   0.16662 15.663 -6324.2
## - KitchenAbvGr      1   0.06001 15.556 -6324.1
## - ExterCond         3   0.11117 15.607 -6323.4
## - LowQualFinSF      1   0.07570 15.572 -6322.7
## - LotConfig         1   0.08267 15.579 -6322.0
## - Foundation        5   0.16972 15.666 -6321.9
## - Functional        1   0.09433 15.591 -6320.9
## - HeatingQC         4   0.17304 15.669 -6319.6
## - MiscVal           1   0.11363 15.610 -6319.1
## - CentralAir        1   0.11500 15.611 -6319.0
## - BldgType          3   0.16209 15.659 -6318.6
## - YearBuilt         1   0.13208 15.628 -6317.4
## - SaleType          3   0.18989 15.686 -6316.1
## - WoodDeckSF        1   0.14855 15.645 -6315.9
```

```
## - MSSubClass      3   0.20238 15.699 -6314.9
## - BsmtExposure     4   0.22501 15.721 -6314.8
## - KitchenQual      3   0.21095 15.707 -6314.1
## - HalfBath         1   0.17386 15.670 -6313.5
## - Exterior1st      7   0.30404 15.800 -6313.5
## - FullBath         1   0.17591 15.672 -6313.4
## - YearRemodAdd     1   0.20054 15.697 -6311.1
## - ScreenPorch      1   0.24176 15.738 -6307.3
## - Condition1       3   0.28621 15.783 -6307.2
## - Fireplaces       1   0.25878 15.755 -6305.7
## - HouseStyle       3   0.34936 15.846 -6301.4
## - SaleCondition    5   0.45706 15.953 -6295.5
## - LotArea          1   0.43825 15.935 -6289.2
## - TotRmsAbvGrd     1   0.48685 15.983 -6284.8
## - GarageArea       1   0.57450 16.071 -6276.9
## - BsmtFinSF2       1   0.69899 16.195 -6265.6
## - Neighborhood    15   1.12045 16.617 -6256.3
## - OverallCond      1   1.08678 16.583 -6231.3
## - MSZoning         3   1.32230 16.819 -6214.8
## - SectFlrSF        1   1.39947 16.896 -6204.1
## - OverallQual      1   1.88461 17.381 -6163.0
## - BsmtUnfSF        1   2.52324 18.020 -6110.6
## - BsmtFinSF1       1   2.89532 18.392 -6080.9
##
## Step:  AIC=-6329.75
## log(SalePrice) ~ MSSubClass + MSZoning + LotArea + Street + Alley +
##     LotShape + LandContour + LotConfig + LandSlope + Neighborhood +
##     Condition1 + BldgType + HouseStyle + OverallQual + OverallCond +
##     YearBuilt + YearRemodAdd + Exterior1st + Exterior2nd + MasVnrType +
##     MasVnrArea + ExterCond + Foundation + BsmtQual + BsmtExposure +
##     BsmtFinType1 + BsmtFinSF1 + BsmtFinType2 + BsmtFinSF2 + BsmtUnfSF +
##     Heating + HeatingQC + CentralAir + SectFlrSF + LowQualFinSF +
##     BsmtFullBath + FullBath + HalfBath + BedroomAbvGr + KitchenAbvGr +
##     KitchenQual + TotRmsAbvGrd + Functional + Fireplaces + GarageFinish +
##     GarageArea + GarageQual + GarageCond + PavedDrive + WoodDeckSF +
##     OpenPorchSF + EnclosedPorch + ThirdSsnPorch + ScreenPorch +
##     PoolQC + MiscVal + MoSold + YrSold + SaleType + SaleCondition
##
##                 Df Sum of Sq    RSS     AIC
## - LandContour    1   0.00061 15.497 -6331.7
## - PavedDrive     2   0.02222 15.519 -6331.7
## - PoolQC         1   0.00111 15.498 -6331.6
## - Exterior2nd    1   0.00191 15.498 -6331.6
## - MasVnrArea     1   0.00240 15.499 -6331.5
## - GarageFinish   2   0.02416 15.521 -6331.5
## - MoSold         1   0.00396 15.500 -6331.4
## - LotShape       1   0.00423 15.501 -6331.4
## - BsmtFinType1   5   0.09193 15.588 -6331.2
## - Alley          2   0.02945 15.526 -6331.0
## - BedroomAbvGr   1   0.01161 15.508 -6330.7
## - OpenPorchSF    1   0.01456 15.511 -6330.4
## - MasVnrType     4   0.08115 15.578 -6330.2
## <none>                       15.496 -6329.8
## - GarageQual     2   0.04287 15.539 -6329.7
```

99

```
## - YrSold          1    0.02606 15.523 -6329.3
## - GarageCond       2    0.05138 15.548 -6328.9
## - Street           1    0.03261 15.529 -6328.7
## - ThirdSsnPorch    1    0.04248 15.539 -6327.8
## - BsmtQual         3    0.08690 15.583 -6327.6
## - LandSlope        2    0.06644 15.563 -6327.5
## - Heating          2    0.07038 15.567 -6327.2
## - EnclosedPorch    1    0.05762 15.554 -6326.4
## - BsmtFinType2     6    0.16668 15.663 -6326.2
## - KitchenAbvGr     1    0.05999 15.556 -6326.1
## - BsmtFullBath     1    0.06171 15.558 -6326.0
## - ExterCond        3    0.11121 15.608 -6325.4
## - LowQualFinSF     1    0.07567 15.572 -6324.7
## - LotConfig        1    0.08266 15.579 -6324.0
## - Foundation       5    0.16978 15.666 -6323.9
## - Functional       1    0.09454 15.591 -6322.9
## - HeatingQC        4    0.17301 15.669 -6321.6
## - MiscVal          1    0.11366 15.610 -6321.1
## - CentralAir       1    0.11498 15.611 -6321.0
## - BldgType         3    0.16207 15.659 -6320.6
## - YearBuilt        1    0.13206 15.629 -6319.4
## - SaleType         3    0.18986 15.686 -6318.1
## - WoodDeckSF       1    0.14860 15.645 -6317.9
## - MSSubClass       3    0.20242 15.699 -6316.9
## - BsmtExposure     4    0.22528 15.722 -6316.8
## - KitchenQual      3    0.21094 15.707 -6316.1
## - Exterior1st      7    0.30403 15.800 -6315.5
## - HalfBath         1    0.17413 15.671 -6315.5
## - FullBath         1    0.17761 15.674 -6315.2
## - YearRemodAdd     1    0.20061 15.697 -6313.1
## - ScreenPorch      1    0.24173 15.738 -6309.3
## - Condition1       3    0.28618 15.783 -6309.2
## - Fireplaces       1    0.25879 15.755 -6307.7
## - HouseStyle       3    0.34963 15.846 -6303.3
## - SaleCondition    5    0.45737 15.954 -6297.5
## - LotArea          1    0.43823 15.935 -6291.2
## - TotRmsAbvGrd     1    0.48764 15.984 -6286.7
## - GarageArea       1    0.57449 16.071 -6278.9
## - BsmtFinSF2       1    0.69906 16.195 -6267.6
## - Neighborhood    15    1.12070 16.617 -6258.3
## - OverallCond      1    1.08846 16.585 -6233.1
## - MSZoning         3    1.32312 16.820 -6216.7
## - SectFlrSF        1    1.39960 16.896 -6206.1
## - OverallQual      1    1.88606 17.383 -6164.9
## - BsmtUnfSF        1    2.52426 18.021 -6112.5
## - BsmtFinSF1       1    2.92816 18.425 -6080.3
##
## Step:  AIC=-6331.69
## log(SalePrice) ~ MSSubClass + MSZoning + LotArea + Street + Alley +
##     LotShape + LotConfig + LandSlope + Neighborhood + Condition1 +
##     BldgType + HouseStyle + OverallQual + OverallCond + YearBuilt +
##     YearRemodAdd + Exterior1st + Exterior2nd + MasVnrType + MasVnrArea +
##     ExterCond + Foundation + BsmtQual + BsmtExposure + BsmtFinType1 +
##     BsmtFinSF1 + BsmtFinType2 + BsmtFinSF2 + BsmtUnfSF + Heating +
```

```
##      HeatingQC + CentralAir + SectFlrSF + LowQualFinSF + BsmtFullBath +
##      FullBath + HalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual +
##      TotRmsAbvGrd + Functional + Fireplaces + GarageFinish + GarageArea +
##      GarageQual + GarageCond + PavedDrive + WoodDeckSF + OpenPorchSF +
##      EnclosedPorch + ThirdSsnPorch + ScreenPorch + PoolQC + MiscVal +
##      MoSold + YrSold + SaleType + SaleCondition
##
##                    Df Sum of Sq    RSS     AIC
## - PavedDrive        2    0.02200 15.519 -6333.6
## - PoolQC            1    0.00108 15.498 -6333.6
## - Exterior2nd       1    0.00195 15.499 -6333.5
## - MasVnrArea        1    0.00234 15.499 -6333.5
## - GarageFinish      2    0.02412 15.521 -6333.4
## - MoSold            1    0.00402 15.501 -6333.3
## - LotShape          1    0.00460 15.502 -6333.3
## - BsmtFinType1      5    0.09172 15.589 -6333.1
## - Alley             2    0.03028 15.527 -6332.9
## - BedroomAbvGr      1    0.01144 15.508 -6332.6
## - OpenPorchSF       1    0.01440 15.511 -6332.3
## - MasVnrType        4    0.08129 15.578 -6332.1
## - GarageQual        2    0.04254 15.540 -6331.7
## <none>                           15.497 -6331.7
## - YrSold            1    0.02606 15.523 -6331.3
## - GarageCond        2    0.05179 15.549 -6330.8
## - Street            1    0.03292 15.530 -6330.6
## - ThirdSsnPorch     1    0.04310 15.540 -6329.7
## - BsmtQual          3    0.08743 15.584 -6329.5
## - Heating           2    0.07043 15.567 -6329.1
## - LandSlope         2    0.07322 15.570 -6328.8
## - EnclosedPorch     1    0.05739 15.554 -6328.3
## - BsmtFinType2      6    0.16667 15.664 -6328.2
## - KitchenAbvGr      1    0.06006 15.557 -6328.1
## - BsmtFullBath      1    0.06168 15.559 -6327.9
## - ExterCond         3    0.11182 15.609 -6327.2
## - LowQualFinSF      1    0.07585 15.573 -6326.6
## - LotConfig         1    0.08238 15.579 -6326.0
## - Foundation        5    0.17026 15.667 -6325.8
## - Functional        1    0.09470 15.592 -6324.8
## - HeatingQC         4    0.17291 15.670 -6323.6
## - MiscVal           1    0.11421 15.611 -6323.0
## - CentralAir        1    0.11442 15.611 -6323.0
## - BldgType          3    0.16292 15.660 -6322.5
## - YearBuilt         1    0.13211 15.629 -6321.4
## - SaleType          3    0.19020 15.687 -6320.0
## - WoodDeckSF        1    0.14873 15.646 -6319.8
## - MSSubClass        3    0.20183 15.699 -6318.9
## - BsmtExposure      4    0.22678 15.724 -6318.6
## - KitchenQual       3    0.21159 15.709 -6318.0
## - HalfBath          1    0.17370 15.671 -6317.5
## - Exterior1st       7    0.30494 15.802 -6317.4
## - FullBath          1    0.17706 15.674 -6317.2
## - YearRemodAdd      1    0.20058 15.698 -6315.0
## - ScreenPorch       1    0.24120 15.738 -6311.3
## - Condition1        3    0.28704 15.784 -6311.0
```

```
## - Fireplaces      1    0.25838 15.755 -6309.7
## - HouseStyle      3    0.35026 15.847 -6305.2
## - SaleCondition   5    0.45788 15.955 -6299.4
## - LotArea         1    0.44288 15.940 -6292.8
## - TotRmsAbvGrd     1    0.48776 15.985 -6288.7
## - GarageArea      1    0.57940 16.076 -6280.4
## - BsmtFinSF2      1    0.69896 16.196 -6269.6
## - Neighborhood    15   1.13953 16.637 -6258.6
## - OverallCond     1    1.08818 16.585 -6235.1
## - MSZoning        3    1.32557 16.823 -6218.4
## - SectFlrSF       1    1.39982 16.897 -6208.0
## - OverallQual     1    1.89850 17.395 -6165.8
## - BsmtUnfSF       1    2.52542 18.022 -6114.3
## - BsmtFinSF1      1    2.93334 18.430 -6081.8
##
## Step:  AIC=-6333.63
## log(SalePrice) ~ MSSubClass + MSZoning + LotArea + Street + Alley +
##     LotShape + LotConfig + LandSlope + Neighborhood + Condition1 +
##     BldgType + HouseStyle + OverallQual + OverallCond + YearBuilt +
##     YearRemodAdd + Exterior1st + Exterior2nd + MasVnrType + MasVnrArea +
##     ExterCond + Foundation + BsmtQual + BsmtExposure + BsmtFinType1 +
##     BsmtFinSF1 + BsmtFinType2 + BsmtFinSF2 + BsmtUnfSF + Heating +
##     HeatingQC + CentralAir + SectFlrSF + LowQualFinSF + BsmtFullBath +
##     FullBath + HalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual +
##     TotRmsAbvGrd + Functional + Fireplaces + GarageFinish + GarageArea +
##     GarageQual + GarageCond + WoodDeckSF + OpenPorchSF + EnclosedPorch +
##     ThirdSsnPorch + ScreenPorch + PoolQC + MiscVal + MoSold +
##     YrSold + SaleType + SaleCondition
##
##                  Df Sum of Sq    RSS     AIC
## - PoolQC          1    0.00104 15.520 -6335.5
## - GarageFinish    2    0.02261 15.542 -6335.5
## - Exterior2nd     1    0.00197 15.521 -6335.4
## - MasVnrArea      1    0.00223 15.521 -6335.4
## - LotShape        1    0.00391 15.523 -6335.3
## - MoSold          1    0.00442 15.523 -6335.2
## - Alley           2    0.02682 15.546 -6335.1
## - BsmtFinType1    5    0.09231 15.611 -6335.0
## - BedroomAbvGr    1    0.01147 15.530 -6334.6
## - OpenPorchSF     1    0.01366 15.533 -6334.4
## - MasVnrType      4    0.08193 15.601 -6334.0
## <none>                         15.519 -6333.6
## - YrSold          1    0.02479 15.544 -6333.3
## - GarageQual      2    0.04631 15.565 -6333.3
## - Street          1    0.03307 15.552 -6332.5
## - GarageCond      2    0.05592 15.575 -6332.4
## - ThirdSsnPorch   1    0.04170 15.561 -6331.7
## - BsmtQual        3    0.08830 15.607 -6331.4
## - Heating         2    0.06711 15.586 -6331.4
## - LandSlope       2    0.07061 15.590 -6331.0
## - EnclosedPorch   1    0.05652 15.575 -6330.4
## - BsmtFinType2    6    0.16651 15.685 -6330.1
## - BsmtFullBath    1    0.05947 15.579 -6330.1
## - KitchenAbvGr    1    0.06420 15.583 -6329.6
```

```
## - ExterCond      3   0.11561 15.635 -6328.8
## - Foundation     5   0.17051 15.690 -6327.8
## - LowQualFinSF   1   0.08502 15.604 -6327.7
## - LotConfig      1   0.08733 15.606 -6327.5
## - Functional     1   0.09501 15.614 -6326.8
## - HeatingQC      4   0.17269 15.692 -6325.6
## - CentralAir     1   0.11949 15.639 -6324.5
## - BldgType       3   0.16350 15.682 -6324.4
## - MiscVal        1   0.12392 15.643 -6324.1
## - SaleType       3   0.18880 15.708 -6322.1
## - WoodDeckSF     1   0.15033 15.669 -6321.6
## - YearBuilt      1   0.15802 15.677 -6320.9
## - MSSubClass     3   0.20284 15.722 -6320.8
## - BsmtExposure   4   0.22801 15.747 -6320.4
## - KitchenQual    3   0.21102 15.730 -6320.0
## - HalfBath       1   0.17251 15.691 -6319.6
## - FullBath       1   0.17626 15.695 -6319.2
## - Exterior1st    7   0.31229 15.831 -6318.7
## - YearRemodAdd   1   0.19214 15.711 -6317.8
## - ScreenPorch    1   0.24639 15.765 -6312.7
## - Condition1     3   0.29338 15.812 -6312.4
## - Fireplaces     1   0.26465 15.784 -6311.1
## - HouseStyle     3   0.35561 15.875 -6306.7
## - SaleCondition  5   0.45455 15.973 -6301.7
## - LotArea        1   0.44052 15.960 -6295.0
## - TotRmsAbvGrd   1   0.48204 16.001 -6291.2
## - GarageArea     1   0.58494 16.104 -6281.9
## - BsmtFinSF2     1   0.69929 16.218 -6271.6
## - Neighborhood  15   1.15866 16.678 -6259.0
## - OverallCond    1   1.09790 16.617 -6236.3
## - MSZoning       3   1.35620 16.875 -6217.9
## - SectFlrSF      1   1.41792 16.937 -6208.6
## - OverallQual    1   1.89240 17.411 -6168.5
## - BsmtUnfSF      1   2.54130 18.060 -6115.3
## - BsmtFinSF1     1   2.93858 18.458 -6083.7
##
## Step:  AIC=-6335.54
## log(SalePrice) ~ MSSubClass + MSZoning + LotArea + Street + Alley +
##     LotShape + LotConfig + LandSlope + Neighborhood + Condition1 +
##     BldgType + HouseStyle + OverallQual + OverallCond + YearBuilt +
##     YearRemodAdd + Exterior1st + Exterior2nd + MasVnrType + MasVnrArea +
##     ExterCond + Foundation + BsmtQual + BsmtExposure + BsmtFinType1 +
##     BsmtFinSF1 + BsmtFinType2 + BsmtFinSF2 + BsmtUnfSF + Heating +
##     HeatingQC + CentralAir + SectFlrSF + LowQualFinSF + BsmtFullBath +
##     FullBath + HalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual +
##     TotRmsAbvGrd + Functional + Fireplaces + GarageFinish + GarageArea +
##     GarageQual + GarageCond + WoodDeckSF + OpenPorchSF + EnclosedPorch +
##     ThirdSsnPorch + ScreenPorch + MiscVal + MoSold + YrSold +
##     SaleType + SaleCondition
##
##                 Df Sum of Sq    RSS     AIC
## - GarageFinish   2   0.02268 15.543 -6337.4
## - Exterior2nd    1   0.00193 15.522 -6337.4
## - MasVnrArea     1   0.00251 15.523 -6337.3
```

```
## - LotShape        1   0.00396 15.524 -6337.2
## - MoSold          1   0.00459 15.525 -6337.1
## - Alley           2   0.02708 15.547 -6337.0
## - BsmtFinType1     5   0.09278 15.613 -6336.9
## - BedroomAbvGr     1   0.01150 15.531 -6336.5
## - OpenPorchSF      1   0.01409 15.534 -6336.2
## - MasVnrType       4   0.08175 15.602 -6335.9
## <none>                        15.520 -6335.5
## - YrSold          1   0.02431 15.544 -6335.3
## - GarageQual       2   0.04660 15.567 -6335.2
## - Street          1   0.03311 15.553 -6334.4
## - GarageCond       2   0.05599 15.576 -6334.3
## - ThirdSsnPorch    1   0.04176 15.562 -6333.6
## - BsmtQual         3   0.08795 15.608 -6333.3
## - Heating          2   0.06698 15.587 -6333.3
## - LandSlope        2   0.07112 15.591 -6332.9
## - EnclosedPorch    1   0.05560 15.576 -6332.3
## - BsmtFinType2     6   0.16589 15.686 -6332.1
## - BsmtFullBath     1   0.05931 15.579 -6332.0
## - KitchenAbvGr     1   0.06390 15.584 -6331.6
## - ExterCond        3   0.11598 15.636 -6330.7
## - Foundation       5   0.17009 15.690 -6329.7
## - LowQualFinSF     1   0.08398 15.604 -6329.7
## - LotConfig        1   0.08732 15.607 -6329.4
## - Functional       1   0.09452 15.615 -6328.7
## - HeatingQC        4   0.17382 15.694 -6327.4
## - CentralAir       1   0.11943 15.639 -6326.4
## - BldgType         3   0.16380 15.684 -6326.3
## - MiscVal          1   0.12613 15.646 -6325.8
## - SaleType         3   0.18983 15.710 -6323.9
## - WoodDeckSF       1   0.15142 15.671 -6323.4
## - YearBuilt        1   0.15870 15.679 -6322.8
## - MSSubClass       3   0.20212 15.722 -6322.7
## - BsmtExposure     4   0.22966 15.750 -6322.2
## - KitchenQual      3   0.21078 15.731 -6321.9
## - HalfBath         1   0.17316 15.693 -6321.4
## - FullBath         1   0.17616 15.696 -6321.1
## - Exterior1st      7   0.31406 15.834 -6320.4
## - YearRemodAdd     1   0.19117 15.711 -6319.7
## - ScreenPorch      1   0.24537 15.765 -6314.7
## - Condition1       3   0.29648 15.816 -6314.0
## - Fireplaces       1   0.26399 15.784 -6313.0
## - HouseStyle       3   0.35457 15.875 -6308.7
## - SaleCondition    5   0.45965 15.980 -6303.1
## - LotArea          1   0.43998 15.960 -6296.9
## - TotRmsAbvGrd     1   0.48829 16.008 -6292.5
## - GarageArea       1   0.58472 16.105 -6283.8
## - BsmtFinSF2       1   0.69861 16.219 -6273.6
## - Neighborhood    15   1.16404 16.684 -6260.5
## - OverallCond      1   1.10453 16.625 -6237.6
## - MSZoning         3   1.35766 16.878 -6219.7
## - SectFlrSF        1   1.43877 16.959 -6208.7
## - OverallQual      1   1.89178 17.412 -6170.4
## - BsmtUnfSF        1   2.55000 18.070 -6116.5
```

```
## - BsmtFinSF1     1   2.96541 18.485 -6083.5
##
## Step:  AIC=-6337.41
## log(SalePrice) ~ MSSubClass + MSZoning + LotArea + Street + Alley +
##     LotShape + LotConfig + LandSlope + Neighborhood + Condition1 +
##     BldgType + HouseStyle + OverallQual + OverallCond + YearBuilt +
##     YearRemodAdd + Exterior1st + Exterior2nd + MasVnrType + MasVnrArea +
##     ExterCond + Foundation + BsmtQual + BsmtExposure + BsmtFinType1 +
##     BsmtFinSF1 + BsmtFinType2 + BsmtFinSF2 + BsmtUnfSF + Heating +
##     HeatingQC + CentralAir + SectFlrSF + LowQualFinSF + BsmtFullBath +
##     FullBath + HalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual +
##     TotRmsAbvGrd + Functional + Fireplaces + GarageArea + GarageQual +
##     GarageCond + WoodDeckSF + OpenPorchSF + EnclosedPorch + ThirdSsnPorch +
##     ScreenPorch + MiscVal + MoSold + YrSold + SaleType + SaleCondition
##
##                 Df Sum of Sq    RSS     AIC
## - Exterior2nd    1   0.00144 15.544 -6339.3
## - MasVnrArea     1   0.00202 15.545 -6339.2
## - BsmtFinType1   5   0.08853 15.631 -6339.2
## - MoSold         1   0.00351 15.546 -6339.1
## - Alley          2   0.02537 15.568 -6339.0
## - LotShape       1   0.00475 15.547 -6339.0
## - BedroomAbvGr   1   0.01348 15.556 -6338.2
## - OpenPorchSF    1   0.01607 15.559 -6337.9
## - MasVnrType     4   0.08514 15.628 -6337.5
## <none>                       15.543 -6337.4
## - YrSold         1   0.02320 15.566 -6337.2
## - GarageQual     2   0.04911 15.592 -6336.8
## - Street         1   0.03237 15.575 -6336.4
## - GarageCond     2   0.05536 15.598 -6336.2
## - BsmtQual       3   0.08672 15.629 -6335.3
## - Heating        2   0.06690 15.610 -6335.2
## - ThirdSsnPorch  1   0.04547 15.588 -6335.2
## - LandSlope      2   0.07290 15.616 -6334.6
## - BsmtFinType2   6   0.16304 15.706 -6334.3
## - EnclosedPorch  1   0.05772 15.600 -6334.0
## - BsmtFullBath   1   0.06184 15.605 -6333.6
## - KitchenAbvGr   1   0.06360 15.606 -6333.5
## - ExterCond      3   0.11563 15.658 -6332.6
## - LowQualFinSF   1   0.08258 15.625 -6331.7
## - LotConfig      1   0.08431 15.627 -6331.6
## - Foundation     5   0.17542 15.718 -6331.1
## - Functional     1   0.09999 15.643 -6330.1
## - HeatingQC      4   0.18336 15.726 -6328.4
## - MiscVal        1   0.11872 15.661 -6328.4
## - CentralAir     1   0.12118 15.664 -6328.1
## - BldgType       3   0.18018 15.723 -6326.7
## - SaleType       3   0.19459 15.737 -6325.3
## - WoodDeckSF     1   0.15961 15.702 -6324.6
## - KitchenQual    3   0.21025 15.753 -6323.9
## - YearBuilt      1   0.16900 15.712 -6323.7
## - BsmtExposure   4   0.23418 15.777 -6323.7
## - MSSubClass     3   0.21694 15.760 -6323.3
## - HalfBath       1   0.18453 15.727 -6322.3
```

```
## - YearRemodAdd    1   0.19634 15.739 -6321.2
## - Exterior1st     7   0.32695 15.870 -6321.2
## - FullBath        1   0.19972 15.742 -6320.9
## - ScreenPorch     1   0.24595 15.789 -6316.6
## - Condition1      3   0.29848 15.841 -6315.8
## - Fireplaces      1   0.26990 15.813 -6314.4
## - HouseStyle      3   0.35482 15.898 -6310.6
## - SaleCondition   5   0.45892 16.002 -6305.1
## - LotArea         1   0.44720 15.990 -6298.2
## - TotRmsAbvGrd    1   0.48951 16.032 -6294.4
## - GarageArea      1   0.59079 16.134 -6285.2
## - BsmtFinSF2      1   0.69529 16.238 -6275.8
## - Neighborhood   15   1.15372 16.696 -6263.4
## - OverallCond     1   1.09483 16.637 -6240.5
## - MSZoning        3   1.34491 16.888 -6222.8
## - SectFlrSF       1   1.42549 16.968 -6211.9
## - OverallQual     1   1.91892 17.462 -6170.3
## - BsmtUnfSF       1   2.55137 18.094 -6118.6
## - BsmtFinSF1      1   2.98766 18.530 -6083.9
##
## Step:  AIC=-6339.28
## log(SalePrice) ~ MSSubClass + MSZoning + LotArea + Street + Alley +
##     LotShape + LotConfig + LandSlope + Neighborhood + Condition1 +
##     BldgType + HouseStyle + OverallQual + OverallCond + YearBuilt +
##     YearRemodAdd + Exterior1st + MasVnrType + MasVnrArea + ExterCond +
##     Foundation + BsmtQual + BsmtExposure + BsmtFinType1 + BsmtFinSF1 +
##     BsmtFinType2 + BsmtFinSF2 + BsmtUnfSF + Heating + HeatingQC +
##     CentralAir + SectFlrSF + LowQualFinSF + BsmtFullBath + FullBath +
##     HalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +
##     Functional + Fireplaces + GarageArea + GarageQual + GarageCond +
##     WoodDeckSF + OpenPorchSF + EnclosedPorch + ThirdSsnPorch +
##     ScreenPorch + MiscVal + MoSold + YrSold + SaleType + SaleCondition
##
##                 Df Sum of Sq    RSS     AIC
## - MasVnrArea     1   0.00193 15.546 -6341.1
## - MoSold         1   0.00349 15.548 -6341.0
## - BsmtFinType1   5   0.08960 15.634 -6340.9
## - Alley          2   0.02549 15.570 -6340.9
## - LotShape       1   0.00478 15.549 -6340.8
## - BedroomAbvGr   1   0.01352 15.558 -6340.0
## - OpenPorchSF    1   0.01579 15.560 -6339.8
## - MasVnrType     4   0.08561 15.630 -6339.3
## <none>                       15.544 -6339.3
## - YrSold         1   0.02288 15.567 -6339.1
## - GarageQual     2   0.04911 15.593 -6338.7
## - Street         1   0.03237 15.576 -6338.3
## - GarageCond     2   0.05575 15.600 -6338.1
## - BsmtQual       3   0.08627 15.630 -6337.2
## - ThirdSsnPorch  1   0.04615 15.590 -6337.0
## - Heating        2   0.06794 15.612 -6336.9
## - LandSlope      2   0.07303 15.617 -6336.5
## - BsmtFinType2   6   0.16257 15.707 -6336.2
## - EnclosedPorch  1   0.05831 15.602 -6335.8
## - BsmtFullBath   1   0.06115 15.605 -6335.6
```

```
## - KitchenAbvGr    1   0.06366 15.608 -6335.3
## - ExterCond       3   0.11619 15.660 -6334.5
## - LowQualFinSF    1   0.08183 15.626 -6333.7
## - LotConfig       1   0.08518 15.629 -6333.3
## - Foundation      5   0.17488 15.719 -6333.0
## - Functional      1   0.09886 15.643 -6332.1
## - HeatingQC       4   0.18215 15.726 -6330.4
## - MiscVal         1   0.11841 15.663 -6330.3
## - CentralAir      1   0.12310 15.667 -6329.8
## - BldgType        3   0.17883 15.723 -6328.7
## - SaleType        3   0.19328 15.737 -6327.3
## - WoodDeckSF      1   0.15995 15.704 -6326.4
## - KitchenQual     3   0.21078 15.755 -6325.7
## - YearBuilt       1   0.16762 15.712 -6325.7
## - BsmtExposure    4   0.23955 15.784 -6325.1
## - MSSubClass      3   0.21862 15.763 -6325.0
## - HalfBath        1   0.18405 15.728 -6324.2
## - YearRemodAdd    1   0.19884 15.743 -6322.8
## - FullBath        1   0.20128 15.745 -6322.6
## - Exterior1st     7   0.34550 15.890 -6321.3
## - ScreenPorch     1   0.24549 15.790 -6318.5
## - Condition1      3   0.29773 15.842 -6317.7
## - Fireplaces      1   0.26901 15.813 -6316.3
## - HouseStyle      3   0.35528 15.899 -6312.4
## - SaleCondition   5   0.45804 16.002 -6307.1
## - LotArea         1   0.44683 15.991 -6300.1
## - TotRmsAbvGrd    1   0.48886 16.033 -6296.3
## - GarageArea      1   0.59430 16.139 -6286.8
## - BsmtFinSF2      1   0.69757 16.242 -6277.5
## - Neighborhood   15   1.17115 16.715 -6263.7
## - OverallCond     1   1.09362 16.638 -6242.5
## - MSZoning        3   1.35785 16.902 -6223.6
## - SectFlrSF       1   1.43167 16.976 -6213.3
## - OverallQual     1   1.91750 17.462 -6172.3
## - BsmtUnfSF       1   2.55063 18.095 -6120.5
## - BsmtFinSF1      1   2.98716 18.531 -6085.9
##
## Step:  AIC=-6341.1
## log(SalePrice) ~ MSSubClass + MSZoning + LotArea + Street + Alley +
##     LotShape + LotConfig + LandSlope + Neighborhood + Condition1 +
##     BldgType + HouseStyle + OverallQual + OverallCond + YearBuilt +
##     YearRemodAdd + Exterior1st + MasVnrType + ExterCond + Foundation +
##     BsmtQual + BsmtExposure + BsmtFinType1 + BsmtFinSF1 + BsmtFinType2 +
##     BsmtFinSF2 + BsmtUnfSF + Heating + HeatingQC + CentralAir +
##     SectFlrSF + LowQualFinSF + BsmtFullBath + FullBath + HalfBath +
##     BedroomAbvGr + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +
##     Functional + Fireplaces + GarageArea + GarageQual + GarageCond +
##     WoodDeckSF + OpenPorchSF + EnclosedPorch + ThirdSsnPorch +
##     ScreenPorch + MiscVal + MoSold + YrSold + SaleType + SaleCondition
##
##                 Df Sum of Sq    RSS     AIC
## - MoSold         1   0.00334 15.549 -6342.8
## - BsmtFinType1   5   0.09036 15.636 -6342.7
## - LotShape       1   0.00485 15.551 -6342.6
```

```
## - Alley           2   0.02699 15.573 -6342.6
## - BedroomAbvGr    1   0.01389 15.560 -6341.8
## - OpenPorchSF     1   0.01500 15.561 -6341.7
## <none>                          15.546 -6341.1
## - YrSold          1   0.02282 15.569 -6341.0
## - GarageQual      2   0.04869 15.595 -6340.6
## - MasVnrType      4   0.09711 15.643 -6340.0
## - Street          1   0.03288 15.579 -6340.0
## - GarageCond      2   0.05543 15.601 -6339.9
## - BsmtQual        3   0.08886 15.635 -6338.8
## - Heating         2   0.06748 15.614 -6338.8
## - ThirdSsnPorch   1   0.04606 15.592 -6338.8
## - LandSlope       2   0.07338 15.620 -6338.3
## - BsmtFinType2    6   0.16294 15.709 -6337.9
## - EnclosedPorch   1   0.05756 15.604 -6337.7
## - BsmtFullBath    1   0.06012 15.606 -6337.5
## - KitchenAbvGr    1   0.06335 15.609 -6337.2
## - ExterCond       3   0.11557 15.662 -6336.3
## - LowQualFinSF    1   0.08125 15.627 -6335.5
## - LotConfig       1   0.08573 15.632 -6335.1
## - Foundation      5   0.17402 15.720 -6334.9
## - Functional      1   0.09975 15.646 -6333.8
## - HeatingQC       4   0.18214 15.728 -6332.2
## - MiscVal         1   0.11910 15.665 -6332.0
## - CentralAir      1   0.12285 15.669 -6331.7
## - BldgType        3   0.17931 15.725 -6330.4
## - SaleType        3   0.19416 15.740 -6329.1
## - WoodDeckSF      1   0.16037 15.707 -6328.2
## - YearBuilt       1   0.16715 15.713 -6327.6
## - KitchenQual     3   0.21259 15.759 -6327.4
## - MSSubClass      3   0.21762 15.764 -6326.9
## - BsmtExposure    4   0.24304 15.789 -6326.6
## - HalfBath        1   0.18564 15.732 -6325.9
## - YearRemodAdd    1   0.19764 15.744 -6324.7
## - FullBath        1   0.20082 15.747 -6324.4
## - Exterior1st     7   0.34461 15.891 -6323.2
## - ScreenPorch     1   0.24741 15.793 -6320.2
## - Condition1      3   0.29748 15.844 -6319.6
## - Fireplaces      1   0.27002 15.816 -6318.1
## - HouseStyle      3   0.35466 15.901 -6314.3
## - SaleCondition   5   0.46151 16.008 -6308.6
## - LotArea         1   0.44971 15.996 -6301.7
## - TotRmsAbvGrd    1   0.48803 16.034 -6298.2
## - GarageArea      1   0.60187 16.148 -6287.9
## - BsmtFinSF2      1   0.69884 16.245 -6279.2
## - Neighborhood   15   1.18486 16.731 -6264.4
## - OverallCond     1   1.09341 16.640 -6244.3
## - MSZoning        3   1.35614 16.902 -6225.6
## - SectFlrSF       1   1.45186 16.998 -6213.4
## - OverallQual     1   1.91999 17.466 -6173.9
## - BsmtUnfSF       1   2.59350 18.140 -6118.9
## - BsmtFinSF1      1   3.04026 18.586 -6083.6
##
## Step:  AIC=-6342.79
```

```
## log(SalePrice) ~ MSSubClass + MSZoning + LotArea + Street + Alley +
##      LotShape + LotConfig + LandSlope + Neighborhood + Condition1 +
##      BldgType + HouseStyle + OverallQual + OverallCond + YearBuilt +
##      YearRemodAdd + Exterior1st + MasVnrType + ExterCond + Foundation +
##      BsmtQual + BsmtExposure + BsmtFinType1 + BsmtFinSF1 + BsmtFinType2 +
##      BsmtFinSF2 + BsmtUnfSF + Heating + HeatingQC + CentralAir +
##      SectFlrSF + LowQualFinSF + BsmtFullBath + FullBath + HalfBath +
##      BedroomAbvGr + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +
##      Functional + Fireplaces + GarageArea + GarageQual + GarageCond +
##      WoodDeckSF + OpenPorchSF + EnclosedPorch + ThirdSsnPorch +
##      ScreenPorch + MiscVal + YrSold + SaleType + SaleCondition
##
##                   Df Sum of Sq    RSS     AIC
## - BsmtFinType1     5   0.08886 15.638 -6344.5
## - LotShape         1   0.00507 15.555 -6344.3
## - Alley            2   0.02656 15.576 -6344.3
## - BedroomAbvGr     1   0.01317 15.563 -6343.6
## - OpenPorchSF      1   0.01611 15.566 -6343.3
## <none>                         15.549 -6342.8
## - YrSold           1   0.02555 15.575 -6342.4
## - GarageQual       2   0.04830 15.598 -6342.3
## - Street           1   0.03296 15.582 -6341.7
## - GarageCond       2   0.05452 15.604 -6341.7
## - MasVnrType       4   0.09760 15.647 -6341.7
## - BsmtQual         3   0.08756 15.637 -6340.6
## - Heating          2   0.06795 15.617 -6340.5
## - ThirdSsnPorch    1   0.04683 15.596 -6340.4
## - LandSlope        2   0.07260 15.622 -6340.0
## - BsmtFinType2     6   0.16161 15.711 -6339.8
## - EnclosedPorch    1   0.05610 15.605 -6339.6
## - BsmtFullBath     1   0.06030 15.610 -6339.2
## - KitchenAbvGr     1   0.06185 15.611 -6339.0
## - ExterCond        3   0.11696 15.666 -6337.9
## - LowQualFinSF     1   0.08063 15.630 -6337.3
## - LotConfig        1   0.08503 15.634 -6336.9
## - Foundation       5   0.17260 15.722 -6336.7
## - Functional       1   0.09967 15.649 -6335.5
## - HeatingQC        4   0.18064 15.730 -6334.0
## - MiscVal          1   0.11757 15.667 -6333.8
## - CentralAir       1   0.12331 15.673 -6333.3
## - BldgType         3   0.17828 15.728 -6332.2
## - SaleType         3   0.19597 15.745 -6330.6
## - WoodDeckSF       1   0.16191 15.711 -6329.7
## - YearBuilt        1   0.16682 15.716 -6329.3
## - KitchenQual      3   0.21284 15.762 -6329.0
## - MSSubClass       3   0.22043 15.770 -6328.3
## - BsmtExposure     4   0.24228 15.792 -6328.3
## - HalfBath         1   0.18448 15.734 -6327.6
## - YearRemodAdd     1   0.19854 15.748 -6326.4
## - FullBath         1   0.20190 15.751 -6326.0
## - Exterior1st      7   0.34514 15.895 -6324.9
## - ScreenPorch      1   0.24741 15.797 -6321.8
## - Condition1       3   0.30239 15.852 -6320.8
## - Fireplaces       1   0.27128 15.821 -6319.7
```

```
## - HouseStyle      3    0.35813 15.908 -6315.7
## - SaleCondition   5    0.46229 16.012 -6310.2
## - LotArea         1    0.44865 15.998 -6303.5
## - TotRmsAbvGrd    1    0.48480 16.034 -6300.2
## - GarageArea      1    0.60076 16.150 -6289.7
## - BsmtFinSF2      1    0.69757 16.247 -6281.0
## - Neighborhood   15    1.19132 16.741 -6265.5
## - OverallCond     1    1.09036 16.640 -6246.3
## - MSZoning        3    1.35288 16.902 -6227.6
## - SectFlrSF       1    1.45385 17.003 -6214.9
## - OverallQual     1    1.94757 17.497 -6173.3
## - BsmtUnfSF       1    2.59019 18.140 -6120.9
## - BsmtFinSF1      1    3.03777 18.587 -6085.5
##
## Step:  AIC=-6344.51
## log(SalePrice) ~ MSSubClass + MSZoning + LotArea + Street + Alley +
##     LotShape + LotConfig + LandSlope + Neighborhood + Condition1 +
##     BldgType + HouseStyle + OverallQual + OverallCond + YearBuilt +
##     YearRemodAdd + Exterior1st + MasVnrType + ExterCond + Foundation +
##     BsmtQual + BsmtExposure + BsmtFinSF1 + BsmtFinType2 + BsmtFinSF2 +
##     BsmtUnfSF + Heating + HeatingQC + CentralAir + SectFlrSF +
##     LowQualFinSF + BsmtFullBath + FullBath + HalfBath + BedroomAbvGr +
##     KitchenAbvGr + KitchenQual + TotRmsAbvGrd + Functional +
##     Fireplaces + GarageArea + GarageQual + GarageCond + WoodDeckSF +
##     OpenPorchSF + EnclosedPorch + ThirdSsnPorch + ScreenPorch +
##     MiscVal + YrSold + SaleType + SaleCondition
##
##                 Df Sum of Sq    RSS     AIC
## - Alley          2    0.0209 15.659 -6346.6
## - LotShape       1    0.0059 15.644 -6346.0
## - BedroomAbvGr   1    0.0149 15.653 -6345.1
## - OpenPorchSF    1    0.0193 15.658 -6344.7
## - YrSold         1    0.0207 15.659 -6344.6
## <none>                       15.638 -6344.5
## - GarageQual     2    0.0494 15.688 -6343.9
## - MasVnrType     4    0.0981 15.736 -6343.4
## - GarageCond     2    0.0549 15.693 -6343.4
## - Street         1    0.0367 15.675 -6343.1
## - BsmtFinType2   6    0.1456 15.784 -6343.0
## - Heating        2    0.0700 15.708 -6342.0
## - LandSlope      2    0.0737 15.712 -6341.7
## - ThirdSsnPorch  1    0.0523 15.691 -6341.7
## - EnclosedPorch  1    0.0552 15.694 -6341.4
## - KitchenAbvGr   1    0.0644 15.703 -6340.5
## - ExterCond      3    0.1131 15.751 -6340.0
## - LotConfig      1    0.0800 15.718 -6339.1
## - LowQualFinSF   1    0.0816 15.720 -6338.9
## - Foundation     5    0.1833 15.822 -6337.6
## - BsmtFullBath   1    0.0988 15.737 -6337.4
## - MiscVal        1    0.1074 15.746 -6336.6
## - Functional     1    0.1128 15.751 -6336.1
## - CentralAir     1    0.1160 15.754 -6335.8
## - HeatingQC      4    0.1835 15.822 -6335.6
## - BldgType       3    0.1729 15.811 -6334.5
```

110

```
## - BsmtQual       4     0.2055 15.844 -6333.5
## - SaleType       3     0.1872 15.825 -6333.2
## - WoodDeckSF     1     0.1547 15.793 -6332.2
## - HalfBath       1     0.1700 15.808 -6330.8
## - KitchenQual    3     0.2165 15.855 -6330.5
## - MSSubClass     3     0.2185 15.857 -6330.3
## - BsmtExposure   4     0.2538 15.892 -6329.1
## - YearBuilt      1     0.1925 15.831 -6328.7
## - FullBath       1     0.2007 15.839 -6328.0
## - YearRemodAdd   1     0.2070 15.845 -6327.4
## - Exterior1st    7     0.3478 15.986 -6326.5
## - ScreenPorch    1     0.2400 15.878 -6324.4
## - Condition1     3     0.3074 15.946 -6322.2
## - Fireplaces     1     0.2702 15.909 -6321.6
## - HouseStyle     3     0.3562 15.994 -6317.8
## - SaleCondition  5     0.4683 16.107 -6311.6
## - LotArea        1     0.4459 16.084 -6305.7
## - TotRmsAbvGrd   1     0.4954 16.134 -6301.2
## - GarageArea     1     0.5985 16.237 -6291.9
## - BsmtFinSF2     1     0.6758 16.314 -6285.0
## - Neighborhood  15     1.1934 16.832 -6267.6
## - OverallCond    1     1.1303 16.768 -6245.1
## - MSZoning       3     1.3725 17.011 -6228.3
## - SectFlrSF      1     1.4445 17.083 -6218.1
## - OverallQual    1     2.0067 17.645 -6171.1
## - BsmtUnfSF      1     2.5288 18.167 -6128.7
## - BsmtFinSF1     1     3.7830 19.421 -6031.7
##
## Step:  AIC=-6346.56
## log(SalePrice) ~ MSSubClass + MSZoning + LotArea + Street + LotShape +
##     LotConfig + LandSlope + Neighborhood + Condition1 + BldgType +
##     HouseStyle + OverallQual + OverallCond + YearBuilt + YearRemodAdd +
##     Exterior1st + MasVnrType + ExterCond + Foundation + BsmtQual +
##     BsmtExposure + BsmtFinSF1 + BsmtFinType2 + BsmtFinSF2 + BsmtUnfSF +
##     Heating + HeatingQC + CentralAir + SectFlrSF + LowQualFinSF +
##     BsmtFullBath + FullBath + HalfBath + BedroomAbvGr + KitchenAbvGr +
##     KitchenQual + TotRmsAbvGrd + Functional + Fireplaces + GarageArea +
##     GarageQual + GarageCond + WoodDeckSF + OpenPorchSF + EnclosedPorch +
##     ThirdSsnPorch + ScreenPorch + MiscVal + YrSold + SaleType +
##     SaleCondition
##
##                 Df Sum of Sq    RSS     AIC
## - LotShape       1     0.0069 15.666 -6347.9
## - BedroomAbvGr   1     0.0125 15.672 -6347.4
## - OpenPorchSF    1     0.0210 15.680 -6346.6
## - YrSold         1     0.0211 15.680 -6346.6
## <none>                        15.659 -6346.6
## - GarageCond     2     0.0505 15.710 -6345.9
## - GarageQual     2     0.0536 15.713 -6345.6
## - MasVnrType     4     0.0991 15.758 -6345.4
## - BsmtFinType2   6     0.1454 15.805 -6345.1
## - Street         1     0.0380 15.697 -6345.0
## - Heating        2     0.0689 15.728 -6344.2
## - ThirdSsnPorch  1     0.0519 15.711 -6343.8
```

```
## - LandSlope       2    0.0754 15.735 -6343.6
## - EnclosedPorch   1    0.0595 15.719 -6343.0
## - KitchenAbvGr    1    0.0706 15.730 -6342.0
## - ExterCond       3    0.1142 15.774 -6342.0
## - LotConfig       1    0.0765 15.736 -6341.5
## - LowQualFinSF    1    0.0814 15.741 -6341.0
## - BsmtFullBath    1    0.1001 15.759 -6339.3
## - Foundation      5    0.1913 15.851 -6338.9
## - MiscVal         1    0.1072 15.766 -6338.7
## - CentralAir      1    0.1117 15.771 -6338.2
## - Functional      1    0.1117 15.771 -6338.2
## - HeatingQC       4    0.1867 15.846 -6337.3
## - BldgType        3    0.1743 15.834 -6336.5
## - BsmtQual        4    0.2037 15.863 -6335.8
## - SaleType        3    0.1840 15.843 -6335.6
## - WoodDeckSF      1    0.1514 15.811 -6334.6
## - HalfBath        1    0.1700 15.829 -6332.9
## - KitchenQual     3    0.2188 15.878 -6332.4
## - MSSubClass      3    0.2189 15.878 -6332.4
## - YearBuilt       1    0.1816 15.841 -6331.8
## - BsmtExposure    4    0.2561 15.915 -6331.0
## - FullBath        1    0.1985 15.858 -6330.3
## - YearRemodAdd    1    0.2168 15.876 -6328.6
## - Exterior1st     7    0.3592 16.018 -6327.6
## - ScreenPorch     1    0.2398 15.899 -6326.5
## - Fireplaces      1    0.2681 15.927 -6323.9
## - Condition1      3    0.3140 15.973 -6323.7
## - HouseStyle      3    0.3572 16.017 -6319.8
## - SaleCondition   5    0.4602 16.119 -6314.5
## - LotArea         1    0.4473 16.107 -6307.6
## - TotRmsAbvGrd    1    0.4890 16.148 -6303.9
## - GarageArea      1    0.6008 16.260 -6293.9
## - BsmtFinSF2      1    0.6784 16.338 -6286.9
## - Neighborhood   15    1.1904 16.850 -6270.1
## - OverallCond     1    1.1299 16.789 -6247.3
## - MSZoning        3    1.3773 17.037 -6230.1
## - SectFlrSF       1    1.4764 17.136 -6217.6
## - OverallQual     1    2.0137 17.673 -6172.8
## - BsmtUnfSF       1    2.5435 18.203 -6129.9
## - BsmtFinSF1      1    3.7989 19.458 -6033.0
##
## Step:  AIC=-6347.92
## log(SalePrice) ~ MSSubClass + MSZoning + LotArea + Street + LotConfig +
##     LandSlope + Neighborhood + Condition1 + BldgType + HouseStyle +
##     OverallQual + OverallCond + YearBuilt + YearRemodAdd + Exterior1st +
##     MasVnrType + ExterCond + Foundation + BsmtQual + BsmtExposure +
##     BsmtFinSF1 + BsmtFinType2 + BsmtFinSF2 + BsmtUnfSF + Heating +
##     HeatingQC + CentralAir + SectFlrSF + LowQualFinSF + BsmtFullBath +
##     FullBath + HalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual +
##     TotRmsAbvGrd + Functional + Fireplaces + GarageArea + GarageQual +
##     GarageCond + WoodDeckSF + OpenPorchSF + EnclosedPorch + ThirdSsnPorch +
##     ScreenPorch + MiscVal + YrSold + SaleType + SaleCondition
##
##                    Df Sum of Sq     RSS      AIC
```

```
## - BedroomAbvGr    1     0.0125 15.679 -6348.8
## - OpenPorchSF     1     0.0211 15.687 -6348.0
## <none>                         15.666 -6347.9
## - YrSold          1     0.0220 15.688 -6347.9
## - GarageCond      2     0.0507 15.717 -6347.2
## - GarageQual      2     0.0550 15.721 -6346.8
## - BsmtFinType2    6     0.1441 15.810 -6346.6
## - MasVnrType      4     0.1007 15.767 -6346.6
## - Street          1     0.0390 15.705 -6346.3
## - Heating         2     0.0688 15.735 -6345.5
## - ThirdSsnPorch   1     0.0518 15.718 -6345.1
## - LandSlope       2     0.0765 15.743 -6344.8
## - EnclosedPorch   1     0.0596 15.726 -6344.4
## - KitchenAbvGr    1     0.0696 15.736 -6343.5
## - ExterCond       3     0.1136 15.780 -6343.4
## - LowQualFinSF    1     0.0824 15.748 -6342.3
## - LotConfig       1     0.0911 15.757 -6341.5
## - BsmtFullBath    1     0.0983 15.764 -6340.8
## - Foundation      5     0.1888 15.855 -6340.5
## - MiscVal         1     0.1064 15.773 -6340.1
## - CentralAir      1     0.1103 15.776 -6339.7
## - Functional      1     0.1111 15.777 -6339.6
## - HeatingQC       4     0.1864 15.853 -6338.7
## - BldgType        3     0.1763 15.842 -6337.7
## - BsmtQual        4     0.2011 15.867 -6337.4
## - SaleType        3     0.1842 15.850 -6336.9
## - WoodDeckSF      1     0.1548 15.821 -6335.6
## - HalfBath        1     0.1712 15.837 -6334.1
## - KitchenQual     3     0.2204 15.887 -6333.6
## - MSSubClass      3     0.2217 15.888 -6333.5
## - YearBuilt       1     0.1876 15.854 -6332.6
## - BsmtExposure    4     0.2606 15.927 -6331.9
## - FullBath        1     0.1989 15.865 -6331.6
## - YearRemodAdd    1     0.2155 15.882 -6330.1
## - Exterior1st     7     0.3590 16.025 -6329.0
## - ScreenPorch     1     0.2445 15.911 -6327.4
## - Fireplaces      1     0.2686 15.935 -6325.2
## - Condition1      3     0.3135 15.980 -6325.1
## - HouseStyle      3     0.3601 16.026 -6320.9
## - SaleCondition   5     0.4621 16.128 -6315.7
## - LotArea         1     0.4580 16.124 -6308.1
## - TotRmsAbvGrd    1     0.4901 16.156 -6305.2
## - GarageArea      1     0.6013 16.267 -6295.2
## - BsmtFinSF2      1     0.6783 16.344 -6288.3
## - Neighborhood   15     1.2150 16.881 -6269.4
## - OverallCond     1     1.1360 16.802 -6248.2
## - MSZoning        3     1.3878 17.054 -6230.6
## - SectFlrSF       1     1.4767 17.143 -6219.0
## - OverallQual     1     2.0093 17.675 -6174.6
## - BsmtUnfSF       1     2.5441 18.210 -6131.3
## - BsmtFinSF1      1     3.8054 19.472 -6034.0
##
## Step:  AIC=-6348.76
## log(SalePrice) ~ MSSubClass + MSZoning + LotArea + Street + LotConfig +
```

```
##      LandSlope + Neighborhood + Condition1 + BldgType + HouseStyle +
##      OverallQual + OverallCond + YearBuilt + YearRemodAdd + Exterior1st +
##      MasVnrType + ExterCond + Foundation + BsmtQual + BsmtExposure +
##      BsmtFinSF1 + BsmtFinType2 + BsmtFinSF2 + BsmtUnfSF + Heating +
##      HeatingQC + CentralAir + SectFlrSF + LowQualFinSF + BsmtFullBath +
##      FullBath + HalfBath + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +
##      Functional + Fireplaces + GarageArea + GarageQual + GarageCond +
##      WoodDeckSF + OpenPorchSF + EnclosedPorch + ThirdSsnPorch +
##      ScreenPorch + MiscVal + YrSold + SaleType + SaleCondition
##
##                   Df Sum of Sq    RSS      AIC
## - OpenPorchSF      1    0.0214 15.700 -6348.8
## <none>                         15.679 -6348.8
## - YrSold           1    0.0216 15.700 -6348.8
## - GarageCond       2    0.0514 15.730 -6348.0
## - MasVnrType       4    0.1003 15.779 -6347.5
## - GarageQual       2    0.0572 15.736 -6347.5
## - BsmtFinType2     6    0.1469 15.826 -6347.2
## - Street           1    0.0393 15.718 -6347.1
## - Heating          2    0.0641 15.743 -6346.8
## - ThirdSsnPorch    1    0.0528 15.732 -6345.9
## - LandSlope        2    0.0753 15.754 -6345.8
## - EnclosedPorch    1    0.0580 15.737 -6345.4
## - KitchenAbvGr     1    0.0634 15.742 -6344.9
## - ExterCond        3    0.1161 15.795 -6344.0
## - LowQualFinSF     1    0.0817 15.760 -6343.2
## - LotConfig        1    0.0904 15.769 -6342.4
## - BsmtFullBath     1    0.0994 15.778 -6341.6
## - Foundation       5    0.1888 15.867 -6341.4
## - MiscVal          1    0.1034 15.782 -6341.2
## - CentralAir       1    0.1071 15.786 -6340.9
## - Functional       1    0.1107 15.789 -6340.5
## - HeatingQC        4    0.1918 15.870 -6339.1
## - BldgType         3    0.1701 15.849 -6339.1
## - SaleType         3    0.1838 15.863 -6337.8
## - BsmtQual         4    0.2103 15.889 -6337.4
## - WoodDeckSF       1    0.1570 15.836 -6336.3
## - MSSubClass       3    0.2143 15.893 -6335.0
## - HalfBath         1    0.1735 15.852 -6334.8
## - YearBuilt        1    0.1865 15.865 -6333.6
## - FullBath         1    0.1888 15.867 -6333.4
## - KitchenQual      3    0.2335 15.912 -6333.3
## - BsmtExposure     4    0.2631 15.942 -6332.6
## - YearRemodAdd     1    0.2246 15.903 -6330.1
## - Exterior1st      7    0.3683 16.047 -6329.0
## - ScreenPorch      1    0.2419 15.921 -6328.5
## - Condition1       3    0.3205 15.999 -6325.4
## - Fireplaces       1    0.2775 15.956 -6325.3
## - HouseStyle       3    0.3602 16.039 -6321.8
## - SaleCondition    5    0.4664 16.145 -6316.2
## - LotArea          1    0.4586 16.137 -6308.9
## - TotRmsAbvGrd     1    0.5255 16.204 -6302.9
## - GarageArea       1    0.6214 16.300 -6294.3
## - BsmtFinSF2       1    0.6784 16.357 -6289.2
```

```
## - Neighborhood  15    1.2334 16.912 -6268.7
## - OverallCond    1    1.1305 16.809 -6249.6
## - MSZoning       3    1.3788 17.058 -6232.3
## - SectFlrSF      1    1.4702 17.149 -6220.5
## - OverallQual    1    2.0357 17.714 -6173.4
## - BsmtUnfSF      1    2.5317 18.210 -6133.3
## - BsmtFinSF1     1    3.8020 19.481 -6035.3
##
## Step:  AIC=-6348.77
## log(SalePrice) ~ MSSubClass + MSZoning + LotArea + Street + LotConfig +
##      LandSlope + Neighborhood + Condition1 + BldgType + HouseStyle +
##      OverallQual + OverallCond + YearBuilt + YearRemodAdd + Exterior1st +
##      MasVnrType + ExterCond + Foundation + BsmtQual + BsmtExposure +
##      BsmtFinSF1 + BsmtFinType2 + BsmtFinSF2 + BsmtUnfSF + Heating +
##      HeatingQC + CentralAir + SectFlrSF + LowQualFinSF + BsmtFullBath +
##      FullBath + HalfBath + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +
##      Functional + Fireplaces + GarageArea + GarageQual + GarageCond +
##      WoodDeckSF + EnclosedPorch + ThirdSsnPorch + ScreenPorch +
##      MiscVal + YrSold + SaleType + SaleCondition
##
##                 Df Sum of Sq    RSS     AIC
## <none>                       15.700 -6348.8
## - YrSold         1    0.0250 15.725 -6348.5
## - GarageCond     2    0.0538 15.754 -6347.8
## - MasVnrType     4    0.0985 15.799 -6347.7
## - GarageQual     2    0.0587 15.759 -6347.3
## - Street         1    0.0378 15.738 -6347.3
## - Heating        2    0.0668 15.767 -6346.6
## - BsmtFinType2   6    0.1551 15.855 -6346.5
## - ThirdSsnPorch  1    0.0516 15.752 -6346.0
## - EnclosedPorch  1    0.0529 15.753 -6345.9
## - LandSlope      2    0.0780 15.778 -6345.6
## - KitchenAbvGr   1    0.0650 15.765 -6344.8
## - ExterCond      3    0.1140 15.814 -6344.3
## - LowQualFinSF   1    0.0821 15.782 -6343.2
## - LotConfig      1    0.0947 15.795 -6342.0
## - CentralAir     1    0.1027 15.803 -6341.3
## - MiscVal        1    0.1034 15.803 -6341.2
## - BsmtFullBath   1    0.1067 15.807 -6340.9
## - Foundation     5    0.1970 15.897 -6340.7
## - Functional     1    0.1107 15.811 -6340.6
## - HeatingQC      4    0.1922 15.892 -6339.1
## - BldgType       3    0.1767 15.877 -6338.5
## - SaleType       3    0.1801 15.880 -6338.2
## - WoodDeckSF     1    0.1493 15.849 -6337.0
## - BsmtQual       4    0.2205 15.921 -6336.5
## - MSSubClass     3    0.2171 15.917 -6334.8
## - YearBuilt      1    0.1827 15.883 -6334.0
## - HalfBath       1    0.1855 15.886 -6333.7
## - KitchenQual    3    0.2309 15.931 -6333.6
## - FullBath       1    0.1949 15.895 -6332.8
## - BsmtExposure   4    0.2634 15.963 -6332.6
## - YearRemodAdd   1    0.2240 15.924 -6330.2
## - Exterior1st    7    0.3582 16.058 -6330.0
```

```
## - ScreenPorch     1    0.2460 15.946 -6328.2
## - Condition1      3    0.3197 16.020 -6325.5
## - Fireplaces      1    0.2854 15.986 -6324.6
## - HouseStyle      3    0.3581 16.058 -6322.0
## - SaleCondition   5    0.4622 16.162 -6316.6
## - LotArea         1    0.4619 16.162 -6308.6
## - TotRmsAbvGrd    1    0.5235 16.224 -6303.1
## - GarageArea      1    0.6243 16.324 -6294.1
## - BsmtFinSF2      1    0.6957 16.396 -6287.8
## - Neighborhood   15    1.2183 16.918 -6270.2
## - OverallCond     1    1.1459 16.846 -6248.4
## - MSZoning        3    1.3653 17.065 -6233.6
## - SectFlrSF       1    1.4744 17.174 -6220.4
## - OverallQual     1    2.0293 17.729 -6174.2
## - BsmtUnfSF       1    2.6363 18.336 -6125.2
## - BsmtFinSF1      1    3.8906 19.591 -6029.1


##
## Call:
## lm(formula = log(SalePrice) ~ MSSubClass + MSZoning + LotArea +
##     Street + LotConfig + LandSlope + Neighborhood + Condition1 +
##     BldgType + HouseStyle + OverallQual + OverallCond + YearBuilt +
##     YearRemodAdd + Exterior1st + MasVnrType + ExterCond + Foundation +
##     BsmtQual + BsmtExposure + BsmtFinSF1 + BsmtFinType2 + BsmtFinSF2 +
##     BsmtUnfSF + Heating + HeatingQC + CentralAir + SectFlrSF +
##     LowQualFinSF + BsmtFullBath + FullBath + HalfBath + KitchenAbvGr +
##     KitchenQual + TotRmsAbvGrd + Functional + Fireplaces + GarageArea +
##     GarageQual + GarageCond + WoodDeckSF + EnclosedPorch + ThirdSsnPorch +
##     ScreenPorch + MiscVal + YrSold + SaleType + SaleCondition,
##     data = train)
##
## Coefficients:
##                               (Intercept)
##                                  1.306e+01
##      MSSubClass1-story single-family other
##                                 -5.315e-02
## MSSubClassmulti-level single-family non PUD
##                                  1.446e-02
##                            MSSubClassother
##                                 -2.419e-02
##                             MSZoningother
##                                 -4.397e-01
##                               MSZoningRL
##                                 -3.242e-02
##                               MSZoningRO
##                                 -9.460e-02
##                                   LotArea
##                                  2.612e-06
##                               StreetPave
##                                  9.095e-02
##                           LotConfigOther
##                                  1.905e-02
##                             LandSlopeMod
##                                  2.841e-02
```

```
##                              LandSlopeSev
##                                -6.502e-02
##                         NeighborhoodCollgCr
##                                -7.392e-02
##                         NeighborhoodCrawfor
##                                 7.644e-02
##                         NeighborhoodEdwards
##                                -1.051e-01
##                         NeighborhoodGilbert
##                                -6.670e-02
##                         NeighborhoodMitchel
##                                -9.711e-02
##                           NeighborhoodNAmes
##                                -7.532e-02
##                         NeighborhoodNoRidge
##                                -1.250e-02
##                         NeighborhoodNridgHt
##                                -2.708e-02
##                          NeighborhoodNWAmes
##                                -7.266e-02
##                         NeighborhoodOldTown
##                                -5.716e-02
##                           NeighborhoodOther
##                                -3.487e-02
##                          NeighborhoodSawyer
##                                -6.233e-02
##                         NeighborhoodSawyerW
##                                -5.395e-02
##                         NeighborhoodSomerst
##                                -3.470e-02
##                          NeighborhoodTimber
##                                -6.922e-02
##                               Condition1Pos
##                                 6.528e-03
##                                Condition1RR
##                                -5.716e-02
##                                Condition1St
##                                -4.798e-02
##                             BldgTypeMultiFam
##                                 3.924e-03
##                                BldgTypeTwnhs
##                                -8.622e-02
##                               BldgTypeTwnhsE
##                                -7.965e-03
##                             HouseStyle2.5Unf
##                                -9.936e-02
##                      HouseStyleEqMore2story
##                                -1.355e-01
##                        HouseStyleLess2story
##                                -4.532e-02
##                                  OverallQual
##                                 5.528e-02
##                                  OverallCond
##                                 3.731e-02
```

```
##                                YearBuilt
##                                1.198e-03
##                             YearRemodAdd
##                                1.063e-03
##                        Exterior1stCemntBd
##                               -9.890e-02
##                        Exterior1stHdBoard
##                               -8.904e-02
##                        Exterior1stMetalSd
##                               -5.921e-02
##                          Exterior1stOther
##                               -6.057e-02
##                        Exterior1stPlywood
##                               -7.777e-02
##                        Exterior1stVinylSd
##                               -6.934e-02
##                        Exterior1stWd Sdng
##                               -8.370e-02
##                        MasVnrTypeBrkFace
##                                4.407e-02
##                        MasVnrTypemissing
##                               -1.358e-03
##                          MasVnrTypeNone
##                                3.314e-02
##                          MasVnrTypeStone
##                                6.446e-02
##                               ExterCondGd
##                                2.163e-02
##                            ExterCondother
##                                8.194e-02
##                               ExterCondTA
##                                4.586e-02
##                          FoundationCBlock
##                                1.901e-02
##                           FoundationPConc
##                                4.240e-02
##                            FoundationSlab
##                                2.415e-02
##                           FoundationStone
##                                1.258e-01
##                            FoundationWood
##                               -6.965e-02
##                                BsmtQualFa
##                               -2.424e-02
##                                BsmtQualGd
##                               -3.397e-02
##                              BsmtQualnone
##                                4.834e-01
##                                BsmtQualTA
##                               -4.527e-02
##                            BsmtExposureGd
##                                5.255e-02
##                            BsmtExposureMn
##                                8.028e-03
```

118

```
##                           BsmtExposureNo
##                              -6.751e-03
##                         BsmtExposurenone
##                              -5.548e-02
##                               BsmtFinSF1
##                               3.116e-04
##                          BsmtFinType2BLQ
##                              -3.136e-02
##                          BsmtFinType2GLQ
##                               3.244e-02
##                          BsmtFinType2LwQ
##                               1.026e-02
##                         BsmtFinType2none
##                              -3.128e-01
##                          BsmtFinType2Rec
##                               1.193e-03
##                          BsmtFinType2Unf
##                               1.326e-02
##                               BsmtFinSF2
##                               2.846e-04
##                                BsmtUnfSF
##                               2.367e-04
##                              HeatingGasW
##                               2.474e-02
##                             HeatingOther
##                              -7.442e-02
##                              HeatingQCFa
##                              -3.361e-02
##                              HeatingQCGd
##                              -2.267e-02
##                              HeatingQCPo
##                              -1.417e-01
##                              HeatingQCTA
##                              -3.544e-02
##                               CentralAirY
##                               4.865e-02
##                                SectFlrSF
##                               2.183e-04
##                              LowQualFinSF
##                               1.695e-04
##                              BsmtFullBath
##                               2.479e-02
##                                 FullBath
##                               3.837e-02
##                                 HalfBath
##                               3.595e-02
##                              KitchenAbvGr
##                              -5.642e-02
##                            KitchenQualFa
##                              -5.807e-02
##                            KitchenQualGd
##                              -6.503e-02
##                            KitchenQualTA
##                              -6.881e-02
```

119

```
##                              TotRmsAbvGrd
##                                 2.301e-02
##                              FunctionalTRUE
##                                 3.899e-02
##                                 Fireplaces
##                                 2.911e-02
##                                 GarageArea
##                                 1.664e-04
##                              GarageQualnone
##                                -6.897e-02
##                                GarageQualPo
##                                -8.174e-02
##                                GarageQualTA
##                                -5.030e-02
##                              GarageCondnone
##                                         NA
##                                GarageCondPo
##                                 1.008e-03
##                                GarageCondTA
##                                 4.223e-02
##                                 WoodDeckSF
##                                 9.418e-05
##                              EnclosedPorch
##                                 1.170e-04
##                              ThirdSsnPorch
##                                 2.125e-04
##                                ScreenPorch
##                                 2.542e-04
##                                    MiscVal
##                                -3.142e-05
##                                     YrSold
##                                -3.328e-03
##                                SaleTypeNew
##                                 1.186e-01
##                              SaleTypeOther
##                                 4.021e-02
##                                 SaleTypeWD
##                                -2.974e-02
##                        SaleConditionAdjLand
##                                 7.553e-02
##                         SaleConditionAlloca
##                                 7.510e-02
##                         SaleConditionFamily
##                                 3.845e-03
##                         SaleConditionNormal
##                                 7.161e-02
##                        SaleConditionPartial
##                                -2.882e-02
```

Final Model (after AIC)

```
fit_aic = lm(log(SalePrice) ~ MSSubClass + MSZoning + LotArea +
    Street + LotConfig + LandSlope + Neighborhood + Condition1 +
    BldgType + HouseStyle + OverallQual + OverallCond + YearBuilt +
    YearRemodAdd + Exterior1st + MasVnrType + ExterCond + Foundation +
    BsmtQual + BsmtExposure + BsmtFinSF1 + BsmtFinType2 + BsmtFinSF2 +
    BsmtUnfSF + Heating + HeatingQC + CentralAir + SectFlrSF +
    LowQualFinSF + BsmtFullBath + FullBath + HalfBath + KitchenAbvGr +
    KitchenQual + TotRmsAbvGrd + Functional + Fireplaces + GarageArea +
    GarageQual + GarageCond + WoodDeckSF + OpenPorchSF + EnclosedPorch +
    ThirdSsnPorch + ScreenPorch + PoolQC + MiscVal + YrSold +
    SaleType + SaleCondition,
    data = train)
```

Make Predictions

Make predictions for the test data

```
predicted.SalePrice2 = exp(predict(fit_aic, newdata=test))
```

```
## Warning in predict.lm(fit_aic, newdata = test): prediction from a rank-deficient
## fit may be misleading
```

Preparing the dataset with the predicted sale prices for the test data:

```
SubmitDF = data.frame(Id=test$Id, SalePrice=predicted.SalePrice2)
write.csv(file='D:\\Datos\\Documents\\Development\\R\\Advanced Statistics\\Project 1 House Prediction\\(
```

Results

4 - Score: 0.13675 -> Witout PoolArea

2nd Approach: Add Predictors Transformations

## Check whether some Quadratic Terms are Significant

YearBuilt

```
#Linear Fit
linear.model = lm(SalePrice ~ YearBuilt, data = train)
summary(linear.model)
```

```
##
## Call:
## lm(formula = SalePrice ~ YearBuilt, data = train)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
```

```
## -144215   -40965   -15342    22663   542819
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -2.535e+06  1.160e+05  -21.86   <2e-16 ***
## YearBuilt    1.378e+03  5.882e+01   23.42   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 67750 on 1451 degrees of freedom
## Multiple R-squared:  0.2744, Adjusted R-squared:  0.2739
## F-statistic: 548.7 on 1 and 1451 DF,  p-value: < 2.2e-16
```

```r
plot(train$YearBuilt, train$SalePrice)
abline(linear.model, col = "blue")
```
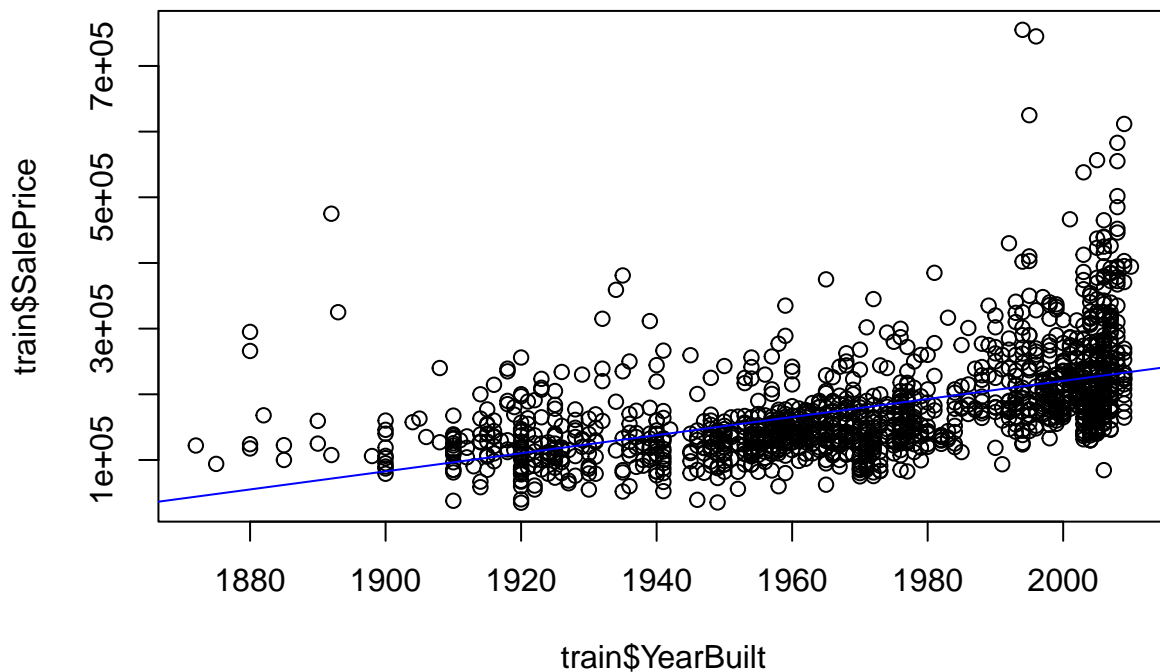


```r
#Quadratic fit
YearBuilt2 <- train$YearBuilt^2
quadratic.model <-lm(data=train, SalePrice ~ YearBuilt + YearBuilt2)
summary(quadratic.model)
```

```
##
## Call:
## lm(formula = SalePrice ~ YearBuilt + YearBuilt2, data = train)
##
```

```
## Residuals:
##     Min      1Q  Median      3Q     Max
## -165042  -38752   -9841   20375  542221
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  8.277e+07  6.527e+06   12.68   <2e-16 ***
## YearBuilt   -8.560e+04  6.654e+03  -12.86   <2e-16 ***
## YearBuilt2   2.217e+01  1.696e+00   13.07   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 64100 on 1450 degrees of freedom
## Multiple R-squared:  0.3509, Adjusted R-squared:   0.35
## F-statistic: 391.9 on 2 and 1450 DF,  p-value: < 2.2e-16
```
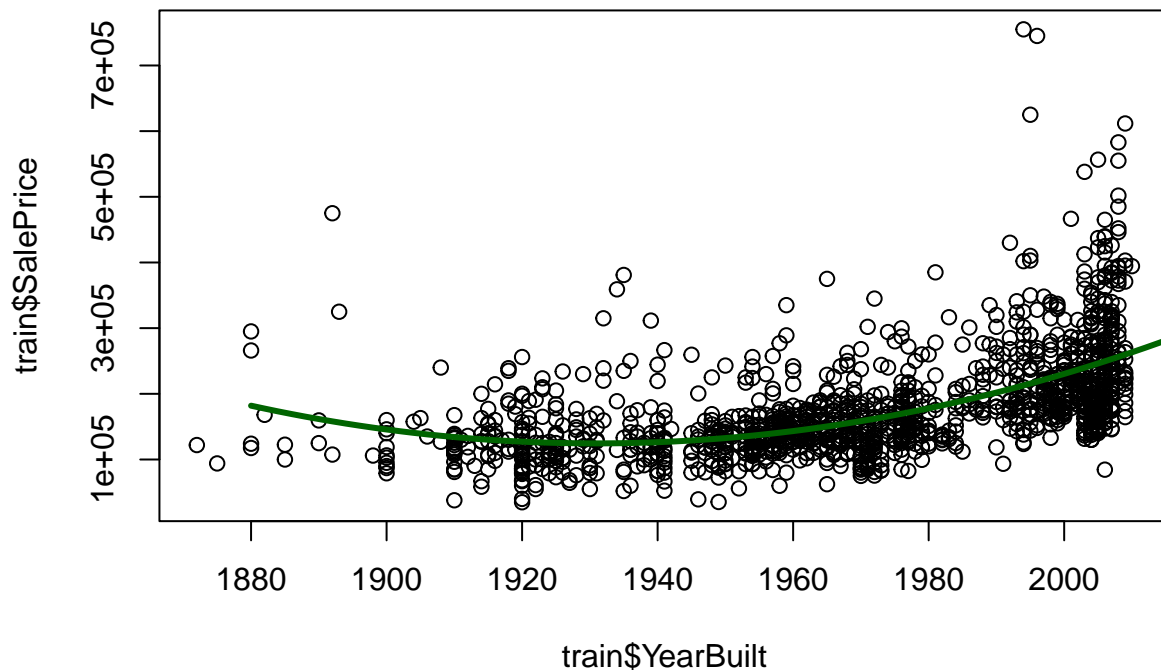
```r
yearvalues <- seq(1880, 2022, 2)

predictedPrices <- predict(quadratic.model,list(YearBuilt=yearvalues, YearBuilt2=yearvalues^2))

plot(train$YearBuilt, train$SalePrice)
abline(quadratic.model, col = "darkgreen")
```

```
## Warning in abline(quadratic.model, col = "darkgreen"): only using the first two
## of 3 regression coefficients
```

```r
lines(yearvalues, predictedPrices, col = "darkgreen", lwd = 3)
```

It looks like a quadratic function follows the trend better and the quadratic term is significant so we will add it in the final model. Let's add this new feature to our datasets

```
train <- train %>% mutate(YearBuilt2 = YearBuilt^2)
test <- test %>% mutate(YearBuilt2 = YearBuilt^2)
```

```
fit_aic = lm(log(SalePrice) ~ MSSubClass + MSZoning + LotArea +
    Street + LotConfig + LandSlope + Neighborhood + Condition1 +
    BldgType + HouseStyle + OverallQual + OverallCond + YearBuilt + YearBuilt2 + #Adding quadratic term
    YearRemodAdd + Exterior1st + MasVnrType + ExterCond + Foundation +
    BsmtQual + BsmtExposure + BsmtFinSF1 + BsmtFinType2 + BsmtFinSF2 +
    BsmtUnfSF + Heating + HeatingQC + CentralAir + SectFlrSF +
    LowQualFinSF + BsmtFullBath + FullBath + HalfBath + KitchenAbvGr +
    KitchenQual + TotRmsAbvGrd + Functional + Fireplaces + GarageArea +
    GarageQual + GarageCond + WoodDeckSF + OpenPorchSF + EnclosedPorch +
    ThirdSsnPorch + ScreenPorch + PoolQC + MiscVal + YrSold +
    SaleType + SaleCondition,
    data = train)

predicted.SalePrice2 = exp(predict(fit_aic, newdata=test))
```

```
## Warning in predict.lm(fit_aic, newdata = test): prediction from a rank-deficient
## fit may be misleading
```

124

```
SubmitDF = data.frame(Id=test$Id, SalePrice=predicted.SalePrice2)
write.csv(file='D:\\Datos\\Documents\\Development\\R\\Advanced Statistics\\Project 1 House Prediction\\
```

Score: 0.13643 (Previous was 0.13675) IMPROVED!

GarageArea

```
#Linear Fit
linear.model = lm(SalePrice ~ GarageArea, data = train)
summary(linear.model)
```

```
##
## Call:
## lm(formula = SalePrice ~ GarageArea, data = train)
##
## Residuals:
##     Min     1Q  Median     3Q     Max
## -282701  -33203   -4873   24329  489372
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 69482.042   3957.496   17.56   <2e-16 ***
## GarageArea    235.752      7.645   30.84   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 61820 on 1451 degrees of freedom
## Multiple R-squared:  0.3959, Adjusted R-squared:  0.3955
## F-statistic:   951 on 1 and 1451 DF,  p-value: < 2.2e-16
```

```
plot(train$GarageArea, train$SalePrice)
abline(linear.model, col = "blue")
```
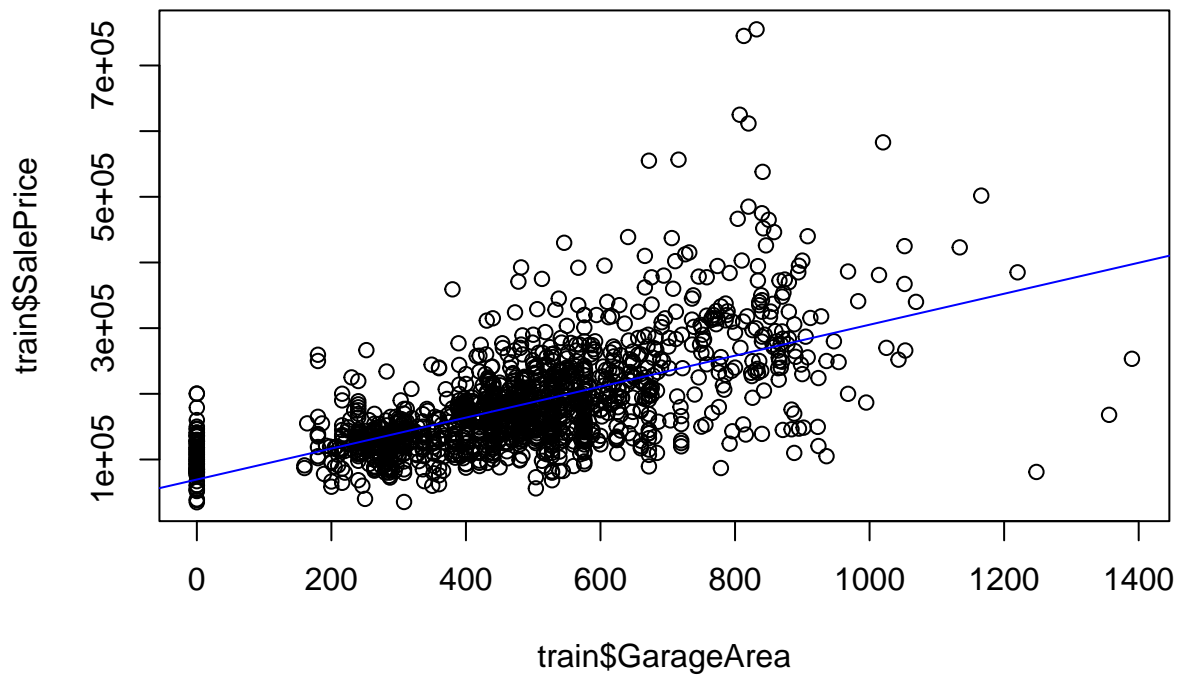
```
#Quadratic fit
GarageArea2 <- train$GarageArea^2
quadratic.model <-lm(data=train, SalePrice ~ GarageArea + GarageArea2)
summary(quadratic.model)
```

```
##
## Call:
## lm(formula = SalePrice ~ GarageArea + GarageArea2, data = train)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -333156  -31982   -4288   24885  482341
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) 8.745e+04  5.700e+03  15.343  < 2e-16 ***
## GarageArea  1.442e+02  2.234e+01   6.458 1.44e-10 ***
## GarageArea2 9.418e-02  2.162e-02   4.357 1.41e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 61440 on 1450 degrees of freedom
## Multiple R-squared:  0.4037, Adjusted R-squared:  0.4029
## F-statistic: 490.9 on 2 and 1450 DF,  p-value: < 2.2e-16
```

```
garagevalues <- seq(0, 1400, 100)

predictedPrices <- predict(quadratic.model,list(GarageArea=garagevalues, GarageArea2=garagevalues^2))

plot(train$GarageArea, train$SalePrice)
abline(quadratic.model, col = "darkgreen")


## Warning in abline(quadratic.model, col = "darkgreen"): only using the first two
## of 3 regression coefficients

lines(garagevalues, predictedPrices, col = "darkgreen", lwd = 3)
```
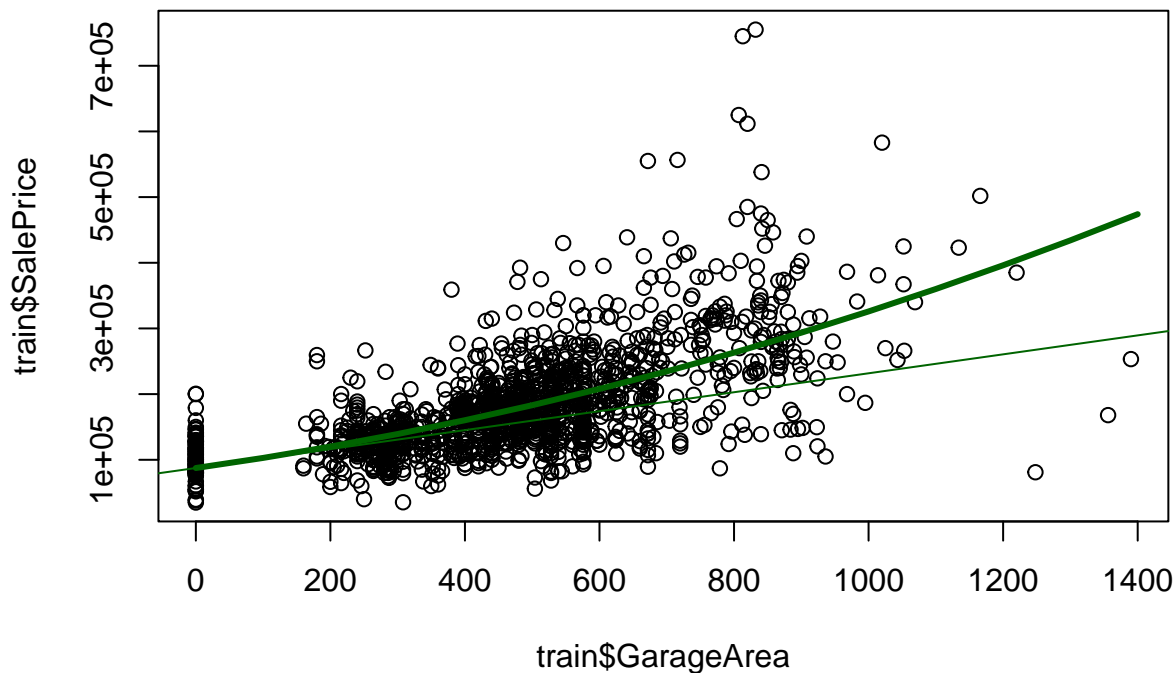

It looks like a quadratic function follows the trend better and the quadratic term is significant so we will add it in the final model. Let's add this new feature to our datasets

```
train <- train %>% mutate(GarageArea2 = GarageArea^2)
test <- test %>% mutate(GarageArea2 = GarageArea^2)


fit_aic = lm(log(SalePrice) ~ MSSubClass + MSZoning + LotArea +
    Street + LotConfig + LandSlope + Neighborhood + Condition1 +
    BldgType + HouseStyle + OverallQual + OverallCond + YearBuilt + YearBuilt2 + #Adding quadratic term
    YearRemodAdd + Exterior1st + MasVnrType + ExterCond + Foundation +
    BsmtQual + BsmtExposure + BsmtFinSF1 + BsmtFinType2 + BsmtFinSF2 +
    BsmtUnfSF + Heating + HeatingQC + CentralAir + SectFlrSF +
    LowQualFinSF + BsmtFullBath + FullBath + HalfBath + KitchenAbvGr +
```

```
    KitchenQual + TotRmsAbvGrd + Functional + Fireplaces + GarageArea + GarageArea2 +  #Adding quadrati
    GarageQual + GarageCond + WoodDeckSF + OpenPorchSF + EnclosedPorch +
    ThirdSsnPorch + ScreenPorch + PoolQC + MiscVal + YrSold +
    SaleType + SaleCondition,
    data = train)

predicted.SalePrice2 = exp(predict(fit_aic, newdata=test))
```

```
## Warning in predict.lm(fit_aic, newdata = test): prediction from a rank-deficient
## fit may be misleading
```

```
SubmitDF = data.frame(Id=test$Id, SalePrice=predicted.SalePrice2)
write.csv(file='D:\\Datos\\Documents\\Development\\R\\Advanced Statistics\\Project 1 House Prediction\\
```

Score: 0.13638 (Previous was 0.13643) IMPROVED! – BEST BY NOW

SectFlrSF

```
#Linear Fit
linear.model = lm(SalePrice ~ SectFlrSF, data = train)
summary(linear.model)
```

```
##
## Call:
## lm(formula = SalePrice ~ SectFlrSF, data = train)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -159600  -45691  -17691   27079  485270
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) 1.607e+05  2.524e+03   63.66   <2e-16 ***
## SectFlrSF   5.825e+01  4.543e+00   12.82   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 75380 on 1451 degrees of freedom
## Multiple R-squared:  0.1018, Adjusted R-squared:  0.1011
## F-statistic: 164.4 on 1 and 1451 DF,  p-value: < 2.2e-16
```

```
plot(train$SectFlrSF, train$SalePrice)
abline(linear.model, col = "blue")
```
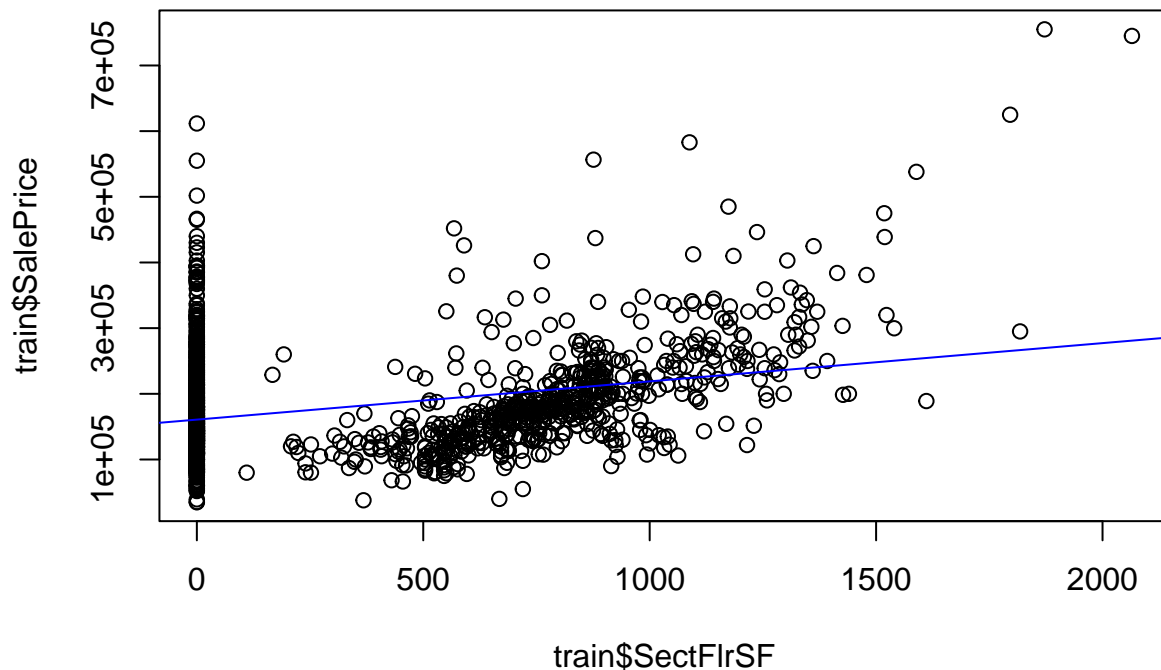
```
#Quadratic fit
SectFlrSF2 <- train$SectFlrSF^2
quadratic.model <-lm(data=train, SalePrice ~ SectFlrSF + SectFlrSF2)
summary(quadratic.model)
```

```
##
## Call:
## lm(formula = SalePrice ~ SectFlrSF + SectFlrSF2, data = train)
##
## Residuals:
##     Min     1Q  Median     3Q    Max
## -244592  -40918  -12418   23582  441239
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  1.704e+05  2.367e+03   72.00   <2e-16 ***
## SectFlrSF   -1.361e+02  1.198e+01  -11.37   <2e-16 ***
## SectFlrSF2   1.859e-01  1.075e-02   17.30   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 68660 on 1450 degrees of freedom
## Multiple R-squared:  0.2554, Adjusted R-squared:  0.2544
## F-statistic: 248.7 on 2 and 1450 DF,  p-value: < 2.2e-16
```
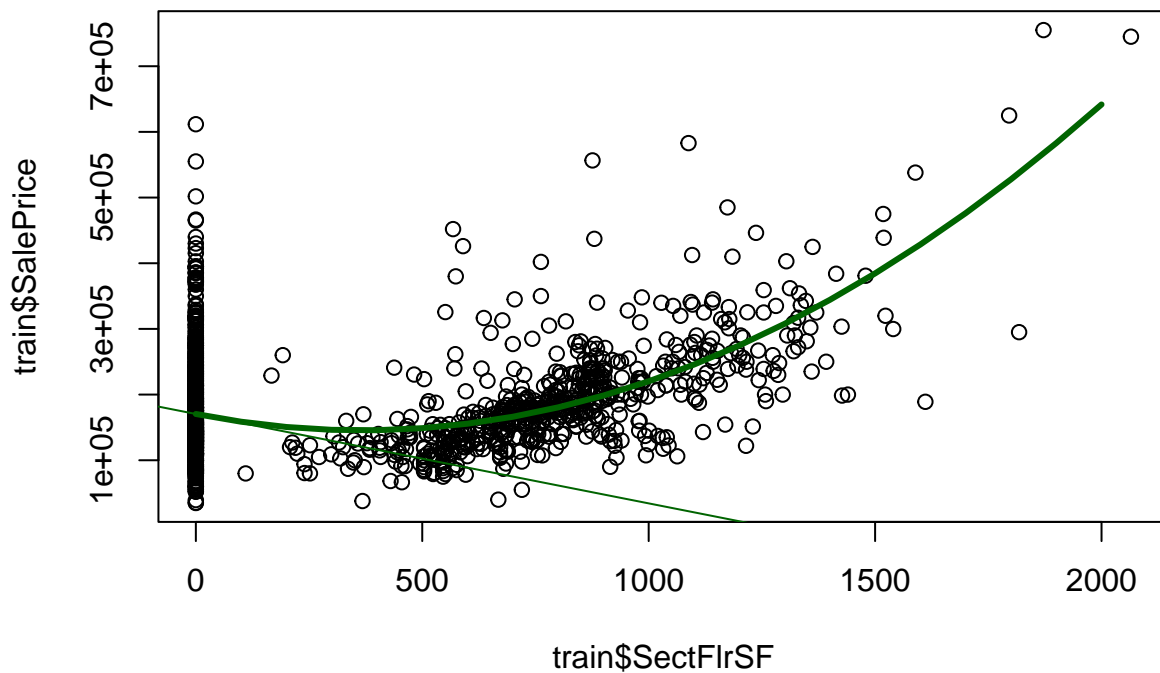
```
values <- seq(0, 2000, 100)

predictedPrices <- predict(quadratic.model,list(SectFlrSF=values, SectFlrSF2=values^2))

plot(train$SectFlrSF, train$SalePrice)
abline(quadratic.model, col = "darkgreen")


## Warning in abline(quadratic.model, col = "darkgreen"): only using the first two
## of 3 regression coefficients

lines(values, predictedPrices, col = "darkgreen", lwd = 3)
```


It looks like a quadratic function follows the trend better and the quadratic term is significant so we will add it in the final model. Let's add this new feature to our datasets

```
train <- train %>% mutate(SectFlrSF2 = SectFlrSF^2)
test <- test %>% mutate(SectFlrSF2 = SectFlrSF^2)


fit_aic = lm(log(SalePrice) ~ MSSubClass + MSZoning + LotArea +
    Street + LotConfig + LandSlope + Neighborhood + Condition1 +
    BldgType + HouseStyle + OverallQual + OverallCond + YearBuilt + YearBuilt2 + #Adding quadratic term
    YearRemodAdd + Exterior1st + MasVnrType + ExterCond + Foundation +
    BsmtQual + BsmtExposure + BsmtFinSF1 + BsmtFinType2 + BsmtFinSF2 +
    BsmtUnfSF + Heating + HeatingQC + CentralAir + SectFlrSF + SectFlrSF2 + #Adding quadratic term Sect
    LowQualFinSF + BsmtFullBath + FullBath + HalfBath + KitchenAbvGr +
```

```
    KitchenQual + TotRmsAbvGrd + Functional + Fireplaces + GarageArea + GarageArea2 +  #Adding quadrati
    GarageQual + GarageCond + WoodDeckSF + OpenPorchSF + EnclosedPorch +
    ThirdSsnPorch + ScreenPorch + PoolQC + MiscVal + YrSold +
    SaleType + SaleCondition,
    data = train)

predicted.SalePrice2 = exp(predict(fit_aic, newdata=test))
```

```
## Warning in predict.lm(fit_aic, newdata = test): prediction from a rank-deficient
## fit may be misleading
```

```
SubmitDF = data.frame(Id=test$Id, SalePrice=predicted.SalePrice2)
write.csv(file='D:\\Datos\\Documents\\Development\\R\\Advanced Statistics\\Project 1 House Prediction\\(
```

Score: 0.13661 (Previous was 0.13638) WORSE!