

title: "Step 3 - Feature Selection" author: "Hyunkyung Kim" date: "November 1, 2018"

```
#install.packages("glmnet")
#install.packages("mlbench")
#install.packages("Boruta")
library(MASS) # stepwise regression
library(caret)
library(tidyverse)
library(psych)
library(glmnet)
library(mlbench)
library(Boruta)
library(leaps) # all subsets regression
library(randomForest)
```

### Import Clean Data

```
H_Clean<-read.csv( file = "C:\\Users\\Hyunkyung
Kim\\Desktop\\CKME999\\136\\dataset\\all\\H_clean.csv")

Train<-H_Clean[!is.na(H_Clean$SalePrice),-1]
Test<-H_Clean[is.na(H_Clean$SalePrice),-1]
```

### Check Outlier for Linear Regression - Cook's Distance.

```
# Linear Fit Model
lmfit<-lm(SalePrice~.,data=Train)
summary(lmfit)

##
## Call:
## lm(formula = SalePrice ~ ., data = Train)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -170748  -11535        0   11479  170748
##
## Coefficients: (3 not defined because of singularities)
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -1.358e+06  1.091e+06  -1.244  0.213676
## MSSubClass     -7.186e+01  4.449e+01  -1.615  0.106529
## MSZoningFV      2.886e+04  1.255e+04   2.299  0.021649 *
## MSZoningRH      2.620e+04  1.254e+04   2.090  0.036833 *
## MSZoningRL      2.471e+04  1.063e+04   2.325  0.020231 *
## MSZoningRM      2.241e+04  1.001e+04   2.238  0.025409 *
## LotFrontage    1.063e+02  4.455e+01   2.386  0.017173 *
## LotArea        4.100e-01  9.777e-02   4.194  2.93e-05 ***
## StreetPave      2.195e+04  1.212e+04   1.811  0.070382 .
## AlleyNoAlley   -1.392e+03  4.414e+03  -0.315  0.752586
## AlleyPave      -1.786e+02  6.320e+03  -0.028  0.977455
## LotShapeIR2     1.076e+04  4.382e+03   2.456  0.014185 *
```

## LotShapeIR3	4.116e+03	9.311e+03	0.442	0.658525	
## LotShapeReg	2.316e+03	1.688e+03	1.372	0.170301	
## LandContourHLS	9.028e+03	5.378e+03	1.679	0.093465	.
## LandContourLow	-6.591e+03	6.582e+03	-1.001	0.316796	
## LandContourLvl	3.966e+03	3.866e+03	1.026	0.305152	
## Utilities	1.522e+04	9.141e+03	1.664	0.096274	.
## LotConfigCulDSac	1.189e+04	3.715e+03	3.200	0.001410	**
## LotConfigFR2	-4.402e+03	4.270e+03	-1.031	0.302778	
## LotConfigFR3	-1.996e+04	1.330e+04	-1.500	0.133784	
## LotConfigInside	1.852e+02	1.896e+03	0.098	0.922200	
## LandSlope	-8.392e+01	3.648e+03	-0.023	0.981649	
## NeighborhoodBlueste	1.634e+04	1.998e+04	0.818	0.413468	
## NeighborhoodBrDale	9.742e+03	1.094e+04	0.891	0.373250	
## NeighborhoodBrkSide	5.072e+03	9.588e+03	0.529	0.596914	
## NeighborhoodClearCr	-9.409e+03	9.519e+03	-0.988	0.323106	
## NeighborhoodCollgCr	-1.047e+04	7.467e+03	-1.402	0.161296	
## NeighborhoodCrawfor	1.598e+04	8.797e+03	1.817	0.069454	.
## NeighborhoodEdwards	-1.146e+04	8.208e+03	-1.397	0.162776	
## NeighborhoodGilbert	-9.124e+03	7.901e+03	-1.155	0.248418	
## NeighborhoodIDOTRR	-4.458e+03	1.090e+04	-0.409	0.682691	
## NeighborhoodMeadowV	-2.644e+03	1.162e+04	-0.227	0.820116	
## NeighborhoodMitchel	-1.151e+04	8.376e+03	-1.374	0.169736	
## NeighborhoodNames	-1.002e+04	8.049e+03	-1.244	0.213632	
## NeighborhoodNoRidge	2.176e+04	8.708e+03	2.498	0.012603	*
## NeighborhoodNPkVill	1.633e+04	1.469e+04	1.111	0.266572	
## NeighborhoodNridgHt	3.079e+04	7.639e+03	4.031	5.89e-05	***
## NeighborhoodNWAmes	-1.367e+04	8.295e+03	-1.648	0.099617	.
## NeighborhoodOldTown	-5.777e+03	9.865e+03	-0.586	0.558270	
## NeighborhoodSawyer	-1.294e+03	8.372e+03	-0.155	0.877195	
## NeighborhoodSawyerW	-2.996e+03	8.062e+03	-0.372	0.710278	
## NeighborhoodSomerst	-1.995e+03	9.367e+03	-0.213	0.831387	
## NeighborhoodStoneBr	4.042e+04	8.682e+03	4.655	3.58e-06	***
## NeighborhoodSWISU	-3.422e+03	1.003e+04	-0.341	0.733021	
## NeighborhoodTimber	-7.234e+03	8.430e+03	-0.858	0.391003	
## NeighborhoodVeenker	3.152e+03	1.096e+04	0.287	0.773808	
## Condition1Feedr	3.751e+03	5.191e+03	0.723	0.470065	
## Condition1Norm	1.404e+04	4.306e+03	3.262	0.001136	**
## Condition1PosA	5.769e+03	1.052e+04	0.548	0.583453	
## Condition1PosN	9.018e+03	7.747e+03	1.164	0.244656	
## Condition1RR Ae	-1.381e+04	9.171e+03	-1.505	0.132485	
## Condition1RR An	1.480e+04	7.271e+03	2.035	0.042045	*
## Condition1RR Ne	-7.139e+03	1.859e+04	-0.384	0.701072	
## Condition1RR Nn	1.341e+04	1.344e+04	0.998	0.318703	
## Condition2Feedr	-1.530e+04	2.371e+04	-0.645	0.518992	
## Condition2Norm	-1.665e+04	2.035e+04	-0.818	0.413278	
## Condition2PosA	3.815e+04	3.446e+04	1.107	0.268453	
## Condition2PosN	-2.352e+05	2.834e+04	-8.299	2.68e-16	***
## Condition2RR Ae	-7.148e+04	6.740e+04	-1.061	0.289075	
## Condition2RR An	-9.186e+03	3.214e+04	-0.286	0.775053	
## Condition2RR Nn	-6.793e+03	2.773e+04	-0.245	0.806523	

## BldgType	4.923e+03	1.777e+03	2.770	0.005694	**
## HouseStyle1.5Unf	9.755e+03	7.973e+03	1.224	0.221346	
## HouseStyle1Story	9.753e+03	4.184e+03	2.331	0.019920	*
## HouseStyle2.5Fin	-1.556e+04	1.265e+04	-1.230	0.218986	
## HouseStyle2.5Unf	-1.133e+04	9.431e+03	-1.201	0.229855	
## HouseStyle2Story	-5.156e+03	3.434e+03	-1.501	0.133486	
## HouseStyleSFoyer	1.448e+03	6.067e+03	0.239	0.811351	
## HouseStyleSLvl	6.873e+03	5.230e+03	1.314	0.189013	
## OverallQual	8.368e+03	1.056e+03	7.922	5.09e-15	***
## OverallCond	5.364e+03	8.968e+02	5.981	2.89e-09	***
## YearBuilt	2.767e+02	8.244e+01	3.356	0.000815	***
## YearRemodAdd	1.581e+01	5.717e+01	0.276	0.782230	
## RoofStyleGable	1.578e+03	1.919e+04	0.082	0.934468	
## RoofStyleGambrel	2.607e+03	2.090e+04	0.125	0.900761	
## RoofStyleHip	5.301e+03	1.926e+04	0.275	0.783152	
## RoofStyleMansard	1.037e+04	2.240e+04	0.463	0.643605	
## RoofStyleShed	5.217e+04	3.530e+04	1.478	0.139668	
## RoofMatlCompShg	6.720e+05	3.524e+04	19.068	< 2e-16	***
## RoofMatlMembran	7.254e+05	4.813e+04	15.072	< 2e-16	***
## RoofMatlMetal	6.924e+05	4.815e+04	14.381	< 2e-16	***
## RoofMatlRoll	6.514e+05	4.368e+04	14.912	< 2e-16	***
## RoofMatlTar&Grv	6.671e+05	4.043e+04	16.500	< 2e-16	***
## RoofMatlWdShake	6.475e+05	3.879e+04	16.694	< 2e-16	***
## RoofMatlWdShngl	7.523e+05	3.675e+04	20.472	< 2e-16	***
## Exterior1stAsphShn	-1.711e+04	3.478e+04	-0.492	0.622833	
## Exterior1stBrkComm	-1.747e+04	2.870e+04	-0.609	0.542749	
## Exterior1stBrkFace	6.813e+03	1.327e+04	0.513	0.607741	
## Exterior1stCBlock	1.034e+03	2.687e+04	0.038	0.969304	
## Exterior1stCemntBd	-6.758e+03	1.976e+04	-0.342	0.732406	
## Exterior1stHdBoard	-1.086e+04	1.339e+04	-0.811	0.417544	
## Exterior1stImStucc	-3.880e+04	2.952e+04	-1.315	0.188913	
## Exterior1stMetalSd	-1.620e+03	1.509e+04	-0.107	0.914558	
## Exterior1stPlywood	-1.615e+04	1.323e+04	-1.221	0.222268	
## Exterior1stStone	1.605e+03	2.498e+04	0.064	0.948796	
## Exterior1stStucco	1.628e+03	1.454e+04	0.112	0.910853	
## Exterior1stVinylSd	-1.206e+04	1.391e+04	-0.867	0.386272	
## Exterior1stWd Sdng	-1.072e+04	1.283e+04	-0.836	0.403540	
## Exterior1stWdShing	-3.507e+03	1.385e+04	-0.253	0.800183	
## Exterior2ndAsphShn	1.047e+04	2.323e+04	0.451	0.652135	
## Exterior2ndBrk Cmn	1.445e+04	2.090e+04	0.691	0.489696	
## Exterior2ndBrkFace	2.328e+03	1.361e+04	0.171	0.864201	
## Exterior2ndCBlock	NA	NA	NA	NA	
## Exterior2ndCmentBd	1.561e+04	1.942e+04	0.804	0.421795	
## Exterior2ndHdBoard	5.434e+03	1.271e+04	0.428	0.668938	
## Exterior2ndImStucc	2.744e+04	1.480e+04	1.854	0.063965	.
## Exterior2ndMetalSd	3.957e+03	1.467e+04	0.270	0.787440	
## Exterior2ndOther	-2.264e+04	2.874e+04	-0.788	0.430868	
## Exterior2ndPlywood	6.978e+03	1.235e+04	0.565	0.572061	
## Exterior2ndStone	-6.028e+03	1.771e+04	-0.340	0.733588	
## Exterior2ndStucco	-5.806e+03	1.404e+04	-0.413	0.679360	

## Exterior2ndVinylSd	1.024e+04	1.332e+04	0.769	0.441955	
## Exterior2ndWd Sdng	8.665e+03	1.225e+04	0.707	0.479463	
## Exterior2ndWd Shng	-5.015e+02	1.288e+04	-0.039	0.968937	
## MasVnrTypeBrkFace	6.918e+03	7.010e+03	0.987	0.323913	
## MasVnrTypeNone	1.319e+04	7.062e+03	1.868	0.061968	.
## MasVnrTypeStone	1.327e+04	7.442e+03	1.783	0.074877	.
## MasVnrArea	3.116e+01	6.014e+00	5.182	2.56e-07	***
## ExterQual	4.105e+03	2.191e+03	1.874	0.061196	.
## ExterCond	-3.296e+03	2.214e+03	-1.488	0.136882	
## FoundationCBlock	3.198e+03	3.262e+03	0.980	0.327141	
## FoundationPConc	4.181e+03	3.553e+03	1.177	0.239482	
## FoundationSlab	1.509e+04	9.445e+03	1.598	0.110262	
## FoundationStone	5.615e+03	1.168e+04	0.481	0.630666	
## FoundationWood	-3.085e+04	1.566e+04	-1.970	0.049007	*
## BsmtQual	3.749e+03	1.784e+03	2.102	0.035776	*
## BsmtCond	-5.638e+03	2.235e+03	-2.523	0.011750	*
## BsmtExposure	5.282e+03	8.848e+02	5.970	3.07e-09	***
## BsmtFinType1	-1.290e+02	5.324e+02	-0.242	0.808567	
## BsmtFinSF1	3.577e+01	5.026e+00	7.118	1.83e-12	***
## BsmtFinType2	-8.406e+01	1.360e+03	-0.062	0.950731	
## BsmtFinSF2	2.299e+01	8.537e+00	2.693	0.007179	**
## BsmtUnfSF	1.546e+01	4.542e+00	3.404	0.000685	***
## TotalBsmtSF	NA	NA	NA	NA	
## HeatingGasA	-6.307e+03	2.647e+04	-0.238	0.811680	
## HeatingGasW	-7.954e+03	2.723e+04	-0.292	0.770265	
## HeatingGrav	-4.322e+03	2.822e+04	-0.153	0.878290	
## HeatingOthW	-4.467e+04	3.259e+04	-1.370	0.170795	
## HeatingWall	5.452e+03	3.057e+04	0.178	0.858497	
## HeatingQC	1.134e+03	1.008e+03	1.125	0.260648	
## CentralAirY	-1.389e+03	4.006e+03	-0.347	0.728904	
## ElectricalFuseF	-1.562e+03	5.978e+03	-0.261	0.793852	
## ElectricalFuseP	8.364e+02	1.783e+04	0.047	0.962592	
## ElectricalMix	1.155e+04	2.732e+04	0.423	0.672519	
## ElectricalSBrkr	-3.758e+03	3.087e+03	-1.217	0.223724	
## X1stFlrSF	4.636e+01	5.597e+00	8.283	3.05e-16	***
## X2ndFlrSF	6.358e+01	5.842e+00	10.883	< 2e-16	***
## LowQualFinSF	1.650e+01	1.942e+01	0.850	0.395611	
## GrLivArea	NA	NA	NA	NA	
## BsmtFullBath	1.840e+03	2.045e+03	0.900	0.368539	
## BsmtHalfBath	4.227e+02	3.161e+03	0.134	0.893632	
## FullBath	2.662e+03	2.285e+03	1.165	0.244363	
## HalfBath	2.853e+03	2.189e+03	1.303	0.192748	
## BedroomAbvGr	-5.866e+03	1.395e+03	-4.204	2.80e-05	***
## KitchenAbvGr	-1.052e+04	4.681e+03	-2.246	0.024849	*
## KitchenQual	7.074e+03	1.719e+03	4.114	4.13e-05	***
## TotRmsAbvGrd	3.257e+03	9.890e+02	3.294	0.001017	**
## Functional	5.922e+03	1.171e+03	5.057	4.90e-07	***
## Fireplaces	5.919e+03	2.314e+03	2.557	0.010667	*
## FireplaceQu	-1.603e+03	8.361e+02	-1.917	0.055450	.
## GarageTypeAttchd	1.219e+04	1.160e+04	1.051	0.293327	

```

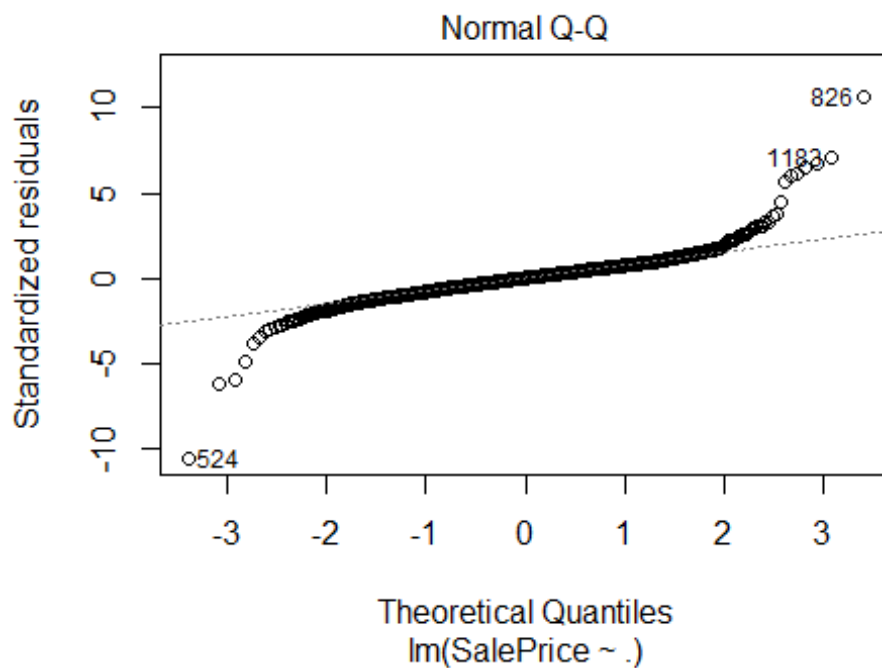
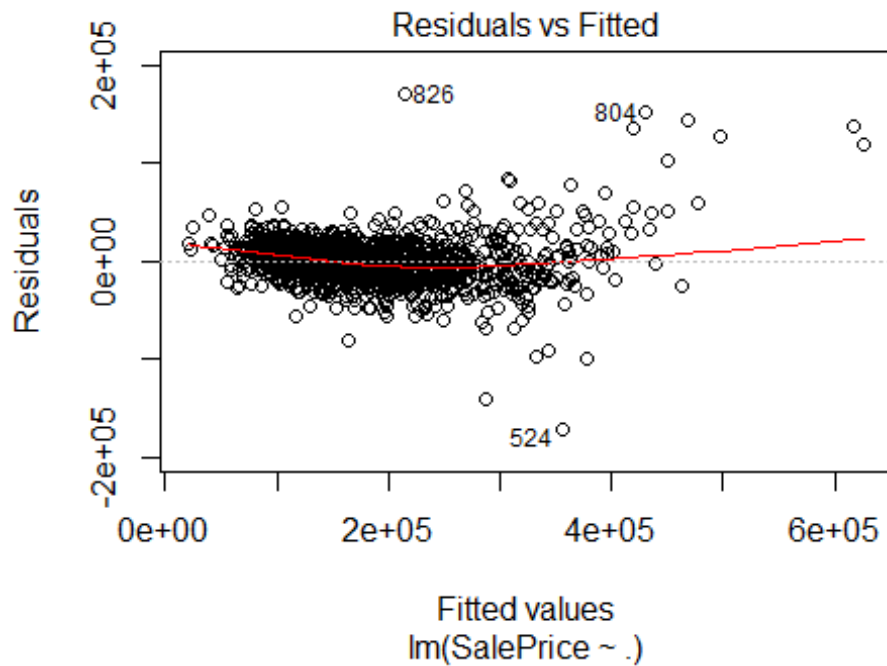
## GarageTypeBasment      2.016e+04  1.343e+04  1.501 0.133637
## GarageTypeBuiltIn      1.343e+04  1.211e+04  1.109 0.267515
## GarageTypeCarPort      1.603e+04  1.499e+04  1.069 0.285109
## GarageTypeDetchd       1.743e+04  1.157e+04  1.506 0.132347
## GarageTypeNoGarage     4.143e+04  1.620e+04  2.558 0.010651 *
## GarageYrBlt            -1.614e+01  6.275e+01 -0.257 0.797108
## GarageFinish           8.042e+02  1.260e+03  0.638 0.523540
## GarageCars             5.016e+03  2.358e+03  2.127 0.033608 *
## GarageArea            1.536e+01  8.231e+00  1.866 0.062254 .
## GarageQual            5.690e+03  3.991e+03  1.426 0.154225
## GarageCond            -1.522e+03  4.089e+03 -0.372 0.709713
## PavedDrive            -2.401e+01  1.732e+03 -0.014 0.988939
## WoodDeckSF            1.287e+01  6.138e+00  2.097 0.036210 *
## OpenPorchSF           9.704e+00  1.197e+01  0.811 0.417805
## EnclosedPorch         -3.309e+00  1.305e+01 -0.254 0.799895
## X3SsnPorch            3.834e+01  2.365e+01  1.621 0.105281
## ScreenPorch           4.231e+01  1.300e+01  3.254 0.001168 **
## PoolArea             -2.288e+01  5.634e+01 -0.406 0.684696
## PoolQC                2.054e+04  8.513e+03  2.413 0.015981 *
## FenceGdWo             1.046e+04  5.118e+03  2.044 0.041132 *
## FenceMnPrv            1.091e+04  4.171e+03  2.616 0.008990 **
## FenceMnWw             5.759e+03  8.637e+03  0.667 0.505075
## FenceNoFence          9.584e+03  3.806e+03  2.518 0.011913 *
## MiscFeatureNoMiscFeature 4.583e+04  9.996e+04  0.459 0.646640
## MiscFeatureOthr        6.085e+04  9.242e+04  0.658 0.510385
## MiscFeatureShed        4.570e+04  9.577e+04  0.477 0.633331
## MiscFeatureTenC       -3.030e+04  9.374e+04 -0.323 0.746596
## MiscVal               2.863e+00  6.258e+00  0.457 0.647440
## MoSold               -6.934e+02  2.555e+02 -2.714 0.006739 **
## YrSold               -9.613e+01  5.336e+02 -0.180 0.857063
## SaleTypeCon           2.740e+04  1.866e+04  1.469 0.142193
## SaleTypeConLD         1.633e+04  1.012e+04  1.613 0.107054
## SaleTypeConLI         5.559e+03  1.221e+04  0.455 0.648880
## SaleTypeConLw        -8.507e+02  1.254e+04 -0.068 0.945946
## SaleTypeCWD           1.609e+04  1.354e+04  1.188 0.235041
## SaleTypeNew           3.515e+04  1.610e+04  2.184 0.029178 *
## SaleTypeOth           1.104e+04  1.543e+04  0.716 0.474268
## SaleTypepWD           4.405e+02  4.401e+03  0.100 0.920284
## SaleConditionAdjLand   1.479e+04  1.503e+04  0.984 0.325309
## SaleConditionAlloca    8.348e+03  8.979e+03  0.930 0.352689
## SaleConditionFamily   -1.214e+02  6.447e+03 -0.019 0.984983
## SaleConditionNormal    7.474e+03  3.025e+03  2.471 0.013619 *
## SaleConditionPartial  -8.874e+03  1.549e+04 -0.573 0.566860
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 24260 on 1258 degrees of freedom
## Multiple R-squared:  0.9196, Adjusted R-squared:  0.9067
## F-statistic: 71.57 on 201 and 1258 DF,  p-value: < 2.2e-16

```

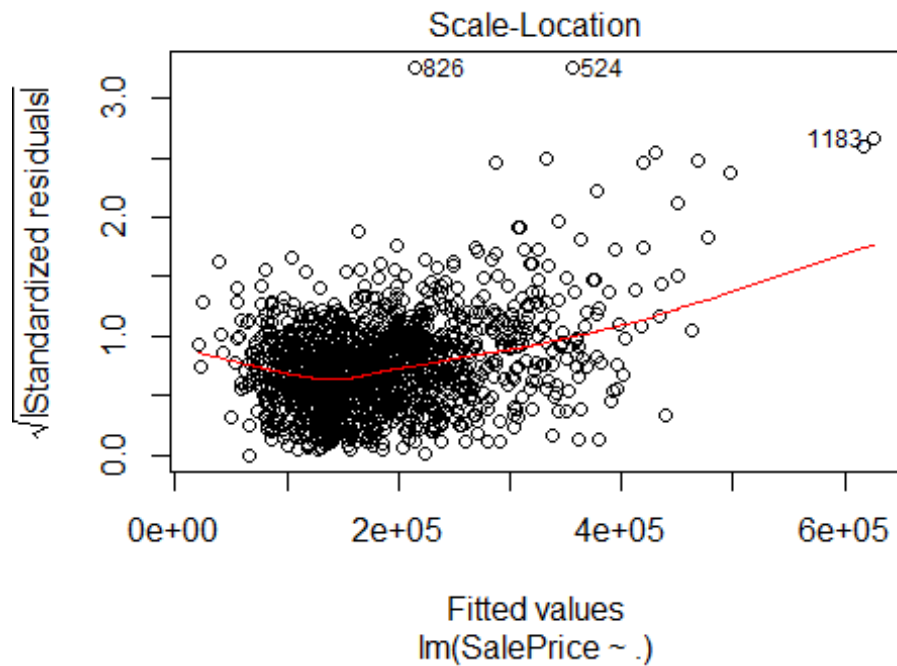
```
plot(lmfit)
```

```
## Warning: not plotting observations with leverage one:
```

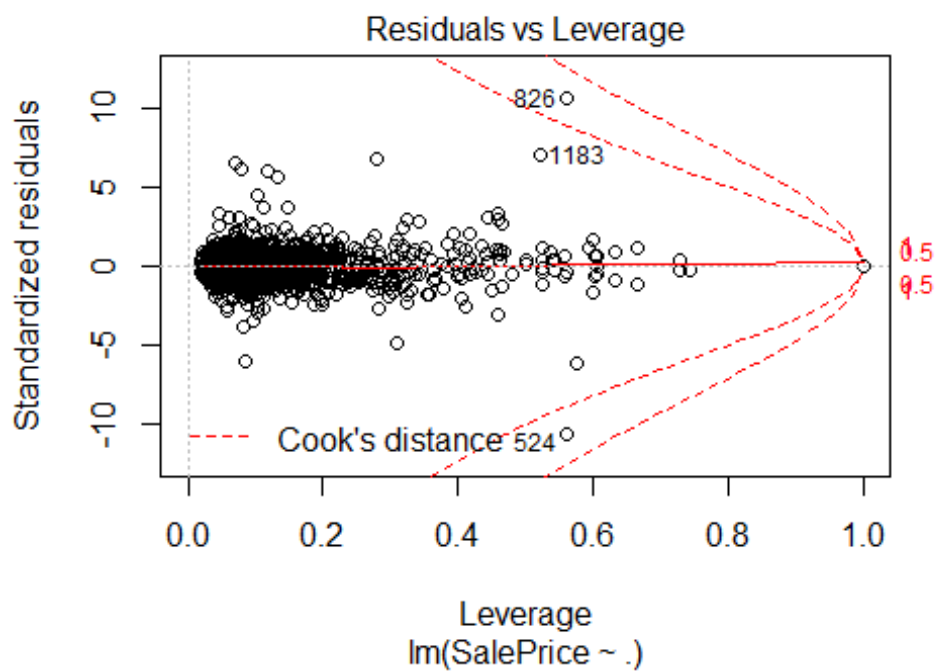
```
## 121, 272, 347, 584, 596, 945, 1004, 1012, 1188, 1231, 1271, 1276, 1299,  
1322, 1371, 1387
```



```
## Warning: not plotting observations with leverage one:
## 121, 272, 347, 584, 596, 945, 1004, 1012, 1188, 1231, 1271, 1276, 1299,
1322, 1371, 1387
```

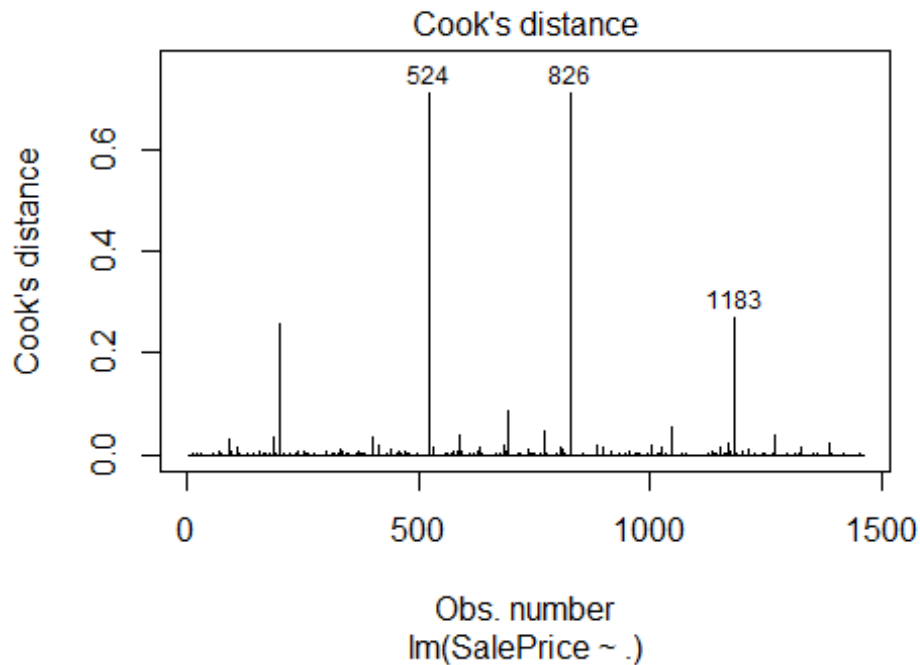


```
## Warning in sqrt(crit * p * (1 - hh)/hh): NaNs produced
## Warning in sqrt(crit * p * (1 - hh)/hh): NaNs produced
```





```
plot(lmfit,which=c(4))
```



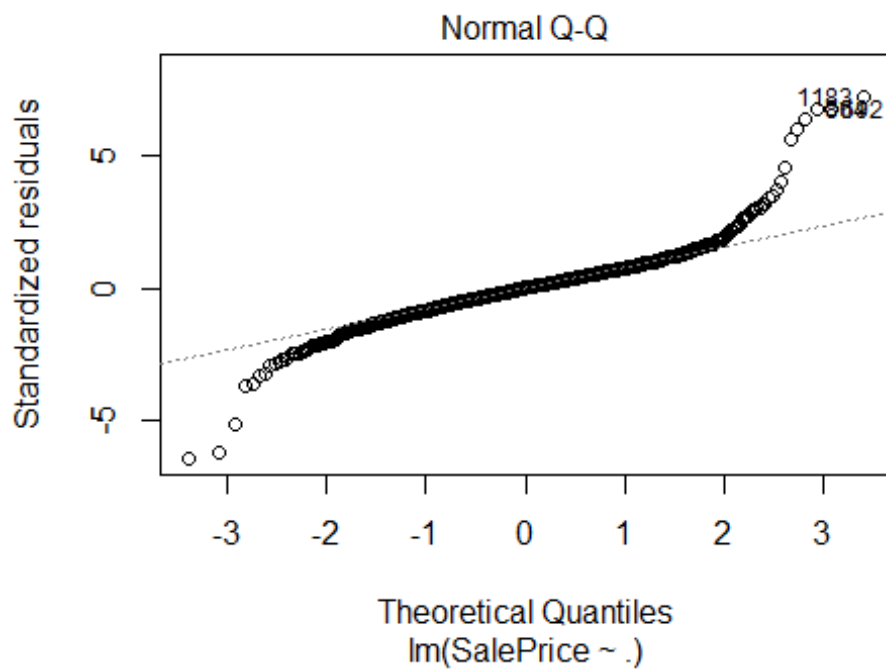
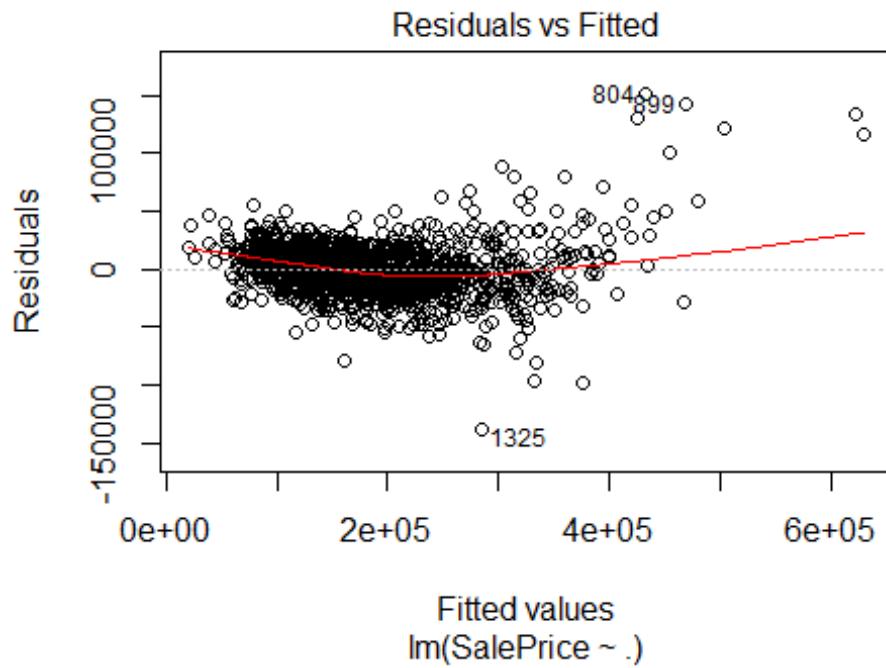
```
#anova(lmfit)
```

### Removing 524 - one outlier removal improved R^2 :

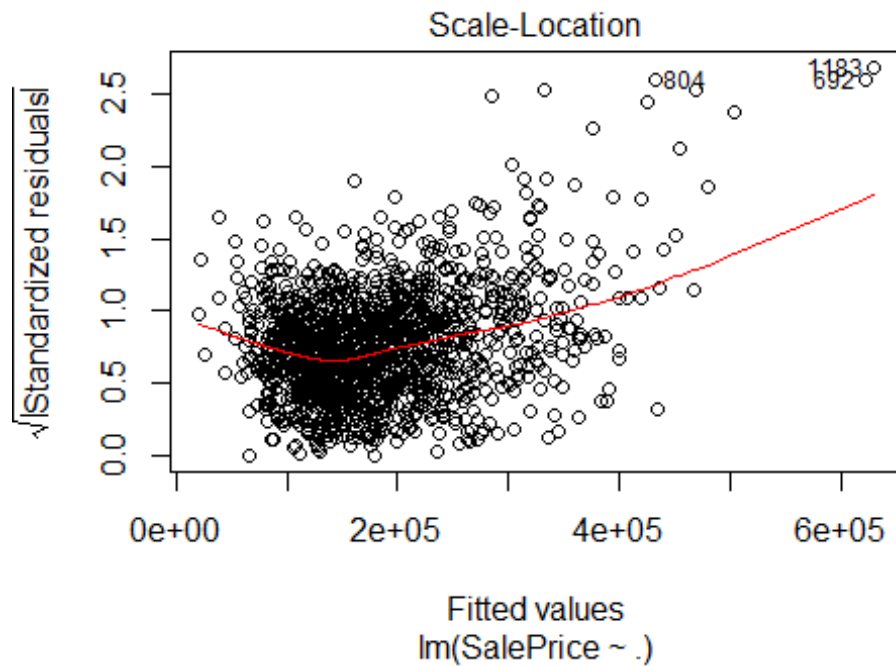
```
lmfit1<-lm(SalePrice~.,data=Train[-524,])  
plot(lmfit1)
```

```
## Warning: not plotting observations with leverage one:
```

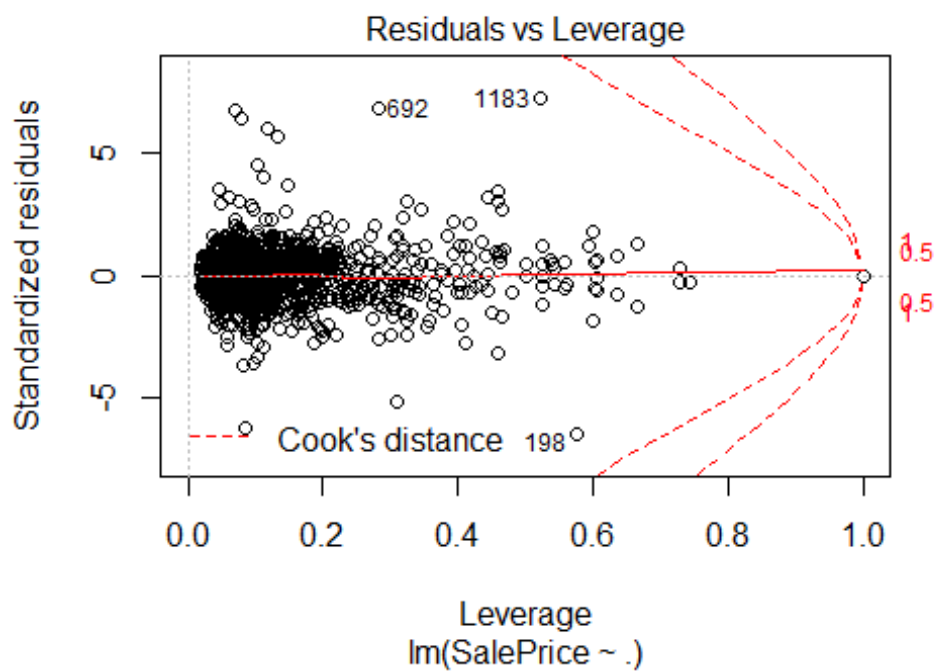
```
## 272, 347, 583, 595, 825, 944, 1003, 1011, 1187, 1230, 1270, 1275, 1298,  
1321, 1370, 1386
```



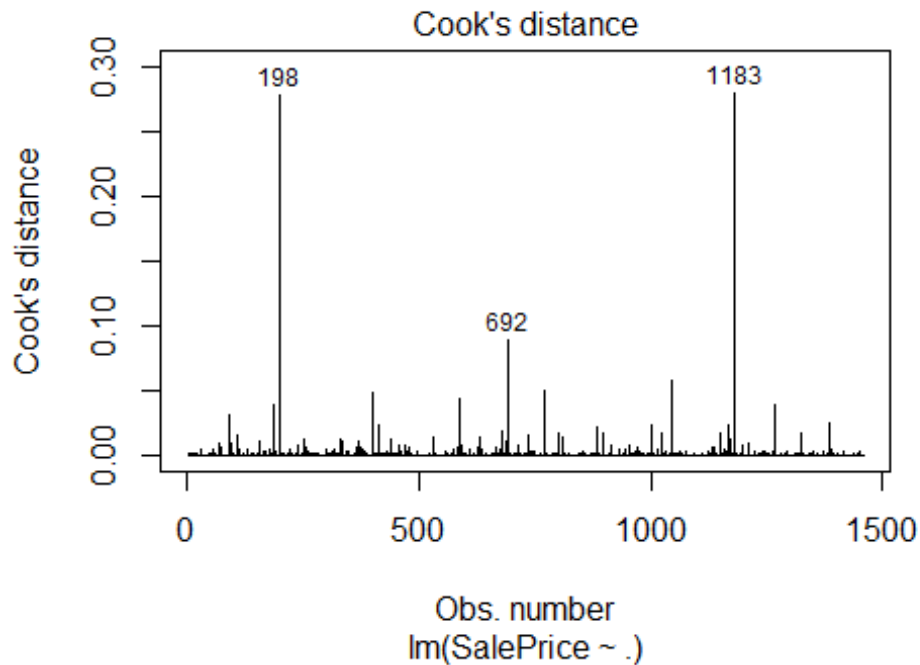
```
## Warning: not plotting observations with leverage one:
## 272, 347, 583, 595, 825, 944, 1003, 1011, 1187, 1230, 1270, 1275, 1298,
1321, 1370, 1386
```



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



```
plot(lmfit1,which=c(4))
```



```
summary(lmfit1)
```

```
##
## Call:
## lm(formula = SalePrice ~ ., data = Train[-524, ])
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -137409  -11020    314   11405  150791
##
## Coefficients: (3 not defined because of singularities)
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -1.526e+06  1.042e+06  -1.465  0.143207
## MSSubClass     -6.360e+01  4.248e+01  -1.497  0.134574
## MSZoningFV      2.950e+04  1.198e+04   2.461  0.013970 *
## MSZoningRH      2.581e+04  1.197e+04   2.157  0.031217 *
## MSZoningRL      2.434e+04  1.014e+04   2.400  0.016561 *
## MSZoningRM      2.047e+04  9.561e+03   2.140  0.032509 *
## LotFrontage    1.067e+02  4.253e+01   2.509  0.012222 *
## LotArea         4.867e-01  9.358e-02   5.200  2.32e-07 ***
## StreetPave      2.261e+04  1.157e+04   1.954  0.050901 .
## AlleyNoAlley    -8.906e+02  4.214e+03  -0.211  0.832651
## AlleyPave       -9.566e+02  6.033e+03  -0.159  0.874044
## LotShapeIR2      9.587e+03  4.184e+03   2.291  0.022123 *
## LotShapeIR3      4.388e+02  8.895e+03   0.049  0.960666
```

## LotShapeReg	1.610e+03	1.612e+03	0.998	0.318383	
## LandContourHLS	5.122e+03	5.146e+03	0.995	0.319744	
## LandContourLow	-1.055e+04	6.293e+03	-1.677	0.093887	.
## LandContourLvl	-8.470e+02	3.716e+03	-0.228	0.819726	
## Utilities	1.276e+04	8.729e+03	1.462	0.143997	
## LotConfigCulDSac	1.108e+04	3.547e+03	3.124	0.001824	**
## LotConfigFR2	-4.087e+03	4.076e+03	-1.003	0.316196	
## LotConfigFR3	-1.610e+04	1.270e+04	-1.267	0.205312	
## LotConfigInside	4.334e+02	1.810e+03	0.239	0.810859	
## LandSlope	2.111e+03	3.488e+03	0.605	0.545195	
## NeighborhoodBlueste	2.057e+04	1.908e+04	1.078	0.281195	
## NeighborhoodBrDale	1.291e+04	1.044e+04	1.236	0.216756	
## NeighborhoodBrkSide	8.988e+03	9.160e+03	0.981	0.326651	
## NeighborhoodClearCr	-9.980e+03	9.087e+03	-1.098	0.272284	
## NeighborhoodCollgCr	-1.000e+04	7.128e+03	-1.403	0.160892	
## NeighborhoodCrawfor	1.696e+04	8.398e+03	2.020	0.043624	*
## NeighborhoodEdwards	-7.079e+03	7.846e+03	-0.902	0.367049	
## NeighborhoodGilbert	-9.679e+03	7.543e+03	-1.283	0.199648	
## NeighborhoodIDOTRR	6.337e+02	1.042e+04	0.061	0.951502	
## NeighborhoodMeadowV	1.542e+03	1.110e+04	0.139	0.889554	
## NeighborhoodMitchel	-9.991e+03	7.997e+03	-1.249	0.211794	
## NeighborhoodNAMES	-7.404e+03	7.687e+03	-0.963	0.335648	
## NeighborhoodNoRidge	1.872e+04	8.317e+03	2.250	0.024606	*
## NeighborhoodNPkVill	1.710e+04	1.402e+04	1.220	0.222858	
## NeighborhoodNridgHt	2.569e+04	7.307e+03	3.516	0.000454	***
## NeighborhoodNWAmes	-1.235e+04	7.919e+03	-1.559	0.119130	
## NeighborhoodOldTown	-1.684e+03	9.424e+03	-0.179	0.858235	
## NeighborhoodSawyer	1.225e+03	7.995e+03	0.153	0.878221	
## NeighborhoodSawyerW	-2.938e+03	7.696e+03	-0.382	0.702696	
## NeighborhoodSomerst	-3.438e+03	8.943e+03	-0.384	0.700685	
## NeighborhoodStoneBr	3.761e+04	8.292e+03	4.536	6.27e-06	***
## NeighborhoodSWISU	-2.535e+03	9.574e+03	-0.265	0.791242	
## NeighborhoodTimber	-8.116e+03	8.048e+03	-1.008	0.313439	
## NeighborhoodVeenker	3.376e+03	1.047e+04	0.323	0.747097	
## Condition1Feedr	3.540e+03	4.956e+03	0.714	0.475229	
## Condition1Norm	1.336e+04	4.111e+03	3.251	0.001182	**
## Condition1PosA	3.389e+03	1.004e+04	0.337	0.735808	
## Condition1PosN	6.881e+03	7.398e+03	0.930	0.352498	
## Condition1RRAE	-1.392e+04	8.755e+03	-1.590	0.112172	
## Condition1RRAN	1.393e+04	6.941e+03	2.006	0.045032	*
## Condition1RRNE	-8.376e+03	1.775e+04	-0.472	0.637059	
## Condition1RRNN	1.218e+04	1.283e+04	0.950	0.342446	
## Condition2Feedr	-1.443e+04	2.263e+04	-0.637	0.523966	
## Condition2Norm	-1.230e+04	1.943e+04	-0.633	0.526635	
## Condition2PosA	3.578e+04	3.289e+04	1.088	0.276895	
## Condition2PosN	-5.063e+04	3.174e+04	-1.595	0.111008	
## Condition2RRAE	-6.827e+04	6.434e+04	-1.061	0.288863	
## Condition2RRAN	-6.991e+03	3.068e+04	-0.228	0.819776	
## Condition2RRNN	-1.328e+03	2.647e+04	-0.050	0.959996	
## BldgType	4.757e+03	1.697e+03	2.803	0.005134	**

## HouseStyle1.5Unf	1.191e+04	7.614e+03	1.565	0.117905	
## HouseStyle1Story	1.126e+04	3.997e+03	2.818	0.004901	**
## HouseStyle2.5Fin	-1.967e+04	1.208e+04	-1.628	0.103749	
## HouseStyle2.5Unf	-1.265e+04	9.004e+03	-1.405	0.160349	
## HouseStyle2Story	-3.984e+03	3.280e+03	-1.215	0.224746	
## HouseStyleSFoyer	3.402e+03	5.794e+03	0.587	0.557157	
## HouseStyleSLvl	8.964e+03	4.996e+03	1.794	0.073003	.
## OverallQual	7.994e+03	1.009e+03	7.923	5.07e-15	***
## OverallCond	5.467e+03	8.562e+02	6.386	2.40e-10	***
## YearBuilt	3.022e+02	7.873e+01	3.838	0.000130	***
## YearRemodAdd	1.519e+01	5.458e+01	0.278	0.780765	
## RoofStyleGable	-3.171e+02	1.832e+04	-0.017	0.986192	
## RoofStyleGambrel	1.558e+02	1.995e+04	0.008	0.993770	
## RoofStyleHip	3.227e+03	1.838e+04	0.176	0.860697	
## RoofStyleMansard	8.564e+03	2.138e+04	0.400	0.688887	
## RoofStyleShed	5.254e+04	3.370e+04	1.559	0.119195	
## RoofMatlCompShg	7.082e+05	3.380e+04	20.951	< 2e-16	***
## RoofMatlMembran	7.674e+05	4.610e+04	16.648	< 2e-16	***
## RoofMatlMetal	7.317e+05	4.610e+04	15.872	< 2e-16	***
## RoofMatlRoll	6.833e+05	4.180e+04	16.348	< 2e-16	***
## RoofMatlTar&Grv	7.014e+05	3.872e+04	18.114	< 2e-16	***
## RoofMatlWdShake	6.830e+05	3.716e+04	18.377	< 2e-16	***
## RoofMatlWdShngl	7.833e+05	3.519e+04	22.260	< 2e-16	***
## Exterior1stAsphShn	-1.784e+04	3.320e+04	-0.537	0.591041	
## Exterior1stBrkComm	-1.963e+04	2.740e+04	-0.717	0.473812	
## Exterior1stBrkFace	5.735e+03	1.267e+04	0.453	0.650799	
## Exterior1stCBlock	-2.521e+03	2.566e+04	-0.098	0.921735	
## Exterior1stCemntBd	-9.878e+03	1.886e+04	-0.524	0.600618	
## Exterior1stHdBoard	-1.137e+04	1.278e+04	-0.890	0.373819	
## Exterior1stImStucc	-3.796e+04	2.818e+04	-1.347	0.178143	
## Exterior1stMetalSd	-2.486e+03	1.441e+04	-0.173	0.863047	
## Exterior1stPlywood	-1.734e+04	1.263e+04	-1.373	0.169934	
## Exterior1stStone	-1.854e+03	2.385e+04	-0.078	0.938069	
## Exterior1stStucco	-1.206e+02	1.388e+04	-0.009	0.993066	
## Exterior1stVinylSd	-1.361e+04	1.328e+04	-1.025	0.305724	
## Exterior1stWd Sdng	-1.145e+04	1.225e+04	-0.935	0.350192	
## Exterior1stWdShing	-3.729e+03	1.322e+04	-0.282	0.777967	
## Exterior2ndAsphShn	8.643e+03	2.218e+04	0.390	0.696789	
## Exterior2ndBrk Cmn	1.525e+04	1.996e+04	0.764	0.444921	
## Exterior2ndBrkFace	1.052e+03	1.299e+04	0.081	0.935462	
## Exterior2ndCBlock	NA	NA	NA	NA	
## Exterior2ndCmentBd	1.638e+04	1.854e+04	0.883	0.377194	
## Exterior2ndHdBoard	5.268e+03	1.213e+04	0.434	0.664106	
## Exterior2ndImStucc	2.668e+04	1.413e+04	1.888	0.059199	.
## Exterior2ndMetalSd	3.616e+03	1.400e+04	0.258	0.796300	
## Exterior2ndOther	-2.097e+04	2.743e+04	-0.764	0.444724	
## Exterior2ndPlywood	6.603e+03	1.179e+04	0.560	0.575436	
## Exterior2ndStone	-6.429e+03	1.690e+04	-0.380	0.703760	
## Exterior2ndStucco	-4.626e+03	1.341e+04	-0.345	0.730114	
## Exterior2ndVinylSd	1.074e+04	1.271e+04	0.845	0.398280	

## Exterior2ndWd Sdng	8.023e+03	1.169e+04	0.686	0.492808	
## Exterior2ndWd Shng	-1.430e+02	1.229e+04	-0.012	0.990717	
## MasVnrTypeBrkFace	7.922e+03	6.692e+03	1.184	0.236773	
## MasVnrTypeNone	1.476e+04	6.743e+03	2.189	0.028759	*
## MasVnrTypeStone	1.727e+04	7.113e+03	2.428	0.015338	*
## MasVnrArea	3.070e+01	5.741e+00	5.347	1.06e-07	***
## ExterQual	4.358e+03	2.092e+03	2.083	0.037416	*
## ExterCond	-3.672e+03	2.114e+03	-1.737	0.082680	.
## FoundationCBlock	2.146e+03	3.116e+03	0.689	0.491187	
## FoundationPConc	3.395e+03	3.393e+03	1.001	0.317168	
## FoundationSlab	1.455e+04	9.016e+03	1.614	0.106840	
## FoundationStone	4.604e+03	1.115e+04	0.413	0.679622	
## FoundationWood	-3.244e+04	1.495e+04	-2.170	0.030169	*
## BsmtQual	3.113e+03	1.704e+03	1.827	0.067917	.
## BsmtCond	-5.925e+03	2.133e+03	-2.778	0.005559	**
## BsmtExposure	5.344e+03	8.446e+02	6.327	3.47e-10	***
## BsmtFinType1	-1.861e+02	5.083e+02	-0.366	0.714359	
## BsmtFinSF1	3.960e+01	4.810e+00	8.233	4.53e-16	***
## BsmtFinType2	6.504e+01	1.299e+03	0.050	0.960061	
## BsmtFinSF2	2.485e+01	8.151e+00	3.048	0.002348	**
## BsmtUnfSF	1.844e+01	4.344e+00	4.245	2.35e-05	***
## TotalBsmtSF	NA	NA	NA	NA	
## HeatingGasA	-4.538e+03	2.526e+04	-0.180	0.857472	
## HeatingGasW	-8.351e+03	2.599e+04	-0.321	0.748065	
## HeatingGrav	-1.869e+03	2.694e+04	-0.069	0.944706	
## HeatingOthW	-4.351e+04	3.112e+04	-1.398	0.162287	
## HeatingWall	7.888e+03	2.919e+04	0.270	0.786989	
## HeatingQC	9.931e+02	9.624e+02	1.032	0.302348	
## CentralAirY	-1.050e+03	3.824e+03	-0.275	0.783742	
## ElectricalFuseF	-1.191e+03	5.706e+03	-0.209	0.834739	
## ElectricalFuseP	4.670e+02	1.702e+04	0.027	0.978114	
## ElectricalMix	1.446e+04	2.608e+04	0.554	0.579496	
## ElectricalSBrkr	-3.175e+03	2.947e+03	-1.077	0.281523	
## X1stFlrSF	5.206e+01	5.367e+00	9.699	< 2e-16	***
## X2ndFlrSF	7.032e+01	5.610e+00	12.535	< 2e-16	***
## LowQualFinSF	2.476e+01	1.855e+01	1.335	0.182220	
## GrLivArea	NA	NA	NA	NA	
## BsmtFullBath	1.388e+03	1.953e+03	0.711	0.477279	
## BsmtHalfBath	3.763e+02	3.017e+03	0.125	0.900783	
## FullBath	2.250e+03	2.182e+03	1.031	0.302660	
## HalfBath	2.677e+03	2.090e+03	1.281	0.200415	
## BedroomAbvGr	-6.865e+03	1.335e+03	-5.142	3.15e-07	***
## KitchenAbvGr	-1.203e+04	4.471e+03	-2.690	0.007242	**
## KitchenQual	6.698e+03	1.642e+03	4.080	4.78e-05	***
## TotRmsAbvGrd	2.806e+03	9.449e+02	2.969	0.003041	**
## Functional	6.551e+03	1.119e+03	5.853	6.16e-09	***
## Fireplaces	4.677e+03	2.212e+03	2.114	0.034707	*
## FireplaceQu	-1.463e+03	7.983e+02	-1.833	0.067011	.
## GarageTypeAttchd	9.409e+03	1.107e+04	0.850	0.395613	
## GarageTypeBasement	1.665e+04	1.283e+04	1.298	0.194588	

```

## GarageTypeBuiltIn      1.301e+04  1.156e+04  1.125 0.260817
## GarageTypeCarPort      1.268e+04  1.432e+04  0.886 0.376026
## GarageTypeDetchd       1.500e+04  1.105e+04  1.358 0.174762
## GarageTypeNoGarage     3.795e+04  1.547e+04  2.454 0.014276 *
## GarageYrBlt            1.065e+01  5.995e+01  0.178 0.859033
## GarageFinish           4.530e+02  1.204e+03  0.376 0.706677
## GarageCars             6.132e+03  2.253e+03  2.721 0.006589 **
## GarageArea            6.382e+00  7.899e+00  0.808 0.419276
## GarageQual            5.914e+03  3.810e+03  1.552 0.120862
## GarageCond            -1.349e+03  3.903e+03  -0.346 0.729740
## PavedDrive             3.347e+01  1.653e+03  0.020 0.983848
## WoodDeckSF            1.221e+01  5.859e+00  2.083 0.037435 *
## OpenPorchSF           2.079e+01  1.147e+01  1.812 0.070184 .
## EnclosedPorch         -2.472e+00  1.246e+01  -0.198 0.842717
## X3SsnPorch            3.552e+01  2.258e+01  1.573 0.115944
## ScreenPorch           4.094e+01  1.241e+01  3.298 0.001002 **
## PoolArea              -9.308e+00  5.379e+01  -0.173 0.862655
## PoolQC                1.745e+04  8.131e+03  2.145 0.032105 *
## FenceGdWo             1.076e+04  4.886e+03  2.203 0.027800 *
## FenceMnPrv            1.112e+04  3.982e+03  2.793 0.005303 **
## FenceMnWw             5.262e+03  8.245e+03  0.638 0.523483
## FenceNoFence          9.674e+03  3.633e+03  2.663 0.007849 **
## MiscFeatureNoMiscFeature 6.169e+04  9.543e+04  0.646 0.518120
## MiscFeatureOthr       7.529e+04  8.823e+04  0.853 0.393674
## MiscFeatureShed       6.095e+04  9.143e+04  0.667 0.505115
## MiscFeatureTenC      -1.861e+04  8.949e+04  -0.208 0.835312
## MiscVal               3.921e+00  5.975e+00  0.656 0.511756
## MoSold                -6.039e+02  2.440e+02  -2.475 0.013465 *
## YrSold                -8.774e+01  5.094e+02  -0.172 0.863267
## SaleTypeCon           2.778e+04  1.781e+04  1.560 0.119070
## SaleTypeConLD         1.516e+04  9.665e+03  1.568 0.117056
## SaleTypeConLI         4.378e+03  1.165e+04  0.376 0.707182
## SaleTypeConLw         3.603e+02  1.198e+04  0.030 0.976005
## SaleTypeCWD           1.653e+04  1.293e+04  1.279 0.201120
## SaleTypeNew           3.395e+04  1.537e+04  2.209 0.027373 *
## SaleTypeOth           1.042e+04  1.473e+04  0.708 0.479302
## SaleTypepWD           8.211e+02  4.201e+03  0.195 0.845085
## SaleConditionAdjLand   1.447e+04  1.435e+04  1.009 0.313363
## SaleConditionAlloca    6.295e+03  8.573e+03  0.734 0.462919
## SaleConditionFamily    5.228e+02  6.154e+03  0.085 0.932313
## SaleConditionNormal    7.653e+03  2.888e+03  2.650 0.008146 **
## SaleConditionPartial  -7.186e+03  1.479e+04  -0.486 0.627103
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 23160 on 1257 degrees of freedom
## Multiple R-squared:  0.9268, Adjusted R-squared:  0.9151
## F-statistic: 79.15 on 201 and 1257 DF,  p-value: < 2.2e-16

```



### Another linear model fit - using Log10 of Saleprice because Sale is skewed.

```
lmfit_log<-lm(log10(SalePrice)~.,data=Train)
summary(lmfit)
```

```
##
## Call:
## lm(formula = SalePrice ~ ., data = Train)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -170748  -11535        0   11479  170748
##
## Coefficients: (3 not defined because of singularities)
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -1.358e+06  1.091e+06  -1.244  0.213676
## MSSubClass     -7.186e+01  4.449e+01  -1.615  0.106529
## MSZoningFV      2.886e+04  1.255e+04   2.299  0.021649 *
## MSZoningRH      2.620e+04  1.254e+04   2.090  0.036833 *
## MSZoningRL      2.471e+04  1.063e+04   2.325  0.020231 *
## MSZoningRM      2.241e+04  1.001e+04   2.238  0.025409 *
## LotFrontage    1.063e+02  4.455e+01   2.386  0.017173 *
## LotArea        4.100e-01  9.777e-02   4.194  2.93e-05 ***
## StreetPave      2.195e+04  1.212e+04   1.811  0.070382 .
## AlleyNoAlley   -1.392e+03  4.414e+03  -0.315  0.752586
## AlleyPave      -1.786e+02  6.320e+03  -0.028  0.977455
## LotShapeIR2     1.076e+04  4.382e+03   2.456  0.014185 *
## LotShapeIR3     4.116e+03  9.311e+03   0.442  0.658525
## LotShapeReg     2.316e+03  1.688e+03   1.372  0.170301
## LandContourHLS   9.028e+03  5.378e+03   1.679  0.093465 .
## LandContourLow  -6.591e+03  6.582e+03  -1.001  0.316796
## LandContourLvl   3.966e+03  3.866e+03   1.026  0.305152
## Utilities       1.522e+04  9.141e+03   1.664  0.096274 .
## LotConfigCulDSac 1.189e+04  3.715e+03   3.200  0.001410 **
## LotConfigFR2    -4.402e+03  4.270e+03  -1.031  0.302778
## LotConfigFR3    -1.996e+04  1.330e+04  -1.500  0.133784
## LotConfigInside  1.852e+02  1.896e+03   0.098  0.922200
## LandSlope      -8.392e+01  3.648e+03  -0.023  0.981649
## NeighborhoodBlueste 1.634e+04  1.998e+04   0.818  0.413468
## NeighborhoodBrDale  9.742e+03  1.094e+04   0.891  0.373250
## NeighborhoodBrkSide 5.072e+03  9.588e+03   0.529  0.596914
## NeighborhoodClearCr -9.409e+03  9.519e+03  -0.988  0.323106
## NeighborhoodCollgCr -1.047e+04  7.467e+03  -1.402  0.161296
## NeighborhoodCrawfor 1.598e+04  8.797e+03   1.817  0.069454 .
## NeighborhoodEdwards -1.146e+04  8.208e+03  -1.397  0.162776
## NeighborhoodGilbert -9.124e+03  7.901e+03  -1.155  0.248418
## NeighborhoodIDOTRR -4.458e+03  1.090e+04  -0.409  0.682691
## NeighborhoodMeadowV -2.644e+03  1.162e+04  -0.227  0.820116
## NeighborhoodMitchel -1.151e+04  8.376e+03  -1.374  0.169736
## NeighborhoodNames -1.002e+04  8.049e+03  -1.244  0.213632
## NeighborhoodNoRidge 2.176e+04  8.708e+03   2.498  0.012603 *
```

## NeighborhoodNPkVill	1.633e+04	1.469e+04	1.111	0.266572	
## NeighborhoodNridgHt	3.079e+04	7.639e+03	4.031	5.89e-05	***
## NeighborhoodNWAmes	-1.367e+04	8.295e+03	-1.648	0.099617	.
## NeighborhoodOldTown	-5.777e+03	9.865e+03	-0.586	0.558270	
## NeighborhoodSawyer	-1.294e+03	8.372e+03	-0.155	0.877195	
## NeighborhoodSawyerW	-2.996e+03	8.062e+03	-0.372	0.710278	
## NeighborhoodSomerst	-1.995e+03	9.367e+03	-0.213	0.831387	
## NeighborhoodStoneBr	4.042e+04	8.682e+03	4.655	3.58e-06	***
## NeighborhoodSWISU	-3.422e+03	1.003e+04	-0.341	0.733021	
## NeighborhoodTimber	-7.234e+03	8.430e+03	-0.858	0.391003	
## NeighborhoodVeenker	3.152e+03	1.096e+04	0.287	0.773808	
## Condition1Feedr	3.751e+03	5.191e+03	0.723	0.470065	
## Condition1Norm	1.404e+04	4.306e+03	3.262	0.001136	**
## Condition1PosA	5.769e+03	1.052e+04	0.548	0.583453	
## Condition1PosN	9.018e+03	7.747e+03	1.164	0.244656	
## Condition1RRAE	-1.381e+04	9.171e+03	-1.505	0.132485	
## Condition1RRAN	1.480e+04	7.271e+03	2.035	0.042045	*
## Condition1RRNE	-7.139e+03	1.859e+04	-0.384	0.701072	
## Condition1RRNN	1.341e+04	1.344e+04	0.998	0.318703	
## Condition2Feedr	-1.530e+04	2.371e+04	-0.645	0.518992	
## Condition2Norm	-1.665e+04	2.035e+04	-0.818	0.413278	
## Condition2PosA	3.815e+04	3.446e+04	1.107	0.268453	
## Condition2PosN	-2.352e+05	2.834e+04	-8.299	2.68e-16	***
## Condition2RRAE	-7.148e+04	6.740e+04	-1.061	0.289075	
## Condition2RRAN	-9.186e+03	3.214e+04	-0.286	0.775053	
## Condition2RRNN	-6.793e+03	2.773e+04	-0.245	0.806523	
## BldgType	4.923e+03	1.777e+03	2.770	0.005694	**
## HouseStyle1.5Unf	9.755e+03	7.973e+03	1.224	0.221346	
## HouseStyle1Story	9.753e+03	4.184e+03	2.331	0.019920	*
## HouseStyle2.5Fin	-1.556e+04	1.265e+04	-1.230	0.218986	
## HouseStyle2.5Unf	-1.133e+04	9.431e+03	-1.201	0.229855	
## HouseStyle2Story	-5.156e+03	3.434e+03	-1.501	0.133486	
## HouseStyleSFoyer	1.448e+03	6.067e+03	0.239	0.811351	
## HouseStyleSLvl	6.873e+03	5.230e+03	1.314	0.189013	
## OverallQual	8.368e+03	1.056e+03	7.922	5.09e-15	***
## OverallCond	5.364e+03	8.968e+02	5.981	2.89e-09	***
## YearBuilt	2.767e+02	8.244e+01	3.356	0.000815	***
## YearRemodAdd	1.581e+01	5.717e+01	0.276	0.782230	
## RoofStyleGable	1.578e+03	1.919e+04	0.082	0.934468	
## RoofStyleGambrel	2.607e+03	2.090e+04	0.125	0.900761	
## RoofStyleHip	5.301e+03	1.926e+04	0.275	0.783152	
## RoofStyleMansard	1.037e+04	2.240e+04	0.463	0.643605	
## RoofStyleShed	5.217e+04	3.530e+04	1.478	0.139668	
## RoofMatlCompShg	6.720e+05	3.524e+04	19.068	< 2e-16	***
## RoofMatlMembran	7.254e+05	4.813e+04	15.072	< 2e-16	***
## RoofMatlMetal	6.924e+05	4.815e+04	14.381	< 2e-16	***
## RoofMatlRoll	6.514e+05	4.368e+04	14.912	< 2e-16	***
## RoofMatlTar&Grv	6.671e+05	4.043e+04	16.500	< 2e-16	***
## RoofMatlWdShake	6.475e+05	3.879e+04	16.694	< 2e-16	***
## RoofMatlWdShngl	7.523e+05	3.675e+04	20.472	< 2e-16	***

## Exterior1stAsphShn	-1.711e+04	3.478e+04	-0.492	0.622833	
## Exterior1stBrkComm	-1.747e+04	2.870e+04	-0.609	0.542749	
## Exterior1stBrkFace	6.813e+03	1.327e+04	0.513	0.607741	
## Exterior1stCBlock	1.034e+03	2.687e+04	0.038	0.969304	
## Exterior1stCemntBd	-6.758e+03	1.976e+04	-0.342	0.732406	
## Exterior1stHdBoard	-1.086e+04	1.339e+04	-0.811	0.417544	
## Exterior1stImStucc	-3.880e+04	2.952e+04	-1.315	0.188913	
## Exterior1stMetalSd	-1.620e+03	1.509e+04	-0.107	0.914558	
## Exterior1stPlywood	-1.615e+04	1.323e+04	-1.221	0.222268	
## Exterior1stStone	1.605e+03	2.498e+04	0.064	0.948796	
## Exterior1stStucco	1.628e+03	1.454e+04	0.112	0.910853	
## Exterior1stVinylSd	-1.206e+04	1.391e+04	-0.867	0.386272	
## Exterior1stWd Sdng	-1.072e+04	1.283e+04	-0.836	0.403540	
## Exterior1stWdShing	-3.507e+03	1.385e+04	-0.253	0.800183	
## Exterior2ndAsphShn	1.047e+04	2.323e+04	0.451	0.652135	
## Exterior2ndBrk Cmn	1.445e+04	2.090e+04	0.691	0.489696	
## Exterior2ndBrkFace	2.328e+03	1.361e+04	0.171	0.864201	
## Exterior2ndCBlock	NA	NA	NA	NA	
## Exterior2ndCmentBd	1.561e+04	1.942e+04	0.804	0.421795	
## Exterior2ndHdBoard	5.434e+03	1.271e+04	0.428	0.668938	
## Exterior2ndImStucc	2.744e+04	1.480e+04	1.854	0.063965	.
## Exterior2ndMetalSd	3.957e+03	1.467e+04	0.270	0.787440	
## Exterior2ndOther	-2.264e+04	2.874e+04	-0.788	0.430868	
## Exterior2ndPlywood	6.978e+03	1.235e+04	0.565	0.572061	
## Exterior2ndStone	-6.028e+03	1.771e+04	-0.340	0.733588	
## Exterior2ndStucco	-5.806e+03	1.404e+04	-0.413	0.679360	
## Exterior2ndVinylSd	1.024e+04	1.332e+04	0.769	0.441955	
## Exterior2ndWd Sdng	8.665e+03	1.225e+04	0.707	0.479463	
## Exterior2ndWd Shng	-5.015e+02	1.288e+04	-0.039	0.968937	
## MasVnrTypeBrkFace	6.918e+03	7.010e+03	0.987	0.323913	
## MasVnrTypeNone	1.319e+04	7.062e+03	1.868	0.061968	.
## MasVnrTypeStone	1.327e+04	7.442e+03	1.783	0.074877	.
## MasVnrArea	3.116e+01	6.014e+00	5.182	2.56e-07	***
## ExterQual	4.105e+03	2.191e+03	1.874	0.061196	.
## ExterCond	-3.296e+03	2.214e+03	-1.488	0.136882	
## FoundationCBlock	3.198e+03	3.262e+03	0.980	0.327141	
## FoundationPConc	4.181e+03	3.553e+03	1.177	0.239482	
## FoundationSlab	1.509e+04	9.445e+03	1.598	0.110262	
## FoundationStone	5.615e+03	1.168e+04	0.481	0.630666	
## FoundationWood	-3.085e+04	1.566e+04	-1.970	0.049007	*
## BsmtQual	3.749e+03	1.784e+03	2.102	0.035776	*
## BsmtCond	-5.638e+03	2.235e+03	-2.523	0.011750	*
## BsmtExposure	5.282e+03	8.848e+02	5.970	3.07e-09	***
## BsmtFinType1	-1.290e+02	5.324e+02	-0.242	0.808567	
## BsmtFinSF1	3.577e+01	5.026e+00	7.118	1.83e-12	***
## BsmtFinType2	-8.406e+01	1.360e+03	-0.062	0.950731	
## BsmtFinSF2	2.299e+01	8.537e+00	2.693	0.007179	**
## BsmtUnfSF	1.546e+01	4.542e+00	3.404	0.000685	***
## TotalBsmtSF	NA	NA	NA	NA	
## HeatingGasA	-6.307e+03	2.647e+04	-0.238	0.811680	

## HeatingGasW	-7.954e+03	2.723e+04	-0.292	0.770265	
## HeatingGrav	-4.322e+03	2.822e+04	-0.153	0.878290	
## HeatingOthW	-4.467e+04	3.259e+04	-1.370	0.170795	
## HeatingWall	5.452e+03	3.057e+04	0.178	0.858497	
## HeatingQC	1.134e+03	1.008e+03	1.125	0.260648	
## CentralAirY	-1.389e+03	4.006e+03	-0.347	0.728904	
## ElectricalFuseF	-1.562e+03	5.978e+03	-0.261	0.793852	
## ElectricalFuseP	8.364e+02	1.783e+04	0.047	0.962592	
## ElectricalMix	1.155e+04	2.732e+04	0.423	0.672519	
## ElectricalSBkr	-3.758e+03	3.087e+03	-1.217	0.223724	
## X1stFlrSF	4.636e+01	5.597e+00	8.283	3.05e-16	***
## X2ndFlrSF	6.358e+01	5.842e+00	10.883	< 2e-16	***
## LowQualFinSF	1.650e+01	1.942e+01	0.850	0.395611	
## GrLivArea	NA	NA	NA	NA	
## BsmtFullBath	1.840e+03	2.045e+03	0.900	0.368539	
## BsmtHalfBath	4.227e+02	3.161e+03	0.134	0.893632	
## FullBath	2.662e+03	2.285e+03	1.165	0.244363	
## HalfBath	2.853e+03	2.189e+03	1.303	0.192748	
## BedroomAbvGr	-5.866e+03	1.395e+03	-4.204	2.80e-05	***
## KitchenAbvGr	-1.052e+04	4.681e+03	-2.246	0.024849	*
## KitchenQual	7.074e+03	1.719e+03	4.114	4.13e-05	***
## TotRmsAbvGrd	3.257e+03	9.890e+02	3.294	0.001017	**
## Functional	5.922e+03	1.171e+03	5.057	4.90e-07	***
## Fireplaces	5.919e+03	2.314e+03	2.557	0.010667	*
## FireplaceQu	-1.603e+03	8.361e+02	-1.917	0.055450	.
## GarageTypeAttchd	1.219e+04	1.160e+04	1.051	0.293327	
## GarageTypeBasement	2.016e+04	1.343e+04	1.501	0.133637	
## GarageTypeBuiltIn	1.343e+04	1.211e+04	1.109	0.267515	
## GarageTypeCarPort	1.603e+04	1.499e+04	1.069	0.285109	
## GarageTypeDetchd	1.743e+04	1.157e+04	1.506	0.132347	
## GarageTypeNoGarage	4.143e+04	1.620e+04	2.558	0.010651	*
## GarageYrBlt	-1.614e+01	6.275e+01	-0.257	0.797108	
## GarageFinish	8.042e+02	1.260e+03	0.638	0.523540	
## GarageCars	5.016e+03	2.358e+03	2.127	0.033608	*
## GarageArea	1.536e+01	8.231e+00	1.866	0.062254	.
## GarageQual	5.690e+03	3.991e+03	1.426	0.154225	
## GarageCond	-1.522e+03	4.089e+03	-0.372	0.709713	
## PavedDrive	-2.401e+01	1.732e+03	-0.014	0.988939	
## WoodDeckSF	1.287e+01	6.138e+00	2.097	0.036210	*
## OpenPorchSF	9.704e+00	1.197e+01	0.811	0.417805	
## EnclosedPorch	-3.309e+00	1.305e+01	-0.254	0.799895	
## X3SsnPorch	3.834e+01	2.365e+01	1.621	0.105281	
## ScreenPorch	4.231e+01	1.300e+01	3.254	0.001168	**
## PoolArea	-2.288e+01	5.634e+01	-0.406	0.684696	
## PoolQC	2.054e+04	8.513e+03	2.413	0.015981	*
## FenceGdWo	1.046e+04	5.118e+03	2.044	0.041132	*
## FenceMnPrv	1.091e+04	4.171e+03	2.616	0.008990	**
## FenceMnWw	5.759e+03	8.637e+03	0.667	0.505075	
## FenceNoFence	9.584e+03	3.806e+03	2.518	0.011913	*
## MiscFeatureNoMiscFeature	4.583e+04	9.996e+04	0.459	0.646640	

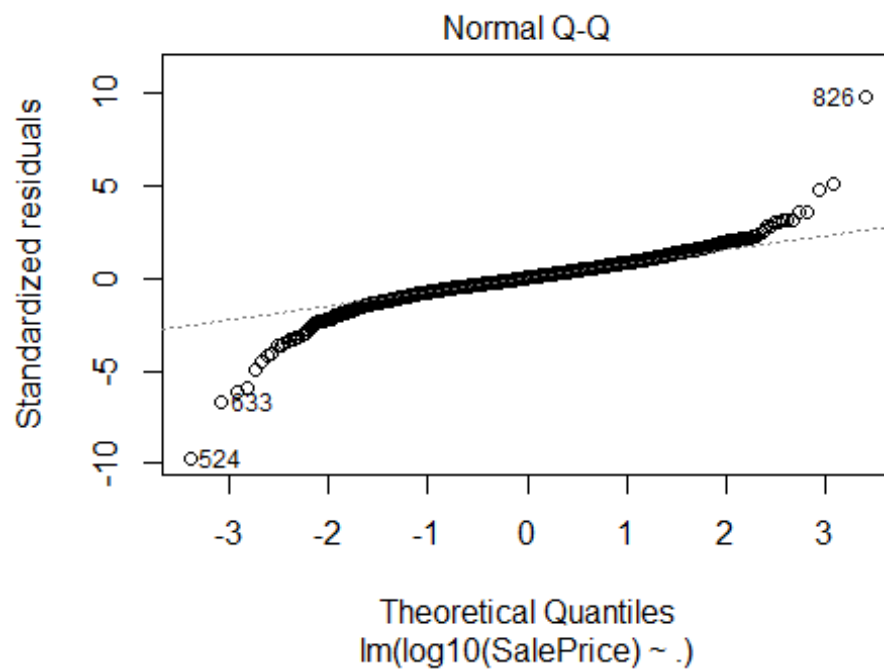
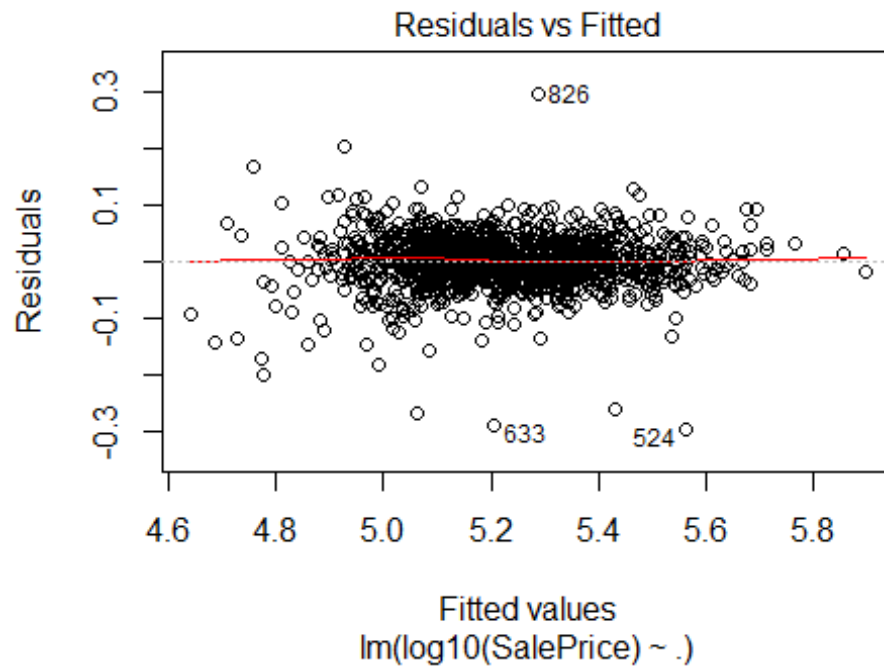
```

## MiscFeatureOthr      6.085e+04  9.242e+04   0.658 0.510385
## MiscFeatureShed     4.570e+04  9.577e+04   0.477 0.633331
## MiscFeatureTenC    -3.030e+04  9.374e+04  -0.323 0.746596
## MiscVal            2.863e+00  6.258e+00   0.457 0.647440
## MoSold             -6.934e+02  2.555e+02  -2.714 0.006739 **
## YrSold             -9.613e+01  5.336e+02  -0.180 0.857063
## SaleTypeCon        2.740e+04  1.866e+04   1.469 0.142193
## SaleTypeConLD      1.633e+04  1.012e+04   1.613 0.107054
## SaleTypeConLI      5.559e+03  1.221e+04   0.455 0.648880
## SaleTypeConLw     -8.507e+02  1.254e+04  -0.068 0.945946
## SaleTypeCWD        1.609e+04  1.354e+04   1.188 0.235041
## SaleTypeNew        3.515e+04  1.610e+04   2.184 0.029178 *
## SaleTypeOth        1.104e+04  1.543e+04   0.716 0.474268
## SaleTypeWD         4.405e+02  4.401e+03   0.100 0.920284
## SaleConditionAdjLand 1.479e+04  1.503e+04   0.984 0.325309
## SaleConditionAlloca 8.348e+03  8.979e+03   0.930 0.352689
## SaleConditionFamily -1.214e+02  6.447e+03  -0.019 0.984983
## SaleConditionNormal 7.474e+03  3.025e+03   2.471 0.013619 *
## SaleConditionPartial -8.874e+03  1.549e+04  -0.573 0.566860
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 24260 on 1258 degrees of freedom
## Multiple R-squared:  0.9196, Adjusted R-squared:  0.9067
## F-statistic: 71.57 on 201 and 1258 DF,  p-value: < 2.2e-16

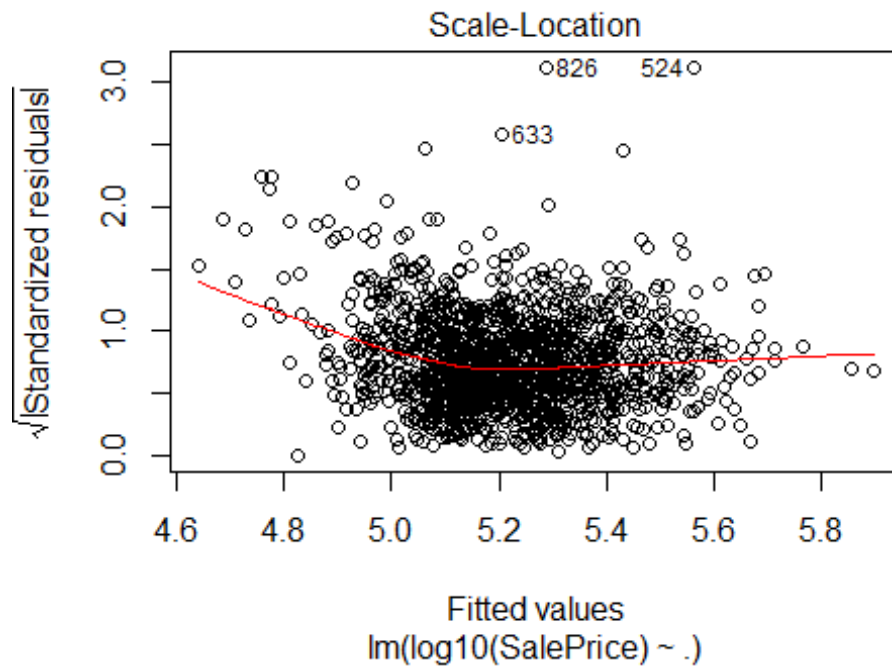
plot(lmfit_log)

## Warning: not plotting observations with leverage one:
## 121, 272, 347, 584, 596, 945, 1004, 1012, 1188, 1231, 1271, 1276, 1299,
1322, 1371, 1387

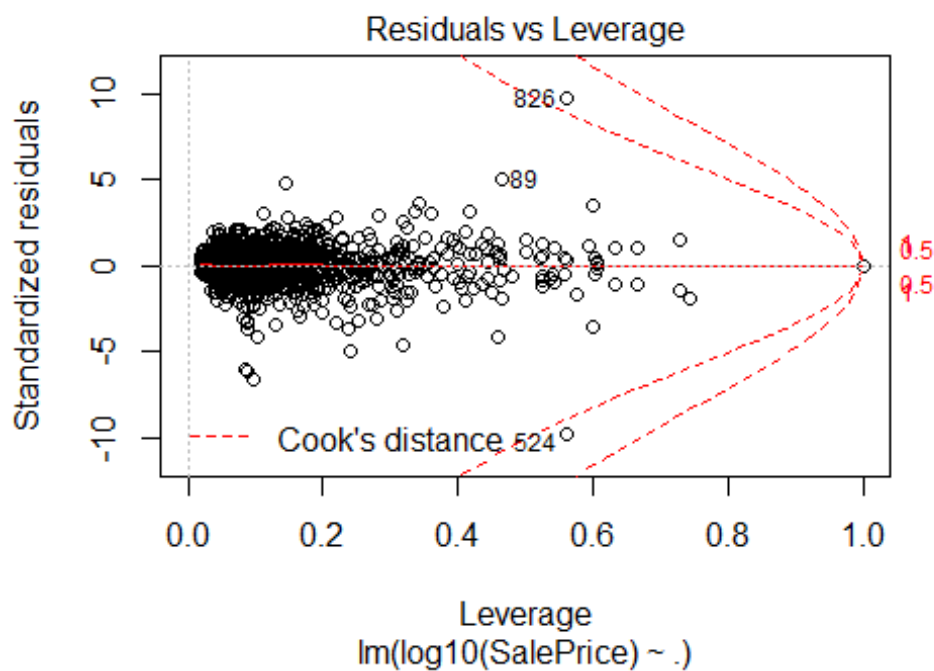
```



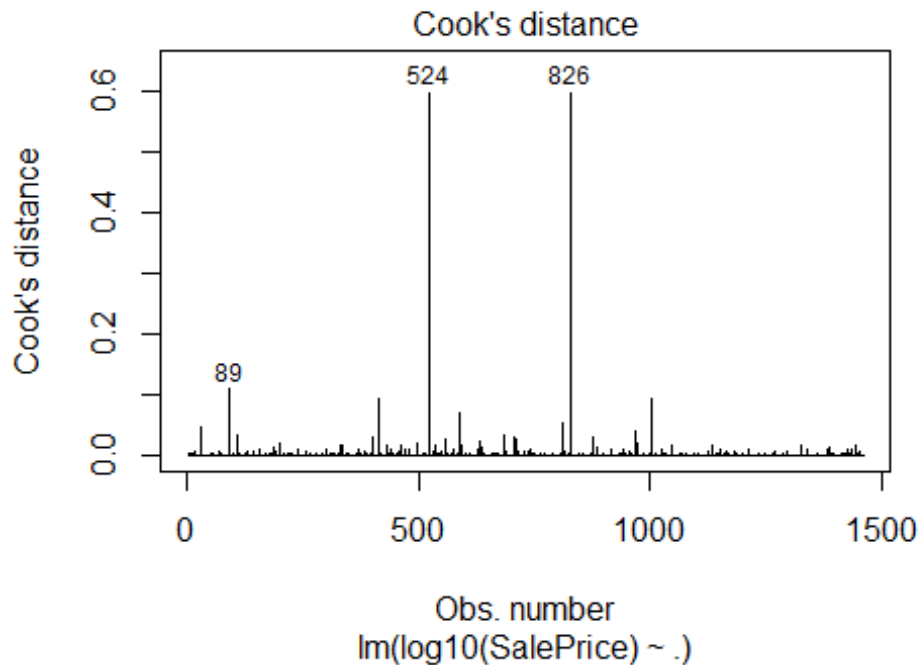
```
## Warning: not plotting observations with leverage one:
## 121, 272, 347, 584, 596, 945, 1004, 1012, 1188, 1231, 1271, 1276, 1299,
1322, 1371, 1387
```



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



```
plot(lmfit_log,which=c(4))
```



524 is a really big house, with great features but has extremely low sale price. 826 is the opposite. It was sold way over than others when looking at its features.

dishould probably try out removing the 524, 826, and possibly 1001, 1183 to see if they make a significant difference in model.

**This outlier removal option is a possible option to enhance the performance in the future.**

## 1. Forward Selection Results

```
#full - assigned as lmfit earlier
null <- lm(SalePrice~1,data=Train)
StepF <- stepAIC(null, scope=list(lower=null, upper=lmfit), direction=
"forward", trace=FALSE) #trace=TRUE
#StepF_Log<- stepAIC(null, scope=list(lower=null, upper=lmfit_Log),
direction= "forward", trace=FALSE) #trace=TRUE
summary(StepF)

##
## Call:
## lm(formula = SalePrice ~ OverallQual + GrLivArea + Neighborhood +
##   BsmtFinSF1 + RoofMatl + MSSubClass + BsmtExposure + KitchenQual +
##   Condition2 + SaleCondition + LotArea + YearBuilt + OverallCond +
##   MasVnrArea + PoolQC + BedroomAbvGr + GarageCars + MasVnrType +
##   TotalBsmtSF + BldgType + Functional + ExterQual + BsmtCond +
##   Condition1 + Exterior1st + MoSold + GarageCond + ScreenPorch +
```



```

##      LandContour + LowQualFinSF + LotConfig + LotFrontage + TotRmsAbvGrd +
##      KitchenAbvGr + WoodDeckSF + Street + GarageArea + LotShape +
##      BsmtQual + Fireplaces + FireplaceQu + PoolArea + RoofStyle +
##      BsmtFinSF2 + Utilities + ExterCond, data = Train)
##
## Residuals:
##      Min        1Q    Median        3Q        Max
## -167510   -11473        222    11201   167510
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -1.671e+06  1.340e+05 -12.471 < 2e-16 ***
## OverallQual     7.652e+03  9.855e+02   7.765 1.62e-14 ***
## GrLivArea      5.487e+01  3.302e+00  16.619 < 2e-16 ***
## NeighborhoodBlueste  2.071e+02  1.875e+04   0.011 0.991190
## NeighborhoodBrDale   4.778e+03  9.529e+03   0.501 0.616196
## NeighborhoodBrkSide   6.805e+03  8.478e+03   0.803 0.422315
## NeighborhoodClearCr  -8.189e+03  9.133e+03  -0.897 0.370074
## NeighborhoodCollgCr  -1.051e+04  7.141e+03  -1.472 0.141186
## NeighborhoodCrawfor   1.502e+04  8.389e+03   1.790 0.073606 .
## NeighborhoodEdwards  -8.914e+03  7.742e+03  -1.151 0.249775
## NeighborhoodGilbert  -8.244e+03  7.575e+03  -1.088 0.276618
## NeighborhoodIDOTRR   -5.778e+03  8.901e+03  -0.649 0.516376
## NeighborhoodMeadowV  -1.122e+04  1.032e+04  -1.087 0.277362
## NeighborhoodMitchel  -1.317e+04  7.940e+03  -1.659 0.097402 .
## NeighborhoodNames   -9.760e+03  7.591e+03  -1.286 0.198745
## NeighborhoodNoRidge   2.372e+04  8.354e+03   2.839 0.004588 **
## NeighborhoodNPkVill   1.791e+04  1.106e+04   1.618 0.105797
## NeighborhoodNridgHt   3.143e+04  7.350e+03   4.276 2.04e-05 ***
## NeighborhoodNWAmes  -1.495e+04  7.895e+03  -1.894 0.058416 .
## NeighborhoodOldTown  -7.359e+03  8.256e+03  -0.891 0.372881
## NeighborhoodSawyer   -2.571e+03  7.981e+03  -0.322 0.747383
## NeighborhoodSawyerW  -4.148e+03  7.750e+03  -0.535 0.592640
## NeighborhoodSomerst   3.100e+03  7.362e+03   0.421 0.673788
## NeighborhoodStoneBr   3.987e+04  8.435e+03   4.726 2.53e-06 ***
## NeighborhoodSWISU    -7.164e+00  9.521e+03  -0.001 0.999400
## NeighborhoodTimber   -7.593e+03  8.149e+03  -0.932 0.351599
## NeighborhoodVeenker   4.880e+03  1.044e+04   0.467 0.640274
## BsmtFinSF1        2.048e+01  1.982e+00  10.338 < 2e-16 ***
## RoofMatlCompShg      6.958e+05  3.310e+04  21.023 < 2e-16 ***
## RoofMatlMembran      7.533e+05  4.615e+04  16.323 < 2e-16 ***
## RoofMatlMetal       7.248e+05  4.582e+04  15.819 < 2e-16 ***
## RoofMatlRoll        6.851e+05  4.166e+04  16.444 < 2e-16 ***
## RoofMatlTar&Grv      6.924e+05  3.794e+04  18.251 < 2e-16 ***
## RoofMatlWdShake      6.742e+05  3.625e+04  18.597 < 2e-16 ***
## RoofMatlWdShngl      7.767e+05  3.455e+04  22.482 < 2e-16 ***
## MSSubClass        -9.178e+01  3.318e+01  -2.766 0.005760 **
## BsmtExposure        5.289e+03  8.056e+02   6.566 7.37e-11 ***
## KitchenQual         7.340e+03  1.601e+03   4.585 4.97e-06 ***
## Condition2Feedr     -1.788e+04  2.181e+04  -0.820 0.412460

```

## Condition2Norm	-1.592e+04	1.865e+04	-0.854	0.393458	
## Condition2PosA	5.104e+04	3.144e+04	1.624	0.104715	
## Condition2PosN	-2.345e+05	2.701e+04	-8.681	< 2e-16	***
## Condition2RRAE	-8.175e+04	4.314e+04	-1.895	0.058314	.
## Condition2RRAN	-8.471e+03	3.097e+04	-0.274	0.784456	
## Condition2RRNN	-6.282e+03	2.586e+04	-0.243	0.808078	
## SaleConditionAdjLand	1.845e+04	1.337e+04	1.379	0.167975	
## SaleConditionAlloca	6.465e+03	8.386e+03	0.771	0.440911	
## SaleConditionFamily	-2.203e+02	6.178e+03	-0.036	0.971560	
## SaleConditionNormal	7.132e+03	2.707e+03	2.635	0.008516	**
## SaleConditionPartial	2.466e+04	3.826e+03	6.446	1.60e-10	***
## LotArea	3.999e-01	8.886e-02	4.501	7.36e-06	***
## YearBuilt	3.877e+02	5.990e+01	6.473	1.35e-10	***
## OverallCond	5.939e+03	7.685e+02	7.728	2.13e-14	***
## MasVnrArea	3.312e+01	5.814e+00	5.696	1.51e-08	***
## PoolQC	3.098e+04	7.611e+03	4.071	4.96e-05	***
## BedroomAbvGr	-5.584e+03	1.300e+03	-4.295	1.87e-05	***
## GarageCars	3.939e+03	2.240e+03	1.758	0.078930	.
## MasVnrTypeBrkFace	9.442e+03	6.740e+03	1.401	0.161521	
## MasVnrTypeNone	1.654e+04	6.794e+03	2.434	0.015046	*
## MasVnrTypeStone	1.478e+04	7.150e+03	2.067	0.038930	*
## TotalBsmtSF	1.190e+01	2.951e+00	4.033	5.81e-05	***
## BldgType	4.225e+03	1.461e+03	2.891	0.003900	**
## Functional	5.728e+03	1.072e+03	5.342	1.08e-07	***
## ExterQual	5.421e+03	2.097e+03	2.585	0.009842	**
## BsmtCond	-7.298e+03	1.850e+03	-3.945	8.39e-05	***
## Condition1Feedr	2.843e+03	4.935e+03	0.576	0.564669	
## Condition1Norm	1.315e+04	4.064e+03	3.237	0.001240	**
## Condition1PosA	3.287e+03	1.015e+04	0.324	0.746185	
## Condition1PosN	7.959e+03	7.419e+03	1.073	0.283609	
## Condition1RRAE	-1.204e+04	8.809e+03	-1.367	0.171930	
## Condition1RRAN	1.256e+04	6.833e+03	1.838	0.066267	.
## Condition1RRNE	-5.278e+03	1.826e+04	-0.289	0.772531	
## Condition1RRNN	1.626e+04	1.258e+04	1.293	0.196273	
## Exterior1stAsphShn	-1.797e+04	2.567e+04	-0.700	0.484062	
## Exterior1stBrkComm	1.623e+03	1.918e+04	0.085	0.932566	
## Exterior1stBrkFace	1.857e+04	7.011e+03	2.648	0.008191	**
## Exterior1stCBlock	1.419e+04	2.564e+04	0.553	0.580018	
## Exterior1stCemntBd	1.452e+04	7.367e+03	1.971	0.048948	*
## Exterior1stHdBoard	1.313e+03	6.334e+03	0.207	0.835810	
## Exterior1stImStucc	-1.647e+04	2.570e+04	-0.641	0.521834	
## Exterior1stMetalSd	7.884e+03	6.161e+03	1.280	0.200895	
## Exterior1stPlywood	-3.606e+03	6.672e+03	-0.540	0.588981	
## Exterior1stStone	-2.532e+03	2.031e+04	-0.125	0.900814	
## Exterior1stStucco	7.085e+03	7.829e+03	0.905	0.365669	
## Exterior1stVinylSd	3.954e+03	6.211e+03	0.637	0.524478	
## Exterior1stWd Sdng	3.651e+03	6.147e+03	0.594	0.552591	
## Exterior1stWdShing	4.398e+03	7.712e+03	0.570	0.568602	
## MoSold	-6.655e+02	2.463e+02	-2.702	0.006988	**
## GarageCond	-4.465e+03	1.263e+03	-3.535	0.000421	***

```
## ScreenPorch          3.817e+01  1.239e+01   3.080 0.002112 **
## LandContourHLS       1.012e+04  5.121e+03   1.977 0.048272 *
## LandContourLow      -8.245e+03  6.095e+03  -1.353 0.176396
## LandContourLvl       3.887e+03  3.567e+03   1.090 0.276036
## LowQualFinSF        -4.612e+01  1.486e+01  -3.102 0.001960 **
## LotConfigCulDSac     1.181e+04  3.565e+03   3.314 0.000945 ***
## LotConfigFR2        -4.001e+03  4.127e+03  -0.969 0.332486
## LotConfigFR3        -2.121e+04  1.305e+04  -1.625 0.104353
## LotConfigInside      3.297e+02  1.830e+03   0.180 0.857050
## LotFrontage          1.066e+02  4.162e+01   2.562 0.010523 *
## TotRmsAbvGrd         2.659e+03  9.465e+02   2.810 0.005032 **
## KitchenAbvGr        -8.465e+03  4.226e+03  -2.003 0.045399 *
## WoodDeckSF           1.240e+01  5.898e+00   2.102 0.035710 *
## StreetPave           2.628e+04  1.121e+04   2.345 0.019158 *
## GarageArea           1.774e+01  7.547e+00   2.350 0.018905 *
## LotShapeIR2           9.280e+03  4.255e+03   2.181 0.029345 *
## LotShapeIR3           6.863e+03  8.828e+03   0.777 0.437071
## LotShapeReg           2.284e+03  1.647e+03   1.387 0.165782
## BsmtQual             3.265e+03  1.593e+03   2.050 0.040549 *
## Fireplaces           6.334e+03  2.247e+03   2.819 0.004881 **
## FireplaceQu         -1.679e+03  8.089e+02  -2.076 0.038089 *
## PoolArea            -1.003e+02  4.890e+01  -2.052 0.040352 *
## RoofStyleGable        4.778e+03  1.861e+04   0.257 0.797397
## RoofStyleGambrel      6.236e+03  2.012e+04   0.310 0.756680
## RoofStyleHip          9.532e+03  1.866e+04   0.511 0.609596
## RoofStyleMansard      1.638e+04  2.134e+04   0.768 0.442750
## RoofStyleShed         5.431e+04  3.432e+04   1.583 0.113756
## BsmtFinSF2            8.567e+00  4.568e+00   1.875 0.060941 .
## Utilities            1.326e+04  8.535e+03   1.554 0.120488
## ExterCond            -3.035e+03  2.105e+03  -1.442 0.149510
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 24330 on 1341 degrees of freedom
## Multiple R-squared:  0.9138, Adjusted R-squared:  0.9062
## F-statistic: 120.5 on 118 and 1341 DF,  p-value: < 2.2e-16
```

Linear Model looks like below.

## 2. Backward Elimination Results

```
StepB <- stepAIC(lmfit, direction= "backward", trace=FALSE)
summary(StepB)

##
## Call:
## lm(formula = SalePrice ~ LotFrontage + LotArea + Street + LotShape +
##   LandContour + Utilities + LotConfig + Neighborhood + Condition1 +
##   Condition2 + BldgType + HouseStyle + OverallQual + OverallCond +
##   YearBuilt + RoofMatl + Exterior1st + MasVnrType + MasVnrArea +
##   ExterQual + ExterCond + Foundation + BsmtQual + BsmtCond +
```

```
##      BsmtExposure + BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF + X1stFlrSF +
##      X2ndFlrSF + HalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual +
##      TotRmsAbvGrd + Functional + Fireplaces + FireplaceQu + GarageType +
##      GarageCars + GarageArea + WoodDeckSF + X3SsnPorch + ScreenPorch +
##      PoolQC + Fence + MiscFeature + MoSold + SaleCondition, data = Train)
##
```

```
## Residuals:
```

```
##      Min      1Q  Median      3Q      Max
## -171434 -11629       0   11196  171434
```

```
##
```

```
## Coefficients:
```

```
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -1.625e+06  1.448e+05 -11.225 < 2e-16 ***
## LotFrontage    1.226e+02  4.302e+01   2.850 0.004434 **
## LotArea        3.862e-01  8.939e-02   4.320 1.67e-05 ***
## StreetPave     2.452e+04  1.151e+04   2.130 0.033325 *
## LotShapeIR2    1.080e+04  4.271e+03   2.530 0.011534 *
## LotShapeIR3    5.438e+03  8.870e+03   0.613 0.539917
## LotShapeReg    2.336e+03  1.641e+03   1.424 0.154745
## LandContourHLS  9.152e+03  5.180e+03   1.767 0.077467 .
## LandContourLow -8.472e+03  6.090e+03  -1.391 0.164424
## LandContourLvl  3.908e+03  3.611e+03   1.082 0.279357
## Utilities      1.262e+04  8.793e+03   1.436 0.151312
## LotConfigCulDSac 1.231e+04  3.601e+03   3.419 0.000649 ***
## LotConfigFR2   -4.564e+03  4.113e+03  -1.110 0.267324
## LotConfigFR3   -2.027e+04  1.299e+04  -1.560 0.118897
## LotConfigInside  4.267e+02  1.830e+03   0.233 0.815658
## NeighborhoodBlueste 1.422e+04  1.914e+04   0.743 0.457598
## NeighborhoodBrDale  8.185e+03  9.811e+03   0.834 0.404301
## NeighborhoodBrkSide  5.904e+03  8.577e+03   0.688 0.491390
## NeighborhoodClearCr -7.501e+03  9.040e+03  -0.830 0.406805
## NeighborhoodCollgCr -9.959e+03  7.131e+03  -1.396 0.162817
## NeighborhoodCrawfor  1.566e+04  8.413e+03   1.862 0.062834 .
## NeighborhoodEdwards -9.020e+03  7.803e+03  -1.156 0.247885
## NeighborhoodGilbert -7.752e+03  7.636e+03  -1.015 0.310196
## NeighborhoodIDOTRR -7.103e+03  8.984e+03  -0.791 0.429304
## NeighborhoodMeadowV -5.250e+03  1.050e+04  -0.500 0.617099
## NeighborhoodMitchel -9.358e+03  7.949e+03  -1.177 0.239267
## NeighborhoodNames -8.663e+03  7.662e+03  -1.131 0.258409
## NeighborhoodNoRidge  2.270e+04  8.386e+03   2.707 0.006882 **
## NeighborhoodNPkVill  2.056e+04  1.119e+04   1.837 0.066427 .
## NeighborhoodNridgHt  3.117e+04  7.367e+03   4.230 2.50e-05 ***
## NeighborhoodNWAmes -1.258e+04  7.917e+03  -1.589 0.112187
## NeighborhoodOldTown -6.290e+03  8.288e+03  -0.759 0.448053
## NeighborhoodSawyer -4.577e+02  8.012e+03  -0.057 0.954453
## NeighborhoodSawyerW -2.662e+03  7.749e+03  -0.344 0.731222
## NeighborhoodSomerst  3.276e+03  7.390e+03   0.443 0.657604
## NeighborhoodStoneBr  3.871e+04  8.425e+03   4.594 4.76e-06 ***
## NeighborhoodSWISU -1.005e+03  9.538e+03  -0.105 0.916116
## NeighborhoodTimber -5.250e+03  8.134e+03  -0.645 0.518764
```

## NeighborhoodVeenker	3.868e+03	1.045e+04	0.370	0.711395	
## Condition1Feedr	3.211e+03	4.957e+03	0.648	0.517256	
## Condition1Norm	1.297e+04	4.125e+03	3.145	0.001697	**
## Condition1PosA	3.563e+03	1.017e+04	0.350	0.726100	
## Condition1PosN	8.190e+03	7.493e+03	1.093	0.274595	
## Condition1RR Ae	-1.520e+04	8.915e+03	-1.705	0.088363	.
## Condition1RR An	1.410e+04	6.919e+03	2.039	0.041695	*
## Condition1RR Ne	-9.543e+03	1.840e+04	-0.519	0.604012	
## Condition1RR Nn	1.708e+04	1.273e+04	1.342	0.179945	
## Condition2Feedr	-1.138e+04	2.234e+04	-0.509	0.610503	
## Condition2Norm	-1.536e+04	1.919e+04	-0.801	0.423479	
## Condition2PosA	5.404e+04	3.287e+04	1.644	0.100401	
## Condition2PosN	-2.348e+05	2.734e+04	-8.591	< 2e-16	***
## Condition2RR Ae	-4.215e+04	4.028e+04	-1.046	0.295589	
## Condition2RR An	-1.235e+04	3.130e+04	-0.395	0.693224	
## Condition2RR Nn	-9.396e+03	2.625e+04	-0.358	0.720437	
## BldgType	6.882e+03	1.065e+03	6.465	1.42e-10	***
## HouseStyle1.5Unf	1.102e+04	7.520e+03	1.465	0.143110	
## HouseStyle1Story	1.152e+04	3.666e+03	3.141	0.001722	**
## HouseStyle2.5Fin	-7.309e+03	9.942e+03	-0.735	0.462383	
## HouseStyle2.5Unf	-1.811e+04	8.585e+03	-2.109	0.035100	*
## HouseStyle2Story	-5.564e+03	3.190e+03	-1.744	0.081400	.
## HouseStyleSFoyer	-3.469e+02	5.769e+03	-0.060	0.952050	
## HouseStyleSLvl1	4.605e+03	4.825e+03	0.955	0.339998	
## OverallQual	8.599e+03	1.007e+03	8.542	< 2e-16	***
## OverallCond	5.759e+03	7.792e+02	7.390	2.59e-13	***
## YearBuilt	3.357e+02	6.637e+01	5.058	4.83e-07	***
## RoofMatlCompShg	6.964e+05	3.355e+04	20.759	< 2e-16	***
## RoofMatlMembran	7.471e+05	4.314e+04	17.320	< 2e-16	***
## RoofMatlMetal	7.160e+05	4.251e+04	16.843	< 2e-16	***
## RoofMatlRoll	6.854e+05	4.179e+04	16.400	< 2e-16	***
## RoofMatlTar&Grv	6.860e+05	3.454e+04	19.862	< 2e-16	***
## RoofMatlWdShake	6.871e+05	3.588e+04	19.149	< 2e-16	***
## RoofMatlWdShngl	7.759e+05	3.502e+04	22.156	< 2e-16	***
## Exterior1stAsphShn	-6.506e+03	2.619e+04	-0.248	0.803833	
## Exterior1stBrkComm	-9.107e+02	1.923e+04	-0.047	0.962236	
## Exterior1stBrkFace	1.425e+04	7.106e+03	2.005	0.045194	*
## Exterior1stCBlock	4.518e+03	2.569e+04	0.176	0.860423	
## Exterior1stCemntBd	1.048e+04	7.470e+03	1.402	0.161046	
## Exterior1stHdBoard	-3.346e+03	6.484e+03	-0.516	0.605965	
## Exterior1stImStucc	-1.022e+04	2.589e+04	-0.395	0.693005	
## Exterior1stMetalSd	4.819e+03	6.272e+03	0.768	0.442419	
## Exterior1stPlywood	-7.035e+03	6.774e+03	-1.039	0.299215	
## Exterior1stStone	-7.497e+03	2.012e+04	-0.373	0.709461	
## Exterior1stStucco	2.850e+03	7.930e+03	0.359	0.719328	
## Exterior1stVinylSd	-3.054e+02	6.327e+03	-0.048	0.961508	
## Exterior1stWd Sdng	5.941e+02	6.264e+03	0.095	0.924457	
## Exterior1stWdShing	9.918e+02	7.793e+03	0.127	0.898747	
## MasVnrTypeBrkFace	6.291e+03	6.857e+03	0.917	0.359098	
## MasVnrTypeNone	1.250e+04	6.908e+03	1.809	0.070623	.

## MasVnrTypeStone	1.174e+04	7.244e+03	1.620	0.105380	
## MasVnrArea	3.170e+01	5.811e+00	5.455	5.83e-08	***
## ExterQual	4.908e+03	2.126e+03	2.309	0.021093	*
## ExterCond	-3.254e+03	2.106e+03	-1.545	0.122616	
## FoundationCBlock	3.578e+03	3.064e+03	1.168	0.243147	
## FoundationPConc	5.308e+03	3.415e+03	1.555	0.120294	
## FoundationSlab	1.740e+04	8.467e+03	2.055	0.040088	*
## FoundationStone	3.448e+03	1.059e+04	0.326	0.744740	
## FoundationWood	-3.373e+04	1.542e+04	-2.187	0.028904	*
## BsmtQual	3.584e+03	1.693e+03	2.117	0.034427	*
## BsmtCond	-6.477e+03	2.073e+03	-3.124	0.001823	**
## BsmtExposure	5.466e+03	8.449e+02	6.469	1.38e-10	***
## BsmtFinSF1	3.722e+01	4.426e+00	8.409	< 2e-16	***
## BsmtFinSF2	2.501e+01	5.787e+00	4.322	1.66e-05	***
## BsmtUnfSF	1.601e+01	4.304e+00	3.721	0.000207	***
## X1stFlrSF	4.845e+01	5.199e+00	9.320	< 2e-16	***
## X2ndFlrSF	6.463e+01	5.154e+00	12.540	< 2e-16	***
## HalfBath	2.613e+03	1.910e+03	1.368	0.171388	
## BedroomAbvGr	-6.339e+03	1.324e+03	-4.789	1.87e-06	***
## KitchenAbvGr	-1.068e+04	4.240e+03	-2.519	0.011882	*
## KitchenQual	7.428e+03	1.609e+03	4.617	4.27e-06	***
## TotRmsAbvGrd	3.558e+03	9.457e+02	3.763	0.000175	***
## Functional	5.535e+03	1.088e+03	5.089	4.13e-07	***
## Fireplaces	6.279e+03	2.254e+03	2.786	0.005417	**
## FireplaceQu	-1.781e+03	8.136e+02	-2.189	0.028777	*
## GarageTypeAttchd	1.146e+04	1.106e+04	1.037	0.299932	
## GarageTypeBasement	1.794e+04	1.273e+04	1.409	0.159077	
## GarageTypeBuiltIn	1.326e+04	1.154e+04	1.149	0.250958	
## GarageTypeCarPort	1.048e+04	1.410e+04	0.743	0.457468	
## GarageTypeDetchd	1.624e+04	1.099e+04	1.478	0.139714	
## GarageTypeNoGarage	2.827e+04	1.193e+04	2.370	0.017926	*
## GarageCars	4.372e+03	2.284e+03	1.914	0.055779	.
## GarageArea	1.633e+01	7.612e+00	2.146	0.032065	*
## WoodDeckSF	1.215e+01	5.944e+00	2.044	0.041175	*
## X3SsnPorch	4.279e+01	2.323e+01	1.842	0.065693	.
## ScreenPorch	4.074e+01	1.256e+01	3.243	0.001212	**
## PoolQC	1.855e+04	2.921e+03	6.352	2.92e-10	***
## FenceGdWo	1.044e+04	4.955e+03	2.106	0.035398	*
## FenceMnPrv	1.152e+04	4.035e+03	2.854	0.004389	**
## FenceMnWw	7.350e+03	8.382e+03	0.877	0.380726	
## FenceNoFence	9.794e+03	3.685e+03	2.658	0.007957	**
## MiscFeatureNoMiscFeature	1.035e+03	2.464e+04	0.042	0.966504	
## MiscFeatureOthr	1.367e+04	3.036e+04	0.450	0.652552	
## MiscFeatureShed	3.158e+03	2.489e+04	0.127	0.899049	
## MiscFeatureTenC	-7.769e+04	3.635e+04	-2.137	0.032772	*
## MoSold	-6.348e+02	2.461e+02	-2.580	0.009996	**
## SaleConditionAdjLand	2.096e+04	1.331e+04	1.574	0.115640	
## SaleConditionAlloca	5.207e+03	8.443e+03	0.617	0.537499	
## SaleConditionFamily	1.099e+03	6.177e+03	0.178	0.858832	
## SaleConditionNormal	7.750e+03	2.708e+03	2.862	0.004280	**

```
## SaleConditionPartial      2.474e+04  3.823e+03   6.472 1.36e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 24170 on 1321 degrees of freedom
## Multiple R-squared:  0.9162, Adjusted R-squared:  0.9075
## F-statistic: 104.7 on 138 and 1321 DF,  p-value: < 2.2e-16
```

### 3. Stepwise

```
StepS <- stepAIC(lmfit, direction= "both", trace=FALSE)
```

### 3. Boruta Feature Selection

Based on Random forest. Selects attributes better than shadow.

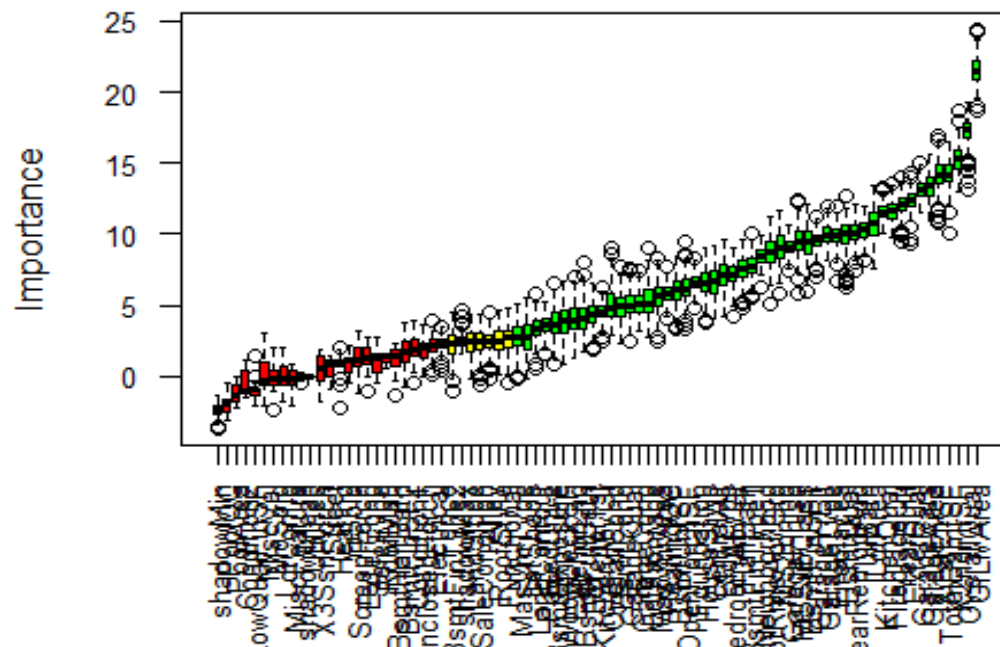
```
set.seed(99)

FS_Boruta<-Boruta(SalePrice~.,data=Train, maxRuns=200)

FS_Boruta

## Boruta performed 199 iterations in 8.253092 mins.
## 50 attributes confirmed important: BedroomAbvGr, BldgType,
## BsmtCond, BsmtExposure, BsmtFinSF1 and 45 more;
## 22 attributes confirmed unimportant: BsmtFinSF2, BsmtHalfBath,
## Condition1, Condition2, Electrical and 17 more;
## 7 tentative attributes left: Alley, BsmtFinType2, Fence,
## Functional, LandSlope and 2 more;

plot(FS_Boruta,las=2, cex.axis=0.8) # Shows the confirmed feature green,
tentative yellow and rejected red.
```



```
getConfirmedFormula(FS_Boruta)
```

```
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + LotShape +
##   LandContour + Neighborhood + BldgType + HouseStyle + OverallQual +
##   OverallCond + YearBuilt + YearRemodAdd + Exterior1st + Exterior2nd +
##   MasVnrType + MasVnrArea + ExterQual + Foundation + BsmtQual +
##   BsmtCond + BsmtExposure + BsmtFinType1 + BsmtFinSF1 + BsmtUnfSF +
##   TotalBsmtSF + HeatingQC + CentralAir + X1stFlrSF + X2ndFlrSF +
##   GrLivArea + BsmtFullBath + FullBath + HalfBath + BedroomAbvGr +
##   KitchenAbvGr + KitchenQual + TotRmsAbvGrd + Fireplaces +
##   FireplaceQu + GarageType + GarageYrBlt + GarageFinish + GarageCars +
##   GarageArea + GarageQual + GarageCond + PavedDrive + WoodDeckSF +
##   OpenPorchSF
## <environment: 0x000000001fea3630>
```

Graph shows important features. Ground Level Area scored the highest then the overall quality. TO decide on the tentative features, we go through one more step.

```
borcheck<-TentativeRoughFix(FS_Boruta)
print(borcheck)
```

```
## Boruta performed 199 iterations in 8.253092 mins.
## Tentatives roughfixed over the last 199 iterations.
## 54 attributes confirmed important: Alley, BedroomAbvGr, BldgType,
## BsmtCond, BsmtExposure and 49 more;
## 25 attributes confirmed unimportant: BsmtFinSF2, BsmtHalfBath,
## Condition1, Condition2, Electrical and 20 more;
```



```
getSelectedAttributes(borcheck, withTentative = F)
```

```
## [1] "MSSubClass" "MSZoning" "LotFrontage" "LotArea"
## [5] "Alley" "LotShape" "LandContour" "LandSlope"
## [9] "Neighborhood" "BldgType" "HouseStyle" "OverallQual"
## [13] "OverallCond" "YearBuilt" "YearRemodAdd" "RoofStyle"
## [17] "Exterior1st" "Exterior2nd" "MasVnrType" "MasVnrArea"
## [21] "ExterQual" "Foundation" "BsmtQual" "BsmtCond"
## [25] "BsmtExposure" "BsmtFinType1" "BsmtFinSF1" "BsmtFinType2"
## [29] "BsmtUnfSF" "TotalBsmtSF" "HeatingQC" "CentralAir"
## [33] "X1stFlrSF" "X2ndFlrSF" "GrLivArea" "BsmtFullBath"
## [37] "FullBath" "HalfBath" "BedroomAbvGr" "KitchenAbvGr"
## [41] "KitchenQual" "TotRmsAbvGrd" "Fireplaces" "FireplaceQu"
## [45] "GarageType" "GarageYrBlt" "GarageFinish" "GarageCars"
## [49] "GarageArea" "GarageQual" "GarageCond" "PavedDrive"
## [53] "WoodDeckSF" "OpenPorchSF"
```

```
attStats(borcheck)
```

##		meanImp	medianImp	minImp	maxImp	normHits
##	MSSubClass	9.550343561	9.4453273	5.8255169	12.44573413	1.000000000
##	MSZoning	9.096415226	9.0624385	5.8229687	11.67247299	1.000000000
##	LotFrontage	5.285318845	5.1540870	2.7437040	9.00153789	0.994974874
##	LotArea	10.734123585	10.7862324	7.5227183	13.38044844	1.000000000
##	Street	0.505557239	0.7857023	-0.9271113	1.45560353	0.000000000
##	Alley	2.436223189	2.5031251	-0.1428585	4.45060091	0.512562814
##	LotShape	2.823686244	2.8238690	-0.1014899	5.54270194	0.618090452
##	LandContour	3.378428281	3.3962788	0.5888934	5.89174760	0.884422111
##	Utilities	0.000000000	0.0000000	0.0000000	0.00000000	0.000000000
##	LotConfig	0.004731448	-0.1276514	-1.7244525	2.04304955	0.000000000
##	LandSlope	2.376129153	2.4366493	-0.1350519	4.38280305	0.492462312
##	Neighborhood	8.513052275	8.5042505	6.2530761	9.97109549	1.000000000
##	Condition1	1.999143256	1.9506751	-0.3998598	3.99221307	0.170854271
##	Condition2	-0.463086298	-1.0211488	-1.4595708	1.14297612	0.000000000
##	BldgType	7.125341031	7.1514780	4.2612532	9.60480110	0.994974874
##	HouseStyle	6.603122869	6.6219228	3.7848718	9.08516718	1.000000000
##	OverallQual	17.256285890	17.3545116	13.1603072	19.33586428	1.000000000
##	OverallCond	5.078283976	4.8165380	2.8827082	9.00995589	0.994974874
##	YearBuilt	12.077291383	12.0867393	9.4134621	13.97829957	1.000000000
##	YearRemodAdd	10.029044696	10.1064025	7.3777980	12.12846637	1.000000000
##	RoofStyle	2.475430552	2.5343785	0.1318786	4.67113931	0.517587940
##	RoofMatl	1.237013207	1.4556147	0.6101594	1.64849349	0.000000000
##	Exterior1st	4.414311542	4.4254767	1.9490654	6.62315581	0.969849246
##	Exterior2nd	4.048542457	3.9804561	1.3564271	7.06202707	0.919597990
##	MasVnrType	2.762702399	2.7369841	-0.1216139	5.03804134	0.653266332
##	MasVnrArea	5.622290822	5.6172280	2.4745964	8.33033161	1.000000000
##	ExterQual	12.420683546	12.4350058	9.3158246	14.34630773	1.000000000
##	ExterCond	1.306755841	1.2800875	-1.0784873	2.82865359	0.010050251
##	Foundation	6.588720459	6.6038604	4.8352477	8.28931831	1.000000000
##	BsmtQual	9.850843624	10.0360169	6.1962442	12.68000313	1.000000000

## BsmtCond	4.883010472	4.9244889	2.2828342	7.65682520	0.979899497
## BsmtExposure	3.710878555	3.7001922	0.9072811	6.57013293	0.874371859
## BsmtFinType1	7.762140251	7.7930462	5.6028038	10.08335624	1.000000000
## BsmtFinSF1	9.400573792	9.4986413	5.9285660	12.13004389	1.000000000
## BsmtFinType2	2.255645292	2.3264288	-1.0124595	4.55805542	0.457286432
## BsmtFinSF2	1.739424587	1.6704657	-0.6849171	3.72302950	0.125628141
## BsmtUnfSF	6.057783250	6.1242962	3.2882867	8.43565033	1.000000000
## TotalBsmtSF	14.234639835	14.2141483	10.0456450	16.52494125	1.000000000
## Heating	0.729650703	0.9966070	-2.2618007	2.06007529	0.000000000
## HeatingQC	5.827261067	5.8477699	4.1185389	7.71878265	1.000000000
## CentralAir	6.593364518	6.7607769	4.1173496	9.18285669	1.000000000
## Electrical	2.157825061	2.2427063	0.0752762	3.99642837	0.286432161
## X1stFlrSF	14.208118277	14.1991615	10.8599838	16.86338354	1.000000000
## X2ndFlrSF	15.297244691	15.3266596	12.9596733	18.65336201	1.000000000
## LowQualFinSF	-0.903858603	-0.9611390	-2.1227215	1.40882604	0.000000000
## GrLivArea	21.571350840	21.5267260	18.6855414	24.40471742	1.000000000
## BsmtFullBath	4.159707252	4.0450690	1.8025466	8.04280192	0.924623116
## BsmtHalfBath	1.234031628	1.4894229	-1.3793280	2.31296241	0.010050251
## FullBath	10.259590217	10.2932124	8.1494455	11.95165121	1.000000000
## HalfBath	7.522381386	7.6378925	4.7838664	9.65764096	1.000000000
## BedroomAbvGr	7.166026222	7.1630653	4.1874768	9.08589511	1.000000000
## KitchenAbvGr	4.556674695	4.5376682	2.4198431	6.26617095	0.994974874
## KitchenQual	11.558558764	11.5805201	10.1259679	13.21992815	1.000000000
## TotRmsAbvGrd	8.735460971	8.7330840	5.0619096	11.16372470	1.000000000
## Functional	2.578333949	2.7004284	-0.4885604	4.77564339	0.592964824
## Fireplaces	9.879803284	9.9562171	6.6607180	11.91348009	1.000000000
## FireplaceQu	11.582867109	11.6030843	9.7782153	13.57001759	1.000000000
## GarageType	9.954206568	9.8818802	8.1071371	11.94167664	1.000000000
## GarageYrBlt	9.550829965	9.5800323	7.0310748	11.30570731	1.000000000
## GarageFinish	9.083016603	9.0882919	7.4054832	10.69156287	1.000000000
## GarageCars	13.139500365	13.1348679	11.5945987	14.96780930	1.000000000
## GarageArea	13.373112230	13.4026193	10.9200560	15.55098456	1.000000000
## GarageQual	5.071503149	4.9308535	2.4425724	7.57730987	0.989949749
## GarageCond	5.084015875	5.0365887	3.2350117	7.45855458	1.000000000
## PavedDrive	3.585717290	3.6137177	1.5355388	5.26535262	0.934673367
## WoodDeckSF	3.856556445	3.9466265	0.8947497	6.67392980	0.884422111
## OpenPorchSF	6.205799972	6.1859845	3.3251866	9.47317517	1.000000000
## EnclosedPorch	1.898397465	2.0299306	0.0172604	3.70445129	0.095477387
## X3SsnPorch	0.460794612	0.5791773	-1.7131194	1.91462529	0.000000000
## ScreenPorch	1.271345252	1.2117712	-1.2193782	3.23310257	0.025125628
## PoolArea	-1.257690738	-1.3936282	-2.2682593	-0.06884157	0.000000000
## PoolQC	-1.957774833	-1.9093006	-3.0697974	-0.50138539	0.000000000
## Fence	2.255762035	2.2864532	0.3593349	3.51272708	0.447236181
## MiscFeature	-0.265018997	-0.1184190	-2.1140067	0.88021496	0.000000000
## MiscVal	-0.016621221	-0.2686400	-2.1089587	2.99240641	0.005025126
## MoSold	-0.176413115	-0.1499020	-2.3758284	2.00031946	0.000000000
## YrSold	0.884121795	1.1302494	-0.4213472	2.21266835	0.005025126
## SaleType	1.068303885	1.3448100	-0.5020431	2.68801487	0.010050251
## SaleCondition	2.438588415	2.4564471	-0.5572602	4.33403945	0.542713568
##	decision				

## MSSubClass	Confirmed
## MSZoning	Confirmed
## LotFrontage	Confirmed
## LotArea	Confirmed
## Street	Rejected
## Alley	Confirmed
## LotShape	Confirmed
## LandContour	Confirmed
## Utilities	Rejected
## LotConfig	Rejected
## LandSlope	Confirmed
## Neighborhood	Confirmed
## Condition1	Rejected
## Condition2	Rejected
## BldgType	Confirmed
## HouseStyle	Confirmed
## OverallQual	Confirmed
## OverallCond	Confirmed
## YearBuilt	Confirmed
## YearRemodAdd	Confirmed
## RoofStyle	Confirmed
## RoofMatl	Rejected
## Exterior1st	Confirmed
## Exterior2nd	Confirmed
## MasVnrType	Confirmed
## MasVnrArea	Confirmed
## ExterQual	Confirmed
## ExterCond	Rejected
## Foundation	Confirmed
## BsmtQual	Confirmed
## BsmtCond	Confirmed
## BsmtExposure	Confirmed
## BsmtFinType1	Confirmed
## BsmtFinSF1	Confirmed
## BsmtFinType2	Confirmed
## BsmtFinSF2	Rejected
## BsmtUnfSF	Confirmed
## TotalBsmtSF	Confirmed
## Heating	Rejected
## HeatingQC	Confirmed
## CentralAir	Confirmed
## Electrical	Rejected
## X1stFlrSF	Confirmed
## X2ndFlrSF	Confirmed
## LowQualFinSF	Rejected
## GrLivArea	Confirmed
## BsmtFullBath	Confirmed
## BsmtHalfBath	Rejected
## FullBath	Confirmed
## HalfBath	Confirmed

```
## BedroomAbvGr Confirmed
## KitchenAbvGr Confirmed
## KitchenQual Confirmed
## TotRmsAbvGrd Confirmed
## Functional Rejected
## Fireplaces Confirmed
## FireplaceQu Confirmed
## GarageType Confirmed
## GarageYrBlt Confirmed
## GarageFinish Confirmed
## GarageCars Confirmed
## GarageArea Confirmed
## GarageQual Confirmed
## GarageCond Confirmed
## PavedDrive Confirmed
## WoodDeckSF Confirmed
## OpenPorchSF Confirmed
## EnclosedPorch Rejected
## X3SsnPorch Rejected
## ScreenPorch Rejected
## PoolArea Rejected
## PoolQC Rejected
## Fence Rejected
## MiscFeature Rejected
## MiscVal Rejected
## MoSold Rejected
## YrSold Rejected
## SaleType Rejected
## SaleCondition Rejected
```

```
getConfirmedFormula(borcheck)
```

```
## SalePrice ~ MSSubClass + MSZoning + LotFrontage + LotArea + Alley +
## LotShape + LandContour + LandSlope + Neighborhood + BldgType +
## HouseStyle + OverallQual + OverallCond + YearBuilt + YearRemodAdd +
## RoofStyle + Exterior1st + Exterior2nd + MasVnrType + MasVnrArea +
## ExterQual + Foundation + BsmtQual + BsmtCond + BsmtExposure +
## BsmtFinType1 + BsmtFinSF1 + BsmtFinType2 + BsmtUnfSF + TotalBsmtSF +
## HeatingQC + CentralAir + X1stFlrSF + X2ndFlrSF + GrLivArea +
## BsmtFullBath + FullBath + HalfBath + BedroomAbvGr + KitchenAbvGr +
## KitchenQual + TotRmsAbvGrd + Fireplaces + FireplaceQu + GarageType +
## GarageYrBlt + GarageFinish + GarageCars + GarageArea + GarageQual +
## GarageCond + PavedDrive + WoodDeckSF + OpenPorchSF
## <environment: 0x0000000025d1c6d8>
```

Anova to check - does look like significantly different between the models. (P between 0.01 to 0.05)

```
anova(StepF, StepS)
```

```
## Analysis of Variance Table
##
## Model 1: SalePrice ~ OverallQual + GrLivArea + Neighborhood + BsmtFinSF1 +
##   RoofMatl + MSSubClass + BsmtExposure + KitchenQual + Condition2 +
##   SaleCondition + LotArea + YearBuilt + OverallCond + MasVnrArea +
##   PoolQC + BedroomAbvGr + GarageCars + MasVnrType + TotalBsmtSF +
##   BldgType + Functional + ExterQual + BsmtCond + Condition1 +
##   Exterior1st + MoSold + GarageCond + ScreenPorch + LandContour +
##   LowQualFinSF + LotConfig + LotFrontage + TotRmsAbvGrd + KitchenAbvGr +
##   WoodDeckSF + Street + GarageArea + LotShape + BsmtQual +
##   Fireplaces + FireplaceQu + PoolArea + RoofStyle + BsmtFinSF2 +
##   Utilities + ExterCond
## Model 2: SalePrice ~ LotFrontage + LotArea + Street + LotShape +
LandContour +
##   Utilities + LotConfig + Neighborhood + Condition1 + Condition2 +
##   BldgType + HouseStyle + OverallQual + OverallCond + YearBuilt +
##   RoofMatl + Exterior1st + MasVnrType + MasVnrArea + ExterQual +
##   ExterCond + Foundation + BsmtQual + BsmtCond + BsmtExposure +
##   BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF + X1stFlrSF + X2ndFlrSF +
##   HalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +
##   Functional + Fireplaces + FireplaceQu + GarageType + GarageCars +
##   GarageArea + WoodDeckSF + X3SsnPorch + ScreenPorch + PoolQC +
##   Fence + MiscFeature + MoSold + SaleCondition
##   Res.Df      RSS Df Sum of Sq      F    Pr(>F)
## 1    1341 7.9363e+11
## 2    1321 7.7147e+11 20 2.2166e+10 1.8977 0.009704 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

**anova**(StepF,StepB)

```
## Analysis of Variance Table
##
## Model 1: SalePrice ~ OverallQual + GrLivArea + Neighborhood + BsmtFinSF1 +
##   RoofMatl + MSSubClass + BsmtExposure + KitchenQual + Condition2 +
##   SaleCondition + LotArea + YearBuilt + OverallCond + MasVnrArea +
##   PoolQC + BedroomAbvGr + GarageCars + MasVnrType + TotalBsmtSF +
##   BldgType + Functional + ExterQual + BsmtCond + Condition1 +
##   Exterior1st + MoSold + GarageCond + ScreenPorch + LandContour +
##   LowQualFinSF + LotConfig + LotFrontage + TotRmsAbvGrd + KitchenAbvGr +
##   WoodDeckSF + Street + GarageArea + LotShape + BsmtQual +
##   Fireplaces + FireplaceQu + PoolArea + RoofStyle + BsmtFinSF2 +
##   Utilities + ExterCond
## Model 2: SalePrice ~ LotFrontage + LotArea + Street + LotShape +
LandContour +
##   Utilities + LotConfig + Neighborhood + Condition1 + Condition2 +
##   BldgType + HouseStyle + OverallQual + OverallCond + YearBuilt +
##   RoofMatl + Exterior1st + MasVnrType + MasVnrArea + ExterQual +
##   ExterCond + Foundation + BsmtQual + BsmtCond + BsmtExposure +
##   BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF + X1stFlrSF + X2ndFlrSF +
```

```
##      HalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +
##      Functional + Fireplaces + FireplaceQu + GarageType + GarageCars +
##      GarageArea + WoodDeckSF + X3SsnPorch + ScreenPorch + PoolQC +
##      Fence + MiscFeature + MoSold + SaleCondition
## Res.Df      RSS Df Sum of Sq      F Pr(>F)
## 1  1341 7.9363e+11
## 2  1321 7.7147e+11 20 2.2166e+10 1.8977 0.009704 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

`anova(StepS, StepB)`

```
## Analysis of Variance Table
##
## Model 1: SalePrice ~ LotFrontage + LotArea + Street + LotShape +
LandContour +
##      Utilities + LotConfig + Neighborhood + Condition1 + Condition2 +
##      BldgType + HouseStyle + OverallQual + OverallCond + YearBuilt +
##      RoofMatl + Exterior1st + MasVnrType + MasVnrArea + ExterQual +
##      ExterCond + Foundation + BsmtQual + BsmtCond + BsmtExposure +
##      BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF + X1stFlrSF + X2ndFlrSF +
##      HalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +
##      Functional + Fireplaces + FireplaceQu + GarageType + GarageCars +
##      GarageArea + WoodDeckSF + X3SsnPorch + ScreenPorch + PoolQC +
##      Fence + MiscFeature + MoSold + SaleCondition
## Model 2: SalePrice ~ LotFrontage + LotArea + Street + LotShape +
LandContour +
##      Utilities + LotConfig + Neighborhood + Condition1 + Condition2 +
##      BldgType + HouseStyle + OverallQual + OverallCond + YearBuilt +
##      RoofMatl + Exterior1st + MasVnrType + MasVnrArea + ExterQual +
##      ExterCond + Foundation + BsmtQual + BsmtCond + BsmtExposure +
##      BsmtFinSF1 + BsmtFinSF2 + BsmtUnfSF + X1stFlrSF + X2ndFlrSF +
##      HalfBath + BedroomAbvGr + KitchenAbvGr + KitchenQual + TotRmsAbvGrd +
##      Functional + Fireplaces + FireplaceQu + GarageType + GarageCars +
##      GarageArea + WoodDeckSF + X3SsnPorch + ScreenPorch + PoolQC +
##      Fence + MiscFeature + MoSold + SaleCondition
## Res.Df      RSS Df Sum of Sq F Pr(>F)
## 1  1321 7.7147e+11
## 2  1321 7.7147e+11  0          0
```

Looks like Stepwise Regression and Backwards elimination give same features.

Three options from four different selections.