

Homework

2022-10-13

```
library(tidyverse)
library(readxl)
```

Part 1.

1.

```
pop <- read_xlsx("SYB61_T03_Population Growth Rates in Urban areas and Capital cities.xlsx", skip = 1, colnames(pop) <- c("RegionCountryArea", "Name", "Year", "Series", "Capital", "CapitalFootnote", "Value")

pop %>% distinct(Capital) %>% count()
```

```
## # A tibble: 1 x 1
##       n
##   <int>
## 1    232
```

There are only 197 recognized sovereign countries in the world. But I haven't thought of a better way to get the number of unique countries in this dataset. Consider using ISO 3166-1 numeric to distinguish between countries and regions, but there is no public dataset of ISO 3166-1 numeric that only contains countries. Relying on one's own identification efficiency is too low. Consider using Capital to identify the number of countries, but I have found that Capital exists in Puerto Rico and Hong Kong, so not only sovereign countries contain Capital data. Therefore, there is no better way to calculate the number of unique countries in this dataset.

The data is in long format.

Variables **Series** and **Year** can be transformed to wide-format variables.

2.

Fill the capital data for further analysis:

```
capital_data <- pop %>% select(Name, Capital) %>% distinct() %>% drop_na()

for(i in 1:length(pop$Capital)){
  if(pop$Name[i] %in% capital_data$Name){
    pop$Capital[i] <- capital_data$Capital[capital_data$Name == pop$Name[i]]
  }
}
```

Delete some information that we do not need:

```
pop_clean <- pop %>% select(RegionCountryArea, Name, Year, Series, Capital, Value)
```

```
pop_clean <- pop_clean %>%
  pivot_wider(names_from = Series,
              values_from = Value)
```

```
head(pop_clean)
```

```
## # A tibble: 6 x 10
##   RegionCountryArea Name      Year Capital `Urban populat~` `Urban populat~`
##           <dbl> <chr>      <dbl> <chr>      <dbl>          <dbl>
## 1             1 Total, all ~ 2005 <NA>      49.2          2.3
## 2             1 Total, all ~ 2010 <NA>      51.7          2.2
## 3             1 Total, all ~ 2015 <NA>      53.9          2
## 4             1 Total, all ~ 2018 <NA>      55.3          NA
## 5             2 Africa      2005 <NA>      36.9          3.5
## 6             2 Africa      2010 <NA>      38.9          3.6
## # ... with 4 more variables:
## #   `Rural population (percent growth rate per annum)` <dbl>,
## #   `Capital city population (thousands)` <dbl>,
## #   `Capital city population (as a percentage of total population)` <dbl>,
## #   `Capital city population (as a percentage of total urban population)` <dbl>
```

3.

```
pop_clean$TotalPopulation <- pop_clean$"Capital city population (thousands)" / (pop_clean$"Capital city"
```

Extreme situations such as war and famine are not considered. Assume that the population growth rate remains constant from 2005 to 2007. Using the total population data in 2005 and the population growth rate, the population data in 2007 can be predicted.

Population of 2007 = Population of 2005 * (1 + Growth Rate)²

Predict the total populations after two years for this tibble.

```
prediction <- pop_clean %>% filter(Year == 2005) %>% mutate(
  Pop2017 = TotalPopulation * (`Urban population (percent)`/100) * (1 + `Urban population (percent grow
```

Insert data into pop_clean:

```
for(i in 1:length(prediction$Name)){
  row = c(prediction$RegionCountryArea[i], prediction$Name[i], 2007, prediction$Capital[i], NA, NA, NA,
  pop_clean <- rbind(pop_clean, row)
}
```

4.

Load gapminder data and transform the data

```
library(gapminder)
gap_data <- gapminder
gap_data <- rename(gap_data, Name = country)
gap_data <- rename(gap_data, Year = year)
gap_data$pop <- gap_data$pop / 1000 # in thousands
```

Merge the data:

```
pop_clean$Year <- as.integer(pop_clean$Year)
merged <- inner_join(pop_clean, gap_data, by =c('Name', 'Year'))
```

```
merged$TotalPopulation <- as.numeric(merged$TotalPopulation)
head(merged)
```

```
## # A tibble: 6 x 15
##   RegionCountryArea Name      Year Capital `Urban populat~` `Urban populat~`
##   <chr>              <chr>    <int> <chr>    <chr>          <chr>
## 1 4                  Afghanistan 2007 Kabul    <NA>          <NA>
## 2 8                  Albania      2007 Tirana  <NA>          <NA>
## 3 12                 Algeria      2007 Algiers <NA>          <NA>
## 4 24                 Angola      2007 Luanda  <NA>          <NA>
## 5 32                 Argentina  2007 Buenos ~ <NA>          <NA>
## 6 36                 Australia  2007 Canberra <NA>          <NA>
## # ... with 9 more variables:
## #   `Rural population (percent growth rate per annum)` <chr>,
## #   `Capital city population (thousands)` <chr>,
## #   `Capital city population (as a percentage of total population)` <chr>,
## #   `Capital city population (as a percentage of total urban population)` <chr>,
## #   TotalPopulation <dbl>, continent <fct>, lifeExp <dbl>, pop <dbl>,
## #   gdpPercap <dbl>
```

Country names in both two datasets are almost the same. Thus, we do not need to change it.

5.

Calculate the absolute error and relative error:

```
merged$AbsoluteError = abs(merged$pop - merged$TotalPopulation)
merged$RelativeError = abs(merged$pop - merged$TotalPopulation) / merged$pop
```

Largest error:

```
max(merged$AbsoluteError, na.rm = TRUE)
```

```
## [1] 97129.74
```

```
max(merged$RelativeError, na.rm = TRUE)
```

```
## [1] 0.6903651
```

Smallest error:

```
min(merged$AbsoluteError, na.rm = TRUE)
```

```
## [1] 1.210559
```

```
min(merged$RelativeError, na.rm = TRUE)
```

```
## [1] 0.0001178027
```

Mean error:

```
mean(merged$AbsoluteError, na.rm = TRUE)
```

```
## [1] 2152.486
```

```
mean(merged$RelativeError, na.rm = TRUE)
```

```
## [1] 0.06751257
```

My interpolation method works not too bad. The mean absolute error was 2152 and the mean relative error was 0.06. That is to say, the predicted value differs by about 6% from the actual value.

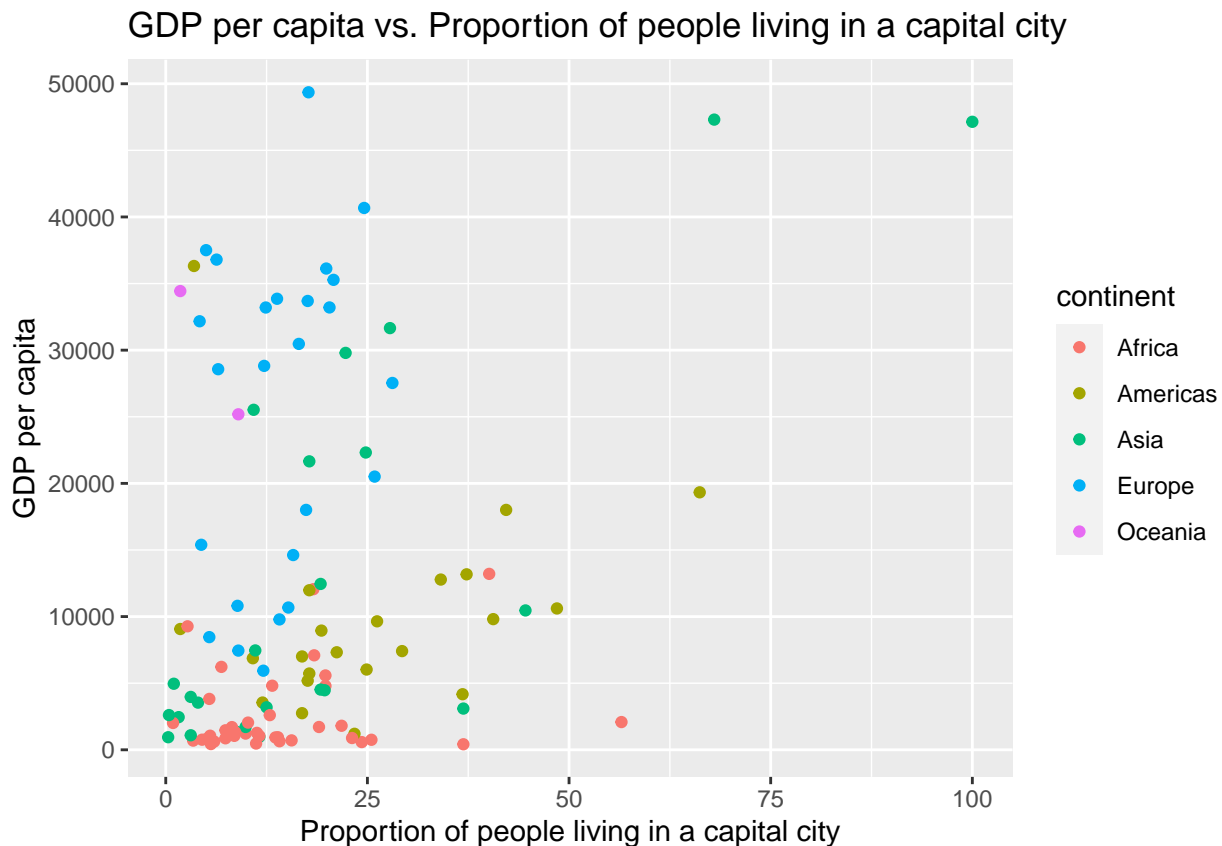
6.

As exact figures for the proportion of the population living in the capital in 2007 were not available, data from other years in the dataset were used instead.

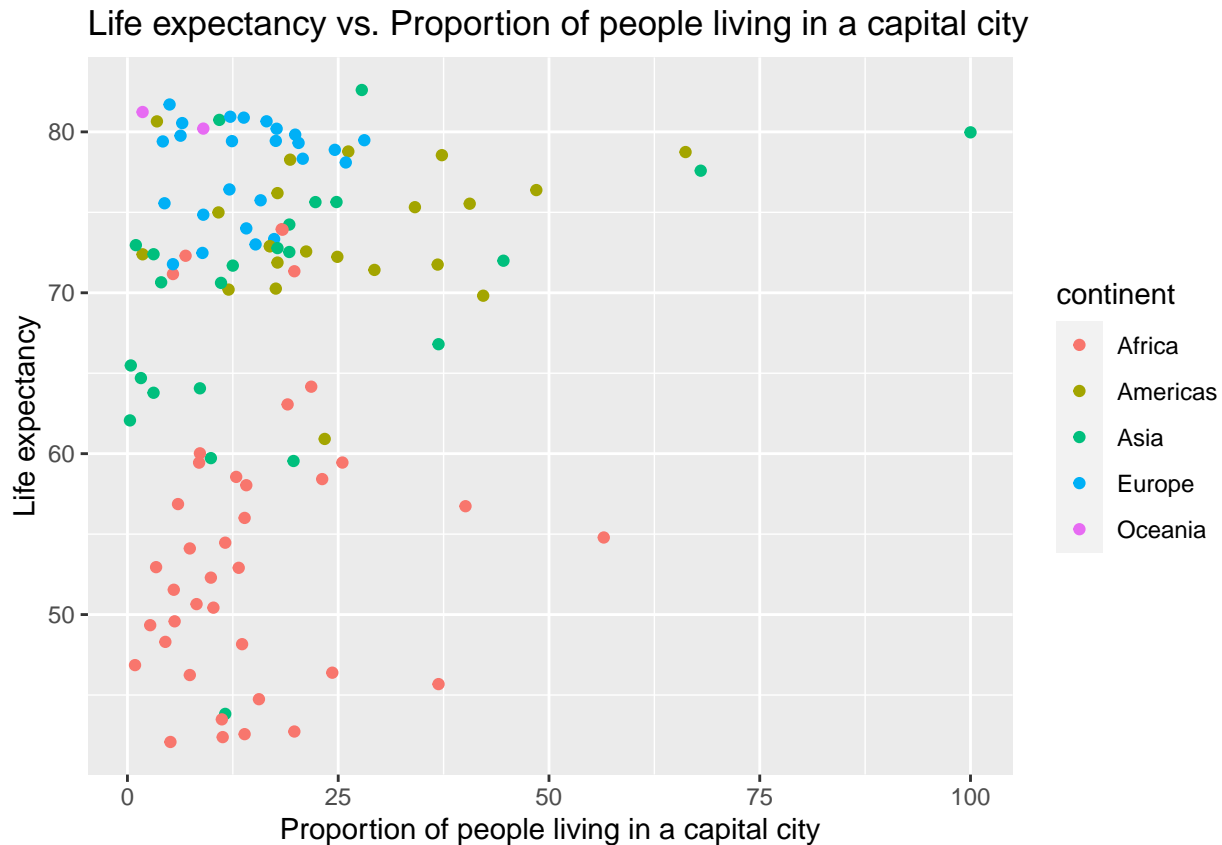
```
captial_proportion <- pop_clean %>% drop_na(`Capital city population (as a percentage of total population)`)  
  select(Name, `Capital city population (as a percentage of total population)`)  
colnames(captial_proportion) <- c('Name', 'propCap')
```

```
dataQ6 <- left_join(merged, captial_proportion, "Name")  
dataQ6$propCap <- as.numeric(dataQ6$propCap)
```

```
ggplot(dataQ6, aes(x = propCap, y = gdpPerCap, color = continent)) + geom_point() +  
  labs(x = 'Proportion of people living in a capital city', y = 'GDP per capita', title = 'GDP per capi')
```



```
ggplot(dataQ6, aes(x = propCap, y = lifeExp, color = continent)) + geom_point() +  
  labs(x = 'Proportion of people living in a capital city', y = 'Life expectancy', title = 'Life expecta')
```



It can be seen from the picture that neither GDP per capita nor life expectancy has a significant linear relationship with the proportion of the capital's population. But if we restrict the data to countries located on the same continent, we can see that the larger the proportion of the population in the capital, the higher the GDP per capita and the higher the life expectancy.

7.

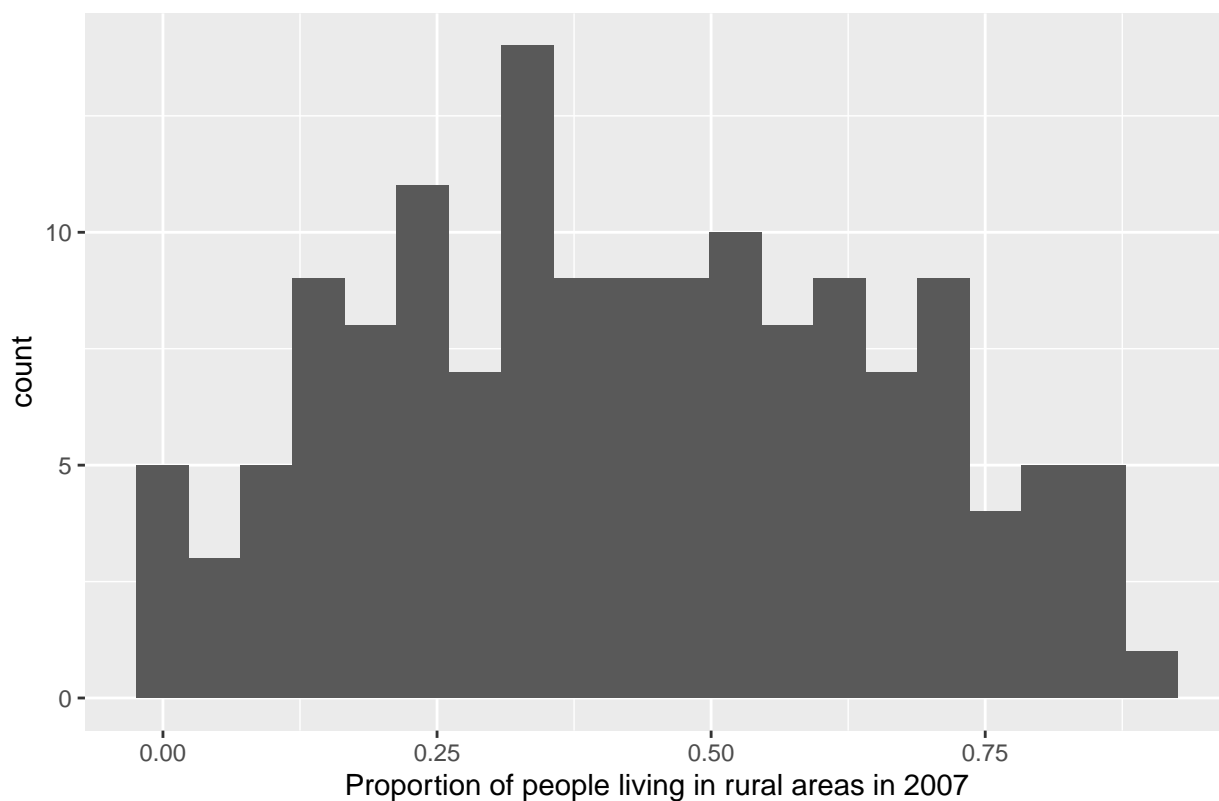
Since there is no real data for 2017, only predicted values can be used.

```
pop_clean <- pop %>% select(RegionCountryArea, Name, Year, Series, Capital, Value)
pop_clean <- pop_clean %>%
  pivot_wider(names_from = Series,
              values_from = Value)
pop_clean$TotalPopulation <- pop_clean$"Capital city population (thousands)" / (pop_clean$"Capital city population (thousands)" / pop_clean$TotalPopulation)

dataQ7 <- pop_clean %>% filter(Year == 2005) %>% mutate(
  Pop2017 = TotalPopulation * (`Urban population (percent)`/100) * (1 + `Urban population (percent growth rate)`,
  PropRural = TotalPopulation * (1-`Urban population (percent)`/100) * (1 + `Rural population (percent growth rate)`,
  PropCapital = `Capital city population (as a percentage of total population)` / 100
) %>% select(Pop2017, PropRural, PropCapital)
dataQ7$PropRural <- dataQ7$PropRural / dataQ7$Pop2017

ggplot(dataQ7, aes(x=PropRural)) + geom_histogram(bins=20) +
  labs(x = 'Proportion of people living in rural areas in 2007',
       title = 'Histogram of the proportion of people living in rural areas in 2007')
```

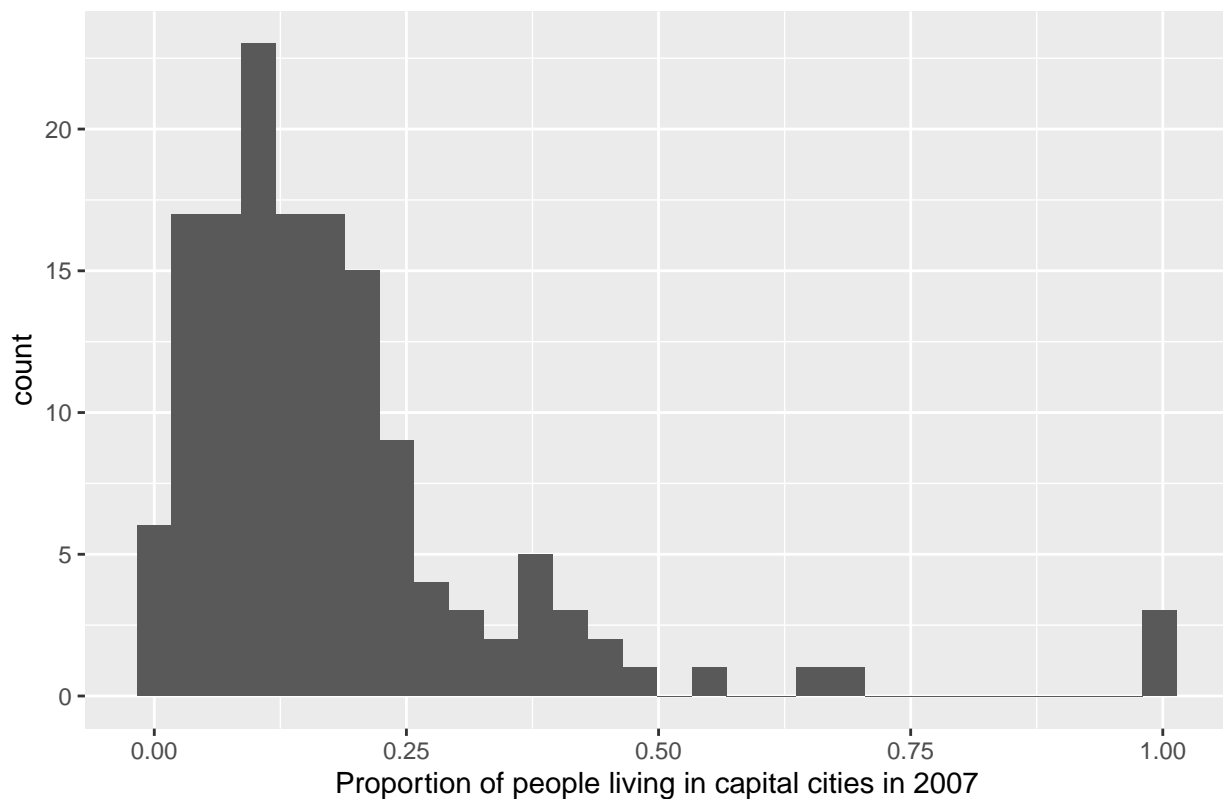
Histogram of the proportion of people living in rural areas in 2007



```
ggplot(dataQ7, aes(x=PropCapital)) + geom_histogram() +  
  labs(x = 'Proportion of people living in capital cities in 2007',  
       title = 'Histogram of the proportion of people living in capital cities in 2007')
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

Histogram of the proportion of people living in capital cities in 2007



The proportion of the population living in rural areas is approximately normally distributed. Most countries are concentrated in the range [0.25, 0.75]. The distribution of the proportion of the population living in the capital is more skewed. In most countries this ratio is less than 0.25.

Part 2.

8.

The code of this chunk is from the Lecture 03:

```
experiment <- read_csv("experiment.csv", skip = 2)
columns <- read_csv("experiment.csv", n_max = 1, col_names = FALSE)
colnames(experiment) <- columns
experiment2 <- experiment %>% select(ResponseId, Age, Gender, Control_Msg,
                                   Norm_Pos_Msg, Norm_Neg_Msg, Emp_Pos_Msg,
                                   Emp_Neg_Msg, starts_with("Outcome"), SC0)
experiment3 <- experiment2 %>% mutate(message = case_when(Control_Msg != "" ~ 0,
                                                         Norm_Pos_Msg != "" ~ 1,
                                                         Norm_Neg_Msg != "" ~ 2,
                                                         Emp_Pos_Msg != "" ~ 3,
                                                         Emp_Neg_Msg != "" ~ 4),
                                   .after = Gender) %>%
  select(-Control_Msg, -Norm_Pos_Msg, -Norm_Neg_Msg,
        -Emp_Pos_Msg, -Emp_Neg_Msg)

experiment3
```

```
## # A tibble: 190 x 25
```

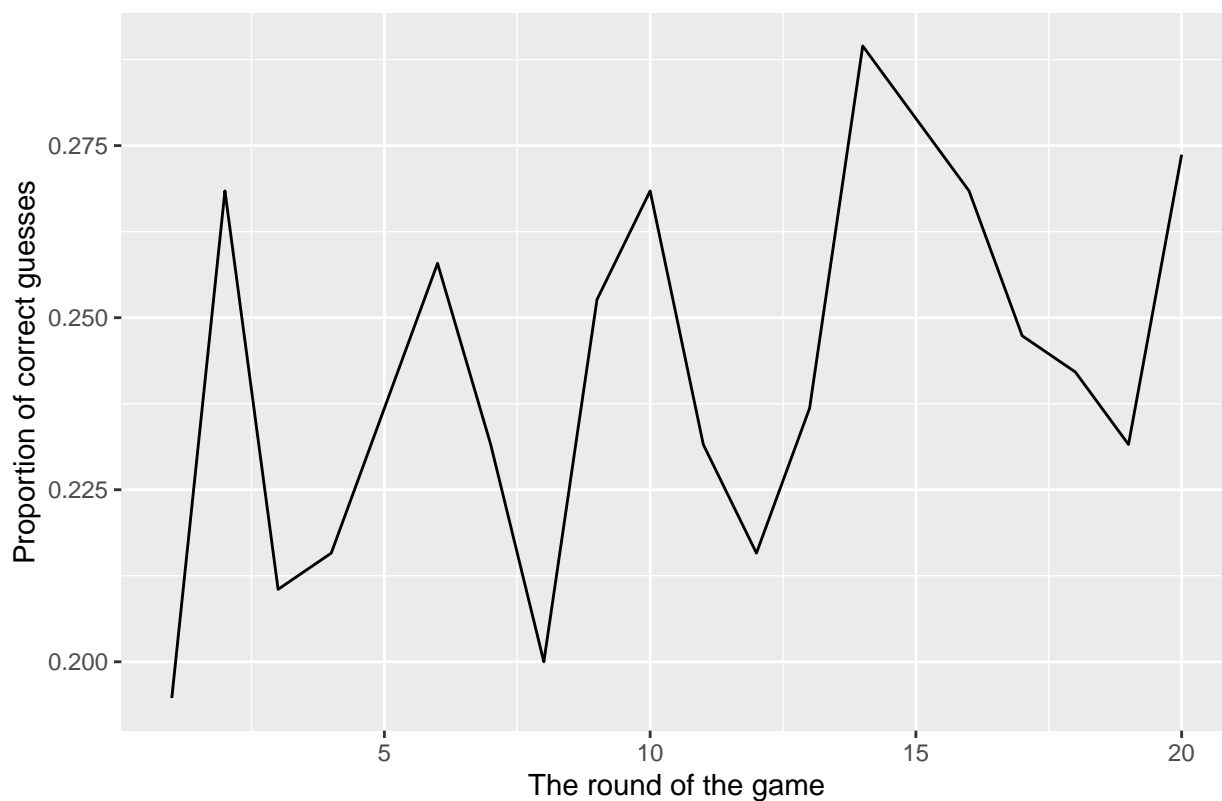
```
##   ResponseId   Age Gender message Outcome1 Outcome2 Outcome3 Outcome4 Outcome5
##   <chr>        <dbl> <chr>   <dbl> <chr>    <chr>    <chr>    <chr>    <chr>
## 1 R_3egj1SAa~  22 Male      4 No (no ~ No (no ~ No (no ~ Yes (bo~ No (no ~
## 2 R_2y3C54jA~  23 Male      4 No (no ~ No (no ~ No (no ~ No (no ~ No (no ~
## 3 R_e3OVbnHy~  25 Male      2 No (no ~ No (no ~ No (no ~ No (no ~ No (no ~
## 4 R_2v67fXe4~  27 Female    3 No (no ~ No (no ~ No (no ~ No (no ~ No (no ~
## 5 R_1LFE4UQb~  22 Female    0 No (no ~ No (no ~ Yes (bo~ No (no ~ No (no ~
## 6 R_pMoNArM9~  25 Male      2 No (no ~ No (no ~ No (no ~ No (no ~ Yes (bo~
## 7 R_3nMzgLv~  22 Male      0 No (no ~ Yes (bo~ No (no ~ No (no ~ No (no ~
## 8 R_2TMNjOB0~  28 Female    2 No (no ~ No (no ~ No (no ~ No (no ~ No (no ~
## 9 R_a4sh9N1Q~  24 Male      2 No (no ~ No (no ~ No (no ~ No (no ~ No (no ~
## 10 R_1DLPR22G~ 21 Female    2 No (no ~ No (no ~ Yes (bo~ Yes (bo~ No (no ~
## # ... with 180 more rows, and 16 more variables: Outcome6 <chr>,
## #   Outcome7 <chr>, Outcome8 <chr>, Outcome9 <chr>, Outcome10 <chr>,
## #   Outcome11 <chr>, Outcome12 <chr>, Outcome13 <chr>, Outcome14 <chr>,
## #   Outcome15 <chr>, Outcome16 <chr>, Outcome17 <chr>, Outcome18 <chr>,
## #   Outcome19 <chr>, Outcome20 <chr>, SCO <dbl>
```

```
result <- experiment3 %>% select(starts_with("Outcome"))
result$Outcome1 <- as.numeric(as.factor(result$Outcome1)) - 1
result$Outcome2 <- as.numeric(as.factor(result$Outcome2)) - 1
result$Outcome3 <- as.numeric(as.factor(result$Outcome3)) - 1
result$Outcome4 <- as.numeric(as.factor(result$Outcome4)) - 1
result$Outcome5 <- as.numeric(as.factor(result$Outcome5)) - 1
result$Outcome6 <- as.numeric(as.factor(result$Outcome6)) - 1
result$Outcome7 <- as.numeric(as.factor(result$Outcome7)) - 1
result$Outcome8 <- as.numeric(as.factor(result$Outcome8)) - 1
result$Outcome9 <- as.numeric(as.factor(result$Outcome9)) - 1
result$Outcome10 <- as.numeric(as.factor(result$Outcome10)) - 1
result$Outcome11 <- as.numeric(as.factor(result$Outcome11)) - 1
result$Outcome12 <- as.numeric(as.factor(result$Outcome12)) - 1
result$Outcome13 <- as.numeric(as.factor(result$Outcome13)) - 1
result$Outcome14 <- as.numeric(as.factor(result$Outcome14)) - 1
result$Outcome15 <- as.numeric(as.factor(result$Outcome15)) - 1
result$Outcome16 <- as.numeric(as.factor(result$Outcome16)) - 1
result$Outcome17 <- as.numeric(as.factor(result$Outcome17)) - 1
result$Outcome18 <- as.numeric(as.factor(result$Outcome18)) - 1
result$Outcome19 <- as.numeric(as.factor(result$Outcome19)) - 1
result$Outcome20 <- as.numeric(as.factor(result$Outcome20)) - 1
accuracy = colSums(result) / length(result$Outcome1)
```

Visualize the proportion of correct guesses by the round of the game (the outcome variable):

```
dataQ8 <- tibble(gameround=seq(1, 20), accuracy = accuracy)
ggplot(dataQ8, aes(x=gameround, y=accuracy)) + geom_line() +
  labs(x = 'The round of the game', title = 'Proportion of correct guesses vs. The round of the game', y = 'Accuracy')
```


Proportion of correct guesses vs. The round of the game



9.

```
result$message <- as.factor(experiment3$message)
result <- result %>% group_by(message) %>% summarise(out1 = mean(Outcome1),
                                                    out2 = mean(Outcome2),
                                                    out3 = mean(Outcome3),
                                                    out4 = mean(Outcome4),
                                                    out5 = mean(Outcome5),
                                                    out6 = mean(Outcome6),
                                                    out7 = mean(Outcome7),
                                                    out8 = mean(Outcome8),
                                                    out9 = mean(Outcome9),
                                                    out10 = mean(Outcome10),
                                                    out11 = mean(Outcome11),
                                                    out12 = mean(Outcome12),
                                                    out13 = mean(Outcome13),
                                                    out14 = mean(Outcome14),
                                                    out15 = mean(Outcome15),
                                                    out16 = mean(Outcome16),
                                                    out17 = mean(Outcome17),
                                                    out18 = mean(Outcome18),
                                                    out19 = mean(Outcome19),
                                                    out20 = mean(Outcome20),)

result <- result %>%
  pivot_longer(
```

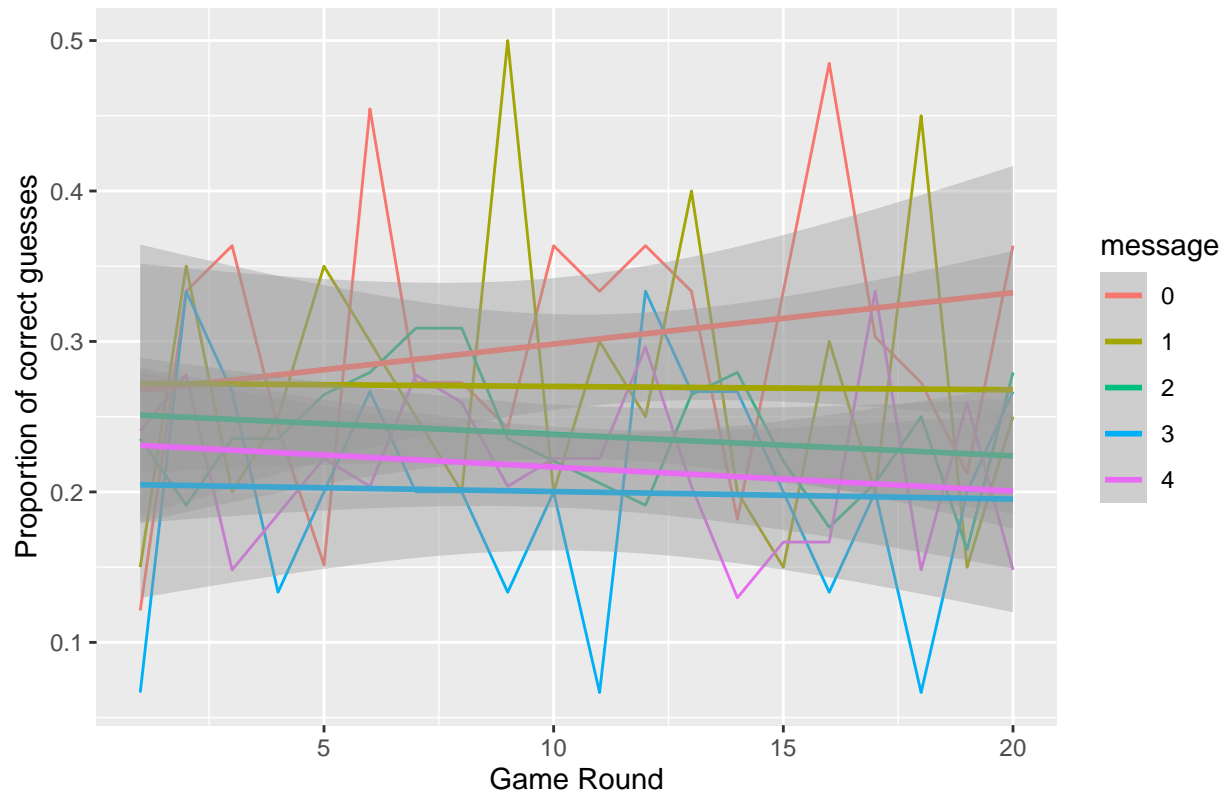
```

cols = !message,
names_to = 'round',
values_to = 'accuracy'
)
result$round <- as.numeric(as.factor(result$round))

ggplot(result, aes(x=round, y=accuracy, color=message)) +
  geom_line() +
  geom_smooth(method = "lm") + labs(x='Game Round', y='Proportion of correct guesses', title='Proportion
## `geom_smooth()` using formula 'y ~ x'

```

Proportion of correct guesses vs. Game Round by different experiment conditions



The proportion of correct guesses of experiment condition 0 is always better than experiment condition 1, experiment condition 1 is better than experiment condition 2, and so on.

Homework 2

2022-10-19

Question 1

```
set.seed(195021)
x = rexp(n=50, rate=2)
```

1.1)

```
x_bar = mean(x)

f = function(lamb, x_bar, n){return(- n*log(lamb) + lamb*n*x_bar) }
ans = optimise(f=f, n=length(x), x_bar=x_bar, interval=c(0,100000))
cbind(ans$minimum, 1/x_bar)
```

```
##          [,1]      [,2]
## [1,] 3.2472 3.2472
```

My estimates is same as $\frac{1}{\bar{x}}$

1.2)

```
library(numDeriv)
lambda = ans$minimum
sigma <- sqrt(solve(hessian(f, lambda, x_bar=x_bar, n=length(x))))
upper <- lambda + 1.96 * sigma
lower <- lambda - 1.96 * sigma
cat(lower, upper, '\n')
```

```
## 2.347122 4.147278
```

The approximate 95% CI for the estimate is [2.347122, 4.147278].

Question 2

2.1)

Using the gout data set, fit a logistic regression for gout using sex, age, and race as predictors (for this you can use glm(), don't forget the link!).

```
data = read.csv('../DATA/goutData.txt', sep = ' ')
data$gout = ifelse(data$gout == 'Y', 1, 0)
data$sex = ifelse(data$sex == 'F', 1, 0)
data$race = ifelse(data$race == 'B', 1, 0)
model = glm(gout~sex+age+race,family=binomial(link=logit), data=data)
summary(model)
```

```
##
## Call:
```

```
## glm(formula = gout ~ sex + age + race, family = binomial(link = logit),
##     data = data)
##
## Deviance Residuals:
##      Min       1Q   Median       3Q      Max
## -0.8294  -0.4256  -0.3537  -0.2713   2.6115
##
## Coefficients:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept) -8.37823    2.40051  -3.490 0.000483 ***
## sex         -0.44915    0.38821  -1.157 0.247288
## age          0.09239    0.03644   2.536 0.011227 *
## race         0.74329    0.41914   1.773 0.076168 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##      Null deviance: 213.11  on 399  degrees of freedom
## Residual deviance: 203.05  on 396  degrees of freedom
## AIC: 211.05
##
## Number of Fisher Scoring iterations: 5
```

2.2)

Calculate the covariance matrix:

```
COV = vcov(model)
```

Compute the predicted risk and 95% CI:

```
test = data.frame(race=c('W', 'W', 'B', 'B'),
                  sex=c('M', 'F', 'M', 'F'),
                  age=c(55, 55, 55, 55))
result = test
test$sex = ifelse(test$sex == 'F', 1, 0)
test$race = ifelse(test$race == 'B', 1, 0)
result$predicted_risk = predict(model, test, type = "response")

test.matrix = as.matrix(cbind(1, test$sex, test$age, test$race)) # include the intercept
SEeta = diag(sqrt(test.matrix %*% COV %*% t(test.matrix)))

log_odds = predict(model, test)
log_odds_upper = log_odds + 1.96 * SEeta
log_odds_lower = log_odds - 1.96 * SEeta

risk_upper = exp(log_odds_upper)/(1+exp(log_odds_upper))
risk_lower = exp(log_odds_lower)/(1+exp(log_odds_lower))

result$percent95CI = rep(0, 4)
for (i in 1:4){
  result$percent95CI[i] = paste('(', risk_lower[i], ',', risk_upper[i], ')')
}
```

result

```
##   race sex age predicted_risk          percent95CI
## 1    W  M  55    0.03568382 ( 0.0143371592240793 , 0.0860392310566476 )
## 2    W  F  55    0.02307028 ( 0.00896344415281758 , 0.0580776176387717 )
## 3    B  M  55    0.07219612 ( 0.0273233949591836 , 0.177327511035585 )
## 4    B  F  55    0.04730937 ( 0.0184214349436718 , 0.116138541574751 )
```

Note, the risk here means the probability of gout for each of the person in the test dataset and it do not means odds.

Question 3

Use 1,000 bootstrap samples to estimate the SE:

```
data = read.csv('../DATA/goutData.txt', sep = ' ')
data$gout = ifelse(data$gout == 'Y', 1, 0)
data$sex = ifelse(data$sex == 'F', 1, 0)
data$race = ifelse(data$race == 'B', 1, 0)

model = glm(gout~sex+age+race,family=binomial(link=logit), data=data)
set.seed(123)
n = dim(data)[1]

B = 1000 # numbrer of bootstrap samples
SEetameans = matrix(rep(0, B*4), nrow = B)

test = data.frame(race=c('W', 'W', 'B', 'B'),
                  sex=c('M', 'F', 'M', 'F'),
                  age=c(55, 55, 55, 55))
test$sex = ifelse(test$sex == 'F', 1, 0)
test$race = ifelse(test$race == 'B', 1, 0)
test.matrix = as.matrix(cbind(1, test$sex, test$age, test$race))

for(i in 1:B){
  index = sample(1:n, size = n, replace = TRUE)
  modelQ3 = glm(gout~sex+age+race,family=binomial(link=logit), data=data[index, ])
  COV = vcov(modelQ3)
  SEeta = diag(sqrt(test.matrix %*% COV %*% t(test.matrix)))

  SEetameans[i, ] = SEeta
}
```

The estimated SE obtained by bootstrap is:

```
SEeta = colMeans(SEetameans)
SEeta
```

```
## [1] 0.4941875 0.5105432 0.5399246 0.5166063
```

The 95% CIs:

```
log_odds = predict(model, test)
log_odds_upper = log_odds + 1.96 * SEeta
log_odds_lower = log_odds - 1.96 * SEeta

risk_upper = exp(log_odds_upper)/(1+exp(log_odds_upper))
```

```

risk_lower = exp(log_odds_lower)/(1+exp(log_odds_lower))

answerQ3 = data.frame(percent95CI_from_Q2=result$percent95CI)
answerQ3$percent95CI_from_Q3 = rep(0, 4)

for (i in 1:4){
  answerQ3$percent95CI_from_Q3[i] = paste('(', risk_lower[i], ',', risk_upper[i], ')')
}

answerQ3

##                                percent95CI_from_Q2
## 1 ( 0.0143371592240793 , 0.0860392310566476 )
## 2 ( 0.00896344415281758 , 0.0580776176387717 )
## 3 ( 0.0273233949591836 , 0.177327511035585 )
## 4 ( 0.0184214349436718 , 0.116138541574751 )
##                                percent95CI_from_Q3
## 1 ( 0.0138526477155667 , 0.088821141074193 )
## 2 ( 0.00860700669025921 , 0.0603580265522246 )
## 3 ( 0.0262961064222747 , 0.183145240013323 )
## 4 ( 0.0177209099752763 , 0.120253320795713 )

```

We can see from the results that the 95% confidence interval obtained by bootstrap is almost the same as the result obtained from the second question.

Homework 3

2022-11-07

```
simXY=function(n,rho){
  x=scale(rexp(n))
  y=x*rho+rnorm(n,sd=sqrt(1-rho^2))
  return(cbind(x,y))
}
# testing it
tmp=simXY(1e6,.23)
cor(tmp)
```

```
##           [,1]      [,2]
## [1,] 1.0000000 0.2301564
## [2,] 0.2301564 1.0000000
```

1) SE of the sample correlation and an approximate 95% CI

1.1)

```
set.seed(195021)
DATA_30=simXY(n=30,rho=.5)
pho=cor(DATA_30)[1, 2]
SE=sqrt((1-pho**2)/(30-2))
lower=pho-1.96*SE
upper=pho+1.96*SE
CI_small_1=c(lower, upper)
cat("Sample Correlation: ", pho, "\n")
```

```
## Sample Correlation: 0.4930354
```

```
cat("The SE: ", SE, "\n")
```

```
## The SE: 0.1644163
```

```
cat("Approximate 95% CI (assuming normality): ", CI_small_1)
```

```
## Approximate 95% CI (assuming normality): 0.1707795 0.8152913
```

1.2)

```
set.seed(195021)
DATA_300=simXY(n=300,rho=.5)
pho=cor(DATA_300)[1, 2]
SE=sqrt((1-pho**2)/(300-2))
lower=pho-1.96*SE
upper=pho+1.96*SE
CI_large_1=c(lower, upper)
cat("Sample Correlation: ", pho, "\n")
```

```
## Sample Correlation: 0.5159531
```

```
cat("The SE: ", SE, "\n")
```

```
## The SE: 0.04962248
```

```
cat("Approximate 95% CI (assuming normality): ", CI_large_1)
```

```
## Approximate 95% CI (assuming normality): 0.418693 0.6132131
```

Since the number of samples becomes larger, the SE becomes smaller. Thus, the 95% CI has become smaller. The Sample Correlation is similar to the small dataset.

2) Bootstrap CIs (percentile method)

For small dataset:

```
set.seed(195021)
SEs_small = rep(1, 5000)
phos_small = rep(1, 5000)
for (i in 1:5000){
  index = sample(30, replace = TRUE)
  current = DATA_30[index, ]
  phos_small[i]=cor(current)[1, 2]
  SEs_small[i]=sqrt((1-phos_small[i]**2)/(30-2))
}
lower=quantile(phos_small, 0.025)
upper=quantile(phos_small, 0.975)
CI_small_2=c(lower, upper)
cat("Sample Correlation: ", mean(phos_small), "\n")
```

```
## Sample Correlation: 0.4720959
```

```
cat("The SE: ", mean(SEs_small), "\n")
```

```
## The SE: 0.1628254
```

```
cat("Approximate 95% CI (Bootstrap CIs percentile method): ", CI_small_2)
```

```
## Approximate 95% CI (Bootstrap CIs percentile method): 0.09457221 0.7349033
```

For large dataset:

```
set.seed(195021)
SEs_large = rep(1, 5000)
phos_large = rep(1, 5000)
for (i in 1:5000){
  index = sample(300, replace = TRUE)
  current = DATA_300[index, ]
  phos_large[i]=cor(current)[1, 2]
  SEs_large[i]=sqrt((1-phos_large[i]**2)/(300-2))
}
lower=quantile(phos_large, 0.025)
upper=quantile(phos_large, 0.975)
CI_large_2=c(lower, upper)
cat("Sample Correlation: ", mean(phos_large), "\n")
```

```
## Sample Correlation: 0.513369
```



```
cat("The SE: ", mean(SEs_large), "\n")
```

```
## The SE: 0.04960615
```

```
cat("Approximate 95% CI (Bootstrap CIs percentile method): ", CI_large_2)
```

```
## Approximate 95% CI (Bootstrap CIs percentile method): 0.4141608 0.6045546
```

3) Bootstrap CI: pivotal method

For small dataset:

```
r_avg = mean(phos_small)
r_minus_avg = phos_small - r_avg
r_minus_avg = r_minus_avg[order(r_minus_avg)]
lower=cor(DATA_30)[1, 2]+quantile(r_minus_avg, 0.025)
upper=cor(DATA_30)[1, 2]+quantile(r_minus_avg, 0.975)
CI_small_3=c(lower, upper)
cat("Approximate 95% CI (Bootstrap CIs pivotal method): ", CI_small_3)
```

```
## Approximate 95% CI (Bootstrap CIs pivotal method): 0.1155118 0.7558429
```

For large dataset:

```
r_avg = mean(phos_large)
r_minus_avg = phos_large - r_avg
r_minus_avg = r_minus_avg[order(r_minus_avg)]
lower=cor(DATA_300)[1, 2]+quantile(r_minus_avg, 0.025)
upper=cor(DATA_300)[1, 2]+quantile(r_minus_avg, 0.975)
CI_large_3=c(lower, upper)
cat("Approximate 95% CI (Bootstrap CIs pivotal method): ", CI_large_3)
```

```
## Approximate 95% CI (Bootstrap CIs pivotal method): 0.4167449 0.6071386
```

4) Bootstrap CI: normal method

For small dataset:

```
lower=cor(DATA_30)[1, 2]-1.96*mean(SEs_small)
upper=cor(DATA_30)[1, 2]+1.96*mean(SEs_small)
CI_small_4=c(lower, upper)
cat("Approximate 95% CI (Bootstrap CIs normal method): ", CI_small_4)
```

```
## Approximate 95% CI (Bootstrap CIs normal method): 0.1738977 0.8121731
```

For large dataset:

```
lower=cor(DATA_300)[1, 2]-1.96*mean(SEs_large)
upper=cor(DATA_300)[1, 2]+1.96*mean(SEs_large)
CI_large_4=c(lower, upper)
cat("Approximate 95% CI (Bootstrap CIs normal method): ", CI_large_4)
```

```
## Approximate 95% CI (Bootstrap CIs normal method): 0.418725 0.6131811
```

5) Compare all the CIs for each of the datasets:

For small dataset:

```
res_small=rbind(CI_small_1, CI_small_2, CI_small_3, CI_small_4)
rownames(res_small)=c('CIs assuming normality',
                      'Bootstrap CIs percentile method',
                      'Bootstrap CIs pivotal method',
                      'Bootstrap CIs normal method')
res_small
```

```
##                2.5%    97.5%
## CIs assuming normality    0.17077948 0.8152913
## Bootstrap CIs percentile method 0.09457221 0.7349033
## Bootstrap CIs pivotal method    0.11551177 0.7558429
## Bootstrap CIs normal method     0.17389769 0.8121731
```

For large dataset:

```
res_large=rbind(CI_large_1, CI_large_2, CI_large_3, CI_large_4)
rownames(res_large)=c('CIs assuming normality',
                      'Bootstrap CIs percentile method',
                      'Bootstrap CIs pivotal method',
                      'Bootstrap CIs normal method')
res_large
```

```
##                2.5%    97.5%
## CIs assuming normality    0.4186930 0.6132131
## Bootstrap CIs percentile method 0.4141608 0.6045546
## Bootstrap CIs pivotal method    0.4167449 0.6071386
## Bootstrap CIs normal method     0.4187250 0.6131811
```

For the small dataset, the results obtained by the four methods are quite different. But for the large dataset, the results obtained by the four methods are not much different. This shows that the number of samples affects the statistical results.

Homework 4

2022-11-16

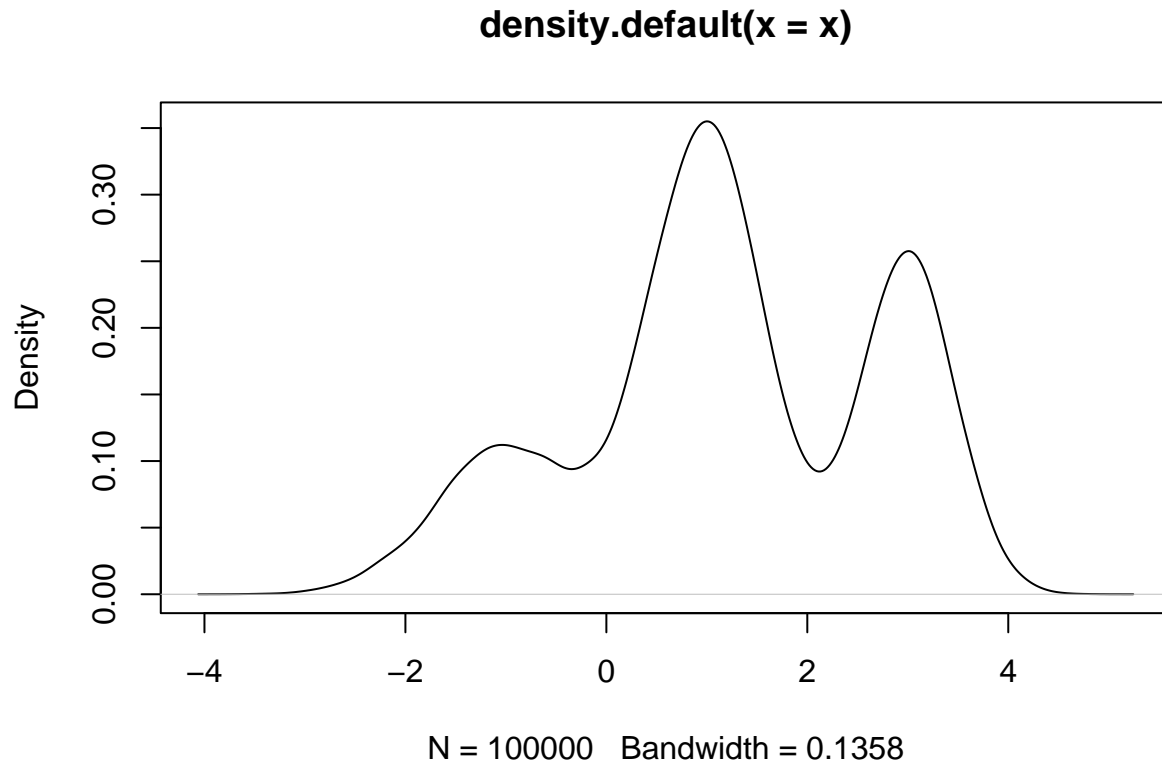
1) Finite Mixture Model

Composition sampling:

```
pi_1=0.2
pi_2=0.5
n=100000 # set this to the desired number of samples
u=runif(n)
z=ifelse(u<pi_1,1,ifelse(u<(pi_1+pi_2),2,3))
x=rep(NA, n)
for (i in 1:n){
  if(z[i]==1){
    x[i]=rnorm(1, -1, sqrt(0.5))
  }
  if(z[i]==2){
    x[i]=rnorm(1, 1, sqrt(0.3))
  }
  if(z[i]==3){
    x[i]=rnorm(1, 3, sqrt(0.2))
  }
}
```

Plot the empirical density of x :

```
plot(density(x))
```



This is very close to the real density plot.

2) The Metropolis Algorithm

Create a function to evaluates the target density:

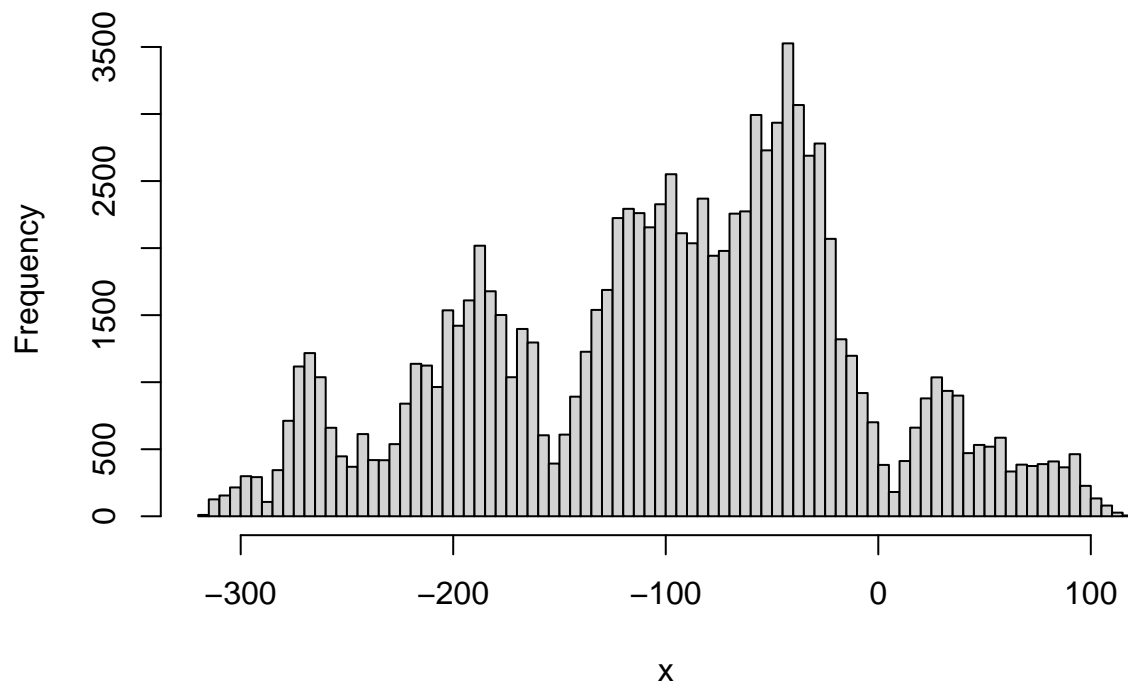
```
f=function(x){
  return(0.2*dnorm(1, -1, sqrt(0.5))+0.5*dnorm(1, 1, sqrt(0.3))+(1-0.2-0.5)*dnorm(1, 3, sqrt(0.2)))
}
```

Metropolis sampling:

```
n=100000
x=rep(NA,n)
x[1]=.5

for(i in 2:n){
  candidate=rnorm(1, x[i-1], sqrt(1))
  alpha=min(1, f(candidate)/f(x[i-1]))
  z=runif(1)<alpha
  x[i]=ifelse(z,candidate,x[i-1])
}
hist(x,100)
```

Histogram of x



SS22-STT-481-001 Midterm Project

Preprocessing

Firstly, we need to combine the train and test data.

```
train <- read.csv("train.csv")
test <- read.csv("test.csv")
df <- rbind(within(train, rm('SalePrice')), test)
```

Next, we should fill the missing value in the data.

Fill Missing Value

```
df$PoolQC[is.na(df$PoolQC)] <- "None"
df$MiscFeature[is.na(df$MiscFeature)] <- "None"
df$Alley[is.na(df$Alley)] <- "None"
df$Fence[is.na(df$Fence)] <- "None"
df$FireplaceQu[is.na(df$FireplaceQu)] <- "None"
df$GarageFinish[is.na(df$GarageFinish)] <- "None"
df$GarageQual[is.na(df$GarageQual)] <- "None"
df$GarageCond[is.na(df$GarageCond)] <- "None"
df$GarageType[is.na(df$GarageType)] <- "None"
df$BsmtCond[is.na(df$BsmtCond)] <- "None"
df$BsmtExposure[is.na(df$BsmtExposure)] <- "None"
df$BsmtQual[is.na(df$BsmtQual)] <- "None"
df$BsmtFinType2[is.na(df$BsmtFinType2)] <- "None"
df$BsmtFinType1[is.na(df$BsmtFinType1)] <- "None"
df$MasVnrType[is.na(df$MasVnrType)] <- "None"
df$MSZoning[is.na(df$MSZoning)] <- "RL"
df$Utilities[is.na(df$Utilities)] <- "AllPub"
df$Functional[is.na(df$Functional)] <- "Typ"
df$Exterior1st[is.na(df$Exterior1st)] <- "Other"
df$Exterior2nd[is.na(df$Exterior2nd)] <- "Other"
df$Electrical[is.na(df$Electrical)] <- "SBrkr"
df$KitchenQual[is.na(df$KitchenQual)] <- "TA"
df$SaleType[is.na(df$SaleType)] <- "WD"
df$MasVnrArea[is.na(df$MasVnrArea)] <- 0
df$BsmtFullBath[is.na(df$BsmtFullBath)] <- 0
df$BsmtHalfBath[is.na(df$BsmtHalfBath)] <- 0
df$BsmtFinSF1[is.na(df$BsmtFinSF1)] <- 0
df$BsmtFinSF2[is.na(df$BsmtFinSF2)] <- 0
df$BsmtUnfSF[is.na(df$BsmtUnfSF)] <- 0
df$TotalBsmtSF[is.na(df$TotalBsmtSF)] <- 0
df$GarageCars[is.na(df$GarageCars)] <- 0
df$GarageArea[is.na(df$GarageArea)] <- 0
df$LotFrontage[is.na(df$LotFrontage)] <- 69
df$GarageYrBlt[is.na(df$GarageYrBlt)] <- 0
```

Check if there still exist missing value:

```
sum(is.na(df))
```

```
## [1] 0
```

Transform data to numeric

The model cannot process character data directly. Thus, we need to transform the character data to numeric data.

```
df$MSZoning <- as.numeric(factor(df$MSZoning))
df$ExterQual <- as.numeric(factor(df$ExterQual))
df$ExterCond <- as.numeric(factor(df$ExterCond))
df$BsmtQual <- as.numeric(factor(df$BsmtQual))
df$BsmtCond <- as.numeric(factor(df$BsmtCond))
df$BsmtExposure <- as.numeric(factor(df$BsmtExposure))
df$BsmtFinType1 <- as.numeric(factor(df$BsmtFinType1))
df$BsmtFinType2 <- as.numeric(factor(df$BsmtFinType2))
df$HeatingQC <- as.numeric(factor(df$HeatingQC))
df$KitchenQual <- as.numeric(factor(df$KitchenQual))
df$FireplaceQu <- as.numeric(factor(df$FireplaceQu))
df$GarageQual <- as.numeric(factor(df$GarageQual))
df$GarageCond <- as.numeric(factor(df$GarageCond))
df$PoolQC <- as.numeric(factor(df$PoolQC))
df$Street <- as.numeric(factor(df$Street))
df$Alley <- as.numeric(factor(df$Alley))
df$LotShape <- as.numeric(factor(df$LotShape))
df$LandContour <- as.numeric(factor(df$LandContour))
df$Utilities <- as.numeric(factor(df$Utilities))
df$LotConfig <- as.numeric(factor(df$LotConfig))
df$LandSlope <- as.numeric(factor(df$LandSlope))
df$Neighborhood <- as.numeric(factor(df$Neighborhood))
df$Condition1 <- as.numeric(factor(df$Condition1))
df$Condition2 <- as.numeric(factor(df$Condition2))
df$BldgType <- as.numeric(factor(df$BldgType))
df$HouseStyle <- as.numeric(factor(df$HouseStyle))
df$RoofStyle <- as.numeric(factor(df$RoofStyle))
df$RoofMatl <- as.numeric(factor(df$RoofMatl))
df$Exterior1st <- as.numeric(factor(df$Exterior1st))
df$Exterior2nd <- as.numeric(factor(df$Exterior2nd))
df$MasVnrType <- as.numeric(factor(df$MasVnrType))
df$Foundation <- as.numeric(factor(df$Foundation))
df$Heating <- as.numeric(factor(df$Heating))
df$CentralAir <- as.numeric(factor(df$CentralAir))
df$Electrical <- as.numeric(factor(df$Electrical))
df$Functional <- as.numeric(factor(df$Functional))
df$GarageType <- as.numeric(factor(df$GarageType))
df$GarageFinish <- as.numeric(factor(df$GarageFinish))
df$PavedDrive <- as.numeric(factor(df$PavedDrive))
df$Fence <- as.numeric(factor(df$Fence))
df$MiscFeature <- as.numeric(factor(df$MiscFeature))
df$SaleType <- as.numeric(factor(df$SaleType))
df$SaleCondition <- as.numeric(factor(df$SaleCondition))
```

```
df$YearBuilt <- df$YearBuilt - min(df$YearBuilt)
df$YearRemodAdd <- df$YearRemodAdd - min(df$YearRemodAdd)
```

Now, we can see the information about the preprocessed data:

```
summary(df)
```

```
##           Id           MSSubClass           MSZoning           LotFrontage
##  Min.      :   1.0           Min.      : 20.00           Min.      :1.000           Min.      : 21.00
## 1st Qu.: 730.5           1st Qu.: 20.00           1st Qu.:4.000           1st Qu.: 60.00
## Median :1460.0           Median : 50.00           Median :4.000           Median : 69.00
## Mean   :1460.0           Mean   : 57.14           Mean   :4.028           Mean   : 69.25
## 3rd Qu.:2189.5           3rd Qu.: 70.00           3rd Qu.:4.000           3rd Qu.: 78.00
## Max.   :2919.0           Max.   :190.00           Max.   :5.000           Max.   :313.00
##           LotArea           Street           Alley           LotShape
##  Min.      : 1300           Min.      :1.000           Min.      :1.000           Min.      :1.000
## 1st Qu.: 7478           1st Qu.:2.000           1st Qu.:2.000           1st Qu.:1.000
## Median : 9453           Median :2.000           Median :2.000           Median :4.000
## Mean   :10168           Mean   :1.996           Mean   :1.986           Mean   :2.948
## 3rd Qu.:11570           3rd Qu.:2.000           3rd Qu.:2.000           3rd Qu.:4.000
## Max.   :215245           Max.   :2.000           Max.   :3.000           Max.   :4.000
##           LandContour           Utilities           LotConfig           LandSlope           Neighborhood
##  Min.      :1.000           Min.      :1           Min.      :1.000           Min.      :1.000           Min.      : 1.00
## 1st Qu.:4.000           1st Qu.:1           1st Qu.:3.000           1st Qu.:1.000           1st Qu.: 8.00
## Median :4.000           Median :1           Median :5.000           Median :1.000           Median :13.00
## Mean   :3.777           Mean   :1           Mean   :4.056           Mean   :1.054           Mean   :13.32
## 3rd Qu.:4.000           3rd Qu.:1           3rd Qu.:5.000           3rd Qu.:1.000           3rd Qu.:18.00
## Max.   :4.000           Max.   :2           Max.   :5.000           Max.   :3.000           Max.   :25.00
##           Condition1           Condition2           BldgType           HouseStyle
##  Min.      :1.00           Min.      :1.000           Min.      :1.000           Min.      :1.000
## 1st Qu.:3.00           1st Qu.:3.000           1st Qu.:1.000           1st Qu.:3.000
## Median :3.00           Median :3.000           Median :1.000           Median :3.000
## Mean   :3.04           Mean   :3.002           Mean   :1.506           Mean   :4.027
## 3rd Qu.:3.00           3rd Qu.:3.000           3rd Qu.:1.000           3rd Qu.:6.000
## Max.   :9.00           Max.   :8.000           Max.   :5.000           Max.   :8.000
##           OverallQual           OverallCond           YearBuilt           YearRemodAdd
##  Min.      : 1.000           Min.      :1.000           Min.      : 0.00           Min.      : 0.00
## 1st Qu.: 5.000           1st Qu.:5.000           1st Qu.: 81.50           1st Qu.:15.00
## Median : 6.000           Median :5.000           Median :101.00           Median :43.00
## Mean   : 6.089           Mean   :5.565           Mean   : 99.31           Mean   :34.26
## 3rd Qu.: 7.000           3rd Qu.:6.000           3rd Qu.:129.00           3rd Qu.:54.00
## Max.   :10.000           Max.   :9.000           Max.   :138.00           Max.   :60.00
##           RoofStyle           RoofMatl           Exterior1st           Exterior2nd
##  Min.      :1.000           Min.      :1.000           Min.      : 1.00           Min.      : 1.00
## 1st Qu.:2.000           1st Qu.:2.000           1st Qu.: 9.00           1st Qu.: 9.00
## Median :2.000           Median :2.000           Median :14.00           Median :14.00
## Mean   :2.396           Mean   :2.063           Mean   :11.23           Mean   :11.33
## 3rd Qu.:2.000           3rd Qu.:2.000           3rd Qu.:14.00           3rd Qu.:14.00
## Max.   :6.000           Max.   :8.000           Max.   :16.00           Max.   :16.00
##           MasVnrType           MasVnrArea           ExterQual           ExterCond
##  Min.      :1.000           Min.      : 0.0           Min.      :1.000           Min.      :1.000
## 1st Qu.:2.000           1st Qu.: 0.0           1st Qu.:3.000           1st Qu.:5.000
## Median :3.000           Median : 0.0           Median :4.000           Median :5.000
## Mean   :2.767           Mean   :101.4           Mean   :3.531           Mean   :4.709
```


##	3rd Qu.:3.000	3rd Qu.: 163.5	3rd Qu.:4.000	3rd Qu.:5.000	
##	Max. :4.000	Max. :1600.0	Max. :4.000	Max. :5.000	
##	Foundation	BsmtQual	BsmtCond	BsmtExposure	BsmtFinType1
##	Min. :1.000	Min. :1.0	Min. :1.000	Min. :1.000	Min. :1.000
##	1st Qu.:2.000	1st Qu.:3.0	1st Qu.:5.000	1st Qu.:3.000	1st Qu.:3.000
##	Median :2.000	Median :3.0	Median :5.000	Median :4.000	Median :3.000
##	Mean :2.393	Mean :3.7	Mean :4.674	Mean :3.328	Mean :4.183
##	3rd Qu.:3.000	3rd Qu.:5.0	3rd Qu.:5.000	3rd Qu.:4.000	3rd Qu.:7.000
##	Max. :6.000	Max. :5.0	Max. :5.000	Max. :5.000	Max. :7.000
##	BsmtFinSF1	BsmtFinType2	BsmtFinSF2	BsmtUnfSF	
##	Min. : 0.0	Min. :1.00	Min. : 0.00	Min. : 0.0	
##	1st Qu.: 0.0	1st Qu.:7.00	1st Qu.: 0.00	1st Qu.: 220.0	
##	Median : 368.0	Median :7.00	Median : 0.00	Median : 467.0	
##	Mean : 441.3	Mean :6.55	Mean : 49.57	Mean : 560.6	
##	3rd Qu.: 733.0	3rd Qu.:7.00	3rd Qu.: 0.00	3rd Qu.: 805.0	
##	Max. :5644.0	Max. :7.00	Max. :1526.00	Max. :2336.0	
##	TotalBsmtSF	Heating	HeatingQC	CentralAir	Electrical
##	Min. : 0	Min. :1.000	Min. :1.000	Min. :1.000	Min. :1.000
##	1st Qu.: 793	1st Qu.:2.000	1st Qu.:1.000	1st Qu.:2.000	1st Qu.:5.000
##	Median : 989	Median :2.000	Median :1.000	Median :2.000	Median :5.000
##	Mean :1051	Mean :2.025	Mean :2.534	Mean :1.933	Mean :4.685
##	3rd Qu.:1302	3rd Qu.:2.000	3rd Qu.:5.000	3rd Qu.:2.000	3rd Qu.:5.000
##	Max. :6110	Max. :6.000	Max. :5.000	Max. :2.000	Max. :5.000
##	X1stFlrSF	X2ndFlrSF	LowQualFinSF	GrLivArea	
##	Min. : 334	Min. : 0.0	Min. : 0.000	Min. : 334	
##	1st Qu.: 876	1st Qu.: 0.0	1st Qu.: 0.000	1st Qu.:1126	
##	Median :1082	Median : 0.0	Median : 0.000	Median :1444	
##	Mean :1160	Mean : 336.5	Mean : 4.694	Mean :1501	
##	3rd Qu.:1388	3rd Qu.: 704.0	3rd Qu.: 0.000	3rd Qu.:1744	
##	Max. :5095	Max. :2065.0	Max. :1064.000	Max. :5642	
##	BsmtFullBath	BsmtHalfBath	FullBath	HalfBath	
##	Min. :0.0000	Min. :0.00000	Min. :0.000	Min. :0.0000	
##	1st Qu.:0.0000	1st Qu.:0.00000	1st Qu.:1.000	1st Qu.:0.0000	
##	Median :0.0000	Median :0.00000	Median :2.000	Median :0.0000	
##	Mean :0.4296	Mean :0.06132	Mean :1.568	Mean :0.3803	
##	3rd Qu.:1.0000	3rd Qu.:0.00000	3rd Qu.:2.000	3rd Qu.:1.0000	
##	Max. :3.0000	Max. :2.00000	Max. :4.000	Max. :2.0000	
##	BedroomAbvGr	KitchenAbvGr	KitchenQual	TotRmsAbvGrd	Functional
##	Min. :0.00	Min. :0.000	Min. :1.000	Min. : 2.000	Min. :1.00
##	1st Qu.:2.00	1st Qu.:1.000	1st Qu.:3.000	1st Qu.: 5.000	1st Qu.:7.00
##	Median :3.00	Median :1.000	Median :4.000	Median : 6.000	Median :7.00
##	Mean :2.86	Mean :1.045	Mean :3.347	Mean : 6.452	Mean :6.76
##	3rd Qu.:3.00	3rd Qu.:1.000	3rd Qu.:4.000	3rd Qu.: 7.000	3rd Qu.:7.00
##	Max. :8.00	Max. :3.000	Max. :4.000	Max. :15.000	Max. :7.00
##	Fireplaces	FireplaceQu	GarageType	GarageYrBlt	
##	Min. :0.0000	Min. :1.000	Min. :1.000	Min. : 0	
##	1st Qu.:0.0000	1st Qu.:3.000	1st Qu.:2.000	1st Qu.:1957	
##	Median :1.0000	Median :4.000	Median :2.000	Median :1977	
##	Mean :0.5971	Mean :4.072	Mean :3.484	Mean :1870	
##	3rd Qu.:1.0000	3rd Qu.:4.000	3rd Qu.:6.000	3rd Qu.:2001	
##	Max. :4.0000	Max. :6.000	Max. :7.000	Max. :2207	
##	GarageFinish	GarageCars	GarageArea	GarageQual	
##	Min. :1.000	Min. :0.000	Min. : 0.0	Min. :1.00	
##	1st Qu.:2.000	1st Qu.:1.000	1st Qu.: 320.0	1st Qu.:6.00	

```
## Median :3.000 Median :2.000 Median : 480.0 Median :6.00
## Mean :2.874 Mean :1.766 Mean : 472.7 Mean :5.69
## 3rd Qu.:4.000 3rd Qu.:2.000 3rd Qu.: 576.0 3rd Qu.:6.00
## Max. :4.000 Max. :5.000 Max. :1488.0 Max. :6.00
## GarageCond PavedDrive WoodDeckSF OpenPorchSF
## Min. :1.000 Min. :1.000 Min. : 0.00 Min. : 0.00
## 1st Qu.:6.000 1st Qu.:3.000 1st Qu.: 0.00 1st Qu.: 0.00
## Median :6.000 Median :3.000 Median : 0.00 Median : 26.00
## Mean :5.764 Mean :2.831 Mean : 93.71 Mean : 47.49
## 3rd Qu.:6.000 3rd Qu.:3.000 3rd Qu.: 168.00 3rd Qu.: 70.00
## Max. :6.000 Max. :3.000 Max. :1424.00 Max. :742.00
## EnclosedPorch X3SsnPorch ScreenPorch PoolArea
## Min. : 0.0 Min. : 0.000 Min. : 0.00 Min. : 0.000
## 1st Qu.: 0.0 1st Qu.: 0.000 1st Qu.: 0.00 1st Qu.: 0.000
## Median : 0.0 Median : 0.000 Median : 0.00 Median : 0.000
## Mean : 23.1 Mean : 2.602 Mean : 16.06 Mean : 2.252
## 3rd Qu.: 0.0 3rd Qu.: 0.000 3rd Qu.: 0.00 3rd Qu.: 0.000
## Max. :1012.0 Max. :508.000 Max. :576.00 Max. :800.000
## PoolQC Fence MiscFeature MiscVal
## Min. :1.000 Min. :1.000 Min. :1.000 Min. : 0.00
## 1st Qu.:4.000 1st Qu.:5.000 1st Qu.:2.000 1st Qu.: 0.00
## Median :4.000 Median :5.000 Median :2.000 Median : 0.00
## Mean :3.993 Mean :4.494 Mean :2.066 Mean : 50.83
## 3rd Qu.:4.000 3rd Qu.:5.000 3rd Qu.:2.000 3rd Qu.: 0.00
## Max. :4.000 Max. :5.000 Max. :5.000 Max. :17000.00
## MoSold YrSold SaleType SaleCondition
## Min. : 1.000 Min. :2006 Min. :1.000 Min. :1.000
## 1st Qu.: 4.000 1st Qu.:2007 1st Qu.:9.000 1st Qu.:5.000
## Median : 6.000 Median :2008 Median :9.000 Median :5.000
## Mean : 6.213 Mean :2008 Mean :8.491 Mean :4.779
## 3rd Qu.: 8.000 3rd Qu.:2009 3rd Qu.:9.000 3rd Qu.:5.000
## Max. :12.000 Max. :2010 Max. :9.000 Max. :6.000
```

Split training and test data:

For the purpose of preprocessing the data, we have combined the training and test data, and now, we should split the data for further analytics.

```
train_index = seq(1, dim(train)[1])
new_train <- df[train_index, ]
new_test <- df[-train_index, ]
new_train$SalePrice <- train$SalePrice
```

KNN Method

For choosing the best k -value, we split the training data into training and validation data.

```
library('FNN')
set.seed(2022)
sub <- sample(1:nrow(new_train), round(nrow(new_train)*0.8))
knn.train <- new_train[sub, ]
knn.val <- new_train[-sub, ]
dim(knn.train)
```

```
## [1] 1168 81
```

```
dim(knn.val)
```

```
## [1] 292 81
```

Define a function to calculate the **RMSE** value according to the predicted results.

```
RMSE <- function(pred, true){  
  return(mean((pred - true)^2)^0.5)  
}
```

Next, we look for the optimal k -value. We use the following criteria to find the value of k that the smaller the RMSE value on the validation set, the better the value of k .

```
set.seed(2022)  
K <- seq(1, 30)  
rmse.knn <- rep(0, length(K))  
counter <- 0  
for(k in K){  
  counter <- counter + 1  
  pred <- knn.reg(within(knn.train, rm('SalePrice')), within(knn.val, rm('SalePrice')),  
                  knn.train$SalePrice, k=k)  
  rmse.knn[counter] <- RMSE(pred$pred, knn.val$SalePrice)  
}
```

```
best_k <- K[which.min(rmse.knn)]  
best_k
```

```
## [1] 4
```

Thus, the best k value is 5.

Then, perform prediction with the best k value and save it as .csv file.

```
result <- data.frame(Id=test$Id)  
pred <- knn.reg(within(new_train, rm('SalePrice')), new_test, new_train$SalePrice, k=best_k)  
result$SalePrice <- pred$pred  
write.csv(result, file = "knn.csv", quote = F, row.names = F)
```

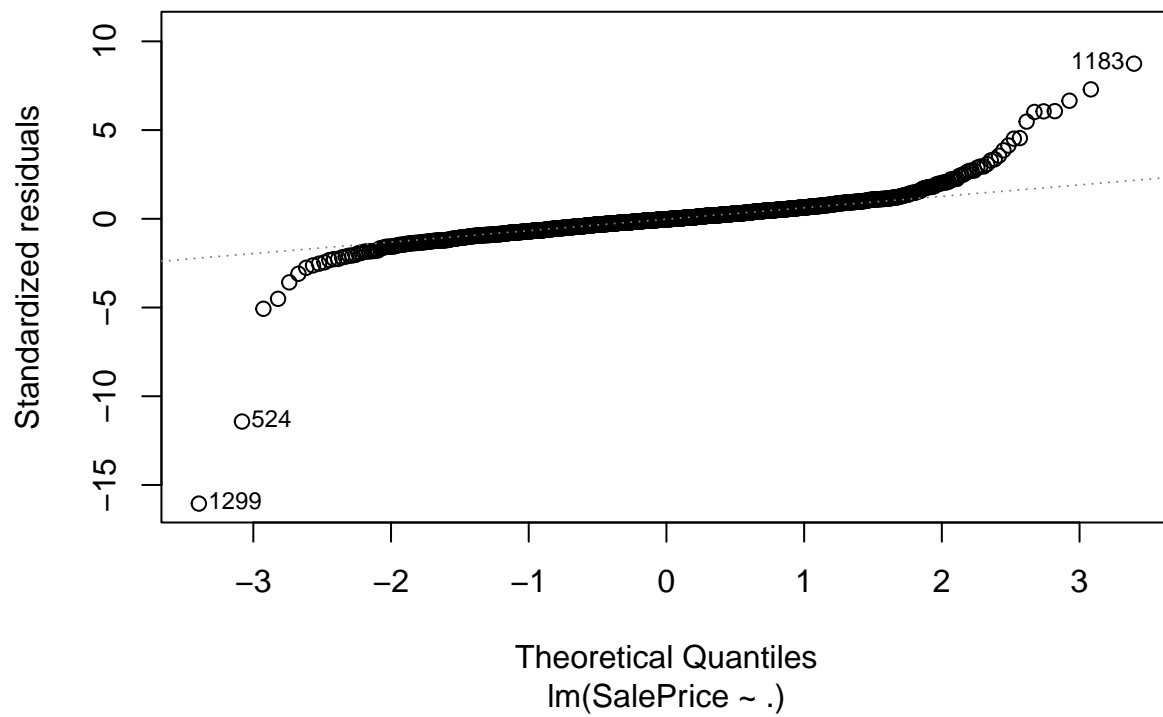
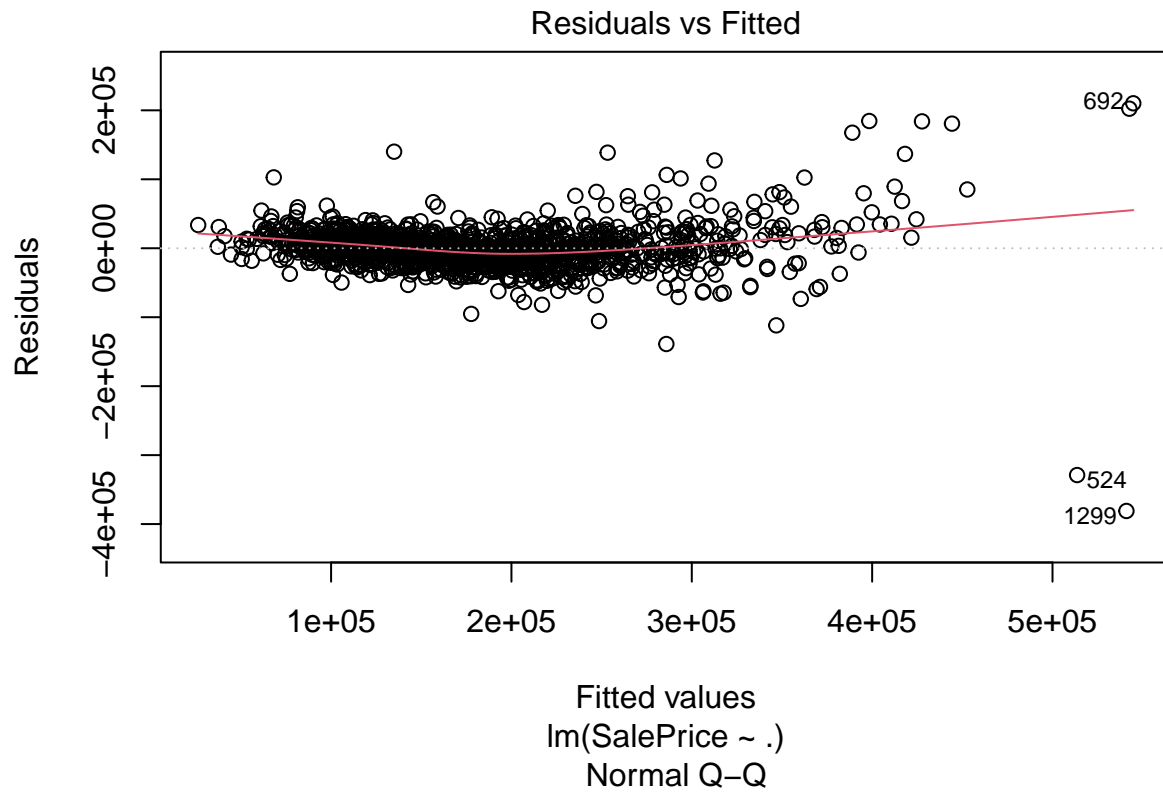
Linear Regression

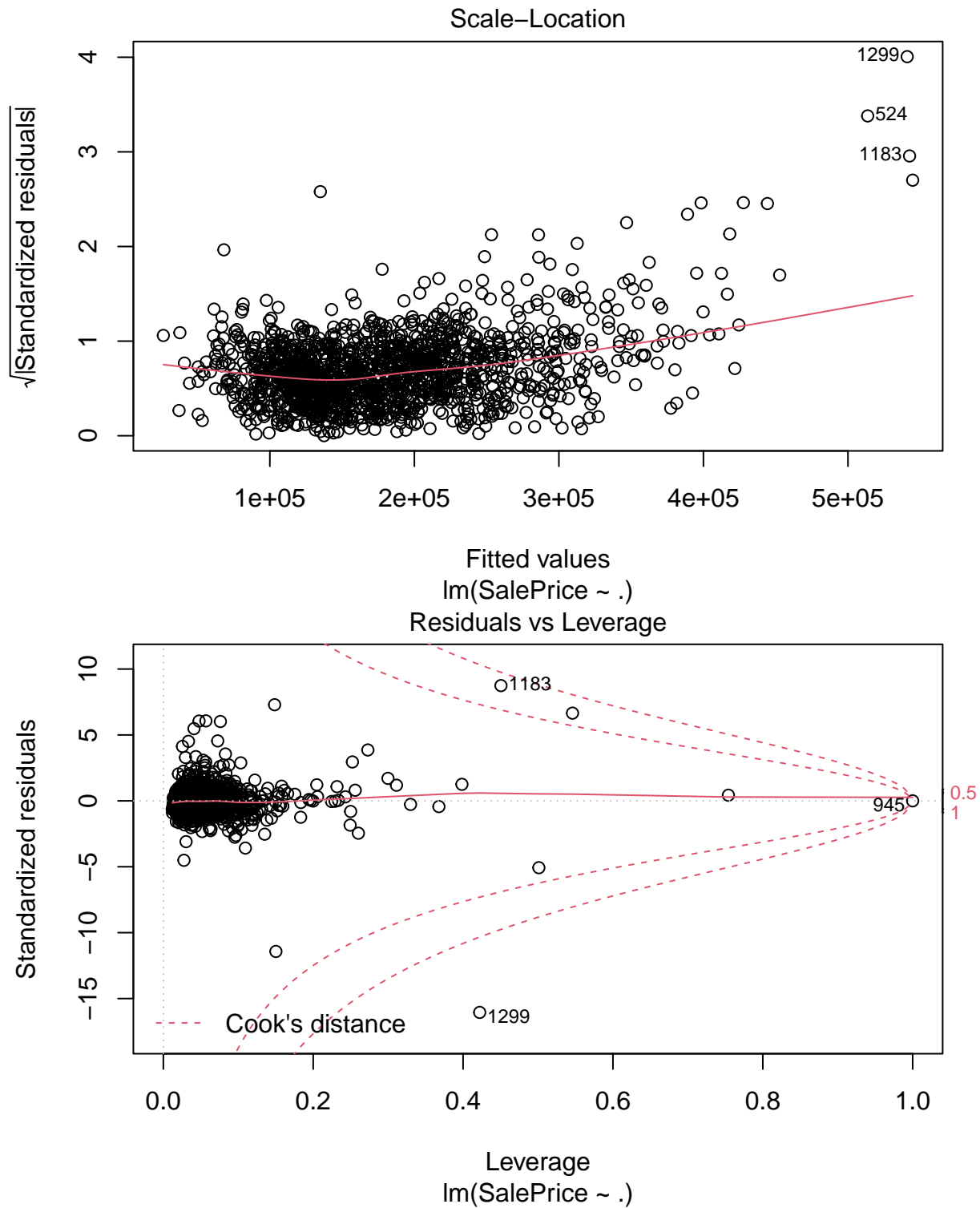
Fit a linear regression model using all the predictors except Id.

```
lm.model <- lm(SalePrice~., data=within(new_train, rm('Id')))
```

Residual diagnostics.

```
plot(lm.model)
```





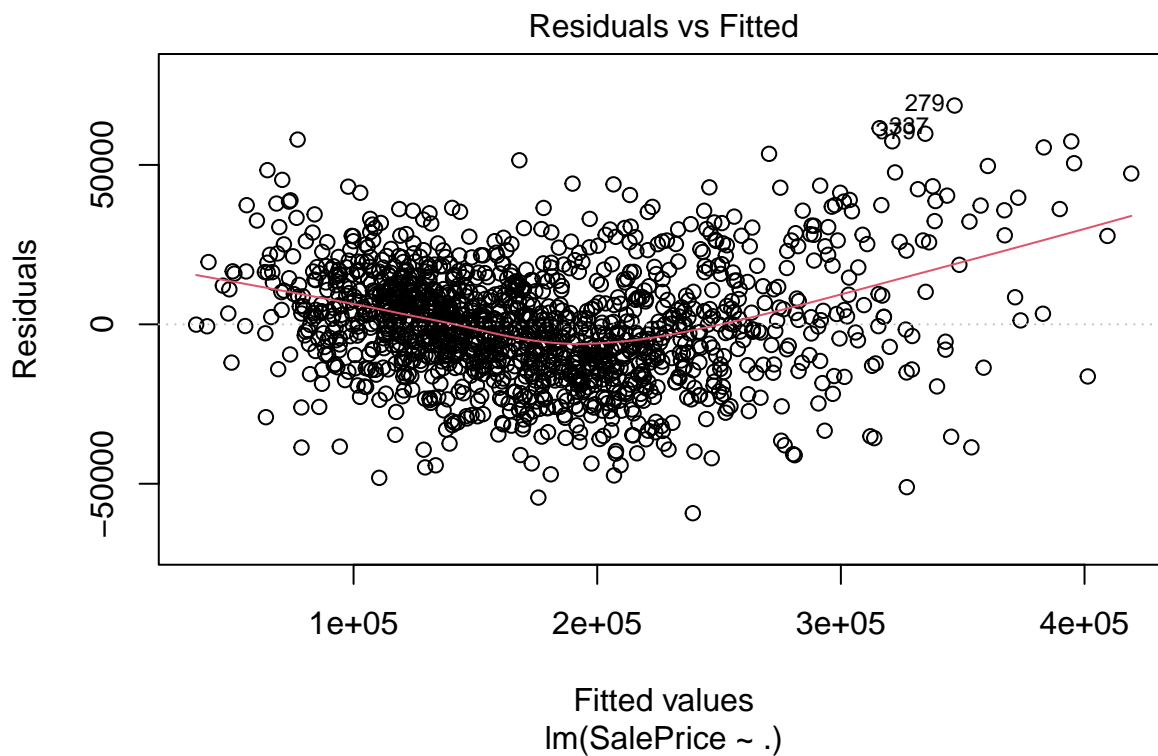
According to the plot, we need detect and delete outliers.

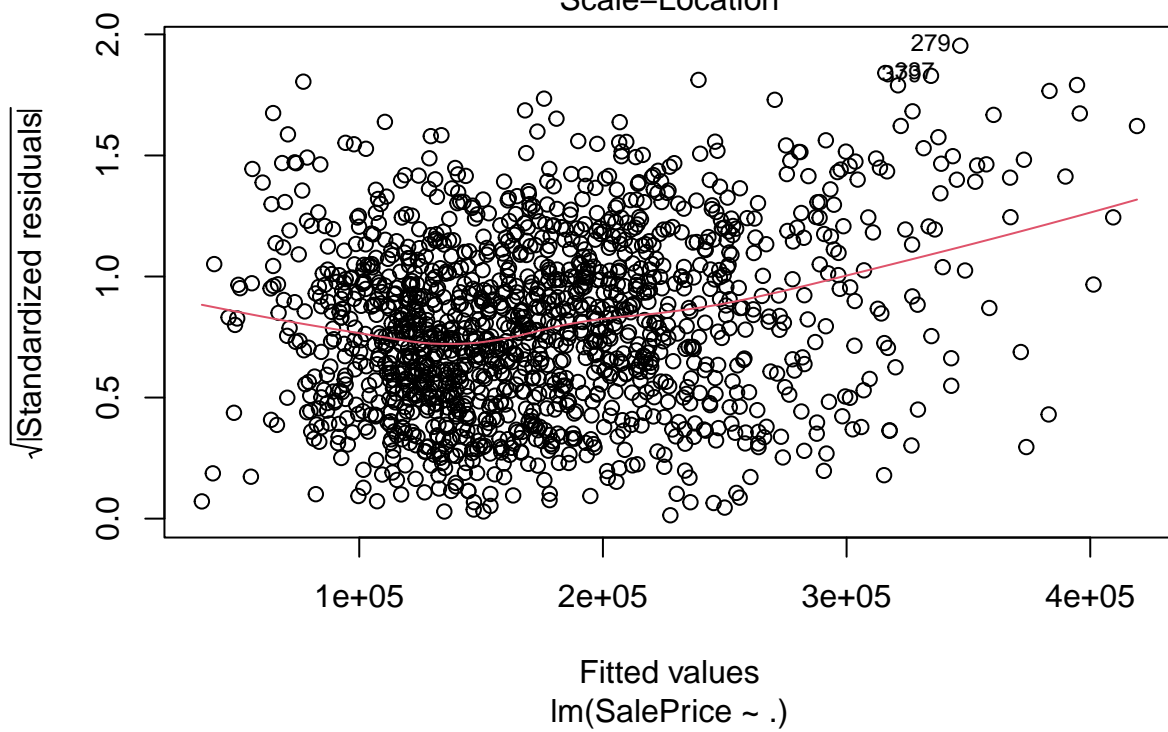
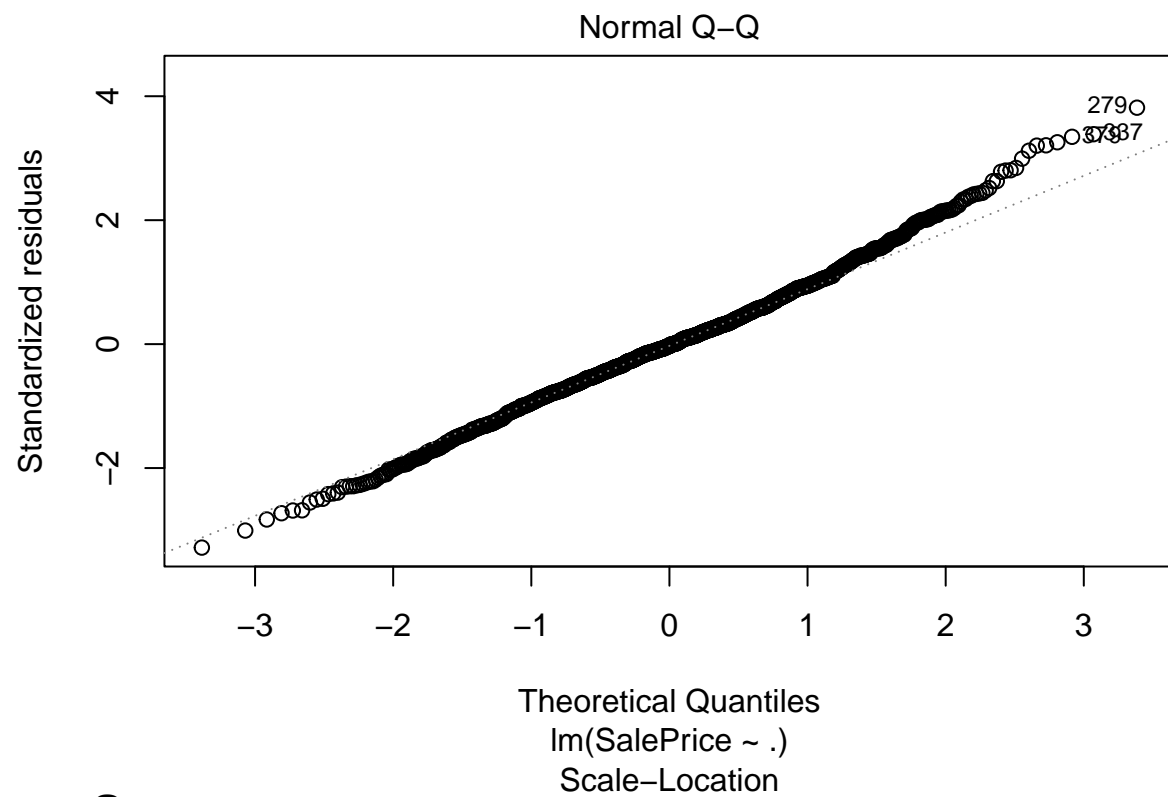
```
outliers <- rstandard(lm.model)[abs(rstandard(lm.model)) > 2]
outliers
```

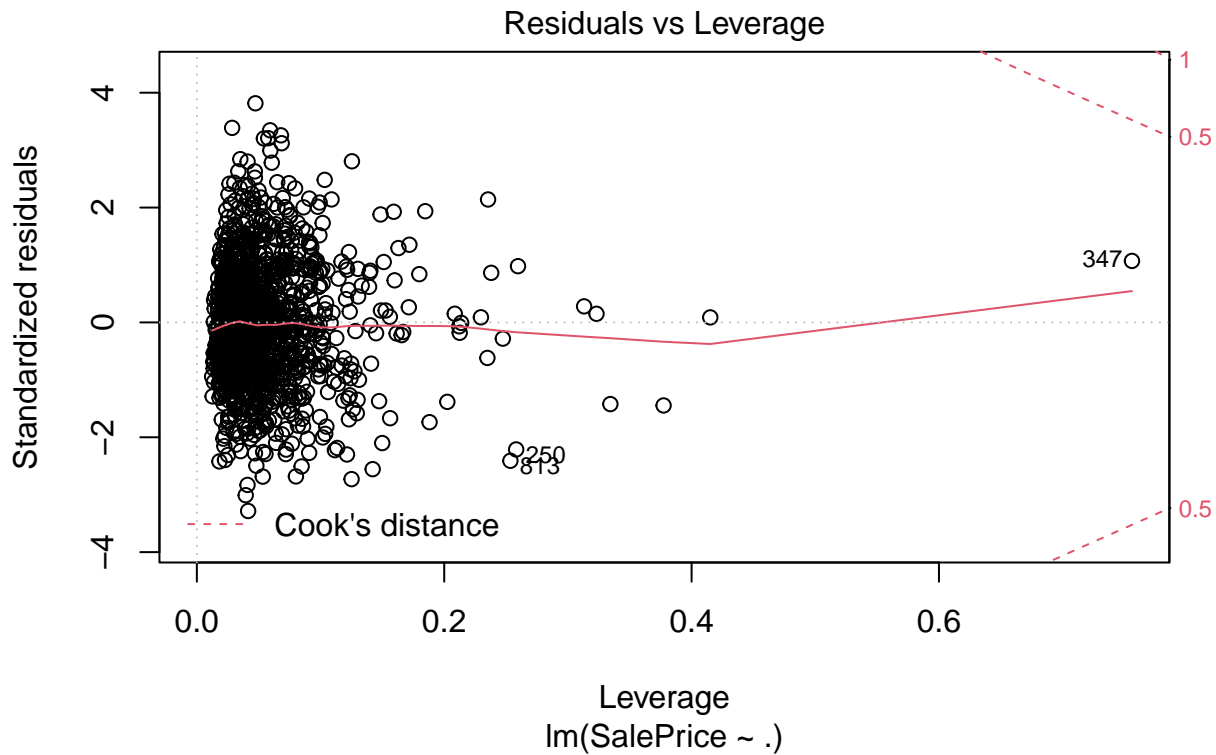
```
##          71          152          179          186          191          198          219
## -2.064671  2.246308  2.945287  2.951551  2.090556 -5.070909  2.505042
```

```
##      232      325      378      413      441      474      497
##  3.083973 -2.170938  2.462101 -2.326236  4.548357  4.131061  2.716481
##      524      582      589      609      629      633      662
## -11.425077 -2.131300 -3.582140  2.718256 -2.759432 -3.095554  2.214714
##      665      667      679      682      689      692      715
##  2.602449 -2.628006  2.009792  2.046193  4.515834  7.294422 -2.032517
##      770      775      799      804      808      886      899
##  2.882599  3.289897  2.239417  6.055002  2.216214  2.693857  6.067305
##      981      991     1025     1047     1066     1143     1170
## -2.261398  2.044413 -2.528833  5.479210  2.059553  2.410350  6.020700
##     1171     1182     1183     1212     1244     1299     1325
##  3.860196  3.557217  8.743246 -2.080197  3.356698 -16.049744 -4.509965
##     1387     1388     1424
## -2.454840 -2.271356  6.654915
```

```
outliers.index <- c(71,152,179,186,191,198,219,232,325,378,413,441,474,
                    497,524,582,589,609,629,633,662,665,667,679,682,689,
                    692,715,770,775,799,804,808,886,899,981,991,1025,1047,
                    1066,1143,1170,1171,1182,1183,1212,1244,1299,1325,1387,1388,1424)
lm.model.new <- lm(SalePrice~., data=within(new_train[-outliers.index, ], rm('Id')))
plot(lm.model.new)
```







After these remedies, we can see that the model looks better.

```
summary(lm.model.new)
```

```
##
## Call:
## lm(formula = SalePrice ~ ., data = within(new_train[-outliers.index,
##      ], rm("Id")))
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -59237 -11528   -491   10614   68623
##
## Coefficients: (3 not defined because of singularities)
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  1.094e+06  7.769e+05   1.408 0.159250
## MSSubClass   -5.921e+01  2.665e+01  -2.221 0.026490 *
## MSZoning     -1.361e+03  9.527e+02  -1.428 0.153389
## LotFrontage   3.132e+01  3.158e+01   0.992 0.321483
## LotArea       5.190e-01  6.427e-02   8.076 1.49e-15 ***
## Street       4.370e+04  8.236e+03   5.306 1.31e-07 ***
## Alley        5.649e+02  2.221e+03   0.254 0.799296
## LotShape     -3.962e+02  3.915e+02  -1.012 0.311734
## LandContour  -3.449e+02  8.095e+02  -0.426 0.670133
## Utilities    -3.858e+04  1.936e+04  -1.992 0.046561 *
## LotConfig     4.951e+01  3.246e+02   0.153 0.878790
## LandSlope     1.983e+03  2.391e+03   0.829 0.407075
## Neighborhood  3.527e+01  9.354e+01   0.377 0.706144
## Condition1    2.386e+02  6.073e+02   0.393 0.694516
## Condition2   -1.757e+03  1.997e+03  -0.880 0.379279
```


## BldgType	-2.304e+03	8.809e+02	-2.615	0.009014	**
## HouseStyle	-1.038e+02	3.906e+02	-0.266	0.790478	
## OverallQual	8.709e+03	7.128e+02	12.219	< 2e-16	***
## OverallCond	5.281e+03	6.185e+02	8.539	< 2e-16	***
## YearBuilt	2.803e+02	4.464e+01	6.281	4.56e-10	***
## YearRemodAdd	3.415e+01	3.933e+01	0.868	0.385356	
## RoofStyle	3.585e+02	6.732e+02	0.533	0.594464	
## RoofMatl	1.115e+03	1.049e+03	1.063	0.288017	
## Exterior1st	-7.655e+02	2.800e+02	-2.733	0.006350	**
## Exterior2nd	5.096e+02	2.881e+02	1.769	0.077129	.
## MasVnrType	4.163e+03	9.772e+02	4.260	2.19e-05	***
## MasVnrArea	2.827e+01	3.827e+00	7.388	2.62e-13	***
## ExterQual	-9.867e+03	1.207e+03	-8.172	6.98e-16	***
## ExterCond	4.093e+02	7.491e+02	0.546	0.584873	
## Foundation	1.492e+03	9.841e+02	1.516	0.129743	
## BsmtQual	-3.122e+03	6.118e+02	-5.103	3.82e-07	***
## BsmtCond	9.076e+02	5.750e+02	1.578	0.114731	
## BsmtExposure	-1.616e+03	5.291e+02	-3.055	0.002294	**
## BsmtFinType1	3.196e+02	3.081e+02	1.037	0.299728	
## BsmtFinSF1	2.821e+01	3.018e+00	9.346	< 2e-16	***
## BsmtFinType2	2.050e+02	6.215e+02	0.330	0.741514	
## BsmtFinSF2	2.335e+01	4.903e+00	4.763	2.11e-06	***
## BsmtUnfSF	9.203e+00	2.642e+00	3.484	0.000511	***
## TotalBsmtSF	NA	NA	NA	NA	
## Heating	-1.165e+02	1.869e+03	-0.062	0.950312	
## HeatingQC	-4.158e+02	3.632e+02	-1.145	0.252425	
## CentralAir	9.727e+02	2.626e+03	0.370	0.711144	
## Electrical	-4.973e+02	5.355e+02	-0.929	0.353206	
## X1stFlrSF	5.644e+01	3.662e+00	15.415	< 2e-16	***
## X2ndFlrSF	4.995e+01	3.022e+00	16.528	< 2e-16	***
## LowQualFinSF	4.494e-01	1.163e+01	0.039	0.969185	
## GrLivArea	NA	NA	NA	NA	
## BsmtFullBath	2.415e+03	1.470e+03	1.643	0.100517	
## BsmtHalfBath	-3.145e+03	2.314e+03	-1.359	0.174275	
## FullBath	-7.485e+02	1.598e+03	-0.468	0.639547	
## HalfBath	4.130e+02	1.517e+03	0.272	0.785460	
## BedroomAbvGr	-4.373e+03	1.005e+03	-4.353	1.45e-05	***
## KitchenAbvGr	-1.484e+04	2.957e+03	-5.018	5.94e-07	***
## KitchenQual	-6.752e+03	8.715e+02	-7.747	1.86e-14	***
## TotRmsAbvGrd	1.824e+03	7.210e+02	2.530	0.011519	*
## Functional	4.297e+03	5.642e+02	7.616	4.96e-14	***
## Fireplaces	4.397e+03	9.958e+02	4.415	1.09e-05	***
## FireplaceQu	-1.935e+03	4.746e+02	-4.077	4.84e-05	***
## GarageType	9.060e+02	3.740e+02	2.422	0.015559	*
## GarageYrBlt	-4.684e+00	1.814e+00	-2.583	0.009914	**
## GarageFinish	-8.446e+02	5.550e+02	-1.522	0.128302	
## GarageCars	5.009e+03	1.709e+03	2.931	0.003441	**
## GarageArea	1.723e+01	5.701e+00	3.022	0.002559	**
## GarageQual	-3.902e+02	7.738e+02	-0.504	0.614143	
## GarageCond	8.715e+02	8.725e+02	0.999	0.318042	
## PavedDrive	1.600e+03	1.206e+03	1.327	0.184699	
## WoodDeckSF	1.622e+01	4.530e+00	3.581	0.000354	***
## OpenPorchSF	1.200e+01	8.596e+00	1.395	0.163100	
## EnclosedPorch	5.519e+00	9.473e+00	0.583	0.560227	

```
## X3SsnPorch      1.065e+01  1.706e+01   0.625 0.532396
## ScreenPorch     3.095e+01  9.822e+00   3.151 0.001664 **
## PoolArea       -1.230e+00  2.903e+01  -0.042 0.966212
## PoolQC          NA          NA        NA        NA
## Fence           7.618e+02  5.032e+02   1.514 0.130276
## MiscFeature    -6.745e+02  1.436e+03  -0.470 0.638559
## MiscVal         1.298e-01  1.029e+00   0.126 0.899642
## MoSold         -7.257e+01  1.893e+02  -0.383 0.701497
## YrSold         -5.770e+02  3.867e+02  -1.492 0.135883
## SaleType       -5.298e+02  3.375e+02  -1.570 0.116684
## SaleCondition   3.339e+03  4.934e+02   6.767 1.96e-11 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 18430 on 1331 degrees of freedom
## Multiple R-squared:  0.9295, Adjusted R-squared:  0.9255
## F-statistic: 230.8 on 76 and 1331 DF,  p-value: < 2.2e-16
```

We can see that the most significant coefficients include:

- LotArea
- Street
- OverallQual
- OverallCond
- YearBuilt
- MasVnrType
- MasVnrArea
- ExterQual
- BsmtQual
- BsmtFinSF1
- BsmtFinSF2
- BsmtUnfSF
- X1stFlrSF
- X2ndFlrSF
- BedroomAbvGr
- KitchenAbvGr
- Functional
- Fireplaces
- FireplaceQu
- WoodDeckSF
- SaleCondition

This shows that customers value these indicators of the house more than other indicators. For example, the street where a house is located has a big impact on its price, with better prices for houses on good streets.

Then, perform prediction and save it as `.csv` file.

```
result <- data.frame(Id=test$Id)
pred <- predict.lm(lm.model.new, new_test)
result$SalePrice <- pred
write.csv(result, file = "lm.csv", quote = F, row.names = F)
```

Subset Selection

From a computational point of view, the optimal subset method is only suitable for a maximum of 30-40 features. However, our dataset has 80 features, so the optimal subset method is not suitable.

We choose backward stepwise because we want the model to perform better than using all variables. Using backward stepwise guarantees this.

We choose BIC as the criterion since I want to have as few variables as possible to be selected..

```
n <- dim(new_train)[1] - length(outliers.index)
model.bic.backward <- step(lm.model.new, direction = "backward", trace = 1, k = log(n))
```

```
## Start: AIC=28136.7
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
##   Alley + LotShape + LandContour + Utilities + 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 + FireplaceQu + GarageType + GarageYrBlt +
##   GarageFinish + GarageCars + GarageArea + GarageQual + GarageCond +
##   PavedDrive + WoodDeckSF + OpenPorchSF + EnclosedPorch + X3SsnPorch +
##   ScreenPorch + PoolArea + PoolQC + Fence + MiscFeature + MiscVal +
##   MoSold + YrSold + SaleType + SaleCondition
##
##
## Step: AIC=28136.7
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
##   Alley + LotShape + LandContour + Utilities + 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 + FireplaceQu + GarageType + GarageYrBlt +
##   GarageFinish + GarageCars + GarageArea + GarageQual + GarageCond +
##   PavedDrive + WoodDeckSF + OpenPorchSF + EnclosedPorch + X3SsnPorch +
##   ScreenPorch + PoolArea + Fence + MiscFeature + MiscVal +
##   MoSold + YrSold + SaleType + SaleCondition
##
##
## Step: AIC=28136.7
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
##   Alley + LotShape + LandContour + Utilities + 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 +
##      BsmtFullBath + BsmtHalfBath + FullBath + HalfBath + BedroomAbvGr +
##      KitchenAbvGr + KitchenQual + TotRmsAbvGrd + Functional +
##      Fireplaces + FireplaceQu + GarageType + GarageYrBlt + GarageFinish +
##      GarageCars + GarageArea + GarageQual + GarageCond + PavedDrive +
##      WoodDeckSF + OpenPorchSF + EnclosedPorch + X3SsnPorch + ScreenPorch +
##      PoolArea + Fence + MiscFeature + MiscVal + MoSold + YrSold +
##      SaleType + SaleCondition
##
##
## Step:   AIC=28136.7
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
##      Alley + LotShape + LandContour + Utilities + 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 + Heating + HeatingQC + CentralAir +
##      Electrical + X1stFlrSF + X2ndFlrSF + LowQualFinSF + BsmtFullBath +
##      BsmtHalfBath + FullBath + HalfBath + BedroomAbvGr + KitchenAbvGr +
##      KitchenQual + TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu +
##      GarageType + GarageYrBlt + GarageFinish + GarageCars + GarageArea +
##      GarageQual + GarageCond + PavedDrive + WoodDeckSF + OpenPorchSF +
##      EnclosedPorch + X3SsnPorch + ScreenPorch + PoolArea + Fence +
##      MiscFeature + MiscVal + MoSold + YrSold + SaleType + SaleCondition
##
##
##      Df      Sum of Sq      RSS      AIC
## - LowQualFinSF    1 5.0694e+05 4.5198e+11 28130
## - PoolArea        1 6.0955e+05 4.5198e+11 28130
## - Heating         1 1.3191e+06 4.5198e+11 28130
## - MiscVal         1 5.4030e+06 4.5198e+11 28130
## - LotConfig       1 7.9007e+06 4.5199e+11 28130
## - Alley           1 2.1962e+07 4.5200e+11 28130
## - HouseStyle      1 2.3981e+07 4.5200e+11 28130
## - HalfBath        1 2.5173e+07 4.5200e+11 28130
## - BsmtFinType2    1 3.6962e+07 4.5202e+11 28130
## - CentralAir      1 4.6589e+07 4.5202e+11 28130
## - Neighborhood    1 4.8295e+07 4.5203e+11 28130
## - MoSold          1 4.9912e+07 4.5203e+11 28130
## - Condition1      1 5.2399e+07 4.5203e+11 28130
## - LandContour     1 6.1642e+07 4.5204e+11 28130
## - FullBath        1 7.4516e+07 4.5205e+11 28130
## - MiscFeature     1 7.4956e+07 4.5205e+11 28130
## - GarageQual      1 8.6356e+07 4.5206e+11 28130
## - RoofStyle       1 9.6292e+07 4.5207e+11 28130
## - ExterCond       1 1.0139e+08 4.5208e+11 28130
## - EnclosedPorch   1 1.1528e+08 4.5209e+11 28130
## - X3SsnPorch      1 1.3244e+08 4.5211e+11 28130
## - LandSlope       1 2.3355e+08 4.5221e+11 28130
## - YearRemodAdd    1 2.5606e+08 4.5223e+11 28130
## - Condition2      1 2.6268e+08 4.5224e+11 28130
## - Electrical      1 2.9289e+08 4.5227e+11 28130
## - LotFrontage     1 3.3402e+08 4.5231e+11 28130

```

```

## - GarageCond      1 3.3881e+08 4.5232e+11 28130
## - LotShape        1 3.4776e+08 4.5233e+11 28130
## - BsmtFinType1    1 3.6547e+08 4.5234e+11 28131
## - RoofMatl        1 3.8365e+08 4.5236e+11 28131
## - HeatingQC       1 4.4518e+08 4.5242e+11 28131
## - PavedDrive      1 5.9807e+08 4.5258e+11 28131
## - BsmtHalfBath    1 6.2746e+08 4.5261e+11 28131
## - OpenPorchSF     1 6.6129e+08 4.5264e+11 28132
## - MSZoning         1 6.9293e+08 4.5267e+11 28132
## - YrSold           1 7.5613e+08 4.5273e+11 28132
## - Fence           1 7.7833e+08 4.5276e+11 28132
## - Foundation      1 7.8049e+08 4.5276e+11 28132
## - GarageFinish    1 7.8640e+08 4.5276e+11 28132
## - SaleType        1 8.3688e+08 4.5282e+11 28132
## - BsmtCond        1 8.4591e+08 4.5282e+11 28132
## - BsmtFullBath    1 9.1722e+08 4.5290e+11 28132
## - Exterior2nd     1 1.0626e+09 4.5304e+11 28133
## - Utilities       1 1.3476e+09 4.5333e+11 28134
## - MSSubClass      1 1.6757e+09 4.5365e+11 28135
## - GarageType      1 1.9924e+09 4.5397e+11 28136
## - TotRmsAbvGrd    1 2.1737e+09 4.5415e+11 28136
## - GarageYrBlt     1 2.2648e+09 4.5424e+11 28136
## - BldgType        1 2.3227e+09 4.5430e+11 28137
## <none>            4.5198e+11 28137
## - Exterior1st     1 2.5373e+09 4.5452e+11 28137
## - GarageCars       1 2.9165e+09 4.5489e+11 28138
## - GarageArea      1 3.1011e+09 4.5508e+11 28139
## - BsmtExposure    1 3.1696e+09 4.5515e+11 28139
## - ScreenPorch     1 3.3715e+09 4.5535e+11 28140
## - BsmtUnfSF       1 4.1212e+09 4.5610e+11 28142
## - WoodDeckSF      1 4.3557e+09 4.5633e+11 28143
## - FireplaceQu     1 5.6431e+09 4.5762e+11 28147
## - MasVnrType      1 6.1634e+09 4.5814e+11 28148
## - BedroomAbvGr    1 6.4338e+09 4.5841e+11 28149
## - Fireplaces      1 6.6205e+09 4.5860e+11 28150
## - BsmtFinSF2      1 7.7043e+09 4.5968e+11 28153
## - KitchenAbvGr    1 8.5492e+09 4.6053e+11 28156
## - BsmtQual        1 8.8435e+09 4.6082e+11 28157
## - Street          1 9.5599e+09 4.6154e+11 28159
## - YearBuilt       1 1.3395e+10 4.6537e+11 28171
## - SaleCondition    1 1.5551e+10 4.6753e+11 28177
## - MasVnrArea      1 1.8535e+10 4.7051e+11 28186
## - Functional      1 1.9694e+10 4.7167e+11 28190
## - KitchenQual     1 2.0379e+10 4.7236e+11 28192
## - LotArea         1 2.2148e+10 4.7413e+11 28197
## - ExterQual       1 2.2679e+10 4.7466e+11 28198
## - OverallCond     1 2.4761e+10 4.7674e+11 28204
## - BsmtFinSF1      1 2.9660e+10 4.8164e+11 28219
## - OverallQual     1 5.0698e+10 5.0268e+11 28279
## - X1stFlrSF       1 8.0687e+10 5.3267e+11 28361
## - X2ndFlrSF       1 9.2766e+10 5.4474e+11 28392
##
## Step:  AIC=28129.46
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +

```

```

## Alley + LotShape + LandContour + Utilities + 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 + Heating + HeatingQC + CentralAir +
## Electrical + X1stFlrSF + X2ndFlrSF + BsmtFullBath + BsmtHalfBath +
## FullBath + HalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual +
## TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu + GarageType +
## GarageYrBlt + GarageFinish + GarageCars + GarageArea + GarageQual +
## GarageCond + PavedDrive + WoodDeckSF + OpenPorchSF + EnclosedPorch +
## X3SsnPorch + ScreenPorch + PoolArea + Fence + MiscFeature +
## MiscVal + MoSold + YrSold + SaleType + SaleCondition
##
##      Df Sum of Sq      RSS      AIC
## - PoolArea      1 6.0038e+05 4.5198e+11 28122
## - Heating        1 1.3257e+06 4.5198e+11 28122
## - MiscVal        1 5.3973e+06 4.5198e+11 28122
## - LotConfig      1 7.8447e+06 4.5199e+11 28122
## - Alley          1 2.2768e+07 4.5200e+11 28122
## - HouseStyle     1 2.4992e+07 4.5200e+11 28122
## - HalfBath       1 2.5374e+07 4.5200e+11 28122
## - BsmtFinType2   1 3.6847e+07 4.5202e+11 28122
## - CentralAir     1 4.6999e+07 4.5203e+11 28122
## - Neighborhood   1 4.9640e+07 4.5203e+11 28122
## - MoSold         1 4.9971e+07 4.5203e+11 28122
## - Condition1     1 5.2328e+07 4.5203e+11 28122
## - LandContour    1 6.2868e+07 4.5204e+11 28122
## - FullBath       1 7.4142e+07 4.5205e+11 28122
## - MiscFeature    1 7.4571e+07 4.5205e+11 28122
## - GarageQual     1 8.5907e+07 4.5206e+11 28122
## - RoofStyle      1 9.6141e+07 4.5207e+11 28122
## - ExterCond      1 1.0171e+08 4.5208e+11 28122
## - EnclosedPorch  1 1.1478e+08 4.5209e+11 28123
## - X3SsnPorch     1 1.3265e+08 4.5211e+11 28123
## - LandSlope      1 2.3375e+08 4.5221e+11 28123
## - YearRemodAdd   1 2.5653e+08 4.5224e+11 28123
## - Condition2     1 2.6359e+08 4.5224e+11 28123
## - Electrical     1 2.9307e+08 4.5227e+11 28123
## - LotFrontage    1 3.3576e+08 4.5231e+11 28123
## - GarageCond     1 3.3835e+08 4.5232e+11 28123
## - LotShape       1 3.4818e+08 4.5233e+11 28123
## - BsmtFinType1   1 3.6621e+08 4.5234e+11 28123
## - RoofMatl       1 3.8352e+08 4.5236e+11 28123
## - HeatingQC      1 4.4529e+08 4.5242e+11 28124
## - PavedDrive     1 6.0261e+08 4.5258e+11 28124
## - BsmtHalfBath   1 6.2869e+08 4.5261e+11 28124
## - OpenPorchSF    1 6.6152e+08 4.5264e+11 28124
## - MSZoning       1 6.9264e+08 4.5267e+11 28124
## - YrSold         1 7.5645e+08 4.5274e+11 28125
## - Fence          1 7.8002e+08 4.5276e+11 28125
## - Foundation     1 7.8084e+08 4.5276e+11 28125
## - GarageFinish   1 7.8844e+08 4.5277e+11 28125

```

```

## - SaleType      1 8.3641e+08 4.5282e+11 28125
## - BsmtCond      1 8.4591e+08 4.5282e+11 28125
## - BsmtFullBath  1 9.1707e+08 4.5290e+11 28125
## - Exterior2nd   1 1.0624e+09 4.5304e+11 28126
## - Utilities     1 1.3473e+09 4.5333e+11 28126
## - MSSubClass    1 1.6898e+09 4.5367e+11 28128
## - GarageType    1 1.9975e+09 4.5398e+11 28128
## - TotRmsAbvGrd  1 2.2512e+09 4.5423e+11 28129
## - GarageYrBlt   1 2.2833e+09 4.5426e+11 28129
## - BldgType      1 2.3312e+09 4.5431e+11 28129
## <none>          4.5198e+11 28130
## - Exterior1st   1 2.5368e+09 4.5452e+11 28130
## - GarageCars    1 2.9165e+09 4.5490e+11 28131
## - GarageArea    1 3.1092e+09 4.5509e+11 28132
## - BsmtExposure  1 3.1703e+09 4.5515e+11 28132
## - ScreenPorch   1 3.3720e+09 4.5535e+11 28133
## - BsmtUnfSF     1 4.1263e+09 4.5610e+11 28135
## - WoodDeckSF    1 4.3585e+09 4.5634e+11 28136
## - FireplaceQu   1 5.6429e+09 4.5762e+11 28140
## - MasVnrType    1 6.1634e+09 4.5814e+11 28141
## - BedroomAbvGr  1 6.4349e+09 4.5841e+11 28142
## - Fireplaces    1 6.6216e+09 4.5860e+11 28143
## - BsmtFinSF2    1 7.7110e+09 4.5969e+11 28146
## - KitchenAbvGr  1 8.7092e+09 4.6069e+11 28149
## - BsmtQual      1 8.8496e+09 4.6083e+11 28150
## - Street        1 9.5809e+09 4.6156e+11 28152
## - YearBuilt     1 1.3538e+10 4.6552e+11 28164
## - SaleCondition 1 1.5562e+10 4.6754e+11 28170
## - MasVnrArea    1 1.8548e+10 4.7053e+11 28179
## - Functional    1 1.9722e+10 4.7170e+11 28182
## - KitchenQual   1 2.0380e+10 4.7236e+11 28184
## - LotArea       1 2.2165e+10 4.7414e+11 28190
## - ExterQual     1 2.2727e+10 4.7471e+11 28191
## - OverallCond   1 2.4811e+10 4.7679e+11 28198
## - BsmtFinSF1    1 2.9689e+10 4.8167e+11 28212
## - OverallQual   1 5.0704e+10 5.0268e+11 28272
## - X1stFlrSF     1 8.1339e+10 5.3332e+11 28355
## - X2ndFlrSF     1 9.3994e+10 5.4597e+11 28388
##
## Step: AIC=28122.21
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
## Alley + LotShape + LandContour + Utilities + 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 + Heating + HeatingQC + CentralAir +
## Electrical + X1stFlrSF + X2ndFlrSF + BsmtFullBath + BsmtHalfBath +
## FullBath + HalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual +
## TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu + GarageType +
## GarageYrBlt + GarageFinish + GarageCars + GarageArea + GarageQual +
## GarageCond + PavedDrive + WoodDeckSF + OpenPorchSF + EnclosedPorch +
## X3SsnPorch + ScreenPorch + Fence + MiscFeature + MiscVal +

```

```

##      MoSold + YrSold + SaleType + SaleCondition
##
##      Df  Sum of Sq      RSS    AIC
## - Heating      1 1.3134e+06 4.5198e+11 28115
## - MiscVal      1 5.4012e+06 4.5198e+11 28115
## - LotConfig    1 7.7681e+06 4.5199e+11 28115
## - Alley        1 2.2769e+07 4.5200e+11 28115
## - HouseStyle   1 2.4879e+07 4.5200e+11 28115
## - HalfBath     1 2.5069e+07 4.5200e+11 28115
## - BsmtFinType2 1 3.7117e+07 4.5202e+11 28115
## - CentralAir   1 4.7173e+07 4.5203e+11 28115
## - MoSold       1 4.9470e+07 4.5203e+11 28115
## - Neighborhood 1 4.9574e+07 4.5203e+11 28115
## - Condition1   1 5.2374e+07 4.5203e+11 28115
## - LandContour  1 6.2883e+07 4.5204e+11 28115
## - FullBath     1 7.4189e+07 4.5205e+11 28115
## - MiscFeature  1 7.4534e+07 4.5205e+11 28115
## - GarageQual   1 8.5929e+07 4.5207e+11 28115
## - RoofStyle    1 9.5639e+07 4.5207e+11 28115
## - ExterCond    1 1.0159e+08 4.5208e+11 28115
## - EnclosedPorch 1 1.1495e+08 4.5209e+11 28115
## - X3SsnPorch   1 1.3273e+08 4.5211e+11 28115
## - LandSlope    1 2.3379e+08 4.5221e+11 28116
## - YearRemodAdd 1 2.5594e+08 4.5224e+11 28116
## - Condition2   1 2.6345e+08 4.5224e+11 28116
## - Electrical   1 2.9294e+08 4.5227e+11 28116
## - LotFrontage  1 3.3571e+08 4.5231e+11 28116
## - GarageCond   1 3.3830e+08 4.5232e+11 28116
## - LotShape     1 3.4870e+08 4.5233e+11 28116
## - BsmtFinType1 1 3.6701e+08 4.5235e+11 28116
## - RoofMatl     1 3.8351e+08 4.5236e+11 28116
## - HeatingQC    1 4.4471e+08 4.5242e+11 28116
## - PavedDrive   1 6.0261e+08 4.5258e+11 28117
## - BsmtHalfBath 1 6.2830e+08 4.5261e+11 28117
## - OpenPorchSF  1 6.6198e+08 4.5264e+11 28117
## - MSZoning     1 6.9271e+08 4.5267e+11 28117
## - YrSold       1 7.5653e+08 4.5274e+11 28117
## - Foundation   1 7.8190e+08 4.5276e+11 28117
## - Fence        1 7.8792e+08 4.5277e+11 28117
## - GarageFinish 1 7.8871e+08 4.5277e+11 28117
## - SaleType     1 8.3621e+08 4.5282e+11 28118
## - BsmtCond     1 8.4562e+08 4.5282e+11 28118
## - BsmtFullBath 1 9.1673e+08 4.5290e+11 28118
## - Exterior2nd  1 1.0641e+09 4.5304e+11 28118
## - Utilities    1 1.3473e+09 4.5333e+11 28119
## - MSSubClass   1 1.6895e+09 4.5367e+11 28120
## - GarageType   1 1.9979e+09 4.5398e+11 28121
## - TotRmsAbvGrd 1 2.2633e+09 4.5424e+11 28122
## - GarageYrBlt  1 2.2827e+09 4.5426e+11 28122
## - BldgType     1 2.3308e+09 4.5431e+11 28122
## - <none>              4.5198e+11 28122
## - Exterior1st  1 2.5373e+09 4.5452e+11 28123
## - GarageCars   1 2.9164e+09 4.5490e+11 28124
## - GarageArea   1 3.1108e+09 4.5509e+11 28125

```



```

## - BsmtExposure      1 3.1721e+09 4.5515e+11 28125
## - ScreenPorch       1 3.3730e+09 4.5535e+11 28125
## - BsmtUnfSF         1 4.1315e+09 4.5611e+11 28128
## - WoodDeckSF        1 4.3593e+09 4.5634e+11 28128
## - FireplaceQu       1 5.6544e+09 4.5763e+11 28132
## - MasVnrType        1 6.1716e+09 4.5815e+11 28134
## - BedroomAbvGr      1 6.4511e+09 4.5843e+11 28135
## - Fireplaces        1 6.6222e+09 4.5860e+11 28135
## - BsmtFinSF2        1 7.7112e+09 4.5969e+11 28139
## - KitchenAbvGr      1 8.7211e+09 4.6070e+11 28142
## - BsmtQual          1 8.8537e+09 4.6083e+11 28142
## - Street            1 9.5814e+09 4.6156e+11 28144
## - YearBuilt         1 1.3540e+10 4.6552e+11 28156
## - SaleCondition     1 1.5561e+10 4.6754e+11 28163
## - MasVnrArea        1 1.8558e+10 4.7054e+11 28172
## - Functional        1 1.9723e+10 4.7170e+11 28175
## - KitchenQual       1 2.0383e+10 4.7236e+11 28177
## - LotArea           1 2.2167e+10 4.7415e+11 28182
## - ExterQual         1 2.2740e+10 4.7472e+11 28184
## - OverallCond       1 2.4829e+10 4.7681e+11 28190
## - BsmtFinSF1        1 2.9717e+10 4.8170e+11 28205
## - OverallQual       1 5.0711e+10 5.0269e+11 28265
## - X1stFlrSF         1 8.1350e+10 5.3333e+11 28348
## - X2ndFlrSF         1 9.3995e+10 5.4597e+11 28381
##
## Step:  AIC=28114.96
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
##   Alley + LotShape + LandContour + Utilities + 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 + HeatingQC + CentralAir + Electrical +
##   X1stFlrSF + X2ndFlrSF + BsmtFullBath + BsmtHalfBath + FullBath +
##   HalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +
##   Functional + Fireplaces + FireplaceQu + GarageType + GarageYrBlt +
##   GarageFinish + GarageCars + GarageArea + GarageQual + GarageCond +
##   PavedDrive + WoodDeckSF + OpenPorchSF + EnclosedPorch + X3SsnPorch +
##   ScreenPorch + Fence + MiscFeature + MiscVal + MoSold + YrSold +
##   SaleType + SaleCondition
##
##           Df Sum of Sq      RSS   AIC
## - MiscVal      1 5.3744e+06 4.5199e+11 28108
## - LotConfig    1 7.7533e+06 4.5199e+11 28108
## - Alley        1 2.2575e+07 4.5200e+11 28108
## - HouseStyle   1 2.4383e+07 4.5200e+11 28108
## - HalfBath     1 2.4728e+07 4.5201e+11 28108
## - BsmtFinType2 1 3.7318e+07 4.5202e+11 28108
## - MoSold       1 4.9275e+07 4.5203e+11 28108
## - Neighborhood 1 4.9452e+07 4.5203e+11 28108
## - Condition1   1 5.2468e+07 4.5203e+11 28108
## - CentralAir   1 5.8110e+07 4.5204e+11 28108
## - LandContour  1 6.4512e+07 4.5205e+11 28108

```

## - MiscFeature	1	7.4211e+07	4.5205e+11	28108
## - FullBath	1	7.5844e+07	4.5206e+11	28108
## - GarageQual	1	8.5387e+07	4.5207e+11	28108
## - RoofStyle	1	9.6625e+07	4.5208e+11	28108
## - ExterCond	1	1.0125e+08	4.5208e+11	28108
## - EnclosedPorch	1	1.1487e+08	4.5210e+11	28108
## - X3SsnPorch	1	1.3311e+08	4.5211e+11	28108
## - LandSlope	1	2.3418e+08	4.5221e+11	28108
## - YearRemodAdd	1	2.5745e+08	4.5224e+11	28108
## - Condition2	1	2.6278e+08	4.5224e+11	28108
## - Electrical	1	2.9164e+08	4.5227e+11	28109
## - LotFrontage	1	3.3490e+08	4.5232e+11	28109
## - GarageCond	1	3.3700e+08	4.5232e+11	28109
## - LotShape	1	3.4968e+08	4.5233e+11	28109
## - BsmtFinType1	1	3.6748e+08	4.5235e+11	28109
## - RoofMatl	1	3.8328e+08	4.5236e+11	28109
## - HeatingQC	1	4.4404e+08	4.5242e+11	28109
## - PavedDrive	1	6.0296e+08	4.5258e+11	28110
## - BsmtHalfBath	1	6.2973e+08	4.5261e+11	28110
## - OpenPorchSF	1	6.6227e+08	4.5264e+11	28110
## - MSZoning	1	6.9700e+08	4.5268e+11	28110
## - YrSold	1	7.5774e+08	4.5274e+11	28110
## - Foundation	1	7.8059e+08	4.5276e+11	28110
## - Fence	1	7.8854e+08	4.5277e+11	28110
## - GarageFinish	1	7.9036e+08	4.5277e+11	28110
## - SaleType	1	8.3617e+08	4.5282e+11	28110
## - BsmtCond	1	8.4787e+08	4.5283e+11	28110
## - BsmtFullBath	1	9.1724e+08	4.5290e+11	28111
## - Exterior2nd	1	1.0632e+09	4.5304e+11	28111
## - Utilities	1	1.3464e+09	4.5333e+11	28112
## - MSSubClass	1	1.6900e+09	4.5367e+11	28113
## - GarageType	1	1.9976e+09	4.5398e+11	28114
## - TotRmsAbvGrd	1	2.2625e+09	4.5424e+11	28115
## - GarageYrBlt	1	2.2814e+09	4.5426e+11	28115
## - BldgType	1	2.3307e+09	4.5431e+11	28115
## <none>			4.5198e+11	28115
## - Exterior1st	1	2.5385e+09	4.5452e+11	28116
## - GarageCars	1	2.9197e+09	4.5490e+11	28117
## - GarageArea	1	3.1201e+09	4.5510e+11	28117
## - BsmtExposure	1	3.1722e+09	4.5515e+11	28118
## - ScreenPorch	1	3.3721e+09	4.5535e+11	28118
## - BsmtUnfSF	1	4.1771e+09	4.5616e+11	28121
## - WoodDeckSF	1	4.3602e+09	4.5634e+11	28121
## - FireplaceQu	1	5.6542e+09	4.5763e+11	28125
## - MasVnrType	1	6.1776e+09	4.5816e+11	28127
## - BedroomAbvGr	1	6.4537e+09	4.5843e+11	28128
## - Fireplaces	1	6.6238e+09	4.5860e+11	28128
## - BsmtFinSF2	1	7.7306e+09	4.5971e+11	28132
## - KitchenAbvGr	1	8.7200e+09	4.6070e+11	28135
## - BsmtQual	1	8.8646e+09	4.6085e+11	28135
## - Street	1	9.5848e+09	4.6157e+11	28137
## - YearBuilt	1	1.3557e+10	4.6554e+11	28149
## - SaleCondition	1	1.5585e+10	4.6757e+11	28155
## - MasVnrArea	1	1.8557e+10	4.7054e+11	28164

```

## - Functional      1 1.9722e+10 4.7170e+11 28168
## - KitchenQual     1 2.0382e+10 4.7236e+11 28170
## - LotArea         1 2.2264e+10 4.7424e+11 28175
## - ExterQual       1 2.2762e+10 4.7474e+11 28177
## - OverallCond     1 2.4910e+10 4.7689e+11 28183
## - BsmtFinSF1      1 2.9823e+10 4.8180e+11 28198
## - OverallQual     1 5.0736e+10 5.0272e+11 28258
## - X1stFlrSF       1 8.1383e+10 5.3336e+11 28341
## - X2ndFlrSF       1 9.4044e+10 5.4603e+11 28374
##
## Step:  AIC=28107.73
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
##   Alley + LotShape + LandContour + Utilities + 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 + HeatingQC + CentralAir + Electrical +
##   X1stFlrSF + X2ndFlrSF + BsmtFullBath + BsmtHalfBath + FullBath +
##   HalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +
##   Functional + Fireplaces + FireplaceQu + GarageType + GarageYrBlt +
##   GarageFinish + GarageCars + GarageArea + GarageQual + GarageCond +
##   PavedDrive + WoodDeckSF + OpenPorchSF + EnclosedPorch + X3SsnPorch +
##   ScreenPorch + Fence + MiscFeature + MoSold + YrSold + SaleType +
##   SaleCondition
##
##           Df  Sum of Sq      RSS   AIC
## - LotConfig      1 7.6203e+06 4.5199e+11 28100
## - Alley          1 2.2377e+07 4.5201e+11 28100
## - HalfBath       1 2.4747e+07 4.5201e+11 28101
## - HouseStyle     1 2.5719e+07 4.5201e+11 28101
## - BsmtFinType2   1 3.7082e+07 4.5202e+11 28101
## - MoSold         1 4.9284e+07 4.5204e+11 28101
## - Neighborhood   1 4.9322e+07 4.5204e+11 28101
## - Condition1     1 5.2456e+07 4.5204e+11 28101
## - CentralAir     1 5.8198e+07 4.5204e+11 28101
## - LandContour    1 6.3665e+07 4.5205e+11 28101
## - MiscFeature    1 6.9740e+07 4.5206e+11 28101
## - FullBath       1 7.6703e+07 4.5206e+11 28101
## - GarageQual     1 8.4951e+07 4.5207e+11 28101
## - ExterCond      1 9.8443e+07 4.5208e+11 28101
## - RoofStyle      1 1.0366e+08 4.5209e+11 28101
## - EnclosedPorch  1 1.1571e+08 4.5210e+11 28101
## - X3SsnPorch     1 1.3277e+08 4.5212e+11 28101
## - LandSlope      1 2.3362e+08 4.5222e+11 28101
## - Condition2     1 2.5747e+08 4.5224e+11 28101
## - YearRemodAdd   1 2.5850e+08 4.5224e+11 28101
## - Electrical     1 2.9013e+08 4.5228e+11 28101
## - LotFrontage    1 3.3493e+08 4.5232e+11 28102
## - GarageCond     1 3.3707e+08 4.5232e+11 28102
## - LotShape       1 3.5390e+08 4.5234e+11 28102
## - BsmtFinType1   1 3.6362e+08 4.5235e+11 28102
## - RoofMatl       1 3.8438e+08 4.5237e+11 28102

```

```

## - HeatingQC      1 4.4355e+08 4.5243e+11 28102
## - PavedDrive     1 5.9906e+08 4.5259e+11 28102
## - BsmtHalfBath   1 6.3459e+08 4.5262e+11 28102
## - OpenPorchSF    1 6.5976e+08 4.5265e+11 28102
## - MSZoning       1 6.9894e+08 4.5268e+11 28103
## - YrSold         1 7.5908e+08 4.5275e+11 28103
## - Foundation     1 7.8397e+08 4.5277e+11 28103
## - Fence          1 7.8819e+08 4.5277e+11 28103
## - GarageFinish   1 7.8952e+08 4.5278e+11 28103
## - SaleType       1 8.3503e+08 4.5282e+11 28103
## - BsmtCond       1 8.4824e+08 4.5283e+11 28103
## - BsmtFullBath   1 9.1221e+08 4.5290e+11 28103
## - Exterior2nd    1 1.0654e+09 4.5305e+11 28104
## - Utilities      1 1.3438e+09 4.5333e+11 28105
## - MSSubClass     1 1.6910e+09 4.5368e+11 28106
## - GarageType     1 1.9930e+09 4.5398e+11 28107
## - TotRmsAbvGrd   1 2.2722e+09 4.5426e+11 28108
## - GarageYrBlt    1 2.2800e+09 4.5427e+11 28108
## - BldgType       1 2.3280e+09 4.5431e+11 28108
## <none>           4.5199e+11 28108
## - Exterior1st    1 2.5416e+09 4.5453e+11 28108
## - GarageCars     1 2.9144e+09 4.5490e+11 28110
## - GarageArea     1 3.1256e+09 4.5511e+11 28110
## - BsmtExposure   1 3.1811e+09 4.5517e+11 28110
## - ScreenPorch    1 3.3729e+09 4.5536e+11 28111
## - BsmtUnfSF      1 4.1907e+09 4.5618e+11 28114
## - WoodDeckSF     1 4.3553e+09 4.5634e+11 28114
## - FireplaceQu    1 5.6488e+09 4.5763e+11 28118
## - MasVnrType     1 6.1828e+09 4.5817e+11 28120
## - BedroomAbvGr   1 6.4683e+09 4.5845e+11 28120
## - Fireplaces     1 6.6274e+09 4.5861e+11 28121
## - BsmtFinSF2     1 7.7343e+09 4.5972e+11 28124
## - KitchenAbvGr   1 8.7297e+09 4.6072e+11 28127
## - BsmtQual       1 8.8779e+09 4.6086e+11 28128
## - Street         1 9.5840e+09 4.6157e+11 28130
## - YearBuilt      1 1.3567e+10 4.6555e+11 28142
## - SaleCondition  1 1.5583e+10 4.6757e+11 28148
## - MasVnrArea     1 1.8553e+10 4.7054e+11 28157
## - Functional     1 1.9717e+10 4.7170e+11 28161
## - KitchenQual    1 2.0377e+10 4.7236e+11 28163
## - LotArea        1 2.2300e+10 4.7429e+11 28168
## - ExterQual      1 2.2760e+10 4.7475e+11 28170
## - OverallCond    1 2.4981e+10 4.7697e+11 28176
## - BsmtFinSF1     1 2.9878e+10 4.8186e+11 28191
## - OverallQual    1 5.0738e+10 5.0272e+11 28250
## - X1stFlrSF      1 8.1488e+10 5.3347e+11 28334
## - X2ndFlrSF      1 9.4117e+10 5.4610e+11 28367
##
## Step:  AIC=28100.5
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
## Alley + LotShape + LandContour + Utilities + 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 + HeatingQC + CentralAir + Electrical +
##      X1stFlrSF + X2ndFlrSF + BsmtFullBath + BsmtHalfBath + FullBath +
##      HalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +
##      Functional + Fireplaces + FireplaceQu + GarageType + GarageYrBlt +
##      GarageFinish + GarageCars + GarageArea + GarageQual + GarageCond +
##      PavedDrive + WoodDeckSF + OpenPorchSF + EnclosedPorch + X3SsnPorch +
##      ScreenPorch + Fence + MiscFeature + MoSold + YrSold + SaleType +
##      SaleCondition
##
##      Df      Sum of Sq      RSS      AIC
## - Alley      1 2.1313e+07 4.5201e+11 28093
## - HalfBath    1 2.4912e+07 4.5202e+11 28093
## - HouseStyle  1 2.5569e+07 4.5202e+11 28093
## - BsmtFinType2 1 3.6270e+07 4.5203e+11 28093
## - MoSold      1 4.8302e+07 4.5204e+11 28093
## - Neighborhood 1 4.9058e+07 4.5204e+11 28093
## - Condition1  1 5.4906e+07 4.5205e+11 28093
## - CentralAir  1 5.9073e+07 4.5205e+11 28093
## - LandContour 1 6.6003e+07 4.5206e+11 28094
## - MiscFeature 1 6.9399e+07 4.5206e+11 28094
## - FullBath    1 7.4907e+07 4.5207e+11 28094
## - GarageQual  1 8.3903e+07 4.5208e+11 28094
## - ExterCond   1 1.0004e+08 4.5209e+11 28094
## - RoofStyle   1 1.0355e+08 4.5210e+11 28094
## - EnclosedPorch 1 1.1252e+08 4.5211e+11 28094
## - X3SsnPorch  1 1.3131e+08 4.5212e+11 28094
## - LandSlope   1 2.3622e+08 4.5223e+11 28094
## - Condition2  1 2.5414e+08 4.5225e+11 28094
## - YearRemodAdd 1 2.5659e+08 4.5225e+11 28094
## - Electrical  1 2.9279e+08 4.5229e+11 28094
## - LotFrontage 1 3.2741e+08 4.5232e+11 28094
## - GarageCond  1 3.3865e+08 4.5233e+11 28094
## - LotShape    1 3.4787e+08 4.5234e+11 28094
## - BsmtFinType1 1 3.6611e+08 4.5236e+11 28094
## - RoofMatl    1 3.8182e+08 4.5238e+11 28094
## - HeatingQC   1 4.4360e+08 4.5244e+11 28095
## - PavedDrive  1 5.9354e+08 4.5259e+11 28095
## - BsmtHalfBath 1 6.3358e+08 4.5263e+11 28095
## - OpenPorchSF 1 6.5406e+08 4.5265e+11 28095
## - MSZoning     1 7.0700e+08 4.5270e+11 28096
## - YrSold       1 7.6007e+08 4.5275e+11 28096
## - Foundation  1 7.7976e+08 4.5277e+11 28096
## - GarageFinish 1 7.8973e+08 4.5278e+11 28096
## - Fence        1 7.9785e+08 4.5279e+11 28096
## - SaleType     1 8.3321e+08 4.5283e+11 28096
## - BsmtCond     1 8.5528e+08 4.5285e+11 28096
## - BsmtFullBath 1 9.1153e+08 4.5291e+11 28096
## - Exterior2nd  1 1.0642e+09 4.5306e+11 28097
## - Utilities    1 1.3490e+09 4.5334e+11 28097
## - MSSubClass   1 1.6877e+09 4.5368e+11 28098
## - GarageType   1 1.9874e+09 4.5398e+11 28099
## - GarageYrBlt  1 2.2855e+09 4.5428e+11 28100

```

```

## - TotRmsAbvGrd    1 2.2927e+09 4.5429e+11 28100
## - BldgType         1 2.3308e+09 4.5432e+11 28100
## <none>              4.5199e+11 28100
## - Exterior1st      1 2.5367e+09 4.5453e+11 28101
## - GarageCars       1 2.9071e+09 4.5490e+11 28102
## - GarageArea       1 3.1344e+09 4.5513e+11 28103
## - BsmtExposure     1 3.1788e+09 4.5517e+11 28103
## - ScreenPorch      1 3.3766e+09 4.5537e+11 28104
## - BsmtUnfSF        1 4.1906e+09 4.5618e+11 28106
## - WoodDeckSF       1 4.3561e+09 4.5635e+11 28107
## - FireplaceQu      1 5.6605e+09 4.5765e+11 28111
## - MasVnrType       1 6.1753e+09 4.5817e+11 28112
## - BedroomAbvGr     1 6.4810e+09 4.5847e+11 28113
## - Fireplaces       1 6.6264e+09 4.5862e+11 28114
## - BsmtFinSF2       1 7.7340e+09 4.5973e+11 28117
## - KitchenAbvGr     1 8.7540e+09 4.6075e+11 28120
## - BsmtQual         1 8.8703e+09 4.6086e+11 28121
## - Street           1 9.6077e+09 4.6160e+11 28123
## - YearBuilt        1 1.3590e+10 4.6558e+11 28135
## - SaleCondition    1 1.5643e+10 4.6764e+11 28141
## - MasVnrArea       1 1.8546e+10 4.7054e+11 28150
## - Functional       1 1.9710e+10 4.7170e+11 28153
## - KitchenQual      1 2.0423e+10 4.7242e+11 28156
## - LotArea          1 2.2323e+10 4.7432e+11 28161
## - ExterQual        1 2.2801e+10 4.7479e+11 28162
## - OverallCond      1 2.4981e+10 4.7697e+11 28169
## - BsmtFinSF1       1 2.9917e+10 4.8191e+11 28184
## - OverallQual      1 5.0733e+10 5.0273e+11 28243
## - X1stFlrSF        1 8.1482e+10 5.3348e+11 28327
## - X2ndFlrSF        1 9.4214e+10 5.4621e+11 28360
##
## Step:  AIC=28093.32
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
##   LotShape + LandContour + Utilities + 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 +
##   HeatingQC + CentralAir + Electrical + X1stFlrSF + X2ndFlrSF +
##   BsmtFullBath + BsmtHalfBath + FullBath + HalfBath + BedroomAbvGr +
##   KitchenAbvGr + KitchenQual + TotRmsAbvGrd + Functional +
##   Fireplaces + FireplaceQu + GarageType + GarageYrBlt + GarageFinish +
##   GarageCars + GarageArea + GarageQual + GarageCond + PavedDrive +
##   WoodDeckSF + OpenPorchSF + EnclosedPorch + X3SsnPorch + ScreenPorch +
##   Fence + MiscFeature + MoSold + YrSold + SaleType + SaleCondition
##
##           Df Sum of Sq      RSS   AIC
## - HalfBath    1 2.5018e+07 4.5204e+11 28086
## - HouseStyle  1 2.6657e+07 4.5204e+11 28086
## - BsmtFinType2 1 3.6348e+07 4.5205e+11 28086
## - Neighborhood 1 4.5643e+07 4.5206e+11 28086
## - MoSold      1 4.9393e+07 4.5206e+11 28086
## - Condition1  1 5.9166e+07 4.5207e+11 28086

```

## - CentralAir	1	6.1478e+07	4.5208e+11	28086
## - LandContour	1	6.5095e+07	4.5208e+11	28086
## - MiscFeature	1	7.2823e+07	4.5209e+11	28086
## - FullBath	1	7.4975e+07	4.5209e+11	28086
## - GarageQual	1	8.4998e+07	4.5210e+11	28086
## - ExterCond	1	9.8733e+07	4.5211e+11	28086
## - RoofStyle	1	1.0554e+08	4.5212e+11	28086
## - EnclosedPorch	1	1.1587e+08	4.5213e+11	28086
## - X3SsnPorch	1	1.3099e+08	4.5215e+11	28086
## - LandSlope	1	2.4044e+08	4.5226e+11	28087
## - Condition2	1	2.5155e+08	4.5227e+11	28087
## - YearRemodAdd	1	2.5706e+08	4.5227e+11	28087
## - Electrical	1	2.9182e+08	4.5231e+11	28087
## - LotFrontage	1	3.2062e+08	4.5234e+11	28087
## - GarageCond	1	3.4877e+08	4.5236e+11	28087
## - LotShape	1	3.5194e+08	4.5237e+11	28087
## - BsmtFinType1	1	3.6456e+08	4.5238e+11	28087
## - RoofMatl	1	3.8252e+08	4.5240e+11	28087
## - HeatingQC	1	4.3778e+08	4.5245e+11	28087
## - PavedDrive	1	5.9251e+08	4.5261e+11	28088
## - BsmtHalfBath	1	6.4026e+08	4.5266e+11	28088
## - OpenPorchSF	1	6.4956e+08	4.5266e+11	28088
## - YrSold	1	7.5950e+08	4.5277e+11	28088
## - Foundation	1	7.9059e+08	4.5281e+11	28088
## - GarageFinish	1	7.9157e+08	4.5281e+11	28088
## - Fence	1	7.9319e+08	4.5281e+11	28088
## - SaleType	1	8.2455e+08	4.5284e+11	28089
## - BsmtCond	1	8.5843e+08	4.5287e+11	28089
## - MSZoning	1	9.0123e+08	4.5292e+11	28089
## - BsmtFullBath	1	9.1140e+08	4.5293e+11	28089
## - Exterior2nd	1	1.0625e+09	4.5308e+11	28089
## - Utilities	1	1.3446e+09	4.5336e+11	28090
## - MSSubClass	1	1.6780e+09	4.5369e+11	28091
## - GarageType	1	2.0205e+09	4.5404e+11	28092
## - TotRmsAbvGrd	1	2.2721e+09	4.5429e+11	28093
## - GarageYrBlt	1	2.2723e+09	4.5429e+11	28093
## - BldgType	1	2.3196e+09	4.5433e+11	28093
## <none>			4.5201e+11	28093
## - Exterior1st	1	2.5353e+09	4.5455e+11	28094
## - GarageCars	1	2.9046e+09	4.5492e+11	28095
## - GarageArea	1	3.1168e+09	4.5513e+11	28096
## - BsmtExposure	1	3.1743e+09	4.5519e+11	28096
## - ScreenPorch	1	3.3759e+09	4.5539e+11	28096
## - BsmtUnfSF	1	4.1963e+09	4.5621e+11	28099
## - WoodDeckSF	1	4.3385e+09	4.5635e+11	28100
## - FireplaceQu	1	5.6718e+09	4.5769e+11	28104
## - MasVnrType	1	6.1896e+09	4.5820e+11	28105
## - BedroomAbvGr	1	6.4739e+09	4.5849e+11	28106
## - Fireplaces	1	6.6208e+09	4.5864e+11	28106
## - BsmtFinSF2	1	7.7379e+09	4.5975e+11	28110
## - KitchenAbvGr	1	8.7459e+09	4.6076e+11	28113
## - BsmtQual	1	8.8514e+09	4.6087e+11	28113
## - Street	1	9.6249e+09	4.6164e+11	28116
## - YearBuilt	1	1.3692e+10	4.6571e+11	28128

```

## - SaleCondition 1 1.5631e+10 4.6765e+11 28134
## - MasVnrArea 1 1.8659e+10 4.7067e+11 28143
## - Functional 1 1.9689e+10 4.7170e+11 28146
## - KitchenQual 1 2.0403e+10 4.7242e+11 28148
## - LotArea 1 2.2311e+10 4.7433e+11 28154
## - ExterQual 1 2.2831e+10 4.7485e+11 28155
## - OverallCond 1 2.5012e+10 4.7703e+11 28162
## - BsmtFinSF1 1 2.9922e+10 4.8194e+11 28176
## - OverallQual 1 5.0871e+10 5.0289e+11 28236
## - X1stFlrSF 1 8.1911e+10 5.3393e+11 28321
## - X2ndFlrSF 1 9.4560e+10 5.4657e+11 28354
##
## Step: AIC=28086.15
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
## LotShape + LandContour + Utilities + 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 +
## HeatingQC + CentralAir + Electrical + X1stFlrSF + X2ndFlrSF +
## BsmtFullBath + BsmtHalfBath + FullBath + BedroomAbvGr + KitchenAbvGr +
## KitchenQual + TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu +
## GarageType + GarageYrBlt + GarageFinish + GarageCars + GarageArea +
## GarageQual + GarageCond + PavedDrive + WoodDeckSF + OpenPorchSF +
## EnclosedPorch + X3SsnPorch + ScreenPorch + Fence + MiscFeature +
## MoSold + YrSold + SaleType + SaleCondition
##
## Df Sum of Sq RSS AIC
## - HouseStyle 1 2.3534e+07 4.5206e+11 28079
## - BsmtFinType2 1 4.0839e+07 4.5208e+11 28079
## - Neighborhood 1 4.7436e+07 4.5209e+11 28079
## - MoSold 1 5.3197e+07 4.5209e+11 28079
## - Condition1 1 6.0028e+07 4.5210e+11 28079
## - CentralAir 1 6.3169e+07 4.5210e+11 28079
## - LandContour 1 6.3834e+07 4.5210e+11 28079
## - MiscFeature 1 7.4116e+07 4.5211e+11 28079
## - GarageQual 1 8.8580e+07 4.5213e+11 28079
## - ExterCond 1 9.9095e+07 4.5214e+11 28079
## - RoofStyle 1 1.0388e+08 4.5214e+11 28079
## - EnclosedPorch 1 1.1419e+08 4.5215e+11 28079
## - FullBath 1 1.2945e+08 4.5217e+11 28079
## - X3SsnPorch 1 1.3404e+08 4.5217e+11 28079
## - LandSlope 1 2.4529e+08 4.5229e+11 28080
## - Condition2 1 2.4713e+08 4.5229e+11 28080
## - YearRemodAdd 1 2.6099e+08 4.5230e+11 28080
## - Electrical 1 2.8619e+08 4.5233e+11 28080
## - LotFrontage 1 3.1493e+08 4.5235e+11 28080
## - GarageCond 1 3.5313e+08 4.5239e+11 28080
## - LotShape 1 3.5761e+08 4.5240e+11 28080
## - BsmtFinType1 1 3.6669e+08 4.5241e+11 28080
## - RoofMatl 1 3.9298e+08 4.5243e+11 28080
## - HeatingQC 1 4.2519e+08 4.5247e+11 28080
## - PavedDrive 1 5.8865e+08 4.5263e+11 28081

```



```

## - BsmtHalfBath      1 6.4420e+08 4.5268e+11 28081
## - OpenPorchSF       1 6.6868e+08 4.5271e+11 28081
## - YrSold            1 7.5950e+08 4.5280e+11 28081
## - Foundation        1 7.6993e+08 4.5281e+11 28081
## - GarageFinish      1 7.9810e+08 4.5284e+11 28081
## - Fence             1 8.0138e+08 4.5284e+11 28081
## - SaleType          1 8.2119e+08 4.5286e+11 28082
## - BsmtCond          1 8.8255e+08 4.5292e+11 28082
## - BsmtFullBath      1 9.0015e+08 4.5294e+11 28082
## - MSZoning          1 9.3413e+08 4.5297e+11 28082
## - Exterior2nd       1 1.0650e+09 4.5310e+11 28082
## - Utilities         1 1.3634e+09 4.5340e+11 28083
## - MSSubClass        1 1.6914e+09 4.5373e+11 28084
## - GarageType        1 2.0016e+09 4.5404e+11 28085
## - TotRmsAbvGrd      1 2.2864e+09 4.5433e+11 28086
## - GarageYrBlt       1 2.2929e+09 4.5433e+11 28086
## - BldgType          1 2.3128e+09 4.5435e+11 28086
## <none>              4.5204e+11 28086
## - Exterior1st       1 2.5515e+09 4.5459e+11 28087
## - GarageCars        1 2.9734e+09 4.5501e+11 28088
## - GarageArea        1 3.0926e+09 4.5513e+11 28088
## - BsmtExposure      1 3.1501e+09 4.5519e+11 28089
## - ScreenPorch       1 3.4052e+09 4.5545e+11 28090
## - BsmtUnfSF         1 4.1765e+09 4.5622e+11 28092
## - WoodDeckSF        1 4.3501e+09 4.5639e+11 28092
## - FireplaceQu       1 5.6694e+09 4.5771e+11 28096
## - MasVnrType        1 6.1646e+09 4.5820e+11 28098
## - BedroomAbvGr      1 6.5127e+09 4.5855e+11 28099
## - Fireplaces        1 6.6662e+09 4.5871e+11 28100
## - BsmtFinSF2        1 7.8187e+09 4.5986e+11 28103
## - KitchenAbvGr      1 8.7304e+09 4.6077e+11 28106
## - BsmtQual          1 8.8405e+09 4.6088e+11 28106
## - Street            1 9.6235e+09 4.6166e+11 28109
## - YearBuilt         1 1.4660e+10 4.6670e+11 28124
## - SaleCondition     1 1.5675e+10 4.6772e+11 28127
## - MasVnrArea        1 1.8660e+10 4.7070e+11 28136
## - Functional        1 1.9771e+10 4.7181e+11 28139
## - KitchenQual       1 2.0456e+10 4.7250e+11 28141
## - LotArea           1 2.2286e+10 4.7433e+11 28147
## - ExterQual         1 2.2815e+10 4.7485e+11 28148
## - OverallCond       1 2.4987e+10 4.7703e+11 28155
## - BsmtFinSF1        1 2.9908e+10 4.8195e+11 28169
## - OverallQual       1 5.0850e+10 5.0289e+11 28229
## - X1stFlrSF         1 8.2446e+10 5.3449e+11 28315
## - X2ndFlrSF         1 1.2085e+11 5.7289e+11 28412
##
## Step:  AIC=28078.97
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
##   LotShape + LandContour + Utilities + LandSlope + Neighborhood +
##   Condition1 + Condition2 + BldgType + OverallQual + OverallCond +
##   YearBuilt + YearRemodAdd + RoofStyle + RoofMatl + Exterior1st +
##   Exterior2nd + MasVnrType + MasVnrArea + ExterQual + ExterCond +
##   Foundation + BsmtQual + BsmtCond + BsmtExposure + BsmtFinType1 +
##   BsmtFinSF1 + BsmtFinType2 + BsmtFinSF2 + BsmtUnfSF + HeatingQC +

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##      CentralAir + Electrical + X1stFlrSF + X2ndFlrSF + BsmtFullBath +
##      BsmtHalfBath + FullBath + BedroomAbvGr + KitchenAbvGr + KitchenQual +
##      TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu + GarageType +
##      GarageYrBlt + GarageFinish + GarageCars + GarageArea + GarageQual +
##      GarageCond + PavedDrive + WoodDeckSF + OpenPorchSF + EnclosedPorch +
##      X3SsnPorch + ScreenPorch + Fence + MiscFeature + MoSold +
##      YrSold + SaleType + SaleCondition
##
##      Df      Sum of Sq      RSS      AIC
## - BsmtFinType2    1 3.8035e+07 4.5210e+11 28072
## - Neighborhood    1 4.4324e+07 4.5211e+11 28072
## - MoSold           1 5.5144e+07 4.5212e+11 28072
## - Condition1       1 5.5864e+07 4.5212e+11 28072
## - CentralAir       1 6.5033e+07 4.5213e+11 28072
## - LandContour      1 6.7716e+07 4.5213e+11 28072
## - MiscFeature      1 7.1836e+07 4.5214e+11 28072
## - GarageQual       1 8.5970e+07 4.5215e+11 28072
## - ExterCond        1 9.6290e+07 4.5216e+11 28072
## - RoofStyle        1 9.8131e+07 4.5216e+11 28072
## - EnclosedPorch    1 1.1077e+08 4.5217e+11 28072
## - FullBath         1 1.2658e+08 4.5219e+11 28072
## - X3SsnPorch       1 1.3616e+08 4.5220e+11 28072
## - LandSlope        1 2.4431e+08 4.5231e+11 28072
## - Condition2       1 2.4742e+08 4.5231e+11 28072
## - YearRemodAdd     1 2.5442e+08 4.5232e+11 28072
## - Electrical       1 2.9172e+08 4.5236e+11 28073
## - LotFrontage      1 3.0659e+08 4.5237e+11 28073
## - LotShape         1 3.4768e+08 4.5241e+11 28073
## - GarageCond       1 3.6385e+08 4.5243e+11 28073
## - BsmtFinType1     1 3.6949e+08 4.5243e+11 28073
## - RoofMatl         1 3.8076e+08 4.5244e+11 28073
## - HeatingQC        1 4.3937e+08 4.5250e+11 28073
## - PavedDrive       1 5.8158e+08 4.5265e+11 28074
## - OpenPorchSF      1 6.5715e+08 4.5272e+11 28074
## - BsmtHalfBath     1 6.5797e+08 4.5272e+11 28074
## - YrSold           1 7.6960e+08 4.5283e+11 28074
## - Foundation       1 7.7080e+08 4.5283e+11 28074
## - GarageFinish     1 7.9531e+08 4.5286e+11 28074
## - Fence            1 8.1164e+08 4.5288e+11 28074
## - SaleType         1 8.3220e+08 4.5290e+11 28074
## - BsmtCond         1 8.8368e+08 4.5295e+11 28074
## - BsmtFullBath     1 8.9195e+08 4.5296e+11 28074
## - MSZoning         1 9.2803e+08 4.5299e+11 28075
## - Exterior2nd      1 1.0831e+09 4.5315e+11 28075
## - Utilities        1 1.4050e+09 4.5347e+11 28076
## - GarageType       1 2.0332e+09 4.5410e+11 28078
## - MSSubClass       1 2.1577e+09 4.5422e+11 28078
## - TotRmsAbvGrd     1 2.2689e+09 4.5433e+11 28079
## - GarageYrBlt      1 2.2969e+09 4.5436e+11 28079
## <none>              4.5206e+11 28079
## - BldgType         1 2.3764e+09 4.5444e+11 28079
## - Exterior1st      1 2.5504e+09 4.5461e+11 28080
## - GarageCars       1 2.9602e+09 4.5502e+11 28081
## - GarageArea       1 3.0838e+09 4.5515e+11 28081

```

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## - BsmtExposure      1 3.1633e+09 4.5523e+11 28082
## - ScreenPorch      1 3.4467e+09 4.5551e+11 28082
## - BsmtUnfSF        1 4.3361e+09 4.5640e+11 28085
## - WoodDeckSF       1 4.3938e+09 4.5646e+11 28085
## - FireplaceQu      1 5.7253e+09 4.5779e+11 28089
## - MasVnrType       1 6.2666e+09 4.5833e+11 28091
## - BedroomAbvGr     1 6.5201e+09 4.5858e+11 28092
## - Fireplaces       1 6.6434e+09 4.5871e+11 28092
## - BsmtFinSF2       1 7.8258e+09 4.5989e+11 28096
## - KitchenAbvGr     1 8.7131e+09 4.6078e+11 28099
## - BsmtQual         1 8.8273e+09 4.6089e+11 28099
## - Street           1 9.6175e+09 4.6168e+11 28101
## - YearBuilt        1 1.4979e+10 4.6704e+11 28118
## - SaleCondition    1 1.5768e+10 4.6783e+11 28120
## - MasVnrArea       1 1.8644e+10 4.7071e+11 28129
## - Functional       1 1.9872e+10 4.7194e+11 28132
## - KitchenQual      1 2.0449e+10 4.7251e+11 28134
## - LotArea          1 2.2602e+10 4.7467e+11 28140
## - ExterQual        1 2.3016e+10 4.7508e+11 28142
## - OverallCond      1 2.4967e+10 4.7703e+11 28147
## - BsmtFinSF1       1 3.0580e+10 4.8264e+11 28164
## - OverallQual      1 5.0833e+10 5.0290e+11 28222
## - X1stFlrSF        1 8.3217e+10 5.3528e+11 28310
## - X2ndFlrSF        1 1.2152e+11 5.7359e+11 28407
##
## Step:  AIC=28071.84
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
##   LotShape + LandContour + Utilities + LandSlope + Neighborhood +
##   Condition1 + Condition2 + BldgType + OverallQual + OverallCond +
##   YearBuilt + YearRemodAdd + RoofStyle + RoofMatl + Exterior1st +
##   Exterior2nd + MasVnrType + MasVnrArea + ExterQual + ExterCond +
##   Foundation + BsmtQual + BsmtCond + BsmtExposure + BsmtFinType1 +
##   BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF + HeatingQC + CentralAir +
##   Electrical + X1stFlrSF + X2ndFlrSF + BsmtFullBath + BsmtHalfBath +
##   FullBath + BedroomAbvGr + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +
##   Functional + Fireplaces + FireplaceQu + GarageType + GarageYrBlt +
##   GarageFinish + GarageCars + GarageArea + GarageQual + GarageCond +
##   PavedDrive + WoodDeckSF + OpenPorchSF + EnclosedPorch + X3SsnPorch +
##   ScreenPorch + Fence + MiscFeature + MoSold + YrSold + SaleType +
##   SaleCondition
##
##           Df Sum of Sq      RSS   AIC
## - Neighborhood  1 4.3507e+07 4.5215e+11 28065
## - Condition1    1 5.3901e+07 4.5216e+11 28065
## - MoSold        1 5.4125e+07 4.5216e+11 28065
## - CentralAir    1 6.4366e+07 4.5217e+11 28065
## - LandContour   1 7.3193e+07 4.5217e+11 28065
## - MiscFeature   1 7.4554e+07 4.5218e+11 28065
## - GarageQual    1 8.5852e+07 4.5219e+11 28065
## - ExterCond     1 9.1675e+07 4.5219e+11 28065
## - RoofStyle     1 1.0492e+08 4.5221e+11 28065
## - EnclosedPorch 1 1.0861e+08 4.5221e+11 28065
## - FullBath      1 1.2901e+08 4.5223e+11 28065
## - X3SsnPorch    1 1.3331e+08 4.5223e+11 28065

```

## - Condition2	1	2.3907e+08	4.5234e+11	28065
## - LandSlope	1	2.4103e+08	4.5234e+11	28065
## - YearRemodAdd	1	2.7319e+08	4.5237e+11	28065
## - Electrical	1	2.8912e+08	4.5239e+11	28066
## - LotFrontage	1	3.1076e+08	4.5241e+11	28066
## - LotShape	1	3.4684e+08	4.5245e+11	28066
## - GarageCond	1	3.6469e+08	4.5247e+11	28066
## - BsmtFinType1	1	3.7102e+08	4.5247e+11	28066
## - RoofMatl	1	3.8724e+08	4.5249e+11	28066
## - HeatingQC	1	4.3981e+08	4.5254e+11	28066
## - PavedDrive	1	5.8283e+08	4.5268e+11	28066
## - OpenPorchSF	1	6.6300e+08	4.5276e+11	28067
## - BsmtHalfBath	1	6.6613e+08	4.5277e+11	28067
## - Foundation	1	7.6305e+08	4.5286e+11	28067
## - YrSold	1	7.7271e+08	4.5287e+11	28067
## - GarageFinish	1	7.9510e+08	4.5290e+11	28067
## - Fence	1	8.3148e+08	4.5293e+11	28067
## - SaleType	1	8.5472e+08	4.5296e+11	28067
## - BsmtFullBath	1	8.8856e+08	4.5299e+11	28067
## - BsmtCond	1	9.2600e+08	4.5303e+11	28068
## - MSZoning	1	9.3293e+08	4.5303e+11	28068
## - Exterior2nd	1	1.0743e+09	4.5318e+11	28068
## - Utilities	1	1.3879e+09	4.5349e+11	28069
## - GarageType	1	2.0376e+09	4.5414e+11	28071
## - MSSubClass	1	2.1462e+09	4.5425e+11	28071
## - TotRmsAbvGrd	1	2.2548e+09	4.5436e+11	28072
## - GarageYrBlt	1	2.2843e+09	4.5439e+11	28072
## <none>			4.5210e+11	28072
## - BldgType	1	2.3848e+09	4.5449e+11	28072
## - Exterior1st	1	2.5373e+09	4.5464e+11	28072
## - GarageCars	1	2.9747e+09	4.5508e+11	28074
## - GarageArea	1	3.0520e+09	4.5515e+11	28074
## - BsmtExposure	1	3.1642e+09	4.5527e+11	28074
## - ScreenPorch	1	3.4878e+09	4.5559e+11	28075
## - WoodDeckSF	1	4.3785e+09	4.5648e+11	28078
## - BsmtUnfSF	1	4.7035e+09	4.5680e+11	28079
## - FireplaceQu	1	5.7409e+09	4.5784e+11	28082
## - MasVnrType	1	6.2538e+09	4.5836e+11	28084
## - BedroomAbvGr	1	6.5501e+09	4.5865e+11	28085
## - Fireplaces	1	6.6355e+09	4.5874e+11	28085
## - KitchenAbvGr	1	8.7656e+09	4.6087e+11	28092
## - BsmtQual	1	8.8229e+09	4.6092e+11	28092
## - Street	1	9.6831e+09	4.6178e+11	28094
## - BsmtFinSF2	1	1.0688e+10	4.6279e+11	28098
## - YearBuilt	1	1.4941e+10	4.6704e+11	28110
## - SaleCondition	1	1.5748e+10	4.6785e+11	28113
## - MasVnrArea	1	1.8610e+10	4.7071e+11	28121
## - Functional	1	1.9981e+10	4.7208e+11	28126
## - KitchenQual	1	2.0419e+10	4.7252e+11	28127
## - LotArea	1	2.2641e+10	4.7474e+11	28133
## - ExterQual	1	2.2979e+10	4.7508e+11	28134
## - OverallCond	1	2.5006e+10	4.7711e+11	28140
## - BsmtFinSF1	1	3.1767e+10	4.8387e+11	28160
## - OverallQual	1	5.1039e+10	5.0314e+11	28215

```

## - X1stFlrSF      1 8.3262e+10 5.3536e+11 28303
## - X2ndFlrSF      1 1.2218e+11 5.7428e+11 28401
##
## Step:  AIC=28064.72
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
##   LotShape + LandContour + Utilities + LandSlope + Condition1 +
##   Condition2 + BldgType + OverallQual + OverallCond + YearBuilt +
##   YearRemodAdd + RoofStyle + RoofMatl + Exterior1st + Exterior2nd +
##   MasVnrType + MasVnrArea + ExterQual + ExterCond + Foundation +
##   BsmtQual + BsmtCond + BsmtExposure + BsmtFinType1 + BsmtFinSF1 +
##   BsmtFinSF2 + BsmtUnfSF + HeatingQC + CentralAir + Electrical +
##   X1stFlrSF + X2ndFlrSF + BsmtFullBath + BsmtHalfBath + FullBath +
##   BedroomAbvGr + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +
##   Functional + Fireplaces + FireplaceQu + GarageType + GarageYrBlt +
##   GarageFinish + GarageCars + GarageArea + GarageQual + GarageCond +
##   PavedDrive + WoodDeckSF + OpenPorchSF + EnclosedPorch + X3SsnPorch +
##   ScreenPorch + Fence + MiscFeature + MoSold + YrSold + SaleType +
##   SaleCondition
##
##           Df  Sum of Sq      RSS   AIC
## - Condition1    1 5.0090e+07 4.5220e+11 28058
## - MoSold         1 5.4053e+07 4.5220e+11 28058
## - CentralAir     1 6.8832e+07 4.5221e+11 28058
## - MiscFeature    1 7.7652e+07 4.5222e+11 28058
## - LandContour    1 7.8552e+07 4.5222e+11 28058
## - ExterCond      1 9.2279e+07 4.5224e+11 28058
## - GarageQual     1 9.2945e+07 4.5224e+11 28058
## - RoofStyle      1 1.1270e+08 4.5226e+11 28058
## - EnclosedPorch  1 1.1766e+08 4.5226e+11 28058
## - FullBath       1 1.2674e+08 4.5227e+11 28058
## - X3SsnPorch     1 1.2923e+08 4.5227e+11 28058
## - LandSlope      1 2.2372e+08 4.5237e+11 28058
## - Condition2     1 2.3279e+08 4.5238e+11 28058
## - YearRemodAdd   1 2.7688e+08 4.5242e+11 28058
## - Electrical     1 2.8035e+08 4.5243e+11 28058
## - LotFrontage    1 3.1700e+08 4.5246e+11 28058
## - LotShape       1 3.4941e+08 4.5249e+11 28059
## - GarageCond     1 3.6517e+08 4.5251e+11 28059
## - BsmtFinType1   1 3.6969e+08 4.5251e+11 28059
## - RoofMatl       1 3.8285e+08 4.5253e+11 28059
## - HeatingQC      1 4.3072e+08 4.5258e+11 28059
## - PavedDrive     1 5.8512e+08 4.5273e+11 28059
## - BsmtHalfBath   1 6.6910e+08 4.5281e+11 28060
## - OpenPorchSF    1 7.0680e+08 4.5285e+11 28060
## - Foundation     1 7.5379e+08 4.5290e+11 28060
## - YrSold         1 7.6491e+08 4.5291e+11 28060
## - GarageFinish   1 7.7457e+08 4.5292e+11 28060
## - Fence          1 8.3202e+08 4.5298e+11 28060
## - SaleType       1 8.4431e+08 4.5299e+11 28060
## - BsmtFullBath   1 8.8302e+08 4.5303e+11 28060
## - BsmtCond       1 9.3258e+08 4.5308e+11 28060
## - Exterior2nd    1 1.0506e+09 4.5320e+11 28061
## - MSZoning       1 1.0801e+09 4.5323e+11 28061
## - Utilities      1 1.3665e+09 4.5351e+11 28062

```

```

## - GarageType      1 2.0176e+09 4.5416e+11 28064
## - MSSubClass      1 2.1269e+09 4.5427e+11 28064
## - TotRmsAbvGrd    1 2.2271e+09 4.5437e+11 28064
## - GarageYrBlt     1 2.2933e+09 4.5444e+11 28065
## <none>              4.5215e+11 28065
## - BldgType        1 2.4029e+09 4.5455e+11 28065
## - Exterior1st     1 2.5309e+09 4.5468e+11 28065
## - GarageCars       1 3.0104e+09 4.5516e+11 28067
## - GarageArea       1 3.0613e+09 4.5521e+11 28067
## - BsmtExposure     1 3.1207e+09 4.5527e+11 28067
## - ScreenPorch     1 3.4725e+09 4.5562e+11 28068
## - WoodDeckSF       1 4.4085e+09 4.5655e+11 28071
## - BsmtUnfSF        1 4.6781e+09 4.5682e+11 28072
## - FireplaceQu      1 5.7564e+09 4.5790e+11 28075
## - MasVnrType       1 6.4434e+09 4.5859e+11 28077
## - BedroomAbvGr    1 6.5202e+09 4.5867e+11 28078
## - Fireplaces       1 6.6079e+09 4.5875e+11 28078
## - KitchenAbvGr     1 8.7221e+09 4.6087e+11 28084
## - BsmtQual         1 8.9090e+09 4.6105e+11 28085
## - Street           1 9.6636e+09 4.6181e+11 28087
## - BsmtFinSF2       1 1.0761e+10 4.6291e+11 28091
## - YearBuilt        1 1.4898e+10 4.6704e+11 28103
## - SaleCondition    1 1.5740e+10 4.6788e+11 28106
## - MasVnrArea       1 1.8760e+10 4.7091e+11 28115
## - Functional       1 1.9976e+10 4.7212e+11 28118
## - KitchenQual      1 2.0419e+10 4.7256e+11 28120
## - LotArea          1 2.2733e+10 4.7488e+11 28126
## - ExterQual        1 2.2975e+10 4.7512e+11 28127
## - OverallCond      1 2.5011e+10 4.7716e+11 28133
## - BsmtFinSF1       1 3.1823e+10 4.8397e+11 28153
## - OverallQual      1 5.1589e+10 5.0373e+11 28210
## - X1stFlrSF        1 8.3470e+10 5.3561e+11 28296
## - X2ndFlrSF        1 1.2214e+11 5.7429e+11 28394
##
## Step:  AIC=28057.63
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
##   LotShape + LandContour + Utilities + LandSlope + Condition2 +
##   BldgType + OverallQual + OverallCond + YearBuilt + YearRemodAdd +
##   RoofStyle + RoofMatl + Exterior1st + Exterior2nd + MasVnrType +
##   MasVnrArea + ExterQual + ExterCond + Foundation + BsmtQual +
##   BsmtCond + BsmtExposure + BsmtFinType1 + BsmtFinSF1 + BsmtFinSF2 +
##   BsmtUnfSF + HeatingQC + CentralAir + Electrical + X1stFlrSF +
##   X2ndFlrSF + BsmtFullBath + BsmtHalfBath + FullBath + BedroomAbvGr +
##   KitchenAbvGr + KitchenQual + TotRmsAbvGrd + Functional +
##   Fireplaces + FireplaceQu + GarageType + GarageYrBlt + GarageFinish +
##   GarageCars + GarageArea + GarageQual + GarageCond + PavedDrive +
##   WoodDeckSF + OpenPorchSF + EnclosedPorch + X3SsnPorch + ScreenPorch +
##   Fence + MiscFeature + MoSold + YrSold + SaleType + SaleCondition
##
##           Df Sum of Sq      RSS   AIC
## - MoSold      1 5.5791e+07 4.5225e+11 28051
## - CentralAir   1 5.8968e+07 4.5225e+11 28051
## - LandContour  1 7.7291e+07 4.5227e+11 28051
## - MiscFeature  1 8.0338e+07 4.5228e+11 28051

```

## - GarageQual	1	8.8044e+07	4.5228e+11	28051
## - ExterCond	1	9.8527e+07	4.5229e+11	28051
## - RoofStyle	1	1.1172e+08	4.5231e+11	28051
## - EnclosedPorch	1	1.1752e+08	4.5231e+11	28051
## - FullBath	1	1.2546e+08	4.5232e+11	28051
## - X3SsnPorch	1	1.4353e+08	4.5234e+11	28051
## - LandSlope	1	2.1990e+08	4.5241e+11	28051
## - Condition2	1	2.5812e+08	4.5245e+11	28051
## - Electrical	1	2.7312e+08	4.5247e+11	28051
## - YearRemodAdd	1	2.8832e+08	4.5248e+11	28051
## - LotFrontage	1	3.0537e+08	4.5250e+11	28051
## - GarageCond	1	3.6338e+08	4.5256e+11	28052
## - BsmtFinType1	1	3.6587e+08	4.5256e+11	28052
## - LotShape	1	3.7081e+08	4.5257e+11	28052
## - RoofMatl	1	3.9039e+08	4.5259e+11	28052
## - HeatingQC	1	4.3274e+08	4.5263e+11	28052
## - PavedDrive	1	6.0512e+08	4.5280e+11	28052
## - BsmtHalfBath	1	6.9745e+08	4.5289e+11	28053
## - OpenPorchSF	1	7.2847e+08	4.5292e+11	28053
## - Foundation	1	7.4095e+08	4.5294e+11	28053
## - YrSold	1	7.7208e+08	4.5297e+11	28053
## - GarageFinish	1	7.9421e+08	4.5299e+11	28053
## - Fence	1	8.3611e+08	4.5303e+11	28053
## - SaleType	1	8.4878e+08	4.5304e+11	28053
## - BsmtFullBath	1	8.7426e+08	4.5307e+11	28053
## - BsmtCond	1	9.2715e+08	4.5312e+11	28053
## - Exterior2nd	1	1.0335e+09	4.5323e+11	28054
## - MSZoning	1	1.0641e+09	4.5326e+11	28054
## - Utilities	1	1.3652e+09	4.5356e+11	28055
## - GarageType	1	2.0508e+09	4.5425e+11	28057
## - MSSubClass	1	2.1176e+09	4.5431e+11	28057
## - TotRmsAbvGrd	1	2.2560e+09	4.5445e+11	28057
## - GarageYrBlt	1	2.2602e+09	4.5446e+11	28057
## <none>			4.5220e+11	28058
## - BldgType	1	2.4448e+09	4.5464e+11	28058
## - Exterior1st	1	2.5120e+09	4.5471e+11	28058
## - GarageCars	1	3.0226e+09	4.5522e+11	28060
## - GarageArea	1	3.0317e+09	4.5523e+11	28060
## - BsmtExposure	1	3.1035e+09	4.5530e+11	28060
## - ScreenPorch	1	3.4790e+09	4.5567e+11	28061
## - WoodDeckSF	1	4.4124e+09	4.5661e+11	28064
## - BsmtUnfSF	1	4.6677e+09	4.5686e+11	28065
## - FireplaceQu	1	5.7592e+09	4.5795e+11	28068
## - MasVnrType	1	6.4524e+09	4.5865e+11	28070
## - BedroomAbvGr	1	6.5061e+09	4.5870e+11	28070
## - Fireplaces	1	6.5713e+09	4.5877e+11	28071
## - KitchenAbvGr	1	8.7750e+09	4.6097e+11	28077
## - BsmtQual	1	8.9657e+09	4.6116e+11	28078
## - Street	1	9.6218e+09	4.6182e+11	28080
## - BsmtFinSF2	1	1.0822e+10	4.6302e+11	28084
## - YearBuilt	1	1.5026e+10	4.6722e+11	28096
## - SaleCondition	1	1.5755e+10	4.6795e+11	28099
## - MasVnrArea	1	1.8742e+10	4.7094e+11	28108
## - Functional	1	1.9928e+10	4.7212e+11	28111

```

## - KitchenQual      1 2.0395e+10 4.7259e+11 28112
## - LotArea          1 2.2744e+10 4.7494e+11 28120
## - ExterQual        1 2.2943e+10 4.7514e+11 28120
## - OverallCond      1 2.5054e+10 4.7725e+11 28126
## - BsmtFinSF1       1 3.1824e+10 4.8402e+11 28146
## - OverallQual      1 5.1666e+10 5.0386e+11 28203
## - X1stFlrSF        1 8.3458e+10 5.3565e+11 28289
## - X2ndFlrSF        1 1.2215e+11 5.7434e+11 28387
##
## Step:  AIC=28050.55
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
##   LotShape + LandContour + Utilities + LandSlope + Condition2 +
##   BldgType + OverallQual + OverallCond + YearBuilt + YearRemodAdd +
##   RoofStyle + RoofMatl + Exterior1st + Exterior2nd + MasVnrType +
##   MasVnrArea + ExterQual + ExterCond + Foundation + BsmtQual +
##   BsmtCond + BsmtExposure + BsmtFinType1 + BsmtFinSF1 + BsmtFinSF2 +
##   BsmtUnfSF + HeatingQC + CentralAir + Electrical + X1stFlrSF +
##   X2ndFlrSF + BsmtFullBath + BsmtHalfBath + FullBath + BedroomAbvGr +
##   KitchenAbvGr + KitchenQual + TotRmsAbvGrd + Functional +
##   Fireplaces + FireplaceQu + GarageType + GarageYrBlt + GarageFinish +
##   GarageCars + GarageArea + GarageQual + GarageCond + PavedDrive +
##   WoodDeckSF + OpenPorchSF + EnclosedPorch + X3SsnPorch + ScreenPorch +
##   Fence + MiscFeature + YrSold + SaleType + SaleCondition
##
##           Df  Sum of Sq      RSS   AIC
## - CentralAir      1 5.7857e+07 4.5231e+11 28044
## - LandContour     1 7.8605e+07 4.5233e+11 28044
## - MiscFeature      1 8.4613e+07 4.5234e+11 28044
## - GarageQual      1 9.2282e+07 4.5234e+11 28044
## - ExterCond       1 9.6525e+07 4.5235e+11 28044
## - RoofStyle       1 1.1112e+08 4.5236e+11 28044
## - EnclosedPorch   1 1.2172e+08 4.5237e+11 28044
## - FullBath        1 1.3093e+08 4.5238e+11 28044
## - X3SsnPorch      1 1.3900e+08 4.5239e+11 28044
## - LandSlope       1 2.2243e+08 4.5247e+11 28044
## - Condition2      1 2.5699e+08 4.5251e+11 28044
## - Electrical      1 2.6733e+08 4.5252e+11 28044
## - YearRemodAdd    1 2.8276e+08 4.5253e+11 28044
## - LotFrontage     1 3.0554e+08 4.5256e+11 28044
## - BsmtFinType1    1 3.5681e+08 4.5261e+11 28044
## - LotShape        1 3.6470e+08 4.5262e+11 28044
## - GarageCond      1 3.6635e+08 4.5262e+11 28044
## - RoofMatl        1 3.7769e+08 4.5263e+11 28044
## - HeatingQC       1 4.3383e+08 4.5268e+11 28045
## - PavedDrive      1 5.9894e+08 4.5285e+11 28045
## - OpenPorchSF     1 7.0780e+08 4.5296e+11 28046
## - BsmtHalfBath    1 7.1196e+08 4.5296e+11 28046
## - YrSold           1 7.2899e+08 4.5298e+11 28046
## - Foundation      1 7.5063e+08 4.5300e+11 28046
## - GarageFinish    1 8.0976e+08 4.5306e+11 28046
## - SaleType        1 8.2454e+08 4.5308e+11 28046
## - Fence           1 8.4422e+08 4.5310e+11 28046
## - BsmtFullBath    1 8.7357e+08 4.5312e+11 28046
## - BsmtCond        1 9.2475e+08 4.5318e+11 28046

```



```

## - Exterior2nd      1 1.0536e+09 4.5330e+11 28047
## - MSZoning         1 1.0587e+09 4.5331e+11 28047
## - Utilities        1 1.3344e+09 4.5359e+11 28048
## - GarageType       1 2.0307e+09 4.5428e+11 28050
## - MSSubClass       1 2.1019e+09 4.5435e+11 28050
## - GarageYrBlt      1 2.2566e+09 4.5451e+11 28050
## - TotRmsAbvGrd    1 2.2985e+09 4.5455e+11 28050
## <none>              4.5225e+11 28051
## - BldgType         1 2.4398e+09 4.5469e+11 28051
## - Exterior1st      1 2.5292e+09 4.5478e+11 28051
## - GarageCars       1 3.0152e+09 4.5527e+11 28053
## - GarageArea       1 3.0455e+09 4.5530e+11 28053
## - BsmtExposure     1 3.0790e+09 4.5533e+11 28053
## - ScreenPorch      1 3.4605e+09 4.5571e+11 28054
## - WoodDeckSF       1 4.3990e+09 4.5665e+11 28057
## - BsmtUnfSF        1 4.7073e+09 4.5696e+11 28058
## - FireplaceQu      1 5.7265e+09 4.5798e+11 28061
## - MasVnrType       1 6.4494e+09 4.5870e+11 28063
## - BedroomAbvGr     1 6.5342e+09 4.5879e+11 28064
## - Fireplaces       1 6.5416e+09 4.5879e+11 28064
## - KitchenAbvGr     1 8.8920e+09 4.6114e+11 28071
## - BsmtQual         1 9.0095e+09 4.6126e+11 28071
## - Street           1 9.6274e+09 4.6188e+11 28073
## - BsmtFinSF2       1 1.0858e+10 4.6311e+11 28077
## - YearBuilt        1 1.5067e+10 4.6732e+11 28089
## - SaleCondition    1 1.5733e+10 4.6798e+11 28092
## - MasVnrArea       1 1.8781e+10 4.7103e+11 28101
## - Functional       1 1.9878e+10 4.7213e+11 28104
## - KitchenQual      1 2.0358e+10 4.7261e+11 28105
## - LotArea          1 2.2797e+10 4.7505e+11 28112
## - ExterQual        1 2.2954e+10 4.7520e+11 28113
## - OverallCond      1 2.5131e+10 4.7738e+11 28119
## - BsmtFinSF1       1 3.1864e+10 4.8411e+11 28139
## - OverallQual      1 5.1648e+10 5.0390e+11 28196
## - X1stFlrSF        1 8.3402e+10 5.3565e+11 28282
## - X2ndFlrSF        1 1.2209e+11 5.7434e+11 28380
##
## Step:  AIC=28043.48
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
##   LotShape + LandContour + Utilities + LandSlope + Condition2 +
##   BldgType + OverallQual + OverallCond + YearBuilt + YearRemodAdd +
##   RoofStyle + RoofMatl + Exterior1st + Exterior2nd + MasVnrType +
##   MasVnrArea + ExterQual + ExterCond + Foundation + BsmtQual +
##   BsmtCond + BsmtExposure + BsmtFinType1 + BsmtFinSF1 + BsmtFinSF2 +
##   BsmtUnfSF + HeatingQC + Electrical + X1stFlrSF + X2ndFlrSF +
##   BsmtFullBath + BsmtHalfBath + FullBath + BedroomAbvGr + KitchenAbvGr +
##   KitchenQual + TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu +
##   GarageType + GarageYrBlt + GarageFinish + GarageCars + GarageArea +
##   GarageQual + GarageCond + PavedDrive + WoodDeckSF + OpenPorchSF +
##   EnclosedPorch + X3SsnPorch + ScreenPorch + Fence + MiscFeature +
##   YrSold + SaleType + SaleCondition
##
##           Df Sum of Sq      RSS   AIC
## - LandContour  1 7.4318e+07 4.5238e+11 28036

```

## - MiscFeature	1	8.3076e+07	4.5239e+11	28036
## - GarageQual	1	9.2965e+07	4.5240e+11	28036
## - ExterCond	1	9.6713e+07	4.5241e+11	28036
## - RoofStyle	1	1.0679e+08	4.5242e+11	28037
## - EnclosedPorch	1	1.2380e+08	4.5243e+11	28037
## - X3SsnPorch	1	1.4072e+08	4.5245e+11	28037
## - FullBath	1	1.4303e+08	4.5245e+11	28037
## - LandSlope	1	2.2829e+08	4.5254e+11	28037
## - Electrical	1	2.4235e+08	4.5255e+11	28037
## - Condition2	1	2.7400e+08	4.5258e+11	28037
## - YearRemodAdd	1	2.9449e+08	4.5260e+11	28037
## - LotFrontage	1	3.0200e+08	4.5261e+11	28037
## - LotShape	1	3.6008e+08	4.5267e+11	28037
## - BsmtFinType1	1	3.6522e+08	4.5267e+11	28037
## - RoofMatl	1	3.7833e+08	4.5269e+11	28037
## - GarageCond	1	3.9128e+08	4.5270e+11	28038
## - HeatingQC	1	4.4416e+08	4.5275e+11	28038
## - PavedDrive	1	6.2923e+08	4.5294e+11	28038
## - OpenPorchSF	1	6.8029e+08	4.5299e+11	28038
## - BsmtHalfBath	1	7.1629e+08	4.5303e+11	28038
## - YrSold	1	7.4159e+08	4.5305e+11	28038
## - Foundation	1	7.4496e+08	4.5305e+11	28039
## - GarageFinish	1	8.0613e+08	4.5311e+11	28039
## - Fence	1	8.3234e+08	4.5314e+11	28039
## - SaleType	1	8.3297e+08	4.5314e+11	28039
## - BsmtFullBath	1	8.7320e+08	4.5318e+11	28039
## - BsmtCond	1	9.6524e+08	4.5327e+11	28039
## - MSZoning	1	1.0417e+09	4.5335e+11	28040
## - Exterior2nd	1	1.0488e+09	4.5336e+11	28040
## - Utilities	1	1.3282e+09	4.5364e+11	28040
## - GarageType	1	2.0285e+09	4.5434e+11	28042
## - MSSubClass	1	2.1925e+09	4.5450e+11	28043
## - GarageYrBlt	1	2.2329e+09	4.5454e+11	28043
## - TotRmsAbvGrd	1	2.3335e+09	4.5464e+11	28044
## <none>			4.5231e+11	28044
## - BldgType	1	2.3907e+09	4.5470e+11	28044
## - Exterior1st	1	2.5170e+09	4.5483e+11	28044
## - GarageCars	1	2.9763e+09	4.5529e+11	28046
## - BsmtExposure	1	3.0720e+09	4.5538e+11	28046
## - GarageArea	1	3.0836e+09	4.5539e+11	28046
## - ScreenPorch	1	3.4816e+09	4.5579e+11	28047
## - WoodDeckSF	1	4.4080e+09	4.5672e+11	28050
## - BsmtUnfSF	1	4.7293e+09	4.5704e+11	28051
## - FireplaceQu	1	5.7329e+09	4.5804e+11	28054
## - MasVnrType	1	6.4507e+09	4.5876e+11	28056
## - BedroomAbvGr	1	6.4966e+09	4.5881e+11	28056
## - Fireplaces	1	6.7116e+09	4.5902e+11	28057
## - BsmtQual	1	8.9758e+09	4.6128e+11	28064
## - KitchenAbvGr	1	9.1088e+09	4.6142e+11	28064
## - Street	1	9.7094e+09	4.6202e+11	28066
## - BsmtFinSF2	1	1.0921e+10	4.6323e+11	28070
## - SaleCondition	1	1.5689e+10	4.6800e+11	28084
## - YearBuilt	1	1.6083e+10	4.6839e+11	28085
## - MasVnrArea	1	1.8783e+10	4.7109e+11	28094

```

## - Functional      1 1.9860e+10 4.7217e+11 28097
## - KitchenQual     1 2.0308e+10 4.7262e+11 28098
## - LotArea         1 2.2816e+10 4.7512e+11 28106
## - ExterQual       1 2.2913e+10 4.7522e+11 28106
## - OverallCond     1 2.6705e+10 4.7901e+11 28117
## - BsmtFinSF1      1 3.1998e+10 4.8431e+11 28132
## - OverallQual     1 5.1815e+10 5.0412e+11 28189
## - X1stFlrSF       1 8.3413e+10 5.3572e+11 28274
## - X2ndFlrSF       1 1.2220e+11 5.7451e+11 28373
##
## Step:  AIC=28036.47
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
##   LotShape + Utilities + LandSlope + Condition2 + BldgType +
##   OverallQual + OverallCond + YearBuilt + YearRemodAdd + RoofStyle +
##   RoofMatl + Exterior1st + Exterior2nd + MasVnrType + MasVnrArea +
##   ExterQual + ExterCond + Foundation + BsmtQual + BsmtCond +
##   BsmtExposure + BsmtFinType1 + BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF +
##   HeatingQC + Electrical + X1stFlrSF + X2ndFlrSF + BsmtFullBath +
##   BsmtHalfBath + FullBath + BedroomAbvGr + KitchenAbvGr + KitchenQual +
##   TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu + GarageType +
##   GarageYrBlt + GarageFinish + GarageCars + GarageArea + GarageQual +
##   GarageCond + PavedDrive + WoodDeckSF + OpenPorchSF + EnclosedPorch +
##   X3SsnPorch + ScreenPorch + Fence + MiscFeature + YrSold +
##   SaleType + SaleCondition
##
##      Df Sum of Sq      RSS   AIC
## - MiscFeature      1 8.7285e+07 4.5247e+11 28030
## - GarageQual       1 8.9560e+07 4.5247e+11 28030
## - ExterCond        1 9.8822e+07 4.5248e+11 28030
## - RoofStyle        1 1.0637e+08 4.5249e+11 28030
## - EnclosedPorch    1 1.2342e+08 4.5251e+11 28030
## - X3SsnPorch       1 1.4693e+08 4.5253e+11 28030
## - FullBath         1 1.5185e+08 4.5253e+11 28030
## - Electrical       1 2.4616e+08 4.5263e+11 28030
## - Condition2       1 2.7087e+08 4.5265e+11 28030
## - YearRemodAdd     1 2.8218e+08 4.5267e+11 28030
## - LotFrontage      1 3.0828e+08 4.5269e+11 28030
## - LandSlope        1 3.5863e+08 4.5274e+11 28030
## - RoofMatl         1 3.6962e+08 4.5275e+11 28030
## - BsmtFinType1     1 3.8160e+08 4.5276e+11 28030
## - LotShape         1 3.9670e+08 4.5278e+11 28030
## - GarageCond       1 4.0347e+08 4.5279e+11 28030
## - HeatingQC        1 4.2871e+08 4.5281e+11 28030
## - PavedDrive       1 6.0537e+08 4.5299e+11 28031
## - OpenPorchSF      1 6.6446e+08 4.5305e+11 28031
## - BsmtHalfBath     1 7.3704e+08 4.5312e+11 28032
## - YrSold           1 7.4915e+08 4.5313e+11 28032
## - Foundation       1 7.5095e+08 4.5313e+11 28032
## - GarageFinish     1 8.0062e+08 4.5318e+11 28032
## - SaleType         1 8.3009e+08 4.5321e+11 28032
## - Fence            1 8.4980e+08 4.5323e+11 28032
## - BsmtFullBath     1 8.6647e+08 4.5325e+11 28032
## - BsmtCond         1 9.7804e+08 4.5336e+11 28032
## - MSZoning         1 1.0556e+09 4.5344e+11 28032

```

```

## - Exterior2nd      1 1.0686e+09 4.5345e+11 28032
## - Utilities        1 1.3307e+09 4.5371e+11 28033
## - GarageType       1 2.0407e+09 4.5442e+11 28036
## - MSSubClass       1 2.1823e+09 4.5457e+11 28036
## - GarageYrBltd    1 2.2679e+09 4.5465e+11 28036
## <none>              4.5238e+11 28036
## - TotRmsAbvGrd    1 2.3511e+09 4.5473e+11 28036
## - BldgType         1 2.3845e+09 4.5477e+11 28037
## - Exterior1st      1 2.5212e+09 4.5490e+11 28037
## - GarageCars       1 3.0234e+09 4.5541e+11 28039
## - GarageArea       1 3.0500e+09 4.5543e+11 28039
## - BsmtExposure     1 3.0856e+09 4.5547e+11 28039
## - ScreenPorch      1 3.4509e+09 4.5583e+11 28040
## - WoodDeckSF       1 4.4032e+09 4.5679e+11 28043
## - BsmtUnfSF        1 4.6864e+09 4.5707e+11 28044
## - FireplaceQu      1 5.7859e+09 4.5817e+11 28047
## - BedroomAbvGr     1 6.4444e+09 4.5883e+11 28049
## - MasVnrType       1 6.4656e+09 4.5885e+11 28049
## - Fireplaces       1 6.7385e+09 4.5912e+11 28050
## - BsmtQual         1 9.0732e+09 4.6146e+11 28057
## - KitchenAbvGr     1 9.1113e+09 4.6149e+11 28057
## - Street           1 9.6407e+09 4.6202e+11 28059
## - BsmtFinSF2       1 1.0875e+10 4.6326e+11 28063
## - SaleCondition    1 1.5693e+10 4.6808e+11 28077
## - YearBuilt        1 1.6008e+10 4.6839e+11 28078
## - MasVnrArea       1 1.8723e+10 4.7111e+11 28086
## - Functional       1 1.9935e+10 4.7232e+11 28090
## - KitchenQual      1 2.0475e+10 4.7286e+11 28092
## - LotArea          1 2.2741e+10 4.7512e+11 28098
## - ExterQual         1 2.2907e+10 4.7529e+11 28099
## - OverallCond      1 2.6799e+10 4.7918e+11 28110
## - BsmtFinSF1       1 3.1942e+10 4.8432e+11 28125
## - OverallQual      1 5.2110e+10 5.0449e+11 28183
## - X1stFlrSF        1 8.3559e+10 5.3594e+11 28268
## - X2ndFlrSF        1 1.2213e+11 5.7451e+11 28366
##
## Step:  AIC=28029.49
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
##   LotShape + Utilities + LandSlope + Condition2 + BldgType +
##   OverallQual + OverallCond + YearBuilt + YearRemodAdd + RoofStyle +
##   RoofMatl + Exterior1st + Exterior2nd + MasVnrType + MasVnrArea +
##   ExterQual + ExterCond + Foundation + BsmtQual + BsmtCond +
##   BsmtExposure + BsmtFinType1 + BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF +
##   HeatingQC + Electrical + X1stFlrSF + X2ndFlrSF + BsmtFullBath +
##   BsmtHalfBath + FullBath + BedroomAbvGr + KitchenAbvGr + KitchenQual +
##   TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu + GarageType +
##   GarageYrBltd + GarageFinish + GarageCars + GarageArea + GarageQual +
##   GarageCond + PavedDrive + WoodDeckSF + OpenPorchSF + EnclosedPorch +
##   X3SsnPorch + ScreenPorch + Fence + YrSold + SaleType + SaleCondition
##
##           Df  Sum of Sq      RSS   AIC
## - GarageQual    1 8.1588e+07 4.5255e+11 28022
## - ExterCond     1 8.8900e+07 4.5256e+11 28022
## - RoofStyle     1 1.0915e+08 4.5258e+11 28023

```

## - EnclosedPorch	1	1.1683e+08	4.5259e+11	28023
## - X3SsnPorch	1	1.4275e+08	4.5261e+11	28023
## - FullBath	1	1.5097e+08	4.5262e+11	28023
## - Condition2	1	2.5998e+08	4.5273e+11	28023
## - Electrical	1	2.6346e+08	4.5273e+11	28023
## - YearRemodAdd	1	3.0817e+08	4.5278e+11	28023
## - LotFrontage	1	3.1371e+08	4.5278e+11	28023
## - LandSlope	1	3.6253e+08	4.5283e+11	28023
## - RoofMatl	1	3.8341e+08	4.5285e+11	28023
## - LotShape	1	3.9440e+08	4.5286e+11	28024
## - BsmtFinType1	1	4.0043e+08	4.5287e+11	28024
## - GarageCond	1	4.0999e+08	4.5288e+11	28024
## - HeatingQC	1	4.1194e+08	4.5288e+11	28024
## - PavedDrive	1	5.8528e+08	4.5306e+11	28024
## - OpenPorchSF	1	6.4767e+08	4.5312e+11	28024
## - Foundation	1	7.2949e+08	4.5320e+11	28024
## - BsmtHalfBath	1	7.5699e+08	4.5323e+11	28025
## - YrSold	1	7.7904e+08	4.5325e+11	28025
## - GarageFinish	1	7.8993e+08	4.5326e+11	28025
## - SaleType	1	8.1243e+08	4.5328e+11	28025
## - BsmtFullBath	1	8.5882e+08	4.5333e+11	28025
## - Fence	1	9.2699e+08	4.5340e+11	28025
## - BsmtCond	1	9.8721e+08	4.5346e+11	28025
## - MSZoning	1	1.0488e+09	4.5352e+11	28026
## - Exterior2nd	1	1.0720e+09	4.5354e+11	28026
## - Utilities	1	1.3232e+09	4.5379e+11	28026
## - GarageType	1	2.0499e+09	4.5452e+11	28029
## - MSSubClass	1	2.1635e+09	4.5463e+11	28029
## - GarageYrBlt	1	2.3017e+09	4.5477e+11	28029
## <none>			4.5247e+11	28030
## - TotRmsAbvGrd	1	2.3618e+09	4.5483e+11	28030
## - BldgType	1	2.3857e+09	4.5486e+11	28030
## - Exterior1st	1	2.5341e+09	4.5500e+11	28030
## - GarageArea	1	3.0361e+09	4.5551e+11	28032
## - GarageCars	1	3.0440e+09	4.5551e+11	28032
## - BsmtExposure	1	3.0984e+09	4.5557e+11	28032
## - ScreenPorch	1	3.4102e+09	4.5588e+11	28033
## - WoodDeckSF	1	4.3445e+09	4.5681e+11	28036
## - BsmtUnfSF	1	4.7202e+09	4.5719e+11	28037
## - FireplaceQu	1	5.9404e+09	4.5841e+11	28041
## - MasVnrType	1	6.4633e+09	4.5893e+11	28042
## - BedroomAbvGr	1	6.4900e+09	4.5896e+11	28042
## - Fireplaces	1	6.7472e+09	4.5922e+11	28043
## - BsmtQual	1	9.0660e+09	4.6154e+11	28050
## - KitchenAbvGr	1	9.1875e+09	4.6166e+11	28050
## - Street	1	1.0093e+10	4.6256e+11	28053
## - BsmtFinSF2	1	1.1136e+10	4.6361e+11	28056
## - SaleCondition	1	1.5656e+10	4.6813e+11	28070
## - YearBuilt	1	1.6073e+10	4.6854e+11	28071
## - MasVnrArea	1	1.8717e+10	4.7119e+11	28079
## - Functional	1	2.0201e+10	4.7267e+11	28084
## - KitchenQual	1	2.0494e+10	4.7296e+11	28085
## - LotArea	1	2.2700e+10	4.7517e+11	28091
## - ExterQual	1	2.2823e+10	4.7529e+11	28092

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## - OverallCond      1 2.6714e+10 4.7918e+11 28103
## - BsmtFinSF1       1 3.2174e+10 4.8464e+11 28119
## - OverallQual      1 5.2158e+10 5.0463e+11 28176
## - X1stFlrSF        1 8.3789e+10 5.3626e+11 28262
## - X2ndFlrSF        1 1.2258e+11 5.7505e+11 28360
##
## Step: AIC=28022.49
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
## LotShape + Utilities + LandSlope + Condition2 + BldgType +
## OverallQual + OverallCond + YearBuilt + YearRemodAdd + RoofStyle +
## RoofMatl + Exterior1st + Exterior2nd + MasVnrType + MasVnrArea +
## ExterQual + ExterCond + Foundation + BsmtQual + BsmtCond +
## BsmtExposure + BsmtFinType1 + BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF +
## HeatingQC + Electrical + X1stFlrSF + X2ndFlrSF + BsmtFullBath +
## BsmtHalfBath + FullBath + BedroomAbvGr + KitchenAbvGr + KitchenQual +
## TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu + GarageType +
## GarageYrBlt + GarageFinish + GarageCars + GarageArea + GarageCond +
## PavedDrive + WoodDeckSF + OpenPorchSF + EnclosedPorch + X3SsnPorch +
## ScreenPorch + Fence + YrSold + SaleType + SaleCondition
##
##           Df Sum of Sq      RSS   AIC
## - ExterCond      1 1.0213e+08 4.5265e+11 28016
## - RoofStyle      1 1.0343e+08 4.5266e+11 28016
## - EnclosedPorch  1 1.0831e+08 4.5266e+11 28016
## - FullBath       1 1.4827e+08 4.5270e+11 28016
## - X3SsnPorch     1 1.4879e+08 4.5270e+11 28016
## - Condition2     1 2.4240e+08 4.5279e+11 28016
## - Electrical     1 2.5472e+08 4.5281e+11 28016
## - LotFrontage    1 3.0931e+08 4.5286e+11 28016
## - YearRemodAdd   1 3.2036e+08 4.5287e+11 28016
## - GarageCond     1 3.2840e+08 4.5288e+11 28016
## - LandSlope      1 3.5100e+08 4.5290e+11 28016
## - RoofMatl       1 3.6896e+08 4.5292e+11 28016
## - LotShape       1 3.8066e+08 4.5293e+11 28016
## - BsmtFinType1   1 3.9209e+08 4.5294e+11 28016
## - HeatingQC      1 4.2377e+08 4.5298e+11 28017
## - PavedDrive     1 5.8013e+08 4.5313e+11 28017
## - OpenPorchSF    1 6.6102e+08 4.5321e+11 28017
## - Foundation     1 6.9092e+08 4.5324e+11 28017
## - BsmtHalfBath   1 7.5829e+08 4.5331e+11 28018
## - GarageFinish   1 7.7978e+08 4.5333e+11 28018
## - YrSold         1 7.9978e+08 4.5335e+11 28018
## - SaleType       1 8.0649e+08 4.5336e+11 28018
## - BsmtFullBath   1 8.6765e+08 4.5342e+11 28018
## - Fence          1 9.4772e+08 4.5350e+11 28018
## - MSZoning       1 1.0192e+09 4.5357e+11 28018
## - BsmtCond       1 1.0333e+09 4.5359e+11 28018
## - Exterior2nd    1 1.1025e+09 4.5365e+11 28019
## - Utilities      1 1.3221e+09 4.5387e+11 28019
## - GarageType     1 2.0490e+09 4.5460e+11 28022
## - MSSubClass     1 2.1957e+09 4.5475e+11 28022
## - TotRmsAbvGrd   1 2.3305e+09 4.5488e+11 28022
## <none>                4.5255e+11 28022
## - BldgType       1 2.3900e+09 4.5494e+11 28023

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## - GarageYrBlt      1 2.4458e+09 4.5500e+11 28023
## - Exterior1st      1 2.5869e+09 4.5514e+11 28023
## - GarageArea       1 3.0068e+09 4.5556e+11 28025
## - GarageCars       1 3.0243e+09 4.5558e+11 28025
## - BsmtExposure     1 3.1170e+09 4.5567e+11 28025
## - ScreenPorch      1 3.4451e+09 4.5600e+11 28026
## - WoodDeckSF       1 4.3960e+09 4.5695e+11 28029
## - BsmtUnfSF        1 4.7495e+09 4.5730e+11 28030
## - FireplaceQu      1 5.8994e+09 4.5845e+11 28034
## - MasVnrType       1 6.4602e+09 4.5901e+11 28035
## - BedroomAbvGr     1 6.5714e+09 4.5912e+11 28036
## - Fireplaces       1 6.7462e+09 4.5930e+11 28036
## - KitchenAbvGr     1 9.1070e+09 4.6166e+11 28043
## - BsmtQual         1 9.2363e+09 4.6179e+11 28044
## - Street           1 1.0077e+10 4.6263e+11 28046
## - BsmtFinSF2       1 1.1073e+10 4.6362e+11 28049
## - SaleCondition    1 1.5589e+10 4.6814e+11 28063
## - YearBuilt        1 1.6084e+10 4.6864e+11 28064
## - MasVnrArea       1 1.8647e+10 4.7120e+11 28072
## - Functional       1 2.0245e+10 4.7280e+11 28077
## - KitchenQual      1 2.0693e+10 4.7324e+11 28078
## - LotArea          1 2.2745e+10 4.7530e+11 28084
## - ExterQual        1 2.2891e+10 4.7544e+11 28085
## - OverallCond      1 2.6635e+10 4.7919e+11 28096
## - BsmtFinSF1       1 3.2119e+10 4.8467e+11 28112
## - OverallQual      1 5.2384e+10 5.0494e+11 28170
## - X1stFlrSF        1 8.3892e+10 5.3644e+11 28255
## - X2ndFlrSF        1 1.2334e+11 5.7590e+11 28355
##
## Step: AIC=28015.56
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
##   LotShape + Utilities + LandSlope + Condition2 + BldgType +
##   OverallQual + OverallCond + YearBuilt + YearRemodAdd + RoofStyle +
##   RoofMatl + Exterior1st + Exterior2nd + MasVnrType + MasVnrArea +
##   ExterQual + Foundation + BsmtQual + BsmtCond + BsmtExposure +
##   BsmtFinType1 + BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF + HeatingQC +
##   Electrical + X1stFlrSF + X2ndFlrSF + BsmtFullBath + BsmtHalfBath +
##   FullBath + BedroomAbvGr + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +
##   Functional + Fireplaces + FireplaceQu + GarageType + GarageYrBlt +
##   GarageFinish + GarageCars + GarageArea + GarageCond + PavedDrive +
##   WoodDeckSF + OpenPorchSF + EnclosedPorch + X3SsnPorch + ScreenPorch +
##   Fence + YrSold + SaleType + SaleCondition
##
##           Df Sum of Sq      RSS   AIC
## - RoofStyle      1 1.0845e+08 4.5276e+11 28009
## - EnclosedPorch  1 1.1938e+08 4.5277e+11 28009
## - X3SsnPorch     1 1.5115e+08 4.5281e+11 28009
## - FullBath       1 1.5870e+08 4.5281e+11 28009
## - Condition2     1 2.5472e+08 4.5291e+11 28009
## - Electrical     1 2.7322e+08 4.5293e+11 28009
## - GarageCond     1 3.1214e+08 4.5297e+11 28009
## - YearRemodAdd   1 3.1545e+08 4.5297e+11 28009
## - LotFrontage    1 3.1821e+08 4.5297e+11 28009
## - LandSlope      1 3.5106e+08 4.5301e+11 28009

```

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## - RoofMatl      1 3.7038e+08 4.5302e+11 28010
## - LotShape      1 3.7286e+08 4.5303e+11 28010
## - BsmtFinType1  1 3.9583e+08 4.5305e+11 28010
## - HeatingQC     1 3.9996e+08 4.5305e+11 28010
## - PavedDrive    1 5.9280e+08 4.5325e+11 28010
## - OpenPorchSF   1 6.4051e+08 4.5329e+11 28010
## - Foundation    1 6.8605e+08 4.5334e+11 28010
## - BsmtHalfBath  1 7.7672e+08 4.5343e+11 28011
## - SaleType      1 7.7956e+08 4.5343e+11 28011
## - GarageFinish  1 7.8892e+08 4.5344e+11 28011
## - YrSold        1 8.2480e+08 4.5348e+11 28011
## - BsmtFullBath  1 8.4532e+08 4.5350e+11 28011
## - Fence         1 9.6597e+08 4.5362e+11 28011
## - MSZoning      1 1.0400e+09 4.5369e+11 28012
## - Exterior2nd   1 1.1201e+09 4.5377e+11 28012
## - BsmtCond      1 1.2030e+09 4.5386e+11 28012
## - Utilities     1 1.3108e+09 4.5396e+11 28012
## - GarageType    1 2.0664e+09 4.5472e+11 28015
## - MSSubClass    1 2.2656e+09 4.5492e+11 28015
## - BldgType      1 2.3307e+09 4.5498e+11 28016
## <none>          4.5265e+11 28016
## - TotRmsAbvGrd  1 2.3521e+09 4.5501e+11 28016
## - GarageYrBlt   1 2.4036e+09 4.5506e+11 28016
## - Exterior1st   1 2.5974e+09 4.5525e+11 28016
## - GarageArea    1 2.9729e+09 4.5563e+11 28018
## - GarageCars    1 3.0791e+09 4.5573e+11 28018
## - BsmtExposure  1 3.1201e+09 4.5577e+11 28018
## - ScreenPorch   1 3.4351e+09 4.5609e+11 28019
## - WoodDeckSF    1 4.3876e+09 4.5704e+11 28022
## - BsmtUnfSF     1 4.7615e+09 4.5742e+11 28023
## - FireplaceQu   1 5.9660e+09 4.5862e+11 28027
## - MasVnrType    1 6.5061e+09 4.5916e+11 28028
## - BedroomAbvGr  1 6.6086e+09 4.5926e+11 28029
## - Fireplaces    1 6.7657e+09 4.5942e+11 28029
## - KitchenAbvGr  1 9.0690e+09 4.6172e+11 28036
## - BsmtQual      1 9.2915e+09 4.6195e+11 28037
## - Street        1 1.0085e+10 4.6274e+11 28039
## - BsmtFinSF2    1 1.1122e+10 4.6378e+11 28042
## - SaleCondition 1 1.5569e+10 4.6822e+11 28056
## - YearBuilt     1 1.6621e+10 4.6927e+11 28059
## - MasVnrArea    1 1.8646e+10 4.7130e+11 28065
## - Functional    1 2.0277e+10 4.7293e+11 28070
## - KitchenQual   1 2.0646e+10 4.7330e+11 28071
## - ExterQual     1 2.2795e+10 4.7545e+11 28078
## - LotArea       1 2.2804e+10 4.7546e+11 28078
## - OverallCond   1 2.6570e+10 4.7922e+11 28089
## - BsmtFinSF1    1 3.2149e+10 4.8480e+11 28105
## - OverallQual   1 5.2514e+10 5.0517e+11 28163
## - X1stFlrSF     1 8.3922e+10 5.3658e+11 28248
## - X2ndFlrSF     1 1.2388e+11 5.7654e+11 28349
##
## Step: AIC=28008.65
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
## LotShape + Utilities + LandSlope + Condition2 + BldgType +

```



```

## OverallQual + OverallCond + YearBuilt + YearRemodAdd + RoofMatl +
## Exterior1st + Exterior2nd + MasVnrType + MasVnrArea + ExterQual +
## Foundation + BsmtQual + BsmtCond + BsmtExposure + BsmtFinType1 +
## BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF + HeatingQC + Electrical +
## X1stFlrSF + X2ndFlrSF + BsmtFullBath + BsmtHalfBath + FullBath +
## BedroomAbvGr + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +
## Functional + Fireplaces + FireplaceQu + GarageType + GarageYrBlt +
## GarageFinish + GarageCars + GarageArea + GarageCond + PavedDrive +
## WoodDeckSF + OpenPorchSF + EnclosedPorch + X3SsnPorch + ScreenPorch +
## Fence + YrSold + SaleType + SaleCondition
##
##          Df Sum of Sq      RSS      AIC
## - EnclosedPorch  1 1.1916e+08 4.5288e+11 28002
## - X3SsnPorch    1 1.5227e+08 4.5291e+11 28002
## - FullBath      1 1.8839e+08 4.5295e+11 28002
## - Condition2    1 2.4619e+08 4.5301e+11 28002
## - Electrical    1 2.7004e+08 4.5303e+11 28002
## - GarageCond    1 2.9977e+08 4.5306e+11 28002
## - YearRemodAdd  1 3.0451e+08 4.5307e+11 28002
## - LotFrontage   1 3.3534e+08 4.5310e+11 28002
## - LandSlope     1 3.3721e+08 4.5310e+11 28002
## - RoofMatl      1 3.5162e+08 4.5311e+11 28002
## - LotShape      1 3.5563e+08 4.5312e+11 28002
## - HeatingQC     1 3.8738e+08 4.5315e+11 28003
## - BsmtFinType1  1 4.1400e+08 4.5318e+11 28003
## - PavedDrive    1 5.6827e+08 4.5333e+11 28003
## - OpenPorchSF   1 6.2060e+08 4.5338e+11 28003
## - Foundation    1 6.8881e+08 4.5345e+11 28004
## - SaleType      1 7.7189e+08 4.5353e+11 28004
## - BsmtHalfBath  1 7.7664e+08 4.5354e+11 28004
## - YrSold        1 8.2627e+08 4.5359e+11 28004
## - GarageFinish  1 8.3373e+08 4.5360e+11 28004
## - BsmtFullBath  1 8.3958e+08 4.5360e+11 28004
## - Fence         1 9.7364e+08 4.5374e+11 28004
## - MSZoning      1 1.0561e+09 4.5382e+11 28005
## - Exterior2nd   1 1.0798e+09 4.5384e+11 28005
## - BsmtCond      1 1.1900e+09 4.5395e+11 28005
## - Utilities     1 1.3369e+09 4.5410e+11 28006
## - GarageType    1 2.0946e+09 4.5486e+11 28008
## - MSSubClass    1 2.2843e+09 4.5505e+11 28008
## - BldgType      1 2.3372e+09 4.5510e+11 28009
## <none>          4.5276e+11 28009
## - GarageYrBlt   1 2.3562e+09 4.5512e+11 28009
## - TotRmsAbvGrd  1 2.4137e+09 4.5518e+11 28009
## - Exterior1st   1 2.5609e+09 4.5532e+11 28009
## - GarageArea    1 2.9197e+09 4.5568e+11 28010
## - BsmtExposure  1 3.0601e+09 4.5582e+11 28011
## - GarageCars    1 3.1179e+09 4.5588e+11 28011
## - ScreenPorch   1 3.4939e+09 4.5626e+11 28012
## - WoodDeckSF    1 4.4331e+09 4.5720e+11 28015
## - BsmtUnfSF     1 4.7366e+09 4.5750e+11 28016
## - FireplaceQu   1 5.9935e+09 4.5876e+11 28020
## - MasVnrType    1 6.4312e+09 4.5919e+11 28021
## - BedroomAbvGr  1 6.6619e+09 4.5942e+11 28022

```

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## - Fireplaces      1 6.7277e+09 4.5949e+11 28022
## - KitchenAbvGr    1 9.0513e+09 4.6181e+11 28029
## - BsmtQual        1 9.2346e+09 4.6200e+11 28030
## - Street          1 1.0050e+10 4.6281e+11 28032
## - BsmtFinSF2      1 1.1147e+10 4.6391e+11 28036
## - SaleCondition   1 1.5713e+10 4.6848e+11 28049
## - YearBuilt       1 1.6605e+10 4.6937e+11 28052
## - MasVnrArea      1 1.9267e+10 4.7203e+11 28060
## - Functional      1 2.0229e+10 4.7299e+11 28063
## - KitchenQual     1 2.0573e+10 4.7334e+11 28064
## - LotArea         1 2.2815e+10 4.7558e+11 28071
## - ExterQual       1 2.3325e+10 4.7609e+11 28072
## - OverallCond     1 2.6726e+10 4.7949e+11 28082
## - BsmtFinSF1      1 3.2376e+10 4.8514e+11 28099
## - OverallQual     1 5.2952e+10 5.0571e+11 28157
## - X1stFlrSF       1 8.4956e+10 5.3772e+11 28244
## - X2ndFlrSF       1 1.2379e+11 5.7655e+11 28342
##
## Step:  AIC=28001.77
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
##   LotShape + Utilities + LandSlope + Condition2 + BldgType +
##   OverallQual + OverallCond + YearBuilt + YearRemodAdd + RoofMatl +
##   Exterior1st + Exterior2nd + MasVnrType + MasVnrArea + ExterQual +
##   Foundation + BsmtQual + BsmtCond + BsmtExposure + BsmtFinType1 +
##   BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF + HeatingQC + Electrical +
##   X1stFlrSF + X2ndFlrSF + BsmtFullBath + BsmtHalfBath + FullBath +
##   BedroomAbvGr + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +
##   Functional + Fireplaces + FireplaceQu + GarageType + GarageYrBlt +
##   GarageFinish + GarageCars + GarageArea + GarageCond + PavedDrive +
##   WoodDeckSF + OpenPorchSF + X3SsnPorch + ScreenPorch + Fence +
##   YrSold + SaleType + SaleCondition
##
##           Df  Sum of Sq      RSS   AIC
## - X3SsnPorch    1 1.4136e+08 4.5302e+11 27995
## - FullBath      1 1.8180e+08 4.5306e+11 27995
## - Condition2    1 2.3382e+08 4.5312e+11 27995
## - Electrical    1 2.7116e+08 4.5315e+11 27995
## - GarageCond    1 3.0274e+08 4.5318e+11 27996
## - YearRemodAdd  1 3.1857e+08 4.5320e+11 27996
## - LandSlope     1 3.3063e+08 4.5321e+11 27996
## - RoofMatl      1 3.3852e+08 4.5322e+11 27996
## - LotFrontage   1 3.4148e+08 4.5322e+11 27996
## - LotShape      1 3.5821e+08 4.5324e+11 27996
## - HeatingQC     1 3.9455e+08 4.5328e+11 27996
## - BsmtFinType1  1 4.1758e+08 4.5330e+11 27996
## - PavedDrive    1 5.5374e+08 4.5344e+11 27996
## - OpenPorchSF   1 5.8496e+08 4.5347e+11 27996
## - Foundation    1 7.0417e+08 4.5359e+11 27997
## - BsmtHalfBath  1 7.8452e+08 4.5367e+11 27997
## - SaleType      1 7.9201e+08 4.5367e+11 27997
## - GarageFinish  1 8.2962e+08 4.5371e+11 27997
## - YrSold        1 8.3350e+08 4.5372e+11 27997
## - BsmtFullBath  1 8.6444e+08 4.5375e+11 27997
## - Fence        1 9.7629e+08 4.5386e+11 27998

```

```

## - MSZoning      1 1.0512e+09 4.5393e+11 27998
## - Exterior2nd   1 1.0795e+09 4.5396e+11 27998
## - BsmtCond      1 1.2030e+09 4.5408e+11 27998
## - Utilities     1 1.3364e+09 4.5422e+11 27999
## - GarageType    1 2.0787e+09 4.5496e+11 28001
## - MSSubClass    1 2.2748e+09 4.5516e+11 28002
## <none>          4.5288e+11 28002
## - GarageYrBlt   1 2.3450e+09 4.5523e+11 28002
## - TotRmsAbvGrd  1 2.3537e+09 4.5524e+11 28002
## - BldgType       1 2.3676e+09 4.5525e+11 28002
## - Exterior1st   1 2.5841e+09 4.5547e+11 28002
## - GarageArea    1 2.9371e+09 4.5582e+11 28004
## - BsmtExposure  1 3.1007e+09 4.5598e+11 28004
## - GarageCars    1 3.1106e+09 4.5599e+11 28004
## - ScreenPorch   1 3.3860e+09 4.5627e+11 28005
## - WoodDeckSF    1 4.3503e+09 4.5723e+11 28008
## - BsmtUnfSF     1 4.7660e+09 4.5765e+11 28009
## - FireplaceQu   1 5.9299e+09 4.5881e+11 28013
## - MasVnrType     1 6.4394e+09 4.5932e+11 28014
## - BedroomAbvGr  1 6.6466e+09 4.5953e+11 28015
## - Fireplaces    1 6.7543e+09 4.5964e+11 28015
## - KitchenAbvGr  1 9.1187e+09 4.6200e+11 28023
## - BsmtQual      1 9.3015e+09 4.6218e+11 28023
## - Street        1 1.0101e+10 4.6298e+11 28026
## - BsmtFinSF2    1 1.1262e+10 4.6414e+11 28029
## - SaleCondition 1 1.5665e+10 4.6855e+11 28042
## - YearBuilt     1 1.7215e+10 4.7010e+11 28047
## - MasVnrArea    1 1.9233e+10 4.7211e+11 28053
## - Functional    1 2.0294e+10 4.7318e+11 28056
## - KitchenQual   1 2.0576e+10 4.7346e+11 28057
## - LotArea       1 2.2738e+10 4.7562e+11 28064
## - ExterQual     1 2.3359e+10 4.7624e+11 28065
## - OverallCond   1 2.6629e+10 4.7951e+11 28075
## - BsmtFinSF1    1 3.2371e+10 4.8525e+11 28092
## - OverallQual   1 5.3717e+10 5.0660e+11 28152
## - X1stFlrSF     1 8.5098e+10 5.3798e+11 28237
## - X2ndFlrSF     1 1.2456e+11 5.7744e+11 28337
##
## Step:  AIC=27994.96
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
##   LotShape + Utilities + LandSlope + Condition2 + BldgType +
##   OverallQual + OverallCond + YearBuilt + YearRemodAdd + RoofMatl +
##   Exterior1st + Exterior2nd + MasVnrType + MasVnrArea + ExterQual +
##   Foundation + BsmtQual + BsmtCond + BsmtExposure + BsmtFinType1 +
##   BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF + HeatingQC + Electrical +
##   X1stFlrSF + X2ndFlrSF + BsmtFullBath + BsmtHalfBath + FullBath +
##   BedroomAbvGr + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +
##   Functional + Fireplaces + FireplaceQu + GarageType + GarageYrBlt +
##   GarageFinish + GarageCars + GarageArea + GarageCond + PavedDrive +
##   WoodDeckSF + OpenPorchSF + ScreenPorch + Fence + YrSold +
##   SaleType + SaleCondition
##
##           Df Sum of Sq      RSS   AIC
## - FullBath  1 1.7299e+08 4.5320e+11 27988

```

## - Condition2	1	2.3329e+08	4.5326e+11	27988
## - Electrical	1	2.7711e+08	4.5330e+11	27989
## - GarageCond	1	2.9716e+08	4.5332e+11	27989
## - LandSlope	1	3.2756e+08	4.5335e+11	27989
## - YearRemodAdd	1	3.2857e+08	4.5335e+11	27989
## - RoofMatl	1	3.3809e+08	4.5336e+11	27989
## - LotFrontage	1	3.6449e+08	4.5339e+11	27989
## - LotShape	1	3.6962e+08	4.5339e+11	27989
## - BsmtFinType1	1	3.9581e+08	4.5342e+11	27989
## - HeatingQC	1	4.1151e+08	4.5343e+11	27989
## - PavedDrive	1	5.4786e+08	4.5357e+11	27989
## - OpenPorchSF	1	5.7262e+08	4.5360e+11	27990
## - Foundation	1	7.3256e+08	4.5376e+11	27990
## - BsmtHalfBath	1	7.6403e+08	4.5379e+11	27990
## - SaleType	1	7.9361e+08	4.5382e+11	27990
## - GarageFinish	1	8.1006e+08	4.5383e+11	27990
## - YrSold	1	8.2242e+08	4.5385e+11	27990
## - BsmtFullBath	1	8.6483e+08	4.5389e+11	27990
## - Fence	1	9.7652e+08	4.5400e+11	27991
## - MSZoning	1	1.0397e+09	4.5406e+11	27991
## - Exterior2nd	1	1.0979e+09	4.5412e+11	27991
## - BsmtCond	1	1.2268e+09	4.5425e+11	27992
## - Utilities	1	1.3425e+09	4.5437e+11	27992
## - GarageType	1	2.0509e+09	4.5507e+11	27994
## - MSSubClass	1	2.2664e+09	4.5529e+11	27995
## - TotRmsAbvGrd	1	2.3342e+09	4.5536e+11	27995
## <none>			4.5302e+11	27995
## - GarageYrBlt	1	2.3497e+09	4.5537e+11	27995
## - BldgType	1	2.3854e+09	4.5541e+11	27995
## - Exterior1st	1	2.6445e+09	4.5567e+11	27996
## - GarageArea	1	2.9391e+09	4.5596e+11	27997
## - BsmtExposure	1	3.0605e+09	4.5608e+11	27997
## - GarageCars	1	3.1114e+09	4.5613e+11	27997
## - ScreenPorch	1	3.3355e+09	4.5636e+11	27998
## - WoodDeckSF	1	4.2743e+09	4.5730e+11	28001
## - BsmtUnfSF	1	4.7682e+09	4.5779e+11	28002
## - FireplaceQu	1	5.9605e+09	4.5898e+11	28006
## - MasVnrType	1	6.3822e+09	4.5941e+11	28007
## - Fireplaces	1	6.7256e+09	4.5975e+11	28008
## - BedroomAbvGr	1	6.7444e+09	4.5977e+11	28008
## - KitchenAbvGr	1	9.1937e+09	4.6222e+11	28016
## - BsmtQual	1	9.2920e+09	4.6231e+11	28016
## - Street	1	1.0096e+10	4.6312e+11	28019
## - BsmtFinSF2	1	1.1190e+10	4.6421e+11	28022
## - SaleCondition	1	1.5619e+10	4.6864e+11	28035
## - YearBuilt	1	1.7170e+10	4.7019e+11	28040
## - MasVnrArea	1	1.9213e+10	4.7224e+11	28046
## - Functional	1	2.0361e+10	4.7338e+11	28050
## - KitchenQual	1	2.0494e+10	4.7352e+11	28050
## - LotArea	1	2.2783e+10	4.7581e+11	28057
## - ExterQual	1	2.3407e+10	4.7643e+11	28059
## - OverallCond	1	2.6723e+10	4.7975e+11	28068
## - BsmtFinSF1	1	3.2318e+10	4.8534e+11	28085
## - OverallQual	1	5.3665e+10	5.0669e+11	28145

```

## - X1stFlrSF      1 8.5630e+10 5.3865e+11 28232
## - X2ndFlrSF      1 1.2490e+11 5.7792e+11 28331
##
## Step: AIC=27988.24
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
## LotShape + Utilities + LandSlope + Condition2 + BldgType +
## OverallQual + OverallCond + YearBuilt + YearRemodAdd + RoofMatl +
## Exterior1st + Exterior2nd + MasVnrType + MasVnrArea + ExterQual +
## Foundation + BsmtQual + BsmtCond + BsmtExposure + BsmtFinType1 +
## BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF + HeatingQC + Electrical +
## X1stFlrSF + X2ndFlrSF + BsmtFullBath + BsmtHalfBath + BedroomAbvGr +
## KitchenAbvGr + KitchenQual + TotRmsAbvGrd + Functional +
## Fireplaces + FireplaceQu + GarageType + GarageYrBlt + GarageFinish +
## GarageCars + GarageArea + GarageCond + PavedDrive + WoodDeckSF +
## OpenPorchSF + ScreenPorch + Fence + YrSold + SaleType + SaleCondition
##
##           Df Sum of Sq      RSS   AIC
## - Condition2      1 2.3906e+08 4.5344e+11 27982
## - GarageCond      1 2.9360e+08 4.5349e+11 27982
## - YearRemodAdd    1 2.9467e+08 4.5349e+11 27982
## - Electrical      1 3.0045e+08 4.5350e+11 27982
## - LandSlope       1 3.2956e+08 4.5353e+11 27982
## - RoofMatl        1 3.5918e+08 4.5356e+11 27982
## - LotShape        1 3.6824e+08 4.5356e+11 27982
## - HeatingQC       1 3.9220e+08 4.5359e+11 27982
## - LotFrontage     1 3.9228e+08 4.5359e+11 27982
## - BsmtFinType1    1 4.1048e+08 4.5361e+11 27982
## - OpenPorchSF     1 5.5729e+08 4.5375e+11 27983
## - PavedDrive      1 5.5957e+08 4.5376e+11 27983
## - BsmtHalfBath    1 7.1950e+08 4.5392e+11 27983
## - Foundation      1 7.4926e+08 4.5395e+11 27983
## - GarageFinish    1 7.9390e+08 4.5399e+11 27984
## - SaleType        1 7.9951e+08 4.5400e+11 27984
## - YrSold          1 8.4156e+08 4.5404e+11 27984
## - Fence           1 9.4087e+08 4.5414e+11 27984
## - MSZoning        1 9.7838e+08 4.5417e+11 27984
## - BsmtFullBath    1 1.0230e+09 4.5422e+11 27984
## - Exterior2nd     1 1.0743e+09 4.5427e+11 27984
## - BsmtCond        1 1.2641e+09 4.5446e+11 27985
## - Utilities       1 1.3391e+09 4.5454e+11 27985
## - GarageType      1 2.1239e+09 4.5532e+11 27988
## - GarageYrBlt     1 2.2819e+09 4.5548e+11 27988
## - MSSubClass      1 2.3179e+09 4.5551e+11 27988
## <none>              4.5320e+11 27988
## - TotRmsAbvGrd    1 2.3411e+09 4.5554e+11 27988
## - BldgType        1 2.4151e+09 4.5561e+11 27988
## - Exterior1st     1 2.6539e+09 4.5585e+11 27989
## - GarageArea      1 2.9721e+09 4.5617e+11 27990
## - GarageCars      1 3.0348e+09 4.5623e+11 27990
## - BsmtExposure    1 3.1446e+09 4.5634e+11 27991
## - ScreenPorch     1 3.4285e+09 4.5662e+11 27992
## - WoodDeckSF      1 4.2775e+09 4.5747e+11 27994
## - BsmtUnfSF       1 4.8060e+09 4.5800e+11 27996
## - FireplaceQu     1 6.2203e+09 4.5942e+11 28000

```

```

## - MasVnrType      1 6.3815e+09 4.5958e+11 28001
## - Fireplaces      1 6.8194e+09 4.6002e+11 28002
## - BedroomAbvGr    1 7.2382e+09 4.6043e+11 28003
## - BsmtQual        1 9.1201e+09 4.6232e+11 28009
## - KitchenAbvGr    1 9.7194e+09 4.6292e+11 28011
## - Street          1 1.0056e+10 4.6325e+11 28012
## - BsmtFinSF2      1 1.1247e+10 4.6444e+11 28016
## - SaleCondition   1 1.5557e+10 4.6875e+11 28028
## - YearBuilt       1 1.7023e+10 4.7022e+11 28033
## - MasVnrArea      1 1.9479e+10 4.7267e+11 28040
## - Functional      1 2.0387e+10 4.7358e+11 28043
## - KitchenQual     1 2.0451e+10 4.7365e+11 28043
## - LotArea         1 2.2631e+10 4.7583e+11 28050
## - ExterQual       1 2.3475e+10 4.7667e+11 28052
## - OverallCond     1 2.6787e+10 4.7998e+11 28062
## - BsmtFinSF1      1 3.2407e+10 4.8560e+11 28078
## - OverallQual     1 5.3492e+10 5.0669e+11 28138
## - X1stFlrSF       1 8.7860e+10 5.4106e+11 28230
## - X2ndFlrSF       1 1.2874e+11 5.8193e+11 28333
##
## Step: AIC=27981.74
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
##   LotShape + Utilities + LandSlope + BldgType + OverallQual +
##   OverallCond + YearBuilt + YearRemodAdd + RoofMatl + Exterior1st +
##   Exterior2nd + MasVnrType + MasVnrArea + ExterQual + Foundation +
##   BsmtQual + BsmtCond + BsmtExposure + BsmtFinType1 + BsmtFinSF1 +
##   BsmtFinSF2 + BsmtUnfSF + HeatingQC + Electrical + X1stFlrSF +
##   X2ndFlrSF + BsmtFullBath + BsmtHalfBath + BedroomAbvGr +
##   KitchenAbvGr + KitchenQual + TotRmsAbvGrd + Functional +
##   Fireplaces + FireplaceQu + GarageType + GarageYrBlt + GarageFinish +
##   GarageCars + GarageArea + GarageCond + PavedDrive + WoodDeckSF +
##   OpenPorchSF + ScreenPorch + Fence + YrSold + SaleType + SaleCondition
##
##           Df Sum of Sq      RSS   AIC
## - GarageCond      1 2.6606e+08 4.5370e+11 27975
## - Electrical      1 3.0804e+08 4.5374e+11 27975
## - YearRemodAdd     1 3.1104e+08 4.5375e+11 27976
## - LotShape        1 3.4524e+08 4.5378e+11 27976
## - LandSlope       1 3.4744e+08 4.5378e+11 27976
## - RoofMatl        1 3.5148e+08 4.5379e+11 27976
## - HeatingQC       1 3.7825e+08 4.5381e+11 27976
## - BsmtFinType1    1 3.9529e+08 4.5383e+11 27976
## - LotFrontage     1 4.0498e+08 4.5384e+11 27976
## - OpenPorchSF     1 5.5214e+08 4.5399e+11 27976
## - PavedDrive      1 5.9147e+08 4.5403e+11 27976
## - BsmtHalfBath    1 7.1068e+08 4.5415e+11 27977
## - Foundation      1 7.7385e+08 4.5421e+11 27977
## - GarageFinish    1 7.9657e+08 4.5423e+11 27977
## - SaleType        1 8.0723e+08 4.5424e+11 27977
## - YrSold          1 8.2162e+08 4.5426e+11 27977
## - Fence           1 9.2953e+08 4.5436e+11 27977
## - BsmtFullBath    1 1.0398e+09 4.5447e+11 27978
## - MSZoning        1 1.0437e+09 4.5448e+11 27978
## - Exterior2nd     1 1.0989e+09 4.5453e+11 27978

```

```

## - BsmtCond      1 1.2450e+09 4.5468e+11 27978
## - Utilities     1 1.3352e+09 4.5477e+11 27979
## - GarageType    1 2.0406e+09 4.5548e+11 27981
## - MSSubClass    1 2.2040e+09 4.5564e+11 27981
## - GarageYrBlt   1 2.2759e+09 4.5571e+11 27982
## - TotRmsAbvGrd  1 2.3037e+09 4.5574e+11 27982
## <none>          4.5344e+11 27982
## - BldgType      1 2.5331e+09 4.5597e+11 27982
## - Exterior1st   1 2.6873e+09 4.5612e+11 27983
## - GarageArea    1 2.8589e+09 4.5629e+11 27983
## - BsmtExposure  1 3.1415e+09 4.5658e+11 27984
## - GarageCars    1 3.1437e+09 4.5658e+11 27984
## - ScreenPorch   1 3.4334e+09 4.5687e+11 27985
## - WoodDeckSF    1 4.2771e+09 4.5771e+11 27988
## - BsmtUnfSF     1 4.7932e+09 4.5823e+11 27989
## - FireplaceQu   1 6.2382e+09 4.5967e+11 27994
## - MasVnrType    1 6.4210e+09 4.5986e+11 27994
## - Fireplaces    1 6.8441e+09 4.6028e+11 27996
## - BedroomAbvGr  1 7.1671e+09 4.6060e+11 27997
## - BsmtQual      1 9.2703e+09 4.6271e+11 28003
## - KitchenAbvGr  1 9.9088e+09 4.6334e+11 28005
## - Street        1 1.0060e+10 4.6350e+11 28005
## - BsmtFinSF2    1 1.1089e+10 4.6452e+11 28008
## - SaleCondition 1 1.5443e+10 4.6888e+11 28022
## - YearBuilt     1 1.6839e+10 4.7027e+11 28026
## - MasVnrArea    1 1.9456e+10 4.7289e+11 28034
## - KitchenQual   1 2.0300e+10 4.7374e+11 28036
## - Functional    1 2.0380e+10 4.7382e+11 28036
## - LotArea       1 2.2532e+10 4.7597e+11 28043
## - ExterQual     1 2.3512e+10 4.7695e+11 28046
## - OverallCond   1 2.6667e+10 4.8010e+11 28055
## - BsmtFinSF1    1 3.2325e+10 4.8576e+11 28071
## - OverallQual   1 5.3611e+10 5.0705e+11 28132
## - X1stFlrSF     1 8.8058e+10 5.4149e+11 28224
## - X2ndFlrSF     1 1.2859e+11 5.8202e+11 28326
##
## Step: AIC=27975.31
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
## LotShape + Utilities + LandSlope + BldgType + OverallQual +
## OverallCond + YearBuilt + YearRemodAdd + RoofMatl + Exterior1st +
## Exterior2nd + MasVnrType + MasVnrArea + ExterQual + Foundation +
## BsmtQual + BsmtCond + BsmtExposure + BsmtFinType1 + BsmtFinSF1 +
## BsmtFinSF2 + BsmtUnfSF + HeatingQC + Electrical + X1stFlrSF +
## X2ndFlrSF + BsmtFullBath + BsmtHalfBath + BedroomAbvGr +
## KitchenAbvGr + KitchenQual + TotRmsAbvGrd + Functional +
## Fireplaces + FireplaceQu + GarageType + GarageYrBlt + GarageFinish +
## GarageCars + GarageArea + PavedDrive + WoodDeckSF + OpenPorchSF +
## ScreenPorch + Fence + YrSold + SaleType + SaleCondition
##
##           Df Sum of Sq      RSS   AIC
## - YearRemodAdd 1 3.0737e+08 4.5401e+11 27969
## - Electrical   1 3.1111e+08 4.5401e+11 27969
## - RoofMatl     1 3.1926e+08 4.5402e+11 27969
## - LandSlope    1 3.3793e+08 4.5404e+11 27969

```

```

## - HeatingQC      1 3.4571e+08 4.5405e+11 27969
## - LotShape       1 3.4639e+08 4.5405e+11 27969
## - BsmtFinType1   1 3.8265e+08 4.5408e+11 27969
## - LotFrontage    1 4.0529e+08 4.5411e+11 27969
## - OpenPorchSF    1 5.6187e+08 4.5426e+11 27970
## - PavedDrive     1 6.6570e+08 4.5437e+11 27970
## - BsmtHalfBath   1 6.8689e+08 4.5439e+11 27970
## - GarageFinish   1 7.8004e+08 4.5448e+11 27970
## - YrSold         1 8.0741e+08 4.5451e+11 27971
## - SaleType       1 8.1178e+08 4.5451e+11 27971
## - Foundation     1 8.1468e+08 4.5452e+11 27971
## - Fence          1 9.4364e+08 4.5464e+11 27971
## - BsmtFullBath   1 1.0417e+09 4.5474e+11 27971
## - MSZoning       1 1.0551e+09 4.5476e+11 27971
## - Exterior2nd    1 1.0933e+09 4.5479e+11 27972
## - Utilities      1 1.3442e+09 4.5505e+11 27972
## - BsmtCond       1 1.3845e+09 4.5509e+11 27972
## - GarageType     1 1.9634e+09 4.5566e+11 27974
## - GarageYrBlt    1 2.0123e+09 4.5571e+11 27974
## - MSSubClass     1 2.2137e+09 4.5591e+11 27975
## - TotRmsAbvGrd   1 2.2776e+09 4.5598e+11 27975
## <none>           4.5370e+11 27975
## - BldgType       1 2.4975e+09 4.5620e+11 27976
## - Exterior1st    1 2.6421e+09 4.5634e+11 27976
## - GarageArea     1 2.9116e+09 4.5661e+11 27977
## - BsmtExposure   1 3.1128e+09 4.5681e+11 27978
## - GarageCars     1 3.1135e+09 4.5681e+11 27978
## - ScreenPorch    1 3.5418e+09 4.5724e+11 27979
## - WoodDeckSF     1 4.3471e+09 4.5805e+11 27982
## - BsmtUnfSF      1 4.7056e+09 4.5841e+11 27983
## - FireplaceQu    1 6.2293e+09 4.5993e+11 27987
## - MasVnrType     1 6.3618e+09 4.6006e+11 27988
## - Fireplaces     1 6.9480e+09 4.6065e+11 27990
## - BedroomAbvGr   1 7.1625e+09 4.6086e+11 27990
## - BsmtQual       1 9.0496e+09 4.6275e+11 27996
## - KitchenAbvGr   1 9.9163e+09 4.6362e+11 27998
## - Street         1 1.0053e+10 4.6375e+11 27999
## - BsmtFinSF2     1 1.0958e+10 4.6466e+11 28002
## - SaleCondition   1 1.5372e+10 4.6907e+11 28015
## - YearBuilt      1 1.7465e+10 4.7117e+11 28021
## - MasVnrArea     1 1.9306e+10 4.7301e+11 28027
## - Functional     1 2.0273e+10 4.7397e+11 28030
## - KitchenQual    1 2.0300e+10 4.7400e+11 28030
## - LotArea        1 2.2695e+10 4.7640e+11 28037
## - ExterQual      1 2.3589e+10 4.7729e+11 28039
## - OverallCond    1 2.6995e+10 4.8070e+11 28049
## - BsmtFinSF1     1 3.2141e+10 4.8584e+11 28064
## - OverallQual    1 5.3966e+10 5.0767e+11 28126
## - X1stFlrSF     1 8.8571e+10 5.4227e+11 28219
## - X2ndFlrSF     1 1.2873e+11 5.8243e+11 28320
##
## Step: AIC=27969.02
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
## LotShape + Utilities + LandSlope + BldgType + OverallQual +

```



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## OverallCond + YearBuilt + RoofMatl + Exterior1st + Exterior2nd +
## MasVnrType + MasVnrArea + ExterQual + Foundation + BsmtQual +
## BsmtCond + BsmtExposure + BsmtFinType1 + BsmtFinSF1 + BsmtFinSF2 +
## BsmtUnfSF + HeatingQC + Electrical + X1stFlrSF + X2ndFlrSF +
## BsmtFullBath + BsmtHalfBath + BedroomAbvGr + KitchenAbvGr +
## KitchenQual + TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu +
## GarageType + GarageYrBlt + GarageFinish + GarageCars + GarageArea +
## PavedDrive + WoodDeckSF + OpenPorchSF + ScreenPorch + Fence +
## YrSold + SaleType + SaleCondition
##
##          Df Sum of Sq      RSS      AIC
## - Electrical      1 2.3208e+08 4.5424e+11 27962
## - RoofMatl        1 2.8335e+08 4.5429e+11 27963
## - LandSlope       1 3.3454e+08 4.5434e+11 27963
## - LotShape        1 3.3731e+08 4.5435e+11 27963
## - LotFrontage     1 3.6971e+08 4.5438e+11 27963
## - BsmtFinType1    1 3.8734e+08 4.5440e+11 27963
## - HeatingQC       1 4.6381e+08 4.5447e+11 27963
## - OpenPorchSF     1 5.8754e+08 4.5460e+11 27964
## - PavedDrive      1 5.9599e+08 4.5460e+11 27964
## - BsmtHalfBath    1 6.7203e+08 4.5468e+11 27964
## - YrSold          1 7.5942e+08 4.5477e+11 27964
## - SaleType        1 7.8082e+08 4.5479e+11 27964
## - Foundation      1 8.2545e+08 4.5483e+11 27964
## - GarageFinish    1 8.3190e+08 4.5484e+11 27964
## - Fence           1 9.1988e+08 4.5493e+11 27965
## - MSZoning        1 1.0932e+09 4.5510e+11 27965
## - BsmtFullBath    1 1.0969e+09 4.5511e+11 27965
## - Exterior2nd     1 1.1154e+09 4.5512e+11 27965
## - BsmtCond        1 1.3115e+09 4.5532e+11 27966
## - Utilities       1 1.3545e+09 4.5536e+11 27966
## - GarageType      1 1.9497e+09 4.5596e+11 27968
## - GarageYrBlt     1 2.1204e+09 4.5613e+11 27968
## - MSSubClass      1 2.2039e+09 4.5621e+11 27969
## - TotRmsAbvGrd    1 2.3222e+09 4.5633e+11 27969
## <none>                4.5401e+11 27969
## - BldgType        1 2.4803e+09 4.5649e+11 27969
## - Exterior1st     1 2.5268e+09 4.5654e+11 27970
## - GarageArea      1 2.8654e+09 4.5687e+11 27971
## - BsmtExposure    1 3.1326e+09 4.5714e+11 27971
## - GarageCars      1 3.2390e+09 4.5725e+11 27972
## - ScreenPorch     1 3.5419e+09 4.5755e+11 27973
## - WoodDeckSF      1 4.3963e+09 4.5840e+11 27975
## - BsmtUnfSF       1 4.7054e+09 4.5871e+11 27976
## - FireplaceQu     1 6.2431e+09 4.6025e+11 27981
## - MasVnrType      1 6.4551e+09 4.6046e+11 27982
## - Fireplaces      1 6.6997e+09 4.6071e+11 27982
## - BedroomAbvGr    1 7.4549e+09 4.6146e+11 27985
## - BsmtQual        1 9.2380e+09 4.6325e+11 27990
## - KitchenAbvGr    1 9.9566e+09 4.6397e+11 27992
## - Street          1 1.0199e+10 4.6421e+11 27993
## - BsmtFinSF2      1 1.0849e+10 4.6486e+11 27995
## - SaleCondition    1 1.5656e+10 4.6966e+11 28010
## - MasVnrArea      1 1.9069e+10 4.7308e+11 28020

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## - Functional      1 2.0002e+10 4.7401e+11 28022
## - KitchenQual     1 2.1194e+10 4.7520e+11 28026
## - YearBuilt       1 2.1660e+10 4.7567e+11 28027
## - LotArea         1 2.2763e+10 4.7677e+11 28031
## - ExterQual       1 2.3643e+10 4.7765e+11 28033
## - BsmtFinSF1      1 3.1925e+10 4.8593e+11 28057
## - OverallCond     1 3.4689e+10 4.8870e+11 28065
## - OverallQual     1 5.4526e+10 5.0853e+11 28122
## - X1stFlrSF       1 8.9998e+10 5.4401e+11 28216
## - X2ndFlrSF       1 1.3032e+11 5.8433e+11 28317
##
## Step:  AIC=27962.49
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
##   LotShape + Utilities + LandSlope + BldgType + OverallQual +
##   OverallCond + YearBuilt + RoofMatl + Exterior1st + Exterior2nd +
##   MasVnrType + MasVnrArea + ExterQual + Foundation + BsmtQual +
##   BsmtCond + BsmtExposure + BsmtFinType1 + BsmtFinSF1 + BsmtFinSF2 +
##   BsmtUnfSF + HeatingQC + X1stFlrSF + X2ndFlrSF + BsmtFullBath +
##   BsmtHalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual +
##   TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu + GarageType +
##   GarageYrBlt + GarageFinish + GarageCars + GarageArea + PavedDrive +
##   WoodDeckSF + OpenPorchSF + ScreenPorch + Fence + YrSold +
##   SaleType + SaleCondition
##
##           Df  Sum of Sq      RSS   AIC
## - RoofMatl    1 2.8561e+08 4.5453e+11 27956
## - LandSlope   1 3.3688e+08 4.5458e+11 27956
## - LotShape    1 3.3791e+08 4.5458e+11 27956
## - LotFrontage 1 3.6009e+08 4.5460e+11 27956
## - BsmtFinType1 1 3.9182e+08 4.5463e+11 27956
## - HeatingQC   1 4.5852e+08 4.5470e+11 27957
## - PavedDrive  1 5.7573e+08 4.5482e+11 27957
## - OpenPorchSF 1 5.7819e+08 4.5482e+11 27957
## - BsmtHalfBath 1 6.7521e+08 4.5492e+11 27957
## - SaleType    1 7.6946e+08 4.5501e+11 27958
## - YrSold      1 7.9784e+08 4.5504e+11 27958
## - Foundation  1 8.1227e+08 4.5505e+11 27958
## - GarageFinish 1 8.2042e+08 4.5506e+11 27958
## - Fence       1 9.3750e+08 4.5518e+11 27958
## - BsmtFullBath 1 1.0805e+09 4.5532e+11 27959
## - MSZoning    1 1.1076e+09 4.5535e+11 27959
## - Exterior2nd 1 1.2140e+09 4.5545e+11 27959
## - BsmtCond    1 1.2524e+09 4.5549e+11 27959
## - Utilities   1 1.2580e+09 4.5550e+11 27959
## - GarageType  1 1.9177e+09 4.5616e+11 27961
## - GarageYrBlt 1 2.0665e+09 4.5631e+11 27962
## - MSSubClass  1 2.2793e+09 4.5652e+11 27962
## - TotRmsAbvGrd 1 2.3054e+09 4.5655e+11 27962
## <none>                4.5424e+11 27962
## - BldgType    1 2.4918e+09 4.5673e+11 27963
## - Exterior1st 1 2.6648e+09 4.5691e+11 27964
## - GarageArea  1 2.8088e+09 4.5705e+11 27964
## - BsmtExposure 1 3.1267e+09 4.5737e+11 27965
## - GarageCars  1 3.1903e+09 4.5743e+11 27965

```

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## - ScreenPorch      1 3.5211e+09 4.5776e+11 27966
## - WoodDeckSF       1 4.3223e+09 4.5856e+11 27969
## - BsmtUnfSF        1 4.7042e+09 4.5894e+11 27970
## - FireplaceQu      1 6.2404e+09 4.6048e+11 27974
## - MasVnrType       1 6.5501e+09 4.6079e+11 27975
## - Fireplaces       1 6.6343e+09 4.6087e+11 27976
## - BedroomAbvGr    1 7.6436e+09 4.6188e+11 27979
## - BsmtQual         1 9.3466e+09 4.6359e+11 27984
## - KitchenAbvGr    1 9.7896e+09 4.6403e+11 27985
## - Street          1 1.0129e+10 4.6437e+11 27986
## - BsmtFinSF2       1 1.0821e+10 4.6506e+11 27988
## - SaleCondition    1 1.5581e+10 4.6982e+11 28003
## - MasVnrArea       1 1.9254e+10 4.7349e+11 28014
## - Functional       1 2.0200e+10 4.7444e+11 28016
## - YearBuilt        1 2.1542e+10 4.7578e+11 28020
## - KitchenQual      1 2.1643e+10 4.7588e+11 28021
## - LotArea          1 2.2709e+10 4.7695e+11 28024
## - ExterQual        1 2.3628e+10 4.7787e+11 28027
## - BsmtFinSF1       1 3.1857e+10 4.8610e+11 28051
## - OverallCond      1 3.4840e+10 4.8908e+11 28059
## - OverallQual      1 5.4371e+10 5.0861e+11 28114
## - X1stFlrSF        1 9.0167e+10 5.4441e+11 28210
## - X2ndFlrSF        1 1.3082e+11 5.8506e+11 28312
##
## Step: AIC=27956.12
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
## LotShape + Utilities + LandSlope + BldgType + OverallQual +
## OverallCond + YearBuilt + Exterior1st + Exterior2nd + MasVnrType +
## MasVnrArea + ExterQual + Foundation + BsmtQual + BsmtCond +
## BsmtExposure + BsmtFinType1 + BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF +
## HeatingQC + X1stFlrSF + X2ndFlrSF + BsmtFullBath + BsmtHalfBath +
## BedroomAbvGr + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +
## Functional + Fireplaces + FireplaceQu + GarageType + GarageYrBlt +
## GarageFinish + GarageCars + GarageArea + PavedDrive + WoodDeckSF +
## OpenPorchSF + ScreenPorch + Fence + YrSold + SaleType + SaleCondition
##
##           Df Sum of Sq      RSS   AIC
## - LotShape      1 3.3724e+08 4.5486e+11 27950
## - BsmtFinType1   1 3.8250e+08 4.5491e+11 27950
## - HeatingQC      1 4.0116e+08 4.5493e+11 27950
## - LotFrontage    1 4.1387e+08 4.5494e+11 27950
## - LandSlope      1 4.3479e+08 4.5496e+11 27950
## - OpenPorchSF    1 5.7958e+08 4.5511e+11 27951
## - PavedDrive     1 6.0094e+08 4.5513e+11 27951
## - BsmtHalfBath   1 6.1719e+08 4.5514e+11 27951
## - SaleType       1 7.4043e+08 4.5527e+11 27951
## - Foundation     1 8.2369e+08 4.5535e+11 27951
## - YrSold         1 8.2445e+08 4.5535e+11 27951
## - GarageFinish   1 8.3453e+08 4.5536e+11 27952
## - Fence          1 9.3323e+08 4.5546e+11 27952
## - MSZoning       1 1.1188e+09 4.5565e+11 27952
## - BsmtFullBath   1 1.1457e+09 4.5567e+11 27952
## - Exterior2nd    1 1.1851e+09 4.5571e+11 27952
## - BsmtCond       1 1.1955e+09 4.5572e+11 27953

```

```

## - Utilities      1 1.2679e+09 4.5579e+11 27953
## - GarageType     1 1.9335e+09 4.5646e+11 27955
## - GarageYrBlt    1 2.0870e+09 4.5661e+11 27955
## - TotRmsAbvGrd   1 2.2557e+09 4.5678e+11 27956
## - MSSubClass     1 2.2609e+09 4.5679e+11 27956
## <none>           4.5453e+11 27956
## - BldgType       1 2.5060e+09 4.5703e+11 27957
## - Exterior1st    1 2.6261e+09 4.5715e+11 27957
## - GarageArea     1 2.7704e+09 4.5730e+11 27957
## - BsmtExposure   1 3.1094e+09 4.5764e+11 27958
## - GarageCars     1 3.2010e+09 4.5773e+11 27959
## - ScreenPorch    1 3.6672e+09 4.5819e+11 27960
## - WoodDeckSF     1 4.5818e+09 4.5911e+11 27963
## - BsmtUnfSF      1 4.6802e+09 4.5921e+11 27963
## - FireplaceQu    1 6.2279e+09 4.6075e+11 27968
## - Fireplaces     1 6.4981e+09 4.6102e+11 27969
## - MasVnrType     1 6.6087e+09 4.6113e+11 27969
## - BedroomAbvGr   1 7.8873e+09 4.6241e+11 27973
## - BsmtQual       1 9.3162e+09 4.6384e+11 27977
## - KitchenAbvGr   1 9.8604e+09 4.6439e+11 27979
## - Street         1 1.0329e+10 4.6485e+11 27980
## - BsmtFinSF2     1 1.0730e+10 4.6526e+11 27982
## - SaleCondition  1 1.5568e+10 4.7009e+11 27996
## - MasVnrArea     1 1.9223e+10 4.7375e+11 28007
## - Functional     1 2.0186e+10 4.7471e+11 28010
## - YearBuilt      1 2.1433e+10 4.7596e+11 28014
## - KitchenQual    1 2.1484e+10 4.7601e+11 28014
## - LotArea        1 2.2950e+10 4.7748e+11 28018
## - ExterQual      1 2.3495e+10 4.7802e+11 28020
## - BsmtFinSF1     1 3.1644e+10 4.8617e+11 28044
## - OverallCond    1 3.4649e+10 4.8918e+11 28052
## - OverallQual    1 5.5345e+10 5.0987e+11 28111
## - X1stFlrSF     1 9.1425e+10 5.4595e+11 28207
## - X2ndFlrSF     1 1.3144e+11 5.8597e+11 28306
##
## Step:  AIC=27949.92
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
## Utilities + LandSlope + BldgType + OverallQual + OverallCond +
## YearBuilt + Exterior1st + Exterior2nd + MasVnrType + MasVnrArea +
## ExterQual + Foundation + BsmtQual + BsmtCond + BsmtExposure +
## BsmtFinType1 + BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF + HeatingQC +
## X1stFlrSF + X2ndFlrSF + BsmtFullBath + BsmtHalfBath + BedroomAbvGr +
## KitchenAbvGr + KitchenQual + TotRmsAbvGrd + Functional +
## Fireplaces + FireplaceQu + GarageType + GarageYrBlt + GarageFinish +
## GarageCars + GarageArea + PavedDrive + WoodDeckSF + OpenPorchSF +
## ScreenPorch + Fence + YrSold + SaleType + SaleCondition
##
##           Df Sum of Sq      RSS   AIC
## - BsmtFinType1  1 3.6533e+08 4.5523e+11 27944
## - HeatingQC     1 3.7911e+08 4.5524e+11 27944
## - LotFrontage   1 4.1766e+08 4.5528e+11 27944
## - LandSlope     1 4.6986e+08 4.5533e+11 27944
## - OpenPorchSF   1 5.5677e+08 4.5542e+11 27944
## - PavedDrive    1 5.9713e+08 4.5546e+11 27944

```

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## - BsmtHalfBath      1 6.2288e+08 4.5549e+11 27945
## - SaleType          1 7.4404e+08 4.5561e+11 27945
## - Foundation        1 8.2191e+08 4.5569e+11 27945
## - YrSold            1 8.6352e+08 4.5573e+11 27945
## - GarageFinish      1 8.9566e+08 4.5576e+11 27945
## - Fence             1 9.4631e+08 4.5581e+11 27946
## - MSZoning          1 1.1034e+09 4.5597e+11 27946
## - BsmtFullBath      1 1.1175e+09 4.5598e+11 27946
## - BsmtCond          1 1.1753e+09 4.5604e+11 27946
## - Exterior2nd       1 1.2147e+09 4.5608e+11 27946
## - Utilities         1 1.2181e+09 4.5608e+11 27946
## - GarageType        1 1.9373e+09 4.5680e+11 27949
## - GarageYrBlt       1 2.0895e+09 4.5695e+11 27949
## - TotRmsAbvGrd      1 2.2509e+09 4.5711e+11 27950
## - MSSubClass        1 2.3043e+09 4.5717e+11 27950
## <none>              4.5486e+11 27950
## - BldgType          1 2.6142e+09 4.5748e+11 27951
## - Exterior1st       1 2.6691e+09 4.5753e+11 27951
## - GarageArea        1 2.7302e+09 4.5759e+11 27951
## - BsmtExposure      1 3.1941e+09 4.5806e+11 27952
## - GarageCars        1 3.2420e+09 4.5811e+11 27953
## - ScreenPorch       1 3.7422e+09 4.5861e+11 27954
## - BsmtUnfSF         1 4.7077e+09 4.5957e+11 27957
## - WoodDeckSF        1 4.7350e+09 4.5960e+11 27957
## - FireplaceQu       1 6.1022e+09 4.6097e+11 27961
## - MasVnrType        1 6.6804e+09 4.6154e+11 27963
## - Fireplaces        1 6.7253e+09 4.6159e+11 27963
## - BedroomAbvGr      1 7.8988e+09 4.6276e+11 27967
## - BsmtQual          1 9.3937e+09 4.6426e+11 27971
## - KitchenAbvGr      1 9.8703e+09 4.6473e+11 27973
## - Street            1 1.0437e+10 4.6530e+11 27975
## - BsmtFinSF2        1 1.0825e+10 4.6569e+11 27976
## - SaleCondition     1 1.5519e+10 4.7038e+11 27990
## - MasVnrArea        1 1.9166e+10 4.7403e+11 28001
## - Functional        1 2.0211e+10 4.7507e+11 28004
## - KitchenQual       1 2.1405e+10 4.7627e+11 28007
## - YearBuilt         1 2.2322e+10 4.7718e+11 28010
## - LotArea           1 2.3325e+10 4.7819e+11 28013
## - ExterQual         1 2.3629e+10 4.7849e+11 28014
## - BsmtFinSF1        1 3.1735e+10 4.8660e+11 28038
## - OverallCond       1 3.5159e+10 4.9002e+11 28048
## - OverallQual       1 5.5169e+10 5.1003e+11 28104
## - X1stFlrSF         1 9.1607e+10 5.4647e+11 28201
## - X2ndFlrSF         1 1.3203e+11 5.8689e+11 28302
##
## Step:  AIC=27943.8
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
## Utilities + LandSlope + BldgType + OverallQual + OverallCond +
## YearBuilt + Exterior1st + Exterior2nd + MasVnrType + MasVnrArea +
## ExterQual + Foundation + BsmtQual + BsmtCond + BsmtExposure +
## BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF + HeatingQC + X1stFlrSF +
## X2ndFlrSF + BsmtFullBath + BsmtHalfBath + BedroomAbvGr +
## KitchenAbvGr + KitchenQual + TotRmsAbvGrd + Functional +
## Fireplaces + FireplaceQu + GarageType + GarageYrBlt + GarageFinish +

```

```

##      GarageCars + GarageArea + PavedDrive + WoodDeckSF + OpenPorchSF +
##      ScreenPorch + Fence + YrSold + SaleType + SaleCondition
##
##      Df      Sum of Sq      RSS      AIC
## - HeatingQC      1 3.9783e+08 4.5563e+11 27938
## - LotFrontage    1 4.0768e+08 4.5564e+11 27938
## - LandSlope      1 4.8409e+08 4.5571e+11 27938
## - PavedDrive     1 5.1779e+08 4.5575e+11 27938
## - OpenPorchSF    1 5.2430e+08 4.5575e+11 27938
## - BsmtHalfBath   1 6.8836e+08 4.5592e+11 27939
## - SaleType       1 7.8112e+08 4.5601e+11 27939
## - Foundation     1 8.5514e+08 4.5608e+11 27939
## - Fence          1 8.8540e+08 4.5611e+11 27939
## - YrSold         1 9.0918e+08 4.5614e+11 27939
## - GarageFinish   1 9.6840e+08 4.5620e+11 27940
## - BsmtFullBath   1 1.0036e+09 4.5623e+11 27940
## - MSZoning       1 1.0893e+09 4.5632e+11 27940
## - BsmtCond       1 1.1544e+09 4.5638e+11 27940
## - Exterior2nd    1 1.2111e+09 4.5644e+11 27940
## - Utilities      1 1.2389e+09 4.5647e+11 27940
## - GarageType     1 1.9954e+09 4.5722e+11 27943
## - GarageYrBlt    1 2.0515e+09 4.5728e+11 27943
## - TotRmsAbvGrd   1 2.2649e+09 4.5749e+11 27944
## <none>                                4.5523e+11 27944
## - MSSubClass     1 2.3593e+09 4.5759e+11 27944
## - Exterior1st    1 2.6098e+09 4.5784e+11 27945
## - BldgType       1 2.6347e+09 4.5786e+11 27945
## - GarageArea     1 2.7711e+09 4.5800e+11 27945
## - BsmtExposure   1 3.1254e+09 4.5835e+11 27946
## - GarageCars     1 3.2276e+09 4.5846e+11 27946
## - ScreenPorch    1 3.8213e+09 4.5905e+11 27948
## - WoodDeckSF     1 4.7138e+09 4.5994e+11 27951
## - BsmtUnfSF      1 5.0919e+09 4.6032e+11 27952
## - FireplaceQu    1 6.0902e+09 4.6132e+11 27955
## - Fireplaces     1 6.6168e+09 4.6185e+11 27957
## - MasVnrType     1 6.7589e+09 4.6199e+11 27957
## - BedroomAbvGr   1 8.0031e+09 4.6323e+11 27961
## - KitchenAbvGr   1 9.6732e+09 4.6490e+11 27966
## - BsmtQual       1 9.7725e+09 4.6500e+11 27966
## - Street         1 1.0254e+10 4.6548e+11 27968
## - BsmtFinSF2     1 1.0551e+10 4.6578e+11 27969
## - SaleCondition  1 1.5487e+10 4.7072e+11 27984
## - MasVnrArea     1 1.9149e+10 4.7438e+11 27995
## - Functional     1 2.0143e+10 4.7537e+11 27998
## - KitchenQual    1 2.1378e+10 4.7661e+11 28001
## - YearBuilt      1 2.1960e+10 4.7719e+11 28003
## - ExterQual      1 2.3435e+10 4.7866e+11 28007
## - LotArea        1 2.3556e+10 4.7878e+11 28008
## - BsmtFinSF1     1 3.1800e+10 4.8703e+11 28032
## - OverallCond    1 3.4794e+10 4.9002e+11 28040
## - OverallQual    1 5.6595e+10 5.1182e+11 28102
## - X1stFlrSF      1 9.1429e+10 5.4666e+11 28194
## - X2ndFlrSF      1 1.3254e+11 5.8777e+11 28296
##

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## Step: AIC=27937.78
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Street +
## Utilities + LandSlope + BldgType + OverallQual + OverallCond +
## YearBuilt + Exterior1st + Exterior2nd + MasVnrType + MasVnrArea +
## ExterQual + Foundation + BsmtQual + BsmtCond + BsmtExposure +
## BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF + X1stFlrSF + X2ndFlrSF +
## BsmtFullBath + BsmtHalfBath + BedroomAbvGr + KitchenAbvGr +
## KitchenQual + TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu +
## GarageType + GarageYrBlt + GarageFinish + GarageCars + GarageArea +
## PavedDrive + WoodDeckSF + OpenPorchSF + ScreenPorch + Fence +
## YrSold + SaleType + SaleCondition
##
##          Df Sum of Sq      RSS   AIC
## - LotFrontage    1 3.8484e+08 4.5601e+11 27932
## - PavedDrive      1 5.0648e+08 4.5613e+11 27932
## - LandSlope       1 5.1362e+08 4.5614e+11 27932
## - OpenPorchSF     1 5.2752e+08 4.5615e+11 27932
## - BsmtHalfBath    1 6.5985e+08 4.5629e+11 27933
## - SaleType        1 7.4399e+08 4.5637e+11 27933
## - YrSold           1 9.2566e+08 4.5655e+11 27933
## - Foundation      1 9.5292e+08 4.5658e+11 27934
## - Fence            1 9.7944e+08 4.5661e+11 27934
## - GarageFinish     1 1.0945e+09 4.5672e+11 27934
## - BsmtFullBath     1 1.0990e+09 4.5673e+11 27934
## - MSZoning         1 1.1167e+09 4.5674e+11 27934
## - Utilities        1 1.2123e+09 4.5684e+11 27934
## - BsmtCond         1 1.2144e+09 4.5684e+11 27934
## - Exterior2nd      1 1.2793e+09 4.5691e+11 27934
## - GarageYrBlt      1 2.0050e+09 4.5763e+11 27937
## - GarageType       1 2.0189e+09 4.5765e+11 27937
## - TotRmsAbvGrd     1 2.3206e+09 4.5795e+11 27938
## - MSSubClass       1 2.3345e+09 4.5796e+11 27938
## <none>              4.5563e+11 27938
## - Exterior1st      1 2.5411e+09 4.5817e+11 27938
## - GarageArea        1 2.6825e+09 4.5831e+11 27939
## - BldgType          1 2.7412e+09 4.5837e+11 27939
## - BsmtExposure      1 3.0637e+09 4.5869e+11 27940
## - GarageCars        1 3.2883e+09 4.5891e+11 27941
## - ScreenPorch       1 3.6870e+09 4.5931e+11 27942
## - WoodDeckSF        1 4.6254e+09 4.6025e+11 27945
## - BsmtUnfSF         1 5.2337e+09 4.6086e+11 27947
## - FireplaceQu       1 6.2958e+09 4.6192e+11 27950
## - Fireplaces        1 6.5801e+09 4.6221e+11 27951
## - MasVnrType        1 6.8692e+09 4.6250e+11 27952
## - BedroomAbvGr     1 8.3608e+09 4.6399e+11 27956
## - BsmtQual          1 9.9185e+09 4.6555e+11 27961
## - KitchenAbvGr     1 1.0018e+10 4.6564e+11 27961
## - Street            1 1.0405e+10 4.6603e+11 27962
## - BsmtFinSF2        1 1.0470e+10 4.6610e+11 27962
## - SaleCondition     1 1.5623e+10 4.7125e+11 27978
## - MasVnrArea        1 1.8975e+10 4.7460e+11 27988
## - Functional        1 2.0047e+10 4.7567e+11 27991
## - KitchenQual       1 2.1863e+10 4.7749e+11 27996
## - YearBuilt         1 2.2824e+10 4.7845e+11 27999

```

```

## - LotArea      1 2.3327e+10 4.7895e+11 28001
## - ExterQual    1 2.4288e+10 4.7991e+11 28004
## - BsmtFinSF1   1 3.1636e+10 4.8726e+11 28025
## - OverallCond  1 3.6055e+10 4.9168e+11 28038
## - OverallQual  1 5.6795e+10 5.1242e+11 28096
## - X1stFlrSF    1 9.1936e+10 5.4756e+11 28189
## - X2ndFlrSF    1 1.3400e+11 5.8962e+11 28294
##
## Step: AIC=27931.71
## SalePrice ~ MSSubClass + MSZoning + LotArea + Street + Utilities +
##   LandSlope + BldgType + OverallQual + OverallCond + YearBuilt +
##   Exterior1st + Exterior2nd + MasVnrType + MasVnrArea + ExterQual +
##   Foundation + BsmtQual + BsmtCond + BsmtExposure + BsmtFinSF1 +
##   BsmtFinSF2 + BsmtUnfSF + X1stFlrSF + X2ndFlrSF + BsmtFullBath +
##   BsmtHalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual +
##   TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu + GarageType +
##   GarageYrBlt + GarageFinish + GarageCars + GarageArea + PavedDrive +
##   WoodDeckSF + OpenPorchSF + ScreenPorch + Fence + YrSold +
##   SaleType + SaleCondition
##
##           Df Sum of Sq      RSS   AIC
## - OpenPorchSF  1 5.1267e+08 4.5652e+11 27926
## - LandSlope    1 5.1590e+08 4.5653e+11 27926
## - PavedDrive   1 5.3913e+08 4.5655e+11 27926
## - BsmtHalfBath  1 6.8294e+08 4.5669e+11 27927
## - SaleType     1 7.5233e+08 4.5676e+11 27927
## - YrSold       1 9.0310e+08 4.5691e+11 27927
## - Foundation   1 9.0658e+08 4.5692e+11 27927
## - Fence        1 9.2509e+08 4.5694e+11 27927
## - BsmtFullBath  1 1.0870e+09 4.5710e+11 27928
## - GarageFinish  1 1.1387e+09 4.5715e+11 27928
## - MSZoning     1 1.2054e+09 4.5722e+11 27928
## - Utilities    1 1.2399e+09 4.5725e+11 27928
## - BsmtCond     1 1.2916e+09 4.5730e+11 27928
## - Exterior2nd  1 1.3533e+09 4.5736e+11 27929
## - GarageType   1 1.8203e+09 4.5783e+11 27930
## - GarageYrBlt  1 2.1647e+09 4.5818e+11 27931
## <none>                4.5601e+11 27932
## - TotRmsAbvGrd  1 2.3855e+09 4.5840e+11 27932
## - MSSubClass    1 2.4774e+09 4.5849e+11 27932
## - Exterior1st   1 2.6136e+09 4.5863e+11 27932
## - GarageArea    1 2.7808e+09 4.5879e+11 27933
## - BsmtExposure  1 3.1881e+09 4.5920e+11 27934
## - BldgType      1 3.2594e+09 4.5927e+11 27934
## - GarageCars    1 3.3896e+09 4.5940e+11 27935
## - ScreenPorch   1 3.6877e+09 4.5970e+11 27936
## - WoodDeckSF    1 4.4610e+09 4.6047e+11 27938
## - BsmtUnfSF     1 5.0685e+09 4.6108e+11 27940
## - FireplaceQu   1 6.3558e+09 4.6237e+11 27944
## - Fireplaces    1 6.6412e+09 4.6265e+11 27945
## - MasVnrType    1 6.7619e+09 4.6277e+11 27945
## - BedroomAbvGr  1 8.1680e+09 4.6418e+11 27950
## - KitchenAbvGr  1 9.7688e+09 4.6578e+11 27954
## - BsmtQual      1 1.0062e+10 4.6607e+11 27955

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## - Street          1 1.0340e+10 4.6635e+11 27956
## - BsmtFinSF2      1 1.0431e+10 4.6644e+11 27956
## - SaleCondition   1 1.5719e+10 4.7173e+11 27972
## - MasVnrArea      1 1.9020e+10 4.7503e+11 27982
## - Functional      1 2.0280e+10 4.7629e+11 27986
## - KitchenQual     1 2.2202e+10 4.7821e+11 27991
## - YearBuilt       1 2.2758e+10 4.7877e+11 27993
## - LotArea         1 2.4330e+10 4.8034e+11 27998
## - ExterQual       1 2.4405e+10 4.8042e+11 27998
## - BsmtFinSF1      1 3.1324e+10 4.8734e+11 28018
## - OverallCond     1 3.5873e+10 4.9188e+11 28031
## - OverallQual     1 5.6602e+10 5.1261e+11 28089
## - X1stFlrSF       1 9.3682e+10 5.4969e+11 28188
## - X2ndFlrSF       1 1.3379e+11 5.8980e+11 28287
##
## Step:  AIC=27926.05
## SalePrice ~ MSSubClass + MSZoning + LotArea + Street + Utilities +
##   LandSlope + BldgType + OverallQual + OverallCond + YearBuilt +
##   Exterior1st + Exterior2nd + MasVnrType + MasVnrArea + ExterQual +
##   Foundation + BsmtQual + BsmtCond + BsmtExposure + BsmtFinSF1 +
##   BsmtFinSF2 + BsmtUnfSF + X1stFlrSF + X2ndFlrSF + BsmtFullBath +
##   BsmtHalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual +
##   TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu + GarageType +
##   GarageYrBlt + GarageFinish + GarageCars + GarageArea + PavedDrive +
##   WoodDeckSF + ScreenPorch + Fence + YrSold + SaleType + SaleCondition
##
##           Df  Sum of Sq      RSS   AIC
## - PavedDrive    1 4.8829e+08 4.5701e+11 27920
## - LandSlope     1 4.8844e+08 4.5701e+11 27920
## - BsmtHalfBath  1 6.7228e+08 4.5720e+11 27921
## - SaleType      1 7.2379e+08 4.5725e+11 27921
## - Fence         1 8.9396e+08 4.5742e+11 27922
## - Foundation    1 9.4220e+08 4.5747e+11 27922
## - YrSold        1 9.7903e+08 4.5750e+11 27922
## - BsmtFullBath  1 1.1296e+09 4.5765e+11 27922
## - GarageFinish  1 1.1677e+09 4.5769e+11 27922
## - Utilities     1 1.1702e+09 4.5769e+11 27922
## - BsmtCond      1 1.2974e+09 4.5782e+11 27923
## - MSZoning      1 1.3614e+09 4.5789e+11 27923
## - Exterior2nd   1 1.3829e+09 4.5791e+11 27923
## - GarageType    1 1.8261e+09 4.5835e+11 27924
## - GarageYrBlt   1 2.2396e+09 4.5876e+11 27926
## <none>          4.5652e+11 27926
## - TotRmsAbvGrd  1 2.3726e+09 4.5890e+11 27926
## - MSSubClass    1 2.5009e+09 4.5903e+11 27926
## - Exterior1st   1 2.6129e+09 4.5914e+11 27927
## - GarageArea    1 2.9577e+09 4.5948e+11 27928
## - BsmtExposure  1 3.1217e+09 4.5965e+11 27928
## - BldgType      1 3.2244e+09 4.5975e+11 27929
## - GarageCars    1 3.2674e+09 4.5979e+11 27929
## - ScreenPorch   1 3.7914e+09 4.6032e+11 27930
## - WoodDeckSF    1 4.3175e+09 4.6084e+11 27932
## - BsmtUnfSF     1 5.3686e+09 4.6189e+11 27935
## - FireplaceQu   1 6.1428e+09 4.6267e+11 27938

```

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## - Fireplaces      1 6.6701e+09 4.6319e+11 27939
## - MasVnrType      1 6.8088e+09 4.6333e+11 27940
## - BedroomAbvGr    1 8.2635e+09 4.6479e+11 27944
## - KitchenAbvGr    1 1.0045e+10 4.6657e+11 27949
## - BsmtQual        1 1.0228e+10 4.6675e+11 27950
## - Street          1 1.0287e+10 4.6681e+11 27950
## - BsmtFinSF2      1 1.0731e+10 4.6726e+11 27952
## - SaleCondition   1 1.5678e+10 4.7220e+11 27966
## - MasVnrArea      1 1.8787e+10 4.7531e+11 27976
## - Functional      1 2.0630e+10 4.7715e+11 27981
## - KitchenQual     1 2.2083e+10 4.7861e+11 27985
## - YearBuilt       1 2.2840e+10 4.7936e+11 27988
## - LotArea         1 2.4328e+10 4.8085e+11 27992
## - ExterQual       1 2.4820e+10 4.8134e+11 27993
## - BsmtFinSF1      1 3.1895e+10 4.8842e+11 28014
## - OverallCond     1 3.6232e+10 4.9276e+11 28026
## - OverallQual     1 5.6792e+10 5.1332e+11 28084
## - X1stFlrSF       1 9.4665e+10 5.5119e+11 28184
## - X2ndFlrSF       1 1.3842e+11 5.9495e+11 28292
##
## Step: AIC=27920.3
## SalePrice ~ MSSubClass + MSZoning + LotArea + Street + Utilities +
##   LandSlope + BldgType + OverallQual + OverallCond + YearBuilt +
##   Exterior1st + Exterior2nd + MasVnrType + MasVnrArea + ExterQual +
##   Foundation + BsmtQual + BsmtCond + BsmtExposure + BsmtFinSF1 +
##   BsmtFinSF2 + BsmtUnfSF + X1stFlrSF + X2ndFlrSF + BsmtFullBath +
##   BsmtHalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual +
##   TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu + GarageType +
##   GarageYrBlt + GarageFinish + GarageCars + GarageArea + WoodDeckSF +
##   ScreenPorch + Fence + YrSold + SaleType + SaleCondition
##
##           Df Sum of Sq      RSS   AIC
## - LandSlope      1 4.8640e+08 4.5750e+11 27915
## - BsmtHalfBath   1 6.4711e+08 4.5766e+11 27915
## - SaleType       1 7.4540e+08 4.5776e+11 27915
## - Foundation     1 8.8020e+08 4.5789e+11 27916
## - Fence          1 8.9025e+08 4.5790e+11 27916
## - YrSold         1 9.6143e+08 4.5797e+11 27916
## - BsmtFullBath   1 1.0965e+09 4.5811e+11 27916
## - GarageFinish   1 1.1069e+09 4.5812e+11 27916
## - Utilities      1 1.1765e+09 4.5819e+11 27917
## - MSZoning       1 1.3155e+09 4.5833e+11 27917
## - BsmtCond       1 1.3908e+09 4.5840e+11 27917
## - Exterior2nd    1 1.4322e+09 4.5844e+11 27918
## - GarageType     1 1.8003e+09 4.5881e+11 27919
## - GarageYrBlt    1 1.9898e+09 4.5900e+11 27919
## - TotRmsAbvGrd   1 2.3192e+09 4.5933e+11 27920
## <none>              4.5701e+11 27920
## - MSSubClass     1 2.5305e+09 4.5954e+11 27921
## - Exterior1st    1 2.7650e+09 4.5978e+11 27922
## - BsmtExposure   1 3.0535e+09 4.6007e+11 27922
## - GarageArea     1 3.0822e+09 4.6009e+11 27922
## - GarageCars     1 3.1423e+09 4.6015e+11 27923
## - BldgType       1 3.2042e+09 4.6022e+11 27923

```

```

## - ScreenPorch      1 3.8726e+09 4.6089e+11 27925
## - WoodDeckSF       1 4.3172e+09 4.6133e+11 27926
## - BsmtUnfSF        1 5.3934e+09 4.6241e+11 27930
## - FireplaceQu      1 6.2153e+09 4.6323e+11 27932
## - MasVnrType       1 6.7368e+09 4.6375e+11 27934
## - Fireplaces       1 6.8530e+09 4.6387e+11 27934
## - BedroomAbvGr    1 8.2466e+09 4.6526e+11 27938
## - BsmtQual         1 1.0093e+10 4.6711e+11 27944
## - KitchenAbvGr     1 1.0280e+10 4.6729e+11 27944
## - Street           1 1.0292e+10 4.6730e+11 27944
## - BsmtFinSF2       1 1.0981e+10 4.6799e+11 27946
## - SaleCondition    1 1.5600e+10 4.7261e+11 27960
## - MasVnrArea       1 1.8773e+10 4.7579e+11 27970
## - Functional       1 2.0524e+10 4.7754e+11 27975
## - KitchenQual      1 2.1794e+10 4.7881e+11 27979
## - LotArea          1 2.4129e+10 4.8114e+11 27986
## - ExterQual        1 2.4537e+10 4.8155e+11 27987
## - YearBuilt        1 2.7581e+10 4.8459e+11 27996
## - BsmtFinSF1       1 3.2290e+10 4.8930e+11 28009
## - OverallCond      1 3.7023e+10 4.9404e+11 28023
## - OverallQual      1 5.6571e+10 5.1358e+11 28077
## - X1stFlrSF        1 9.5251e+10 5.5226e+11 28180
## - X2ndFlrSF        1 1.3906e+11 5.9607e+11 28287
##
## Step:  AIC=27914.55
## SalePrice ~ MSSubClass + MSZoning + LotArea + Street + Utilities +
##   BldgType + OverallQual + OverallCond + YearBuilt + Exterior1st +
##   Exterior2nd + MasVnrType + MasVnrArea + ExterQual + Foundation +
##   BsmtQual + BsmtCond + BsmtExposure + BsmtFinSF1 + BsmtFinSF2 +
##   BsmtUnfSF + X1stFlrSF + X2ndFlrSF + BsmtFullBath + BsmtHalfBath +
##   BedroomAbvGr + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +
##   Functional + Fireplaces + FireplaceQu + GarageType + GarageYrBlt +
##   GarageFinish + GarageCars + GarageArea + WoodDeckSF + ScreenPorch +
##   Fence + YrSold + SaleType + SaleCondition
##
##           Df  Sum of Sq      RSS   AIC
## - BsmtHalfBath  1 6.2078e+08 4.5812e+11 27909
## - SaleType      1 6.9401e+08 4.5819e+11 27909
## - Foundation    1 9.2533e+08 4.5842e+11 27910
## - Fence         1 9.6067e+08 4.5846e+11 27910
## - YrSold        1 9.8844e+08 4.5849e+11 27910
## - GarageFinish  1 1.0904e+09 4.5859e+11 27911
## - BsmtFullBath  1 1.1121e+09 4.5861e+11 27911
## - Utilities     1 1.1972e+09 4.5870e+11 27911
## - MSZoning      1 1.3947e+09 4.5889e+11 27912
## - BsmtCond      1 1.4339e+09 4.5893e+11 27912
## - Exterior2nd   1 1.4438e+09 4.5894e+11 27912
## - GarageType    1 1.8734e+09 4.5937e+11 27913
## - GarageYrBlt   1 2.0017e+09 4.5950e+11 27913
## - TotRmsAbvGrd  1 2.1588e+09 4.5966e+11 27914
## <none>                4.5750e+11 27915
## - MSSubClass    1 2.5706e+09 4.6007e+11 27915
## - Exterior1st   1 2.8265e+09 4.6033e+11 27916
## - GarageArea    1 3.0192e+09 4.6052e+11 27917

```

```

## - BldgType      1 3.1549e+09 4.6065e+11 27917
## - GarageCars    1 3.2063e+09 4.6071e+11 27917
## - BsmtExposure  1 3.4290e+09 4.6093e+11 27918
## - ScreenPorch   1 3.9602e+09 4.6146e+11 27919
## - WoodDeckSF    1 4.4039e+09 4.6190e+11 27921
## - BsmtUnfSF     1 5.3046e+09 4.6280e+11 27924
## - FireplaceQu   1 6.0904e+09 4.6359e+11 27926
## - Fireplaces    1 6.8950e+09 4.6439e+11 27928
## - MasVnrType    1 6.9147e+09 4.6441e+11 27928
## - BedroomAbvGr  1 8.4490e+09 4.6595e+11 27933
## - Street        1 9.9792e+09 4.6748e+11 27938
## - BsmtQual      1 1.0079e+10 4.6758e+11 27938
## - KitchenAbvGr  1 1.0371e+10 4.6787e+11 27939
## - BsmtFinSF2    1 1.1024e+10 4.6852e+11 27941
## - SaleCondition 1 1.5336e+10 4.7283e+11 27954
## - MasVnrArea    1 1.8892e+10 4.7639e+11 27964
## - Functional    1 2.0172e+10 4.7767e+11 27968
## - KitchenQual   1 2.1877e+10 4.7938e+11 27973
## - ExterQual     1 2.4606e+10 4.8210e+11 27981
## - YearBuilt     1 2.7227e+10 4.8473e+11 27989
## - BsmtFinSF1    1 3.2226e+10 4.8972e+11 28003
## - LotArea       1 3.2686e+10 4.9018e+11 28004
## - OverallCond   1 3.6909e+10 4.9441e+11 28016
## - OverallQual   1 5.6147e+10 5.1365e+11 28070
## - X1stFlrSF     1 9.6341e+10 5.5384e+11 28176
## - X2ndFlrSF     1 1.4176e+11 5.9926e+11 28287
##
## Step: AIC=27909.21
## SalePrice ~ MSSubClass + MSZoning + LotArea + Street + Utilities +
##   BldgType + OverallQual + OverallCond + YearBuilt + Exterior1st +
##   Exterior2nd + MasVnrType + MasVnrArea + ExterQual + Foundation +
##   BsmtQual + BsmtCond + BsmtExposure + BsmtFinSF1 + BsmtFinSF2 +
##   BsmtUnfSF + X1stFlrSF + X2ndFlrSF + BsmtFullBath + BedroomAbvGr +
##   KitchenAbvGr + KitchenQual + TotRmsAbvGrd + Functional +
##   Fireplaces + FireplaceQu + GarageType + GarageYrBlt + GarageFinish +
##   GarageCars + GarageArea + WoodDeckSF + ScreenPorch + Fence +
##   YrSold + SaleType + SaleCondition
##
##           Df Sum of Sq      RSS   AIC
## - SaleType      1 7.0881e+08 4.5883e+11 27904
## - Fence         1 9.4195e+08 4.5906e+11 27905
## - YrSold        1 9.6657e+08 4.5909e+11 27905
## - Foundation    1 9.8008e+08 4.5910e+11 27905
## - GarageFinish  1 1.1120e+09 4.5923e+11 27905
## - MSZoning      1 1.3440e+09 4.5946e+11 27906
## - Utilities     1 1.3860e+09 4.5951e+11 27906
## - BsmtCond      1 1.6035e+09 4.5972e+11 27907
## - Exterior2nd   1 1.6101e+09 4.5973e+11 27907
## - BsmtFullBath  1 1.8319e+09 4.5995e+11 27908
## - GarageType    1 1.9061e+09 4.6003e+11 27908
## - GarageYrBlt   1 1.9821e+09 4.6010e+11 27908
## - TotRmsAbvGrd  1 2.1761e+09 4.6030e+11 27909
## <none>                4.5812e+11 27909
## - MSSubClass    1 2.6056e+09 4.6073e+11 27910

```

```

## - GarageArea      1 3.0536e+09 4.6117e+11 27911
## - Exterior1st     1 3.1315e+09 4.6125e+11 27912
## - GarageCars      1 3.1470e+09 4.6127e+11 27912
## - BldgType        1 3.1953e+09 4.6131e+11 27912
## - BsmtExposure    1 3.2231e+09 4.6134e+11 27912
## - ScreenPorch     1 3.9274e+09 4.6205e+11 27914
## - WoodDeckSF      1 4.3006e+09 4.6242e+11 27915
## - BsmtUnfSF       1 5.3443e+09 4.6346e+11 27918
## - FireplaceQu     1 6.0817e+09 4.6420e+11 27920
## - Fireplaces      1 6.8309e+09 4.6495e+11 27923
## - MasVnrType      1 7.1315e+09 4.6525e+11 27924
## - BedroomAbvGr    1 8.8045e+09 4.6692e+11 27929
## - Street          1 9.8827e+09 4.6800e+11 27932
## - BsmtQual        1 1.0025e+10 4.6814e+11 27932
## - KitchenAbvGr    1 1.0343e+10 4.6846e+11 27933
## - BsmtFinSF2      1 1.0584e+10 4.6870e+11 27934
## - SaleCondition   1 1.5629e+10 4.7375e+11 27949
## - MasVnrArea      1 1.8930e+10 4.7705e+11 27959
## - Functional      1 2.0492e+10 4.7861e+11 27964
## - KitchenQual     1 2.1724e+10 4.7984e+11 27967
## - ExterQual       1 2.4915e+10 4.8304e+11 27976
## - YearBuilt       1 2.7004e+10 4.8512e+11 27983
## - BsmtFinSF1     1 3.1607e+10 4.8973e+11 27996
## - LotArea         1 3.2394e+10 4.9051e+11 27998
## - OverallCond     1 3.6294e+10 4.9441e+11 28009
## - OverallQual     1 5.6435e+10 5.1455e+11 28066
## - X1stFlrSF       1 9.7043e+10 5.5516e+11 28172
## - X2ndFlrSF       1 1.4309e+11 6.0121e+11 28285
##
## Step:  AIC=27904.14
## SalePrice ~ MSSubClass + MSZoning + LotArea + Street + Utilities +
##   BldgType + OverallQual + OverallCond + YearBuilt + Exterior1st +
##   Exterior2nd + MasVnrType + MasVnrArea + ExterQual + Foundation +
##   BsmtQual + BsmtCond + BsmtExposure + BsmtFinSF1 + BsmtFinSF2 +
##   BsmtUnfSF + X1stFlrSF + X2ndFlrSF + BsmtFullBath + BedroomAbvGr +
##   KitchenAbvGr + KitchenQual + TotRmsAbvGrd + Functional +
##   Fireplaces + FireplaceQu + GarageType + GarageYrBlt + GarageFinish +
##   GarageCars + GarageArea + WoodDeckSF + ScreenPorch + Fence +
##   YrSold + SaleCondition
##
##              Df  Sum of Sq      RSS   AIC
## - Foundation    1 8.4487e+08 4.5967e+11 27900
## - Fence          1 9.0774e+08 4.5974e+11 27900
## - YrSold         1 9.4685e+08 4.5978e+11 27900
## - GarageFinish   1 1.1353e+09 4.5996e+11 27900
## - Utilities      1 1.1903e+09 4.6002e+11 27900
## - MSZoning       1 1.4685e+09 4.6030e+11 27901
## - BsmtCond       1 1.5216e+09 4.6035e+11 27902
## - Exterior2nd    1 1.6024e+09 4.6043e+11 27902
## - BsmtFullBath   1 1.7861e+09 4.6061e+11 27902
## - GarageType     1 1.8295e+09 4.6066e+11 27902
## - GarageYrBlt    1 1.9865e+09 4.6081e+11 27903
## - TotRmsAbvGrd   1 2.2693e+09 4.6110e+11 27904
## <none>              4.5883e+11 27904

```

```

## - MSSubClass      1 2.5582e+09 4.6139e+11 27905
## - GarageCars      1 3.1171e+09 4.6195e+11 27906
## - BsmtExposure    1 3.1249e+09 4.6195e+11 27906
## - Exterior1st     1 3.1370e+09 4.6197e+11 27906
## - BldgType        1 3.1833e+09 4.6201e+11 27907
## - GarageArea      1 3.1884e+09 4.6202e+11 27907
## - ScreenPorch     1 3.8512e+09 4.6268e+11 27909
## - WoodDeckSF      1 4.0760e+09 4.6290e+11 27909
## - BsmtUnfSF       1 5.3821e+09 4.6421e+11 27913
## - FireplaceQu     1 6.3605e+09 4.6519e+11 27916
## - Fireplaces      1 6.6809e+09 4.6551e+11 27917
## - MasVnrType      1 7.3091e+09 4.6614e+11 27919
## - BedroomAbvGr    1 9.1071e+09 4.6794e+11 27925
## - Street          1 9.8266e+09 4.6865e+11 27927
## - BsmtQual        1 9.9584e+09 4.6879e+11 27927
## - KitchenAbvGr    1 1.0464e+10 4.6929e+11 27929
## - BsmtFinSF2      1 1.0630e+10 4.6946e+11 27929
## - SaleCondition    1 1.4924e+10 4.7375e+11 27942
## - MasVnrArea      1 1.9084e+10 4.7791e+11 27954
## - Functional      1 2.0670e+10 4.7950e+11 27959
## - KitchenQual     1 2.1454e+10 4.8028e+11 27961
## - ExterQual       1 2.5431e+10 4.8426e+11 27973
## - YearBuilt       1 2.7314e+10 4.8614e+11 27978
## - BsmtFinSF1      1 3.1459e+10 4.9029e+11 27990
## - LotArea         1 3.2254e+10 4.9108e+11 27992
## - OverallCond     1 3.5828e+10 4.9466e+11 28003
## - OverallQual     1 5.6268e+10 5.1510e+11 28060
## - X1stFlrSF       1 9.7777e+10 5.5661e+11 28169
## - X2ndFlrSF       1 1.4296e+11 6.0179e+11 28279
##
## Step:  AIC=27899.48
## SalePrice ~ MSSubClass + MSZoning + LotArea + Street + Utilities +
##   BldgType + OverallQual + OverallCond + YearBuilt + Exterior1st +
##   Exterior2nd + MasVnrType + MasVnrArea + ExterQual + BsmtQual +
##   BsmtCond + BsmtExposure + BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF +
##   X1stFlrSF + X2ndFlrSF + BsmtFullBath + BedroomAbvGr + KitchenAbvGr +
##   KitchenQual + TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu +
##   GarageType + GarageYrBlt + GarageFinish + GarageCars + GarageArea +
##   WoodDeckSF + ScreenPorch + Fence + YrSold + SaleCondition
##
##           Df  Sum of Sq      RSS   AIC
## - Fence      1 8.5785e+08 4.6053e+11 27895
## - YrSold      1 9.1214e+08 4.6059e+11 27895
## - GarageFinish 1 1.1688e+09 4.6084e+11 27896
## - Utilities   1 1.1981e+09 4.6087e+11 27896
## - BsmtCond    1 1.4613e+09 4.6113e+11 27897
## - MSZoning    1 1.5210e+09 4.6119e+11 27897
## - Exterior2nd 1 1.6399e+09 4.6131e+11 27897
## - GarageType  1 1.6878e+09 4.6136e+11 27897
## - BsmtFullBath 1 1.7572e+09 4.6143e+11 27898
## - GarageYrBlt 1 2.0686e+09 4.6174e+11 27898
## - TotRmsAbvGrd 1 2.1800e+09 4.6185e+11 27899
## <none>                4.5967e+11 27900
## - MSSubClass    1 2.5719e+09 4.6225e+11 27900

```

```

## - BsmtExposure      1 3.0364e+09 4.6271e+11 27902
## - Exterior1st       1 3.0693e+09 4.6274e+11 27902
## - GarageCars        1 3.1657e+09 4.6284e+11 27902
## - GarageArea        1 3.1919e+09 4.6287e+11 27902
## - BldgType          1 3.2011e+09 4.6287e+11 27902
## - ScreenPorch       1 3.8046e+09 4.6348e+11 27904
## - WoodDeckSF        1 4.0350e+09 4.6371e+11 27904
## - BsmtUnfSF         1 4.7410e+09 4.6441e+11 27907
## - Fireplaces        1 6.4227e+09 4.6610e+11 27912
## - FireplaceQu       1 6.4864e+09 4.6616e+11 27912
## - MasVnrType        1 7.4837e+09 4.6716e+11 27915
## - BedroomAbvGr      1 9.1806e+09 4.6885e+11 27920
## - BsmtFinSF2        1 9.9859e+09 4.6966e+11 27922
## - Street            1 1.0021e+10 4.6969e+11 27923
## - KitchenAbvGr      1 1.0073e+10 4.6975e+11 27923
## - BsmtQual          1 1.0337e+10 4.7001e+11 27924
## - SaleCondition     1 1.4980e+10 4.7465e+11 27937
## - MasVnrArea        1 1.8763e+10 4.7844e+11 27949
## - Functional        1 2.1391e+10 4.8106e+11 27956
## - KitchenQual       1 2.1948e+10 4.8162e+11 27958
## - ExterQual         1 2.6636e+10 4.8631e+11 27972
## - BsmtFinSF1       1 3.0629e+10 4.9030e+11 27983
## - LotArea           1 3.2115e+10 4.9179e+11 27987
## - OverallCond       1 3.5264e+10 4.9494e+11 27996
## - YearBuilt         1 3.6927e+10 4.9660e+11 28001
## - OverallQual       1 5.5783e+10 5.1546e+11 28054
## - X1stFlrSF         1 1.0324e+11 5.6292e+11 28178
## - X2ndFlrSF         1 1.4592e+11 6.0560e+11 28280
##
## Step:  AIC=27894.85
## SalePrice ~ MSSubClass + MSZoning + LotArea + Street + Utilities +
##   BldgType + OverallQual + OverallCond + YearBuilt + Exterior1st +
##   Exterior2nd + MasVnrType + MasVnrArea + ExterQual + BsmtQual +
##   BsmtCond + BsmtExposure + BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF +
##   X1stFlrSF + X2ndFlrSF + BsmtFullBath + BedroomAbvGr + KitchenAbvGr +
##   KitchenQual + TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu +
##   GarageType + GarageYrBlt + GarageFinish + GarageCars + GarageArea +
##   WoodDeckSF + ScreenPorch + YrSold + SaleCondition
##
##           Df  Sum of Sq      RSS   AIC
## - YrSold      1 9.8260e+08 4.6151e+11 27891
## - Utilities    1 1.1348e+09 4.6167e+11 27891
## - GarageFinish 1 1.2537e+09 4.6178e+11 27891
## - BsmtCond     1 1.3759e+09 4.6191e+11 27892
## - MSZoning     1 1.4596e+09 4.6199e+11 27892
## - BsmtFullBath 1 1.6208e+09 4.6215e+11 27892
## - Exterior2nd  1 1.6243e+09 4.6216e+11 27893
## - GarageType   1 1.8293e+09 4.6236e+11 27893
## - GarageYrBlt  1 2.0531e+09 4.6258e+11 27894
## - TotRmsAbvGrd 1 2.0659e+09 4.6260e+11 27894
## <none>                4.6053e+11 27895
## - MSSubClass   1 2.5817e+09 4.6311e+11 27896
## - Exterior1st  1 2.9235e+09 4.6345e+11 27896
## - BldgType     1 3.0298e+09 4.6356e+11 27897

```

```

## - BsmtExposure      1 3.0747e+09 4.6361e+11 27897
## - GarageCars        1 3.1536e+09 4.6368e+11 27897
## - GarageArea        1 3.2308e+09 4.6376e+11 27897
## - WoodDeckSF        1 3.7315e+09 4.6426e+11 27899
## - ScreenPorch       1 3.9107e+09 4.6444e+11 27900
## - BsmtUnfSF         1 4.9961e+09 4.6553e+11 27903
## - FireplaceQu       1 6.3830e+09 4.6691e+11 27907
## - Fireplaces        1 6.4393e+09 4.6697e+11 27907
## - MasVnrType        1 7.8411e+09 4.6837e+11 27911
## - BedroomAbvGr      1 9.1570e+09 4.6969e+11 27915
## - KitchenAbvGr      1 9.7853e+09 4.7032e+11 27917
## - BsmtFinSF2        1 9.8630e+09 4.7039e+11 27917
## - Street            1 9.9369e+09 4.7047e+11 27918
## - BsmtQual          1 1.0755e+10 4.7129e+11 27920
## - SaleCondition     1 1.5322e+10 4.7585e+11 27934
## - MasVnrArea        1 1.8719e+10 4.7925e+11 27944
## - KitchenQual       1 2.1942e+10 4.8247e+11 27953
## - Functional        1 2.2189e+10 4.8272e+11 27954
## - ExterQual         1 2.7502e+10 4.8803e+11 27969
## - BsmtFinSF1        1 3.1221e+10 4.9175e+11 27980
## - LotArea           1 3.3039e+10 4.9357e+11 27985
## - OverallCond       1 3.4734e+10 4.9526e+11 27990
## - YearBuilt         1 3.7538e+10 4.9807e+11 27998
## - OverallQual       1 5.5317e+10 5.1585e+11 28047
## - X1stFlrSF         1 1.0337e+11 5.6390e+11 28173
## - X2ndFlrSF         1 1.4730e+11 6.0783e+11 28278
##
## Step:  AIC=27890.6
## SalePrice ~ MSSubClass + MSZoning + LotArea + Street + Utilities +
##   BldgType + OverallQual + OverallCond + YearBuilt + Exterior1st +
##   Exterior2nd + MasVnrType + MasVnrArea + ExterQual + BsmtQual +
##   BsmtCond + BsmtExposure + BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF +
##   X1stFlrSF + X2ndFlrSF + BsmtFullBath + BedroomAbvGr + KitchenAbvGr +
##   KitchenQual + TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu +
##   GarageType + GarageYrBlt + GarageFinish + GarageCars + GarageArea +
##   WoodDeckSF + ScreenPorch + SaleCondition
##
##           Df  Sum of Sq      RSS   AIC
## - Utilities      1 1.1813e+09 4.6270e+11 27887
## - BsmtCond       1 1.2071e+09 4.6272e+11 27887
## - GarageFinish   1 1.2117e+09 4.6273e+11 27887
## - MSZoning       1 1.4150e+09 4.6293e+11 27888
## - BsmtFullBath   1 1.4326e+09 4.6295e+11 27888
## - Exterior2nd    1 1.6919e+09 4.6321e+11 27888
## - GarageType     1 1.8359e+09 4.6335e+11 27889
## - GarageYrBlt    1 2.1143e+09 4.6363e+11 27890
## - TotRmsAbvGrd   1 2.1489e+09 4.6366e+11 27890
## <none>              4.6151e+11 27891
## - MSSubClass     1 2.4767e+09 4.6399e+11 27891
## - Exterior1st    1 2.9322e+09 4.6445e+11 27892
## - BldgType       1 3.0676e+09 4.6458e+11 27893
## - GarageCars     1 3.2118e+09 4.6473e+11 27893
## - GarageArea     1 3.2646e+09 4.6478e+11 27893
## - BsmtExposure   1 3.3118e+09 4.6483e+11 27893

```



```

## - WoodDeckSF      1 3.5848e+09 4.6510e+11 27894
## - ScreenPorch     1 3.8412e+09 4.6535e+11 27895
## - BsmtUnfSF       1 5.1001e+09 4.6661e+11 27899
## - FireplaceQu     1 6.4788e+09 4.6799e+11 27903
## - Fireplaces      1 6.5202e+09 4.6803e+11 27903
## - MasVnrType      1 7.5205e+09 4.6903e+11 27906
## - BedroomAbvGr    1 9.1247e+09 4.7064e+11 27911
## - BsmtFinSF2      1 9.8599e+09 4.7137e+11 27913
## - Street          1 1.0108e+10 4.7162e+11 27914
## - KitchenAbvGr    1 1.0180e+10 4.7169e+11 27914
## - BsmtQual        1 1.0863e+10 4.7238e+11 27916
## - SaleCondition   1 1.5300e+10 4.7681e+11 27929
## - MasVnrArea      1 1.8530e+10 4.8004e+11 27939
## - KitchenQual     1 2.1914e+10 4.8343e+11 27949
## - Functional      1 2.2309e+10 4.8382e+11 27950
## - ExterQual       1 2.7054e+10 4.8857e+11 27964
## - BsmtFinSF1      1 3.1709e+10 4.9322e+11 27977
## - LotArea         1 3.3265e+10 4.9478e+11 27981
## - OverallCond     1 3.4352e+10 4.9587e+11 27984
## - YearBuilt       1 3.7627e+10 4.9914e+11 27994
## - OverallQual     1 5.5266e+10 5.1678e+11 28043
## - X1stFlrSF       1 1.0307e+11 5.6458e+11 28167
## - X2ndFlrSF       1 1.4687e+11 6.0838e+11 28272
##
## Step:  AIC=27886.95
## SalePrice ~ MSSubClass + MSZoning + LotArea + Street + BldgType +
## OverallQual + OverallCond + YearBuilt + Exterior1st + Exterior2nd +
## MasVnrType + MasVnrArea + ExterQual + BsmtQual + BsmtCond +
## BsmtExposure + BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF + X1stFlrSF +
## X2ndFlrSF + BsmtFullBath + BedroomAbvGr + KitchenAbvGr +
## KitchenQual + TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu +
## GarageType + GarageYrBlt + GarageFinish + GarageCars + GarageArea +
## WoodDeckSF + ScreenPorch + SaleCondition
##
##           Df Sum of Sq      RSS   AIC
## - BsmtCond      1 1.1736e+09 4.6387e+11 27883
## - GarageFinish   1 1.1962e+09 4.6389e+11 27883
## - MSZoning       1 1.4137e+09 4.6411e+11 27884
## - BsmtFullBath   1 1.4641e+09 4.6416e+11 27884
## - Exterior2nd    1 1.7339e+09 4.6443e+11 27885
## - GarageType     1 1.8500e+09 4.6455e+11 27885
## - TotRmsAbvGrd   1 2.0441e+09 4.6474e+11 27886
## - GarageYrBlt    1 2.0916e+09 4.6479e+11 27886
## <none>              4.6270e+11 27887
## - MSSubClass     1 2.4394e+09 4.6513e+11 27887
## - Exterior1st    1 2.9389e+09 4.6563e+11 27889
## - BldgType       1 3.0760e+09 4.6577e+11 27889
## - GarageCars     1 3.1592e+09 4.6585e+11 27889
## - GarageArea     1 3.2631e+09 4.6596e+11 27890
## - BsmtExposure   1 3.3414e+09 4.6604e+11 27890
## - ScreenPorch    1 3.4660e+09 4.6616e+11 27890
## - WoodDeckSF     1 3.6199e+09 4.6631e+11 27891
## - BsmtUnfSF      1 5.3860e+09 4.6808e+11 27896
## - FireplaceQu    1 6.3410e+09 4.6904e+11 27899

```

```

## - Fireplaces      1 6.4939e+09 4.6919e+11 27899
## - MasVnrType      1 7.4880e+09 4.7018e+11 27902
## - BedroomAbvGr    1 9.0858e+09 4.7178e+11 27907
## - BsmtFinSF2      1 9.7979e+09 4.7249e+11 27909
## - Street          1 1.0066e+10 4.7276e+11 27910
## - KitchenAbvGr    1 1.0139e+10 4.7283e+11 27910
## - BsmtQual        1 1.0967e+10 4.7366e+11 27913
## - SaleCondition    1 1.6192e+10 4.7889e+11 27928
## - MasVnrArea      1 1.7941e+10 4.8064e+11 27933
## - KitchenQual      1 2.1631e+10 4.8433e+11 27944
## - Functional       1 2.2251e+10 4.8495e+11 27946
## - ExterQual        1 2.7321e+10 4.9002e+11 27960
## - BsmtFinSF1      1 3.2500e+10 4.9520e+11 27975
## - LotArea         1 3.3096e+10 4.9579e+11 27977
## - OverallCond      1 3.4285e+10 4.9698e+11 27980
## - YearBuilt        1 3.7530e+10 5.0023e+11 27990
## - OverallQual      1 5.5056e+10 5.1775e+11 28038
## - X1stFlrSF        1 1.0320e+11 5.6590e+11 28163
## - X2ndFlrSF        1 1.4844e+11 6.1114e+11 28272
##
## Step: AIC=27883.27
## SalePrice ~ MSSubClass + MSZoning + LotArea + Street + BldgType +
## OverallQual + OverallCond + YearBuilt + Exterior1st + Exterior2nd +
## MasVnrType + MasVnrArea + ExterQual + BsmtQual + BsmtExposure +
## BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF + X1stFlrSF + X2ndFlrSF +
## BsmtFullBath + BedroomAbvGr + KitchenAbvGr + KitchenQual +
## TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu + GarageType +
## GarageYrBlt + GarageFinish + GarageCars + GarageArea + WoodDeckSF +
## ScreenPorch + SaleCondition
##
##      Df Sum of Sq      RSS   AIC
## - GarageFinish    1 1.2105e+09 4.6508e+11 27880
## - MSZoning         1 1.3505e+09 4.6522e+11 27880
## - BsmtFullBath     1 1.4588e+09 4.6533e+11 27880
## - Exterior2nd      1 1.6919e+09 4.6556e+11 27881
## - GarageType       1 1.8327e+09 4.6570e+11 27882
## - GarageYrBlt      1 2.0392e+09 4.6591e+11 27882
## - TotRmsAbvGrd     1 2.1078e+09 4.6598e+11 27882
## - MSSubClass       1 2.3915e+09 4.6626e+11 27883
## <none>              4.6387e+11 27883
## - Exterior1st      1 2.9318e+09 4.6680e+11 27885
## - GarageCars       1 3.0851e+09 4.6695e+11 27885
## - BldgType         1 3.1343e+09 4.6700e+11 27886
## - GarageArea       1 3.3089e+09 4.6718e+11 27886
## - BsmtExposure     1 3.3687e+09 4.6724e+11 27886
## - ScreenPorch      1 3.5273e+09 4.6740e+11 27887
## - WoodDeckSF       1 3.5785e+09 4.6745e+11 27887
## - FireplaceQu      1 6.2210e+09 4.7009e+11 27895
## - Fireplaces       1 6.5933e+09 4.7046e+11 27896
## - BsmtUnfSF        1 6.6999e+09 4.7057e+11 27896
## - MasVnrType       1 7.4168e+09 4.7129e+11 27898
## - BedroomAbvGr     1 9.2864e+09 4.7316e+11 27904
## - Street           1 9.8179e+09 4.7369e+11 27906
## - KitchenAbvGr     1 1.0136e+10 4.7400e+11 27906

```

```

## - BsmtFinSF2      1 1.0509e+10 4.7438e+11 27908
## - BsmtQual        1 1.0547e+10 4.7442e+11 27908
## - SaleCondition   1 1.6176e+10 4.8004e+11 27924
## - MasVnrArea      1 1.8163e+10 4.8203e+11 27930
## - KitchenQual     1 2.1518e+10 4.8539e+11 27940
## - Functional      1 2.1954e+10 4.8582e+11 27941
## - ExterQual       1 2.6582e+10 4.9045e+11 27954
## - LotArea         1 3.3148e+10 4.9702e+11 27973
## - OverallCond     1 3.5437e+10 4.9931e+11 27980
## - BsmtFinSF1      1 3.6106e+10 4.9997e+11 27982
## - YearBuilt       1 3.9573e+10 5.0344e+11 27991
## - OverallQual     1 5.5843e+10 5.1971e+11 28036
## - X1stFlrSF       1 1.0211e+11 5.6598e+11 28156
## - X2ndFlrSF       1 1.4793e+11 6.1179e+11 28266
##
## Step:  AIC=27879.69
## SalePrice ~ MSSubClass + MSZoning + LotArea + Street + BldgType +
## OverallQual + OverallCond + YearBuilt + Exterior1st + Exterior2nd +
## MasVnrType + MasVnrArea + ExterQual + BsmtQual + BsmtExposure +
## BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF + X1stFlrSF + X2ndFlrSF +
## BsmtFullBath + BedroomAbvGr + KitchenAbvGr + KitchenQual +
## TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu + GarageType +
## GarageYrBlt + GarageCars + GarageArea + WoodDeckSF + ScreenPorch +
## SaleCondition
##
##           Df Sum of Sq      RSS   AIC
## - MSZoning      1 1.2830e+09 4.6636e+11 27876
## - GarageType    1 1.4252e+09 4.6650e+11 27877
## - BsmtFullBath  1 1.4307e+09 4.6651e+11 27877
## - Exterior2nd   1 1.6690e+09 4.6675e+11 27878
## <none>                4.6508e+11 27880
## - TotRmsAbvGrd  1 2.4197e+09 4.6750e+11 27880
## - MSSubClass    1 2.4251e+09 4.6750e+11 27880
## - Exterior1st   1 2.9110e+09 4.6799e+11 27881
## - GarageArea    1 3.0648e+09 4.6814e+11 27882
## - BldgType      1 3.1341e+09 4.6821e+11 27882
## - BsmtExposure  1 3.4051e+09 4.6848e+11 27883
## - GarageCars    1 3.4427e+09 4.6852e+11 27883
## - ScreenPorch   1 3.6244e+09 4.6870e+11 27883
## - WoodDeckSF    1 3.7285e+09 4.6881e+11 27884
## - GarageYrBlt   1 3.8255e+09 4.6890e+11 27884
## - FireplaceQu   1 6.1501e+09 4.7123e+11 27891
## - BsmtUnfSF     1 6.5462e+09 4.7163e+11 27892
## - Fireplaces    1 7.0562e+09 4.7214e+11 27894
## - MasVnrType    1 7.2588e+09 4.7234e+11 27894
## - Street        1 9.8243e+09 4.7490e+11 27902
## - BedroomAbvGr  1 1.0007e+10 4.7509e+11 27902
## - BsmtFinSF2    1 1.0452e+10 4.7553e+11 27904
## - KitchenAbvGr  1 1.0598e+10 4.7568e+11 27904
## - BsmtQual      1 1.1116e+10 4.7620e+11 27906
## - SaleCondition  1 1.6326e+10 4.8140e+11 27921
## - MasVnrArea    1 1.7726e+10 4.8281e+11 27925
## - KitchenQual   1 2.2197e+10 4.8728e+11 27938
## - Functional    1 2.2454e+10 4.8753e+11 27939

```

```

## - ExterQual      1 2.7571e+10 4.9265e+11 27954
## - LotArea        1 3.3564e+10 4.9864e+11 27971
## - OverallCond    1 3.5306e+10 5.0039e+11 27976
## - BsmtFinSF1     1 3.6241e+10 5.0132e+11 27978
## - YearBuilt      1 4.3802e+10 5.0888e+11 27999
## - OverallQual    1 5.6204e+10 5.2128e+11 28033
## - X1stFlrSF      1 1.0229e+11 5.6737e+11 28152
## - X2ndFlrSF      1 1.4930e+11 6.1438e+11 28264
##
## Step:  AIC=27876.32
## SalePrice ~ MSSubClass + LotArea + Street + BldgType + OverallQual +
## OverallCond + YearBuilt + Exterior1st + Exterior2nd + MasVnrType +
## MasVnrArea + ExterQual + BsmtQual + BsmtExposure + BsmtFinSF1 +
## BsmtFinSF2 + BsmtUnfSF + X1stFlrSF + X2ndFlrSF + BsmtFullBath +
## BedroomAbvGr + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +
## Functional + Fireplaces + FireplaceQu + GarageType + GarageYrBlt +
## GarageCars + GarageArea + WoodDeckSF + ScreenPorch + SaleCondition
##
##           Df Sum of Sq      RSS   AIC
## - BsmtFullBath  1 1.3348e+09 4.6770e+11 27873
## - GarageType    1 1.4700e+09 4.6783e+11 27874
## - Exterior2nd   1 1.6227e+09 4.6798e+11 27874
## - TotRmsAbvGrd  1 2.3334e+09 4.6870e+11 27876
## <none>                4.6636e+11 27876
## - MSSubClass    1 2.4343e+09 4.6880e+11 27876
## - Exterior1st   1 2.9166e+09 4.6928e+11 27878
## - GarageCars    1 3.0906e+09 4.6945e+11 27878
## - BsmtExposure  1 3.2040e+09 4.6957e+11 27879
## - BldgType      1 3.3063e+09 4.6967e+11 27879
## - WoodDeckSF    1 3.5249e+09 4.6989e+11 27880
## - GarageArea    1 3.5879e+09 4.6995e+11 27880
## - ScreenPorch   1 3.6504e+09 4.7001e+11 27880
## - GarageYrBlt   1 3.8212e+09 4.7018e+11 27881
## - FireplaceQu   1 6.1575e+09 4.7252e+11 27888
## - BsmtUnfSF     1 6.3586e+09 4.7272e+11 27888
## - Fireplaces    1 6.9021e+09 4.7326e+11 27890
## - MasVnrType    1 7.5390e+09 4.7390e+11 27892
## - Street        1 9.3316e+09 4.7569e+11 27897
## - BedroomAbvGr  1 9.9340e+09 4.7630e+11 27899
## - BsmtFinSF2    1 1.0401e+10 4.7676e+11 27900
## - KitchenAbvGr  1 1.0587e+10 4.7695e+11 27901
## - BsmtQual      1 1.0826e+10 4.7719e+11 27901
## - SaleCondition  1 1.5792e+10 4.8215e+11 27916
## - MasVnrArea    1 1.7437e+10 4.8380e+11 27921
## - KitchenQual   1 2.2386e+10 4.8875e+11 27935
## - Functional    1 2.3373e+10 4.8974e+11 27938
## - ExterQual     1 2.8687e+10 4.9505e+11 27953
## - LotArea       1 3.4041e+10 5.0040e+11 27968
## - OverallCond   1 3.4408e+10 5.0077e+11 27969
## - BsmtFinSF1    1 3.6093e+10 5.0245e+11 27974
## - YearBuilt     1 4.9418e+10 5.1578e+11 28011
## - OverallQual   1 5.5874e+10 5.2224e+11 28028
## - X1stFlrSF     1 1.0292e+11 5.6929e+11 28150
## - X2ndFlrSF     1 1.5105e+11 6.1741e+11 28264

```

```

##
## Step: AIC=27873.09
## SalePrice ~ MSSubClass + LotArea + Street + BldgType + OverallQual +
## OverallCond + YearBuilt + Exterior1st + Exterior2nd + MasVnrType +
## MasVnrArea + ExterQual + BsmtQual + BsmtExposure + BsmtFinSF1 +
## BsmtFinSF2 + BsmtUnfSF + X1stFlrSF + X2ndFlrSF + BedroomAbvGr +
## KitchenAbvGr + KitchenQual + TotRmsAbvGrd + Functional +
## Fireplaces + FireplaceQu + GarageType + GarageYrBlt + GarageCars +
## GarageArea + WoodDeckSF + ScreenPorch + SaleCondition
##
##      Df Sum of Sq      RSS   AIC
## - GarageType      1 1.5576e+09 4.6925e+11 27870
## - Exterior2nd      1 1.7502e+09 4.6945e+11 27871
## - MSSubClass       1 2.1987e+09 4.6990e+11 27872
## - TotRmsAbvGrd     1 2.4028e+09 4.7010e+11 27873
## <none>              4.6770e+11 27873
## - Exterior1st      1 2.9296e+09 4.7063e+11 27875
## - GarageCars       1 3.0366e+09 4.7073e+11 27875
## - BldgType         1 3.4518e+09 4.7115e+11 27876
## - BsmtExposure     1 3.5124e+09 4.7121e+11 27876
## - ScreenPorch      1 3.5317e+09 4.7123e+11 27876
## - WoodDeckSF       1 3.7078e+09 4.7140e+11 27877
## - GarageArea       1 3.7538e+09 4.7145e+11 27877
## - GarageYrBlt      1 3.9589e+09 4.7166e+11 27878
## - FireplaceQu      1 5.9946e+09 4.7369e+11 27884
## - BsmtUnfSF        1 6.2782e+09 4.7398e+11 27885
## - Fireplaces       1 6.9033e+09 4.7460e+11 27886
## - MasVnrType       1 7.5632e+09 4.7526e+11 27888
## - Street           1 9.2228e+09 4.7692e+11 27893
## - BedroomAbvGr     1 1.0202e+10 4.7790e+11 27896
## - KitchenAbvGr     1 1.0443e+10 4.7814e+11 27897
## - BsmtQual         1 1.0948e+10 4.7864e+11 27898
## - BsmtFinSF2       1 1.2771e+10 4.8047e+11 27904
## - SaleCondition    1 1.5719e+10 4.8342e+11 27912
## - MasVnrArea       1 1.6919e+10 4.8462e+11 27916
## - KitchenQual      1 2.2792e+10 4.9049e+11 27933
## - Functional       1 2.3559e+10 4.9126e+11 27935
## - ExterQual        1 2.8634e+10 4.9633e+11 27950
## - OverallCond      1 3.4030e+10 5.0173e+11 27965
## - LotArea          1 3.4497e+10 5.0219e+11 27966
## - BsmtFinSF1       1 4.9705e+10 5.1740e+11 28008
## - YearBuilt        1 4.9927e+10 5.1762e+11 28009
## - OverallQual      1 5.5634e+10 5.2333e+11 28024
## - X1stFlrSF        1 1.0232e+11 5.7002e+11 28144
## - X2ndFlrSF        1 1.4997e+11 6.1767e+11 28257
##
## Step: AIC=27870.52
## SalePrice ~ MSSubClass + LotArea + Street + BldgType + OverallQual +
## OverallCond + YearBuilt + Exterior1st + Exterior2nd + MasVnrType +
## MasVnrArea + ExterQual + BsmtQual + BsmtExposure + BsmtFinSF1 +
## BsmtFinSF2 + BsmtUnfSF + X1stFlrSF + X2ndFlrSF + BedroomAbvGr +
## KitchenAbvGr + KitchenQual + TotRmsAbvGrd + Functional +
## Fireplaces + FireplaceQu + GarageYrBlt + GarageCars + GarageArea +
## WoodDeckSF + ScreenPorch + SaleCondition

```

```

##
##          Df  Sum of Sq      RSS      AIC
## - Exterior2nd      1 1.8239e+09 4.7108e+11 27869
## - MSSubClass       1 2.1557e+09 4.7141e+11 27870
## <none>              4.6925e+11 27870
## - TotRmsAbvGrd    1 2.4262e+09 4.7168e+11 27870
## - Exterior1st     1 2.9409e+09 4.7220e+11 27872
## - GarageCars       1 3.1682e+09 4.7242e+11 27873
## - BldgType         1 3.2922e+09 4.7255e+11 27873
## - ScreenPorch      1 3.3547e+09 4.7261e+11 27873
## - BsmtExposure     1 3.4249e+09 4.7268e+11 27874
## - WoodDeckSF       1 3.4370e+09 4.7269e+11 27874
## - GarageArea       1 4.0167e+09 4.7327e+11 27875
## - BsmtUnfSF        1 6.3324e+09 4.7559e+11 27882
## - FireplaceQu      1 6.3545e+09 4.7561e+11 27882
## - Fireplaces       1 6.3658e+09 4.7562e+11 27882
## - GarageYrBlt      1 6.3918e+09 4.7565e+11 27882
## - MasVnrType       1 8.3411e+09 4.7760e+11 27888
## - Street           1 9.2197e+09 4.7847e+11 27891
## - KitchenAbvGr     1 1.0119e+10 4.7937e+11 27893
## - BedroomAbvGr     1 1.0210e+10 4.7946e+11 27894
## - BsmtQual         1 1.1195e+10 4.8045e+11 27896
## - BsmtFinSF2       1 1.2580e+10 4.8183e+11 27900
## - SaleCondition    1 1.5608e+10 4.8486e+11 27909
## - MasVnrArea       1 1.7728e+10 4.8698e+11 27916
## - Functional       1 2.3057e+10 4.9231e+11 27931
## - KitchenQual      1 2.3191e+10 4.9245e+11 27931
## - ExterQual        1 2.8859e+10 4.9811e+11 27947
## - LotArea          1 3.4010e+10 5.0326e+11 27962
## - OverallCond      1 3.4060e+10 5.0331e+11 27962
## - BsmtFinSF1       1 4.9269e+10 5.1852e+11 28004
## - YearBuilt        1 4.9859e+10 5.1911e+11 28006
## - OverallQual      1 5.4714e+10 5.2397e+11 28019
## - X1stFlrSF        1 1.0079e+11 5.7005e+11 28137
## - X2ndFlrSF        1 1.4968e+11 6.1893e+11 28253
##
## Step:  AIC=27868.74
## SalePrice ~ MSSubClass + LotArea + Street + BldgType + OverallQual +
## OverallCond + YearBuilt + Exterior1st + MasVnrType + MasVnrArea +
## ExterQual + BsmtQual + BsmtExposure + BsmtFinSF1 + BsmtFinSF2 +
## BsmtUnfSF + X1stFlrSF + X2ndFlrSF + BedroomAbvGr + KitchenAbvGr +
## KitchenQual + TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu +
## GarageYrBlt + GarageCars + GarageArea + WoodDeckSF + ScreenPorch +
## SaleCondition
##
##          Df  Sum of Sq      RSS      AIC
## - Exterior1st      1 1.1662e+09 4.7224e+11 27865
## - TotRmsAbvGrd     1 2.2405e+09 4.7332e+11 27868
## <none>              4.7108e+11 27869
## - MSSubClass       1 2.6240e+09 4.7370e+11 27869
## - BldgType         1 3.2460e+09 4.7432e+11 27871
## - WoodDeckSF       1 3.3232e+09 4.7440e+11 27871
## - GarageCars       1 3.3653e+09 4.7444e+11 27872
## - ScreenPorch      1 3.4329e+09 4.7451e+11 27872

```

```

## - BsmtExposure      1 3.4968e+09 4.7458e+11 27872
## - GarageArea        1 3.8540e+09 4.7493e+11 27873
## - BsmtUnfSF         1 6.1328e+09 4.7721e+11 27880
## - Fireplaces        1 6.4617e+09 4.7754e+11 27881
## - GarageYrBlt       1 6.5029e+09 4.7758e+11 27881
## - FireplaceQu       1 6.6466e+09 4.7773e+11 27881
## - MasVnrType        1 8.5739e+09 4.7965e+11 27887
## - Street            1 9.0074e+09 4.8009e+11 27888
## - KitchenAbvGr      1 9.4052e+09 4.8048e+11 27889
## - BedroomAbvGr      1 1.0292e+10 4.8137e+11 27892
## - BsmtQual          1 1.1441e+10 4.8252e+11 27895
## - BsmtFinSF2        1 1.2604e+10 4.8368e+11 27899
## - SaleCondition     1 1.5758e+10 4.8684e+11 27908
## - MasVnrArea        1 1.7416e+10 4.8849e+11 27913
## - Functional        1 2.2681e+10 4.9376e+11 27928
## - KitchenQual       1 2.3127e+10 4.9421e+11 27929
## - ExterQual         1 2.8232e+10 4.9931e+11 27943
## - LotArea           1 3.3149e+10 5.0423e+11 27957
## - OverallCond       1 3.4302e+10 5.0538e+11 27960
## - BsmtFinSF1        1 4.8526e+10 5.1960e+11 28000
## - YearBuilt         1 4.9584e+10 5.2066e+11 28002
## - OverallQual       1 5.6238e+10 5.2732e+11 28020
## - X1stFlrSF         1 1.0149e+11 5.7256e+11 28136
## - X2ndFlrSF         1 1.5174e+11 6.2282e+11 28255
##
## Step:  AIC=27864.97
## SalePrice ~ MSSubClass + LotArea + Street + BldgType + OverallQual +
## OverallCond + YearBuilt + MasVnrType + MasVnrArea + ExterQual +
## BsmtQual + BsmtExposure + BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF +
## X1stFlrSF + X2ndFlrSF + BedroomAbvGr + KitchenAbvGr + KitchenQual +
## TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu + GarageYrBlt +
## GarageCars + GarageArea + WoodDeckSF + ScreenPorch + SaleCondition
##
##           Df  Sum of Sq      RSS   AIC
## - TotRmsAbvGrd  1 2.1869e+09 4.7443e+11 27864
## <none>                4.7224e+11 27865
## - MSSubClass    1 2.5444e+09 4.7479e+11 27865
## - BldgType      1 3.0223e+09 4.7527e+11 27867
## - GarageCars    1 3.1402e+09 4.7538e+11 27867
## - WoodDeckSF    1 3.2319e+09 4.7548e+11 27867
## - BsmtExposure  1 3.3128e+09 4.7556e+11 27868
## - ScreenPorch   1 3.5908e+09 4.7584e+11 27868
## - GarageArea    1 4.0217e+09 4.7627e+11 27870
## - BsmtUnfSF     1 6.0019e+09 4.7825e+11 27876
## - GarageYrBlt   1 6.3417e+09 4.7859e+11 27876
## - FireplaceQu   1 6.5744e+09 4.7882e+11 27877
## - Fireplaces    1 6.6309e+09 4.7888e+11 27877
## - MasVnrType    1 8.6056e+09 4.8085e+11 27883
## - Street        1 9.0501e+09 4.8129e+11 27884
## - KitchenAbvGr  1 9.2796e+09 4.8152e+11 27885
## - BedroomAbvGr  1 1.0104e+10 4.8235e+11 27888
## - BsmtQual      1 1.0957e+10 4.8320e+11 27890
## - BsmtFinSF2    1 1.2751e+10 4.8500e+11 27895
## - SaleCondition 1 1.5645e+10 4.8789e+11 27904

```

```

## - MasVnrArea      1 1.7594e+10 4.8984e+11 27909
## - Functional      1 2.2925e+10 4.9517e+11 27924
## - KitchenQual     1 2.3134e+10 4.9538e+11 27925
## - ExterQual       1 2.7984e+10 5.0023e+11 27939
## - LotArea         1 3.3147e+10 5.0539e+11 27953
## - OverallCond     1 3.4684e+10 5.0693e+11 27958
## - BsmtFinSF1      1 4.9106e+10 5.2135e+11 27997
## - YearBuilt       1 4.9989e+10 5.2223e+11 27999
## - OverallQual     1 5.5361e+10 5.2761e+11 28014
## - X1stFlrSF       1 1.0264e+11 5.7488e+11 28135
## - X2ndFlrSF       1 1.5182e+11 6.2407e+11 28250
##
## Step:  AIC=27864.22
## SalePrice ~ MSSubClass + LotArea + Street + BldgType + OverallQual +
## OverallCond + YearBuilt + MasVnrType + MasVnrArea + ExterQual +
## BsmtQual + BsmtExposure + BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF +
## X1stFlrSF + X2ndFlrSF + BedroomAbvGr + KitchenAbvGr + KitchenQual +
## Functional + Fireplaces + FireplaceQu + GarageYrBlt + GarageCars +
## GarageArea + WoodDeckSF + ScreenPorch + SaleCondition
##
##           Df Sum of Sq      RSS      AIC
## <none>                4.7443e+11 27864
## - MSSubClass      1 2.4717e+09 4.7690e+11 27864
## - ScreenPorch     1 3.2444e+09 4.7768e+11 27867
## - WoodDeckSF      1 3.3412e+09 4.7777e+11 27867
## - BsmtExposure    1 3.4208e+09 4.7785e+11 27867
## - BldgType        1 3.5381e+09 4.7797e+11 27867
## - GarageCars      1 3.5491e+09 4.7798e+11 27868
## - GarageArea      1 3.7001e+09 4.7813e+11 27868
## - BsmtUnfSF       1 5.7429e+09 4.8017e+11 27874
## - GarageYrBlt     1 6.3770e+09 4.8081e+11 27876
## - Fireplaces      1 6.7347e+09 4.8117e+11 27877
## - FireplaceQu     1 6.9984e+09 4.8143e+11 27878
## - KitchenAbvGr    1 7.5867e+09 4.8202e+11 27879
## - BedroomAbvGr    1 7.9215e+09 4.8235e+11 27880
## - MasVnrType      1 8.8680e+09 4.8330e+11 27883
## - Street          1 9.1086e+09 4.8354e+11 27884
## - BsmtQual        1 1.1210e+10 4.8564e+11 27890
## - BsmtFinSF2      1 1.2320e+10 4.8675e+11 27893
## - SaleCondition   1 1.5670e+10 4.9010e+11 27903
## - MasVnrArea      1 1.7689e+10 4.9212e+11 27908
## - Functional      1 2.2670e+10 4.9710e+11 27923
## - KitchenQual     1 2.3233e+10 4.9766e+11 27924
## - ExterQual       1 2.9107e+10 5.0354e+11 27941
## - LotArea         1 3.2685e+10 5.0712e+11 27951
## - OverallCond     1 3.4489e+10 5.0892e+11 27956
## - BsmtFinSF1      1 4.7870e+10 5.2230e+11 27992
## - YearBuilt       1 4.9173e+10 5.2360e+11 27996
## - OverallQual     1 5.6296e+10 5.3073e+11 28015
## - X1stFlrSF       1 1.3828e+11 6.1272e+11 28217
## - X2ndFlrSF       1 2.3874e+11 7.1317e+11 28431

```

```
summary(model.bic.backward)
```

```
##
```



```
## Call:
## lm(formula = SalePrice ~ MSSubClass + LotArea + Street + BldgType +
##     OverallQual + OverallCond + YearBuilt + MasVnrType + MasVnrArea +
##     ExterQual + BsmtQual + BsmtExposure + BsmtFinSF1 + BsmtFinSF2 +
##     BsmtUnfSF + X1stFlrSF + X2ndFlrSF + BedroomAbvGr + KitchenAbvGr +
##     KitchenQual + Functional + Fireplaces + FireplaceQu + GarageYrBlt +
##     GarageCars + GarageArea + WoodDeckSF + ScreenPorch + SaleCondition,
##     data = within(new_train[-outliers.index, ], rm("Id")))
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -64513 -12099   -117   11229   70714
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -8.559e+04  1.786e+04  -4.791  1.84e-06 ***
## MSSubClass   -6.419e+01  2.396e+01  -2.679   0.00746 **
## LotArea       5.506e-01  5.651e-02   9.743 < 2e-16 ***
## Street       4.115e+04  8.001e+03   5.144  3.08e-07 ***
## BldgType     -2.603e+03  8.119e+02  -3.206   0.00138 **
## OverallQual   8.812e+03  6.891e+02  12.787 < 2e-16 ***
## OverallCond   5.174e+03  5.170e+02  10.009 < 2e-16 ***
## YearBuilt     3.246e+02  2.716e+01  11.951 < 2e-16 ***
## MasVnrType    4.828e+03  9.513e+02   5.075  4.40e-07 ***
## MasVnrArea    2.667e+01  3.721e+00   7.168  1.24e-12 ***
## ExterQual    -1.060e+04  1.153e+03  -9.195 < 2e-16 ***
## BsmtQual     -3.359e+03  5.887e+02  -5.706  1.41e-08 ***
## BsmtExposure -1.580e+03  5.012e+02  -3.152   0.00166 **
## BsmtFinSF1    2.929e+01  2.484e+00  11.792 < 2e-16 ***
## BsmtFinSF2    2.257e+01  3.774e+00   5.982  2.80e-09 ***
## BsmtUnfSF     9.801e+00  2.400e+00   4.084  4.68e-05 ***
## X1stFlrSF     6.146e+01  3.067e+00  20.041 < 2e-16 ***
## X2ndFlrSF     5.597e+01  2.125e+00  26.333 < 2e-16 ***
## BedroomAbvGr -4.147e+03  8.645e+02  -4.797  1.79e-06 ***
## KitchenAbvGr -1.263e+04  2.690e+03  -4.694  2.94e-06 ***
## KitchenQual  -6.982e+03  8.500e+02  -8.215  4.85e-16 ***
## Functional    4.467e+03  5.505e+02   8.115  1.07e-15 ***
## Fireplaces    4.281e+03  9.679e+02   4.423  1.05e-05 ***
## FireplaceQu   -2.091e+03  4.637e+02  -4.509  7.08e-06 ***
## GarageYrBlt   -6.329e+00  1.471e+00  -4.304  1.80e-05 ***
## GarageCars    5.316e+03  1.656e+03   3.211   0.00135 **
## GarageArea    1.808e+01  5.514e+00   3.278   0.00107 **
## WoodDeckSF    1.369e+01  4.394e+00   3.115   0.00188 **
## ScreenPorch   2.926e+01  9.531e+00   3.070   0.00218 **
## SaleCondition  3.218e+03  4.771e+02   6.746  2.23e-11 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 18560 on 1378 degrees of freedom
## Multiple R-squared:  0.926, Adjusted R-squared:  0.9244
## F-statistic: 594.4 on 29 and 1378 DF, p-value: < 2.2e-16
```

After selection, the remaining features are almost all significant. We can see that the coefficients of SaleCondition is 3.218e+03. It means that the better condition of sale, the higher the price of the house.

Then, perform prediction and save it as .csv file.

```
result <- data.frame(Id=test$Id)
pred <- predict.lm(model.bic.backward, new_test)
result$SalePrice <- pred
write.csv(result, file = "backward.csv", quote = F, row.names = F)
```

Shrinkage Methods

We use cross-validation to choose the best tuning parameters for both methods.

```
x = as.matrix(within(new_train, rm("SalePrice")))
y = new_train$SalePrice
```

For Ridge Regression

```
library(glmnet)
grid = 10^seq(10,-2,length=100)

ridge_cv <- cv.glmnet(x, y, alpha = 0, lambda = grid)
best_lambda <- ridge_cv$lambda.min
best_lambda
```

```
## [1] 35111.92
```

Building the final ridge regression model:

```
best.ridge <- glmnet(x, y, alpha = 0, lambda = best_lambda)
```

```
coef(best.ridge)
```

```
## 81 x 1 sparse Matrix of class "dgCMatrix"
##              s0
## (Intercept)  1.310666e+06
## Id          -1.812186e+00
## MSSubClass   -6.016543e+01
## MSZoning     -5.160536e+02
## LotFrontage  -1.983455e+01
## LotArea      3.041314e-01
## Street       2.375718e+04
## Alley        1.930729e+03
## LotShape     -1.105823e+03
## LandContour  1.489782e+03
## Utilities    -3.075597e+04
## LotConfig    -1.377559e+02
## LandSlope     4.463708e+03
## Neighborhood 2.608028e+02
## Condition1   -3.949864e+02
## Condition2   -5.334256e+03
## BldgType     -2.082023e+03
## HouseStyle    -4.353440e+02
## OverallQual   7.496233e+03
## OverallCond   2.850137e+03
## YearBuilt     7.955788e+01
## YearRemodAdd  1.212366e+02
```

## RoofStyle	2.732370e+03
## RoofMatl	4.575687e+03
## Exterior1st	-3.292676e+02
## Exterior2nd	3.818778e+01
## MasVnrType	3.080321e+03
## MasVnrArea	2.850006e+01
## ExterQual	-9.094443e+03
## ExterCond	6.890875e+02
## Foundation	2.155075e+03
## BsmtQual	-4.185062e+03
## BsmtCond	7.954283e+02
## BsmtExposure	-2.726249e+03
## BsmtFinType1	-5.960284e+02
## BsmtFinSF1	7.836518e+00
## BsmtFinType2	1.061085e+02
## BsmtFinSF2	4.092138e+00
## BsmtUnfSF	5.786910e-01
## TotalBsmtSF	9.577301e+00
## Heating	-5.662095e+02
## HeatingQC	-1.252578e+03
## CentralAir	3.996261e+03
## Electrical	-3.476854e+01
## X1stFlrSF	1.446653e+01
## X2ndFlrSF	1.186317e+01
## LowQualFinSF	-8.174539e+00
## GrLivArea	1.594184e+01
## BsmtFullBath	4.992966e+03
## BsmtHalfBath	-4.043991e+02
## FullBath	6.951393e+03
## HalfBath	3.894580e+03
## BedroomAbvGr	-4.395806e+02
## KitchenAbvGr	-1.100855e+04
## KitchenQual	-7.968878e+03
## TotRmsAbvGrd	3.375551e+03
## Functional	2.664278e+03
## Fireplaces	6.707582e+03
## FireplaceQu	-1.602444e+03
## GarageType	-1.310250e+02
## GarageYrBlt	-1.519197e+00
## GarageFinish	-1.965488e+03
## GarageCars	7.168533e+03
## GarageArea	1.843063e+01
## GarageQual	-4.817876e+02
## GarageCond	8.144152e+02
## PavedDrive	2.324198e+03
## WoodDeckSF	2.051474e+01
## OpenPorchSF	1.101682e+01
## EnclosedPorch	3.161650e+00
## X3SsnPorch	1.983384e+01
## ScreenPorch	3.915627e+01
## PoolArea	-4.613489e+01
## PoolQC	-2.029144e+04
## Fence	3.777790e+02
## MiscFeature	-2.376309e+03

```
## MiscVal      -2.281062e-01
## MoSold       3.617330e+01
## YrSold       -6.008808e+02
## SaleType     -4.112268e+02
## SaleCondition 2.131646e+03
```

All features have coefficients, so ridge regression cannot perform feature selection.

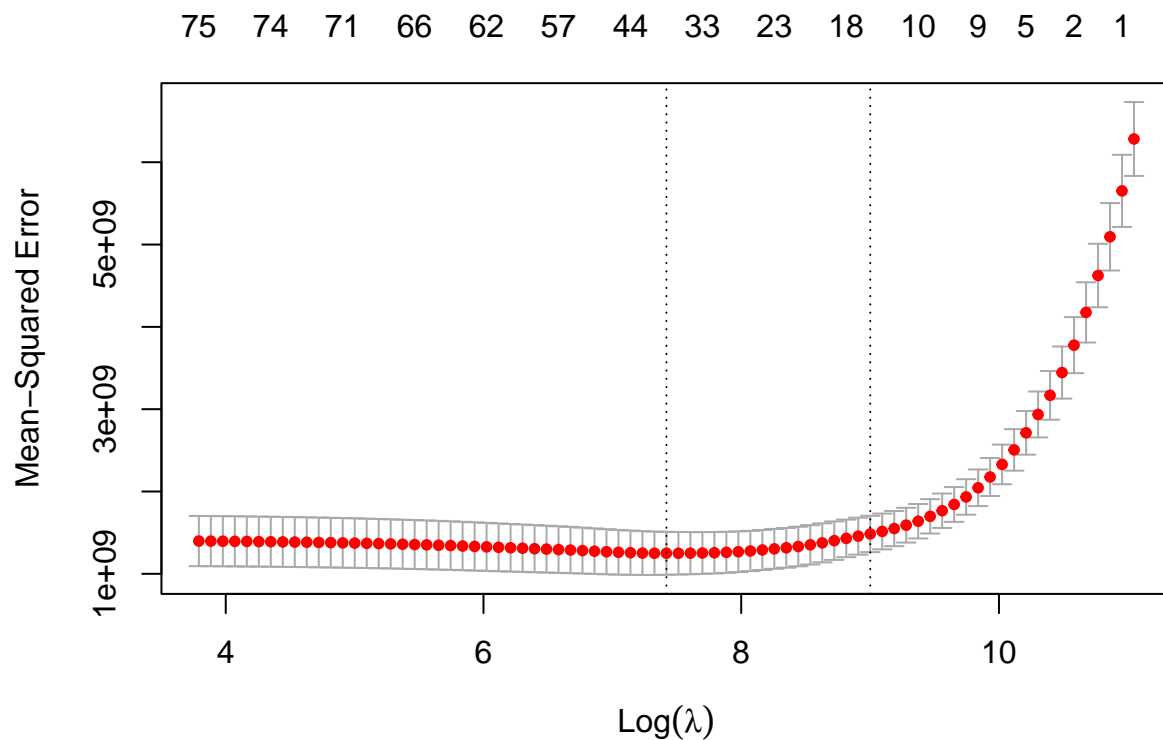
Then, perform prediction for the best ridge regression model and save it as .csv file.

```
result <- data.frame(Id=test$Id)
pred <- predict(best.ridge, as.matrix(new_test))
result$SalePrice <- pred
write.csv(result, file = "ridge.csv", quote = F, row.names = F)
```

For Lasso

Choose the best value of the parameter λ .

```
cv.lasso <- cv.glmnet(x, y, alpha=1)
plot(cv.lasso)
```



```
bestlam <- cv.lasso$lambda.min
bestlam
```

```
## [1] 1668.449
```

The best value of λ is:.

```
bestlam
```

```
## [1] 1668.449
```

Building the final lasso model:

```
best.lasso <- glmnet(x, y, alpha = 1, lambda = bestlam)
```

```
coef(best.lasso)
```

```
## 81 x 1 sparse Matrix of class "dgCMatrix"
```

```
##              s0
## (Intercept) 27043.9994952
## Id          .
## MSSubClass  -132.7913529
## MSZoning    .
## LotFrontage .
## LotArea     0.3094553
## Street      736.5048580
## Alley       .
## LotShape    -414.7751735
## LandContour 308.2995675
## Utilities   .
## LotConfig   .
## LandSlope   .
## Neighborhood .
## Condition1  .
## Condition2  -356.3894585
## BldgType    -119.9296067
## HouseStyle  .
## OverallQual 13739.8396585
## OverallCond 2512.3855449
## YearBuilt   123.2275760
## YearRemodAdd 43.1947521
## RoofStyle   746.9579921
## RoofMatl    2324.8542153
## Exterior1st .
## Exterior2nd .
## MasVnrType  1498.7914886
## MasVnrArea  24.0234072
## ExterQual   -9274.1861362
## ExterCond   .
## Foundation  .
## BsmtQual    -4468.8490062
## BsmtCond    .
## BsmtExposure -2524.3938825
## BsmtFinType1 -619.6620910
## BsmtFinSF1   8.9788280
## BsmtFinType2 .
## BsmtFinSF2   .
## BsmtUnfSF    .
## TotalBsmtSF  4.5522112
## Heating     .
## HeatingQC   -307.4314259
## CentralAir  1435.3156047
## Electrical  .
## X1stFlrSF    3.0159229
## X2ndFlrSF    .
## LowQualFinSF .
## GrLivArea    44.4557330
```

```
## BsmtFullBath    4277.4091473
## BsmtHalfBath    .
## FullBath        .
## HalfBath        .
## BedroomAbvGr    .
## KitchenAbvGr    -2510.1798133
## KitchenQual     -8916.5465904
## TotRmsAbvGrd    373.9319155
## Functional      2038.3048385
## Fireplaces      4716.3451178
## FireplaceQu     -447.4914111
## GarageType      .
## GarageYrBlt     .
## GarageFinish    -1050.5497465
## GarageCars      10781.1299222
## GarageArea      .
## GarageQual      .
## GarageCond      .
## PavedDrive      4.9003078
## WoodDeckSF      14.4017094
## OpenPorchSF     .
## EnclosedPorch   .
## X3SsnPorch      .
## ScreenPorch     21.1917780
## PoolArea        .
## PoolQC          .
## Fence           .
## MiscFeature     .
## MiscVal         .
## MoSold          .
## YrSold          .
## SaleType        .
## SaleCondition   1585.3675237
```

According to the coefficients of the best Lasso model, we can see that many coefficients is zero. It means that the LASSO considers these features unimportant.

Then, perform prediction for the best lasso model and save it as `.csv` file.

```
result <- data.frame(Id=test$Id)
pred <- predict(best.lasso, as.matrix(new_test))
result$SalePrice <- pred
write.csv(result, file = "lasso.csv", quote = F, row.names = F)
```

Comparison of LASSO and Ridge

LASSO can do a better job in terms of model interpretation. The reason is that LASSO can do feature selection. The remaining feature is more important. Ridge retains all the features, and we have no way of knowing which ones are more important to the sale price of the house.

Estimated Test Errors (CV estimate) and True Test Errors of the models in item 1-4.

We use the 10-fold cross validation to estimate test error.

For ease of comparison, we also calculate the value which computed by the root mean squared errors (RMSEs) between the logarithm of the predicted value and the logarithm of the observed sales price.

For the model in item 1 (knn)

```
set.seed(9999)
fold.index <- cut(sample(1:nrow(new_train)), breaks=10, labels=FALSE)
mse <- 0
log.rmse <- 0
for(i in 1:10){
  pred <- knn.reg(within(new_train[fold.index!=i,], rm('SalePrice')),
                  within(new_train[fold.index==i,], rm('SalePrice')),
                  new_train[fold.index!=i,]$SalePrice, k=best_k)
  mse <- mse + RMSE(pred$pred, new_train[fold.index==i,]$SalePrice)^2
  log.rmse <- log.rmse + RMSE(log(pred$pred), log(new_train[fold.index==i,]$SalePrice))
}

mse/10

## [1] 2237860909

log.rmse/10

## [1] 0.2267953
```

For the model in item 2 (Linear regression)

```
set.seed(9999)
cv.lm.train <- new_train[-outliers.index, ]
fold.index <- cut(sample(1:nrow(cv.lm.train)), breaks=10, labels=FALSE)
mse <- 0
log.rmse <- 0
for(i in 1:10){
  model.cv.lm <- lm(SalePrice~., data=within(cv.lm.train[fold.index!=i, ], rm('Id')))
  pred <- predict.lm(model.cv.lm, within(cv.lm.train[fold.index==i, ], rm('Id')))
  mse <- mse + RMSE(pred, cv.lm.train[fold.index==i,]$SalePrice)^2
  log.rmse <- log.rmse + RMSE(log(pred), log(cv.lm.train[fold.index==i,]$SalePrice))
}

mse/10

## [1] 369297795

log.rmse/10

## [1] 0.1276399
```

For the model in item 3 (Backward stepwise)

```
set.seed(9999)
fold.index <- cut(sample(1:nrow(new_train)), breaks=10, labels=FALSE)
mse <- 0
log.rmse <- 0
formula <- SalePrice ~ MSSubClass + LotArea + Street + BldgType +
  OverallQual + OverallCond + YearBuilt + MasVnrType + MasVnrArea +
```

```

    ExterQual + BsmtQual + BsmtExposure + BsmtFinSF1 + BsmtFinSF2 +
    BsmtUnfSF + X1stFlrSF + X2ndFlrSF + BedroomAbvGr + KitchenAbvGr +
    KitchenQual + Functional + Fireplaces + FireplaceQu + GarageYrBlt +
    GarageCars + GarageArea + WoodDeckSF + ScreenPorch + SaleCondition
for(i in 1:10){
  model.cv.lm <- lm(formula, data=within(new_train[fold.index!=i, ], rm('Id')))
  pred <- predict.lm(model.cv.lm, within(new_train[fold.index==i, ], rm('Id')))
  mse <- mse + RMSE(pred, new_train[fold.index==i,$SalePrice]^2
  log.rmse <- log.rmse + RMSE(log(pred), log(new_train[fold.index==i,$SalePrice))
}

```

```
mse/10
```

```
## [1] 1206513837
```

```
log.rmse/10
```

```
## [1] 0.1543136
```

For the model in item 4 (Ridge Regression)

```

set.seed(9999)
fold.index <- cut(sample(1:nrow(new_train)), breaks=10, labels=FALSE)
mse <- 0
log.rmse <- 0
for(i in 1:10){
  model.cv <- glmnet(as.matrix(within(new_train[fold.index!=i, ], rm('SalePrice'))),
                    new_train[fold.index!=i, ]$SalePrice, alpha = 0, lambda = best_lambda)
  pred <- predict(model.cv, as.matrix(within(new_train[fold.index==i, ], rm('SalePrice'))))
  mse <- mse + RMSE(pred, new_train[fold.index==i,$SalePrice]^2
  log.rmse <- log.rmse + RMSE(log(pred), log(new_train[fold.index==i,$SalePrice))
}

```

```
mse/10
```

```
## [1] 1252776319
```

```
log.rmse/10
```

```
## [1] 0.1492509
```

For the model in item 4 (LASSO Regression)

```

set.seed(9999)
fold.index <- cut(sample(1:nrow(new_train)), breaks=10, labels=FALSE)
mse <- 0
log.rmse <- 0
for(i in 1:10){
  model.cv <- glmnet(as.matrix(within(new_train[fold.index!=i, ], rm('SalePrice'))),
                    new_train[fold.index!=i, ]$SalePrice, alpha = 1, lambda = bestlam)
  pred <- predict(model.cv, as.matrix(within(new_train[fold.index==i, ], rm('SalePrice'))))
  mse <- mse + RMSE(pred, new_train[fold.index==i,$SalePrice]^2
  log.rmse <- log.rmse + RMSE(log(pred), log(new_train[fold.index==i,$SalePrice))
}

```


mse/10

[1] 1283503897

log.rmse/10

[1] 0.1559399

Submit your predictions to Kaggle and see the true test mean squared error for each method.

5 submissions for Xuancen Guo		Sort by Select...
All Successful Selected		
Submission and Description		Public Score
ridge.csv just now by Xuancen Guo add submission details		0.16076
backward.csv a few seconds ago by Xuancen Guo add submission details		0.16287
lm.csv a minute ago by Xuancen Guo add submission details		0.16976
knn.csv 2 minutes ago by Xuancen Guo add submission details		0.25500
lasso.csv 2 minutes ago by Xuancen Guo add submission details		0.15960
No more submissions to show		

Figure 1: Result from kaggle.

Compare the CV MSEs and the true test MSEs

Method	True Test Error from Kaggle	10-fold Test Error	10-fold Test Error (logarithm)
KNN	0.25500	2237860909	0.2267953
Linear Regression	0.16976	369297795	0.1276399
Backward Stepwise	0.16287	1206513837	0.1543136
Ridge Regression	0.16076	1252776319	0.1492509
LASSO	0.15960	1283503897	0.1559399

It doesn't look similar. KNN has the worst performance between the two. However, the linear programming algorithm performs best in CV, which does not match the results on Kaggle. The performance of the models in item 3-4 on Kaggle is similar to that in CV.