

# STT481 Final Project

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*Note: I put the Kaggle score screenshots in a separate pdf file*

```
# Packages that are used in the project
library(ggplot2)
library(ggpubr)

## Loading required package: magrittr

#library(Rmisc)
library(FNN)
library(caret)

## Loading required package: lattice

library(dplyr)

##
## Attaching package: 'dplyr'

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

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

library(glmnet)

## Loading required package: Matrix

## Loaded glmnet 3.0-2

library(MASS)

##
## Attaching package: 'MASS'

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

library(leaps)
library(pls)

##
## Attaching package: 'pls'
```

```
## The following object is masked from 'package:caret':  
##  
##      R2  
  
## The following object is masked from 'package:stats':  
##  
##      loadings
```

**Below is the bonus part: Preprocessing**

## Introduction to the data and the problem

In this project, it is given 80 characteristics of nearly 1,500 houses that have been sold. Then, it is asking to predict the selling price of the house based on these characteristics. With the 79 explanatory variables describing (almost) every aspect of residential homes in Ames, Iowa, the project requires to predict the final price of each house. Below, there will be more details about how I preprocess the data and give more introduction about the data.

## Explain the raw data

### Importing data

```
train <- read.csv("train.csv")  
test <- read.csv("test.csv")
```

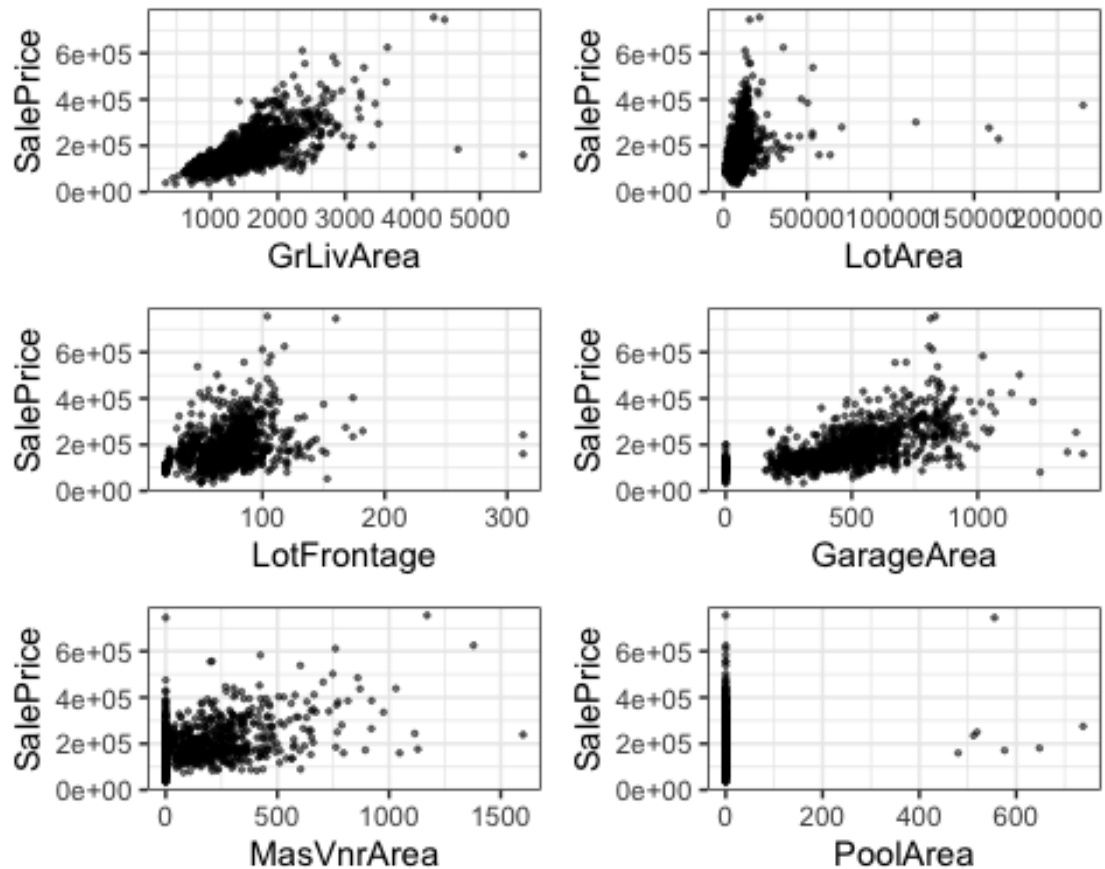
### Observation from the raw data

- Here, a relationship performance graph is created which is shown below. These are the relationship between sales price and all kinds of area. From the plots below, we can see that there are many outliers from the certain boundary. These outliers may be deleted during the data processing. At last, we also can observe that pool area has barely relationship with sales price. So, we can ignore that in our further study.

```
# Observation from graphs  
p1 <- subset(train, !is.na(GrLivArea))  
p2 <- subset(train, !is.na(LotArea))  
p3 <- subset(train, !is.na(LotFrontage))  
p4 <- subset(train, !is.na(GarageArea))  
p5 <- subset(train, !is.na(MasVnrArea))  
p6 <- subset(train, !is.na(PoolArea))  
  
p1 <- ggplot(p1, aes(GrLivArea, SalePrice)) + geom_point(size=0.5,alpha =  
0.5) + theme_bw()  
p2 <- ggplot(p2, aes(LotArea, SalePrice)) + geom_point(size=0.5,alpha = 0.5)  
+ theme_bw()  
p3 <- ggplot(p3, aes(LotFrontage, SalePrice)) + geom_point(size=0.5,alpha =  
0.5) + theme_bw()  
p4 <- ggplot(p4, aes(GarageArea, SalePrice)) + geom_point(size=0.5,alpha =  
0.5) + theme_bw()  
p5 <- ggplot(p5, aes(MasVnrArea, SalePrice)) + geom_point(size=0.5,alpha =  
0.5) + theme_bw()
```

```
p6 <- ggplot(p6, aes(PoolArea, SalePrice)) + geom_point(size=0.5,alpha = 0.5)
+ theme_bw()
```

```
ggarrange(p1, p2, p3, p4, p5, p6, ncol = 2, nrow = 3)
```



## Cleaning data

Below, I will start removing outliers, filling missing values and etc, if any; also, each cleaning process includes a corresponding explanation on how I cleaned it.

### Removing outliers

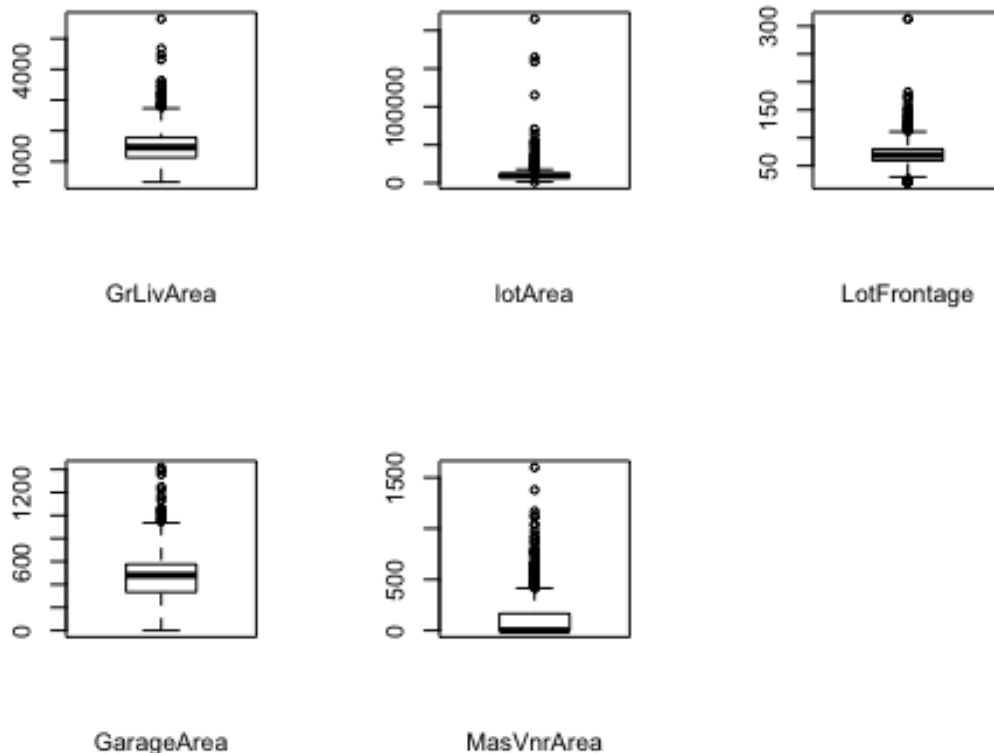
- As it mentioned earlier, there are many outlier existing. So, there are some boxplots are created below for a deeper understanding on what kinds of outliers we are looking at. At this step, I am trying to move the outliers as many as possible. As observed, I defined that when  $GrLivArea < 4000$ ,  $LotArea < 100000$ ,  $LotFrontage < 200$ ,  $GarageArea < 1250$ ,  $MasVnrArea < 1250$ , these are not considered outliers.

```
# plot boxplots for GrLivArea, LotArea, LotFrontage, GarageArea, MasVnrArea
par(mfrow=c(2,3))
boxplot(train$GrLivArea, xlab="GrLivArea")
boxplot(train$LotArea, xlab="LotArea")
boxplot(train$LotFrontage, xlab="LotFrontage")
boxplot(train$GarageArea, xlab="GarageArea")
```

```
boxplot(train$MasVnrArea, xlab="MasVnrArea")
```

```
# remove some outliers
```

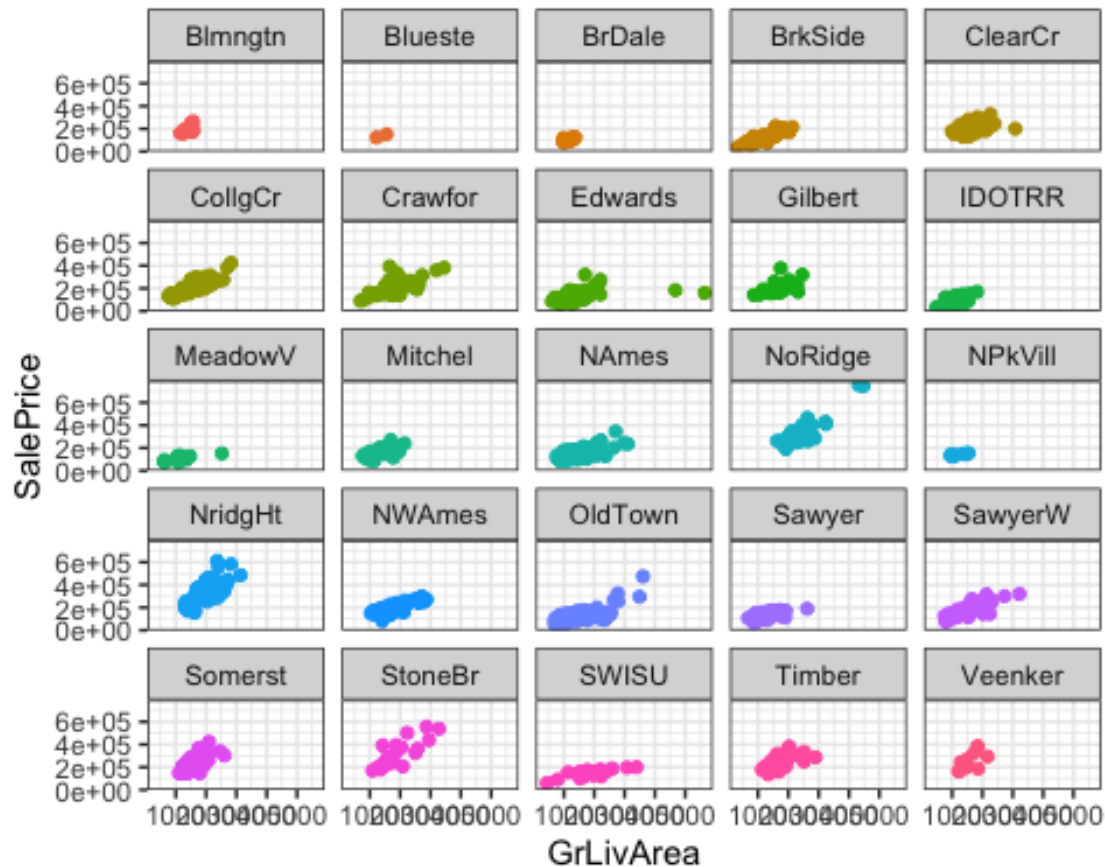
```
training <- subset(train, GrLivArea < 4000 | is.na(GrLivArea))
training <- subset(training, LotArea < 100000 | is.na(LotArea))
training <- subset(training, LotFrontage < 200 | is.na(LotFrontage))
training <- subset(training, GarageArea < 1250 | is.na(GarageArea))
training <- subset(training, MasVnrArea < 1250 | is.na(MasVnrArea))
```



- Using *GrLivArea* as an example, I believed that the area of the house should be one of the important factors that affect the *SalePrice*. Since then, for the graph below, we can classify the area of the house by neighborhood and observe its relationship with the *SalePrice*. As except, it tends to be has the positive correlation with *SalePrice*.

```
# plotting
```

```
ggplot(training, aes(GrLivArea, SalePrice)) + geom_point(aes(color = Neighborhood)) +
  scale_x_continuous("GrLivArea") +
  scale_y_continuous("SalePrice") +
  theme_bw() + facet_wrap( ~ Neighborhood) + theme(legend.position="none")
```



- If we try to combine both training and testing dataset, we will find that there are two types of data: factor and string. Below, it tries to observe how many data are belong to string and factor data.
- Moreover, after dealing with the important predictors (which we think is important features), we are focus on the entire data set. Here, we can realize that in both train and test data set. They both get the missing values and some other fact that may affect our prediction. So, we are combining the test and train together. Since the test doesn't has the column *SalePrice*, so, we just give it a temporary value "NA". Then, we check the type of the predictors.

```
#unique(train$MiscFeature)
#unique(test$MiscFeature)

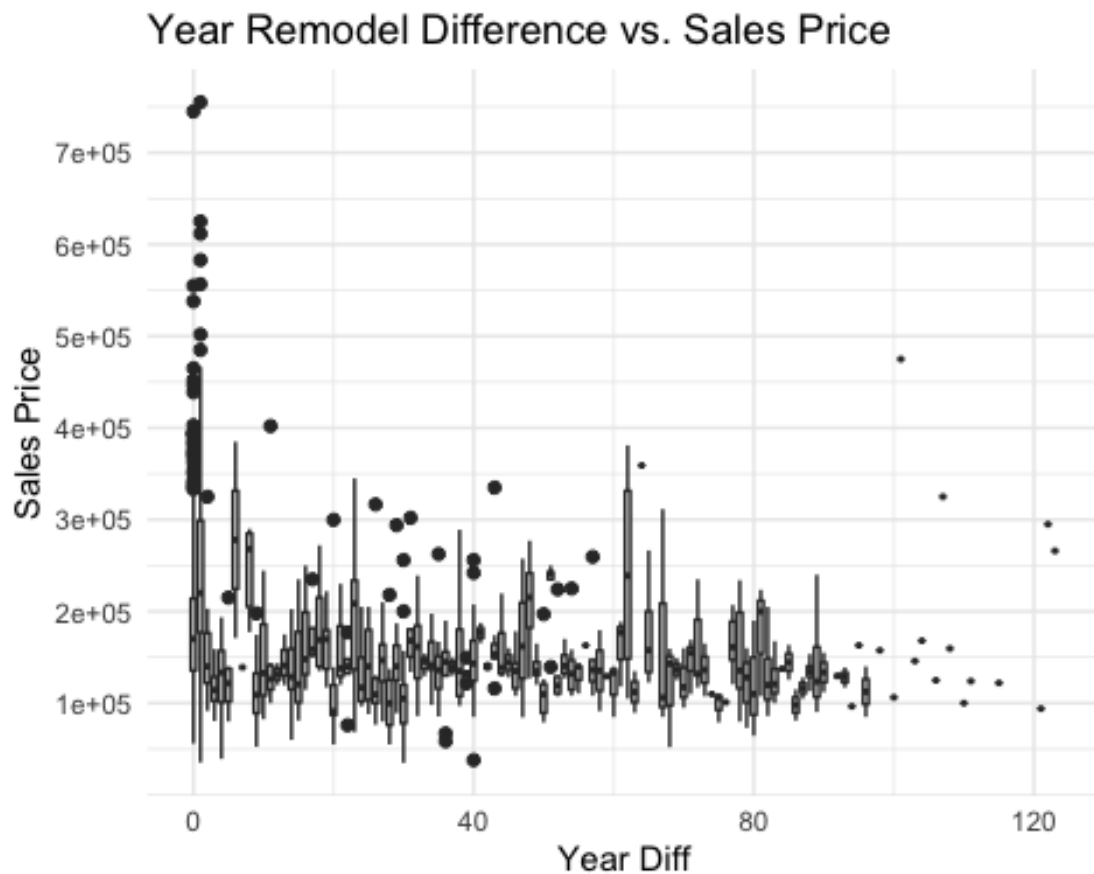
# if we try to combine both training and testing dataset
test$SalePrice <- NA
all <- rbind(train, test)
res <- sapply(all, class )
table(res)

## res
## factor integer
##      43      38
```

```
all <- all %>%
  mutate(YrRemodel_Diff = YearRemodAdd - YearBuilt)

ggplot(data = all[all$SalePrice > 0,], aes(x = YrRemodel_Diff, y = SalePrice,
group = YrRemodel_Diff)) +
  geom_boxplot(na.rm = T) +
  geom_smooth(na.rm = T) +
  theme_minimal() +
  labs(x = "Year Diff",
       y = "Sales Price",
       title = "Year Remodel Difference vs. Sales Price") +
  scale_y_continuous(breaks =
c(100000,200000,300000,400000,500000,600000,700000))

## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```



- Below I tried to find out how many missing values in each variable
- From the value of the above variables, we can see that there are many variables in the dataset with missing values, so we need to deal with missing values first. By doing so, let's firstly sort by the proportion of missing values in each variable.

```
res <- sapply(all, function(x) sum(is.na(x)) ) # Count missing values for
all variables
```

```
rate <- sapply(all, function(x) res/2909) # Sort by missing rate
```

```
miss <- sort(res, decreasing=T)
```

```
miss[miss>0]
```

```
##      PoolQC  MiscFeature      Alley      Fence      SalePrice
FireplaceQu
##      2909      2814      2721      2348      1459
1420
## LotFrontage  GarageYrBlt  GarageFinish  GarageQual  GarageCond
GarageType
##      486      159      159      159      159
157
##      BsmtCond  BsmtExposure      BsmtQual  BsmtFinType2  BsmtFinType1
MasVnrType
##      82      82      81      80      79
24
## MasVnrArea      MSZoning      Utilities  BsmtFullBath  BsmtHalfBath
Functional
##      23      4      2      2      2
2
## Exterior1st  Exterior2nd  BsmtFinSF1  BsmtFinSF2  BsmtUnfSF
TotalBsmtSF
##      1      1      1      1      1
1
## Electrical  KitchenQual  GarageCars  GarageArea  SaleType
##      1      1      1      1      1
```

```
summary(all[,names(miss)[miss>0]])
```

```
## PoolQC      MiscFeature  Alley      Fence      SalePrice
FireplaceQu
## Ex : 4 Gar2: 5 Grv1: 120 GdPrv: 118 Min. : 34900 Ex :
43
## Fa : 2 Othr: 4 Pave: 78 GdWo : 112 1st Qu.:129975 Fa :
74
## Gd : 4 Shed: 95 NA's:2721 MnPrv: 329 Median :163000 Gd :
744
## NA's:2909 TenC: 1 MnWw : 12 Mean :180921 Po :
46
## NA's:2814 NA's :2348 3rd Qu.:214000 TA :
592
## Max. :755000
NA's:1420
## NA's :1459
## LotFrontage  GarageYrBlt  GarageFinish  GarageQual  GarageCond
## Min. : 21.00 Min. :1895 Fin : 719 Ex : 3 Ex : 3
```



```

## 1st Qu.: 59.00 1st Qu.:1960 RFn : 811 Fa : 124 Fa : 74
## Median : 68.00 Median :1979 Unf :1230 Gd : 24 Gd : 15
## Mean : 69.31 Mean :1978 NA's: 159 Po : 5 Po : 14
## 3rd Qu.: 80.00 3rd Qu.:2002 TA :2604 TA :2654
## Max. :313.00 Max. :2207 NA's: 159 NA's: 159
## NA's :486 NA's :159
## GarageType BsmtCond BsmtExposure BsmtQual BsmtFinType2
BsmtFinType1
## 2Types : 23 Fa : 104 Av : 418 Ex : 258 ALQ : 52 ALQ :429
## Attchd :1723 Gd : 122 Gd : 276 Fa : 88 BLQ : 68 BLQ :269
## Basement: 36 Po : 5 Mn : 239 Gd :1209 GLQ : 34 GLQ :849
## BuiltIn: 186 TA :2606 No :1904 TA :1283 LwQ : 87 LwQ :154
## CarPort: 15 NA's: 82 NA's: 82 NA's: 81 Rec : 105 Rec :288
## Detchd : 779 Unf :2493 Unf :851
## NA's : 157 NA's: 80 NA's: 79
## MasVnrType MasVnrArea MSZoning Utilities
BsmtFullBath
## BrkCmn : 25 Min. : 0.0 C (all): 25 AllPub:2916 Min.
:0.0000
## BrkFace: 879 1st Qu.: 0.0 FV : 139 NoSeWa: 1 1st
Qu.:0.0000
## None :1742 Median : 0.0 RH : 26 NA's : 2 Median
:0.0000
## Stone : 249 Mean : 102.2 RL :2265 Mean
:0.4299
## NA's : 24 3rd Qu.: 164.0 RM : 460 3rd
Qu.:1.0000
## Max. :1600.0 NA's : 4 Max.
:3.0000
## NA's :23 NA's :2
## BsmtHalfBath Functional Exterior1st Exterior2nd
## Min. :0.00000 Typ :2717 VinylSd:1025 VinylSd:1014
## 1st Qu.:0.00000 Min2 : 70 MetalSd: 450 MetalSd: 447
## Median :0.00000 Min1 : 65 HdBoard: 442 HdBoard: 406
## Mean :0.06136 Mod : 35 Wd Sdng: 411 Wd Sdng: 391
## 3rd Qu.:0.00000 Maj1 : 19 Plywood: 221 Plywood: 270
## Max. :2.00000 (Other): 11 (Other): 369 (Other): 390
## NA's :2 NA's : 2 NA's : 1 NA's : 1
## BsmtFinSF1 BsmtFinSF2 BsmtUnfSF TotalBsmtSF
## Min. : 0.0 Min. : 0.00 Min. : 0.0 Min. : 0.0
## 1st Qu.: 0.0 1st Qu.: 0.00 1st Qu.: 220.0 1st Qu.: 793.0
## Median : 368.5 Median : 0.00 Median : 467.0 Median : 989.5
## Mean : 441.4 Mean : 49.58 Mean : 560.8 Mean :1051.8
## 3rd Qu.: 733.0 3rd Qu.: 0.00 3rd Qu.: 805.5 3rd Qu.:1302.0
## Max. :5644.0 Max. :1526.00 Max. :2336.0 Max. :6110.0
## NA's :1 NA's :1 NA's :1 NA's :1
## Electrical KitchenQual GarageCars GarageArea SaleType
## FuseA: 188 Ex : 205 Min. :0.000 Min. : 0.0 WD :2525
## FuseF: 50 Fa : 70 1st Qu.:1.000 1st Qu.: 320.0 New : 239
## FuseP: 8 Gd :1151 Median :2.000 Median : 480.0 COD : 87

```

```
## Mix : 1 TA :1492 Mean :1.767 Mean : 472.9 ConLD : 26
## SBrkr:2671 NA's: 1 3rd Qu.:2.000 3rd Qu.: 576.0 CWD : 12
## NA's : 1 Max. :5.000 Max. :1488.0 (Other): 29
## NA's :1 NA's :1 NA's : 1
```

- From above, we can see that there are lots of missing data. The more missing *PoolQC*, *MiscFeature*, *Alley*, *Fence*, and *FireplaceQu* are due to the fact that the house does not have a swimming pool, special facilities, side lanes, fences, and fireplaces. Due to the large amount of missing, let us remove these variables directly.

```
Drop <- names(all) %in%
c("PoolQC", "MiscFeature", "Alley", "Fence", "FireplaceQu")
all <- all[!Drop]
```

## Fill the missing values

- Now, let's use NA as a new factor

By looking at the description file, we can see that the garage-related 5 variables: *GarageType*, *GarageYrBlt*, *GarageFinish*, *GarageQual*, *GarageCond*. These 5 variables are missing since the houses do not have garages. Similarly, the five variables, *BsmtExposure*, *BsmtFinType2*, *BsmtQual*, *BsmtCond*, and *BsmtFinType1*, are about the basement, and they are all missing because the house has no basement. However, since the number of such variables missings are relatively small, the missing values are only replaced by *Missing* here.

Filling the NA value for the garage-related 5 variables: *GarageType*, *GarageYrBlt*, *GarageFinish*, *GarageQual*, *GarageCond*.

```
Garage <- c("GarageType", "GarageQual", "GarageCond", "GarageFinish")
Bsmt <- c("BsmtExposure", "BsmtFinType2", "BsmtQual", "BsmtCond", "BsmtFinType1")
for (x in c(Garage, Bsmt)) {
  all[[x]] <- factor( all[[x]], levels= c(levels(all[[x]]),c('Missing')))
  all[[x]][is.na(all[[x]])] <- "Missing"
}
```

Since *GarageYrBlt* is the year of the garage, we replace this variable with the year of construction of the house.

```
# Tidy GarageYrBlt separately
all$GarageYrBlt[is.na(all$GarageYrBlt)] <-
all$YearBuilt[is.na(all$GarageYrBlt)]
```

- Now, it is time for filling in missing data

Firstly, by filling in the missing data by the median (for *LotFrontage*):

Since variable *LotFrontage* is the distance from house to street and it is a numeric variable which we can add with the median.

```
# adding median to the variable LotFrontage (filling data)
all$LotFrontage[is.na(all$LotFrontage)] <- median(all$LotFrontage, na.rm = T)
```

## Manually filling missing values

Secondly, filling in the missing data by its corresponding “None” (for *MasVnrType*):

Since variable *MasVnrType* represents the Exterior Wall Decoration Material, and this variable should have little effect on the price. Thus, I replaced the NA in *MasVnrType* by its own value, “None”.

```
# Fill with None
all[["MasVnrType"]][is.na(all[["MasVnrType"]])] <- "None"
```

Thirdly, variable *LotFrontage* house to street distance

This is a numeric variable that we add with the median Median.

```
# Fill with median
all$LotFrontage[is.na(all$LotFrontage)] <- median(all$LotFrontage, na.rm = T)
```

Four, filling in the missing data which is “NA” values by “0” (for *MasVnrArea*):

Since variable *MasVnrArea* represents Area of exterior wall decoration material, and these missing values related to their “NA” value in *MasVnrType*, thus, “NA” value in *MasVnrArea* should be replaced with 0.

```
# Fill with zero
all[["MasVnrArea"]][is.na(all[["MasVnrArea"]])] <- 0
```

Five, get rid of data that has no distinction:

For the variable *Utilities* which has no distinction, so we discarded directly which means it is set to be “Null” value.

```
# Set Utilities to "Null"
all$Utilities <- NULL
```

Six, for variables, which are missing due to the none relationship with facility and they are all numeric, are replaced by 0. From the dataset, we can see that these variables are *BsmtFullBath*, *BsmtHalfBath*, *BsmtFinSF1*, *BsmtFinSF2*, *BsmtUnfSF*, *TotalBsmtSF*, *GarageCars*, *GarageArea*.

```
# Fill with 0
Param0 <-
c("BsmtFullBath", "BsmtHalfBath", "BsmtFinSF1", "BsmtFinSF2", "BsmtUnfSF", "TotalBsmtSF", "GarageCars", "GarageArea")
for (x in Param0) {
  all[[x]][is.na(all[[x]])] <- 0
}
```

Seven, among variables *MSZoning*, *Functional*, *Exterior1st*, *Exterior2nd*, *KitchenQual*, *Electrical*, *SaleType*, they are all factor variables and there are only a few missing values. Thus, they are replaced by the most factors.

```
# Supplemented with the highest frequency factor
Req <-
c("MSZoning", "Functional", "Exterior1st", "Exterior2nd", "KitchenQual", "Electrical", "SaleType")
for (x in Req) all[[x]][is.na(all[[x]])] <-
levels(all[[x]])[which.max(table(all[[x]])]
```

- Now, let's generate new training & testing datasets.

After a series of missing values, we see the last 75 variables remaining and there is no missing data. Here, I split the dataset into a training set and a testing set by whether *SalePrice* is NA or not, so that it is prepared for the following model training.

```
# Separate training sets and test sets by whether SalePrice is empty
training <- all[!is.na(all$SalePrice), ]
testing <- all[is.na(all$SalePrice), ]

y_train <- training$Saleprice
train2 <- training %>% dplyr::select(-SalePrice)
test2 <- testing %>% dplyr::select(-SalePrice)
train <- as.matrix(train2)
test <- as.matrix(test2)
```

## Evaluation Method & Model Interpretation:

1. KNN Method
2. Linear Regression
3. Subset Selection
4. Shrinkage Methods
5. Generalized Additive Models
6. Regression Trees
7. Bagging
8. Random Forest
9. Boosting

*Before starting the evaluation, let make some functons for transferring, such as transferring data type character to factor, evaluation results, and pre pocessing*

### Basic functions that are needed:

```
change_char_to_factor <- function(df){
  for(col in names(df)){
    if(class(df[, col]) == "character" ){
      if(sum(is.na(df[,col])) == 0 ){
        df[, col] <- as.factor(df[, col])
      }
    }
  }
}
```

```

    } else {
      df[, col] <- NULL
    }
  }
}
return (df)
}

evalute_model <- function(model, data, y){
  prediction <- predict(model, data)
  pred_df <- data.frame(obs = y, pred=prediction)
  return (pred_df)
}

pre_process <- function(df, method){
  pre_model <- preProcess(df, method = method)
  pre_data <- predict(pre_model, df)

  return (pre_data)
}

```

## 1. KNN Method

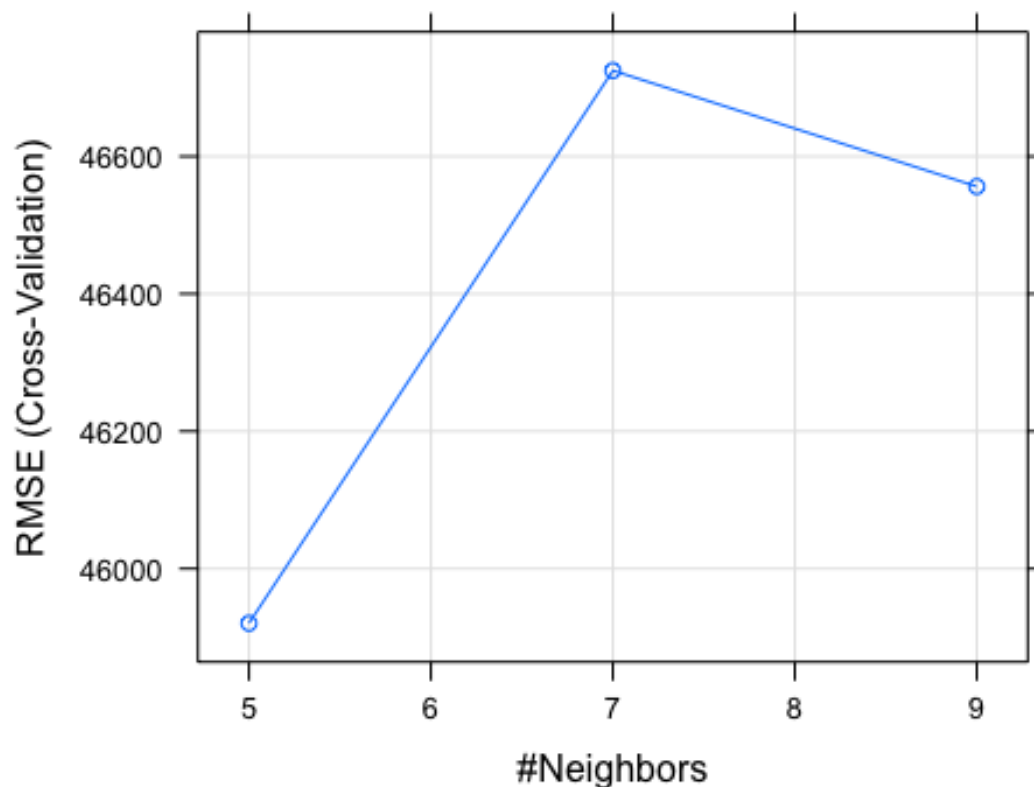
```

set.seed(781)
train_control <- trainControl(method="cv", number = 15)
my_Folds <- createFolds(training, k = 1)
my_Control <- trainControl(verboseIter = FALSE, index = my_Folds)
set.seed(1)
knn <- train(SalePrice ~ ., training, method = "knn", trControl =
train_control)
knn

## k-Nearest Neighbors
##
## 1460 samples
## 75 predictor
##
## No pre-processing
## Resampling: Cross-Validated (15 fold)
## Summary of sample sizes: 1363, 1362, 1364, 1363, 1362, 1364, ...
## Resampling results across tuning parameters:
##
##  k  RMSE      Rsquared  MAE
##  5  45920.48  0.6728827  29486.37
##  7  46724.88  0.6665881  29593.26
##  9  46556.13  0.6735277  29733.63
##
## RMSE was used to select the optimal model using the smallest value.
## The final value used for the model was k = 5.

plot(knn)

```



```
knn_pred <- predict(knn,testing)
soln<- data.frame(Id = testing$Id, SalePrice = knn_pred)
write.csv(soln,"Price+KNN.csv",row.names=FALSE)

# CV error
k <- 10
set.seed(1)
folds <- sample(1:k, nrow(training), replace = T)
cv.errors <- rep(NA, k)

for (j in 1:k){
  best_temp <- knn
  pred <- predict(best_temp, training[folds==j,])
  cv.errors[j] <- mean((training$SalePrice[folds==j]-pred)^2)
}

cv.error <- mean(cv.errors)
cv.error

## [1] 1418125008
```

- From the table process and the plot that are shown and recommended above, we would take k=5 for KNN method and it will yeild a nice result.

- After submitting the price prediction result for KNN method, the score for that in Kaggle is 0.26118. As we see, the score is quite high, therefore it might be not a good idea to choose KNN method as the final model selection.

## 2. Linear Regression

*# Basic linear model (simplest model, adding all terms together)*

```
lm_fit <- lm(SalePrice ~ LotArea + Neighborhood + Condition1 + Condition2 +
  BldgType + HouseStyle + YearBuilt + YearRemodAdd + MoSold + YrSold +
  ExterQual + ExterCond, training)
```

```
summary(lm_fit)
```

```
##
```

```
## Call:
```

```
## lm(formula = SalePrice ~ LotArea + Neighborhood + Condition1 +
##      Condition2 + BldgType + HouseStyle + YearBuilt + YearRemodAdd +
##      MoSold + YrSold + ExterQual + ExterCond, data = training)
##
```

```
## Residuals:
```

```
##      Min       1Q   Median       3Q      Max
## -211695  -20833   -2811   16133   408732
```

```
##
```

```
## Coefficients:
```

```
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   1.789e+06  1.732e+06   1.033  0.301620
## LotArea       1.183e+00  1.254e-01   9.437 < 2e-16 ***
## NeighborhoodBlueste -5.662e+03  3.210e+04  -0.176  0.860038
## NeighborhoodBrDale -2.550e+04  1.665e+04  -1.532  0.125780
## NeighborhoodBrkSide -4.056e+04  1.399e+04  -2.899  0.003805 **
## NeighborhoodClearCr -1.818e+04  1.442e+04  -1.261  0.207508
## NeighborhoodCollgCr -4.337e+04  1.173e+04  -3.698  0.000225 ***
## NeighborhoodCrawfor  1.332e+04  1.353e+04   0.984  0.325178
## NeighborhoodEdwards -5.647e+04  1.263e+04  -4.473  8.34e-06 ***
## NeighborhoodGilbert -5.989e+04  1.253e+04  -4.779  1.94e-06 ***
## NeighborhoodIDOTRR -5.883e+04  1.466e+04  -4.013  6.32e-05 ***
## NeighborhoodMeadowV -2.875e+04  1.567e+04  -1.834  0.066837 .
## NeighborhoodMitchel -4.587e+04  1.305e+04  -3.515  0.000454 ***
## NeighborhoodNames   -4.067e+04  1.227e+04  -3.314  0.000945 ***
## NeighborhoodNoRidge  6.623e+04  1.326e+04   4.994  6.65e-07 ***
## NeighborhoodNPkVill  9.669e+03  1.808e+04   0.535  0.592970
## NeighborhoodNridgHt  3.907e+04  1.211e+04   3.226  0.001285 **
## NeighborhoodNWAmes  -2.649e+04  1.283e+04  -2.066  0.039059 *
## NeighborhoodOldTown -4.452e+04  1.354e+04  -3.287  0.001038 **
## NeighborhoodSawyer   -4.966e+04  1.295e+04  -3.834  0.000132 ***
## NeighborhoodSawyerW  -3.189e+04  1.255e+04  -2.540  0.011187 *
## NeighborhoodSomerst -2.041e+04  1.183e+04  -1.725  0.084787 .
## NeighborhoodStoneBr  6.995e+04  1.352e+04   5.175  2.62e-07 ***
## NeighborhoodSWISU    -3.786e+04  1.557e+04  -2.431  0.015162 *
## NeighborhoodTimber   -1.541e+04  1.338e+04  -1.151  0.249880
## NeighborhoodVeenker   1.994e+04  1.683e+04   1.185  0.236331
```

```

## Condition1Feedr      -9.521e+03  8.327e+03  -1.143  0.253068
## Condition1Norm       -1.445e+03  6.916e+03  -0.209  0.834491
## Condition1PosA        3.523e+04  1.667e+04   2.114  0.034727 *
## Condition1PosN        2.888e+04  1.252e+04   2.307  0.021204 *
## Condition1RR Ae      -2.803e+04  1.496e+04  -1.873  0.061307 .
## Condition1RRAn       -7.190e+02  1.153e+04  -0.062  0.950282
## Condition1RRNe       -3.789e+04  3.112e+04  -1.218  0.223501
## Condition1RRNn        1.147e+04  2.080e+04   0.551  0.581526
## Condition2Feedr       1.011e+03  3.752e+04   0.027  0.978506
## Condition2Norm        4.672e+02  3.220e+04   0.015  0.988424
## Condition2PosA        5.947e+04  6.262e+04   0.950  0.342402
## Condition2PosN      -1.176e+05  4.563e+04  -2.578  0.010028 *
## Condition2RR Ae       3.780e+04  5.403e+04   0.700  0.484272
## Condition2RRAn      -1.417e+04  5.372e+04  -0.264  0.792043
## Condition2RRNn      -1.934e+04  4.419e+04  -0.438  0.661650
## BldgType2fmCon       -5.485e+03  8.561e+03  -0.641  0.521853
## BldgTypeDuplex       -9.580e+03  6.444e+03  -1.487  0.137323
## BldgTypeTwnhs       -7.253e+04  8.478e+03  -8.555  < 2e-16 ***
## BldgTypeTwnhsE      -5.487e+04  5.306e+03 -10.340  < 2e-16 ***
## HouseStyle1.5Unf     -2.131e+04  1.217e+04  -1.752  0.080066 .
## HouseStyle1Story     -1.516e+04  4.400e+03  -3.445  0.000588 ***
## HouseStyle2.5Fin       7.840e+04  1.600e+04   4.900  1.07e-06 ***
## HouseStyle2.5Unf      1.467e+04  1.415e+04   1.037  0.299903
## HouseStyle2Story      3.937e+03  4.644e+03   0.848  0.396774
## HouseStyleSFoyer     -1.937e+04  8.526e+03  -2.271  0.023271 *
## HouseStyleSLvl      -6.324e+03  6.790e+03  -0.931  0.351853
## YearBuilt            6.380e+02  8.891e+01   7.176  1.16e-12 ***
## YearRemodAdd         4.649e+02  7.649e+01   6.078  1.57e-09 ***
## MoSold              -3.552e+02  4.196e+02  -0.846  0.397453
## YrSold              -1.815e+03  8.570e+02  -2.118  0.034334 *
## ExterQualFa         -1.461e+05  1.460e+04 -10.013  < 2e-16 ***
## ExterQualGd         -9.554e+04  6.965e+03 -13.717  < 2e-16 ***
## ExterQualTA         -1.242e+05  7.620e+03 -16.300  < 2e-16 ***
## ExterCondFa         -1.111e+04  3.129e+04  -0.355  0.722522
## ExterCondGd          3.212e+03  3.015e+04   0.107  0.915189
## ExterCondPo         -3.958e+04  5.203e+04  -0.761  0.446978
## ExterCondTA         -9.390e+02  3.003e+04  -0.031  0.975057
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 42010 on 1397 degrees of freedom
## Multiple R-squared:  0.7323, Adjusted R-squared:  0.7204
## F-statistic: 61.63 on 62 and 1397 DF,  p-value: < 2.2e-16

```

Below, it is tried to remove one predictor at a time and observed its corresponding p-value, so that all variables in the linear formula are related to the predictor, SalePrice:

```

# second linear model (get rid of variables that are non statistical
# significant)
lm1 <- lm(SalePrice ~ LotArea + Neighborhood + Condition1 + Condition2 +

```



```
BldgType + HouseStyle + YearBuilt + YearRemodAdd + YrSold + ExterQual,  
training)
```

```
summary(lm1)
```

```
##
```

```
## Call:
```

```
## lm(formula = SalePrice ~ LotArea + Neighborhood + Condition1 +  
##      Condition2 + BldgType + HouseStyle + YearBuilt + YearRemodAdd +  
##      YrSold + ExterQual, data = training)
```

```
##
```

```
## Residuals:
```

```
##      Min       1Q   Median       3Q      Max  
## -210997  -21085   -2305    16199   408240
```

```
##
```

```
## Coefficients:
```

```
##              Estimate Std. Error t value Pr(>|t|)  
## (Intercept)   1.605e+06  1.709e+06   0.939  0.347684  
## LotArea       1.191e+00  1.253e-01   9.507 < 2e-16 ***  
## NeighborhoodBlueste -3.410e+03  3.202e+04  -0.106  0.915209  
## NeighborhoodBrDale -2.515e+04  1.664e+04  -1.512  0.130801  
## NeighborhoodBrkSide -4.112e+04  1.395e+04  -2.948  0.003249 **  
## NeighborhoodClearCr -1.801e+04  1.441e+04  -1.250  0.211596  
## NeighborhoodCollgCr -4.305e+04  1.172e+04  -3.673  0.000249 ***  
## NeighborhoodCrawfor  1.419e+04  1.350e+04   1.051  0.293441  
## NeighborhoodEdwards -5.598e+04  1.261e+04  -4.438  9.77e-06 ***  
## NeighborhoodGilbert -5.995e+04  1.253e+04  -4.786  1.88e-06 ***  
## NeighborhoodIDOTRR -5.933e+04  1.464e+04  -4.053  5.33e-05 ***  
## NeighborhoodMeadowV -2.837e+04  1.565e+04  -1.813  0.070108 .  
## NeighborhoodMitchel -4.508e+04  1.303e+04  -3.461  0.000555 ***  
## NeighborhoodNames -3.996e+04  1.226e+04  -3.260  0.001139 **  
## NeighborhoodNoRidge  6.656e+04  1.325e+04   5.021  5.79e-07 ***  
## NeighborhoodNPkVill  9.637e+03  1.806e+04   0.534  0.593756  
## NeighborhoodNridgHt  3.867e+04  1.210e+04   3.195  0.001427 **  
## NeighborhoodNWAmes -2.557e+04  1.280e+04  -1.997  0.046053 *  
## NeighborhoodOldTown -4.344e+04  1.351e+04  -3.216  0.001328 **  
## NeighborhoodSawyer -4.873e+04  1.294e+04  -3.767  0.000172 ***  
## NeighborhoodSawyerW -3.206e+04  1.255e+04  -2.555  0.010726 *  
## NeighborhoodSomerst -2.058e+04  1.183e+04  -1.740  0.082063 .  
## NeighborhoodStoneBr  6.950e+04  1.349e+04   5.152  2.95e-07 ***  
## NeighborhoodSWISU -3.782e+04  1.556e+04  -2.430  0.015235 *  
## NeighborhoodTimber -1.501e+04  1.338e+04  -1.122  0.262157  
## NeighborhoodVeenker  2.090e+04  1.679e+04   1.245  0.213424  
## Condition1Feedr -9.812e+03  8.318e+03  -1.180  0.238327  
## Condition1Norm -1.760e+03  6.900e+03  -0.255  0.798747  
## Condition1PosA  3.453e+04  1.665e+04   2.074  0.038307 *  
## Condition1PosN  2.855e+04  1.250e+04   2.283  0.022553 *  
## Condition1RR Ae -2.750e+04  1.496e+04  -1.839  0.066141 .  
## Condition1RRAn -3.045e+02  1.150e+04  -0.026  0.978889  
## Condition1RRNe -3.730e+04  3.109e+04  -1.200  0.230412
```

```

## Condition1RRNn      1.292e+04  2.074e+04   0.623  0.533290
## Condition2Feedr     -1.990e+03  3.741e+04  -0.053  0.957582
## Condition2Norm      -1.305e+03  3.212e+04  -0.041  0.967605
## Condition2PosA       5.599e+04  5.499e+04   1.018  0.308795
## Condition2PosN      -1.204e+05  4.556e+04  -2.643  0.008315 **
## Condition2RRAE       3.535e+04  5.398e+04   0.655  0.512601
## Condition2RRAn      -1.577e+04  5.367e+04  -0.294  0.768892
## Condition2RRNn      -1.870e+04  4.410e+04  -0.424  0.671590
## BldgType2fmCon      -7.206e+03  8.398e+03  -0.858  0.391018
## BldgTypeDuplex      -1.015e+04  6.425e+03  -1.580  0.114323
## BldgTypeTwnhs       -7.219e+04  8.472e+03  -8.521  < 2e-16 ***
## BldgTypeTwnhsE      -5.464e+04  5.293e+03 -10.322  < 2e-16 ***
## HouseStyle1.5Unf     -2.053e+04  1.214e+04  -1.691  0.090970 .
## HouseStyle1Story     -1.522e+04  4.388e+03  -3.468  0.000541 ***
## HouseStyle2.5Fin      7.909e+04  1.596e+04  4.956  8.06e-07 ***
## HouseStyle2.5Unf     1.508e+04  1.410e+04   1.069  0.285141
## HouseStyle2Story     3.867e+03  4.633e+03   0.835  0.404020
## HouseStyleSFoyer     -1.872e+04  8.504e+03  -2.201  0.027885 *
## HouseStyleSLvl      -6.399e+03  6.782e+03  -0.944  0.345575
## YearBuilt            6.350e+02  8.812e+01  7.206  9.40e-13 ***
## YearRemodAdd         4.796e+02  7.550e+01  6.352  2.86e-10 ***
## YrSold              -1.736e+03  8.463e+02  -2.051  0.040463 *
## ExterQualFa         -1.496e+05  1.433e+04 -10.440  < 2e-16 ***
## ExterQualGd         -9.571e+04  6.959e+03 -13.754  < 2e-16 ***
## ExterQualTA         -1.245e+05  7.610e+03 -16.358  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 41990 on 1402 degrees of freedom
## Multiple R-squared:  0.7315, Adjusted R-squared:  0.7206
## F-statistic: 67.01 on 57 and 1402 DF,  p-value: < 2.2e-16

# Liner model prediction
lm.pred <- predict(lm1, testing)

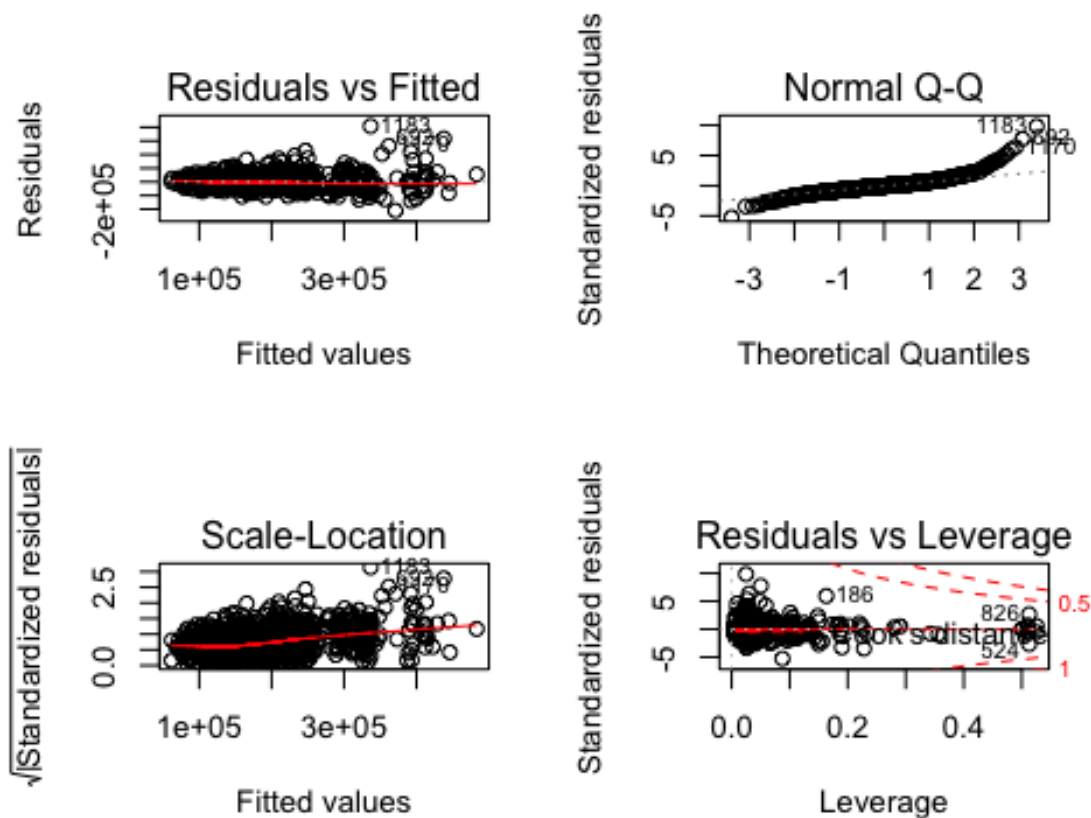
# First try (for linear model): write out prediction and save in a csv file
temp<- data.frame(Id = testing$Id, SalePrice = lm.pred)
write.csv(temp, file = "Price+Linear_Regression.csv", row.names = FALSE)

par(mfrow=c(2,2))
plot(lm1)

## Warning: not plotting observations with leverage one:
## 584, 1004, 1231

## Warning: not plotting observations with leverage one:
## 584, 1004, 1231

```



- My first try on linear regression model (which is simply removing variables that are non-statistical significant) yields a Kaggle score of 0.22357. It performs better than the KNN method, but the score is still quite high. So, again, it might be not a good idea to choose this method.

Now, let's try to improve the linear model little bit (second try).

```
# advanced linear model
lm_adv <- lm(log(SalePrice) ~ OverallQual + YearRemodAdd + X1stFlrSF +
  GrLivArea + Fireplaces + GarageArea + MSSubClass + MSZoning + Neighborhood +
  ExterQual + BsmtQual + BsmtFinType1 + KitchenQual + HouseStyle, training)

summary(lm_adv)

##
## Call:
## lm(formula = log(SalePrice) ~ OverallQual + YearRemodAdd + X1stFlrSF +
##   GrLivArea + Fireplaces + GarageArea + MSSubClass + MSZoning +
##   Neighborhood + ExterQual + BsmtQual + BsmtFinType1 + KitchenQual +
##   HouseStyle, data = training)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
```

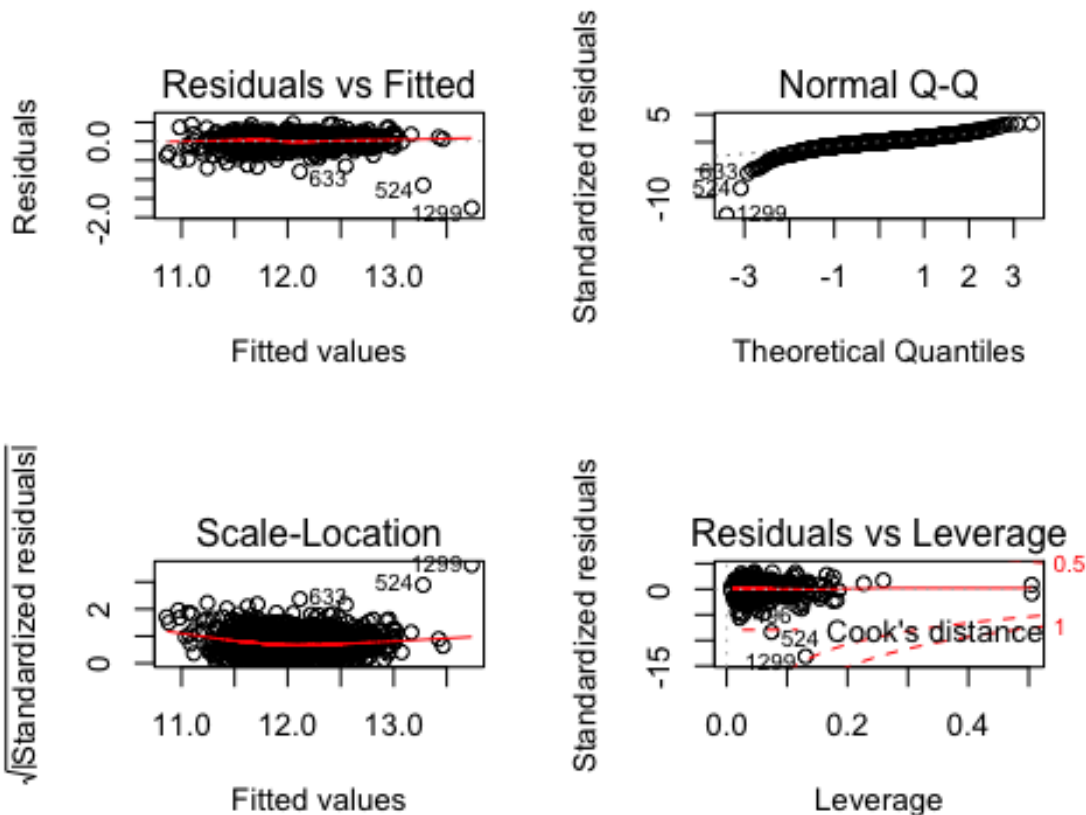
```

## -1.75234 -0.06182 0.00753 0.07420 0.47366
##
## Coefficients: (1 not defined because of singularities)
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    6.918e+00  5.566e-01  12.428 < 2e-16 ***
## OverallQual    6.883e-02  5.478e-03  12.564 < 2e-16 ***
## YearRemodAdd   2.020e-03  2.751e-04   7.342 3.54e-13 ***
## X1stFlrSF      1.004e-05  2.913e-05   0.344 0.730529
## GrLivArea      2.388e-04  2.439e-05   9.790 < 2e-16 ***
## Fireplaces     4.477e-02  7.403e-03   6.047 1.88e-09 ***
## GarageArea     2.286e-04  2.458e-05   9.298 < 2e-16 ***
## MSSubClass    -5.711e-04  1.314e-04  -4.346 1.49e-05 ***
## MSZoningFV     3.885e-01  6.729e-02   5.773 9.58e-09 ***
## MSZoningRH     3.624e-01  6.745e-02   5.373 9.04e-08 ***
## MSZoningRL     4.064e-01  5.621e-02   7.230 7.89e-13 ***
## MSZoningRM     3.652e-01  5.295e-02   6.897 8.01e-12 ***
## NeighborhoodBlueste -7.952e-02  1.107e-01  -0.718 0.472691
## NeighborhoodBrDale -1.347e-01  5.795e-02  -2.325 0.020223 *
## NeighborhoodBrkSide -4.521e-02  4.662e-02  -0.970 0.332267
## NeighborhoodClearCr 1.105e-01  4.716e-02   2.344 0.019223 *
## NeighborhoodCollgCr 1.866e-02  3.907e-02   0.478 0.633024
## NeighborhoodCrawfor 9.873e-02  4.343e-02   2.273 0.023151 *
## NeighborhoodEdwards -1.163e-01  4.194e-02  -2.772 0.005640 **
## NeighborhoodGilbert 3.128e-02  4.142e-02   0.755 0.450208
## NeighborhoodIDOTRR -1.149e-01  5.376e-02  -2.137 0.032801 *
## NeighborhoodMeadowV -1.805e-01  5.657e-02  -3.192 0.001446 **
## NeighborhoodMitchel -3.267e-02  4.377e-02  -0.746 0.455579
## NeighborhoodNames   -3.063e-02  4.087e-02  -0.750 0.453649
## NeighborhoodNoRidge 1.179e-01  4.463e-02   2.641 0.008362 **
## NeighborhoodNPkVill -6.460e-02  6.150e-02  -1.050 0.293720
## NeighborhoodNridgHt 1.127e-01  4.066e-02   2.771 0.005659 **
## NeighborhoodNWAmes  -1.864e-02  4.234e-02  -0.440 0.659780
## NeighborhoodOldTown -1.229e-01  4.664e-02  -2.634 0.008520 **
## NeighborhoodSawyer  -4.416e-02  4.315e-02  -1.023 0.306366
## NeighborhoodSawyerW -1.289e-02  4.182e-02  -0.308 0.757956
## NeighborhoodSomerst 7.195e-02  4.859e-02   1.481 0.138955
## NeighborhoodStoneBr 1.674e-01  4.595e-02   3.643 0.000279 ***
## NeighborhoodSWISU   -8.019e-02  5.078e-02  -1.579 0.114542
## NeighborhoodTimber  5.542e-02  4.386e-02   1.263 0.206651
## NeighborhoodVeenker 1.464e-01  5.664e-02   2.584 0.009856 **
## ExterQualFa      -5.401e-02  5.336e-02  -1.012 0.311656
## ExterQualGd       4.326e-03  2.700e-02   0.160 0.872721
## ExterQualTA       1.112e-03  2.992e-02   0.037 0.970348
## BsmtQualFa       -1.325e-01  3.411e-02  -3.886 0.000107 ***
## BsmtQualGd       -6.622e-02  1.884e-02  -3.515 0.000453 ***
## BsmtQualTA       -1.000e-01  2.226e-02  -4.494 7.57e-06 ***
## BsmtQualMissing  -2.992e-01  3.432e-02  -8.719 < 2e-16 ***
## BsmtFinType1BLQ   -2.472e-02  1.577e-02  -1.568 0.117153
## BsmtFinType1GLQ   -1.555e-02  1.414e-02  -1.100 0.271562
## BsmtFinType1LwQ   -5.309e-02  1.998e-02  -2.657 0.007975 **

```

```
## BsmtFinType1Rec      -3.485e-02  1.669e-02  -2.088  0.036980  *
## BsmtFinType1Unf      -9.720e-02  1.341e-02  -7.249  6.90e-13  ***
## BsmtFinType1Missing      NA      NA      NA      NA
## KitchenQualFa        -1.256e-01  3.447e-02  -3.642  0.000280  ***
## KitchenQualGd        -4.511e-02  2.005e-02  -2.250  0.024628  *
## KitchenQualTA        -7.461e-02  2.267e-02  -3.291  0.001022  **
## HouseStyle1.5Unf      -2.818e-02  4.285e-02  -0.658  0.510953
## HouseStyle1Story      -5.983e-04  2.087e-02  -0.029  0.977132
## HouseStyle2.5Fin      -3.229e-02  5.877e-02  -0.549  0.582839
## HouseStyle2.5Unf      1.844e-02  4.721e-02  0.391  0.696168
## HouseStyle2Story      -2.030e-02  1.754e-02  -1.157  0.247338
## HouseStyleSFoyer      3.498e-02  3.167e-02  1.105  0.269540
## HouseStyleSLvl       2.327e-02  2.509e-02  0.928  0.353812
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1431 on 1402 degrees of freedom
## Multiple R-squared:  0.8767, Adjusted R-squared:  0.8717
## F-statistic: 174.9 on 57 and 1402 DF,  p-value: < 2.2e-16

par(mfrow=c(2,2))
plot(lm_adv)
```



```
# advance Linear model prediction
lm.pred.adv <- predict(lm_adv, testing)

## Warning in predict.lm(lm_adv, testing): prediction from a rank-deficient
fit may
## be misleading

# write csv.
res <- data.frame(Id = testing$Id, SalePrice = exp(lm.pred.adv))
write.csv(res, file = "Price+Advanced_linear.csv", row.names = FALSE)

# cv error for linear regression
k <- 10
set.seed(1)
folds <- sample(1:k, nrow(training), replace = T)
cv.errors <- rep(NA, k)

for (j in 1:k){
  best_temp <- lm_adv
  pred <- predict(best_temp, training[folds==j,])
  cv.errors[j] <- mean((training$SalePrice[folds==j]-pred)^2)
}

## Warning in predict.lm(best_temp, training[folds == j, ]): prediction from
a
## rank-deficient fit may be misleading

## Warning in predict.lm(best_temp, training[folds == j, ]): prediction from
a
## rank-deficient fit may be misleading

## Warning in predict.lm(best_temp, training[folds == j, ]): prediction from
a
## rank-deficient fit may be misleading

## Warning in predict.lm(best_temp, training[folds == j, ]): prediction from
a
## rank-deficient fit may be misleading

## Warning in predict.lm(best_temp, training[folds == j, ]): prediction from
a
## rank-deficient fit may be misleading
```

```
## Warning in predict.lm(best_temp, training[folds == j, ]): prediction from
a
## rank-deficient fit may be misleading

## Warning in predict.lm(best_temp, training[folds == j, ]): prediction from
a
## rank-deficient fit may be misleading

## Warning in predict.lm(best_temp, training[folds == j, ]): prediction from
a
## rank-deficient fit may be misleading

cv.error <- mean(cv.errors)
cv.error

## [1] 38949911699
```

- My second try on linear regression model (which I adjusted some of the predictors and take the log of the formula) improves a better kaggle score of 0.15133. It performs better than my first try on linear model.

### 3.Subset Selection

Below is a function for getting the best size for subset selection method

```
predict.regsubsets <- function(object, newdata, id,...){
  form <- as.formula(object$call[[2]])
  mat <- model.matrix(form, newdata)
  coefi <- coef(object, id=id)
  xvars <- names(coefi)
  mat[,xvars] %*% coefi
}

set.seed(1)
best_fit <- regsubsets(SalePrice~., data=training, method='forward',
nvmax=35)

## Warning in leaps.setup(x, y, wt = wt, nbest = nbest, nvmax = nvmax,
force.in =
## force.in, : 9 linear dependencies found

## Reordering variables and trying again:

best_summary <- summary(best_fit)
best_no <- which.max(best_summary$adjr2)
# par(mfrow=c(2,2))
# plot(best_summary$cp, xlab='No.Vars', ylab='c_p', type='l')
# points(which.min(best_summary$cp),
best_summary$cp[which.min(best_summary$cp)], col='red', cex=2, pch=19)
# plot(best_summary$bic, xlab='No.Vars', ylab='bic', type='l')
```

```
# points(which.min(best_summary$bic),
best_summary$cp[which.min(best_summary$bic)], col='red', cex=2, pch=19)
# plot(best_summary$adjr2, xlab='No.Vars', ylab='adjr2', type='l')
# points(which.max(best_summary$adjr2),
best_summary$cp[which.max(best_summary$adjr2)], col='red', cex=2, pch=19)
```

*forward selection:*

In Forward Selection, we combine all kinds of possibilities of variables, ranging from null model to full model. Choosing the best one using CV estimates, AIC, BIC, etc. (Smallest RSS, largest R square)

```
empty <- lm(log(SalePrice)~1, data=training)
full <- lm(log(SalePrice)~.-Id, data=training)

set.seed(1234)
# Forward Stepwise
lm.for <- step(empty, scope=list(lower=empty, upper=full),
direction="forward")

## Start: AIC=-2678.57
## log(SalePrice) ~ 1
##
##
```

	Df	Sum of Sq	RSS	AIC
## + OverallQual	1	155.462	77.339	-4285.5
## + Neighborhood	24	132.884	99.916	-3865.5
## + GrLivArea	1	114.375	118.426	-3663.4
## + GarageCars	1	107.845	124.956	-3585.0
## + ExterQual	3	107.349	125.451	-3575.2
## + BsmtQual	4	105.296	127.505	-3549.5
## + KitchenQual	3	104.211	128.590	-3539.2
## + GarageArea	1	98.627	134.174	-3481.1
## + GarageFinish	3	88.705	144.096	-3372.9
## + TotalBsmtSF	1	87.232	145.568	-3362.1
## + X1stFlrSF	1	82.967	149.834	-3319.9
## + FullBath	1	82.354	150.447	-3314.0
## + YearBuilt	1	80.098	152.702	-3292.2
## + GarageType	6	77.904	154.896	-3261.4
## + GarageYrBlt	1	75.291	157.509	-3247.0
## + YearRemodAdd	1	74.476	158.325	-3239.5
## + Foundation	5	70.690	162.110	-3197.0
## + TotRmsAbvGrd	1	66.490	166.311	-3167.6
## + Fireplaces	1	55.770	177.031	-3076.4
## + HeatingQC	4	54.363	178.438	-3058.9
## + BsmtFinType1	6	52.999	179.802	-3043.7
## + MasVnrType	3	43.800	189.000	-2976.9
## + MasVnrArea	1	42.402	190.399	-2970.1
## + MSZoning	4	40.935	191.865	-2952.9
## + Exterior1st	14	42.261	190.540	-2943.0
## + Exterior2nd	15	39.917	192.884	-2923.2



## + GarageCond	5	33.793	199.008	-2897.6
## + BsmtExposure	4	33.196	199.605	-2895.2
## + BsmtFinSF1	1	32.220	200.581	-2894.1
## + GarageQual	5	32.908	199.893	-2891.1
## + SaleCondition	5	30.036	202.765	-2870.3
## + CentralAir	1	28.779	204.021	-2869.2
## + LotFrontage	1	26.027	206.773	-2849.7
## + WoodDeckSF	1	25.991	206.809	-2849.4
## + SaleType	8	27.963	204.838	-2849.4
## + OpenPorchSF	1	23.996	208.805	-2835.4
## + X2ndFlrSF	1	23.735	209.066	-2833.6
## + HalfBath	1	22.951	209.850	-2828.1
## + HouseStyle	7	23.768	209.033	-2821.8
## + Electrical	4	22.469	210.331	-2818.8
## + PavedDrive	2	21.703	211.097	-2817.5
## + LotShape	3	20.446	212.355	-2806.8
## + BsmtCond	4	20.169	212.631	-2802.9
## + LotArea	1	15.415	217.386	-2776.6
## + YrRemodel_Diff	1	14.171	218.629	-2768.3
## + BsmtFullBath	1	12.991	219.810	-2760.4
## + BsmtUnfSF	1	11.472	221.329	-2750.4
## + BedroomAbvGr	1	10.173	222.627	-2741.8
## + ExterCond	4	10.595	222.205	-2738.6
## + RoofStyle	5	10.033	222.767	-2732.9
## + BsmtFinType2	6	10.075	222.726	-2731.2
## + BldgType	4	9.345	223.456	-2730.4
## + Condition1	8	9.879	222.922	-2725.9
## + Heating	5	7.670	225.131	-2717.5
## + LandContour	3	5.967	226.834	-2710.5
## + EnclosedPorch	1	5.172	227.629	-2709.4
## + KitchenAbvGr	1	5.068	227.732	-2708.7
## + LotConfig	4	5.433	227.367	-2705.1
## + Functional	6	5.538	227.263	-2701.7
## + ScreenPorch	1	3.420	229.381	-2698.2
## + RoofMatl	7	4.167	228.634	-2690.9
## + MSSubClass	1	1.273	231.527	-2684.6
## + PoolArea	1	1.134	231.667	-2683.7
## + Condition2	7	2.803	229.998	-2682.3
## + Street	1	0.766	232.034	-2681.4
## + MoSold	1	0.765	232.036	-2681.4
## + X3SsnPorch	1	0.702	232.099	-2681.0
## + LowQualFinSF	1	0.336	232.465	-2678.7
## + YrSold	1	0.323	232.477	-2678.6
## <none>			232.801	-2678.6
## + OverallCond	1	0.316	232.484	-2678.6
## + MiscVal	1	0.093	232.707	-2677.2
## + LandSlope	2	0.346	232.455	-2676.7
## + BsmtHalfBath	1	0.006	232.794	-2676.6
## + BsmtFinSF2	1	0.005	232.795	-2676.6
##				

## Step: AIC=-4285.48

## log(SalePrice) ~ OverallQual

##

##		Df	Sum of Sq	RSS	AIC
##	+ Neighborhood	24	20.6465	56.692	-4690.9
##	+ GrLivArea	1	16.8041	60.535	-4641.1
##	+ GarageCars	1	13.1156	64.223	-4554.8
##	+ X1stFlrSF	1	13.0033	64.335	-4552.2
##	+ GarageArea	1	12.4937	64.845	-4540.7
##	+ MSZoning	4	11.0375	66.301	-4502.3
##	+ TotalBsmtSF	1	9.7627	67.576	-4480.5
##	+ TotRmsAbvGrd	1	9.7610	67.578	-4480.5
##	+ GarageType	6	9.3303	68.008	-4461.2
##	+ GarageFinish	3	8.3939	68.945	-4447.2
##	+ BsmtFinSF1	1	7.6656	69.673	-4435.9
##	+ Fireplaces	1	7.5422	69.796	-4433.3
##	+ FullBath	1	7.0075	70.331	-4422.1
##	+ LotArea	1	6.8729	70.466	-4419.4
##	+ KitchenQual	3	5.9030	71.436	-4395.4
##	+ BsmtQual	4	5.5493	71.789	-4386.2
##	+ BsmtFullBath	1	4.9857	72.353	-4380.8
##	+ LotFrontage	1	4.9736	72.365	-4380.5
##	+ YearBuilt	1	4.8924	72.446	-4378.9
##	+ BsmtFinType1	6	5.3623	71.976	-4378.4
##	+ WoodDeckSF	1	4.7627	72.576	-4376.3
##	+ YearRemodAdd	1	4.4648	72.874	-4370.3
##	+ GarageYrBlt	1	4.4603	72.878	-4370.2
##	+ CentralAir	1	4.2028	73.136	-4365.1
##	+ GarageQual	5	4.5975	72.741	-4365.0
##	+ BldgType	4	4.3733	72.965	-4362.5
##	+ LotShape	3	4.2007	73.138	-4361.0
##	+ Foundation	5	4.3877	72.951	-4360.8
##	+ GarageCond	5	4.3348	73.004	-4359.7
##	+ BedroomAbvGr	1	3.7319	73.607	-4355.7
##	+ BsmtExposure	4	3.8779	73.461	-4352.6
##	+ ExterQual	3	3.6996	73.639	-4351.0
##	+ PavedDrive	2	3.3808	73.958	-4346.7
##	+ HeatingQC	4	3.2177	74.121	-4339.5
##	+ Exterior1st	14	4.1290	73.210	-4337.6
##	+ MasVnrArea	1	2.4647	74.874	-4330.8
##	+ Electrical	4	2.7072	74.631	-4329.5
##	+ MSSubClass	1	2.3596	74.979	-4328.7
##	+ Exterior2nd	15	3.7339	73.605	-4327.7
##	+ SaleCondition	5	2.6087	74.730	-4325.6
##	+ HalfBath	1	2.0616	75.277	-4322.9
##	+ LandSlope	2	2.0152	75.323	-4320.0
##	+ HouseStyle	7	2.5251	74.814	-4319.9
##	+ LandContour	3	1.9473	75.391	-4316.7
##	+ LotConfig	4	1.8726	75.466	-4313.3
##	+ X2ndFlrSF	1	1.5450	75.794	-4312.9

```

## + Heating          5      1.8223 75.516 -4310.3
## + MasVnrType        3      1.4450 75.894 -4307.0
## + OpenPorchSF       1      1.2143 76.124 -4306.6
## + ExterCond         4      1.5194 75.819 -4306.4
## + ScreenPorch      1      1.0869 76.252 -4304.1
## + BsmtCond          4      1.3194 76.019 -4302.6
## + Condition1       8      1.6894 75.649 -4301.7
## + RoofStyle        5      1.2784 76.060 -4299.8
## + Functional        6      1.3719 75.967 -4299.6
## + RoofMatl         7      1.4432 75.895 -4299.0
## + EnclosedPorch    1      0.7382 76.600 -4297.5
## + SaleType         8      1.4337 75.905 -4296.8
## + BsmtFinSF2       1      0.6598 76.679 -4296.0
## + YrRemodel_Diff   1      0.5981 76.740 -4294.8
## + BsmtFinType2     6      0.9102 76.428 -4290.8
## + Condition2       7      0.9978 76.341 -4290.4
## + OverallCond      1      0.3436 76.995 -4290.0
## + BsmtUnfSF        1      0.2290 77.110 -4287.8
## + X3SsnPorch       1      0.2109 77.128 -4287.5
## + BsmtHalfBath     1      0.1784 77.160 -4286.8
## + <none>            77.339 -4285.5
## + PoolArea         1      0.0640 77.275 -4284.7
## + YrSold            1      0.0518 77.287 -4284.5
## + LowQualFinSF     1      0.0400 77.299 -4284.2
## + Street           1      0.0202 77.318 -4283.9
## + MiscVal          1      0.0074 77.331 -4283.6
## + KitchenAbvGr     1      0.0018 77.337 -4283.5
## + MoSold           1      0.0001 77.339 -4283.5
##
## Step:  AIC=-4690.89
## log(SalePrice) ~ OverallQual + Neighborhood
##
##           Df Sum of Sq    RSS    AIC
## + GrLivArea      1  14.8307 41.861 -5131.7
## + TotRmsAbvGrd   1   8.8439 47.848 -4936.5
## + X1stFlrSF      1   7.8819 48.810 -4907.4
## + GarageArea     1   7.3897 49.302 -4892.8
## + GarageCars     1   6.9623 49.730 -4880.2
## + TotalBsmtSF    1   5.4613 51.231 -4836.8
## + Fireplaces     1   4.3451 52.347 -4805.3
## + FullBath       1   4.2300 52.462 -4802.1
## + BsmtFinSF1     1   3.9123 52.780 -4793.3
## + KitchenQual    3   3.7012 52.991 -4783.5
## + GarageFinish   3   3.6762 53.016 -4782.8
## + BedroomAbvGr  1   3.3418 53.350 -4777.6
## + GarageType     6   3.4142 53.278 -4769.6
## + LotArea        1   3.0014 53.691 -4768.3
## + BldgType       4   3.1533 53.539 -4766.4
## + X2ndFlrSF     1   2.6774 54.015 -4759.5
## + YearRemodAdd   1   2.5956 54.096 -4757.3

```

## + WoodDeckSF	1	2.5094	54.183	-4755.0
## + BsmtQual	4	2.6538	54.038	-4752.9
## + BsmtFullBath	1	2.3895	54.303	-4751.8
## + BsmtExposure	4	2.5008	54.191	-4748.8
## + BsmtFinType1	6	2.5815	54.111	-4746.9
## + GarageQual	5	2.4065	54.286	-4744.2
## + CentralAir	1	2.0497	54.642	-4742.7
## + LotFrontage	1	1.9178	54.774	-4739.1
## + GarageCond	5	2.0588	54.633	-4734.9
## + HeatingQC	4	1.9632	54.729	-4734.3
## + SaleCondition	5	2.0300	54.662	-4734.1
## + HalfBath	1	1.6474	55.045	-4731.9
## + GarageYrBlt	1	1.5870	55.105	-4730.3
## + OverallCond	1	1.5535	55.139	-4729.5
## + OpenPorchSF	1	1.4910	55.201	-4727.8
## + Exterior1st	14	2.3335	54.359	-4724.3
## + ExterQual	3	1.5007	55.191	-4724.1
## + Heating	5	1.6279	55.064	-4723.4
## + HouseStyle	7	1.6004	55.092	-4718.7
## + MSZoning	4	1.3246	55.368	-4717.4
## + MasVnrArea	1	1.0431	55.649	-4716.0
## + ScreenPorch	1	1.0290	55.663	-4715.6
## + Foundation	5	1.2416	55.451	-4713.2
## + Electrical	4	1.1164	55.576	-4711.9
## + YearBuilt	1	0.7542	55.938	-4708.4
## + BsmtCond	4	0.9804	55.712	-4708.4
## + LotShape	3	0.8990	55.793	-4708.2
## + PavedDrive	2	0.7694	55.923	-4706.8
## + ExterCond	4	0.9161	55.776	-4706.7
## + LotConfig	4	0.8602	55.832	-4705.2
## + SaleType	8	1.1442	55.548	-4704.7
## + LandSlope	2	0.6446	56.047	-4703.6
## + MSSubClass	1	0.5201	56.172	-4702.3
## + YrRemodel_Diff	1	0.5087	56.183	-4702.1
## + Functional	6	0.8695	55.823	-4701.5
## + Exterior2nd	15	1.5265	55.166	-4700.7
## + MasVnrType	3	0.5692	56.123	-4699.6
## + BsmtFinType2	6	0.7725	55.920	-4698.9
## + RoofMatl	7	0.8273	55.865	-4698.4
## + BsmtFinSF2	1	0.2467	56.445	-4695.3
## + RoofStyle	5	0.4957	56.196	-4693.7
## + LandContour	3	0.3139	56.378	-4693.0
## + PoolArea	1	0.1577	56.534	-4693.0
## + Condition1	8	0.6691	56.023	-4692.2
## + X3SsnPorch	1	0.1245	56.568	-4692.1
## <none>			56.692	-4690.9
## + BsmtHalfBath	1	0.0528	56.639	-4690.3
## + LowQualFinSF	1	0.0450	56.647	-4690.1
## + BsmtUnfSF	1	0.0422	56.650	-4690.0
## + EnclosedPorch	1	0.0394	56.653	-4689.9

```

## + YrSold          1    0.0391 56.653 -4689.9
## + MiscVal         1    0.0134 56.679 -4689.2
## + KitchenAbvGr    1    0.0091 56.683 -4689.1
## + MoSold          1    0.0058 56.686 -4689.0
## + Street          1    0.0006 56.691 -4688.9
## + Condition2      7    0.3695 56.323 -4686.4
##
## Step:  AIC=-5131.67
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea
##
##           Df Sum of Sq  RSS    AIC
## + BsmtFinType1  6    4.0333 37.828 -5267.6
## + GarageCars    1    3.3599 38.501 -5251.8
## + GarageArea    1    3.1722 38.689 -5244.7
## + BsmtFullBath  1    3.0721 38.789 -5241.0
## + BsmtFinSF1    1    2.9336 38.928 -5235.7
## + OverallCond   1    2.8869 38.974 -5234.0
## + CentralAir    1    2.7254 39.136 -5228.0
## + BsmtExposure  4    2.8718 38.990 -5227.4
## + GarageFinish  3    2.8062 39.055 -5227.0
## + YearRemodAdd  1    2.4138 39.448 -5216.4
## + KitchenQual   3    2.4356 39.426 -5213.2
## + TotalBsmtSF   1    2.3262 39.535 -5213.1
## + GarageType    6    2.5298 39.332 -5210.7
## + BsmtQual      4    2.3219 39.540 -5207.0
## + RoofMatl      7    2.4252 39.436 -5204.8
## + GarageQual    5    2.1783 39.683 -5199.7
## + GarageCond    5    2.1443 39.717 -5198.4
## + YearBuilt     1    1.8474 40.014 -5195.6
## + BsmtCond      4    1.9759 39.885 -5194.3
## + GarageYrBlt   1    1.6910 40.170 -5189.9
## + X1stFlrSF     1    1.6902 40.171 -5189.8
## + HeatingQC     4    1.7803 40.081 -5187.1
## + HouseStyle    7    1.9078 39.954 -5185.8
## + MSSubClass    1    1.5449 40.317 -5184.6
## + X2ndFlrSF     1    1.5104 40.351 -5183.3
## + SaleCondition  5    1.6903 40.171 -5181.8
## + BldgType      4    1.6263 40.235 -5181.5
## + Foundation    5    1.6371 40.224 -5179.9
## + WoodDeckSF    1    1.2893 40.572 -5175.3
## + Fireplaces    1    1.2802 40.581 -5175.0
## + MSZoning      4    1.4021 40.459 -5173.4
## + ExterCond     4    1.2281 40.633 -5167.1
## + Heating       5    1.2265 40.635 -5165.1
## + Exterior1st   14    1.7227 40.139 -5165.0
## + PavedDrive    2    1.0542 40.807 -5164.9
## + KitchenAbvGr  1    0.9721 40.889 -5164.0
## + BsmtFinType2  6    1.1845 40.677 -5161.6
## + Electrical    4    1.0499 40.811 -5160.8
## + LotArea       1    0.8516 41.010 -5159.7

```

```

## + Exterior2nd      15      1.5681 40.293 -5157.4
## + ExterQual         3      0.8913 40.970 -5157.1
## + Functional        6      1.0400 40.821 -5156.4
## + ScreenPorch       1      0.5997 41.262 -5150.7
## + LandContour       3      0.6273 41.234 -5147.7
## + Condition1        8      0.8658 40.996 -5146.2
## + SaleType          8      0.8036 41.058 -5144.0
## + BsmtUnfSF         1      0.3871 41.474 -5143.2
## + LotConfig         4      0.5472 41.314 -5142.9
## + LotShape          3      0.4596 41.402 -5141.8
## + MasVnrType        3      0.4539 41.408 -5141.6
## + Condition2        7      0.6429 41.218 -5140.3
## + LandSlope         2      0.2941 41.567 -5138.0
## + OpenPorchSF       1      0.1984 41.663 -5136.6
## + LowQualFinSF      1      0.1619 41.699 -5135.3
## + BsmtFinSF2        1      0.1538 41.708 -5135.0
## + X3SsnPorch        1      0.1378 41.724 -5134.5
## + BedroomAbvGr      1      0.1326 41.729 -5134.3
## + LotFrontage       1      0.1175 41.744 -5133.8
## + YrRemodel_Diff    1      0.0922 41.769 -5132.9
## + MasVnrArea        1      0.0906 41.771 -5132.8
## + BsmtHalfBath      1      0.0850 41.776 -5132.6
## + EnclosedPorch     1      0.0753 41.786 -5132.3
## <none>              41.861 -5131.7
## + RoofStyle         5      0.2837 41.578 -5131.6
## + PoolArea          1      0.0441 41.817 -5131.2
## + FullBath          1      0.0163 41.845 -5130.2
## + MoSold            1      0.0103 41.851 -5130.0
## + YrSold            1      0.0057 41.856 -5129.9
## + Street            1      0.0028 41.859 -5129.8
## + HalfBath          1      0.0025 41.859 -5129.8
## + TotRmsAbvGrd      1      0.0007 41.861 -5129.7
## + MiscVal           1      0.0005 41.861 -5129.7
##
## Step:  AIC=-5267.58
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1
##
##           Df Sum of Sq  RSS    AIC
## + GarageCars      1    3.2614 34.567 -5397.2
## + GarageArea       1    2.7952 35.033 -5377.7
## + RoofMatl         7    2.6670 35.161 -5360.3
## + OverallCond      1    2.2531 35.575 -5355.2
## + GarageFinish     3    2.2301 35.598 -5350.3
## + CentralAir       1    2.0483 35.780 -5346.9
## + YearRemodAdd     1    1.9967 35.831 -5344.8
## + KitchenQual      3    1.9069 35.921 -5337.1
## + GarageType       6    2.0493 35.779 -5336.9
## + MSSubClass       1    1.7084 36.120 -5333.1
## + SaleCondition    5    1.8809 35.947 -5332.0
## + GarageQual       5    1.8331 35.995 -5330.1

```

## + GarageCond	5	1.7604	36.068	-5327.2
## + BldgType	4	1.6256	36.202	-5323.7
## + GarageYrBlt	1	1.3940	36.434	-5320.4
## + YearBuilt	1	1.3448	36.483	-5318.4
## + MSZoning	4	1.4555	36.373	-5316.9
## + X1stFlrSF	1	1.2772	36.551	-5315.7
## + HeatingQC	4	1.4133	36.415	-5315.2
## + HouseStyle	7	1.4595	36.369	-5311.0
## + X2ndFlrSF	1	1.1260	36.702	-5309.7
## + TotalBsmtSF	1	1.0102	36.818	-5305.1
## + BsmtExposure	4	1.1374	36.691	-5304.2
## + BsmtQual	3	1.0864	36.742	-5304.1
## + WoodDeckSF	1	0.8909	36.937	-5300.4
## + Fireplaces	1	0.8862	36.942	-5300.2
## + Heating	5	1.0232	36.805	-5297.6
## + Exterior1st	14	1.4477	36.380	-5296.6
## + ExterCond	4	0.9041	36.924	-5294.9
## + BsmtFullBath	1	0.7305	37.098	-5294.1
## + Exterior2nd	15	1.4088	36.419	-5293.0
## + LotArea	1	0.6908	37.137	-5292.5
## + Functional	6	0.9048	36.923	-5290.9
## + SaleType	8	1.0037	36.824	-5290.8
## + BsmtCond	3	0.7066	37.121	-5289.1
## + ExterQual	3	0.7000	37.128	-5288.9
## + Foundation	5	0.7540	37.074	-5287.0
## + ScreenPorch	1	0.5232	37.305	-5285.9
## + PavedDrive	2	0.5244	37.304	-5284.0
## + LandContour	3	0.5736	37.255	-5283.9
## + LotConfig	4	0.6063	37.222	-5283.2
## + KitchenAbvGr	1	0.4471	37.381	-5282.9
## + Condition2	7	0.7428	37.085	-5282.5
## + Electrical	4	0.5862	37.242	-5282.4
## + BsmtFinSF1	1	0.3717	37.456	-5280.0
## + Condition1	8	0.7237	37.104	-5279.8
## + LotShape	3	0.3268	37.501	-5274.2
## + MasVnrType	3	0.3038	37.524	-5273.4
## + LowQualFinSF	1	0.1518	37.676	-5271.5
## + FullBath	1	0.1429	37.685	-5271.1
## + BsmtFinType2	6	0.3783	37.450	-5270.3
## + OpenPorchSF	1	0.1121	37.716	-5269.9
## + YrRemodel_Diff	1	0.1093	37.719	-5269.8
## + X3SsnPorch	1	0.0978	37.730	-5269.4
## + LandSlope	2	0.1410	37.687	-5269.0
## + LotFrontage	1	0.0854	37.743	-5268.9
## + PoolArea	1	0.0771	37.751	-5268.6
## + BsmtUnfSF	1	0.0759	37.752	-5268.5
## + BsmtFinSF2	1	0.0756	37.752	-5268.5
## + TotRmsAbvGrd	1	0.0734	37.755	-5268.4
## <none>			37.828	-5267.6
## + EnclosedPorch	1	0.0487	37.779	-5267.5

```

## + RoofStyle      5      0.2534 37.575 -5267.4
## + MasVnrArea     1      0.0314 37.797 -5266.8
## + BedroomAbvGr   1      0.0173 37.811 -5266.3
## + BsmtHalfBath    1      0.0151 37.813 -5266.2
## + YrSold          1      0.0148 37.813 -5266.2
## + HalfBath        1      0.0060 37.822 -5265.8
## + Street          1      0.0009 37.827 -5265.6
## + MoSold          1      0.0002 37.828 -5265.6
## + MiscVal         1      0.0000 37.828 -5265.6
##
## Step:  AIC=-5397.22
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##      GarageCars
##
##           Df Sum of Sq   RSS   AIC
## + OverallCond      1   2.68084 31.886 -5513.1
## + RoofMatl         7   2.32484 32.242 -5484.9
## + YearRemodAdd     1   1.84148 32.725 -5475.1
## + CentralAir       1   1.78701 32.780 -5472.7
## + MSZoning         4   1.58248 32.984 -5457.6
## + MSSubClass       1   1.33750 33.229 -5452.8
## + KitchenQual      3   1.42642 33.140 -5452.7
## + SaleCondition    5   1.48390 33.083 -5451.3
## + BldgType         4   1.34823 33.219 -5447.3
## + HeatingQC        4   1.33884 33.228 -5446.9
## + GarageType       6   1.07359 33.493 -5431.3
## + X1stFlrSF        1   0.80855 33.758 -5429.8
## + Fireplaces       1   0.77487 33.792 -5428.3
## + WoodDeckSF       1   0.73027 33.836 -5426.4
## + X2ndFlrSF        1   0.72477 33.842 -5426.2
## + YearBuilt        1   0.70758 33.859 -5425.4
## + BsmtExposure     4   0.84039 33.726 -5425.2
## + HouseStyle       7   0.97433 33.592 -5425.0
## + BsmtQual         3   0.75903 33.808 -5423.6
## + GarageFinish     3   0.75852 33.808 -5423.6
## + Exterior1st     14   1.26414 33.303 -5423.6
## + TotalBsmtSF      1   0.65918 33.908 -5423.3
## + Functional       6   0.89025 33.677 -5423.3
## + Exterior2nd     15   1.26883 33.298 -5421.8
## + ExterCond        4   0.69335 33.873 -5418.8
## + LotArea          1   0.55291 34.014 -5418.8
## + Heating          5   0.72237 33.844 -5418.1
## + BsmtFullBath     1   0.52622 34.041 -5417.6
## + Condition2       7   0.80139 33.765 -5417.5
## + BsmtCond         3   0.61242 33.954 -5417.3
## + SaleType         8   0.83712 33.730 -5417.0
## + KitchenAbvGr     1   0.46441 34.102 -5415.0
## + ScreenPorch      1   0.45490 34.112 -5414.6
## + Foundation       5   0.62274 33.944 -5413.8
## + ExterQual        3   0.52416 34.043 -5413.5

```



```

## + LotConfig      4    0.55583 34.011 -5412.9
## + Condition1     8    0.68896 33.878 -5410.6
## + LandContour    3    0.43362 34.133 -5409.6
## + Electrical     4    0.44888 34.118 -5408.3
## + GarageYrBlt    1    0.29264 34.274 -5407.6
## + YrRemodel_Diff 1    0.28384 34.283 -5407.3
## + GarageQual     5    0.44636 34.120 -5406.2
## + BsmtFinSF1     1    0.24103 34.326 -5405.4
## + GarageCond     5    0.42388 34.143 -5405.2
## + LotShape       3    0.28105 34.286 -5403.1
## + PavedDrive     2    0.22017 34.347 -5402.5
## + GarageArea     1    0.12427 34.442 -5400.5
## + OpenPorchSF    1    0.12294 34.444 -5400.4
## + FullBath       1    0.10607 34.461 -5399.7
## + BsmtFinSF2     1    0.08177 34.485 -5398.7
## + X3SsnPorch     1    0.07323 34.494 -5398.3
## + LowQualFinSF   1    0.06578 34.501 -5398.0
## + BsmtFinType2   6    0.29932 34.267 -5397.9
## + TotRmsAbvGrd   1    0.06111 34.506 -5397.8
## <none>           34.567 -5397.2
## + LandSlope      2    0.09161 34.475 -5397.1
## + PoolArea       1    0.03978 34.527 -5396.9
## + MasVnrType     3    0.13317 34.434 -5396.9
## + BsmtUnfSF      1    0.03627 34.530 -5396.7
## + EnclosedPorch  1    0.02706 34.540 -5396.4
## + LotFrontage    1    0.01746 34.549 -5396.0
## + Street         1    0.01494 34.552 -5395.8
## + BsmtHalfBath   1    0.01274 34.554 -5395.8
## + YrSold         1    0.00528 34.561 -5395.4
## + MiscVal        1    0.00415 34.563 -5395.4
## + HalfBath       1    0.00185 34.565 -5395.3
## + MoSold         1    0.00022 34.567 -5395.2
## + BedroomAbvGr   1    0.00017 34.567 -5395.2
## + MasVnrArea     1    0.00007 34.567 -5395.2
## + RoofStyle      5    0.16528 34.401 -5394.2
##
## Step:  AIC=-5513.08
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##      GarageCars + OverallCond
##
##           Df Sum of Sq  RSS    AIC
## + RoofMatl    7   2.27801 29.608 -5607.3
## + YearBuilt    1   1.49762 30.388 -5581.3
## + MSSubClass   1   1.25422 30.632 -5569.7
## + TotalBsmtSF  1   1.25085 30.635 -5569.5
## + X1stFlrSF    1   1.24866 30.637 -5569.4
## + MSZoning     4   1.32667 30.559 -5567.1
## + X2ndFlrSF    1   1.14668 30.739 -5564.6
## + SaleCondition 5   1.26520 30.621 -5562.2
## + HouseStyle   7   1.33779 30.548 -5561.7

```

## + CentralAir	1	1.03044	30.855	-5559.0
## + BsmtQual	3	1.08554	30.800	-5557.7
## + BldgType	4	1.10194	30.784	-5556.4
## + Fireplaces	1	0.93522	30.951	-5554.5
## + GarageType	6	1.12506	30.761	-5553.5
## + KitchenQual	3	0.89158	30.994	-5548.5
## + GarageFinish	3	0.88369	31.002	-5548.1
## + BsmtExposure	4	0.90266	30.983	-5547.0
## + Foundation	5	0.85718	31.029	-5542.9
## + HeatingQC	4	0.81365	31.072	-5542.8
## + BsmtFullBath	1	0.68479	31.201	-5542.8
## + YearRemodAdd	1	0.67081	31.215	-5542.1
## + Exterior1st	14	1.21628	30.670	-5541.9
## + SaleType	8	0.90191	30.984	-5539.0
## + Exterior2nd	15	1.15492	30.731	-5536.9
## + WoodDeckSF	1	0.54978	31.336	-5536.5
## + LotArea	1	0.51965	31.366	-5535.1
## + Condition2	7	0.74628	31.140	-5533.7
## + Condition1	8	0.73299	31.153	-5531.0
## + ScreenPorch	1	0.42544	31.460	-5530.7
## + GarageYrBlt	1	0.41302	31.473	-5530.1
## + LandContour	3	0.47412	31.412	-5529.0
## + BsmtFinSF1	1	0.35427	31.532	-5527.4
## + LotConfig	4	0.46513	31.421	-5526.5
## + Heating	5	0.44622	31.440	-5523.7
## + KitchenAbvGr	1	0.26703	31.619	-5523.4
## + Functional	6	0.47572	31.410	-5523.0
## + ExterQual	3	0.31261	31.573	-5521.5
## + BsmtCond	3	0.30110	31.585	-5520.9
## + PavedDrive	2	0.21319	31.673	-5518.9
## + FullBath	1	0.14199	31.744	-5517.6
## + BsmtUnfSF	1	0.13784	31.748	-5517.4
## + OpenPorchSF	1	0.10284	31.783	-5515.8
## + LotShape	3	0.18447	31.701	-5515.6
## + GarageCond	5	0.26727	31.619	-5515.4
## + BsmtFinSF2	1	0.08857	31.797	-5515.1
## + MasVnrType	3	0.17318	31.713	-5515.0
## + GarageArea	1	0.08537	31.801	-5515.0
## + ExterCond	4	0.21390	31.672	-5514.9
## + YrRemodel_Diff	1	0.06715	31.819	-5514.2
## + GarageQual	5	0.23258	31.653	-5513.8
## + LowQualFinSF	1	0.05699	31.829	-5513.7
## + LandSlope	2	0.09762	31.788	-5513.6
## + X3SsnPorch	1	0.05227	31.834	-5513.5
## <none>			31.886	-5513.1
## + TotRmsAbvGrd	1	0.04314	31.843	-5513.1
## + RoofStyle	5	0.21246	31.673	-5512.8
## + PoolArea	1	0.03451	31.851	-5512.7
## + YrSold	1	0.03076	31.855	-5512.5
## + LotFrontage	1	0.03030	31.856	-5512.5

```

## + Electrical      4    0.14037 31.746 -5511.5
## + Street          1    0.00632 31.880 -5511.4
## + MasVnrArea       1    0.00614 31.880 -5511.4
## + EnclosedPorch    1    0.00613 31.880 -5511.4
## + HalfBath         1    0.00450 31.881 -5511.3
## + BedroomAbvGr     1    0.00375 31.882 -5511.3
## + MiscVal          1    0.00128 31.885 -5511.1
## + BsmtHalfBath     1    0.00071 31.885 -5511.1
## + MoSold           1    0.00003 31.886 -5511.1
## + BsmtFinType2     6    0.21041 31.676 -5510.7
##
## Step:  AIC=-5607.3
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##      GarageCars + OverallCond + RoofMatl
##
##              Df Sum of Sq   RSS   AIC
## + TotalBsmtSF    1   2.90424 26.704 -5756.0
## + X1stFlrSF      1   1.99539 27.613 -5707.2
## + YearBuilt       1   1.95626 27.652 -5705.1
## + X2ndFlrSF      1   1.80673 27.801 -5697.2
## + HouseStyle      7   1.80178 27.806 -5685.0
## + BsmtFinSF1      1   1.54204 28.066 -5683.4
## + MSSubClass      1   1.35829 28.250 -5673.9
## + SaleCondition   5   1.50583 28.102 -5673.5
## + MSZoning        4   1.34124 28.267 -5667.0
## + BsmtQual        3   1.23724 28.371 -5663.6
## + CentralAir      1   1.08308 28.525 -5659.7
## + Fireplaces      1   0.99470 28.613 -5655.2
## + GarageType      6   1.14393 28.464 -5652.8
## + BldgType        4   1.05148 28.556 -5652.1
## + KitchenQual     3   0.98352 28.624 -5650.6
## + BsmtExposure    4   1.01116 28.597 -5650.0
## + GarageFinish    3   0.94304 28.665 -5648.6
## + BsmtFullBath    1   0.85778 28.750 -5648.2
## + SaleType        8   1.12787 28.480 -5648.0
## + Foundation      5   0.96494 28.643 -5645.7
## + LotArea         1   0.72715 28.881 -5641.6
## + YearRemodAdd    1   0.71267 28.895 -5640.9
## + HeatingQC       4   0.82720 28.781 -5640.7
## + Condition2      7   0.86497 28.743 -5636.6
## + GarageYrBlt     1   0.55885 29.049 -5633.1
## + Exterior1st    14   1.01621 28.592 -5630.3
## + WoodDeckSF      1   0.49850 29.109 -5630.1
## + Functional      6   0.59815 29.010 -5625.1
## + ExterQual       3   0.45323 29.155 -5623.8
## + GarageArea      1   0.36788 29.240 -5623.6
## + Condition1      8   0.63728 28.971 -5623.1
## + ScreenPorch     1   0.35288 29.255 -5622.8
## + LotFrontage     1   0.35164 29.256 -5622.7
## + Exterior2nd    15   0.89033 28.718 -5621.9

```

```

## + KitchenAbvGr      1    0.32708 29.281 -5621.5
## + LotConfig         4    0.43328 29.175 -5620.8
## + Heating           5    0.44885 29.159 -5619.6
## + BsmtCond          3    0.33057 29.277 -5617.7
## + MasVnrType        3    0.30947 29.298 -5616.6
## + LandContour       3    0.28964 29.318 -5615.7
## + PavedDrive        2    0.24702 29.361 -5615.5
## + LotShape          3    0.23800 29.370 -5613.1
## + YrRemodel_Diff    1    0.13975 29.468 -5612.2
## + OpenPorchSF       1    0.13052 29.477 -5611.7
## + LowQualFinSF      1    0.11889 29.489 -5611.2
## + ExterCond         4    0.23775 29.370 -5611.1
## + GarageCond        5    0.26829 29.340 -5610.6
## + BsmtUnfSF         1    0.10340 29.505 -5610.4
## + RoofStyle         5    0.25652 29.351 -5610.0
## + BedroomAbvGr      1    0.08608 29.522 -5609.5
## + BsmtFinSF2        1    0.07421 29.534 -5609.0
## + X3SsnPorch        1    0.04834 29.560 -5607.7
## + FullBath          1    0.04632 29.562 -5607.6
## + PoolArea          1    0.04575 29.562 -5607.6
## + GarageQual        5    0.20616 29.402 -5607.5
## + <none>             29.608 -5607.3
## + MasVnrArea        1    0.03743 29.570 -5607.1
## + LandSlope         2    0.07030 29.538 -5606.8
## + YrSold            1    0.02406 29.584 -5606.5
## + HalfBath          1    0.02170 29.586 -5606.4
## + Electrical        4    0.14112 29.467 -5606.3
## + EnclosedPorch     1    0.00885 29.599 -5605.7
## + BsmtFinType2      6    0.20887 29.399 -5605.6
## + MoSold            1    0.00645 29.602 -5605.6
## + Street            1    0.00479 29.603 -5605.5
## + BsmtHalfBath      1    0.00270 29.605 -5605.4
## + MiscVal           1    0.00248 29.605 -5605.4
## + TotRmsAbvGrd     1    0.00001 29.608 -5605.3
##
## Step:  AIC=-5756.03
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##      GarageCars + OverallCond + RoofMatl + TotalBsmtSF
##
##           Df Sum of Sq  RSS    AIC
## + YearBuilt      1   1.54304 25.161 -5840.9
## + SaleCondition   5   1.23825 25.465 -5815.4
## + CentralAir      1   1.05279 25.651 -5812.8
## + Condition2      7   1.23158 25.472 -5811.0
## + MSZoning        4   1.11189 25.592 -5810.1
## + GarageFinish    3   0.85057 25.853 -5797.3
## + Fireplaces      1   0.76440 25.939 -5796.4
## + GarageType      6   0.89455 25.809 -5793.8
## + BsmtQual        3   0.77341 25.930 -5792.9
## + BldgType        4   0.78192 25.922 -5791.4

```

## + Foundation	5	0.78035	25.923	-5789.3
## + YearRemodAdd	1	0.61610	26.088	-5788.1
## + KitchenQual	3	0.66007	26.044	-5786.6
## + KitchenAbvGr	1	0.58717	26.116	-5786.5
## + BsmtUnfSF	1	0.58686	26.117	-5786.5
## + GarageYrBlt	1	0.58027	26.123	-5786.1
## + HeatingQC	4	0.68514	26.018	-5786.0
## + SaleType	8	0.82544	25.878	-5785.9
## + BsmtFinSF1	1	0.51797	26.186	-5782.6
## + BsmtFullBath	1	0.44883	26.255	-5778.8
## + Functional	6	0.60797	26.096	-5777.7
## + BsmtExposure	4	0.53531	26.168	-5777.6
## + WoodDeckSF	1	0.39250	26.311	-5775.6
## + LotArea	1	0.38717	26.317	-5775.4
## + HalfBath	1	0.35394	26.350	-5773.5
## + MSSubClass	1	0.35290	26.351	-5773.5
## + ScreenPorch	1	0.30960	26.394	-5771.1
## + Condition1	8	0.55658	26.147	-5770.8
## + PavedDrive	2	0.25938	26.444	-5766.3
## + LotConfig	4	0.32972	26.374	-5766.2
## + Heating	5	0.36496	26.339	-5766.1
## + GarageCond	5	0.35342	26.350	-5765.5
## + BsmtCond	3	0.28084	26.423	-5765.5
## + Exterior1st	14	0.66263	26.041	-5764.7
## + GarageQual	5	0.33196	26.372	-5764.3
## + GarageArea	1	0.17996	26.524	-5763.9
## + LotFrontage	1	0.14698	26.557	-5762.1
## + LandContour	3	0.20326	26.500	-5761.2
## + ExterQual	3	0.19745	26.506	-5760.9
## + LotShape	3	0.17389	26.530	-5759.6
## + LowQualFinSF	1	0.08976	26.614	-5758.9
## + YrRemodel_Diff	1	0.08808	26.616	-5758.9
## + ExterCond	4	0.19474	26.509	-5758.7
## + BsmtFinType2	6	0.24403	26.460	-5757.4
## + OpenPorchSF	1	0.06059	26.643	-5757.3
## + MasVnrType	3	0.13251	26.571	-5757.3
## + PoolArea	1	0.05370	26.650	-5757.0
## + Electrical	4	0.15106	26.553	-5756.3
## <none>			26.704	-5756.0
## + YrSold	1	0.03314	26.671	-5755.8
## + LandSlope	2	0.06568	26.638	-5755.6
## + X3SsnPorch	1	0.01763	26.686	-5755.0
## + BedroomAbvGr	1	0.01543	26.688	-5754.9
## + TotRmsAbvGrd	1	0.01344	26.690	-5754.8
## + FullBath	1	0.01129	26.692	-5754.6
## + MasVnrArea	1	0.00687	26.697	-5754.4
## + Street	1	0.00685	26.697	-5754.4
## + BsmtFinSF2	1	0.00508	26.699	-5754.3
## + MiscVal	1	0.00435	26.699	-5754.3
## + MoSold	1	0.00313	26.701	-5754.2

```

## + EnclosedPorch      1    0.00285 26.701 -5754.2
## + X1stFlrSF          1    0.00271 26.701 -5754.2
## + X2ndFlrSF          1    0.00110 26.703 -5754.1
## + BsmtHalfBath       1    0.00067 26.703 -5754.1
## + Exterior2nd       15    0.48438 26.219 -5752.8
## + HouseStyle         7    0.14436 26.559 -5749.9
## + RoofStyle          5    0.05206 26.652 -5748.9
##
## Step:  AIC=-5840.93
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##      GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt
##
##              Df Sum of Sq  RSS    AIC
## + Condition2    7   1.33836 23.822 -5906.7
## + MSZoning       4   1.18712 23.974 -5903.5
## + BldgType       4   1.11092 24.050 -5898.9
## + Fireplaces     1   0.88824 24.272 -5891.4
## + SaleCondition  5   1.01089 24.150 -5890.8
## + BsmtUnfSF      1   0.62803 24.533 -5875.8
## + LotArea        1   0.62313 24.538 -5875.5
## + CentralAir     1   0.58800 24.573 -5873.5
## + BsmtFinSF1     1   0.54543 24.615 -5870.9
## + KitchenAbvGr   1   0.50482 24.656 -5868.5
## + BsmtFullBath   1   0.50404 24.657 -5868.5
## + Functional     6   0.65949 24.501 -5867.7
## + MSSubClass     1   0.39871 24.762 -5862.3
## + KitchenQual    3   0.46461 24.696 -5862.1
## + BsmtExposure   4   0.49177 24.669 -5861.7
## + GarageFinish    3   0.45521 24.705 -5861.6
## + ScreenPorch    1   0.36455 24.796 -5860.2
## + BsmtQual       3   0.42929 24.731 -5860.1
## + GarageType     6   0.51565 24.645 -5859.2
## + WoodDeckSF     1   0.33132 24.829 -5858.3
## + SaleType       8   0.55900 24.602 -5857.7
## + HeatingQC      4   0.34822 24.812 -5853.3
## + LotFrontage    1   0.23774 24.923 -5852.8
## + Condition1     8   0.47002 24.691 -5852.5
## + LotConfig      4   0.29314 24.867 -5850.0
## + GarageArea     1   0.19023 24.970 -5850.0
## + YearRemodAdd   1   0.17735 24.983 -5849.3
## + YrRemodel_Diff 1   0.17735 24.983 -5849.3
## + HalfBath       1   0.17089 24.990 -5848.9
## + Heating        5   0.29886 24.862 -5848.4
## + LandContour    3   0.17260 24.988 -5845.0
## + GarageQual     5   0.22647 24.934 -5844.1
## + Foundation     5   0.22369 24.937 -5844.0
## + LotShape       3   0.15190 25.009 -5843.8
## + ExterQual      3   0.14546 25.015 -5843.4
## + PoolArea       1   0.06861 25.092 -5842.9
## + LowQualFinSF   1   0.05459 25.106 -5842.1

```

```

## + EnclosedPorch      1  0.05383 25.107 -5842.1
## + GarageCond         5  0.18661 24.974 -5841.8
## + Exterior1st       14  0.49154 24.669 -5841.7
## + LandSlope          2  0.08111 25.079 -5841.6
## + TotRmsAbvGrd       1  0.03891 25.122 -5841.2
## <none>                25.161 -5840.9
## + OpenPorchSF        1  0.02822 25.132 -5840.6
## + MasVnrType         3  0.09348 25.067 -5840.4
## + YrSold             1  0.02270 25.138 -5840.2
## + BsmtCond           3  0.09049 25.070 -5840.2
## + PavedDrive         2  0.05561 25.105 -5840.2
## + X1stFlrSF          1  0.02033 25.140 -5840.1
## + GarageYrBlt        1  0.02022 25.140 -5840.1
## + Street             1  0.01360 25.147 -5839.7
## + ExterCond           4  0.11577 25.045 -5839.7
## + FullBath           1  0.01120 25.149 -5839.6
## + X3SsnPorch         1  0.01043 25.150 -5839.5
## + BedroomAbvGr       1  0.00905 25.152 -5839.5
## + BsmtFinSF2          1  0.00710 25.154 -5839.3
## + MiscVal            1  0.00694 25.154 -5839.3
## + MoSold             1  0.00533 25.155 -5839.2
## + X2ndFlrSF          1  0.00531 25.155 -5839.2
## + BsmtHalfBath       1  0.00101 25.160 -5839.0
## + MasVnrArea         1  0.00046 25.160 -5839.0
## + BsmtFinType2       6  0.15885 25.002 -5838.2
## + Electrical         4  0.06542 25.095 -5836.7
## + RoofStyle          5  0.06568 25.095 -5834.7
## + HouseStyle         7  0.08394 25.077 -5831.8
## + Exterior2nd       15  0.23373 24.927 -5824.6
##
## Step:  AIC=-5906.73
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##      GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##      Condition2
##
##              Df Sum of Sq   RSS   AIC
## + MSZoning      4  1.21524 22.607 -5975.2
## + SaleCondition  5  1.13368 22.689 -5967.9
## + BldgType       4  1.10231 22.720 -5967.9
## + BsmtUnfSF      1  0.79456 23.028 -5954.3
## + Fireplaces     1  0.76822 23.054 -5952.6
## + BsmtFinSF1     1  0.71088 23.111 -5949.0
## + LotArea        1  0.70595 23.116 -5948.7
## + CentralAir     1  0.57533 23.247 -5940.4
## + Functional     6  0.71684 23.105 -5939.3
## + BsmtFullBath   1  0.49722 23.325 -5935.5
## + KitchenAbvGr   1  0.48927 23.333 -5935.0
## + SaleType       8  0.70002 23.122 -5934.3
## + KitchenQual    3  0.52612 23.296 -5933.3
## + BsmtQual       3  0.50321 23.319 -5931.9

```

## + BsmtExposure	4	0.50756	23.315	-5930.2
## + GarageFinish	3	0.46244	23.360	-5929.4
## + MSSubClass	1	0.37955	23.443	-5928.2
## + GarageType	6	0.49131	23.331	-5925.2
## + WoodDeckSF	1	0.32331	23.499	-5924.7
## + ScreenPorch	1	0.31885	23.503	-5924.4
## + LotFrontage	1	0.29471	23.528	-5922.9
## + GarageArea	1	0.26466	23.558	-5921.0
## + HeatingQC	4	0.32007	23.502	-5918.5
## + Condition1	8	0.40962	23.413	-5916.1
## + LotConfig	4	0.27357	23.549	-5915.6
## + HalfBath	1	0.16817	23.654	-5915.1
## + YearRemodAdd	1	0.16083	23.661	-5914.6
## + YrRemodel_Diff	1	0.16083	23.661	-5914.6
## + ExterQual	3	0.22526	23.597	-5914.6
## + Heating	5	0.28755	23.535	-5914.5
## + Exterior1st	14	0.53221	23.290	-5911.7
## + GarageQual	5	0.22350	23.599	-5910.5
## + LotShape	3	0.15254	23.670	-5910.1
## + Foundation	5	0.21002	23.612	-5909.7
## + LowQualFinSF	1	0.05841	23.764	-5908.3
## + PoolArea	1	0.05676	23.765	-5908.2
## + EnclosedPorch	1	0.05631	23.766	-5908.2
## + GarageCond	5	0.18350	23.639	-5908.0
## + LandSlope	2	0.08167	23.741	-5907.7
## + LandContour	3	0.11312	23.709	-5907.7
## + BedroomAbvGr	1	0.04299	23.779	-5907.4
## + OpenPorchSF	1	0.03589	23.786	-5906.9
## <none>			23.822	-5906.7
## + MasVnrType	3	0.09331	23.729	-5906.5
## + YrSold	1	0.02654	23.796	-5906.4
## + FullBath	1	0.02464	23.798	-5906.2
## + BsmtCond	3	0.08549	23.737	-5906.0
## + GarageYrBlt	1	0.01851	23.804	-5905.9
## + PavedDrive	2	0.04998	23.772	-5905.8
## + X1stFlrSF	1	0.01705	23.805	-5905.8
## + Street	1	0.01407	23.808	-5905.6
## + TotRmsAbvGrd	1	0.01018	23.812	-5905.4
## + MasVnrArea	1	0.00705	23.815	-5905.2
## + X3SsnPorch	1	0.00673	23.816	-5905.1
## + BsmtFinSF2	1	0.00534	23.817	-5905.1
## + X2ndFlrSF	1	0.00356	23.819	-5905.0
## + RoofStyle	5	0.13323	23.689	-5904.9
## + BsmtFinType2	6	0.16536	23.657	-5904.9
## + MoSold	1	0.00251	23.820	-5904.9
## + ExterCond	4	0.10015	23.722	-5904.9
## + BsmtHalfBath	1	0.00181	23.820	-5904.8
## + MiscVal	1	0.00030	23.822	-5904.8
## + Electrical	4	0.06823	23.754	-5902.9
## + HouseStyle	7	0.08382	23.738	-5897.9



```

## + Exterior2nd      15    0.27404 23.548 -5893.6
##
## Step:  AIC=-5975.18
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##      GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##      Condition2 + MSZoning
##
##              Df Sum of Sq    RSS    AIC
## + BsmtUnfSF      1    0.86022 21.747 -6029.8
## + SaleCondition    5    0.93920 21.668 -6027.1
## + BsmtFinSF1      1    0.78260 21.824 -6024.6
## + BldgType        4    0.86284 21.744 -6024.0
## + Fireplaces      1    0.72201 21.885 -6020.6
## + LotArea         1    0.65042 21.957 -6015.8
## + Functional      6    0.77390 21.833 -6014.0
## + BsmtFullBath    1    0.50195 22.105 -6006.0
## + BsmtExposure    4    0.57807 22.029 -6005.0
## + BsmtQual        3    0.54785 22.059 -6005.0
## + GarageFinish    3    0.53229 22.075 -6004.0
## + SaleType        8    0.67853 21.928 -6003.7
## + CentralAir      1    0.45324 22.154 -6002.7
## + KitchenQual     3    0.50423 22.103 -6002.1
## + KitchenAbvGr    1    0.39725 22.210 -5999.1
## + ScreenPorch     1    0.31617 22.291 -5993.7
## + GarageType      6    0.43295 22.174 -5991.4
## + WoodDeckSF      1    0.27028 22.337 -5990.7
## + HeatingQC       4    0.35840 22.249 -5990.5
## + GarageArea      1    0.23647 22.371 -5988.5
## + LotFrontage     1    0.22637 22.381 -5987.9
## + MSSubClass      1    0.22254 22.384 -5987.6
## + Exterior1st    14    0.59532 22.012 -5986.1
## + Heating         5    0.31614 22.291 -5985.7
## + YearRemodAdd     1    0.17917 22.428 -5984.8
## + YrRemodel_Diff  1    0.17917 22.428 -5984.8
## + Condition1      8    0.38586 22.221 -5984.3
## + LotConfig       4    0.22178 22.385 -5981.6
## + LandContour     3    0.18520 22.422 -5981.2
## + ExterQual       3    0.18084 22.426 -5980.9
## + GarageQual      5    0.23894 22.368 -5980.7
## + HalfBath        1    0.10391 22.503 -5979.9
## + Foundation      5    0.22273 22.384 -5979.6
## + BedroomAbvGr    1    0.07893 22.528 -5978.3
## + GarageCond      5    0.20183 22.405 -5978.3
## + LandSlope       2    0.10772 22.499 -5978.2
## + LotShape        3    0.13149 22.476 -5977.7
## + EnclosedPorch   1    0.06551 22.541 -5977.4
## + PoolArea        1    0.05714 22.550 -5976.9
## + OpenPorchSF     1    0.05580 22.551 -5976.8
## + MasVnrType      3    0.10507 22.502 -5976.0
## + LowQualFinSF    1    0.03643 22.571 -5975.5

```

```

## <none>                22.607 -5975.2
## + FullBath            1  0.02904 22.578 -5975.1
## + RoofStyle           5  0.15161 22.455 -5975.0
## + GarageYrBltd       1  0.02697 22.580 -5974.9
## + Electrical          4  0.11278 22.494 -5974.5
## + YrSold              1  0.01833 22.589 -5974.4
## + ExterCond           4  0.10932 22.498 -5974.3
## + X1stFlrSF           1  0.01651 22.590 -5974.2
## + MasVnrArea          1  0.01147 22.596 -5973.9
## + BsmtFinType2        6  0.16479 22.442 -5973.9
## + X2ndFlrSF           1  0.00514 22.602 -5973.5
## + X3SsnPorch          1  0.00478 22.602 -5973.5
## + BsmtFinSF2          1  0.00379 22.603 -5973.4
## + TotRmsAbvGrd        1  0.00377 22.603 -5973.4
## + BsmtCond            3  0.06401 22.543 -5973.3
## + Street              1  0.00137 22.606 -5973.3
## + PavedDrive          2  0.03167 22.575 -5973.2
## + MiscVal             1  0.00029 22.607 -5973.2
## + BsmtHalfBath        1  0.00004 22.607 -5973.2
## + MoSold              1  0.00001 22.607 -5973.2
## + Exterior2nd         15  0.34011 22.267 -5967.3
## + HouseStyle          7  0.08394 22.523 -5966.6
##
## Step:  AIC=-6029.82
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##      GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##      Condition2 + MSZoning + BsmtUnfSF
##
##              Df Sum of Sq  RSS    AIC
## + SaleCondition  5  1.01588 20.731 -6089.7
## + BldgType       4  0.84760 20.899 -6079.9
## + Functional     6  0.81280 20.934 -6073.4
## + Fireplaces     1  0.57990 21.167 -6067.3
## + LotArea        1  0.50117 21.246 -6061.9
## + SaleType       8  0.69315 21.054 -6061.1
## + CentralAir     1  0.43575 21.311 -6057.4
## + GarageFinish   3  0.43531 21.311 -6053.3
## + KitchenAbvGr   1  0.36983 21.377 -6052.9
## + KitchenQual    3  0.41831 21.328 -6052.2
## + BsmtQual       3  0.38222 21.365 -6049.7
## + HeatingQC      4  0.37871 21.368 -6047.5
## + ScreenPorch    1  0.28431 21.462 -6047.0
## + MSSubClass     1  0.27027 21.477 -6046.1
## + GarageType     6  0.41080 21.336 -6045.7
## + Exterior1st    14  0.63050 21.116 -6044.8
## + BsmtExposure   4  0.33648 21.410 -6044.6
## + LotFrontage    1  0.24400 21.503 -6044.3
## + Heating        5  0.32542 21.421 -6041.8
## + Condition1     8  0.40150 21.345 -6041.0
## + YearRemodAdd   1  0.17787 21.569 -6039.8

```

```

## + YrRemodel_Diff 1 0.17787 21.569 -6039.8
## + GarageArea 1 0.17229 21.575 -6039.4
## + WoodDeckSF 1 0.17061 21.576 -6039.3
## + Foundation 5 0.24821 21.499 -6036.6
## + GarageQual 5 0.23573 21.511 -6035.7
## + LotConfig 4 0.19613 21.551 -6035.0
## + ExterQual 3 0.16575 21.581 -6035.0
## + BsmtFullBath 1 0.10058 21.646 -6034.6
## + LandContour 3 0.15655 21.590 -6034.4
## + GarageCond 5 0.21078 21.536 -6034.0
## + HalfBath 1 0.06992 21.677 -6032.5
## + BsmtFinType2 6 0.21193 21.535 -6032.1
## + EnclosedPorch 1 0.06371 21.683 -6032.1
## + OpenPorchSF 1 0.05892 21.688 -6031.8
## + LotShape 3 0.10134 21.645 -6030.6
## + BsmtFinSF1 1 0.03736 21.709 -6030.3
## + BsmtFinSF2 1 0.03736 21.709 -6030.3
## + GarageYrBlt 1 0.03407 21.713 -6030.1
## + LowQualFinSF 1 0.03250 21.714 -6030.0
## + PoolArea 1 0.03015 21.717 -6029.8
## <none> 21.747 -6029.8
## + LandSlope 2 0.05699 21.690 -6029.6
## + ExterCond 4 0.11487 21.632 -6029.6
## + BedroomAbvGr 1 0.01860 21.728 -6029.1
## + TotRmsAbvGrd 1 0.01784 21.729 -6029.0
## + PavedDrive 2 0.04592 21.701 -6028.9
## + YrSold 1 0.01606 21.731 -6028.9
## + X3SsnPorch 1 0.01370 21.733 -6028.7
## + MasVnrArea 1 0.01325 21.734 -6028.7
## + X1stFlrSF 1 0.01247 21.734 -6028.7
## + MasVnrType 3 0.07182 21.675 -6028.6
## + Electrical 4 0.10117 21.646 -6028.6
## + FullBath 1 0.00967 21.737 -6028.5
## + X2ndFlrSF 1 0.00340 21.743 -6028.0
## + BsmtCond 3 0.06049 21.686 -6027.9
## + BsmtHalfBath 1 0.00084 21.746 -6027.9
## + Street 1 0.00021 21.747 -6027.8
## + MiscVal 1 0.00016 21.747 -6027.8
## + MoSold 1 0.00005 21.747 -6027.8
## + RoofStyle 5 0.11140 21.635 -6027.3
## + Exterior2nd 15 0.38850 21.358 -6026.1
## + HouseStyle 7 0.07279 21.674 -6020.7
##
## Step: AIC=-6089.66
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
## GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
## Condition2 + MSZoning + BsmtUnfSF + SaleCondition
##
## Df Sum of Sq RSS AIC
## + Functional 6 0.75692 19.974 -6132.0

```

## + BldgType	4	0.66487	20.066	-6129.3
## + Fireplaces	1	0.53321	20.198	-6125.7
## + CentralAir	1	0.50462	20.226	-6123.6
## + LotArea	1	0.46923	20.262	-6121.1
## + KitchenAbvGr	1	0.36545	20.366	-6113.6
## + KitchenQual	3	0.41469	20.316	-6113.2
## + GarageFinish	3	0.40221	20.329	-6112.3
## + ScreenPorch	1	0.29091	20.440	-6108.3
## + HeatingQC	4	0.35532	20.376	-6106.9
## + GarageType	6	0.36200	20.369	-6103.4
## + BsmtExposure	4	0.30415	20.427	-6103.2
## + Heating	5	0.32849	20.402	-6103.0
## + MSSubClass	1	0.21615	20.515	-6103.0
## + LotFrontage	1	0.20932	20.522	-6102.5
## + Condition1	8	0.39774	20.333	-6101.9
## + WoodDeckSF	1	0.19829	20.533	-6101.7
## + BsmtQual	3	0.24154	20.489	-6100.8
## + Exterior1st	14	0.50992	20.221	-6098.0
## + LotConfig	4	0.22909	20.502	-6097.9
## + GarageArea	1	0.13298	20.598	-6097.1
## + Foundation	5	0.24341	20.488	-6096.9
## + GarageCond	5	0.23880	20.492	-6096.6
## + YearRemodAdd	1	0.11856	20.612	-6096.0
## + YrRemodel_Diff	1	0.11856	20.612	-6096.0
## + GarageQual	5	0.22398	20.507	-6095.5
## + BsmtFullBath	1	0.09691	20.634	-6094.5
## + EnclosedPorch	1	0.07208	20.659	-6092.7
## + SaleType	8	0.26255	20.468	-6092.3
## + LandContour	3	0.11574	20.615	-6091.8
## + BsmtFinType2	6	0.19897	20.532	-6091.7
## + PoolArea	1	0.05573	20.675	-6091.6
## + LotShape	3	0.11101	20.620	-6091.5
## + ExterQual	3	0.10730	20.624	-6091.2
## + HalfBath	1	0.04820	20.683	-6091.1
## + OpenPorchSF	1	0.04625	20.685	-6090.9
## + ExterCond	4	0.12621	20.605	-6090.6
## + PavedDrive	2	0.06591	20.665	-6090.3
## + LandSlope	2	0.06311	20.668	-6090.1
## <none>			20.731	-6089.7
## + GarageYrBlt	1	0.02436	20.707	-6089.4
## + LowQualFinSF	1	0.02329	20.708	-6089.3
## + BsmtFinSF1	1	0.02318	20.708	-6089.3
## + BsmtFinSF2	1	0.02318	20.708	-6089.3
## + X1stFlrSF	1	0.01938	20.712	-6089.0
## + BsmtCond	3	0.07572	20.655	-6089.0
## + Electrical	4	0.10216	20.629	-6088.9
## + X3SsnPorch	1	0.01329	20.718	-6088.6
## + FullBath	1	0.01191	20.719	-6088.5
## + BedroomAbvGr	1	0.01154	20.719	-6088.5
## + MasVnrArea	1	0.00886	20.722	-6088.3

```

## + TotRmsAbvGrd      1    0.00878 20.722 -6088.3
## + X2ndFlrSF          1    0.00853 20.722 -6088.3
## + YrSold             1    0.00754 20.723 -6088.2
## + MoSold            1    0.00166 20.729 -6087.8
## + Street            1    0.00081 20.730 -6087.7
## + MiscVal           1    0.00061 20.730 -6087.7
## + BsmtHalfBath       1    0.00012 20.731 -6087.7
## + MasVnrType         3    0.02861 20.702 -6085.7
## + RoofStyle          5    0.07436 20.657 -6084.9
## + HouseStyle         7    0.07926 20.652 -6081.3
## + Exterior2nd       15    0.29304 20.438 -6080.4
##
## Step:  AIC=-6131.97
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##      GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##      Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional
##
##              Df Sum of Sq    RSS    AIC
## + BldgType      4    0.68963 19.284 -6175.3
## + Fireplaces    1    0.51719 19.457 -6168.3
## + CentralAir    1    0.50983 19.464 -6167.7
## + LotArea       1    0.47464 19.499 -6165.1
## + KitchenAbvGr  1    0.40830 19.566 -6160.1
## + KitchenQual   3    0.41416 19.560 -6156.6
## + HeatingQC     4    0.40071 19.573 -6153.6
## + GarageFinish  3    0.35338 19.621 -6152.0
## + ScreenPorch   1    0.28581 19.688 -6151.0
## + Condition1    8    0.46057 19.513 -6150.0
## + Heating       5    0.34714 19.627 -6147.6
## + MSSubClass    1    0.21946 19.755 -6146.1
## + YearRemodAdd  1    0.20989 19.764 -6145.4
## + YrRemodel_Diff 1    0.20989 19.764 -6145.4
## + WoodDeckSF    1    0.19835 19.776 -6144.5
## + BsmtQual       3    0.24074 19.733 -6143.7
## + Exterior1st   14    0.52825 19.446 -6143.1
## + LotFrontage   1    0.17823 19.796 -6143.1
## + BsmtExposure   4    0.25464 19.719 -6142.7
## + GarageType     6    0.30006 19.674 -6142.1
## + LotConfig      4    0.22495 19.749 -6140.5
## + GarageArea     1    0.13752 19.837 -6140.1
## + GarageCond     5    0.22737 19.747 -6138.7
## + Foundation     5    0.21791 19.756 -6138.0
## + SaleType       8    0.28413 19.690 -6136.9
## + BsmtFullBath   1    0.08708 19.887 -6136.3
## + GarageQual     5    0.18250 19.791 -6135.4
## + EnclosedPorch  1    0.07111 19.903 -6135.2
## + LandContour    3    0.11817 19.856 -6134.6
## + ExterQual      3    0.11789 19.856 -6134.6
## + OpenPorchSF    1    0.05549 19.919 -6134.0
## + LotShape       3    0.10664 19.867 -6133.8

```

```

## + X1stFlrSF      1  0.04514 19.929 -6133.3
## + BsmtFinType2   6  0.18083 19.793 -6133.2
## + PoolArea       1  0.03574 19.938 -6132.6
## + BedroomAbvGr   1  0.03483 19.939 -6132.5
## + LandSlope       2  0.05932 19.915 -6132.3
## + HalfBath        1  0.03176 19.942 -6132.3
## + X2ndFlrSF      1  0.03043 19.944 -6132.2
## <none>           19.974 -6132.0
## + BsmtCond        3  0.08020 19.894 -6131.8
## + GarageYrBlt     1  0.02486 19.949 -6131.8
## + Electrical      4  0.10205 19.872 -6131.4
## + PavedDrive      2  0.04108 19.933 -6131.0
## + LowQualFinSF    1  0.01239 19.962 -6130.9
## + X3SsnPorch      1  0.01209 19.962 -6130.9
## + BsmtFinSF1      1  0.00793 19.966 -6130.5
## + BsmtFinSF2      1  0.00793 19.966 -6130.5
## + FullBath        1  0.00601 19.968 -6130.4
## + MoSold          1  0.00408 19.970 -6130.3
## + MasVnrArea      1  0.00361 19.970 -6130.2
## + YrSold           1  0.00353 19.971 -6130.2
## + TotRmsAbvGrd    1  0.00242 19.972 -6130.1
## + Street          1  0.00174 19.972 -6130.1
## + BsmtHalfBath    1  0.00114 19.973 -6130.1
## + MiscVal         1  0.00051 19.974 -6130.0
## + RoofStyle       5  0.08856 19.885 -6128.5
## + ExterCond        4  0.05848 19.916 -6128.2
## + MasVnrType       3  0.01334 19.961 -6126.9
## + HouseStyle       7  0.09890 19.875 -6125.2
## + Exterior2nd     15  0.27717 19.697 -6122.4
##
## Step:  AIC=-6175.27
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##   GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##   Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##   BldgType
##
##           Df Sum of Sq   RSS   AIC
## + CentralAir      1  0.44010 18.844 -6207.0
## + LotArea          1  0.42511 18.859 -6205.8
## + Fireplaces       1  0.39250 18.892 -6203.3
## + KitchenQual      3  0.36920 18.915 -6197.5
## + Heating          5  0.40704 18.877 -6196.4
## + ScreenPorch      1  0.27047 19.014 -6193.9
## + HeatingQC        4  0.33813 18.946 -6193.1
## + Condition1       8  0.42125 18.863 -6191.5
## + BsmtExposure     4  0.29593 18.988 -6189.8
## + Exterior1st     14  0.55306 18.731 -6189.8
## + YearRemodAdd     1  0.20351 19.081 -6188.8
## + YrRemodel_Diff   1  0.20351 19.081 -6188.8
## + WoodDeckSF       1  0.15239 19.132 -6184.9

```

```

## + GarageFinish      3    0.19578 19.089 -6184.2
## + BsmtQual          3    0.18481 19.100 -6183.3
## + BsmtFullBath      1    0.12972 19.155 -6183.1
## + LotConfig         4    0.18408 19.100 -6181.3
## + SaleType          8    0.28555 18.999 -6181.0
## + Foundation        5    0.19835 19.086 -6180.4
## + GarageArea        1    0.09148 19.193 -6180.2
## + GarageCond        5    0.19556 19.089 -6180.1
## + KitchenAbvGr      1    0.08398 19.200 -6179.6
## + BsmtFinType2      6    0.20672 19.078 -6179.0
## + LotFrontage       1    0.07370 19.211 -6178.9
## + LandContour       3    0.11952 19.165 -6178.3
## + ExterQual         3    0.10511 19.179 -6177.2
## + X1stFlrSF         1    0.04894 19.235 -6177.0
## + EnclosedPorch     1    0.04884 19.235 -6177.0
## + LotShape          3    0.09756 19.187 -6176.7
## + GarageQual        5    0.14554 19.139 -6176.3
## + GarageYrBlt       1    0.03500 19.249 -6175.9
## + BedroomAbvGr      1    0.03409 19.250 -6175.9
## + X2ndFlrSF         1    0.03247 19.252 -6175.7
## + BsmtCond          3    0.08438 19.200 -6175.7
## + HalfBath          1    0.03129 19.253 -6175.6
## + OpenPorchSF       1    0.02665 19.258 -6175.3
## <none>              19.284 -6175.3
## + PoolArea          1    0.02523 19.259 -6175.2
## + LandSlope         2    0.04668 19.238 -6174.8
## + PavedDrive        2    0.04462 19.240 -6174.7
## + GarageType        6    0.14779 19.137 -6174.5
## + LowQualFinSF      1    0.01461 19.270 -6174.4
## + X3SsnPorch        1    0.00976 19.275 -6174.0
## + BsmtFinSF1        1    0.00802 19.276 -6173.9
## + BsmtFinSF2        1    0.00802 19.276 -6173.9
## + YrSold            1    0.00587 19.279 -6173.7
## + Electrical        4    0.08483 19.200 -6173.7
## + MasVnrArea        1    0.00563 19.279 -6173.7
## + TotRmsAbvGrd      1    0.00529 19.279 -6173.7
## + FullBath          1    0.00170 19.283 -6173.4
## + MoSold            1    0.00145 19.283 -6173.4
## + Street            1    0.00091 19.284 -6173.3
## + MiscVal           1    0.00037 19.284 -6173.3
## + BsmtHalfBath      1    0.00026 19.284 -6173.3
## + MSSubClass        1    0.00012 19.284 -6173.3
## + ExterCond         4    0.07639 19.208 -6173.1
## + RoofStyle         5    0.09238 19.192 -6172.3
## + MasVnrType        3    0.02466 19.260 -6171.1
## + HouseStyle        7    0.09461 19.190 -6168.4
## + Exterior2nd      15    0.24971 19.035 -6164.3
##
## Step:  AIC=-6206.97
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +

```

```
## GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
## Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
## BldgType + CentralAir
##
```

	Df	Sum of Sq	RSS	AIC
## + LotArea	1	0.39178	18.453	-6235.6
## + Fireplaces	1	0.32203	18.522	-6230.1
## + KitchenQual	3	0.35548	18.489	-6228.8
## + Condition1	8	0.44278	18.401	-6225.7
## + ScreenPorch	1	0.24817	18.596	-6224.3
## + Heating	5	0.34285	18.501	-6223.8
## + BsmtExposure	4	0.30515	18.539	-6222.8
## + Exterior1st	14	0.52330	18.321	-6220.1
## + YearRemodAdd	1	0.18980	18.654	-6219.8
## + YrRemodel_Diff	1	0.18980	18.654	-6219.8
## + BsmtQual	3	0.22973	18.614	-6218.9
## + WoodDeckSF	1	0.14231	18.702	-6216.0
## + HeatingQC	4	0.21833	18.626	-6216.0
## + LotConfig	4	0.21087	18.633	-6215.4
## + BsmtFullBath	1	0.12495	18.719	-6214.7
## + GarageFinish	3	0.17531	18.669	-6214.6
## + SaleType	8	0.29787	18.546	-6214.2
## + Foundation	5	0.20137	18.643	-6212.7
## + BsmtFinType2	6	0.22515	18.619	-6212.5
## + LotFrontage	1	0.07126	18.773	-6210.5
## + ExterQual	3	0.12083	18.723	-6210.4
## + GarageArea	1	0.06721	18.777	-6210.2
## + KitchenAbvGr	1	0.06215	18.782	-6209.8
## + LotShape	3	0.10839	18.736	-6209.4
## + LandContour	3	0.10069	18.744	-6208.8
## + BedroomAbvGr	1	0.04860	18.796	-6208.7
## + OpenPorchSF	1	0.04849	18.796	-6208.7
## + EnclosedPorch	1	0.04223	18.802	-6208.2
## + HalfBath	1	0.03469	18.810	-6207.7
## + X1stFlrSF	1	0.03273	18.812	-6207.5
## + PoolArea	1	0.02591	18.818	-6207.0
## <none>			18.844	-6207.0
## + LowQualFinSF	1	0.02522	18.819	-6206.9
## + GarageCond	5	0.12192	18.722	-6206.5
## + LandSlope	2	0.04450	18.800	-6206.4
## + X2ndFlrSF	1	0.01699	18.827	-6206.3
## + GarageYrBlt	1	0.01177	18.832	-6205.9
## + X3SsnPorch	1	0.00975	18.834	-6205.7
## + GarageQual	5	0.11173	18.733	-6205.7
## + MasVnrArea	1	0.00679	18.837	-6205.5
## + BsmtFinSF1	1	0.00588	18.838	-6205.4
## + BsmtFinSF2	1	0.00588	18.838	-6205.4
## + BsmtCond	3	0.05685	18.787	-6205.4
## + FullBath	1	0.00524	18.839	-6205.4
## + YrSold	1	0.00378	18.840	-6205.3



```

## + TotRmsAbvGrd      1    0.00309 18.841 -6205.2
## + MoSold             1    0.00153 18.843 -6205.1
## + MSSubClass         1    0.00145 18.843 -6205.1
## + Street             1    0.00118 18.843 -6205.1
## + MiscVal            1    0.00052 18.844 -6205.0
## + BsmtHalfBath       1    0.00026 18.844 -6205.0
## + PavedDrive         2    0.02510 18.819 -6204.9
## + ExterCond          4    0.07523 18.769 -6204.8
## + RoofStyle          5    0.09963 18.745 -6204.7
## + GarageType         6    0.11129 18.733 -6203.6
## + MasVnrType         3    0.02822 18.816 -6203.2
## + HouseStyle         7    0.10267 18.742 -6201.0
## + Electrical         4    0.01533 18.829 -6200.2
## + Exterior2nd       15    0.26576 18.578 -6197.7
##
## Step:  AIC=-6235.65
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##      GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##      Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##      BldgType + CentralAir + LotArea
##
##              Df Sum of Sq   RSS   AIC
## + KitchenQual    3    0.37533 18.077 -6259.7
## + Condition1     8    0.44659 18.006 -6255.4
## + ScreenPorch    1    0.26108 18.191 -6254.5
## + Fireplaces     1    0.25465 18.198 -6253.9
## + Heating        5    0.31566 18.137 -6250.8
## + YearRemodAdd   1    0.20311 18.249 -6249.8
## + YrRemodel_Diff 1    0.20311 18.249 -6249.8
## + BsmtQual       3    0.24769 18.205 -6249.4
## + Exterior1st   14    0.49964 17.953 -6247.7
## + HeatingQC      4    0.23640 18.216 -6246.5
## + BsmtExposure   4    0.22061 18.232 -6245.2
## + Foundation     5    0.22438 18.228 -6243.5
## + WoodDeckSF     1    0.11776 18.335 -6243.0
## + SaleType       8    0.28986 18.163 -6242.8
## + GarageFinish   3    0.16199 18.291 -6242.5
## + BsmtFullBath   1    0.10418 18.348 -6241.9
## + BsmtFinType2   6    0.22441 18.228 -6241.5
## + LotConfig      4    0.15795 18.295 -6240.2
## + LandSlope      2    0.10400 18.349 -6239.9
## + ExterQual      3    0.12688 18.326 -6239.7
## + GarageArea     1    0.06613 18.386 -6238.9
## + EnclosedPorch  1    0.05184 18.401 -6237.8
## + OpenPorchSF    1    0.04706 18.405 -6237.4
## + BedroomAbvGr   1    0.04284 18.410 -6237.0
## + HalfBath       1    0.04219 18.410 -6237.0
## + KitchenAbvGr   1    0.03997 18.413 -6236.8
## + LotFrontage    1    0.03933 18.413 -6236.8
## + PoolArea       1    0.02614 18.426 -6235.7

```

```

## <none> 18.453 -6235.6
## + X1stFlrSF 1 0.02187 18.431 -6235.4
## + LowQualFinSF 1 0.02131 18.431 -6235.3
## + LandContour 3 0.06837 18.384 -6235.1
## + GarageYrBlt 1 0.01773 18.435 -6235.1
## + GarageCond 5 0.11761 18.335 -6235.0
## + GarageQual 5 0.11325 18.339 -6234.6
## + Street 1 0.01085 18.442 -6234.5
## + X2ndFlrSF 1 0.01037 18.442 -6234.5
## + BsmtFinSF1 1 0.00991 18.443 -6234.4
## + BsmtFinSF2 1 0.00991 18.443 -6234.4
## + X3SsnPorch 1 0.00749 18.445 -6234.2
## + TotRmsAbvGrd 1 0.00714 18.445 -6234.2
## + MasVnrArea 1 0.00567 18.447 -6234.1
## + YrSold 1 0.00406 18.448 -6234.0
## + FullBath 1 0.00375 18.449 -6233.9
## + MSSubClass 1 0.00303 18.450 -6233.9
## + RoofStyle 5 0.10318 18.349 -6233.8
## + MoSold 1 0.00163 18.451 -6233.8
## + BsmtHalfBath 1 0.00100 18.451 -6233.7
## + PavedDrive 2 0.02545 18.427 -6233.7
## + MiscVal 1 0.00000 18.453 -6233.6
## + BsmtCond 3 0.04977 18.403 -6233.6
## + MasVnrType 3 0.04263 18.410 -6233.0
## + ExterCond 4 0.06306 18.389 -6232.6
## + LotShape 3 0.02715 18.425 -6231.8
## + GarageType 6 0.09867 18.354 -6231.5
## + HouseStyle 7 0.10552 18.347 -6230.0
## + Electrical 4 0.01422 18.438 -6228.8
## + Exterior2nd 15 0.25280 18.200 -6225.8
##
## Step: AIC=-6259.65
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
## GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
## Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
## BldgType + CentralAir + LotArea + KitchenQual
##
## Df Sum of Sq RSS AIC
## + ScreenPorch 1 0.24879 17.828 -6277.9
## + Condition1 8 0.41627 17.661 -6277.7
## + Fireplaces 1 0.24301 17.834 -6277.4
## + Heating 5 0.30626 17.771 -6274.6
## + BsmtExposure 4 0.23952 17.838 -6271.1
## + SaleType 8 0.31694 17.760 -6269.5
## + YearRemodAdd 1 0.13149 17.946 -6268.3
## + YrRemodel_Diff 1 0.13149 17.946 -6268.3
## + Exterior1st 14 0.44390 17.633 -6268.0
## + BsmtQual 3 0.17481 17.902 -6267.8
## + HeatingQC 4 0.19565 17.881 -6267.5
## + WoodDeckSF 1 0.12087 17.956 -6267.4

```

## + Foundation	5	0.20658	17.871	-6266.4
## + GarageFinish	3	0.15403	17.923	-6266.1
## + LotConfig	4	0.17261	17.905	-6265.7
## + BsmtFullBath	1	0.09012	17.987	-6264.9
## + BsmtFinType2	6	0.20609	17.871	-6264.4
## + LandSlope	2	0.10621	17.971	-6264.3
## + GarageArea	1	0.06795	18.009	-6263.1
## + EnclosedPorch	1	0.04364	18.034	-6261.2
## + OpenPorchSF	1	0.04212	18.035	-6261.1
## + LotFrontage	1	0.04190	18.035	-6261.0
## + KitchenAbvGr	1	0.03714	18.040	-6260.7
## + HalfBath	1	0.03237	18.045	-6260.3
## + GarageCond	5	0.13019	17.947	-6260.2
## <none>			18.077	-6259.7
## + GarageQual	5	0.12308	17.954	-6259.6
## + LowQualFinSF	1	0.02341	18.054	-6259.5
## + PoolArea	1	0.02079	18.056	-6259.3
## + LandContour	3	0.06983	18.007	-6259.3
## + BedroomAbvGr	1	0.02023	18.057	-6259.3
## + X1stFlrSF	1	0.01956	18.058	-6259.2
## + GarageYrBlt	1	0.01154	18.066	-6258.6
## + Street	1	0.00892	18.068	-6258.4
## + X2ndFlrSF	1	0.00848	18.069	-6258.3
## + YrSold	1	0.00778	18.069	-6258.3
## + FullBath	1	0.00776	18.069	-6258.3
## + X3SsnPorch	1	0.00776	18.069	-6258.3
## + BsmtFinSF1	1	0.00716	18.070	-6258.2
## + BsmtFinSF2	1	0.00716	18.070	-6258.2
## + MasVnrArea	1	0.00642	18.071	-6258.2
## + MSSubClass	1	0.00438	18.073	-6258.0
## + TotRmsAbvGrd	1	0.00420	18.073	-6258.0
## + MoSold	1	0.00098	18.076	-6257.7
## + BsmtHalfBath	1	0.00090	18.076	-6257.7
## + MiscVal	1	0.00029	18.077	-6257.7
## + BsmtCond	3	0.04971	18.027	-6257.7
## + PavedDrive	2	0.02418	18.053	-6257.6
## + GarageType	6	0.12180	17.955	-6257.5
## + MasVnrType	3	0.04497	18.032	-6257.3
## + RoofStyle	5	0.09410	17.983	-6257.3
## + ExterCond	4	0.05954	18.018	-6256.5
## + ExterQual	3	0.02948	18.048	-6256.0
## + LotShape	3	0.02723	18.050	-6255.9
## + HouseStyle	7	0.11283	17.964	-6254.8
## + Electrical	4	0.00686	18.070	-6252.2
## + Exterior2nd	15	0.19040	17.887	-6245.1

##

## Step: AIC=-6277.88

## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +

## GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +

## Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +

## BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch

##

##	Df	Sum of Sq	RSS	AIC
## + Condition1	8	0.40511	17.423	-6295.4
## + Heating	5	0.30113	17.527	-6292.8
## + Fireplaces	1	0.19201	17.636	-6291.7
## + WoodDeckSF	1	0.17139	17.657	-6290.0
## + BsmtExposure	4	0.23272	17.596	-6289.1
## + SaleType	8	0.32737	17.501	-6288.9
## + YearRemodAdd	1	0.13798	17.690	-6287.2
## + YrRemodel_Diff	1	0.13798	17.690	-6287.2
## + HeatingQC	4	0.20922	17.619	-6287.1
## + BsmtQual	3	0.17176	17.657	-6286.0
## + Exterior1st	14	0.42787	17.401	-6285.4
## + Foundation	5	0.21186	17.616	-6285.3
## + GarageFinish	3	0.15119	17.677	-6284.3
## + BsmtFullBath	1	0.09386	17.735	-6283.6
## + LotConfig	4	0.16359	17.665	-6283.3
## + BsmtFinType2	6	0.20992	17.619	-6283.2
## + LandSlope	2	0.10143	17.727	-6282.2
## + EnclosedPorch	1	0.07475	17.754	-6282.0
## + GarageArea	1	0.06824	17.760	-6281.5
## + LotFrontage	1	0.04439	17.784	-6279.5
## + KitchenAbvGr	1	0.03339	17.795	-6278.6
## + OpenPorchSF	1	0.03186	17.797	-6278.5
## + LandContour	3	0.07795	17.750	-6278.3
## + LowQualFinSF	1	0.02600	17.802	-6278.0
## + X1stFlrSF	1	0.02524	17.803	-6278.0
## <none>			17.828	-6277.9
## + HalfBath	1	0.02112	17.807	-6277.6
## + BedroomAbvGr	1	0.02070	17.808	-6277.6
## + GarageCond	5	0.11689	17.712	-6277.5
## + GarageQual	5	0.11608	17.712	-6277.4
## + PoolArea	1	0.01711	17.811	-6277.3
## + Street	1	0.01503	17.813	-6277.1
## + GarageYrBlt	1	0.01318	17.815	-6277.0
## + X3SsnPorch	1	0.01199	17.816	-6276.9
## + X2ndFlrSF	1	0.01170	17.817	-6276.8
## + BsmtFinSF1	1	0.01116	17.817	-6276.8
## + BsmtFinSF2	1	0.01116	17.817	-6276.8
## + FullBath	1	0.01088	17.817	-6276.8
## + YrSold	1	0.00906	17.819	-6276.6
## + TotRmsAbvGrd	1	0.00584	17.823	-6276.4
## + MSSubClass	1	0.00448	17.824	-6276.3
## + MasVnrArea	1	0.00374	17.825	-6276.2
## + GarageType	6	0.12322	17.705	-6276.0
## + MoSold	1	0.00134	17.827	-6276.0
## + BsmtHalfBath	1	0.00078	17.828	-6275.9
## + MiscVal	1	0.00000	17.828	-6275.9
## + RoofStyle	5	0.09538	17.733	-6275.7

```

## + BsmtCond      3    0.04530 17.783 -6275.6
## + PavedDrive    2    0.01838 17.810 -6275.4
## + MasVnrType     3    0.04082 17.788 -6275.2
## + ExterCond      4    0.06078 17.768 -6274.9
## + ExterQual      3    0.02743 17.801 -6274.1
## + HouseStyle     7    0.11861 17.710 -6273.6
## + LotShape       3    0.01804 17.810 -6273.4
## + Electrical     4    0.00776 17.821 -6270.5
## + Exterior2nd    15   0.18204 17.646 -6262.9
##
## Step:  AIC=-6295.44
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##      GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##      Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##      BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##      Condition1
##
##              Df Sum of Sq    RSS    AIC
## + Fireplaces      1    0.20637 17.217 -6310.8
## + Heating          5    0.27626 17.147 -6308.8
## + SaleType         8    0.33152 17.092 -6307.5
## + Exterior1st     14    0.46882 16.954 -6307.3
## + BsmtExposure     4    0.22744 17.196 -6306.6
## + WoodDeckSF       1    0.14209 17.281 -6305.4
## + HeatingQC        4    0.20516 17.218 -6304.7
## + YearRemodAdd     1    0.12120 17.302 -6303.6
## + YrRemodel_Diff   1    0.12120 17.302 -6303.6
## + Foundation       5    0.21221 17.211 -6303.3
## + BsmtQual         3    0.15435 17.269 -6302.4
## + BsmtFullBath     1    0.10393 17.319 -6302.2
## + LotConfig        4    0.17143 17.252 -6301.9
## + LandSlope        2    0.11857 17.305 -6301.4
## + EnclosedPorch    1    0.08241 17.341 -6300.4
## + BsmtFinType2     6    0.19987 17.223 -6300.3
## + GarageFinish     3    0.12819 17.295 -6300.2
## + GarageArea       1    0.07735 17.346 -6299.9
## + LotFrontage      1    0.05135 17.372 -6297.8
## + LandContour      3    0.09284 17.330 -6297.2
## + KitchenAbvGr     1    0.03251 17.391 -6296.2
## + GarageCond       5    0.12350 17.300 -6295.8
## + OpenPorchSF      1    0.02750 17.396 -6295.7
## + PoolArea         1    0.02456 17.399 -6295.5
## + GarageQual       5    0.11941 17.304 -6295.5
## + X1stFlrSF        1    0.02425 17.399 -6295.5
## <none>                                17.423 -6295.4
## + HalfBath         1    0.02376 17.399 -6295.4
## + LowQualFinSF     1    0.02014 17.403 -6295.1
## + Street           1    0.02003 17.403 -6295.1
## + BsmtFinSF1       1    0.01340 17.410 -6294.6
## + BsmtFinSF2       1    0.01340 17.410 -6294.6

```

```

## + X2ndFlrSF      1  0.01220 17.411 -6294.5
## + X3SsnPorch     1  0.01216 17.411 -6294.5
## + BedroomAbvGr   1  0.01118 17.412 -6294.4
## + GarageYrBlt     1  0.01002 17.413 -6294.3
## + YrSold          1  0.00854 17.415 -6294.2
## + FullBath        1  0.00679 17.416 -6294.0
## + TotRmsAbvGrd    1  0.00586 17.417 -6293.9
## + MoSold          1  0.00531 17.418 -6293.9
## + MasVnrArea       1  0.00392 17.419 -6293.8
## + MSSubClass       1  0.00284 17.420 -6293.7
## + BsmtHalfBath     1  0.00046 17.423 -6293.5
## + MiscVal          1  0.00000 17.423 -6293.4
## + GarageType       6  0.10972 17.314 -6292.7
## + MasVnrType       3  0.03701 17.386 -6292.5
## + BsmtCond         3  0.03567 17.388 -6292.4
## + PavedDrive       2  0.01149 17.412 -6292.4
## + RoofStyle        5  0.07992 17.343 -6292.2
## + ExterQual        3  0.02132 17.402 -6291.2
## + ExterCond        4  0.04332 17.380 -6291.1
## + LotShape         3  0.01718 17.406 -6290.9
## + HouseStyle       7  0.09377 17.329 -6289.3
## + Electrical       4  0.00819 17.415 -6288.1
## + Exterior2nd     15  0.21260 17.211 -6283.4
##
## Step:  AIC=-6310.84
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##      GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##      Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##      BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##      Condition1 + Fireplaces
##
##              Df Sum of Sq    RSS    AIC
## + Heating      5  0.29285 16.924 -6325.9
## + Exterior1st  14  0.47232 16.745 -6323.5
## + SaleType      8  0.32649 16.890 -6322.8
## + YearRemodAdd  1  0.14886 17.068 -6321.5
## + YrRemodel_Diff 1  0.14886 17.068 -6321.5
## + BsmtExposure  4  0.20609 17.011 -6320.4
## + HeatingQC     4  0.20281 17.014 -6320.1
## + Foundation    5  0.21880 16.998 -6319.5
## + WoodDeckSF    1  0.12464 17.092 -6319.4
## + BsmtQual      3  0.17137 17.046 -6319.4
## + LandSlope     2  0.12916 17.088 -6317.8
## + BsmtFullBath  1  0.09652 17.120 -6317.0
## + LotConfig     4  0.16133 17.056 -6316.6
## + GarageArea    1  0.08795 17.129 -6316.3
## + EnclosedPorch 1  0.08336 17.134 -6315.9
## + BsmtFinType2  6  0.18858 17.028 -6314.9
## + GarageFinish  3  0.11364 17.103 -6314.5
## + LotFrontage   1  0.05247 17.164 -6313.3

```

```

## + LandContour      3    0.09592 17.121 -6313.0
## + KitchenAbvGr     1    0.02738 17.189 -6311.2
## + PoolArea         1    0.02402 17.193 -6310.9
## <none>                                17.217 -6310.8
## + Street           1    0.02346 17.193 -6310.8
## + OpenPorchSF      1    0.02280 17.194 -6310.8
## + GarageYrBlt      1    0.02155 17.195 -6310.7
## + GarageCond       5    0.11478 17.102 -6310.6
## + HalfBath         1    0.01844 17.198 -6310.4
## + X3SsnPorch       1    0.01652 17.200 -6310.2
## + LowQualFinSF     1    0.01280 17.204 -6309.9
## + FullBath         1    0.01231 17.205 -6309.9
## + X1stFlrSF        1    0.01180 17.205 -6309.8
## + TotRmsAbvGrd     1    0.01054 17.206 -6309.7
## + BsmtFinSF1       1    0.00863 17.208 -6309.6
## + BsmtFinSF2       1    0.00863 17.208 -6309.6
## + YrSold           1    0.00815 17.209 -6309.5
## + GarageQual       5    0.10102 17.116 -6309.4
## + MoSold           1    0.00677 17.210 -6309.4
## + X2ndFlrSF        1    0.00529 17.212 -6309.3
## + BedroomAbvGr     1    0.00311 17.214 -6309.1
## + MSSubClass       1    0.00158 17.215 -6309.0
## + MasVnrArea       1    0.00117 17.216 -6308.9
## + BsmtHalfBath     1    0.00032 17.217 -6308.9
## + MiscVal          1    0.00002 17.217 -6308.8
## + BsmtCond         3    0.03795 17.179 -6308.1
## + RoofStyle        5    0.08371 17.133 -6308.0
## + PavedDrive       2    0.01147 17.205 -6307.8
## + MasVnrType       3    0.03189 17.185 -6307.5
## + GarageType       6    0.09705 17.120 -6307.1
## + ExterQual        3    0.02442 17.192 -6306.9
## + LotShape         3    0.02113 17.196 -6306.6
## + ExterCond        4    0.03820 17.179 -6306.1
## + Electrical       4    0.00901 17.208 -6303.6
## + HouseStyle       7    0.07150 17.145 -6302.9
## + Exterior2nd     15    0.23734 16.980 -6301.1
##
## Step:  AIC=-6325.89
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##   GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##   Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##   BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##   Condition1 + Fireplaces + Heating
##
##           Df Sum of Sq   RSS   AIC
## + BsmtExposure  4    0.21932 16.705 -6336.9
## + Exterior1st  14    0.44263 16.481 -6336.6
## + SaleType      8    0.30461 16.619 -6336.4
## + YearRemodAdd  1    0.13729 16.787 -6335.8
## + YrRemodel_Diff 1    0.13729 16.787 -6335.8

```

```

## + HeatingQC          4    0.19944 16.725 -6335.2
## + WoodDeckSF         1    0.13006 16.794 -6335.1
## + BsmtQual           3    0.17454 16.750 -6335.0
## + Foundation         5    0.21573 16.708 -6334.6
## + LandSlope          2    0.14263 16.781 -6334.2
## + LotConfig          4    0.17071 16.753 -6332.7
## + GarageArea         1    0.09676 16.827 -6332.3
## + BsmtFullBath       1    0.09620 16.828 -6332.2
## + EnclosedPorch      1    0.07570 16.848 -6330.4
## + BsmtFinType2       6    0.18714 16.737 -6330.1
## + GarageFinish       3    0.11382 16.810 -6329.7
## + LotFrontage        1    0.06601 16.858 -6329.6
## + LandContour        3    0.09171 16.832 -6327.8
## + KitchenAbvGr       1    0.03419 16.890 -6326.8
## + GarageCond         5    0.12418 16.800 -6326.6
## + PoolArea           1    0.02668 16.897 -6326.2
## <none>                16.924 -6325.9
## + GarageYrBltd       1    0.02166 16.902 -6325.8
## + OpenPorchSF        1    0.02021 16.904 -6325.6
## + Street              1    0.01893 16.905 -6325.5
## + X3SsnPorch         1    0.01735 16.907 -6325.4
## + HalfBath           1    0.01541 16.909 -6325.2
## + X1stFlrSF          1    0.01505 16.909 -6325.2
## + LowQualFinSF       1    0.01031 16.914 -6324.8
## + MoSold             1    0.01029 16.914 -6324.8
## + TotRmsAbvGrd       1    0.01003 16.914 -6324.8
## + BsmtFinSF1         1    0.00976 16.914 -6324.7
## + BsmtFinSF2         1    0.00976 16.914 -6324.7
## + FullBath           1    0.00835 16.916 -6324.6
## + GarageQual         5    0.10069 16.823 -6324.6
## + X2ndFlrSF          1    0.00806 16.916 -6324.6
## + BedroomAbvGr       1    0.00678 16.917 -6324.5
## + YrSold              1    0.00473 16.919 -6324.3
## + MasVnrArea         1    0.00282 16.921 -6324.1
## + BsmtHalfBath       1    0.00066 16.923 -6323.9
## + MSSubClass         1    0.00042 16.924 -6323.9
## + MiscVal            1    0.00006 16.924 -6323.9
## + BsmtCond           3    0.03881 16.885 -6323.2
## + PavedDrive         2    0.01032 16.914 -6322.8
## + GarageType         6    0.10258 16.822 -6322.8
## + MasVnrType         3    0.03296 16.891 -6322.7
## + RoofStyle          5    0.07757 16.846 -6322.6
## + LotShape           3    0.02690 16.897 -6322.2
## + ExterQual          3    0.02311 16.901 -6321.9
## + ExterCond          4    0.02559 16.898 -6320.1
## + Electrical         4    0.01123 16.913 -6318.9
## + HouseStyle         7    0.06091 16.863 -6317.1
## + Exterior2nd       15    0.23026 16.694 -6315.9
##
## Step:  AIC=-6336.93

```



```
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##   GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##   Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##   BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##   Condition1 + Fireplaces + Heating + BsmtExposure
##
```

	Df	Sum of Sq	RSS	AIC
## + Exterior1st	14	0.45492	16.250	-6349.2
## + HeatingQC	4	0.22260	16.482	-6348.5
## + YearRemodAdd	1	0.13377	16.571	-6346.7
## + YrRemodel_Diff	1	0.13377	16.571	-6346.7
## + Foundation	5	0.21027	16.494	-6345.4
## + LandSlope	2	0.13929	16.565	-6345.2
## + SaleType	8	0.26753	16.437	-6344.5
## + LotConfig	4	0.17339	16.531	-6344.2
## + WoodDeckSF	1	0.10528	16.599	-6344.2
## + GarageArea	1	0.09834	16.606	-6343.6
## + BsmtQual	3	0.14305	16.562	-6343.5
## + BsmtFullBath	1	0.09125	16.613	-6342.9
## + EnclosedPorch	1	0.07267	16.632	-6341.3
## + GarageFinish	3	0.11195	16.593	-6340.7
## + LotFrontage	1	0.05817	16.647	-6340.0
## + GarageCond	5	0.14224	16.562	-6339.4
## + BsmtFinType2	6	0.15211	16.553	-6338.3
## + PoolArea	1	0.03664	16.668	-6338.1
## + LandContour	3	0.07654	16.628	-6337.6
## + GarageQual	5	0.11769	16.587	-6337.3
## + GarageYrBlt	1	0.02487	16.680	-6337.1
## + Street	1	0.02412	16.681	-6337.0
## <none>			16.705	-6336.9
## + KitchenAbvGr	1	0.02044	16.684	-6336.7
## + X3SsnPorch	1	0.02026	16.684	-6336.7
## + OpenPorchSF	1	0.01966	16.685	-6336.6
## + TotRmsAbvGrd	1	0.01828	16.686	-6336.5
## + HalfBath	1	0.01742	16.687	-6336.5
## + BsmtFinSF1	1	0.01153	16.693	-6335.9
## + BsmtFinSF2	1	0.01153	16.693	-6335.9
## + X1stFlrSF	1	0.01118	16.694	-6335.9
## + FullBath	1	0.00985	16.695	-6335.8
## + MoSold	1	0.00938	16.695	-6335.7
## + LowQualFinSF	1	0.00794	16.697	-6335.6
## + X2ndFlrSF	1	0.00591	16.699	-6335.4
## + MSSubClass	1	0.00558	16.699	-6335.4
## + GarageType	6	0.11711	16.588	-6335.2
## + BedroomAbvGr	1	0.00286	16.702	-6335.2
## + BsmtHalfBath	1	0.00200	16.703	-6335.1
## + YrSold	1	0.00183	16.703	-6335.1
## + MasVnrArea	1	0.00021	16.704	-6334.9
## + MiscVal	1	0.00009	16.705	-6334.9
## + PavedDrive	2	0.01485	16.690	-6334.2

```

## + BsmtCond      3    0.02901 16.676 -6333.5
## + LotShape      3    0.02745 16.677 -6333.3
## + MasVnrType    3    0.02702 16.678 -6333.3
## + RoofStyle     5    0.06767 16.637 -6332.9
## + ExterQual     3    0.02196 16.683 -6332.9
## + ExterCond     4    0.03164 16.673 -6331.7
## + Electrical    4    0.01192 16.693 -6330.0
## + Exterior2nd   15   0.24424 16.460 -6328.4
## + HouseStyle    7    0.04604 16.659 -6327.0
##
## Step:  AIC=-6349.24
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##      GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##      Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##      BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##      Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st
##
##              Df Sum of Sq    RSS      AIC
## + YearRemodAdd  1  0.136360 16.113 -6359.5
## + YrRemodel_Diff 1  0.136360 16.113 -6359.5
## + LandSlope     2  0.154334 16.096 -6359.2
## + LotConfig     4  0.184876 16.065 -6357.9
## + WoodDeckSF    1  0.117554 16.132 -6357.8
## + SaleType      8  0.268541 15.981 -6357.6
## + GarageArea    1  0.113573 16.136 -6357.5
## + BsmtFullBath  1  0.093178 16.157 -6355.6
## + BsmtQual      3  0.135630 16.114 -6355.5
## + HeatingQC     4  0.156015 16.094 -6355.3
## + Foundation    5  0.174845 16.075 -6355.0
## + LotFrontage   1  0.071332 16.178 -6353.7
## + GarageCond    5  0.156291 16.093 -6353.4
## + EnclosedPorch 1  0.066033 16.184 -6353.2
## + GarageFinish  3  0.103973 16.146 -6352.6
## + GarageQual    5  0.146253 16.104 -6352.4
## + LandContour   3  0.084927 16.165 -6350.9
## + PoolArea      1  0.040553 16.209 -6350.9
## + GarageType    6  0.146802 16.103 -6350.5
## + GarageYrBlt   1  0.030174 16.220 -6350.0
## + X3SsnPorch    1  0.025997 16.224 -6349.6
## + BsmtFinType2  6  0.133313 16.116 -6349.3
## <none>                                16.250 -6349.2
## + OpenPorchSF   1  0.020606 16.229 -6349.1
## + HalfBath      1  0.019618 16.230 -6349.0
## + Street        1  0.018373 16.231 -6348.9
## + TotRmsAbvGrd  1  0.015650 16.234 -6348.6
## + KitchenAbvGr  1  0.015579 16.234 -6348.6
## + X1stFlrSF     1  0.014882 16.235 -6348.6
## + BsmtFinSF1    1  0.012371 16.237 -6348.4
## + BsmtFinSF2    1  0.012371 16.237 -6348.4
## + MoSold        1  0.009800 16.240 -6348.1

```

```

## + X2ndFlrSF      1  0.009667 16.240 -6348.1
## + MasVnrArea     1  0.005790 16.244 -6347.8
## + FullBath       1  0.004491 16.245 -6347.6
## + LowQualFinSF   1  0.004414 16.245 -6347.6
## + MSSubClass     1  0.003729 16.246 -6347.6
## + BsmtHalfBath   1  0.002892 16.247 -6347.5
## + YrSold         1  0.002462 16.247 -6347.5
## + BedroomAbvGr   1  0.000293 16.250 -6347.3
## + MiscVal        1  0.000151 16.250 -6347.3
## + MasVnrType     3  0.038038 16.212 -6346.7
## + PavedDrive     2  0.014230 16.236 -6346.5
## + LotShape       3  0.023744 16.226 -6345.4
## + BsmtCond       3  0.019084 16.231 -6345.0
## + ExterQual      3  0.012646 16.237 -6344.4
## + ExterCond      4  0.034298 16.215 -6344.3
## + RoofStyle      5  0.055596 16.194 -6344.2
## + Electrical     4  0.007773 16.242 -6341.9
## + HouseStyle     7  0.047423 16.202 -6339.5
## + Exterior2nd    14  0.129190 16.121 -6332.9
##
## Step:  AIC=-6359.54
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##   GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##   Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##   BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##   Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st +
##   YearRemodAdd
##
##           Df Sum of Sq   RSS   AIC
## + LandSlope      2  0.156259 15.957 -6369.8
## + GarageArea     1  0.125694 15.988 -6369.0
## + LotConfig      4  0.181376 15.932 -6368.1
## + WoodDeckSF     1  0.114932 15.998 -6368.0
## + SaleType       8  0.256490 15.857 -6367.0
## + GarageCond     5  0.186756 15.927 -6366.6
## + BsmtFullBath   1  0.086350 16.027 -6365.4
## + GarageQual     5  0.173179 15.940 -6365.3
## + BsmtQual       3  0.126077 15.987 -6365.0
## + Foundation     5  0.168268 15.945 -6364.9
## + LotFrontage    1  0.070291 16.043 -6363.9
## + GarageFinish   3  0.110199 16.003 -6363.6
## + EnclosedPorch  1  0.064443 16.049 -6363.4
## + HeatingQC      4  0.126107 15.987 -6363.0
## + GarageType     6  0.166138 15.947 -6362.7
## + PoolArea       1  0.042298 16.071 -6361.4
## + LandContour    3  0.081483 16.032 -6360.9
## + <none>                16.113 -6359.5
## + X3SsnPorch     1  0.021350 16.092 -6359.5
## + OpenPorchSF    1  0.019447 16.094 -6359.3
## + GarageYrBlt    1  0.019228 16.094 -6359.3

```

```

## + HalfBath          1  0.018557 16.095 -6359.2
## + KitchenAbvGr      1  0.018363 16.095 -6359.2
## + BsmtFinType2       6  0.127833 15.986 -6359.2
## + Street            1  0.015834 16.098 -6359.0
## + TotRmsAbvGrd      1  0.013988 16.099 -6358.8
## + BsmtFinSF1         1  0.013292 16.100 -6358.7
## + BsmtFinSF2         1  0.013292 16.100 -6358.7
## + MoSold            1  0.009824 16.104 -6358.4
## + MasVnrArea         1  0.008368 16.105 -6358.3
## + X1stFlrSF          1  0.007817 16.106 -6358.3
## + YrSold             1  0.005554 16.108 -6358.0
## + LowQualFinSF       1  0.004777 16.109 -6358.0
## + X2ndFlrSF          1  0.004221 16.109 -6357.9
## + BsmtHalfBath       1  0.003598 16.110 -6357.9
## + FullBath           1  0.002154 16.111 -6357.7
## + MSSubClass         1  0.001774 16.112 -6357.7
## + MiscVal            1  0.000442 16.113 -6357.6
## + BedroomAbvGr      1  0.000001 16.113 -6357.5
## + MasVnrType         3  0.043756 16.070 -6357.5
## + PavedDrive         2  0.021701 16.092 -6357.5
## + BsmtCond           3  0.030406 16.083 -6356.3
## + LotShape           3  0.018618 16.095 -6355.2
## + ExterCond          4  0.038493 16.075 -6355.0
## + RoofStyle          5  0.055826 16.058 -6354.6
## + ExterQual          3  0.010990 16.102 -6354.5
## + Electrical         4  0.016188 16.097 -6353.0
## + HouseStyle         7  0.048740 16.065 -6350.0
## + Exterior2nd       14  0.133288 15.980 -6343.7
##
## Step:  AIC=-6369.77
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##   GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##   Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##   BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##   Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st +
##   YearRemodAdd + LandSlope
##
##           Df Sum of Sq   RSS   AIC
## + GarageArea      1  0.130369 15.827 -6379.7
## + GarageCond       5  0.197024 15.760 -6377.9
## + WoodDeckSF       1  0.109240 15.848 -6377.8
## + LotConfig        4  0.174185 15.783 -6377.8
## + BsmtFullBath      1  0.097414 15.860 -6376.7
## + GarageQual        5  0.183728 15.774 -6376.7
## + Foundation        5  0.180247 15.777 -6376.4
## + BsmtQual          3  0.123833 15.833 -6375.1
## + GarageType        6  0.183333 15.774 -6374.6
## + GarageFinish      3  0.107794 15.849 -6373.7
## + EnclosedPorch     1  0.063563 15.894 -6373.6
## + HeatingQC         4  0.126496 15.831 -6373.4

```

```

## + SaleType      8  0.212424 15.745 -6373.3
## + LotFrontage   1  0.049335 15.908 -6372.3
## + PoolArea      1  0.036336 15.921 -6371.1
## + LandContour   3  0.077963 15.879 -6370.9
## + HalfBath      1  0.029837 15.927 -6370.5
## + RoofStyle     5  0.111777 15.845 -6370.0
## + GarageYrBlt   1  0.023094 15.934 -6369.9
## <none>          15.957 -6369.8
## + BsmtFinType2  6  0.130062 15.827 -6369.7
## + X3SsnPorch    1  0.020299 15.937 -6369.6
## + BsmtCond      3  0.061827 15.895 -6369.4
## + Street        1  0.017419 15.940 -6369.4
## + KitchenAbvGr  1  0.016669 15.941 -6369.3
## + OpenPorchSF   1  0.013174 15.944 -6369.0
## + BsmtFinSF1    1  0.012106 15.945 -6368.9
## + BsmtFinSF2    1  0.012106 15.945 -6368.9
## + MoSold        1  0.008393 15.949 -6368.5
## + TotRmsAbvGrd  1  0.008284 15.949 -6368.5
## + MasVnrArea    1  0.008082 15.949 -6368.5
## + LowQualFinSF  1  0.006359 15.951 -6368.4
## + X1stFlrSF     1  0.005219 15.952 -6368.2
## + YrSold        1  0.003018 15.954 -6368.0
## + MSSubClass    1  0.002472 15.955 -6368.0
## + PavedDrive    2  0.024209 15.933 -6368.0
## + X2ndFlrSF     1  0.002132 15.955 -6368.0
## + BsmtHalfBath  1  0.001969 15.955 -6368.0
## + MasVnrType    3  0.044781 15.912 -6367.9
## + BedroomAbvGr  1  0.000635 15.957 -6367.8
## + MiscVal       1  0.000472 15.957 -6367.8
## + FullBath      1  0.000039 15.957 -6367.8
## + LotShape      3  0.017280 15.940 -6365.4
## + ExterCond     4  0.037636 15.920 -6365.2
## + ExterQual     3  0.008749 15.948 -6364.6
## + Electrical    4  0.015438 15.942 -6363.2
## + HouseStyle    7  0.047444 15.910 -6360.1
## + Exterior2nd  14  0.135769 15.821 -6354.2
##
## Step:  AIC=-6379.75
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##   GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##   Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##   BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##   Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st +
##   YearRemodAdd + LandSlope + GarageArea
##
##           Df Sum of Sq   RSS   AIC
## + WoodDeckSF  1  0.108035 15.719 -6387.7
## + LotConfig   4  0.166914 15.660 -6387.2
## + Foundation  5  0.184754 15.642 -6386.9
## + GarageType  6  0.203087 15.624 -6386.6

```

```

## + BsmtFullBath      1  0.086977 15.740 -6385.8
## + BsmtQual          3  0.125833 15.701 -6385.4
## + GarageCond        5  0.153334 15.674 -6384.0
## + HeatingQC         4  0.131162 15.696 -6383.9
## + SaleType          8  0.211113 15.616 -6383.4
## + EnclosedPorch     1  0.057146 15.770 -6383.0
## + LotFrontage       1  0.045818 15.781 -6382.0
## + GarageQual        5  0.129701 15.697 -6381.8
## + HalfBath          1  0.040673 15.786 -6381.5
## + GarageFinish      3  0.083036 15.744 -6381.4
## + LandContour       3  0.078977 15.748 -6381.1
## + PoolArea          1  0.034686 15.792 -6381.0
## + BsmtFinType2      6  0.138027 15.689 -6380.5
## + RoofStyle         5  0.113189 15.714 -6380.2
## + Street            1  0.025704 15.801 -6380.1
## <none>              15.827 -6379.7
## + X3SsnPorch        1  0.017726 15.809 -6379.4
## + BsmtCond          3  0.059051 15.768 -6379.2
## + KitchenAbvGr      1  0.014804 15.812 -6379.1
## + TotRmsAbvGrd      1  0.014522 15.812 -6379.1
## + OpenPorchSF       1  0.012778 15.814 -6378.9
## + BsmtFinSF1        1  0.011756 15.815 -6378.8
## + BsmtFinSF2        1  0.011756 15.815 -6378.8
## + MasVnrArea        1  0.008424 15.818 -6378.5
## + LowQualFinSF      1  0.007876 15.819 -6378.5
## + MoSold            1  0.006850 15.820 -6378.4
## + MasVnrType        3  0.047474 15.779 -6378.1
## + YrSold            1  0.003131 15.824 -6378.0
## + GarageYrBlt       1  0.002569 15.824 -6378.0
## + MSSubClass        1  0.002123 15.825 -6377.9
## + BsmtHalfBath      1  0.001790 15.825 -6377.9
## + X1stFlrSF         1  0.001721 15.825 -6377.9
## + MiscVal           1  0.000498 15.826 -6377.8
## + FullBath          1  0.000361 15.826 -6377.8
## + BedroomAbvGr     1  0.000205 15.827 -6377.8
## + X2ndFlrSF         1  0.000187 15.827 -6377.8
## + PavedDrive        2  0.015661 15.811 -6377.2
## + ExterCond         4  0.042165 15.785 -6375.6
## + LotShape          3  0.019213 15.808 -6375.5
## + ExterQual         3  0.009886 15.817 -6374.7
## + Electrical        4  0.018723 15.808 -6373.5
## + HouseStyle        7  0.057261 15.770 -6371.0
## + Exterior2nd      14  0.123003 15.704 -6363.1
##
## Step:  AIC=-6387.75
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##      GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##      Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##      BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##      Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st +

```

```

##      YearRemodAdd + LandSlope + GarageArea + WoodDeckSF
##
##      Df Sum of Sq    RSS    AIC
## + LotConfig      4  0.166202 15.553 -6395.3
## + Foundation      5  0.180219 15.539 -6394.6
## + GarageType       6  0.190439 15.528 -6393.5
## + BsmtFullBath     1  0.083164 15.636 -6393.5
## + HeatingQC        4  0.138635 15.580 -6392.7
## + BsmtQual         3  0.114298 15.604 -6392.4
## + EnclosedPorch    1  0.070004 15.649 -6392.3
## + SaleType         8  0.210399 15.508 -6391.4
## + LotFrontage      1  0.056228 15.663 -6391.0
## + GarageCond       5  0.137622 15.581 -6390.6
## + GarageQual       5  0.131608 15.587 -6390.0
## + HalfBath         1  0.039569 15.679 -6389.4
## + BsmtFinType2     6  0.146358 15.572 -6389.4
## + PoolArea         1  0.029908 15.689 -6388.5
## + GarageFinish      3  0.072780 15.646 -6388.5
## + LandContour      3  0.072200 15.647 -6388.5
## + Street           1  0.028134 15.691 -6388.4
## + RoofStyle        5  0.110208 15.609 -6388.0
## + X3SsnPorch       1  0.023168 15.696 -6387.9
## <none>                                15.719 -6387.7
## + OpenPorchSF      1  0.016284 15.703 -6387.3
## + BsmtCond         3  0.059213 15.660 -6387.3
## + BsmtFinSF1       1  0.015751 15.703 -6387.2
## + BsmtFinSF2       1  0.015751 15.703 -6387.2
## + TotRmsAbvGrd     1  0.014741 15.704 -6387.1
## + KitchenAbvGr     1  0.014703 15.704 -6387.1
## + MoSold           1  0.008186 15.711 -6386.5
## + MasVnrArea        1  0.007377 15.711 -6386.4
## + LowQualFinSF     1  0.006499 15.712 -6386.4
## + YrSold           1  0.003674 15.715 -6386.1
## + MasVnrType       3  0.045352 15.673 -6386.0
## + BsmtHalfBath     1  0.002340 15.716 -6386.0
## + X1stFlrSF        1  0.001361 15.717 -6385.9
## + MSSubClass       1  0.001014 15.718 -6385.8
## + GarageYrBlt      1  0.000857 15.718 -6385.8
## + FullBath         1  0.000406 15.718 -6385.8
## + MiscVal          1  0.000376 15.718 -6385.8
## + BedroomAbvGr     1  0.000318 15.719 -6385.8
## + X2ndFlrSF        1  0.000136 15.719 -6385.8
## + PavedDrive       2  0.014657 15.704 -6385.1
## + ExterCond        4  0.049121 15.670 -6384.3
## + LotShape         3  0.018459 15.700 -6383.5
## + ExterQual        3  0.009724 15.709 -6382.7
## + Electrical       4  0.019345 15.699 -6381.5
## + HouseStyle       7  0.059159 15.660 -6379.3
## + Exterior2nd     14  0.125338 15.593 -6371.4
##

```

```

## Step:  AIC=-6395.27
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##   GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##   Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##   BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##   Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st +
##   YearRemodAdd + LandSlope + GarageArea + WoodDeckSF + LotConfig
##
##           Df Sum of Sq   RSS   AIC
## + Foundation      5  0.188656 15.364 -6403.1
## + HeatingQC       4  0.146079 15.406 -6401.0
## + GarageType      6  0.185656 15.367 -6400.8
## + BsmtFullBath    1  0.079763 15.473 -6400.8
## + LotFrontage     1  0.073176 15.479 -6400.2
## + BsmtQual        3  0.108149 15.444 -6399.5
## + EnclosedPorch   1  0.063672 15.489 -6399.3
## + GarageQual      5  0.135851 15.417 -6398.1
## + GarageCond      5  0.127703 15.425 -6397.3
## + SaleType        8  0.189413 15.363 -6397.2
## + HalfBath        1  0.038756 15.514 -6396.9
## + BsmtFinType2    6  0.140302 15.412 -6396.5
## + GarageFinish    3  0.075825 15.477 -6396.4
## + PoolArea        1  0.030849 15.522 -6396.2
## + Street          1  0.026758 15.526 -6395.8
## + RoofStyle       5  0.111456 15.441 -6395.8
## + LandContour     3  0.066625 15.486 -6395.5
## + X3SsnPorch      1  0.023907 15.529 -6395.5
## + <none>           15.553 -6395.3
## + TotRmsAbvGrd    1  0.020129 15.533 -6395.2
## + OpenPorchSF     1  0.016410 15.536 -6394.8
## + KitchenAbvGr    1  0.014815 15.538 -6394.7
## + BsmtCond        3  0.056929 15.496 -6394.6
## + BsmtFinSF1      1  0.012425 15.540 -6394.4
## + BsmtFinSF2      1  0.012425 15.540 -6394.4
## + LowQualFinSF    1  0.007926 15.545 -6394.0
## + MoSold          1  0.006718 15.546 -6393.9
## + MasVnrType      3  0.049152 15.503 -6393.9
## + MasVnrArea      1  0.004852 15.548 -6393.7
## + YrSold           1  0.004842 15.548 -6393.7
## + FullBath        1  0.003316 15.549 -6393.6
## + BsmtHalfBath    1  0.002821 15.550 -6393.5
## + BedroomAbvGr    1  0.002232 15.550 -6393.5
## + MiscVal         1  0.002097 15.550 -6393.5
## + MSSubClass      1  0.001987 15.551 -6393.5
## + X1stFlrSF       1  0.000931 15.552 -6393.4
## + GarageYrBlt     1  0.000190 15.552 -6393.3
## + X2ndFlrSF       1  0.000009 15.553 -6393.3
## + ExterCond       4  0.056201 15.496 -6392.6
## + PavedDrive      2  0.013242 15.539 -6392.5
## + LotShape        3  0.018302 15.534 -6391.0

```



```

## + ExterQual      3  0.007472 15.545 -6390.0
## + Electrical     4  0.017673 15.535 -6388.9
## + HouseStyle     7  0.059631 15.493 -6386.9
## + Exterior2nd   14  0.131400 15.421 -6379.7
##
## Step: AIC=-6403.09
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##   GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##   Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##   BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##   Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st +
##   YearRemodAdd + LandSlope + GarageArea + WoodDeckSF + LotConfig +
##   Foundation
##
##           Df Sum of Sq   RSS   AIC
## + LotFrontage  1  0.094775 15.269 -6410.1
## + HeatingQC    4  0.148116 15.216 -6409.2
## + BsmtFullBath  1  0.079979 15.284 -6408.7
## + EnclosedPorch 1  0.061912 15.302 -6407.0
## + GarageType    6  0.161639 15.202 -6406.5
## + SaleType      8  0.199659 15.164 -6406.2
## + BsmtQual      3  0.094512 15.269 -6406.1
## + HalfBath      1  0.038695 15.325 -6404.8
## + X3SsnPorch    1  0.035997 15.328 -6404.5
## + PoolArea      1  0.031519 15.332 -6404.1
## + GarageQual    5  0.114434 15.249 -6404.0
## + BsmtFinType2  6  0.129333 15.235 -6403.4
## + KitchenAbvGr  1  0.024236 15.340 -6403.4
## + Street        1  0.024234 15.340 -6403.4
## + GarageFinish  3  0.064707 15.299 -6403.2
## + GarageCond    5  0.106176 15.258 -6403.2
## + <none>                15.364 -6403.1
## + BsmtCond      3  0.060787 15.303 -6402.9
## + TotRmsAbvGrd  1  0.012827 15.351 -6402.3
## + RoofStyle     5  0.096579 15.267 -6402.3
## + BsmtFinSF1    1  0.012420 15.351 -6402.3
## + BsmtFinSF2    1  0.012420 15.351 -6402.3
## + OpenPorchSF   1  0.009719 15.354 -6402.0
## + MasVnrType     3  0.051727 15.312 -6402.0
## + LandContour    3  0.051163 15.313 -6402.0
## + LowQualFinSF   1  0.007698 15.356 -6401.8
## + MasVnrArea     1  0.006715 15.357 -6401.7
## + MoSold         1  0.006432 15.357 -6401.7
## + YrSold         1  0.005183 15.359 -6401.6
## + MSSubClass     1  0.003147 15.361 -6401.4
## + MiscVal        1  0.002376 15.362 -6401.3
## + X1stFlrSF      1  0.002270 15.362 -6401.3
## + BsmtHalfBath   1  0.002065 15.362 -6401.3
## + FullBath       1  0.001892 15.362 -6401.3
## + BedroomAbvGr   1  0.000869 15.363 -6401.2

```

```

## + X2ndFlrSF      1  0.000399 15.364 -6401.1
## + GarageYrBlt    1  0.000161 15.364 -6401.1
## + PavedDrive     2  0.013221 15.351 -6400.3
## + ExterCond      4  0.055111 15.309 -6400.3
## + LotShape       3  0.017299 15.347 -6398.7
## + Electrical     4  0.031120 15.333 -6398.0
## + ExterQual      3  0.002957 15.361 -6397.4
## + HouseStyle     7  0.074228 15.290 -6396.2
## + Exterior2nd   14  0.144582 15.219 -6388.9
##
## Step:  AIC=-6410.12
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##      GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##      Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##      BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##      Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st +
##      YearRemodAdd + LandSlope + GarageArea + WoodDeckSF + LotConfig +
##      Foundation + LotFrontage
##
##              Df Sum of Sq    RSS    AIC
## + HeatingQC      4  0.144039 15.125 -6416.0
## + BsmtFullBath    1  0.080772 15.188 -6415.9
## + EnclosedPorch   1  0.055744 15.213 -6413.5
## + GarageType      6  0.148923 15.120 -6412.4
## + SaleType        8  0.188536 15.081 -6412.3
## + HalfBath        1  0.042401 15.227 -6412.2
## + BsmtQual        3  0.080681 15.188 -6411.9
## + GarageQual      5  0.116702 15.152 -6411.3
## + X3SsnPorch      1  0.030940 15.238 -6411.1
## + BsmtFinType2    6  0.131376 15.138 -6410.7
## + Street          1  0.025432 15.244 -6410.6
## + KitchenAbvGr    1  0.024632 15.245 -6410.5
## + GarageCond      5  0.107090 15.162 -6410.4
## + PoolArea        1  0.023687 15.245 -6410.4
## + <none>              15.269 -6410.1
## + GarageFinish    3  0.059853 15.209 -6409.9
## + BsmtFinSF1      1  0.014811 15.254 -6409.5
## + BsmtFinSF2      1  0.014811 15.254 -6409.5
## + BsmtCond        3  0.055092 15.214 -6409.4
## + MasVnrType      3  0.054345 15.215 -6409.3
## + LowQualFinSF    1  0.012142 15.257 -6409.3
## + TotRmsAbvGrd    1  0.011519 15.258 -6409.2
## + OpenPorchSF     1  0.010333 15.259 -6409.1
## + MasVnrArea      1  0.008102 15.261 -6408.9
## + LandContour     3  0.049670 15.220 -6408.9
## + YrSold           1  0.006878 15.262 -6408.8
## + MoSold           1  0.005522 15.264 -6408.6
## + MiscVal         1  0.002844 15.266 -6408.4
## + FullBath        1  0.002255 15.267 -6408.3
## + MSSubClass      1  0.001588 15.268 -6408.3

```

```

## + BsmtHalfBath      1  0.001508 15.268 -6408.3
## + X1stFlrSF         1  0.000687 15.268 -6408.2
## + BedroomAbvGr     1  0.000375 15.269 -6408.2
## + GarageYrBlt       1  0.000102 15.269 -6408.1
## + X2ndFlrSF         1  0.000056 15.269 -6408.1
## + RoofStyle         5  0.082531 15.187 -6408.0
## + PavedDrive        2  0.013219 15.256 -6407.4
## + ExterCond          4  0.051824 15.217 -6407.1
## + LotShape           3  0.019358 15.250 -6406.0
## + Electrical         4  0.032986 15.236 -6405.3
## + ExterQual          3  0.003955 15.265 -6404.5
## + HouseStyle         7  0.086019 15.183 -6404.4
## + Exterior2nd       14  0.131853 15.137 -6394.8
##
## Step:  AIC=-6415.96
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##   GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##   Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##   BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##   Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st +
##   YearRemodAdd + LandSlope + GarageArea + WoodDeckSF + LotConfig +
##   Foundation + LotFrontage + HeatingQC
##
##           Df Sum of Sq   RSS   AIC
## + BsmtFullBath      1  0.072097 15.053 -6420.9
## + EnclosedPorch      1  0.060939 15.064 -6419.9
## + SaleType           8  0.202994 14.922 -6419.7
## + GarageType         6  0.154293 14.971 -6418.9
## + HalfBath           1  0.043376 15.082 -6418.2
## + BsmtQual           3  0.075557 15.050 -6417.3
## + GarageQual         5  0.115168 15.010 -6417.1
## + PoolArea           1  0.030957 15.094 -6417.0
## + GarageCond         5  0.112145 15.013 -6416.8
## + Street             1  0.027618 15.098 -6416.6
## + X3SsnPorch         1  0.024431 15.101 -6416.3
## + BsmtFinType2       6  0.127010 14.998 -6416.3
## + KitchenAbvGr       1  0.022028 15.103 -6416.1
## + <none>              15.125 -6416.0
## + BsmtFinSF1         1  0.015221 15.110 -6415.4
## + BsmtFinSF2         1  0.015221 15.110 -6415.4
## + LowQualFinSF       1  0.013719 15.111 -6415.3
## + TotRmsAbvGrd       1  0.010640 15.114 -6415.0
## + GarageFinish       3  0.051291 15.074 -6414.9
## + OpenPorchSF        1  0.009664 15.115 -6414.9
## + YrSold              1  0.007715 15.117 -6414.7
## + MasVnrArea          1  0.006518 15.119 -6414.6
## + BsmtCond           3  0.045952 15.079 -6414.4
## + MoSold             1  0.004442 15.121 -6414.4
## + MasVnrType          3  0.045587 15.079 -6414.4
## + FullBath           1  0.002223 15.123 -6414.2

```

```

## + MiscVal      1  0.002045 15.123 -6414.2
## + BsmtHalfBath 1  0.001884 15.123 -6414.1
## + LandContour  3  0.043103 15.082 -6414.1
## + MSSubClass   1  0.001292 15.124 -6414.1
## + BedroomAbvGr 1  0.001238 15.124 -6414.1
## + X1stFlrSF    1  0.001022 15.124 -6414.1
## + ExterCond     4  0.062375 15.063 -6414.0
## + RoofStyle     5  0.082675 15.042 -6414.0
## + X2ndFlrSF    1  0.000016 15.125 -6414.0
## + GarageYrBlt   1  0.000001 15.125 -6414.0
## + PavedDrive    2  0.010096 15.115 -6412.9
## + LotShape      3  0.019664 15.105 -6411.9
## + HouseStyle    7  0.095172 15.030 -6411.2
## + Electrical    4  0.032796 15.092 -6411.1
## + ExterQual      3  0.004046 15.121 -6410.4
## + Exterior2nd   14 0.147821 14.977 -6402.3
##
## Step:  AIC=-6420.94
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##   GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##   Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##   BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##   Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st +
##   YearRemodAdd + LandSlope + GarageArea + WoodDeckSF + LotConfig +
##   Foundation + LotFrontage + HeatingQC + BsmtFullBath
##
##           Df Sum of Sq   RSS   AIC
## + SaleType      8  0.206955 14.846 -6425.1
## + EnclosedPorch  1  0.054681 14.998 -6424.2
## + GarageType     6  0.153869 14.899 -6423.9
## + GarageQual     5  0.126539 14.927 -6423.3
## + HalfBath       1  0.039809 15.013 -6422.8
## + BsmtQual       3  0.076056 14.977 -6422.3
## + PoolArea       1  0.031190 15.022 -6422.0
## + GarageCond     5  0.112443 14.941 -6421.9
## + Street         1  0.028846 15.024 -6421.7
## + X3SsnPorch     1  0.024404 15.029 -6421.3
## + BsmtFinType2   6  0.123394 14.930 -6421.0
## + KitchenAbvGr   1  0.020654 15.032 -6420.9
## + <none>                15.053 -6420.9
## + BsmtFinSF1     1  0.017211 15.036 -6420.6
## + BsmtFinSF2     1  0.017211 15.036 -6420.6
## + LowQualFinSF   1  0.014543 15.039 -6420.3
## + GarageFinish    3  0.051673 15.001 -6420.0
## + YrSold          1  0.010327 15.043 -6419.9
## + MasVnrArea      1  0.009808 15.043 -6419.9
## + TotRmsAbvGrd    1  0.008526 15.044 -6419.8
## + OpenPorchSF     1  0.006705 15.046 -6419.6
## + FullBath        1  0.006493 15.046 -6419.6
## + MasVnrType      3  0.047187 15.006 -6419.5

```

```

## + MoSold          1  0.004641 15.048 -6419.4
## + BsmtCond        3  0.045214 15.008 -6419.3
## + ExterCond       4  0.064284 14.989 -6419.2
## + MSSubClass      1  0.002207 15.051 -6419.1
## + BsmtHalfBath    1  0.002148 15.051 -6419.1
## + MiscVal         1  0.001841 15.051 -6419.1
## + BedroomAbvGr    1  0.001387 15.052 -6419.1
## + X1stFlrSF       1  0.001234 15.052 -6419.1
## + GarageYrBlt     1  0.000164 15.053 -6419.0
## + X2ndFlrSF       1  0.000004 15.053 -6418.9
## + LandContour     3  0.040226 15.013 -6418.8
## + RoofStyle       5  0.077890 14.975 -6418.5
## + PavedDrive      2  0.012709 15.040 -6418.2
## + HouseStyle      7  0.105653 14.947 -6417.2
## + LotShape        3  0.021144 15.032 -6417.0
## + Electrical      4  0.033529 15.020 -6416.2
## + ExterQual       3  0.005265 15.048 -6415.4
## + Exterior2nd    14  0.153230 14.900 -6407.9
##
## Step:  AIC=-6425.15
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##   GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##   Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##   BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##   Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st +
##   YearRemodAdd + LandSlope + GarageArea + WoodDeckSF + LotConfig +
##   Foundation + LotFrontage + HeatingQC + BsmtFullBath + SaleType
##
##           Df Sum of Sq   RSS   AIC
## + EnclosedPorch  1  0.056487 14.790 -6428.7
## + GarageCond     5  0.129096 14.717 -6427.9
## + GarageQual     5  0.128234 14.718 -6427.8
## + GarageType     6  0.147569 14.698 -6427.7
## + HalfBath       1  0.043461 14.803 -6427.4
## + Street         1  0.042827 14.803 -6427.4
## + BsmtQual       3  0.073572 14.773 -6426.4
## + PoolArea       1  0.032837 14.813 -6426.4
## + X3SsnPorch     1  0.024930 14.821 -6425.6
## <none>                      14.846 -6425.1
## + BsmtFinSF1     1  0.019876 14.826 -6425.1
## + BsmtFinSF2     1  0.019876 14.826 -6425.1
## + LowQualFinSF   1  0.017402 14.829 -6424.9
## + KitchenAbvGr   1  0.015789 14.830 -6424.7
## + ExterCond      4  0.075823 14.770 -6424.6
## + GarageFinish   3  0.051453 14.795 -6424.2
## + OpenPorchSF    1  0.010362 14.836 -6424.2
## + MasVnrArea     1  0.009491 14.837 -6424.1
## + YrSold         1  0.009476 14.837 -6424.1
## + BsmtCond       3  0.049033 14.797 -6424.0
## + TotRmsAbvGrd   1  0.007696 14.838 -6423.9

```

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## + MasVnrType      3  0.048158 14.798 -6423.9
## + FullBath        1  0.007454 14.839 -6423.9
## + MoSold          1  0.006403 14.840 -6423.8
## + LandContour     3  0.046288 14.800 -6423.7
## + BsmtFinType2    6  0.105952 14.740 -6423.6
## + MSSubClass      1  0.001953 14.844 -6423.3
## + BedroomAbvGr    1  0.001842 14.844 -6423.3
## + BsmtHalfBath     1  0.001334 14.845 -6423.3
## + MiscVal         1  0.001162 14.845 -6423.3
## + X2ndFlrSF       1  0.000803 14.845 -6423.2
## + X1stFlrSF       1  0.000132 14.846 -6423.2
## + GarageYrBlt     1  0.000005 14.846 -6423.1
## + PavedDrive      2  0.015966 14.830 -6422.7
## + RoofStyle       5  0.071036 14.775 -6422.2
## + HouseStyle      7  0.101806 14.744 -6421.2
## + LotShape        3  0.018026 14.828 -6420.9
## + Electrical      4  0.037064 14.809 -6420.8
## + ExterQual       3  0.008193 14.838 -6420.0
## + Exterior2nd    14  0.157529 14.688 -6412.7
##
## Step:  AIC=-6428.71
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##   GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##   Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##   BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##   Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st +
##   YearRemodAdd + LandSlope + GarageArea + WoodDeckSF + LotConfig +
##   Foundation + LotFrontage + HeatingQC + BsmtFullBath + SaleType +
##   EnclosedPorch
##
##           Df Sum of Sq   RSS   AIC
## + GarageCond      5  0.134970 14.655 -6432.1
## + GarageQual      5  0.128974 14.661 -6431.5
## + GarageType      6  0.145854 14.644 -6431.2
## + HalfBath        1  0.042401 14.747 -6430.9
## + Street          1  0.040969 14.749 -6430.8
## + BsmtQual        3  0.075770 14.714 -6430.2
## + X3SsnPorch      1  0.027601 14.762 -6429.4
## + PoolArea        1  0.027144 14.762 -6429.4
## + BsmtFinSF1      1  0.022330 14.767 -6428.9
## + BsmtFinSF2      1  0.022330 14.767 -6428.9
## + <none>                                14.790 -6428.7
## + BsmtCond        3  0.056283 14.733 -6428.3
## + KitchenAbvGr    1  0.015716 14.774 -6428.3
## + LowQualFinSF    1  0.014423 14.775 -6428.1
## + OpenPorchSF     1  0.013640 14.776 -6428.1
## + GarageFinish     3  0.050582 14.739 -6427.7
## + TotRmsAbvGrd    1  0.009946 14.780 -6427.7
## + MasVnrArea      1  0.009578 14.780 -6427.7
## + YrSold          1  0.009253 14.780 -6427.6

```

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## + ExterCond      4  0.069770 14.720 -6427.6
## + BsmtFinType2   6  0.108264 14.681 -6427.4
## + LandContour    3  0.047019 14.743 -6427.4
## + FullBath       1  0.006228 14.783 -6427.3
## + MoSold         1  0.004853 14.785 -6427.2
## + MasVnrType     3  0.045130 14.744 -6427.2
## + MSSubClass     1  0.003611 14.786 -6427.1
## + BedroomAbvGr   1  0.001314 14.788 -6426.8
## + MiscVal        1  0.001155 14.788 -6426.8
## + BsmtHalfBath   1  0.000765 14.789 -6426.8
## + X1stFlrSF      1  0.000585 14.789 -6426.8
## + X2ndFlrSF      1  0.000157 14.789 -6426.7
## + GarageYrBlt    1  0.000018 14.790 -6426.7
## + PavedDrive     2  0.016258 14.773 -6426.3
## + RoofStyle      5  0.072741 14.717 -6425.9
## + LotShape       3  0.019963 14.770 -6424.7
## + Electrical     4  0.039397 14.750 -6424.6
## + HouseStyle     7  0.090336 14.699 -6423.7
## + ExterQual      3  0.008869 14.781 -6423.6
## + Exterior2nd   14  0.162420 14.627 -6416.8
##
## Step:  AIC=-6432.1
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##   GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##   Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##   BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##   Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st +
##   YearRemodAdd + LandSlope + GarageArea + WoodDeckSF + LotConfig +
##   Foundation + LotFrontage + HeatingQC + BsmtFullBath + SaleType +
##   EnclosedPorch + GarageCond
##
##           Df Sum of Sq    RSS    AIC
## + HalfBath      1  0.048153 14.607 -6434.9
## + Street        1  0.040022 14.615 -6434.1
## + BsmtQual      3  0.078790 14.576 -6434.0
## + X3SsnPorch    1  0.029990 14.625 -6433.1
## + KitchenAbvGr  1  0.025255 14.629 -6432.6
## + PoolArea      1  0.023972 14.631 -6432.5
## + BsmtFinSF1    1  0.021967 14.633 -6432.3
## + BsmtFinSF2    1  0.021967 14.633 -6432.3
## <none>                14.655 -6432.1
## + GarageType    5  0.099728 14.555 -6432.1
## + GarageQual    4  0.079553 14.575 -6432.0
## + ExterCond     4  0.078205 14.576 -6431.9
## + MasVnrArea    1  0.014146 14.640 -6431.5
## + OpenPorchSF   1  0.013121 14.642 -6431.4
## + LowQualFinSF  1  0.011321 14.643 -6431.2
## + LandContour   3  0.049238 14.605 -6431.0
## + TotRmsAbvGrd  1  0.008975 14.646 -6431.0
## + YrSold        1  0.008486 14.646 -6430.9

```

```

## + MasVnrType      3  0.047626 14.607 -6430.9
## + BsmtFinType2    6  0.106767 14.548 -6430.8
## + MoSold          1  0.006705 14.648 -6430.8
## + FullBath        1  0.005607 14.649 -6430.7
## + MSSubClass      1  0.003596 14.651 -6430.5
## + BedroomAbvGr    1  0.002196 14.652 -6430.3
## + MiscVal         1  0.001211 14.653 -6430.2
## + BsmtCond        3  0.041108 14.614 -6430.2
## + BsmtHalfBath    1  0.000658 14.654 -6430.2
## + X1stFlrSF       1  0.000284 14.654 -6430.1
## + X2ndFlrSF       1  0.000233 14.654 -6430.1
## + GarageYrBlt     1  0.000180 14.654 -6430.1
## + RoofStyle       5  0.080145 14.575 -6430.1
## + GarageFinish     2  0.011411 14.643 -6429.2
## + PavedDrive      2  0.008184 14.646 -6428.9
## + Electrical      4  0.041361 14.613 -6428.2
## + LotShape        3  0.019019 14.636 -6428.0
## + ExterQual        3  0.010659 14.644 -6427.2
## + HouseStyle      7  0.078832 14.576 -6426.0
## + Exterior2nd    14  0.157246 14.497 -6419.8
##
## Step:  AIC=-6434.9
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##   GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##   Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##   BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##   Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st +
##   YearRemodAdd + LandSlope + GarageArea + WoodDeckSF + LotConfig +
##   Foundation + LotFrontage + HeatingQC + BsmtFullBath + SaleType +
##   EnclosedPorch + GarageCond + HalfBath
##
##           Df Sum of Sq   RSS   AIC
## + Street      1  0.040650 14.566 -6437.0
## + BsmtQual    3  0.077659 14.529 -6436.7
## + FullBath    1  0.030713 14.576 -6436.0
## + X3SsnPorch  1  0.030294 14.576 -6435.9
## + GarageQual  4  0.087676 14.519 -6435.7
## + PoolArea    1  0.027419 14.579 -6435.6
## + KitchenAbvGr 1  0.023463 14.583 -6435.3
## + BsmtFinSF1  1  0.022995 14.584 -6435.2
## + BsmtFinSF2  1  0.022995 14.584 -6435.2
## <none>                14.607 -6434.9
## + GarageType   5  0.096573 14.510 -6434.6
## + LandContour  3  0.053216 14.553 -6434.2
## + MasVnrArea   1  0.012659 14.594 -6434.2
## + ExterCond    4  0.071985 14.534 -6434.1
## + MasVnrType   3  0.051969 14.555 -6434.1
## + TotRmsAbvGrd 1  0.009910 14.597 -6433.9
## + YrSold       1  0.009080 14.597 -6433.8
## + LowQualFinSF 1  0.008715 14.598 -6433.8

```



```

## + OpenPorchSF      1  0.008691 14.598 -6433.8
## + BsmtFinType2     6  0.107085 14.499 -6433.6
## + MSSubClass       1  0.007056 14.599 -6433.6
## + X1stFlrSF        1  0.006842 14.600 -6433.6
## + MoSold           1  0.004789 14.602 -6433.4
## + BedroomAbvGr     1  0.004206 14.602 -6433.3
## + X2ndFlrSF        1  0.002646 14.604 -6433.2
## + MiscVal          1  0.000969 14.605 -6433.0
## + BsmtHalfBath     1  0.000608 14.606 -6433.0
## + GarageYrBlt      1  0.000015 14.606 -6432.9
## + RoofStyle        5  0.075496 14.531 -6432.5
## + BsmtCond         3  0.034268 14.572 -6432.3
## + PavedDrive       2  0.009544 14.597 -6431.9
## + GarageFinish     2  0.009512 14.597 -6431.9
## + Electrical       4  0.041609 14.565 -6431.1
## + LotShape         3  0.019393 14.587 -6430.8
## + ExterQual        3  0.011221 14.595 -6430.0
## + HouseStyle       7  0.081321 14.525 -6429.1
## + Exterior2nd     14  0.154675 14.452 -6422.4
##
## Step:  AIC=-6436.97
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##   GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##   Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##   BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##   Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st +
##   YearRemodAdd + LandSlope + GarageArea + WoodDeckSF + LotConfig +
##   Foundation + LotFrontage + HeatingQC + BsmtFullBath + SaleType +
##   EnclosedPorch + GarageCond + HalfBath + Street
##
##           Df Sum of Sq   RSS   AIC
## + KitchenAbvGr  1  0.033918 14.532 -6438.4
## + BsmtQual      3  0.072478 14.493 -6438.3
## + X3SsnPorch    1  0.030025 14.536 -6438.0
## + FullBath      1  0.028711 14.537 -6437.9
## + PoolArea      1  0.027483 14.538 -6437.7
## + GarageQual    4  0.085634 14.480 -6437.6
## + BsmtFinSF1    1  0.021063 14.545 -6437.1
## + BsmtFinSF2    1  0.021063 14.545 -6437.1
## + <none>                14.566 -6437.0
## + LandContour   3  0.055012 14.511 -6436.5
## + ExterCond     4  0.072627 14.493 -6436.3
## + MasVnrType    3  0.051093 14.515 -6436.1
## + MasVnrArea    1  0.010782 14.555 -6436.1
## + OpenPorchSF   1  0.009918 14.556 -6436.0
## + LowQualFinSF  1  0.009595 14.556 -6435.9
## + TotRmsAbvGrd  1  0.008278 14.557 -6435.8
## + YrSold        1  0.008225 14.558 -6435.8
## + MSSubClass    1  0.007303 14.559 -6435.7
## + X1stFlrSF     1  0.006842 14.559 -6435.7

```

```

## + MoSold          1  0.004733 14.561 -6435.4
## + BedroomAbvGr    1  0.004651 14.561 -6435.4
## + BsmtFinType2     6  0.103704 14.462 -6435.4
## + X2ndFlrSF        1  0.002502 14.563 -6435.2
## + GarageType       5  0.080855 14.485 -6435.1
## + MiscVal          1  0.000562 14.565 -6435.0
## + BsmtHalfBath     1  0.000443 14.565 -6435.0
## + GarageYrBlt      1  0.000035 14.566 -6435.0
## + RoofStyle        5  0.077337 14.489 -6434.7
## + BsmtCond         3  0.034291 14.531 -6434.4
## + PavedDrive       2  0.010299 14.556 -6434.0
## + GarageFinish     2  0.009909 14.556 -6434.0
## + Electrical       4  0.042036 14.524 -6433.2
## + LotShape         3  0.021351 14.544 -6433.1
## + ExterQual        3  0.006165 14.560 -6431.6
## + HouseStyle       7  0.080051 14.486 -6431.0
## + Exterior2nd     14  0.162922 14.403 -6425.4
##
## Step:  AIC=-6438.38
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##   GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##   Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##   BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##   Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st +
##   YearRemodAdd + LandSlope + GarageArea + WoodDeckSF + LotConfig +
##   Foundation + LotFrontage + HeatingQC + BsmtFullBath + SaleType +
##   EnclosedPorch + GarageCond + HalfBath + Street + KitchenAbvGr
##
##           Df Sum of Sq   RSS   AIC
## + FullBath      1  0.037152 14.495 -6440.1
## + X3SsnPorch    1  0.029752 14.502 -6439.4
## + BsmtQual      3  0.068430 14.463 -6439.3
## + GarageQual    4  0.087166 14.445 -6439.2
## + PoolArea      1  0.026485 14.505 -6439.0
## + BsmtFinSF1    1  0.020066 14.512 -6438.4
## + BsmtFinSF2    1  0.020066 14.512 -6438.4
## + <none>                14.532 -6438.4
## + LandContour   3  0.056616 14.475 -6438.1
## + ExterCond     4  0.076080 14.456 -6438.0
## + TotRmsAbvGrd  1  0.015882 14.516 -6438.0
## + LowQualFinSF  1  0.011662 14.520 -6437.5
## + MasVnrArea    1  0.010135 14.522 -6437.4
## + MasVnrType    3  0.049785 14.482 -6437.4
## + OpenPorchSF   1  0.009311 14.523 -6437.3
## + X1stFlrSF     1  0.006815 14.525 -6437.1
## + MSSubClass    1  0.006455 14.525 -6437.0
## + YrSold        1  0.005819 14.526 -6437.0
## + BsmtFinType2  6  0.103377 14.428 -6436.8
## + BedroomAbvGr  1  0.004149 14.528 -6436.8
## + MoSold        1  0.004113 14.528 -6436.8

```

```

## + X2ndFlrSF      1  0.002190 14.530 -6436.6
## + MiscVal        1  0.000322 14.532 -6436.4
## + BsmtHalfBath   1  0.000289 14.532 -6436.4
## + GarageYrBltd   1  0.000079 14.532 -6436.4
## + RoofStyle      5  0.077878 14.454 -6436.2
## + GarageType     5  0.075888 14.456 -6436.0
## + BsmtCond       3  0.033073 14.499 -6435.7
## + GarageFinish   2  0.011403 14.521 -6435.5
## + PavedDrive     2  0.008414 14.524 -6435.2
## + Electrical     4  0.045123 14.487 -6434.9
## + LotShape       3  0.019963 14.512 -6434.4
## + HouseStyle     7  0.089700 14.442 -6433.4
## + ExterQual      3  0.006034 14.526 -6433.0
## + Exterior2nd   14  0.157454 14.374 -6426.3
##
## Step:  AIC=-6440.11
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##   GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##   Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##   BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##   Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st +
##   YearRemodAdd + LandSlope + GarageArea + WoodDeckSF + LotConfig +
##   Foundation + LotFrontage + HeatingQC + BsmtFullBath + SaleType +
##   EnclosedPorch + GarageCond + HalfBath + Street + KitchenAbvGr +
##   FullBath
##
##           Df Sum of Sq   RSS   AIC
## + BsmtQual      3  0.070664 14.424 -6441.2
## + GarageQual     4  0.089551 14.405 -6441.2
## + X3SsnPorch     1  0.028062 14.467 -6440.9
## + PoolArea       1  0.027658 14.467 -6440.9
## + BsmtFinSF1     1  0.020124 14.475 -6440.1
## + BsmtFinSF2     1  0.020124 14.475 -6440.1
## <none>                                14.495 -6440.1
## + ExterCond      4  0.078009 14.417 -6440.0
## + TotRmsAbvGrd   1  0.013779 14.481 -6439.5
## + LandContour    3  0.049973 14.445 -6439.2
## + RoofStyle      5  0.089439 14.405 -6439.2
## + X1stFlrSF      1  0.010229 14.485 -6439.1
## + MasVnrType     3  0.049601 14.445 -6439.1
## + MasVnrArea     1  0.009617 14.485 -6439.1
## + LowQualFinSF   1  0.009272 14.486 -6439.0
## + OpenPorchSF    1  0.008366 14.486 -6439.0
## + MSSubClass     1  0.008021 14.487 -6438.9
## + YrSold         1  0.006403 14.488 -6438.8
## + BsmtFinType2   6  0.105266 14.389 -6438.8
## + X2ndFlrSF      1  0.004697 14.490 -6438.6
## + MoSold         1  0.004431 14.490 -6438.6
## + BedroomAbvGr   1  0.001580 14.493 -6438.3
## + BsmtHalfBath   1  0.000895 14.494 -6438.2

```

```

## + MiscVal      1  0.000427 14.494 -6438.2
## + GarageYrBlt  1  0.000223 14.495 -6438.1
## + BsmtCond     3  0.033692 14.461 -6437.5
## + GarageType   5  0.072901 14.422 -6437.5
## + Electrical   4  0.051060 14.444 -6437.3
## + PavedDrive   2  0.008969 14.486 -6437.0
## + GarageFinish 2  0.006839 14.488 -6436.8
## + LotShape     3  0.020397 14.474 -6436.2
## + HouseStyle   7  0.090580 14.404 -6435.3
## + ExterQual     3  0.005980 14.489 -6434.7
## + Exterior2nd 14  0.156913 14.338 -6428.0
##
## Step:  AIC=-6441.25
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##   GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##   Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##   BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##   Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st +
##   YearRemodAdd + LandSlope + GarageArea + WoodDeckSF + LotConfig +
##   Foundation + LotFrontage + HeatingQC + BsmtFullBath + SaleType +
##   EnclosedPorch + GarageCond + HalfBath + Street + KitchenAbvGr +
##   FullBath + BsmtQual
##
##           Df Sum of Sq   RSS   AIC
## + GarageQual      4  0.102113 14.322 -6443.6
## + X3SsnPorch      1  0.029294 14.395 -6442.2
## + PoolArea        1  0.028365 14.396 -6442.1
## <none>                                14.424 -6441.2
## + ExterCond       4  0.076184 14.348 -6441.0
## + BsmtFinSF1      1  0.016611 14.408 -6440.9
## + BsmtFinSF2      1  0.016611 14.408 -6440.9
## + TotRmsAbvGrd    1  0.015122 14.409 -6440.8
## + RoofStyle       5  0.089717 14.334 -6440.4
## + LandContour     3  0.049525 14.374 -6440.3
## + X1stFlrSF       1  0.009247 14.415 -6440.2
## + YrSold          1  0.007935 14.416 -6440.1
## + MasVnrType      3  0.046922 14.377 -6440.0
## + LowQualFinSF    1  0.007047 14.417 -6440.0
## + MasVnrArea      1  0.006188 14.418 -6439.9
## + OpenPorchSF     1  0.005675 14.418 -6439.8
## + MSSubClass      1  0.004908 14.419 -6439.7
## + X2ndFlrSF       1  0.004555 14.419 -6439.7
## + BedroomAbvGr    1  0.004541 14.419 -6439.7
## + MoSold          1  0.002525 14.421 -6439.5
## + GarageYrBlt     1  0.000530 14.424 -6439.3
## + BsmtHalfBath     1  0.000444 14.424 -6439.3
## + MiscVal         1  0.000401 14.424 -6439.3
## + BsmtFinType2    6  0.094556 14.329 -6438.9
## + BsmtCond        3  0.032957 14.391 -6438.6
## + Electrical      4  0.048769 14.375 -6438.2

```

```

## + PavedDrive      2  0.008599 14.415 -6438.1
## + GarageType      5  0.067087 14.357 -6438.1
## + GarageFinish    2  0.007535 14.416 -6438.0
## + LotShape        3  0.021725 14.402 -6437.4
## + HouseStyle      7  0.087277 14.337 -6436.1
## + ExterQual       3  0.001531 14.422 -6435.4
## + Exterior2nd    14  0.142432 14.282 -6427.7
##
## Step:  AIC=-6443.62
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##   GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##   Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##   BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##   Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st +
##   YearRemodAdd + LandSlope + GarageArea + WoodDeckSF + LotConfig +
##   Foundation + LotFrontage + HeatingQC + BsmtFullBath + SaleType +
##   EnclosedPorch + GarageCond + HalfBath + Street + KitchenAbvGr +
##   FullBath + BsmtQual + GarageQual
##
##              Df Sum of Sq   RSS   AIC
## + PoolArea      1  0.027423 14.294 -6444.4
## + X3SsnPorch    1  0.025902 14.296 -6444.3
## + ExterCond      4  0.083441 14.239 -6444.2
## + LowQualFinSF  1  0.023577 14.298 -6444.0
## <none>                                14.322 -6443.6
## + BsmtFinSF1    1  0.019586 14.302 -6443.6
## + BsmtFinSF2    1  0.019586 14.302 -6443.6
## + TotRmsAbvGrd  1  0.015256 14.307 -6443.2
## + MasVnrType     3  0.051379 14.271 -6442.9
## + RoofStyle      5  0.087898 14.234 -6442.6
## + MasVnrArea     1  0.009082 14.313 -6442.5
## + GarageYrBlt    1  0.008547 14.313 -6442.5
## + X1stFlrSF      1  0.008192 14.314 -6442.5
## + YrSold         1  0.007112 14.315 -6442.3
## + BedroomAbvGr  1  0.006099 14.316 -6442.2
## + MSSubClass     1  0.004596 14.317 -6442.1
## + LandContour    3  0.042936 14.279 -6442.0
## + OpenPorchSF    1  0.003175 14.319 -6441.9
## + MoSold         1  0.001998 14.320 -6441.8
## + X2ndFlrSF      1  0.001803 14.320 -6441.8
## + BsmtCond       3  0.040697 14.281 -6441.8
## + BsmtFinType2   6  0.099074 14.223 -6441.8
## + BsmtHalfBath   1  0.001213 14.321 -6441.7
## + MiscVal        1  0.000164 14.322 -6441.6
## + HouseStyle     7  0.115121 14.207 -6441.4
## + PavedDrive     2  0.012570 14.309 -6440.9
## + GarageFinish   2  0.006197 14.316 -6440.3
## + Electrical     4  0.045157 14.277 -6440.2
## + GarageType     5  0.060670 14.261 -6439.8
## + LotShape       3  0.016256 14.306 -6439.3

```

```

## + ExterQual      3  0.002385 14.320 -6437.9
## + Exterior2nd   14  0.145434 14.177 -6430.5
##
## Step:  AIC=-6444.42
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##   GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##   Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##   BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##   Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st +
##   YearRemodAdd + LandSlope + GarageArea + WoodDeckSF + LotConfig +
##   Foundation + LotFrontage + HeatingQC + BsmtFullBath + SaleType +
##   EnclosedPorch + GarageCond + HalfBath + Street + KitchenAbvGr +
##   FullBath + BsmtQual + GarageQual + PoolArea
##
##           Df Sum of Sq   RSS   AIC
## + LowQualFinSF  1  0.026550 14.268 -6445.1
## + X3SsnPorch    1  0.026371 14.268 -6445.1
## + ExterCond      4  0.084838 14.210 -6445.1
## + BsmtFinSF2     1  0.020131 14.274 -6444.5
## + BsmtFinSF1     1  0.020131 14.274 -6444.5
## + <none>                14.294 -6444.4
## + TotRmsAbvGrd   1  0.018372 14.276 -6444.3
## + MasVnrType      3  0.054095 14.240 -6444.0
## + MasVnrArea      1  0.011812 14.283 -6443.6
## + X1stFlrSF       1  0.009380 14.285 -6443.4
## + RoofStyle       5  0.086366 14.208 -6443.3
## + GarageYrBlt     1  0.007792 14.287 -6443.2
## + BedroomAbvGr    1  0.006252 14.288 -6443.1
## + YrSold           1  0.005630 14.289 -6443.0
## + BsmtFinType2     6  0.102346 14.192 -6442.9
## + MSSubClass       1  0.004674 14.290 -6442.9
## + OpenPorchSF      1  0.003217 14.291 -6442.7
## + X2ndFlrSF        1  0.002103 14.292 -6442.6
## + LandContour      3  0.041187 14.253 -6442.6
## + MoSold           1  0.001885 14.293 -6442.6
## + BsmtHalfBath     1  0.001236 14.293 -6442.5
## + MiscVal          1  0.000407 14.294 -6442.5
## + BsmtCond         3  0.037741 14.257 -6442.3
## + HouseStyle       7  0.110447 14.184 -6441.7
## + PavedDrive       2  0.011669 14.283 -6441.6
## + Electrical       4  0.046376 14.248 -6441.2
## + GarageFinish     2  0.006662 14.288 -6441.1
## + GarageType       5  0.060115 14.234 -6440.6
## + LotShape         3  0.016064 14.278 -6440.1
## + ExterQual        3  0.002796 14.292 -6438.7
## + Exterior2nd     14  0.148166 14.146 -6431.6
##
## Step:  AIC=-6445.13
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##   GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +

```

```

##      Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##      BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##      Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st +
##      YearRemodAdd + LandSlope + GarageArea + WoodDeckSF + LotConfig +
##      Foundation + LotFrontage + HeatingQC + BsmtFullBath + SaleType +
##      EnclosedPorch + GarageCond + HalfBath + Street + KitchenAbvGr +
##      FullBath + BsmtQual + GarageQual + PoolArea + LowQualFinSF
##
##              Df Sum of Sq    RSS    AIC
## + X3SsnPorch    1  0.026924 14.241 -6445.9
## + ExterCond      4  0.084562 14.183 -6445.8
## <none>                                14.268 -6445.1
## + TotRmsAbvGrd  1  0.019360 14.249 -6445.1
## + BsmtFinSF1    1  0.018847 14.249 -6445.1
## + BsmtFinSF2    1  0.018847 14.249 -6445.1
## + MasVnrType     3  0.052118 14.216 -6444.5
## + MasVnrArea     1  0.009815 14.258 -6444.1
## + RoofStyle      5  0.085317 14.183 -6443.9
## + X1stFlrSF      1  0.007317 14.261 -6443.9
## + X2ndFlrSF      1  0.007317 14.261 -6443.9
## + GarageYrBlt    1  0.006383 14.262 -6443.8
## + YrSold          1  0.006206 14.262 -6443.8
## + BedroomAbvGr   1  0.005916 14.262 -6443.7
## + MSSubClass      1  0.004600 14.263 -6443.6
## + BsmtFinType2    6  0.100587 14.167 -6443.5
## + OpenPorchSF     1  0.002830 14.265 -6443.4
## + LandContour     3  0.041388 14.227 -6443.4
## + MoSold          1  0.002111 14.266 -6443.3
## + BsmtHalfBath    1  0.001391 14.267 -6443.3
## + MiscVal         1  0.000365 14.268 -6443.2
## + BsmtCond        3  0.034325 14.234 -6442.7
## + PavedDrive      2  0.011721 14.256 -6442.3
## + GarageFinish    2  0.006617 14.261 -6441.8
## + Electrical      4  0.044826 14.223 -6441.7
## + GarageType      5  0.058366 14.210 -6441.1
## + LotShape        3  0.015509 14.252 -6440.7
## + HouseStyle      7  0.091562 14.176 -6440.5
## + ExterQual        3  0.001929 14.266 -6439.3
## + Exterior2nd     14  0.147978 14.120 -6432.4
##
## Step:  AIC=-6445.89
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##      GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##      Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##      BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##      Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st +
##      YearRemodAdd + LandSlope + GarageArea + WoodDeckSF + LotConfig +
##      Foundation + LotFrontage + HeatingQC + BsmtFullBath + SaleType +
##      EnclosedPorch + GarageCond + HalfBath + Street + KitchenAbvGr +
##      FullBath + BsmtQual + GarageQual + PoolArea + LowQualFinSF +

```

```

##      X3SsnPorch
##
##           Df Sum of Sq    RSS      AIC
## + ExterCond      4  0.084905 14.156 -6446.6
## + TotRmsAbvGrd   1  0.021575 14.220 -6446.1
## <none>                                14.241 -6445.9
## + BsmtFinSF1     1  0.017875 14.223 -6445.7
## + BsmtFinSF2     1  0.017875 14.223 -6445.7
## + MasVnrType      3  0.049050 14.192 -6444.9
## + MasVnrArea      1  0.008875 14.232 -6444.8
## + BedroomAbvGr   1  0.007030 14.234 -6444.6
## + RoofStyle       5  0.084765 14.156 -6444.6
## + GarageYrBlt     1  0.006710 14.234 -6444.6
## + YrSold           1  0.006355 14.235 -6444.5
## + X1stFlrSF       1  0.006291 14.235 -6444.5
## + X2ndFlrSF       1  0.006291 14.235 -6444.5
## + BsmtFinType2    6  0.102273 14.139 -6444.4
## + MSSubClass      1  0.003957 14.237 -6444.3
## + OpenPorchSF     1  0.003487 14.238 -6444.2
## + LandContour     3  0.042119 14.199 -6444.2
## + MoSold           1  0.002600 14.239 -6444.2
## + BsmtHalfBath    1  0.000895 14.240 -6444.0
## + MiscVal         1  0.000364 14.241 -6443.9
## + BsmtCond        3  0.033692 14.207 -6443.3
## + PavedDrive      2  0.011617 14.229 -6443.1
## + GarageFinish    2  0.005842 14.235 -6442.5
## + Electrical      4  0.043500 14.198 -6442.4
## + GarageType      5  0.061525 14.180 -6442.2
## + LotShape        3  0.015109 14.226 -6441.4
## + HouseStyle      7  0.089201 14.152 -6441.1
## + ExterQual       3  0.001837 14.239 -6440.1
## + Exterior2nd    14  0.144737 14.096 -6432.8
##
## Step:  AIC=-6446.62
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##      GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##      Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##      BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##      Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st +
##      YearRemodAdd + LandSlope + GarageArea + WoodDeckSF + LotConfig +
##      Foundation + LotFrontage + HeatingQC + BsmtFullBath + SaleType +
##      EnclosedPorch + GarageCond + HalfBath + Street + KitchenAbvGr +
##      FullBath + BsmtQual + GarageQual + PoolArea + LowQualFinSF +
##      X3SsnPorch + ExterCond
##
##           Df Sum of Sq    RSS      AIC
## + TotRmsAbvGrd   1  0.021362 14.135 -6446.8
## <none>                                14.156 -6446.6
## + BsmtFinSF1     1  0.017845 14.138 -6446.5
## + BsmtFinSF2     1  0.017845 14.138 -6446.5

```



```

## + MasVnrArea      1  0.010972 14.145 -6445.8
## + MasVnrType      3  0.049457 14.107 -6445.7
## + X1stFlrSF       1  0.009203 14.147 -6445.6
## + X2ndFlrSF       1  0.009203 14.147 -6445.6
## + BedroomAbvGr    1  0.008647 14.148 -6445.5
## + GarageYrBlt     1  0.007116 14.149 -6445.4
## + BsmtFinType2     6  0.101603 14.055 -6445.1
## + YrSold           1  0.004896 14.151 -6445.1
## + MSSubClass       1  0.004505 14.152 -6445.1
## + OpenPorchSF     1  0.004098 14.152 -6445.0
## + LandContour      3  0.042347 14.114 -6445.0
## + MoSold           1  0.002994 14.153 -6444.9
## + RoofStyle        5  0.080083 14.076 -6444.9
## + BsmtHalfBath     1  0.001086 14.155 -6444.7
## + MiscVal          1  0.000002 14.156 -6444.6
## + BsmtCond         3  0.036917 14.119 -6444.4
## + PavedDrive       2  0.010686 14.146 -6443.7
## + GarageFinish     2  0.006087 14.150 -6443.2
## + GarageType       5  0.060595 14.096 -6442.9
## + HouseStyle       7  0.097156 14.059 -6442.7
## + Electrical       4  0.037402 14.119 -6442.5
## + LotShape         3  0.014077 14.142 -6442.1
## + ExterQual        3  0.002072 14.154 -6440.8
## + Exterior2nd     14  0.143097 14.013 -6433.5
##
## Step:  AIC=-6446.83
## log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea + BsmtFinType1 +
##   GarageCars + OverallCond + RoofMatl + TotalBsmtSF + YearBuilt +
##   Condition2 + MSZoning + BsmtUnfSF + SaleCondition + Functional +
##   BldgType + CentralAir + LotArea + KitchenQual + ScreenPorch +
##   Condition1 + Fireplaces + Heating + BsmtExposure + Exterior1st +
##   YearRemodAdd + LandSlope + GarageArea + WoodDeckSF + LotConfig +
##   Foundation + LotFrontage + HeatingQC + BsmtFullBath + SaleType +
##   EnclosedPorch + GarageCond + HalfBath + Street + KitchenAbvGr +
##   FullBath + BsmtQual + GarageQual + PoolArea + LowQualFinSF +
##   X3SsnPorch + ExterCond + TotRmsAbvGrd
##
##           Df Sum of Sq   RSS   AIC
## <none>                14.135 -6446.8
## + BsmtFinSF1      1  0.019238 14.116 -6446.8
## + BsmtFinSF2      1  0.019238 14.116 -6446.8
## + MasVnrArea      1  0.011117 14.124 -6446.0
## + X1stFlrSF       1  0.009342 14.125 -6445.8
## + X2ndFlrSF       1  0.009342 14.125 -6445.8
## + MasVnrType      3  0.047117 14.088 -6445.7
## + GarageYrBlt     1  0.007537 14.127 -6445.6
## + BsmtFinType2     6  0.103706 14.031 -6445.6
## + RoofStyle       5  0.084128 14.051 -6445.5
## + MSSubClass      1  0.005445 14.129 -6445.4
## + LandContour     3  0.043510 14.091 -6445.3

```

```
## + YrSold      1  0.004751 14.130 -6445.3
## + OpenPorchSF 1  0.004084 14.131 -6445.2
## + MoSold      1  0.002210 14.133 -6445.1
## + BedroomAbvGr 1  0.001232 14.134 -6445.0
## + BsmtHalfBath 1  0.000880 14.134 -6444.9
## + MiscVal     1  0.000000 14.135 -6444.8
## + BsmtCond    3  0.036357 14.098 -6444.6
## + PavedDrive  2  0.011594 14.123 -6444.0
## + GarageFinish 2  0.006297 14.129 -6443.5
## + HouseStyle  7  0.099396 14.035 -6443.1
## + GarageType   5  0.059776 14.075 -6443.0
## + Electrical   4  0.036576 14.098 -6442.6
## + LotShape     3  0.014851 14.120 -6442.4
## + ExterQual    3  0.001297 14.133 -6441.0
## + Exterior2nd 14  0.142277 13.992 -6433.6
```

### # Prediction

```
summary(lm.for)
```

```
##
```

```
## Call:
```

```
## lm(formula = log(SalePrice) ~ OverallQual + Neighborhood + GrLivArea +
##   BsmtFinType1 + GarageCars + OverallCond + RoofMatl + TotalBsmtSF +
##   YearBuilt + Condition2 + MSZoning + BsmtUnfSF + SaleCondition +
##   Functional + BldgType + CentralAir + LotArea + KitchenQual +
##   ScreenPorch + Condition1 + Fireplaces + Heating + BsmtExposure +
##   Exterior1st + YearRemodAdd + LandSlope + GarageArea + WoodDeckSF +
##   LotConfig + Foundation + LotFrontage + HeatingQC + BsmtFullBath +
##   SaleType + EnclosedPorch + GarageCond + HalfBath + Street +
##   KitchenAbvGr + FullBath + BsmtQual + GarageQual + PoolArea +
##   LowQualFinSF + X3SsnPorch + ExterCond + TotRmsAbvGrd, data = training)
```

```
##
```

```
## Residuals:
```

```
##      Min       1Q   Median       3Q      Max
## -0.72182 -0.04734  0.00349  0.05362  0.72182
```

```
##
```

```
## Coefficients: (2 not defined because of singularities)
```

```
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    2.486e+00  7.798e-01   3.188 0.001465 **
## OverallQual     4.375e-02  4.329e-03  10.106 < 2e-16 ***
## NeighborhoodBlueste -3.817e-02  8.379e-02  -0.456 0.648767
## NeighborhoodBrDale  -5.244e-02  4.733e-02  -1.108 0.268066
## NeighborhoodBrkSide  2.851e-02  4.018e-02   0.710 0.478122
## NeighborhoodClearCr  2.839e-02  3.913e-02   0.725 0.468374
## NeighborhoodCollgCr -1.894e-02  3.129e-02  -0.605 0.545138
## NeighborhoodCrawfor  1.166e-01  3.664e-02   3.182 0.001498 **
## NeighborhoodEdwards -6.988e-02  3.436e-02  -2.034 0.042157 *
## NeighborhoodGilbert -1.775e-02  3.327e-02  -0.534 0.593694
## NeighborhoodIDOTRR  -1.359e-02  4.619e-02  -0.294 0.768670
## NeighborhoodMeadowV -1.630e-01  4.773e-02  -3.414 0.000659 ***
```

## NeighborhoodMitchel	-5.309e-02	3.510e-02	-1.513	0.130644	
## NeighborhoodNames	-2.929e-02	3.348e-02	-0.875	0.381954	
## NeighborhoodNoRidge	3.544e-02	3.599e-02	0.985	0.324974	
## NeighborhoodNPkVill	4.498e-03	4.805e-02	0.094	0.925423	
## NeighborhoodNridgHt	7.478e-02	3.132e-02	2.387	0.017119	*
## NeighborhoodNWAmes	-2.864e-02	3.468e-02	-0.826	0.409175	
## NeighborhoodOldTown	-3.316e-02	4.119e-02	-0.805	0.420978	
## NeighborhoodSawyer	-2.530e-02	3.516e-02	-0.720	0.471873	
## NeighborhoodSawyerW	-1.412e-02	3.389e-02	-0.417	0.677004	
## NeighborhoodSomerst	3.884e-02	3.842e-02	1.011	0.312302	
## NeighborhoodStoneBr	1.148e-01	3.555e-02	3.230	0.001269	**
## NeighborhoodSWISU	5.237e-03	4.161e-02	0.126	0.899877	
## NeighborhoodTimber	-3.561e-03	3.505e-02	-0.102	0.919093	
## NeighborhoodVeenker	4.232e-02	4.604e-02	0.919	0.358217	
## GrLivArea	2.272e-04	1.620e-05	14.024	< 2e-16	***
## BsmtFinType1BLQ	-3.303e-03	1.201e-02	-0.275	0.783401	
## BsmtFinType1GLQ	1.268e-02	1.104e-02	1.148	0.251085	
## BsmtFinType1LwQ	-2.136e-02	1.555e-02	-1.374	0.169778	
## BsmtFinType1Rec	-1.090e-02	1.280e-02	-0.851	0.394688	
## BsmtFinType1Unf	-1.636e-02	1.266e-02	-1.293	0.196389	
## BsmtFinType1Missing	-4.736e-04	1.128e-01	-0.004	0.996650	
## GarageCars	2.096e-02	1.010e-02	2.075	0.038192	*
## OverallCond	3.691e-02	3.782e-03	9.759	< 2e-16	***
## RoofMatlCompShg	2.687e+00	1.408e-01	19.084	< 2e-16	***
## RoofMatlMembran	2.980e+00	1.861e-01	16.008	< 2e-16	***
## RoofMatlMetal	2.834e+00	1.861e-01	15.225	< 2e-16	***
## RoofMatlRoll	2.760e+00	1.816e-01	15.201	< 2e-16	***
## RoofMatlTar&Grv	2.714e+00	1.443e-01	18.802	< 2e-16	***
## RoofMatlWdShake	2.736e+00	1.504e-01	18.192	< 2e-16	***
## RoofMatlWdShngl	2.724e+00	1.466e-01	18.585	< 2e-16	***
## TotalBsmtSF	1.493e-04	1.546e-05	9.661	< 2e-16	***
## YearBuilt	1.839e-03	3.146e-04	5.847	6.32e-09	***
## Condition2Feedr	9.909e-02	1.002e-01	0.988	0.323120	
## Condition2Norm	4.819e-02	8.613e-02	0.559	0.575953	
## Condition2PosA	2.735e-01	1.571e-01	1.741	0.081960	.
## Condition2PosN	-8.341e-01	1.206e-01	-6.918	7.16e-12	***
## Condition2RRAE	-8.452e-02	1.396e-01	-0.606	0.544863	
## Condition2RRAN	-4.866e-02	1.392e-01	-0.350	0.726746	
## Condition2RRNn	1.138e-02	1.181e-01	0.096	0.923215	
## MSZoningFV	4.174e-01	5.257e-02	7.940	4.36e-15	***
## MSZoningRH	4.122e-01	5.243e-02	7.861	7.93e-15	***
## MSZoningRL	4.087e-01	4.468e-02	9.148	< 2e-16	***
## MSZoningRM	3.670e-01	4.167e-02	8.806	< 2e-16	***
## BsmtUnfSF	-4.987e-05	1.307e-05	-3.815	0.000143	***
## SaleConditionAdjLand	1.156e-01	6.002e-02	1.926	0.054372	.
## SaleConditionAlloca	6.786e-02	3.730e-02	1.819	0.069105	.
## SaleConditionFamily	2.273e-02	2.732e-02	0.832	0.405563	
## SaleConditionNormal	7.335e-02	1.274e-02	5.757	1.07e-08	***
## SaleConditionPartial	-3.709e-02	6.672e-02	-0.556	0.578349	
## FunctionalMaj2	-2.375e-01	5.999e-02	-3.959	7.94e-05	***

## FunctionalMin1	3.848e-02	3.667e-02	1.049	0.294226	
## FunctionalMin2	3.433e-02	3.617e-02	0.949	0.342733	
## FunctionalMod	-5.162e-02	4.406e-02	-1.172	0.241599	
## FunctionalSev	-2.852e-01	1.195e-01	-2.388	0.017092	*
## FunctionalTyp	6.974e-02	3.137e-02	2.223	0.026372	*
## BldgType2fmCon	1.875e-03	2.593e-02	0.072	0.942362	
## BldgTypeDuplex	-1.681e-02	2.708e-02	-0.621	0.534992	
## BldgTypeTwnhs	-8.694e-02	2.448e-02	-3.551	0.000397	***
## BldgTypeTwnhsE	-4.623e-02	1.673e-02	-2.763	0.005812	**
## CentralAirY	6.500e-02	1.630e-02	3.988	7.02e-05	***
## LotArea	2.160e-06	4.339e-07	4.978	7.28e-07	***
## KitchenQualFa	-6.063e-02	2.632e-02	-2.303	0.021424	*
## KitchenQualGd	-5.935e-02	1.459e-02	-4.068	5.04e-05	***
## KitchenQualTA	-5.686e-02	1.666e-02	-3.413	0.000662	***
## ScreenPorch	2.325e-04	5.451e-05	4.265	2.15e-05	***
## Condition1Feedr	4.090e-02	2.183e-02	1.873	0.061269	.
## Condition1Norm	8.271e-02	1.810e-02	4.571	5.32e-06	***
## Condition1PosA	4.286e-02	4.382e-02	0.978	0.328228	
## Condition1PosN	8.172e-02	3.237e-02	2.525	0.011699	*
## Condition1RR Ae	-2.734e-02	4.035e-02	-0.678	0.498185	
## Condition1RR An	4.111e-02	2.996e-02	1.372	0.170251	
## Condition1RR Ne	9.811e-03	7.956e-02	0.123	0.901883	
## Condition1RR Nn	7.614e-02	5.571e-02	1.367	0.171954	
## Fireplaces	2.376e-02	5.868e-03	4.049	5.44e-05	***
## HeatingGasA	1.468e-01	1.156e-01	1.271	0.204085	
## HeatingGasW	2.271e-01	1.189e-01	1.911	0.056215	.
## HeatingGrav	-2.177e-02	1.252e-01	-0.174	0.861925	
## HeatingOthW	1.827e-01	1.410e-01	1.296	0.195298	
## HeatingWall	2.189e-01	1.313e-01	1.667	0.095846	.
## BsmtExposureGd	3.711e-02	1.323e-02	2.805	0.005101	**
## BsmtExposureMn	-6.631e-03	1.309e-02	-0.507	0.612544	
## BsmtExposureNo	-1.312e-02	9.065e-03	-1.447	0.147999	
## BsmtExposureMissing	-4.502e-02	1.053e-01	-0.427	0.669175	
## Exterior1stAsphShn	5.111e-02	1.145e-01	0.447	0.655294	
## Exterior1stBrkComm	-1.672e-01	8.779e-02	-1.905	0.057032	.
## Exterior1stBrkFace	9.488e-02	3.163e-02	3.000	0.002753	**
## Exterior1stCBlock	-6.732e-02	1.126e-01	-0.598	0.550190	
## Exterior1stCemntBd	5.004e-02	3.305e-02	1.514	0.130294	
## Exterior1stHdBoard	1.251e-02	2.889e-02	0.433	0.665152	
## Exterior1stImStucc	3.197e-02	1.107e-01	0.289	0.772734	
## Exterior1stMetalSd	4.377e-02	2.812e-02	1.556	0.119872	
## Exterior1stPlywood	2.252e-02	3.044e-02	0.740	0.459538	
## Exterior1stStone	4.092e-03	8.674e-02	0.047	0.962386	
## Exterior1stStucco	4.221e-02	3.559e-02	1.186	0.235862	
## Exterior1stVinylSd	3.707e-02	2.814e-02	1.317	0.187970	
## Exterior1stWd Sdng	1.407e-02	2.799e-02	0.503	0.615237	
## Exterior1stWdShing	1.487e-02	3.490e-02	0.426	0.670001	
## YearRemodAdd	6.661e-04	2.345e-04	2.841	0.004574	**
## LandSlopeMod	1.509e-02	1.542e-02	0.978	0.328125	
## LandSlopeSev	-1.261e-01	4.501e-02	-2.801	0.005171	**

## GarageArea	9.650e-05	3.337e-05	2.892	0.003891	**
## WoodDeckSF	8.889e-05	2.584e-05	3.439	0.000601	***
## LotConfigCulDSac	2.684e-02	1.431e-02	1.875	0.060985	.
## LotConfigFR2	-3.130e-02	1.790e-02	-1.749	0.080563	.
## LotConfigFR3	-8.516e-02	5.673e-02	-1.501	0.133559	.
## LotConfigInside	-1.421e-02	7.880e-03	-1.803	0.071567	.
## FoundationCBlock	1.343e-02	1.404e-02	0.957	0.338768	.
## FoundationPConc	3.306e-02	1.523e-02	2.170	0.030158	*
## FoundationSlab	-2.353e-02	4.366e-02	-0.539	0.590063	.
## FoundationStone	1.001e-01	4.737e-02	2.113	0.034833	*
## FoundationWood	-1.258e-01	6.533e-02	-1.926	0.054343	.
## LotFrontage	4.231e-04	1.880e-04	2.251	0.024570	*
## HeatingQCFa	-2.612e-02	2.028e-02	-1.288	0.198071	.
## HeatingQCGd	-2.154e-02	9.171e-03	-2.348	0.019019	*
## HeatingQCPo	-9.130e-02	1.157e-01	-0.789	0.430231	.
## HeatingQCTA	-3.511e-02	9.140e-03	-3.841	0.000128	***
## BsmtFullBath	2.257e-02	8.252e-03	2.735	0.006316	**
## SaleTypeCon	5.604e-02	7.952e-02	0.705	0.481106	.
## SaleTypeConLD	1.254e-01	4.294e-02	2.920	0.003556	**
## SaleTypeConLI	-3.632e-02	5.139e-02	-0.707	0.479802	.
## SaleTypeConLw	3.009e-02	5.296e-02	0.568	0.569954	.
## SaleTypeCWD	6.329e-02	5.763e-02	1.098	0.272306	.
## SaleTypeNew	1.398e-01	6.913e-02	2.022	0.043388	*
## SaleTypeOth	6.450e-02	6.536e-02	0.987	0.323911	.
## SaleTypeWD	-1.923e-02	1.841e-02	-1.044	0.296551	.
## EnclosedPorch	1.106e-04	5.428e-05	2.038	0.041733	*
## GarageCondFa	2.673e-01	1.511e-01	1.770	0.077011	.
## GarageCondGd	3.142e-01	1.552e-01	2.025	0.043101	*
## GarageCondPo	4.330e-01	1.619e-01	2.675	0.007570	**
## GarageCondTA	3.036e-01	1.493e-01	2.033	0.042225	*
## GarageCondMissing	-6.834e-02	7.859e-02	-0.870	0.384674	.
## HalfBath	2.255e-02	8.494e-03	2.655	0.008019	**
## StreetPave	9.989e-02	5.027e-02	1.987	0.047127	*
## KitchenAbvGr	-5.386e-02	2.443e-02	-2.204	0.027667	*
## FullBath	1.711e-02	9.520e-03	1.797	0.072550	.
## BsmtQualFa	-3.511e-02	2.725e-02	-1.288	0.197919	.
## BsmtQualGd	-3.707e-02	1.428e-02	-2.595	0.009559	**
## BsmtQualTA	-4.539e-02	1.782e-02	-2.546	0.010999	*
## BsmtQualMissing	NA	NA	NA	NA	.
## GarageQualFa	-3.695e-01	1.292e-01	-2.859	0.004312	**
## GarageQualGd	-2.977e-01	1.328e-01	-2.242	0.025120	*
## GarageQualPo	-4.121e-01	1.581e-01	-2.606	0.009253	**
## GarageQualTA	-3.338e-01	1.279e-01	-2.610	0.009152	**
## GarageQualMissing	NA	NA	NA	NA	.
## PoolArea	1.444e-04	7.929e-05	1.822	0.068752	.
## LowQualFinSF	-1.097e-04	6.845e-05	-1.602	0.109405	.
## X3SsnPorch	1.651e-04	1.003e-04	1.646	0.100108	.
## ExterCondFa	-9.009e-02	8.031e-02	-1.122	0.262165	.
## ExterCondGd	-7.691e-02	7.610e-02	-1.011	0.312350	.
## ExterCondPo	-1.250e-01	1.382e-01	-0.905	0.365804	.

```

## ExterCondTA          -5.447e-02  7.598e-02  -0.717  0.473506
## TotRmsAbvGrd         5.296e-03  3.781e-03   1.401  0.161577
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1044 on 1298 degrees of freedom
## Multiple R-squared:  0.9393, Adjusted R-squared:  0.9318
## F-statistic: 124.7 on 161 and 1298 DF,  p-value: < 2.2e-16

lm.pred <- predict(lm.for,testing)

## Warning in predict.lm(lm.for, testing): prediction from a rank-deficient
fit may
## be misleading

res <- data.frame(Id = testing$Id, SalePrice = exp(lm.pred))
write.csv(res, file = "Price+Forward_Step.csv", row.names = FALSE)

# CV Error for forward subset selection
k <- 10
set.seed(1)
folds <- sample(1:k, nrow(training), replace = T)
cv.errors <- rep(NA, k)

for (j in 1:k){
  best_temp <- regsubsets(SalePrice~., data=training[folds!=j,], nvmax=35,
method="forward")
  pred <- predict.regsubsets(best_temp, training[folds==j,], id=best_no)
  cv.errors[j] <- mean((training$SalePrice[folds==j]-pred)^2)
}

## Warning in leaps.setup(x, y, wt = wt, nbest = nbest, nvmax = nvmax,
force.in =
## force.in, : 10 linear dependencies found

## Reordering variables and trying again:

## Warning in leaps.setup(x, y, wt = wt, nbest = nbest, nvmax = nvmax,
force.in =
## force.in, : 10 linear dependencies found

## Reordering variables and trying again:

## Warning in leaps.setup(x, y, wt = wt, nbest = nbest, nvmax = nvmax,
force.in =
## force.in, : 11 linear dependencies found

## Reordering variables and trying again:

## Warning in leaps.setup(x, y, wt = wt, nbest = nbest, nvmax = nvmax,
force.in =
## force.in, : 12 linear dependencies found

```

```

## Reordering variables and trying again:

## Warning in leaps.setup(x, y, wt = wt, nbest = nbest, nvmax = nvmax,
force.in =
## force.in, : 9 linear dependencies found

## Reordering variables and trying again:

## Warning in leaps.setup(x, y, wt = wt, nbest = nbest, nvmax = nvmax,
force.in =
## force.in, : 13 linear dependencies found

## Reordering variables and trying again:

## Warning in leaps.setup(x, y, wt = wt, nbest = nbest, nvmax = nvmax,
force.in =
## force.in, : 12 linear dependencies found

## Reordering variables and trying again:

## Warning in leaps.setup(x, y, wt = wt, nbest = nbest, nvmax = nvmax,
force.in =
## force.in, : 11 linear dependencies found

## Reordering variables and trying again:

## Warning in leaps.setup(x, y, wt = wt, nbest = nbest, nvmax = nvmax,
force.in =
## force.in, : 14 linear dependencies found

## Reordering variables and trying again:

## Warning in leaps.setup(x, y, wt = wt, nbest = nbest, nvmax = nvmax,
force.in =
## force.in, : 11 linear dependencies found

## Reordering variables and trying again:

cv.error <- mean(cv.errors)
cv.error

## [1] 1836188577

```

- By doing the forward subset selection, the Kaggle score is 0.13163.

*backward selection:*

In Backward Selection, it goes from Full model and removes variables which are least statistically significant.

```

emptyb <- lm(log(SalePrice)~1, data=training)
fullb <- lm(log(SalePrice)~.-Id, data=training)
set.seed(1234)

```

*## Forward Stepwise*

```
lm.forb <- step(fullb, scope=list(lower=fullb, upper=emptyb),  
direction="backward")
```

```
## Start: AIC=-6389.77
```

```
## log(SalePrice) ~ (Id + MSSubClass + MSZoning + LotFrontage +  
##   LotArea + Street + LotShape + LandContour + LotConfig + LandSlope +  
##   Neighborhood + Condition1 + Condition2 + BldgType + HouseStyle +  
##   OverallQual + OverallCond + YearBuilt + YearRemodAdd + RoofStyle +  
##   RoofMatl + Exterior1st + Exterior2nd + MasVnrType + MasVnrArea +  
##   ExterQual + ExterCond + Foundation + BsmtQual + BsmtCond +  
##   BsmtExposure + BsmtFinType1 + BsmtFinSF1 + BsmtFinType2 +  
##   BsmtFinSF2 + BsmtUnfSF + TotalBsmtSF + Heating + HeatingQC +  
##   CentralAir + Electrical + X1stFlrSF + X2ndFlrSF + LowQualFinSF +  
##   GrLivArea + BsmtFullBath + BsmtHalfBath + FullBath + HalfBath +  
##   BedroomAbvGr + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +  
##   Functional + Fireplaces + GarageType + GarageYrBlt + GarageFinish +  
##   GarageCars + GarageArea + GarageQual + GarageCond + PavedDrive +  
##   WoodDeckSF + OpenPorchSF + EnclosedPorch + X3SsnPorch + ScreenPorch +  
##   PoolArea + MiscVal + MoSold + YrSold + SaleType + SaleCondition +  
##   YrRemodel_Diff) - Id
```

```
lm.forb
```

```
##
```

```
## Call:
```

```
## lm(formula = log(SalePrice) ~ (Id + MSSubClass + MSZoning + LotFrontage +  
##   LotArea + Street + LotShape + LandContour + LotConfig + LandSlope +  
##   Neighborhood + Condition1 + Condition2 + BldgType + HouseStyle +  
##   OverallQual + OverallCond + YearBuilt + YearRemodAdd + RoofStyle +  
##   RoofMatl + Exterior1st + Exterior2nd + MasVnrType + MasVnrArea +  
##   ExterQual + ExterCond + Foundation + BsmtQual + BsmtCond +  
##   BsmtExposure + BsmtFinType1 + BsmtFinSF1 + BsmtFinType2 +  
##   BsmtFinSF2 + BsmtUnfSF + TotalBsmtSF + Heating + HeatingQC +  
##   CentralAir + Electrical + X1stFlrSF + X2ndFlrSF + LowQualFinSF +  
##   GrLivArea + BsmtFullBath + BsmtHalfBath + FullBath + HalfBath +  
##   BedroomAbvGr + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +  
##   Functional + Fireplaces + GarageType + GarageYrBlt + GarageFinish +  
##   GarageCars + GarageArea + GarageQual + GarageCond + PavedDrive +  
##   WoodDeckSF + OpenPorchSF + EnclosedPorch + X3SsnPorch + ScreenPorch +  
##   PoolArea + MiscVal + MoSold + YrSold + SaleType + SaleCondition +  
##   YrRemodel_Diff) - Id, data = training)
```

```
##
```

```
## Coefficients:
```

##	(Intercept)	MSSubClass	MSZoningFV
##	7.440e+00	-1.881e-04	4.459e-01
##	MSZoningRH	MSZoningRL	MSZoningRM
##	4.324e-01	4.198e-01	3.773e-01
##	LotFrontage	LotArea	StreetPave
##	3.123e-04	2.940e-06	9.746e-02



##	LotShapeIR2	LotShapeIR3	LotShapeReg
##	2.392e-02	1.828e-02	6.856e-03
##	LandContourHLS	LandContourLow	LandContourLv1
##	2.555e-02	-2.493e-02	2.342e-02
##	LotConfigCulDSac	LotConfigFR2	LotConfigFR3
##	2.691e-02	-3.685e-02	-9.293e-02
##	LotConfigInside	LandSlopeMod	LandSlopeSev
##	-1.410e-02	3.372e-02	-2.025e-01
##	NeighborhoodBlueste	NeighborhoodBrDale	NeighborhoodBrkSide
##	-5.330e-02	-5.839e-02	1.045e-02
##	NeighborhoodClearCr	NeighborhoodCollgCr	NeighborhoodCrawfor
##	1.771e-02	-2.336e-02	1.121e-01
##	NeighborhoodEdwards	NeighborhoodGilbert	NeighborhoodIDOTRR
##	-8.560e-02	-1.421e-02	-3.166e-02
##	NeighborhoodMeadowV	NeighborhoodMitchel	NeighborhoodNAMES
##	-1.662e-01	-5.650e-02	-4.200e-02
##	NeighborhoodNoRidge	NeighborhoodNPkVill	NeighborhoodNridgHt
##	3.145e-02	-6.906e-03	7.328e-02
##	NeighborhoodNWAmes	NeighborhoodOldTown	NeighborhoodSawyer
##	-4.467e-02	-4.443e-02	-3.056e-02
##	NeighborhoodSawyerW	NeighborhoodSomerst	NeighborhoodStoneBr
##	-1.225e-02	1.982e-02	1.334e-01
##	NeighborhoodSWISU	NeighborhoodTimber	NeighborhoodVeenker
##	1.775e-03	-3.545e-03	4.637e-02
##	Condition1Feedr	Condition1Norm	Condition1PosA
##	4.010e-02	9.012e-02	4.308e-02
##	Condition1PosN	Condition1RRAE	Condition1RRAN
##	9.504e-02	-2.939e-02	4.521e-02
##	Condition1RRNE	Condition1RRNN	Condition2Feedr
##	2.541e-02	8.823e-02	1.192e-01
##	Condition2Norm	Condition2PosA	Condition2PosN
##	5.606e-02	2.289e-01	-8.194e-01
##	Condition2RRAE	Condition2RRAN	Condition2RRNN
##	-5.254e-01	-4.396e-02	4.109e-02
##	BldgType2fmCon	BldgTypeDuplex	BldgTypeTwnhs
##	2.476e-02	-1.049e-02	-6.319e-02
##	BldgTypeTwnhsE	HouseStyle1.5Unf	HouseStyle1Story
##	-2.478e-02	5.464e-03	-2.487e-02
##	HouseStyle2.5Fin	HouseStyle2.5Unf	HouseStyle2Story
##	-1.013e-01	2.841e-02	-2.442e-02
##	HouseStyleSFoyer	HouseStyleSLvl	OverallQual
##	-1.903e-02	-9.860e-03	4.129e-02
##	OverallCond	YearBuilt	YearRemodAdd
##	3.613e-02	1.718e-03	8.266e-04
##	RoofStyleGable	RoofStyleGambrel	RoofStyleHip
##	-1.291e-02	-5.341e-03	-9.864e-03
##	RoofStyleMansard	RoofStyleShed	RoofMatlCompShg
##	5.486e-02	4.533e-01	2.682e+00
##	RoofMatlMembran	RoofMatlMetal	RoofMatlRoll
##	3.077e+00	2.951e+00	2.712e+00

##	RoofMatlTar&Grv	RoofMatlWdShake	RoofMatlWdShngl
##	2.710e+00	2.624e+00	2.731e+00
##	Exterior1stAsphShn	Exterior1stBrkComm	Exterior1stBrkFace
##	-2.173e-03	-2.387e-01	7.252e-02
##	Exterior1stCBlock	Exterior1stCemntBd	Exterior1stHdBoard
##	-5.667e-02	-1.072e-01	-2.917e-02
##	Exterior1stImStucc	Exterior1stMetalSd	Exterior1stPlywood
##	-2.352e-02	2.319e-02	-2.072e-02
##	Exterior1stStone	Exterior1stStucco	Exterior1stVinylSd
##	3.498e-02	1.272e-03	-2.470e-02
##	Exterior1stWd Sdng	Exterior1stWdShing	Exterior2ndAsphShn
##	-5.517e-02	-2.240e-02	4.537e-02
##	Exterior2ndBrk Cmn	Exterior2ndBrkFace	Exterior2ndCBlock
##	5.808e-02	-1.713e-02	NA
##	Exterior2ndCmentBd	Exterior2ndHdBoard	Exterior2ndImStucc
##	1.515e-01	3.370e-02	4.536e-02
##	Exterior2ndMetalSd	Exterior2ndOther	Exterior2ndPlywood
##	1.560e-02	-5.219e-02	3.566e-02
##	Exterior2ndStone	Exterior2ndStucco	Exterior2ndVinylSd
##	-3.177e-02	3.592e-02	5.752e-02
##	Exterior2ndWd Sdng	Exterior2ndWd Shng	MasVnrTypeBrkFace
##	7.114e-02	3.856e-02	3.852e-02
##	MasVnrTypeNone	MasVnrTypeStone	MasVnrArea
##	3.039e-02	4.980e-02	8.235e-06
##	ExterQualFa	ExterQualGd	ExterQualTA
##	9.734e-03	5.368e-04	5.784e-03
##	ExterCondFa	ExterCondGd	ExterCondPo
##	-1.072e-01	-8.311e-02	-9.888e-02
##	ExterCondTA	FoundationCBlock	FoundationPConc
##	-6.226e-02	1.871e-02	3.403e-02
##	FoundationSlab	FoundationStone	FoundationWood
##	-3.473e-02	9.810e-02	-1.341e-01
##	BsmtQualFa	BsmtQualGd	BsmtQualTA
##	-3.057e-02	-2.704e-02	-3.443e-02
##	BsmtQualMissing	BsmtCondGd	BsmtCondPo
##	1.577e-01	2.024e-02	3.177e-01
##	BsmtCondTA	BsmtCondMissing	BsmtExposureGd
##	1.801e-02	NA	2.966e-02
##	BsmtExposureMn	BsmtExposureNo	BsmtExposureMissing
##	-6.546e-03	-1.211e-02	-5.154e-02
##	BsmtFinType1BLQ	BsmtFinType1GLQ	BsmtFinType1LwQ
##	-5.515e-03	1.116e-02	-2.462e-02
##	BsmtFinType1Rec	BsmtFinType1Unf	BsmtFinType1Missing
##	-1.086e-02	-1.237e-02	NA
##	BsmtFinSF1	BsmtFinType2BLQ	BsmtFinType2GLQ
##	1.464e-04	-6.338e-02	1.449e-02
##	BsmtFinType2LwQ	BsmtFinType2Rec	BsmtFinType2Unf
##	-3.245e-02	-2.759e-02	-1.051e-02
##	BsmtFinType2Missing	BsmtFinSF2	BsmtUnfSF
##	-1.315e-01	1.402e-04	9.034e-05

##	TotalBsmtSF	HeatingGasA	HeatingGasW
##	NA	1.411e-01	2.105e-01
##	HeatingGrav	HeatingOthW	HeatingWall
##	-4.773e-02	1.659e-01	2.234e-01
##	HeatingQCFa	HeatingQCGd	HeatingQCPo
##	-1.676e-02	-2.030e-02	-9.802e-02
##	HeatingQCTA	CentralAirY	ElectricalFuseF
##	-3.410e-02	6.400e-02	-8.504e-04
##	ElectricalFuseP	ElectricalMix	ElectricalSBBrkr
##	-7.953e-02	-2.685e-01	-1.445e-02
##	X1stFlrSF	X2ndFlrSF	LowQualFinSF
##	2.297e-04	2.232e-04	1.867e-04
##	GrLivArea	BsmtFullBath	BsmtHalfBath
##	NA	2.307e-02	2.911e-03
##	FullBath	HalfBath	BedroomAbvGr
##	1.833e-02	2.328e-02	7.732e-03
##	KitchenAbvGr	KitchenQualFa	KitchenQualGd
##	-4.527e-02	-5.508e-02	-6.466e-02
##	KitchenQualTA	TotRmsAbvGrd	FunctionalMaj2
##	-6.361e-02	3.747e-03	-2.509e-01
##	FunctionalMin1	FunctionalMin2	FunctionalMod
##	3.710e-02	3.259e-02	-6.201e-02
##	FunctionalSev	FunctionalTyp	Fireplaces
##	-2.820e-01	6.566e-02	2.292e-02
##	GarageTypeAttchd	GarageTypeBasment	GarageTypeBuiltIn
##	1.105e-01	9.259e-02	9.438e-02
##	GarageTypeCarPort	GarageTypeDetchd	GarageTypeMissing
##	1.330e-01	1.073e-01	1.863e-02
##	GarageYrBlt	GarageFinishRFn	GarageFinishUnf
##	-1.107e-04	-1.305e-03	-9.942e-03
##	GarageFinishMissing	GarageCars	GarageArea
##	NA	1.777e-02	1.222e-04
##	GarageQualFa	GarageQualGd	GarageQualPo
##	-3.870e-01	-3.095e-01	-4.156e-01
##	GarageQualTA	GarageQualMissing	GarageCondFa
##	-3.388e-01	NA	2.737e-01
##	GarageCondGd	GarageCondPo	GarageCondTA
##	3.140e-01	4.352e-01	2.969e-01
##	GarageCondMissing	PavedDriveP	PavedDriveY
##	NA	-1.080e-02	1.145e-02
##	WoodDeckSF	OpenPorchSF	EnclosedPorch
##	9.534e-05	4.095e-05	1.141e-04
##	X3SsnPorch	ScreenPorch	PoolArea
##	1.641e-04	2.425e-04	1.335e-04
##	MiscVal	MoSold	YrSold
##	7.763e-08	-6.040e-04	-2.456e-03
##	SaleTypeCon	SaleTypeConLD	SaleTypeConLI
##	9.112e-02	1.312e-01	-2.646e-02
##	SaleTypeConLw	SaleTypeCWD	SaleTypeNew
##	2.976e-02	6.507e-02	7.946e-02

```
##           SaleType0th           SaleTypeWD SaleConditionAdjLand
##           7.078e-02           -1.616e-02           1.088e-01
## SaleConditionAlloca SaleConditionFamily SaleConditionNormal
##           7.195e-02           1.509e-02           6.657e-02
## SaleConditionPartial YrRemodel_Diff
##           1.613e-02           NA
```

```
## Check Result
summary(lm.forb)
```

```
##
## Call:
## lm(formula = log(SalePrice) ~ (Id + MSSubClass + MSZoning + LotFrontage +
## LotArea + Street + LotShape + LandContour + LotConfig + LandSlope +
## Neighborhood + Condition1 + Condition2 + BldgType + HouseStyle +
## OverallQual + OverallCond + YearBuilt + YearRemodAdd + RoofStyle +
## RoofMatl + Exterior1st + Exterior2nd + MasVnrType + MasVnrArea +
## ExterQual + ExterCond + Foundation + BsmtQual + BsmtCond +
## BsmtExposure + BsmtFinType1 + BsmtFinSF1 + BsmtFinType2 +
## BsmtFinSF2 + BsmtUnfSF + TotalBsmtSF + Heating + HeatingQC +
## CentralAir + Electrical + X1stFlrSF + X2ndFlrSF + LowQualFinSF +
## GrLivArea + BsmtFullBath + BsmtHalfBath + FullBath + HalfBath +
## BedroomAbvGr + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +
## Functional + Fireplaces + GarageType + GarageYrBlt + GarageFinish +
## GarageCars + GarageArea + GarageQual + GarageCond + PavedDrive +
## WoodDeckSF + OpenPorchSF + EnclosedPorch + X3SsnPorch + ScreenPorch +
## PoolArea + MiscVal + MoSold + YrSold + SaleType + SaleCondition +
## YrRemodel_Diff) - Id, data = training)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.69893 -0.04569  0.00271  0.05073  0.69893
##
## Coefficients: (9 not defined because of singularities)
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    7.440e+00  4.818e+00   1.544 0.122775
## MSSubClass     -1.881e-04  3.709e-04  -0.507 0.612169
## MSZoningFV      4.459e-01  5.464e-02   8.161 8.17e-16 ***
## MSZoningRH      4.324e-01  5.453e-02   7.930 4.90e-15 ***
## MSZoningRL      4.198e-01  4.661e-02   9.007 < 2e-16 ***
## MSZoningRM      3.773e-01  4.357e-02   8.660 < 2e-16 ***
## LotFrontage     3.123e-04  1.978e-04   1.579 0.114657
## LotArea         2.940e-06  4.975e-07   5.909 4.44e-09 ***
## StreetPave      9.746e-02  5.528e-02   1.763 0.078149 .
## LotShapeIR2     2.392e-02  1.936e-02   1.235 0.216926
## LotShapeIR3     1.828e-02  4.068e-02   0.449 0.653331
## LotShapeReg     6.856e-03  7.365e-03   0.931 0.352071
## LandContourHLS   2.555e-02  2.353e-02   1.086 0.277772
## LandContourLow  -2.493e-02  2.931e-02  -0.851 0.395207
## LandContourLvl   2.342e-02  1.691e-02   1.385 0.166211
```

## LotConfigCulDSac	2.691e-02	1.507e-02	1.786	0.074366	.
## LotConfigFR2	-3.685e-02	1.842e-02	-2.000	0.045704	*
## LotConfigFR3	-9.293e-02	5.775e-02	-1.609	0.107835	
## LotConfigInside	-1.410e-02	8.181e-03	-1.724	0.084997	.
## LandSlopeMod	3.372e-02	1.824e-02	1.849	0.064739	.
## LandSlopeSev	-2.025e-01	5.223e-02	-3.878	0.000111	***
## NeighborhoodBlueste	-5.330e-02	8.705e-02	-0.612	0.540468	
## NeighborhoodBrDale	-5.839e-02	5.012e-02	-1.165	0.244225	
## NeighborhoodBrkSide	1.045e-02	4.301e-02	0.243	0.808070	
## NeighborhoodClearCr	1.771e-02	4.213e-02	0.420	0.674382	
## NeighborhoodCollgCr	-2.336e-02	3.321e-02	-0.703	0.481913	
## NeighborhoodCrawfor	1.121e-01	3.902e-02	2.873	0.004135	**
## NeighborhoodEdwards	-8.560e-02	3.647e-02	-2.347	0.019075	*
## NeighborhoodGilbert	-1.421e-02	3.520e-02	-0.404	0.686374	
## NeighborhoodIDOTRR	-3.166e-02	4.894e-02	-0.647	0.517815	
## NeighborhoodMeadowV	-1.662e-01	5.116e-02	-3.248	0.001194	**
## NeighborhoodMitchel	-5.650e-02	3.726e-02	-1.516	0.129653	
## NeighborhoodNames	-4.200e-02	3.562e-02	-1.179	0.238557	
## NeighborhoodNoRidge	3.145e-02	3.858e-02	0.815	0.415019	
## NeighborhoodNPkVill	-6.906e-03	6.417e-02	-0.108	0.914312	
## NeighborhoodNridgHt	7.328e-02	3.434e-02	2.134	0.033025	*
## NeighborhoodNWAmes	-4.467e-02	3.664e-02	-1.219	0.223049	
## NeighborhoodOldTown	-4.443e-02	4.370e-02	-1.017	0.309583	
## NeighborhoodSawyer	-3.056e-02	3.714e-02	-0.823	0.410670	
## NeighborhoodSawyerW	-1.225e-02	3.564e-02	-0.344	0.731178	
## NeighborhoodSomerst	1.982e-02	4.123e-02	0.481	0.630906	
## NeighborhoodStoneBr	1.334e-01	3.806e-02	3.504	0.000475	***
## NeighborhoodSWISU	1.775e-03	4.427e-02	0.040	0.968018	
## NeighborhoodTimber	-3.545e-03	3.708e-02	-0.096	0.923859	
## NeighborhoodVeenker	4.637e-02	4.810e-02	0.964	0.335187	
## Condition1Feedr	4.010e-02	2.281e-02	1.758	0.078936	.
## Condition1Norm	9.012e-02	1.901e-02	4.742	2.37e-06	***
## Condition1PosA	4.308e-02	4.578e-02	0.941	0.346829	
## Condition1PosN	9.504e-02	3.402e-02	2.794	0.005290	**
## Condition1RR Ae	-2.939e-02	4.149e-02	-0.709	0.478754	
## Condition1RR An	4.521e-02	3.134e-02	1.443	0.149368	
## Condition1RR Ne	2.541e-02	8.033e-02	0.316	0.751797	
## Condition1RR Nn	8.823e-02	5.877e-02	1.501	0.133541	
## Condition2Feedr	1.192e-01	1.072e-01	1.112	0.266558	
## Condition2Norm	5.606e-02	9.293e-02	0.603	0.546475	
## Condition2PosA	2.289e-01	1.700e-01	1.347	0.178244	
## Condition2PosN	-8.194e-01	1.267e-01	-6.470	1.41e-10	***
## Condition2RR Ae	-5.254e-01	2.119e-01	-2.479	0.013310	*
## Condition2RR An	-4.396e-02	1.447e-01	-0.304	0.761311	
## Condition2RR Nn	4.109e-02	1.243e-01	0.330	0.741104	
## BldgType2fmCon	2.476e-02	5.614e-02	0.441	0.659232	
## BldgTypeDuplex	-1.049e-02	3.335e-02	-0.315	0.753182	
## BldgTypeTwnhs	-6.319e-02	4.513e-02	-1.400	0.161742	
## BldgTypeTwnhsE	-2.478e-02	4.054e-02	-0.611	0.541205	
## HouseStyle1.5Unf	5.464e-03	3.620e-02	0.151	0.880044	

## HouseStyle1Story	-2.487e-02	1.970e-02	-1.263	0.206891	
## HouseStyle2.5Fin	-1.013e-01	5.617e-02	-1.803	0.071562	.
## HouseStyle2.5Unf	2.841e-02	4.214e-02	0.674	0.500312	
## HouseStyle2Story	-2.442e-02	1.597e-02	-1.529	0.126540	
## HouseStyleSFoyer	-1.903e-02	2.859e-02	-0.666	0.505631	
## HouseStyleSLvl	-9.860e-03	2.511e-02	-0.393	0.694609	
## OverallQual	4.129e-02	4.621e-03	8.936	< 2e-16	***
## OverallCond	3.613e-02	3.990e-03	9.053	< 2e-16	***
## YearBuilt	1.718e-03	3.664e-04	4.690	3.03e-06	***
## YearRemodAdd	8.266e-04	2.513e-04	3.289	0.001035	**
## RoofStyleGable	-1.291e-02	8.437e-02	-0.153	0.878394	
## RoofStyleGambrel	-5.341e-03	9.227e-02	-0.058	0.953851	
## RoofStyleHip	-9.864e-03	8.462e-02	-0.117	0.907227	
## RoofStyleMansard	5.486e-02	9.818e-02	0.559	0.576407	
## RoofStyleShed	4.533e-01	1.588e-01	2.854	0.004389	**
## RoofMatlCompShg	2.682e+00	1.531e-01	17.515	< 2e-16	***
## RoofMatlMembran	3.077e+00	2.190e-01	14.048	< 2e-16	***
## RoofMatlMetal	2.951e+00	2.144e-01	13.761	< 2e-16	***
## RoofMatlRoll	2.712e+00	1.917e-01	14.152	< 2e-16	***
## RoofMatlTar&Grv	2.710e+00	1.747e-01	15.513	< 2e-16	***
## RoofMatlWdShake	2.624e+00	1.694e-01	15.493	< 2e-16	***
## RoofMatlWdShngl	2.731e+00	1.589e-01	17.187	< 2e-16	***
## Exterior1stAsphShn	-2.173e-03	1.516e-01	-0.014	0.988564	
## Exterior1stBrkComm	-2.387e-01	1.270e-01	-1.879	0.060473	.
## Exterior1stBrkFace	7.252e-02	5.843e-02	1.241	0.214796	
## Exterior1stCBlock	-5.667e-02	1.247e-01	-0.454	0.649565	
## Exterior1stCemntBd	-1.072e-01	8.729e-02	-1.228	0.219828	
## Exterior1stHdBoard	-2.917e-02	5.927e-02	-0.492	0.622692	
## Exterior1stImStucc	-2.352e-02	1.259e-01	-0.187	0.851874	
## Exterior1stMetalSd	2.319e-02	6.692e-02	0.347	0.729007	
## Exterior1stPlywood	-2.072e-02	5.844e-02	-0.355	0.722957	
## Exterior1stStone	3.498e-02	1.112e-01	0.315	0.753088	
## Exterior1stStucco	1.272e-03	6.463e-02	0.020	0.984300	
## Exterior1stVinylSd	-2.470e-02	6.074e-02	-0.407	0.684280	
## Exterior1stWd Sdng	-5.517e-02	5.656e-02	-0.975	0.329580	
## Exterior1stWdShing	-2.240e-02	6.102e-02	-0.367	0.713559	
## Exterior2ndAsphShn	4.537e-02	1.018e-01	0.446	0.655867	
## Exterior2ndBrk Cmn	5.808e-02	9.226e-02	0.629	0.529153	
## Exterior2ndBrkFace	-1.713e-02	6.056e-02	-0.283	0.777348	
## Exterior2ndCBlock	NA	NA	NA	NA	
## Exterior2ndCmentBd	1.515e-01	8.589e-02	1.764	0.077982	.
## Exterior2ndHdBoard	3.370e-02	5.695e-02	0.592	0.554109	
## Exterior2ndImStucc	4.536e-02	6.516e-02	0.696	0.486457	
## Exterior2ndMetalSd	1.560e-02	6.523e-02	0.239	0.810986	
## Exterior2ndOther	-5.219e-02	1.247e-01	-0.419	0.675539	
## Exterior2ndPlywood	3.566e-02	5.531e-02	0.645	0.519237	
## Exterior2ndStone	-3.177e-02	7.865e-02	-0.404	0.686360	
## Exterior2ndStucco	3.592e-02	6.216e-02	0.578	0.563414	
## Exterior2ndVinylSd	5.752e-02	5.863e-02	0.981	0.326686	
## Exterior2ndWd Sdng	7.114e-02	5.474e-02	1.300	0.193983	

## Exterior2ndWd Shng	3.856e-02	5.698e-02	0.677	0.498700	
## MasVnrTypeBrkFace	3.852e-02	3.104e-02	1.241	0.214839	
## MasVnrTypeNone	3.039e-02	3.127e-02	0.972	0.331459	
## MasVnrTypeStone	4.980e-02	3.278e-02	1.519	0.129019	
## MasVnrArea	8.235e-06	2.628e-05	0.313	0.754114	
## ExterQualFa	9.734e-03	5.022e-02	0.194	0.846333	
## ExterQualGd	5.368e-04	2.196e-02	0.024	0.980502	
## ExterQualTA	5.784e-03	2.427e-02	0.238	0.811697	
## ExterCondFa	-1.072e-01	8.273e-02	-1.296	0.195348	
## ExterCondGd	-8.311e-02	7.906e-02	-1.051	0.293415	
## ExterCondPo	-9.888e-02	1.436e-01	-0.689	0.491210	
## ExterCondTA	-6.226e-02	7.887e-02	-0.789	0.430037	
## FoundationCBlock	1.871e-02	1.458e-02	1.283	0.199661	
## FoundationPConc	3.403e-02	1.569e-02	2.168	0.030313	*
## FoundationSlab	-3.473e-02	4.604e-02	-0.754	0.450792	
## FoundationStone	9.810e-02	5.063e-02	1.938	0.052908	.
## FoundationWood	-1.341e-01	6.756e-02	-1.985	0.047332	*
## BsmtQualFa	-3.057e-02	2.894e-02	-1.056	0.291088	
## BsmtQualGd	-2.704e-02	1.517e-02	-1.783	0.074876	.
## BsmtQualTA	-3.443e-02	1.887e-02	-1.824	0.068336	.
## BsmtQualMissing	1.577e-01	1.684e-01	0.937	0.349136	
## BsmtCondGd	2.024e-02	2.418e-02	0.837	0.402586	
## BsmtCondPo	3.177e-01	1.371e-01	2.317	0.020678	*
## BsmtCondTA	1.801e-02	1.946e-02	0.926	0.354746	
## BsmtCondMissing	NA	NA	NA	NA	
## BsmtExposureGd	2.966e-02	1.374e-02	2.159	0.031046	*
## BsmtExposureMn	-6.546e-03	1.388e-02	-0.472	0.637173	
## BsmtExposureNo	-1.211e-02	9.968e-03	-1.215	0.224618	
## BsmtExposureMissing	-5.154e-02	1.059e-01	-0.487	0.626463	
## BsmtFinType1BLQ	-5.515e-03	1.269e-02	-0.435	0.663927	
## BsmtFinType1GLQ	1.116e-02	1.149e-02	0.972	0.331469	
## BsmtFinType1LwQ	-2.462e-02	1.716e-02	-1.435	0.151585	
## BsmtFinType1Rec	-1.086e-02	1.365e-02	-0.796	0.426269	
## BsmtFinType1Unf	-1.237e-02	1.334e-02	-0.927	0.353856	
## BsmtFinType1Missing	NA	NA	NA	NA	
## BsmtFinSF1	1.464e-04	2.424e-05	6.042	2.02e-09	***
## BsmtFinType2BLQ	-6.338e-02	3.455e-02	-1.834	0.066845	.
## BsmtFinType2GLQ	1.449e-02	4.278e-02	0.339	0.734871	
## BsmtFinType2LwQ	-3.245e-02	3.377e-02	-0.961	0.336754	
## BsmtFinType2Rec	-2.759e-02	3.249e-02	-0.849	0.395979	
## BsmtFinType2Unf	-1.051e-02	3.456e-02	-0.304	0.761065	
## BsmtFinType2Missing	-1.315e-01	1.149e-01	-1.144	0.252689	
## BsmtFinSF2	1.402e-04	4.146e-05	3.382	0.000743	***
## BsmtUnfSF	9.034e-05	2.217e-05	4.076	4.88e-05	***
## TotalBsmtSF	NA	NA	NA	NA	
## HeatingGasA	1.411e-01	1.177e-01	1.199	0.230848	
## HeatingGasW	2.105e-01	1.213e-01	1.735	0.082906	.
## HeatingGrav	-4.773e-02	1.289e-01	-0.370	0.711245	
## HeatingOthW	1.659e-01	1.441e-01	1.152	0.249574	
## HeatingWall	2.234e-01	1.366e-01	1.635	0.102272	

## HeatingQCFa	-1.676e-02	2.139e-02	-0.784	0.433338	
## HeatingQCGd	-2.030e-02	9.448e-03	-2.148	0.031872	*
## HeatingQCPo	-9.802e-02	1.222e-01	-0.802	0.422762	
## HeatingQCTA	-3.410e-02	9.456e-03	-3.607	0.000323	***
## CentralAirY	6.400e-02	1.777e-02	3.601	0.000330	***
## ElectricalFuseF	-8.504e-04	2.638e-02	-0.032	0.974289	
## ElectricalFuseP	-7.953e-02	8.502e-02	-0.936	0.349715	
## ElectricalMix	-2.685e-01	2.046e-01	-1.312	0.189689	
## ElectricalSBkr	-1.445e-02	1.346e-02	-1.074	0.283000	
## X1stFlrSF	2.297e-04	2.563e-05	8.960	< 2e-16	***
## X2ndFlrSF	2.232e-04	2.524e-05	8.844	< 2e-16	***
## LowQualFinSF	1.867e-04	8.448e-05	2.210	0.027259	*
## GrLivArea	NA	NA	NA	NA	
## BsmtFullBath	2.307e-02	9.047e-03	2.550	0.010892	*
## BsmtHalfBath	2.911e-03	1.377e-02	0.211	0.832557	
## FullBath	1.833e-02	1.007e-02	1.820	0.069000	.
## HalfBath	2.328e-02	9.571e-03	2.432	0.015145	*
## BedroomAbvGr	7.732e-03	6.225e-03	1.242	0.214405	
## KitchenAbvGr	-4.527e-02	2.591e-02	-1.748	0.080796	.
## KitchenQualFa	-5.508e-02	2.836e-02	-1.942	0.052365	.
## KitchenQualGd	-6.466e-02	1.584e-02	-4.081	4.77e-05	***
## KitchenQualTA	-6.361e-02	1.784e-02	-3.566	0.000376	***
## TotRmsAbvGrd	3.747e-03	4.306e-03	0.870	0.384295	
## FunctionalMaj2	-2.509e-01	6.604e-02	-3.800	0.000152	***
## FunctionalMin1	3.710e-02	3.937e-02	0.942	0.346199	
## FunctionalMin2	3.259e-02	3.941e-02	0.827	0.408392	
## FunctionalMod	-6.201e-02	4.765e-02	-1.301	0.193372	
## FunctionalSev	-2.820e-01	1.333e-01	-2.116	0.034518	*
## FunctionalTyp	6.566e-02	3.415e-02	1.923	0.054705	.
## Fireplaces	2.292e-02	6.109e-03	3.751	0.000184	***
## GarageTypeAttchd	1.105e-01	5.017e-02	2.202	0.027829	*
## GarageTypeBasment	9.259e-02	5.763e-02	1.607	0.108413	
## GarageTypeBuiltIn	9.438e-02	5.215e-02	1.810	0.070575	.
## GarageTypeCarPort	1.330e-01	6.687e-02	1.989	0.046875	*
## GarageTypeDetchd	1.073e-01	5.026e-02	2.134	0.033049	*
## GarageTypeMissing	1.863e-02	9.513e-02	0.196	0.844736	
## GarageYrBlt	-1.107e-04	2.716e-04	-0.408	0.683594	
## GarageFinishRFn	-1.305e-03	8.973e-03	-0.145	0.884384	
## GarageFinishUnf	-9.942e-03	1.104e-02	-0.900	0.368063	
## GarageFinishMissing	NA	NA	NA	NA	
## GarageCars	1.777e-02	1.041e-02	1.707	0.088102	.
## GarageArea	1.222e-04	3.592e-05	3.403	0.000689	***
## GarageQualFa	-3.870e-01	1.373e-01	-2.819	0.004889	**
## GarageQualGd	-3.095e-01	1.404e-01	-2.204	0.027735	*
## GarageQualPo	-4.156e-01	1.760e-01	-2.362	0.018335	*
## GarageQualTA	-3.388e-01	1.358e-01	-2.495	0.012719	*
## GarageQualMissing	NA	NA	NA	NA	
## GarageCondFa	2.737e-01	1.582e-01	1.730	0.083815	.
## GarageCondGd	3.140e-01	1.633e-01	1.923	0.054733	.
## GarageCondPo	4.352e-01	1.700e-01	2.559	0.010602	*



```

## GarageCondTA          2.969e-01  1.566e-01  1.896 0.058213 .
## GarageCondMissing      NA          NA      NA      NA
## PavedDriveP          -1.080e-02  2.543e-02 -0.425 0.671032
## PavedDriveY           1.145e-02  1.586e-02  0.722 0.470167
## WoodDeckSF            9.534e-05  2.671e-05  3.570 0.000370 ***
## OpenPorchSF           4.095e-05  5.239e-05  0.782 0.434581
## EnclosedPorch         1.141e-04  5.669e-05  2.013 0.044349 *
## X3SsnPorch            1.641e-04  1.026e-04  1.599 0.110098
## ScreenPorch           2.425e-04  5.594e-05  4.336 1.57e-05 ***
## PoolArea              1.335e-04  8.379e-05  1.593 0.111374
## MiscVal               7.763e-08  6.490e-06  0.012 0.990458
## MoSold                -6.040e-04  1.120e-03 -0.539 0.589795
## YrSold                -2.456e-03  2.362e-03 -1.040 0.298613
## SaleTypeCon           9.112e-02  8.067e-02  1.130 0.258896
## SaleTypeConLD         1.312e-01  4.432e-02  2.961 0.003123 **
## SaleTypeConLI        -2.646e-02  5.273e-02 -0.502 0.615918
## SaleTypeConLw         2.976e-02  5.554e-02  0.536 0.592097
## SaleTypeCWD           6.507e-02  5.904e-02  1.102 0.270600
## SaleTypeNew           7.946e-02  7.091e-02  1.121 0.262694
## SaleTypeOth           7.078e-02  6.618e-02  1.070 0.285015
## SaleTypeWD           -1.616e-02  1.908e-02 -0.847 0.397241
## SaleConditionAdjLand  1.088e-01  6.651e-02  1.636 0.102194
## SaleConditionAlloca   7.195e-02  3.935e-02  1.828 0.067746 .
## SaleConditionFamily   1.509e-02  2.788e-02  0.541 0.588353
## SaleConditionNormal    6.657e-02  1.320e-02  5.042 5.31e-07 ***
## SaleConditionPartial  1.613e-02  6.827e-02  0.236 0.813259
## YrRemodel_Diff        NA          NA      NA      NA
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1043 on 1227 degrees of freedom
## Multiple R-squared:  0.9427, Adjusted R-squared:  0.9319
## F-statistic: 87.04 on 232 and 1227 DF,  p-value: < 2.2e-16

lm.pred <- predict(lm.forb,testing)

## Warning in predict.lm(lm.forb, testing): prediction from a rank-deficient
fit
## may be misleading

res <- data.frame(Id = testing$Id, SalePrice = exp(lm.pred))
write.csv(res, file = "Price+Backward_Step.csv", row.names = FALSE)

# CV Error for Backward subset selection
k <- 10
set.seed(1)
folds <- sample(1:k, nrow(training), replace = T)
cv.errors <- rep(NA, k)

for (j in 1:k){
  best_temp <- regsubsets(SalePrice~., data=training[folds!=j,], nvmax=35,

```

```

method="backward")
  pred <- predict.regsbsets(best_temp, training[folds==j,], id=best_no)
  cv.errors[j] <- mean((training$SalePrice[folds==j]-pred)^2)
}

## Warning in leaps.setup(x, y, wt = wt, nbest = nbest, nvmax = nvmax,
force.in =
## force.in, : 10 linear dependencies found

## Reordering variables and trying again:

## Warning in leaps.setup(x, y, wt = wt, nbest = nbest, nvmax = nvmax,
force.in =
## force.in, : 10 linear dependencies found

## Reordering variables and trying again:

## Warning in leaps.setup(x, y, wt = wt, nbest = nbest, nvmax = nvmax,
force.in =
## force.in, : 11 linear dependencies found

## Reordering variables and trying again:

## Warning in leaps.setup(x, y, wt = wt, nbest = nbest, nvmax = nvmax,
force.in =
## force.in, : 12 linear dependencies found

## Reordering variables and trying again:

## Warning in leaps.setup(x, y, wt = wt, nbest = nbest, nvmax = nvmax,
force.in =
## force.in, : 9 linear dependencies found

## Reordering variables and trying again:

## Warning in leaps.setup(x, y, wt = wt, nbest = nbest, nvmax = nvmax,
force.in =
## force.in, : 13 linear dependencies found

## Reordering variables and trying again:

## Warning in leaps.setup(x, y, wt = wt, nbest = nbest, nvmax = nvmax,
force.in =
## force.in, : 12 linear dependencies found

## Reordering variables and trying again:

## Warning in leaps.setup(x, y, wt = wt, nbest = nbest, nvmax = nvmax,
force.in =
## force.in, : 11 linear dependencies found

## Reordering variables and trying again:

```

```
## Warning in leaps.setup(x, y, wt = wt, nbest = nbest, nvmax = nvmax,
force.in =
## force.in, : 14 linear dependencies found
## Reordering variables and trying again:
## Warning in leaps.setup(x, y, wt = wt, nbest = nbest, nvmax = nvmax,
force.in =
## force.in, : 11 linear dependencies found
## Reordering variables and trying again:
cv.error <- mean(cv.errors)
cv.error

## [1] 1796968623
```

- By doing the backward subset selection, the Kaggle score is 0.13624.

## 4. Shrinkage Methods

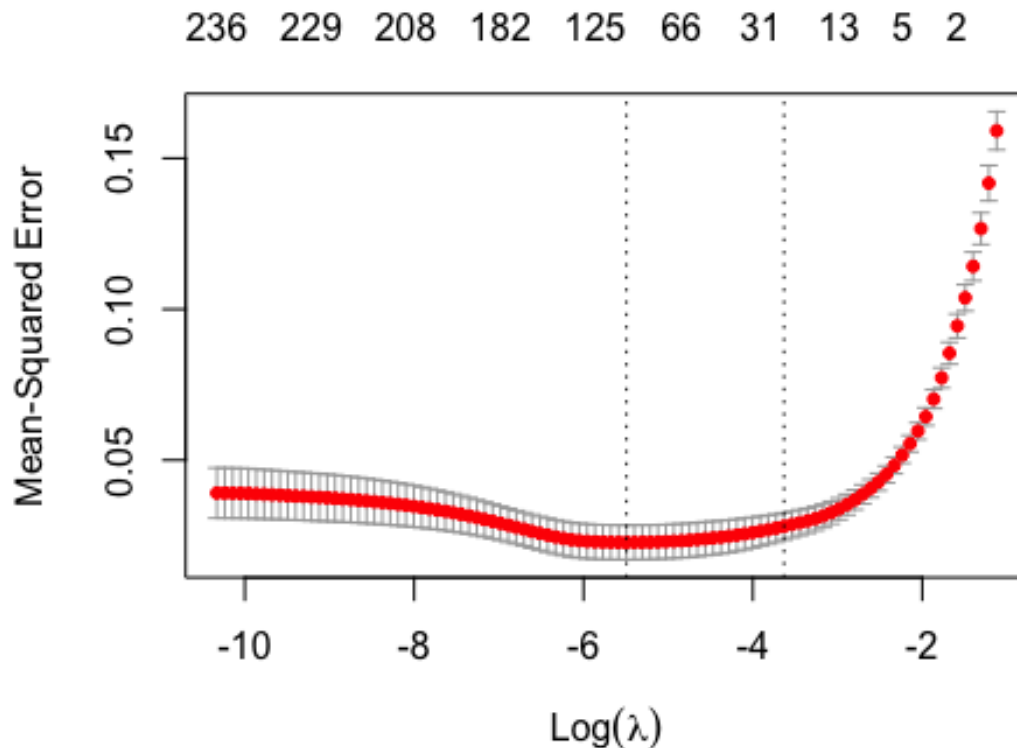
### *Lasso*

```
LASSO_formula <- as.formula(log(SalePrice)~ .-Id )
x <- model.matrix(LASSO_formula, training)
y <- log(training$SalePrice)
set.seed(1234)

lm.lasso <- cv.glmnet(x, y, alpha=1) # cv error
lm.lasso

##
## Call:  cv.glmnet(x = x, y = y, alpha = 1)
##
## Measure: Mean-Squared Error
##
##      Lambda Measure      SE Nonzero
## min 0.004118 0.02276 0.005694      96
## 1se 0.026468 0.02805 0.004469      21

plot(lm.lasso)
```



```
testing$SalePrice <- 1
test_x <- model.matrix(LASSO_formula, testing)
lasso.pred <- predict(lm.lasso, newx = test_x, s = "lambda.min")
res <- data.frame(Id = testing$Id, SalePrice = exp(lasso.pred))
write.csv(res, file = "Price+Lasso.csv", row.names = FALSE)
```

- The kaggle score for lasso method is 0.13157. So far, this is the best result I got. Now, let see how well does ridge regression perform.

### Ridge Regression

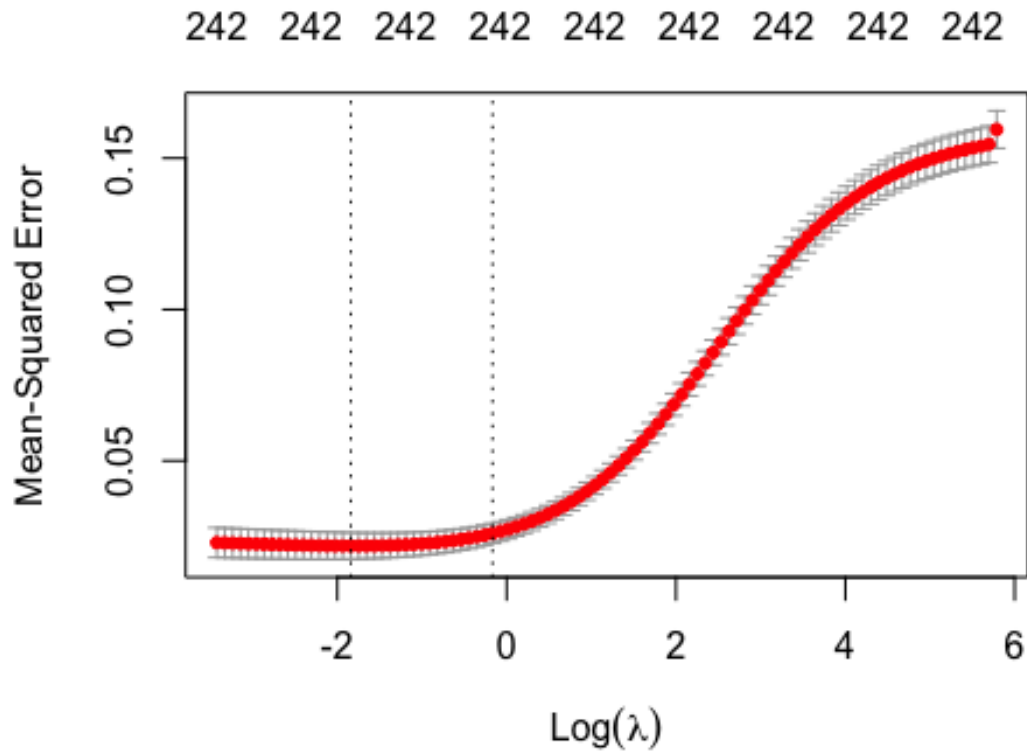
```
ridge_formula <- as.formula(log(SalePrice)~.)

x <- model.matrix(ridge_formula, training)
y <- log(training$SalePrice)

set.seed(1234)
cv.ridge <- cv.glmnet(x, y, alpha = 0) #cv error
cv.ridge

##
## Call:  cv.glmnet(x = x, y = y, alpha = 0)
##
## Measure: Mean-Squared Error
```

```
##
##      Lambda Measure      SE Nonzero
## min 0.1587 0.02187 0.004364      242
## 1se 0.8468 0.02600 0.003290      242
plot(cv.ridge)
```



```
testing$SalePrice <- 1
ridge.test.x <- model.matrix(ridge_formula, testing)
ridge.pred <- predict(cv.ridge, newx = ridge.test.x, s = "lambda.min")

soln <- data.frame(Id = testing$Id, SalePrice = exp(ridge.pred))
write.csv(soln, file = "Price+Ridge.csv", row.names = FALSE)
```

- The kaggle score of Ridge Regression is 0.13790. That performs slightly worse than the Lasso method.

## 5. Generalized Additive Models

```
library(mgcv)

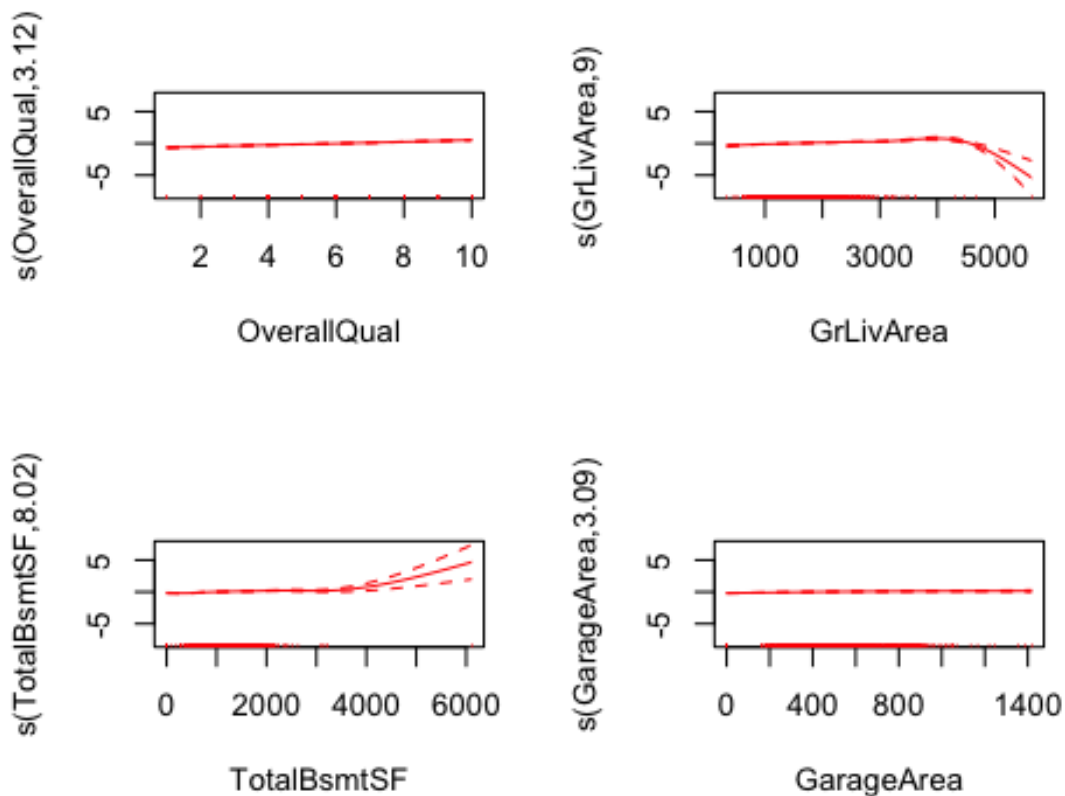
## Loading required package: nlme

##
## Attaching package: 'nlme'
```

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

## This is mgcv 1.8-31. For overview type 'help("mgcv-package")'.

gam.fit <- gam(log(SalePrice) ~ s(OverallQual) + s(GrLivArea)
              + s(TotalBsmtSF) + s(GarageArea),
              data = training)
par(mfrow = c(2, 2))
plot(gam.fit, se = T, col = "red")
```



```
gam.pred <- predict(gam.fit, testing)
write.csv(exp(gam.pred), "Price+GAM.csv")

# CV Error for GAM
k <- 10
set.seed(1)
folds <- sample(1:k, nrow(training), replace=T)
cv.error <- rep(NA, k)

for (j in 1:k){
  best_temp <- gam.fit
  pred <- predict(best_temp, training[folds==j,])
```

```

  cv.error[j] <- mean((training$SalePrice[folds==j]-pred)^2)
}
cv.errors <- mean(cv.error)
cv.errors

## [1] 38949914107

knitr::include_graphics("gam.png")

```

- By submitting the GAM model prediction to Kaggle, the score is 0.16986

## 6. Regression Trees

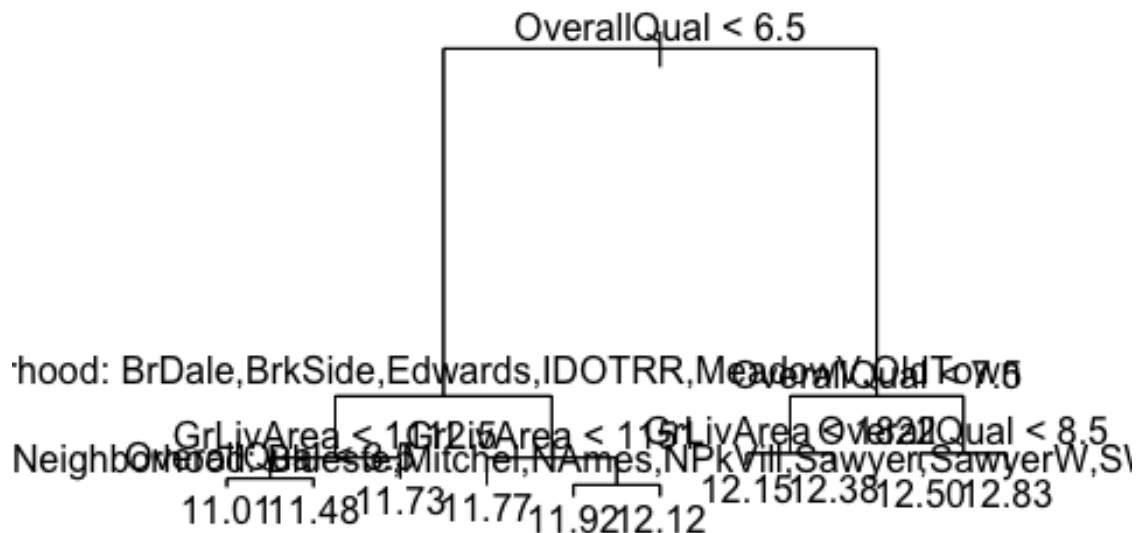
```

library(tree)
tree.fit <- tree(log(SalePrice) ~.-Id, data = training)
summary(tree.fit)

##
## Regression tree:
## tree(formula = log(SalePrice) ~ . - Id, data = training)
## Variables actually used in tree construction:
## [1] "OverallQual" "Neighborhood" "GrLivArea"
## Number of terminal nodes: 10
## Residual mean deviance: 0.04059 = 58.86 / 1450
## Distribution of residuals:
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## -1.13300 -0.10810  0.00689  0.00000  0.11690  0.79520

plot(tree.fit)
text(tree.fit, pretty = 0)

```



```

set.seed(1234)
tree.cv <- cv.tree(tree.fit, k = 10) # cv error
tree.cv

## $size
## [1] 10  9  8  7  6  5  4  3  2  1
##
## $dev
## [1] 65.99897 67.58295 73.17056 73.17056 78.43268 83.87018 90.54206
## [8] 123.68479 125.67029 233.16193
##
## $k
## [1] -Inf 2.669610 3.617844 3.631448 4.988011 6.426864
## [7] 8.418803 17.696352 19.039340 107.453137
##
## $method
## [1] "deviance"
##
## attr(,"class")
## [1] "prune" "tree.sequence"

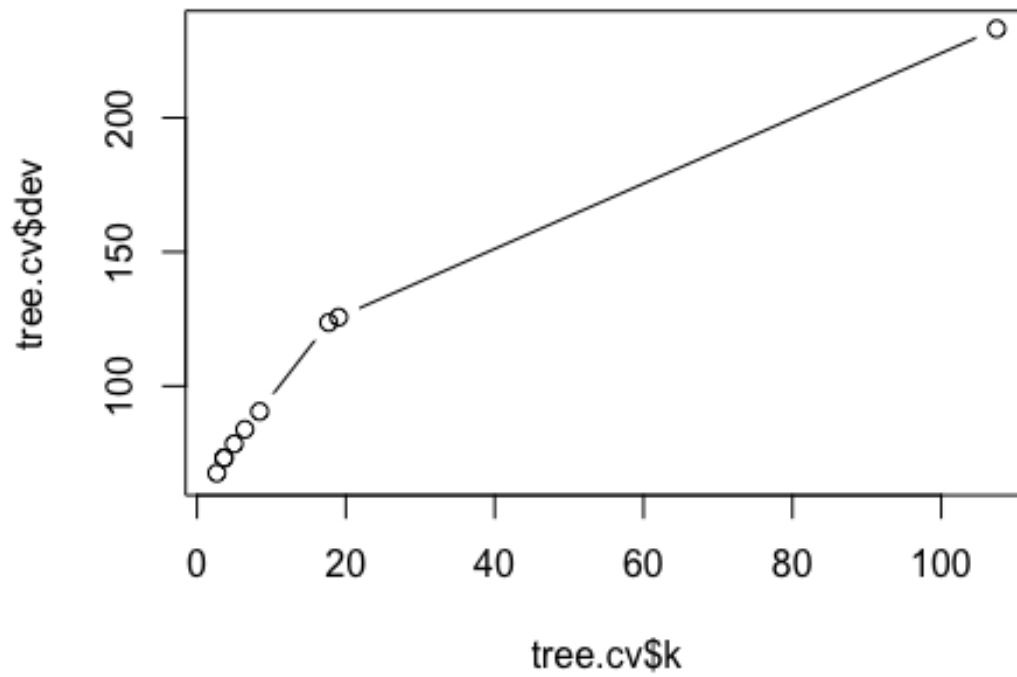
par(nfrow = c(1,2))

## Warning in par(nfrow = c(1, 2)): "nfrow" is not a graphical parameter

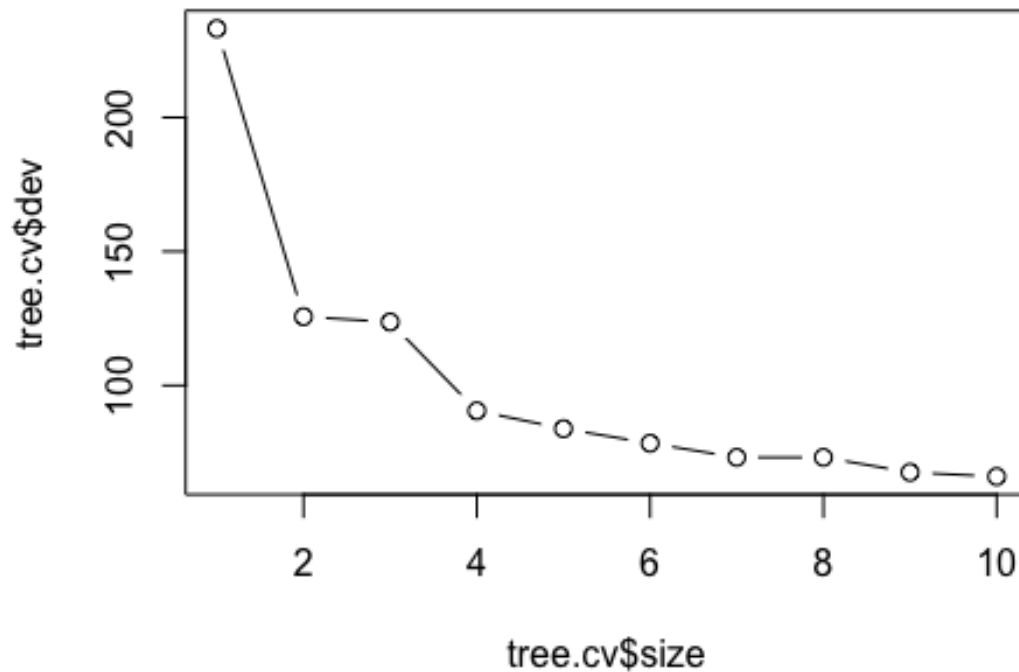
```



```
plot(tree.cv$k, tree.cv$dev, type = "b")
```



```
plot(tree.cv$size, tree.cv$dev, type = "b")
```



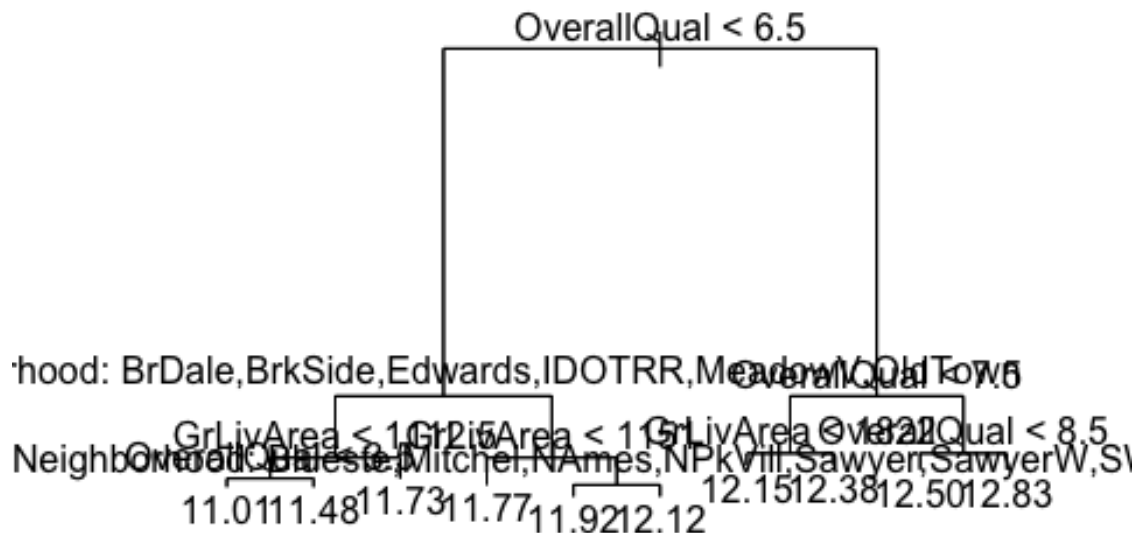
```
best.size <- tree.cv$size[which.min(tree.cv$dev)]
best.size

## [1] 10

prunetree <- prune.tree(tree.fit, best = best.size)
par(nfrow = c(1,1))

## Warning in par(nfrow = c(1, 1)): "nfrow" is not a graphical parameter

plot(prunetree)
text(prunetree, pretty = 0)
```



```

rtpred <- predict(prunetree, newdata = testing)
write.csv(exp(rtpred), "Price+Regression_Trees.csv")

knitr::include_graphics("rt.png")

```

- By submitting the regression trees model prediction to Kaggle, the score is 0.22079

## 7. Bagging

```

library(randomForest)

## randomForest 4.6-14

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

##
## Attaching package: 'randomForest'

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

```





```

# CV Error for Random Forest
k <- 10
set.seed(1)
folds <- sample(1:k, nrow(training), replace=T)
cv.error <- rep(NA,k)

for (j in 1:k){
  best_temp <- house_model
  pred <- predict(best_temp, training[folds==j,])
  cv.error[j] <- mean((training$SalePrice[folds==j]-pred)^2)
}
cv.errors <- mean(cv.error)
cv.errors

## [1] 38949910115

knitr::include_graphics("rf.png")

```

- By submitting the random forest model prediction to Kaggle, the score is 0.14471

## 9. Boosting

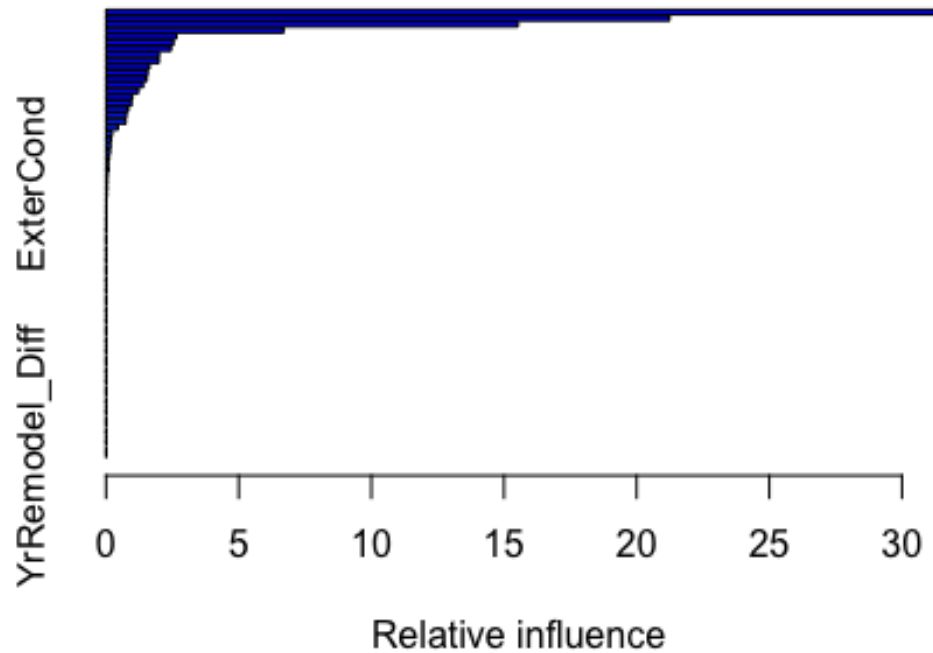
```

library(gbm)

## Loaded gbm 2.1.5

boosting <- gbm(log(SalePrice) ~ .-Id , data = training,
                 distribution = "gaussian", n.trees = 1000, shrinkage =
0.01)
summary(boosting)

```



##	var	rel.inf
## OverallQual	OverallQual	31.429353209
## GrLivArea	GrLivArea	21.237413151
## Neighborhood	Neighborhood	15.530205706
## TotalBsmtSF	TotalBsmtSF	6.690151550
## ExterQual	ExterQual	2.656891566
## GarageCars	GarageCars	2.544995621
## GarageType	GarageType	2.448686628
## CentralAir	CentralAir	2.005962449
## BsmtFinSF1	BsmtFinSF1	1.998795792
## KitchenQual	KitchenQual	1.640036731
## GarageArea	GarageArea	1.569287673
## OverallCond	OverallCond	1.536345468
## GarageFinish	GarageFinish	1.399065962
## Fireplaces	Fireplaces	1.218684791
## YearRemodAdd	YearRemodAdd	0.995721434
## LotArea	LotArea	0.963819218
## X1stFlrSF	X1stFlrSF	0.842023947
## GarageCond	GarageCond	0.769938520
## BsmtQual	BsmtQual	0.744853674
## SaleCondition	SaleCondition	0.456506359
## BsmtFinType1	BsmtFinType1	0.235876209
## GarageQual	GarageQual	0.198429847

## BsmtExposure	BsmtExposure	0.172084693
## MSZoning	MSZoning	0.157285337
## FullBath	FullBath	0.119327775
## BsmtCond	BsmtCond	0.091621238
## X2ndFlrSF	X2ndFlrSF	0.091179900
## Functional	Functional	0.060610864
## ExterCond	ExterCond	0.053519811
## BsmtFullBath	BsmtFullBath	0.044781247
## WoodDeckSF	WoodDeckSF	0.036674330
## ScreenPorch	ScreenPorch	0.018632343
## OpenPorchSF	OpenPorchSF	0.012703745
## GarageYrBlt	GarageYrBlt	0.012446134
## SaleType	SaleType	0.008846946
## PavedDrive	PavedDrive	0.007240135
## MSSubClass	MSSubClass	0.000000000
## LotFrontage	LotFrontage	0.000000000
## Street	Street	0.000000000
## LotShape	LotShape	0.000000000
## LandContour	LandContour	0.000000000
## LotConfig	LotConfig	0.000000000
## LandSlope	LandSlope	0.000000000
## Condition1	Condition1	0.000000000
## Condition2	Condition2	0.000000000
## BldgType	BldgType	0.000000000
## HouseStyle	HouseStyle	0.000000000
## YearBuilt	YearBuilt	0.000000000
## RoofStyle	RoofStyle	0.000000000
## RoofMatl	RoofMatl	0.000000000
## Exterior1st	Exterior1st	0.000000000
## Exterior2nd	Exterior2nd	0.000000000
## MasVnrType	MasVnrType	0.000000000
## MasVnrArea	MasVnrArea	0.000000000
## Foundation	Foundation	0.000000000
## BsmtFinType2	BsmtFinType2	0.000000000
## BsmtFinSF2	BsmtFinSF2	0.000000000
## BsmtUnfSF	BsmtUnfSF	0.000000000
## Heating	Heating	0.000000000
## HeatingQC	HeatingQC	0.000000000
## Electrical	Electrical	0.000000000
## LowQualFinSF	LowQualFinSF	0.000000000
## BsmtHalfBath	BsmtHalfBath	0.000000000
## HalfBath	HalfBath	0.000000000
## BedroomAbvGr	BedroomAbvGr	0.000000000
## KitchenAbvGr	KitchenAbvGr	0.000000000
## TotRmsAbvGrd	TotRmsAbvGrd	0.000000000
## EnclosedPorch	EnclosedPorch	0.000000000
## X3SsnPorch	X3SsnPorch	0.000000000
## PoolArea	PoolArea	0.000000000
## MiscVal	MiscVal	0.000000000
## MoSold	MoSold	0.000000000



```
## YrSold                YrSold  0.000000000
## YrRemodel_Diff YrRemodel_Diff 0.000000000

yhat.boost <- predict(boosting, newdata = testing, n.trees = 1000)
write.csv(exp(yhat.boost), "Price+Boosting.csv")

# CV Error for Boosting
k <- 10
set.seed(1)
folds <- sample(1:k, nrow(training), replace=T)
cv.error <- rep(NA,k)

for (j in 1:k){
  best_temp <- boosting
  pred <- predict(best_temp, training[folds==j,], n.trees = 1000)
  cv.error[j] <- mean((training$SalePrice[folds==j]-pred)^2)
}
cv.errors <- mean(cv.error)
cv.errors

## [1] 38949914325

knitr::include_graphics("boosting.png")
```

- By submitting the boosting model prediction to Kaggle, the score is 0.14403

### Exploration: Combination (Lasso+Forward+Boost)

- Finally, I combine the lasso, forward, and boost because they got the best results.

```
lm<- as.data.frame(lm.pred.adv)
forw <- as.data.frame(lm.pred)
lasso <- as.data.frame(lasso.pred)

df <- data.frame(Id = testing$Id,
                 SalePrice = 0.45 * exp(lasso$`1`) + 0.35 *
exp(forw$lm.pred) + 0.2 * exp(yhat.boost))
write.csv(df, "Price+Combination.csv", row.names = FALSE)
```

- By submitting the combination models to Kaggle, the score is 0.12659

### Explain how/why you chose the tuning parameters

- In the package *mgcv*, the function *gam()*, which contains a method called Generalized Cross-validation (GCV). GCV will automatically choose the number of knots for your model so that simplicity is balanced against explanatory power.
- For Lasso method, the function *cv.glmnet* from the R package *glmnet* does automatic cross-validation on a grid of  $\lambda$  values used for  $l_1$ -penalized regression problems. In particular, for the lasso. The *glmnet* package also supports the more general elastic net penalty, which is a combination of  $l_1$  and  $l_2$  penalization.

- For lambda in ridge regression, from the plot I made earlier, it is easier to observe that the lambda will perform well when it is in its minimum; also, by looking at the cv.glmnet, we can see the result as well. Moreover, as I mentioned in the previous bullet point, the function cv.glmnet from the R package glmnet does automatic cross-validation on a grid of  $\lambda$  values used for  $l_1$ -penalized regression problems.
- For the rest of the chosen parameters, the reasons why I chosen them are explained in their corresponding model interpretation parts. (I wrote the previous three bullet points here is just for the grader to have a easy time to check all my parts in this final project)

### Before submitting to Kaggle, which method perform the best?

- By just looking at the CV errors among all the methods, we can see that the lasso, forward subset selection, and boosting perform relatively better than others based on their relatively lower CV errors. Thus, I also made another prediction on combining lasso, forward subset selection, and boost in one model which is shown in the part "Exploration: Combination (Lasso+Forward+Boost)".

### Which Methods Performed the Best and the Worst?

```
score.val <- c(0.26118, 0.22357, 0.15133, 0.13163, 0.13624, 0.13157, 0.13790,
0.16986, 0.22079, 0.14891, 0.14471, 0.14403, 0.12659)
model_name <- c("KNN", "Linear Regression (simple)", "Linear Regression
(advance)", "Foreward Subset Selection", "Backward Subset Selection",
"Lasso", "Ridge Regression", "GAM", "Regression Tree", "Bagging", "Random
Forest", "Boosting", "Combination")
```

```
conclu.table <- data.frame(Method=model_name, Kaggle_Score = score.val)
conclu.table
```

##	Method	Kaggle_Score
## 1	KNN	0.26118
## 2	Linear Regression (simple)	0.22357
## 3	Linear Regression (advance)	0.15133
## 4	Foreward Subset Selection	0.13163
## 5	Backward Subset Selection	0.13624
## 6	Lasso	0.13157
## 7	Ridge Regression	0.13790
## 8	GAM	0.16986
## 9	Regression Tree	0.22079
## 10	Bagging	0.14891
## 11	Random Forest	0.14471
## 12	Boosting	0.14403
## 13	Combination	0.12659

- From the summary table which has each corresponding method and Kaggle score above, we can see that the Lasso method performs the best and the KNN method performs the worst. Also, I includes the Kaggle scores screenshots for each method in a separate PDF file.

## Discussion on Why the methods perform the best and the worst

- In my opinion, because the shrinking and removing the coefficients can reduce variance without a substantial increase of the bias, this is very useful when we have a small number of observation and a large number of features (in this project is relatively matched). Moreover, the Lasso helps us to increase the model interpretability by eliminating irrelevant variables that are not associated with the response variable; in this way, the overfitting is reduced (which is also applied in this project).
- KNN performs the worst; it might be deal with several reasons: first, the curse of dimensionality which means KNN works well with small number of input variables but as the numbers of variables grow KNN algorithm struggles to predict the output of new data point (in this project, we have a relatively large number of predictors); second, KNN is sensitive in outlier because it simply chose the neighbors based on distance criteria; third, missing value treatment which means kNN inherently has no capability of dealing with missing value problem.

## Key Technical Issues

One of the things I got into troubles a lot is how the csv files I wrote does not have a matching ID number; also, in the csv files, the columns' names for both "Id" and "SalePrice" are not shown or changed as it should be which led Kaggle have a hard time to recognize my work and give the corresponding score. Another notable issue would be how R gives me an warning/error when I tried to write the cv.fold in boosting model for finding the best size.

## Conclusion & Summary

- I've processed the data meticulously. However, there are still some details I may enhance. For example, I've kept most of the parameters (variables) in data cleaning. However, this may cause overfitting consequences.
- Lasso, among all advanced models (excluding the combination model), has the best performance, whose result is 0.13157.
- The huge discrepancy in scores between this project and the midterm one is due to the data processing and cleaning. Therefore, what's noticable is that whatever models you use, data processing always plays one of the most significant role in estimating values.

## Discussion of Further Questions

Based on the best score I get, there is definitely having room to improve my accuracy. In addition, in the process of preprocessing data, I kept lots of variables to go through the evaluation model part which might have a high chance to induce overfitting problem. Moreover, as there are lot of methods can be done to fill with the missing values (there are lots of them and in different types as well); I would try other filling methods for the NA value for further investigation.