136_Liz_Project_Step5_Regularized Linear Regression

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```
#install.packages("glmnet")
#install.packages("mlbench")
#install.packages("Boruta")
library(caret)

## Loading required package: lattice

## Loading required package: ggplot2

library(tidyverse)

## -- Attaching packages -----------------------------------------------------
---------------------------- tidyverse 1.2.1 --

## v tibble  1.4.2     v purrr   0.2.5
## v tidyr   0.8.1     v dplyr   0.7.7
## v readr   1.1.1     v stringr 1.3.1
## v tibble  1.4.2     v forcats 0.3.0

## -- Conflicts --------------------------------------------------------------
---------------------- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
## x purrr::lift()   masks caret::lift()

library(psych)

##
## Attaching package: 'psych'

## The following objects are masked from 'package:ggplot2':
##
##     %+%, alpha

library(glmnet)

## Loading required package: Matrix

##
## Attaching package: 'Matrix'

## The following object is masked from 'package:tidyr':
##
##     expand
```

```
## Loading required package: foreach

##
## Attaching package: 'foreach'

## The following objects are masked from 'package:purrr':
##
##     accumulate, when

## Loaded glmnet 2.0-16

library(mlbench)
library(Boruta)

## Loading required package: ranger

library(MASS) # stepwise regression

##
## Attaching package: 'MASS'

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

library(leaps) # all subsets regression
library(randomForest)

## randomForest 4.6-14

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

##
## Attaching package: 'randomForest'

## The following object is masked from 'package:ranger':
##
##     importance

## The following object is masked from 'package:psych':
##
##     outlier

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

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

Import Clean Data

```
H_Clean<-read.csv( file = "C:\\Users\\Hyunkyung Kim\\Desktop\\CKME999\\136\\d
ataset\\all\\H_clean.csv")
#H_Clean$MSSubClass<-as.factor(H_Clean$MSSubClass)
#Train<-H_Clean[!is.na(H_Clean$SalePrice),]
#Test<-H_Clean[is.na(H_Clean$SalePrice),]
act<-read.csv( file = "C:\\Users\\Hyunkyung Kim\\Desktop\\CKME999\\136\\datas
et\\all\\AMES_test.csv")
# Test Price
H_clean_Combined<-merge(H_Clean[,-81], act, by = 'Id')
actual<-act[1461:2919,2]
```

Divide as Train/Validate/Test set - give indexes.- Possibly for future.

Train - 1:1460 (50%) Validate - Random from 1460 to 2919 (20%) Test - Random from 1460 to 2919 (30%)

```
set.seed(100)

IndexTrain<-1:1460
IV<-NULL
IV[1:1460]<-0
IV[1461:2919]<-sample(2,1459, replace=T, prob=c(0.4,0.6))
#IV<-
## IV==1 is Validate, IV=2 is Test

#HTrain<-H_clean_Combined[IV==0,]
#HValid<-H_clean_Combined[IV==1,]
#HTest<-H_clean_Combined[IV==2,]

#
H_Eng<-H_clean_Combined
```

Remove Utilities - among 2919 observations there are only 1 exception and there is no point of keeping it. This is in the training set but since the test set does not contain any of level 1 and one observation will give too much variance. This is also causing issues when tuning.

```
H_Eng<-H_Eng[,names(H_Eng)!="Utilities"]
```

Function to predict and shoot out RMSE(log)

```
PdRMSE<-function(x,y=H_Clean[1461:2919,-81],z=actual){
Pdfun<-predict(x,newdata=y)
#return(Pdfun)
return(RMSE(log(Pdfun),log(z)))

}
```

```
f2<-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 +      Exter
Cond #Removed Utilities.
f3<- 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

f4<-SalePrice ~MSSubClass+MSZoning+LotFrontage+LotArea+Alley+LotShape+LandCon
tour+LandSlope+Neighborhood+
BldgType+HouseStyle+OverallQual+OverallCond+YearBuilt+YearRemodAdd+RoofStyle+
Exterior1st+Exterior2nd+
MasVnrType+MasVnrArea+ExterQual+Foundation+BsmtQual+BsmtCond+BsmtExposure+Bsm
tFinType1+BsmtFinSF1+
BsmtFinType2+BsmtUnfSF+TotalBsmtSF+HeatingQC+CentralAir+X1stFlrSF+X2ndFlrSF+G
rLivArea+BsmtFullBath+
FullBath+HalfBath+BedroomAbvGr+KitchenAbvGr+KitchenQual+TotRmsAbvGrd+Fireplac
es+FireplaceQu+GarageType+
GarageYrBlt+GarageFinish+GarageCars+GarageArea+GarageQual+GarageCond+PavedDri
ve+WoodDeckSF+OpenPorchSF
```

Divide into numeric and categorical.

```
HC_numeric<-unlist(lapply(H_Clean,is.numeric))
HC_cat<-unlist(lapply(H_Clean,is.factor))
```

Need to update factors into numerics for glmnet - otherwise do not work. x_train <- model.matrix(~ .-1, train[,features]) best_lambda <- lm$lambda[which.min(lm$cvm)] H_cat_dummy

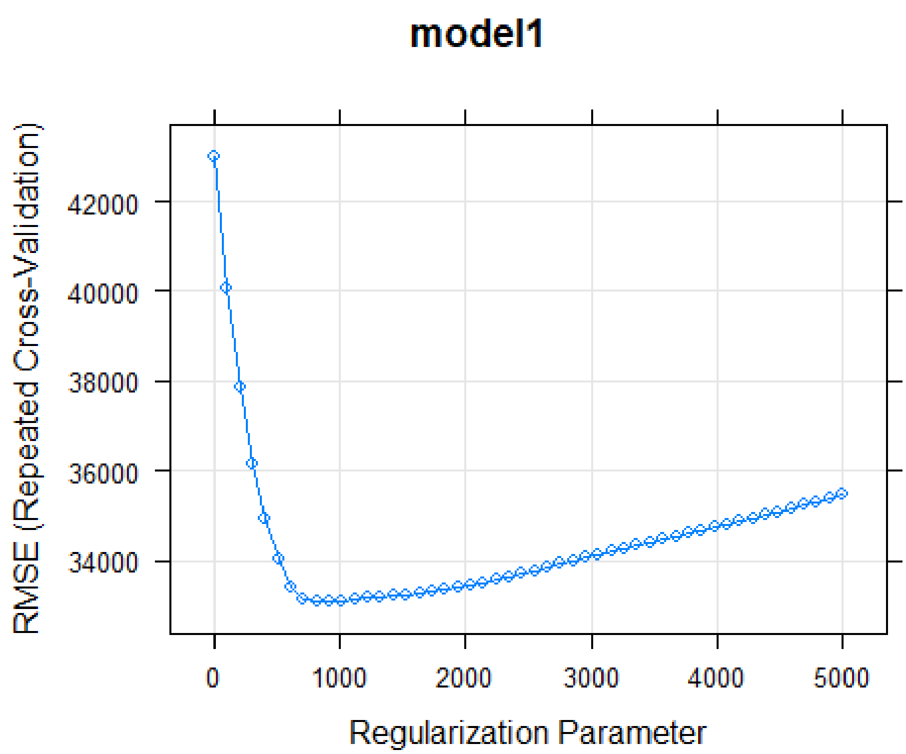
Lasso

```
tc<-trainControl(method="repeatedcv", number=10, repeats=5)
#Trainset -DummyVariables
H_Dummy_Train<-  as.data.frame(model.matrix(~.-1,data=H_Eng[IV==0,-1], na.act
ion = na.pass)) # Remove ID

#TestSet  -DummyVariables
```

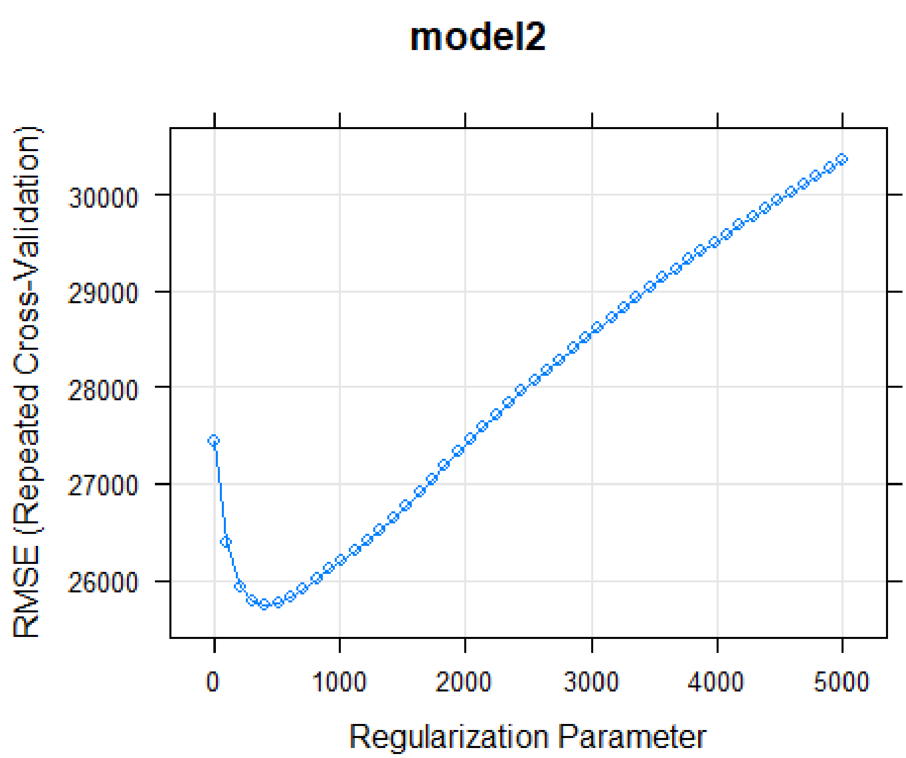
```r
H_Dummy_Test<-  as.data.frame(model.matrix(~.-1,data=H_Eng[1461:2919,-c(1,80)
])) # RemoveID, salePrice
  #as.data.frame

dim(H_Dummy_Train)
```

```
## [1] 1460  218
```

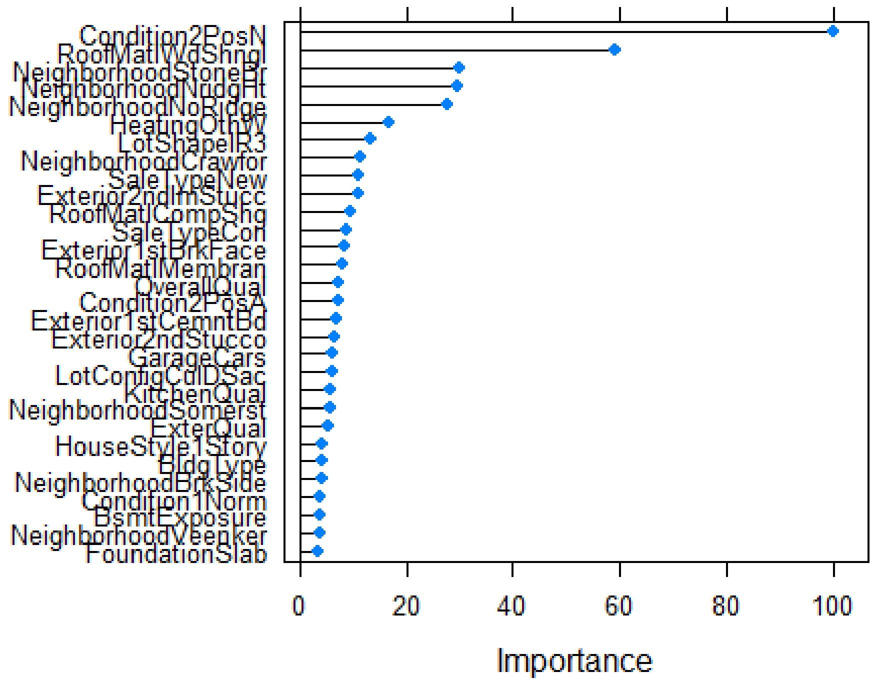
```r
set.seed(12334)

myLasso1<-train(SalePrice~.,
                 data = H_Dummy_Train
                 ,method='glmnet',
                 tuneGrid=expand.grid(alpha=1,lambda=seq(0.001,5000,length=50
)), trControl=tc)
myLasso2<-train(SalePrice~., data = H_Dummy_Train[-c(524,1299),]
  ,method='glmnet',tuneGrid=expand.grid(alpha=1,lambda=seq(0.001,5000,length=
50)), trControl=tc)
#myLasso3 <-train(f3, data = H_Dummy_Train
#  ,method='glmnet',tuneGrid=expand.grid(alpha=1,lambda=seq(500,1500,length=5
0)), trControl=tc)
#myLasso4 <-train(f4, data = H_Dummy_Train
 # ,method='glmnet',tuneGrid=expand.grid(alpha=1,lambda=seq(500,1500,length=5
0)), trControl=tc)

set.seed(12334)

plot(myLasso1, main='model1')
```



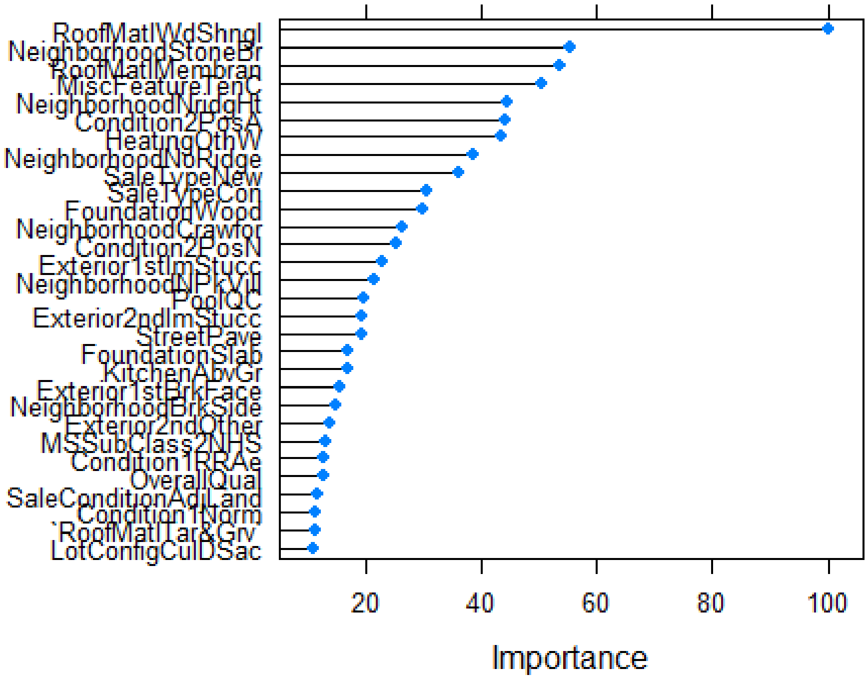

```
plot(myLasso2, main='model2')
```



```r
#plot(myLasso3,main='model3')
#plot(myLasso4,main='model4')

plot(varImp(myLasso1), Scale=F, top=30)
```




```r
plot(varImp(myLasso2), Scale=F ,top=30)
```




```
#plot(varImp(myLasso3), Scale=F, top=25)
#plot(varImp(myLasso4), Scale=F ,top=25)

varImp(myLasso1)
```

```
## glmnet variable importance
##
##   only 20 most important variables shown (out of 217)
##
##                      Overall
## Condition2PosN      100.000
## RoofMatlWdShngl      59.138
## NeighborhoodStoneBr  29.849
## NeighborhoodNridgHt  29.735
## NeighborhoodNoRidge  27.677
## HeatingOthW          16.673
## LotShapeIR3          13.449
## NeighborhoodCrawfor  11.482
## SaleTypeNew          11.246
## Exterior2ndImStucc   11.068
## RoofMatlCompShg       9.446
## SaleTypeCon           8.942
## Exterior1stBrkFace    8.549
## RoofMatlMembran       7.930
## OverallQual           7.379
## Condition2PosA        7.239
## Exterior1stCemntBd    6.787
```

```
## Exterior2ndStucco     6.576
## GarageCars            6.321
## LotConfigCulDSac      6.023
```

```
varImp(myLasso2)
```

```
## glmnet variable importance
##
##   only 20 most important variables shown (out of 217)
##
##                      Overall
## RoofMatlWdShngl      100.00
## NeighborhoodStoneBr   55.45
## RoofMatlMembran       53.59
## MiscFeatureTenC       50.47
## NeighborhoodNridgHt   44.53
## Condition2PosA        44.21
## HeatingOthW           43.41
## NeighborhoodNoRidge   38.69
## SaleTypeNew           36.26
## SaleTypeCon           30.68
## FoundationWood        29.92
## NeighborhoodCrawfor   26.56
## Condition2PosN        25.40
## Exterior1stImStucc    22.90
## NeighborhoodNPkVill   21.33
## PoolQC                19.71
## Exterior2ndImStucc    19.52
## StreetPave            19.29
## FoundationSlab        17.01
## KitchenAbvGr          16.95
```

```
#varImp(myLasso3)
#varImp(myLasso4)


coef(myLasso1)
```

```
## NULL
```

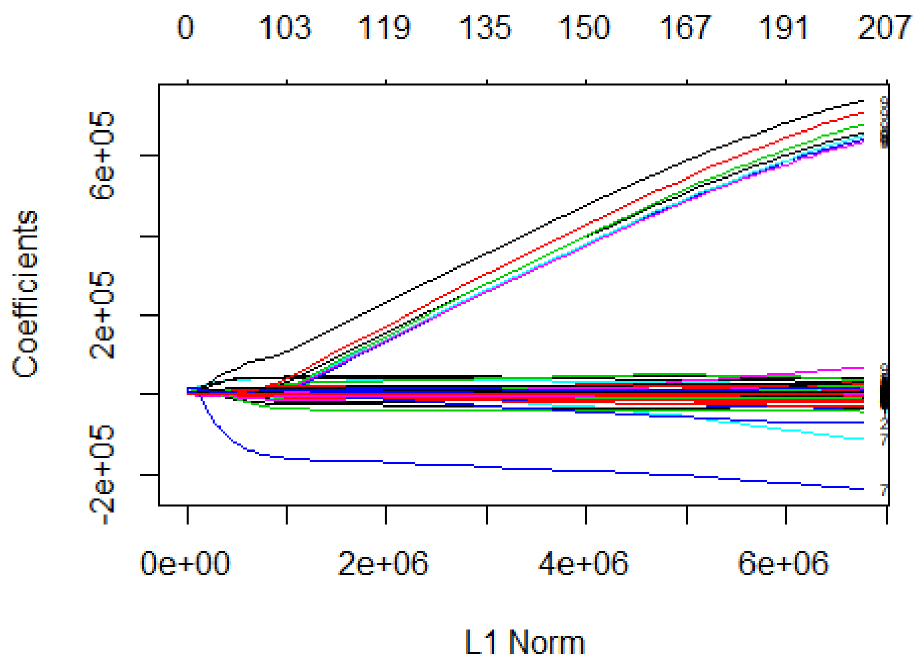
```
coef(myLasso2     )
```

```
## NULL
```

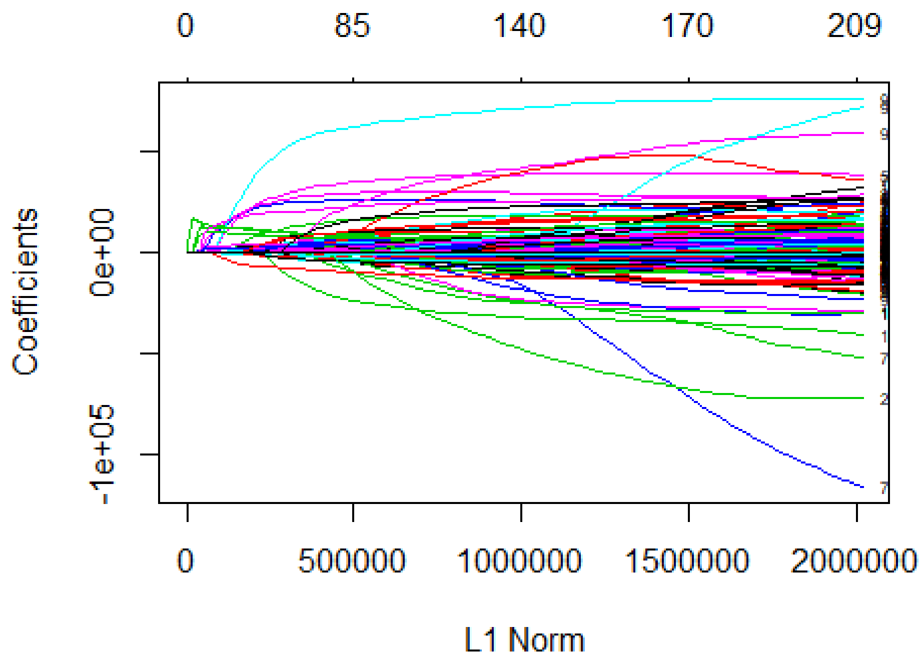
```
#coef(myLasso3)
#coef(myLasso4)

myLasso1$bestTune
```

```
##    alpha   lambda
## 10     1 918.3682
```

```r
myLasso2$bestTune

##   alpha   lambda
## 5     1 408.1642

#myLasso3$bestTune
#myLasso4$bestTune

plot(myLasso1$finalModel, label=T)
```




```r
plot(myLasso2$finalModel ,label=T)
```




```
#plot(myLasso3$finalModel)
#plot(myLasso4$finalModel)
```

Example of Coeff

```
coef(myLasso1$finalModel, s=myLasso1$bestTune$lambda)

## 218 x 1 sparse Matrix of class "dgCMatrix"
##                                          1
## (Intercept)                  -4.539657e+05
## `MSSubClass1N+PUD`            .
## MSSubClass1NHFin              .
## MSSubClass1NHUnf              .
## MSSubClass1SFA                .
## MSSubClass1SNEW               3.324209e+03
## MSSubClass1SOLD               .
## MSSubClass1SPUD               .
## MSSubClass2FCONV              .
## MSSubClass2NHS                .
## MSSubClass2SNEW               .
## MSSubClass2SOLD               .
## MSSubClassDUPL                .
## MSSubClassMLPUD               .
## MSSubClassSPL                 .
## MSSubClassSPLF                .
## MSZoningFV                    .
## MSZoningRH                    .
```

```
## MSZoningRL                   .
## MSZoningRM                 -1.320008e+03
## LotFrontage                  .
## LotArea                     2.883250e-01
## StreetPave                  9.064636e+02
## AlleyNoAlley                 .
## AlleyPave                    .
## LotShapeIR2                 4.803337e+03
## LotShapeIR3                -1.930629e+04
## LotShapeReg                  .
## LandContourHLS              5.082823e+03
## LandContourLow               .
## LandContourLvl               .
## LotConfigCulDSac            8.645689e+03
## LotConfigFR2               -7.405997e+01
## LotConfigFR3               -1.786943e+03
## LotConfigInside              .
## LandSlope                    .
## NeighborhoodBlueste          .
## NeighborhoodBrDale           .
## NeighborhoodBrkSide         6.082094e+03
## NeighborhoodClearCr          .
## NeighborhoodCollgCr          .
## NeighborhoodCrawfor         1.648233e+04
## NeighborhoodEdwards        -2.066387e+03
## NeighborhoodGilbert          .
## NeighborhoodIDOTRR           .
## NeighborhoodMeadowV          .
## NeighborhoodMitchel          .
## NeighborhoodNAmes            .
## NeighborhoodNoRidge         3.972892e+04
## NeighborhoodNPkVill          .
## NeighborhoodNridgHt         4.268321e+04
## NeighborhoodNWAmes         -1.668130e+03
## NeighborhoodOldTown        -3.074045e+03
## NeighborhoodSawyer           .
## NeighborhoodSawyerW          .
## NeighborhoodSomerst         8.055050e+03
## NeighborhoodStoneBr         4.284677e+04
## NeighborhoodSWISU            .
## NeighborhoodTimber           .
## NeighborhoodVeenker         5.446138e+03
## Condition1Feedr            -2.546385e+03
## Condition1Norm              5.640058e+03
## Condition1PosA               .
## Condition1PosN               .
## Condition1RRAe             -1.742488e+03
## Condition1RRAn               .
## Condition1RRNe               .
## Condition1RRNn               .
```

```
## Condition2Feedr              .
## Condition2Norm               .
## Condition2PosA               1.039167e+04
## Condition2PosN              -1.435469e+05
## Condition2RRAe               .
## Condition2RRAn               .
## Condition2RRNn               .
## BldgType                     6.336518e+03
## HouseStyle1.5Unf             .
## HouseStyle1Story             6.371419e+03
## HouseStyle2.5Fin            -1.913174e+03
## HouseStyle2.5Unf             .
## HouseStyle2Story             .
## HouseStyleSFoyer             .
## HouseStyleSLvl               .
## OverallQual                  1.059280e+04
## OverallCond                  2.917256e+03
## YearBuilt                    1.251559e+02
## YearRemodAdd                 2.071373e+01
## RoofStyleGable              -4.890518e+03
## RoofStyleGambrel             .
## RoofStyleHip                 .
## RoofStyleMansard             .
## RoofStyleShed                .
## RoofMatlCompShg              1.355943e+04
## RoofMatlMembran              1.138374e+04
## RoofMatlMetal                .
## RoofMatlRoll                 .
## `RoofMatlTar&Grv`            .
## RoofMatlWdShake              .
## RoofMatlWdShngl              8.489081e+04
## Exterior1stAsphShn           .
## Exterior1stBrkComm           .
## Exterior1stBrkFace           1.227188e+04
## Exterior1stCBlock            .
## Exterior1stCemntBd           9.742071e+03
## Exterior1stHdBoard          -1.622847e+03
## Exterior1stImStucc          -4.960084e+02
## Exterior1stMetalSd           .
## Exterior1stPlywood           .
## Exterior1stStone             .
## Exterior1stStucco            .
## Exterior1stVinylSd           .
## `Exterior1stWd Sdng`        -4.264067e+02
## Exterior1stWdShing           .
## Exterior2ndAsphShn           .
## `Exterior2ndBrk Cmn`         .
## Exterior2ndBrkFace           .
## Exterior2ndCBlock            .
## Exterior2ndCmentBd           .
```

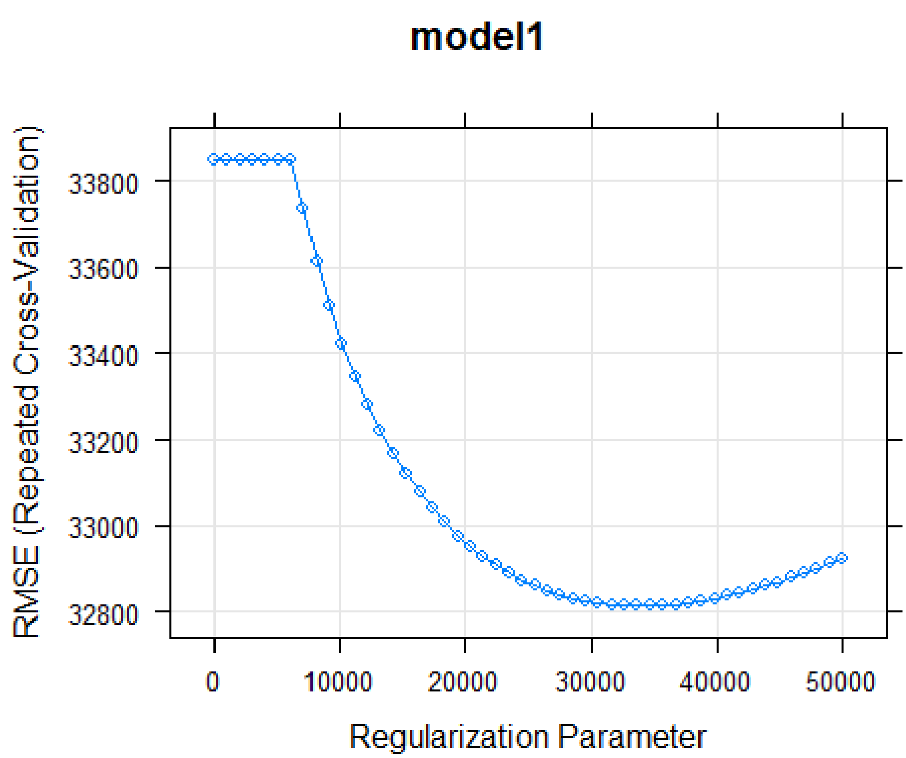
```
## Exterior2ndHdBoard         .
## Exterior2ndImStucc         1.588788e+04
## Exterior2ndMetalSd         .
## Exterior2ndOther           .
## Exterior2ndPlywood         .
## Exterior2ndStone           .
## Exterior2ndStucco         -9.439429e+03
## Exterior2ndVinylSd         .
## `Exterior2ndWd Sdng`       .
## `Exterior2ndWd Shng`      -3.744145e+03
## MasVnrTypeBrkFace         -1.402610e+03
## MasVnrTypeNone             .
## MasVnrTypeStone            .
## MasVnrArea                 1.973263e+01
## ExterQual                  7.905622e+03
## ExterCond                  .
## FoundationCBlock           .
## FoundationPConc            .
## FoundationSlab             5.251551e+03
## FoundationStone            .
## FoundationWood             .
## BsmtQual                   3.274180e+03
## BsmtCond                  -9.214782e+01
## BsmtExposure               5.513707e+03
## BsmtFinType1               1.071152e+03
## BsmtFinSF1                 7.588560e+00
## BsmtFinType2               .
## BsmtFinSF2                 .
## BsmtUnfSF                  .
## TotalBsmtSF                .
## HeatingGasA                .
## HeatingGasW                .
## HeatingGrav                .
## HeatingOthW               -2.393407e+04
## HeatingWall                .
## HeatingQC                  5.769865e+02
## CentralAirY                .
## ElectricalFuseF            .
## ElectricalFuseP            .
## ElectricalMix              .
## ElectricalSBrkr            .
## X1stFlrSF                  .
## X2ndFlrSF                  .
## LowQualFinSF              -2.162492e+00
## GrLivArea                  4.852910e+01
## BsmtFullBath               3.776391e+03
## BsmtHalfBath               .
## FullBath                   3.728424e+03
## HalfBath                   8.072234e+02
## BedroomAbvGr              -1.688012e+03
```

```
## KitchenAbvGr             -3.294560e+03
## KitchenQual               8.104659e+03
## TotRmsAbvGrd              1.087187e+03
## Functional                3.129704e+03
## Fireplaces                3.584246e+03
## FireplaceQu               9.321132e+01
## GarageTypeAttchd          .
## GarageTypeBasment        -9.226457e+01
## GarageTypeBuiltIn         9.694822e+02
## GarageTypeCarPort         .
## GarageTypeDetchd          .
## GarageTypeNoGarage        3.992096e+03
## GarageYrBlt               .
## GarageFinish              .
## GarageCars                9.073116e+03
## GarageArea                .
## GarageQual                .
## GarageCond                .
## PavedDrive                .
## WoodDeckSF                9.939889e+00
## OpenPorchSF               .
## EnclosedPorch             .
## X3SsnPorch                .
## ScreenPorch               2.585779e+01
## PoolArea                  .
## PoolQC                    .
## FenceGdWo                 .
## FenceMnPrv                .
## FenceMnWw                 .
## FenceNoFence              .
## MiscFeatureNoMiscFeature  .
## MiscFeatureOthr           .
## MiscFeatureShed           .
## MiscFeatureTenC           .
## MiscVal                   .
## MoSold                   -1.214922e+02
## YrSold                    .
## SaleTypeCon               1.283538e+04
## SaleTypeConLD             .
## SaleTypeConLI             .
## SaleTypeConLw             .
## SaleTypeCWD               .
## SaleTypeNew               1.614275e+04
## SaleTypeOth               .
## SaleTypeWD                .
## SaleConditionAdjLand      .
## SaleConditionAlloca       .
## SaleConditionFamily      -1.783551e+02
## SaleConditionNormal       .
## SaleConditionPartial      .
```

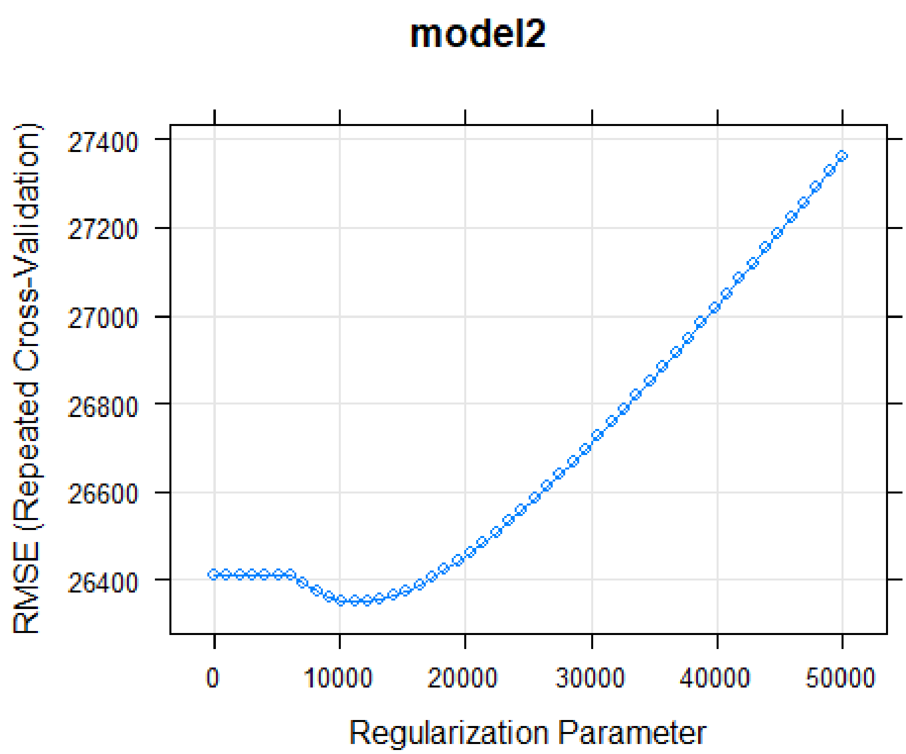
```r
abcde<-predict(myLasso1, newdata=H_Dummy_Test)
#RMSE(abcde, actual)


PdRMSE(myLasso1,H_Dummy_Test,H_Eng$SalePrice[1461:2919])

## [1] 0.1530179

PdRMSE(myLasso2,H_Dummy_Test,H_Eng$SalePrice[1461:2919])

## [1] 0.154825
```

Ridge

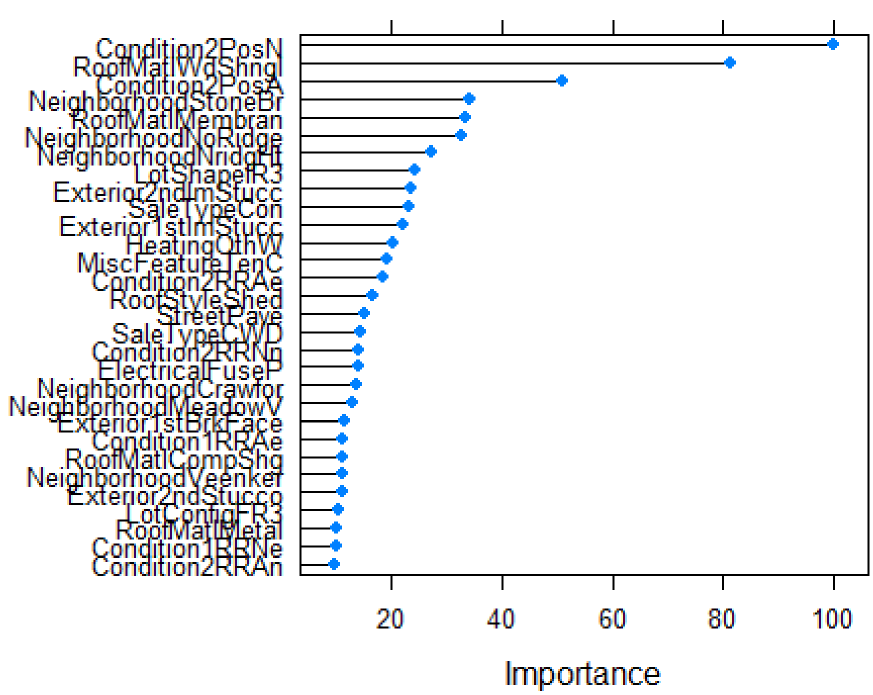
```r
set.seed(12334)
myRidge1 <-train(SalePrice~.,
                 data = H_Dummy_Train
                 ,method='glmnet',
                 tuneGrid=expand.grid(alpha=0,lambda=seq(0.001,50000,length=5
0)), trControl=tc)
set.seed(12334)
myRidge2 <-train(SalePrice~., data = H_Dummy_Train[-c(524,1299),]
  ,method='glmnet',tuneGrid=expand.grid(alpha=0,lambda=seq(0.001,50000,length
=50)), trControl=tc) # without outlier

plot(myRidge1, main='model1')
```



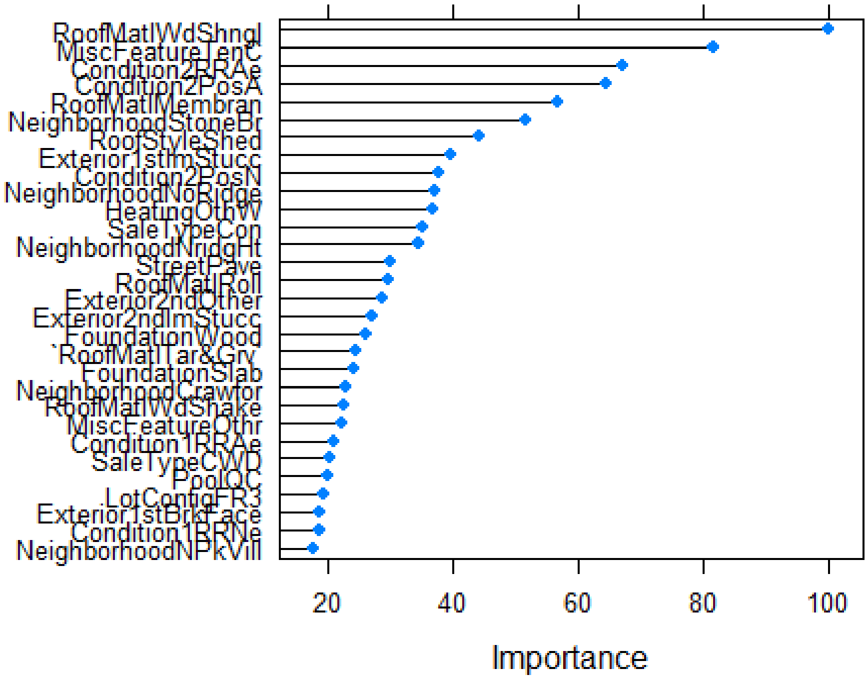

```r
plot(myRidge2, main='model2')
```




```r
plot(varImp(myRidge1), Scale=F, top=30)
```

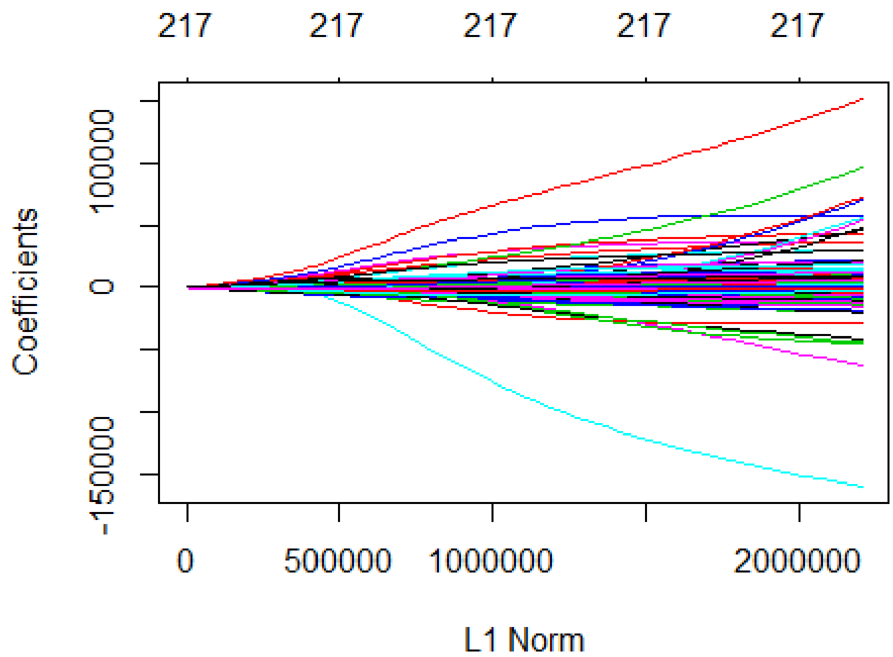



```r
plot(varImp(myRidge2), Scale=F ,top=30)
```

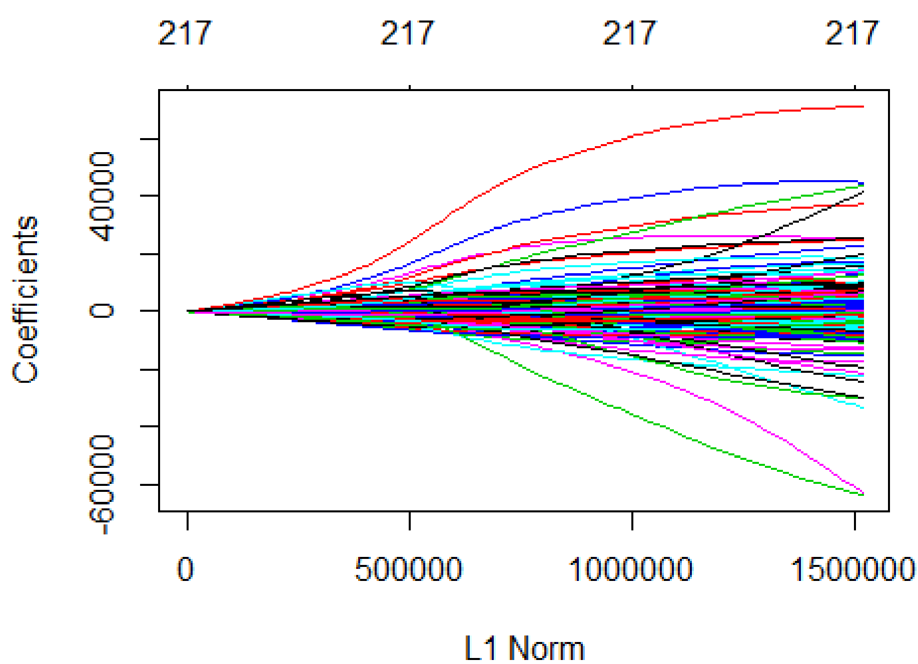



```r
varImp(myRidge1)

## glmnet variable importance
##
##   only 20 most important variables shown (out of 217)
##
##                      Overall
## Condition2PosN       100.00
## RoofMatlWdShngl       81.32
## Condition2PosA        51.01
## NeighborhoodStoneBr   34.28
## RoofMatlMembran       33.52
## NeighborhoodNoRidge   32.76
## NeighborhoodNridgHt   27.18
## LotShapeIR3           24.51
## Exterior2ndImStucc    23.81
## SaleTypeCon           23.32
## Exterior1stImStucc    22.02
## HeatingOthW           20.42
## MiscFeatureTenC       19.28
## Condition2RRAe        18.43
## RoofStyleShed         16.74
## StreetPave            15.28
## SaleTypeCWD           14.58
## Condition2RRNn        14.22
## ElectricalFuseP       14.14
## NeighborhoodCrawfor   13.89
```

```r
varImp(myRidge2)

## glmnet variable importance
##
##   only 20 most important variables shown (out of 217)
##
##                     Overall
## RoofMatlWdShngl      100.00
## MiscFeatureTenC       81.82
## Condition2RRAe        67.22
## Condition2PosA        64.38
## RoofMatlMembran       56.91
## NeighborhoodStoneBr   51.42
## RoofStyleShed         44.23
## Exterior1stImStucc    39.65
## Condition2PosN        37.52
## NeighborhoodNoRidge   37.15
## HeatingOthW           36.83
## SaleTypeCon           35.16
## NeighborhoodNridgHt   34.37
## StreetPave            29.90
## RoofMatlRoll          29.52
## Exterior2ndOther      28.65
## Exterior2ndImStucc    27.00
## FoundationWood        25.92
## `RoofMatlTar&Grv`     24.53
## FoundationSlab        23.95

myRidge1$bestTune

##    alpha   lambda
## 34     0 33673.47

myRidge2$bestTune

##    alpha   lambda
## 12     0 11224.49

plot(myRidge1$finalModel)
```

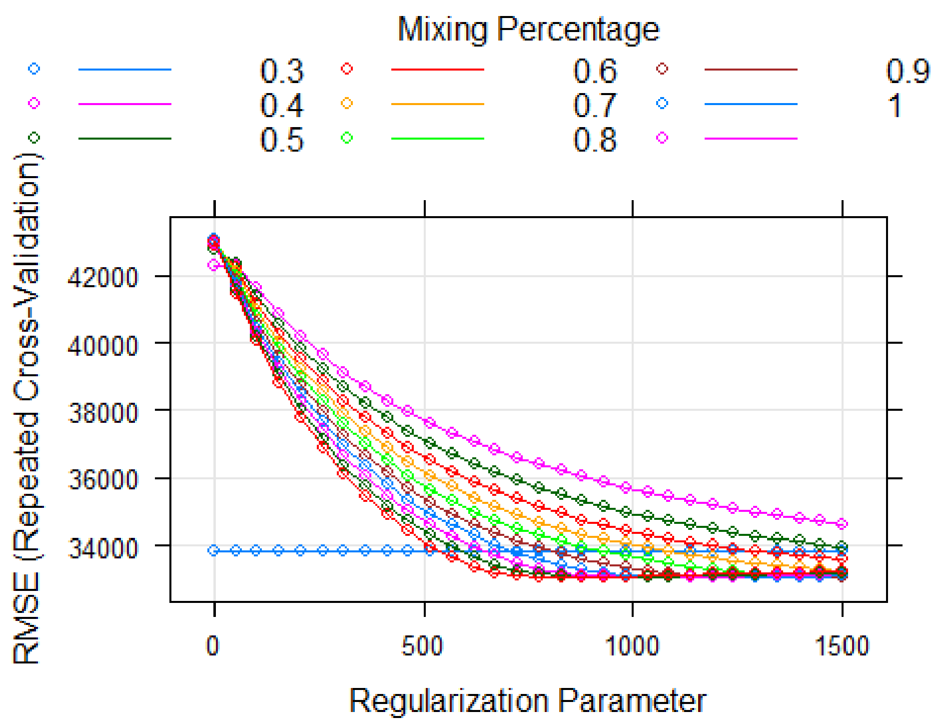



```r
plot(myRidge2$finalModel)
```

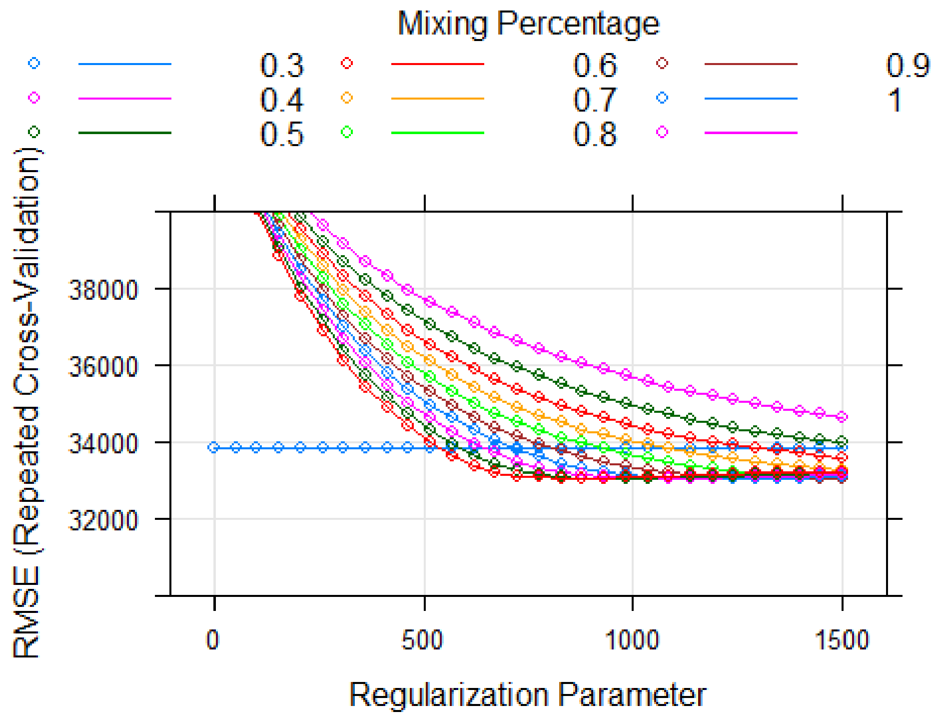


Elasticnet

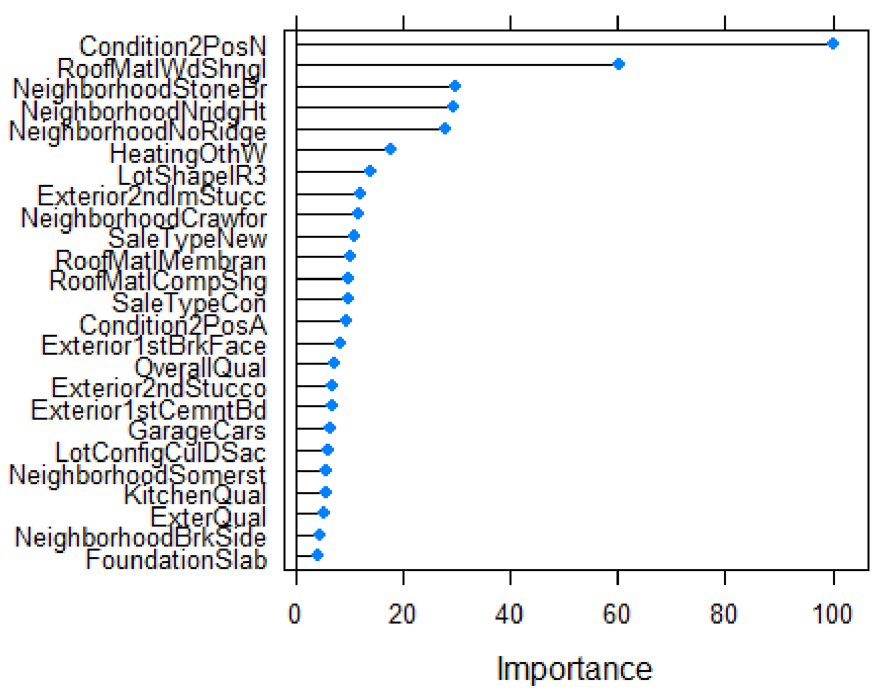
```
PdRMSE(myRidge1,H_Dummy_Test)

## [1] 0.1521245

PdRMSE(myRidge2,H_Dummy_Test)

## [1] 0.156761

set.seed(12334)
myEla1<-train(SalePrice~.,data=H_Dummy_Train,method='glmnet',tuneGrid=expand.
grid(alpha=seq(0, 1,length=11),lambda=seq(0.0001,1500,length=30)), trControl=
tc)

min(myEla1$result$RMSE)

## [1] 33040.03

plot(myEla1, cex=0.8)
```




```
plot(myEla1,  ylim=c(30000,40000))
```




```
plot(varImp(myEla1),top=25)
```




```
varImp(myEla1)
```

```
## glmnet variable importance
##
##   only 20 most important variables shown (out of 217)
##
##                     Overall
## Condition2PosN      100.000
## RoofMatlWdShngl      60.404
## NeighborhoodStoneBr  29.976
## NeighborhoodNridgHt  29.489
## NeighborhoodNoRidge  28.100
## HeatingOthW          17.753
## LotShapeIR3          14.026
## Exterior2ndImStucc   12.103
## NeighborhoodCrawfor  11.760
## SaleTypeNew          11.186
## RoofMatlMembran      10.417
## RoofMatlCompShg      10.006
## SaleTypeCon           9.934
## Condition2PosA        9.478
## Exterior1stBrkFace    8.561
## OverallQual           7.251
## Exterior2ndStucco     6.862
## Exterior1stCemntBd    6.786
## GarageCars            6.389
## LotConfigCulDSac      6.089
```

```
myEla1$bestTune
```

```
##     alpha   lambda
## 208   0.6 1396.552
```

```
myEla1
```

```
## glmnet
##
## 1460 samples
##  217 predictor
##
## No pre-processing
## Resampling: Cross-Validated (10 fold, repeated 5 times)
## Summary of sample sizes: 1314, 1314, 1313, 1316, 1315, 1313, ...
## Resampling results across tuning parameters:
##
##   alpha  lambda      RMSE      Rsquared   MAE
##   0.0       0.00010  33849.39  0.8236609  19442.43
##   0.0      51.72423  33849.39  0.8236609  19442.43
##   0.0     103.44837  33849.39  0.8236609  19442.43
##   0.0     155.17250  33849.39  0.8236609  19442.43
##   0.0     206.89664  33849.39  0.8236609  19442.43
##   0.0     258.62077  33849.39  0.8236609  19442.43
##   0.0     310.34491  33849.39  0.8236609  19442.43
```

```
##   0.0     362.06904  33849.39  0.8236609  19442.43
##   0.0     413.79318  33849.39  0.8236609  19442.43
##   0.0     465.51731  33849.39  0.8236609  19442.43
##   0.0     517.24144  33849.39  0.8236609  19442.43
##   0.0     568.96558  33849.39  0.8236609  19442.43
##   0.0     620.68971  33849.39  0.8236609  19442.43
##   0.0     672.41385  33849.39  0.8236609  19442.43
##   0.0     724.13798  33849.39  0.8236609  19442.43
##   0.0     775.86212  33849.39  0.8236609  19442.43
##   0.0     827.58625  33849.39  0.8236609  19442.43
##   0.0     879.31039  33849.39  0.8236609  19442.43
##   0.0     931.03452  33849.39  0.8236609  19442.43
##   0.0     982.75866  33849.39  0.8236609  19442.43
##   0.0    1034.48279  33849.39  0.8236609  19442.43
##   0.0    1086.20692  33849.39  0.8236609  19442.43
##   0.0    1137.93106  33849.39  0.8236609  19442.43
##   0.0    1189.65519  33849.39  0.8236609  19442.43
##   0.0    1241.37933  33849.39  0.8236609  19442.43
##   0.0    1293.10346  33849.39  0.8236609  19442.43
##   0.0    1344.82760  33849.39  0.8236609  19442.43
##   0.0    1396.55173  33849.39  0.8236609  19442.43
##   0.0    1448.27587  33849.39  0.8236609  19442.43
##   0.0    1500.00000  33849.39  0.8236609  19442.43
##   0.1       0.00010  42266.77  0.7493704  20801.35
##   0.1      51.72423  42266.77  0.7493704  20801.35
##   0.1     103.44837  41607.06  0.7544213  20663.02
##   0.1     155.17250  40862.51  0.7602992  20509.61
##   0.1     206.89664  40210.20  0.7656094  20377.76
##   0.1     258.62077  39640.22  0.7703653  20270.28
##   0.1     310.34491  39137.35  0.7746480  20180.30
##   0.1     362.06904  38694.63  0.7784909  20102.19
##   0.1     413.79318  38298.65  0.7819837  20033.56
##   0.1     465.51731  37945.27  0.7851397  19971.71
##   0.1     517.24144  37624.78  0.7880350  19915.94
##   0.1     568.96558  37332.95  0.7906963  19866.14
##   0.1     620.68971  37066.74  0.7931421  19820.31
##   0.1     672.41385  36822.49  0.7954019  19779.57
##   0.1     724.13798  36597.02  0.7975000  19741.21
##   0.1     775.86212  36388.11  0.7994498  19704.94
##   0.1     827.58625  36200.09  0.8012147  19670.87
##   0.1     879.31039  36022.81  0.8028799  19638.23
##   0.1     931.03452  35857.98  0.8044250  19607.31
##   0.1     982.75866  35706.90  0.8058444  19578.80
##   0.1    1034.48279  35561.80  0.8072096  19551.62
##   0.1    1086.20692  35432.68  0.8084241  19526.33
##   0.1    1137.93106  35306.64  0.8096129  19501.21
##   0.1    1189.65519  35191.68  0.8106952  19476.02
##   0.1    1241.37933  35079.27  0.8117548  19451.76
##   0.1    1293.10346  34979.31  0.8126973  19428.82
##   0.1    1344.82760  34882.19  0.8136128  19406.91
```

```
##   0.1    1396.55173  34792.78  0.8144539  19386.29
##   0.1    1448.27587  34709.37  0.8152354  19366.47
##   0.1    1500.00000  34627.73  0.8160009  19346.64
##   0.2       0.00010  42753.43  0.7457785  20863.57
##   0.2      51.72423  42333.56  0.7489153  20759.95
##   0.2     103.44837  41364.76  0.7563657  20519.67
##   0.2     155.17250  40532.39  0.7629930  20317.19
##   0.2     206.89664  39822.68  0.7688007  20154.92
##   0.2     258.62077  39209.86  0.7739601  20028.50
##   0.2     310.34491  38673.13  0.7785926  19925.61
##   0.2     362.06904  38197.96  0.7827711  19839.70
##   0.2     413.79318  37771.85  0.7865585  19763.71
##   0.2     465.51731  37383.98  0.7900652  19695.77
##   0.2     517.24144  37032.70  0.7932585  19633.86
##   0.2     568.96558  36710.32  0.7962063  19576.83
##   0.2     620.68971  36420.07  0.7988885  19525.66
##   0.2     672.41385  36155.95  0.8013461  19479.13
##   0.2     724.13798  35917.19  0.8035787  19436.54
##   0.2     775.86212  35697.85  0.8056356  19396.53
##   0.2     827.58625  35494.46  0.8075470  19358.71
##   0.2     879.31039  35310.48  0.8092786  19324.40
##   0.2     931.03452  35141.02  0.8108724  19292.04
##   0.2     982.75866  34983.92  0.8123498  19262.02
##   0.2    1034.48279  34841.13  0.8136922  19233.33
##   0.2    1086.20692  34705.83  0.8149646  19206.23
##   0.2    1137.93106  34587.06  0.8160803  19180.81
##   0.2    1189.65519  34472.15  0.8171625  19155.70
##   0.2    1241.37933  34370.65  0.8181179  19131.58
##   0.2    1293.10346  34273.92  0.8190276  19108.04
##   0.2    1344.82760  34188.56  0.8198298  19086.29
##   0.2    1396.55173  34109.57  0.8205720  19066.10
##   0.2    1448.27587  34035.11  0.8212734  19046.67
##   0.2    1500.00000  33970.21  0.8218817  19028.71
##   0.3       0.00010  42915.80  0.7446177  20882.34
##   0.3      51.72423  42205.71  0.7499201  20683.84
##   0.3     103.44837  41145.75  0.7581227  20391.36
##   0.3     155.17250  40259.69  0.7651983  20161.03
##   0.3     206.89664  39511.48  0.7713970  19986.22
##   0.3     258.62077  38863.51  0.7769084  19857.06
##   0.3     310.34491  38290.33  0.7819009  19749.65
##   0.3     362.06904  37776.16  0.7864273  19657.94
##   0.3     413.79318  37308.12  0.7906039  19574.93
##   0.3     465.51731  36892.68  0.7943672  19499.91
##   0.3     517.24144  36523.21  0.7977606  19434.82
##   0.3     568.96558  36188.72  0.8008583  19375.86
##   0.3     620.68971  35886.26  0.8036697  19322.99
##   0.3     672.41385  35613.22  0.8062211  19275.92
##   0.3     724.13798  35366.39  0.8085362  19233.46
##   0.3     775.86212  35144.24  0.8106217  19195.33
##   0.3     827.58625  34941.76  0.8125280  19158.58
```

```
##   0.3     879.31039  34756.62  0.8142754  19124.29
##   0.3     931.03452  34594.82  0.8158072  19093.83
##   0.3     982.75866  34447.17  0.8172084  19067.02
##   0.3    1034.48279  34315.65  0.8184539  19043.07
##   0.3    1086.20692  34200.20  0.8195489  19020.51
##   0.3    1137.93106  34095.14  0.8205459  18998.98
##   0.3    1189.65519  34001.53  0.8214372  18978.04
##   0.3    1241.37933  33916.51  0.8222494  18959.25
##   0.3    1293.10346  33839.16  0.8229934  18941.04
##   0.3    1344.82760  33771.33  0.8236472  18924.76
##   0.3    1396.55173  33703.74  0.8243077  18907.54
##   0.3    1448.27587  33643.11  0.8249022  18890.39
##   0.3    1500.00000  33585.94  0.8254674  18875.48
##   0.4       0.00010  42988.02  0.7441182  20889.42
##   0.4      51.72423  42083.68  0.7508868  20610.75
##   0.4     103.44837  40947.32  0.7596990  20278.91
##   0.4     155.17250  40022.35  0.7671621  20031.52
##   0.4     206.89664  39241.63  0.7736656  19855.86
##   0.4     258.62077  38545.35  0.7796285  19721.81
##   0.4     310.34491  37925.99  0.7850156  19607.61
##   0.4     362.06904  37373.96  0.7899081  19507.60
##   0.4     413.79318  36887.75  0.7942985  19419.79
##   0.4     465.51731  36458.07  0.7982244  19343.45
##   0.4     517.24144  36074.21  0.8017699  19280.07
##   0.4     568.96558  35728.69  0.8049858  19224.31
##   0.4     620.68971  35417.24  0.8079022  19174.19
##   0.4     672.41385  35139.30  0.8105186  19127.92
##   0.4     724.13798  34893.59  0.8128410  19087.13
##   0.4     775.86212  34678.06  0.8148857  19053.51
##   0.4     827.58625  34488.70  0.8166888  19024.70
##   0.4     879.31039  34320.54  0.8182946  18998.04
##   0.4     931.03452  34175.11  0.8196847  18973.89
##   0.4     982.75866  34048.19  0.8209001  18951.71
##   0.4    1034.48279  33931.72  0.8220279  18932.36
##   0.4    1086.20692  33825.32  0.8230704  18912.10
##   0.4    1137.93106  33724.57  0.8240694  18893.38
##   0.4    1189.65519  33632.57  0.8249937  18873.08
##   0.4    1241.37933  33550.43  0.8258231  18854.63
##   0.4    1293.10346  33476.47  0.8265720  18834.57
##   0.4    1344.82760  33412.50  0.8272232  18816.25
##   0.4    1396.55173  33350.56  0.8278433  18793.06
##   0.4    1448.27587  33291.69  0.8284294  18768.15
##   0.4    1500.00000  33240.36  0.8289432  18744.40
##   0.5       0.00010  43025.96  0.7438296  20889.53
##   0.5      51.72423  41971.23  0.7517741  20542.57
##   0.5     103.44837  40771.68  0.7611056  20181.89
##   0.5     155.17250  39816.89  0.7688579  19927.93
##   0.5     206.89664  38984.47  0.7758365  19749.04
##   0.5     258.62077  38245.09  0.7821531  19607.63
##   0.5     310.34491  37586.95  0.7879251  19486.07
```

```
##   0.5     362.06904  37014.34  0.7930502  19380.80
##   0.5     413.79318  36513.48  0.7976027  19294.74
##   0.5     465.51731  36064.07  0.8017462  19224.20
##   0.5     517.24144  35659.02  0.8055240  19160.82
##   0.5     568.96558  35305.60  0.8088415  19107.37
##   0.5     620.68971  34996.88  0.8117585  19059.14
##   0.5     672.41385  34729.30  0.8143056  19020.53
##   0.5     724.13798  34498.80  0.8165058  18988.34
##   0.5     775.86212  34296.44  0.8184452  18959.73
##   0.5     827.58625  34118.98  0.8201587  18935.14
##   0.5     879.31039  33962.39  0.8216867  18912.33
##   0.5     931.03452  33810.41  0.8232010  18888.68
##   0.5     982.75866  33680.79  0.8245039  18867.61
##   0.5    1034.48279  33565.10  0.8256746  18844.17
##   0.5    1086.20692  33467.34  0.8266675  18822.52
##   0.5    1137.93106  33372.56  0.8276135  18790.85
##   0.5    1189.65519  33292.26  0.8284181  18760.48
##   0.5    1241.37933  33224.62  0.8290937  18728.51
##   0.5    1293.10346  33168.05  0.8296537  18698.76
##   0.5    1344.82760  33124.83  0.8300830  18673.51
##   0.5    1396.55173  33094.27  0.8303838  18654.62
##   0.5    1448.27587  33071.24  0.8306087  18638.44
##   0.5    1500.00000  33054.50  0.8307732  18625.64
##   0.6       0.00010  43028.04  0.7438177  20877.69
##   0.6      51.72423  41856.20  0.7526869  20477.45
##   0.6     103.44837  40607.42  0.7624444  20093.47
##   0.6     155.17250  39612.76  0.7705512  19838.09
##   0.6     206.89664  38731.69  0.7779305  19653.11
##   0.6     258.62077  37948.94  0.7846714  19504.17
##   0.6     310.34491  37268.89  0.7906801  19377.81
##   0.6     362.06904  36676.90  0.7960170  19276.59
##   0.6     413.79318  36150.55  0.8008508  19193.64
##   0.6     465.51731  35681.97  0.8052120  19124.14
##   0.6     517.24144  35278.02  0.8090078  19066.23
##   0.6     568.96558  34930.10  0.8123133  19016.44
##   0.6     620.68971  34632.52  0.8151563  18977.64
##   0.6     672.41385  34377.71  0.8175985  18945.77
##   0.6     724.13798  34153.75  0.8197726  18920.36
##   0.6     775.86212  33943.49  0.8218598  18894.88
##   0.6     827.58625  33761.68  0.8236867  18870.62
##   0.6     879.31039  33606.46  0.8252591  18845.05
##   0.6     931.03452  33469.30  0.8266404  18814.49
##   0.6     982.75866  33348.99  0.8278466  18776.61
##   0.6    1034.48279  33253.54  0.8288028  18736.50
##   0.6    1086.20692  33176.87  0.8295647  18698.25
##   0.6    1137.93106  33126.00  0.8300686  18668.28
##   0.6    1189.65519  33090.15  0.8304188  18645.45
##   0.6    1241.37933  33065.14  0.8306644  18627.42
##   0.6    1293.10346  33048.06  0.8308309  18614.01
##   0.6    1344.82760  33041.97  0.8308860  18606.15
```

```
##   0.6    1396.55173  33040.03  0.8309037  18601.19
##   0.6    1448.27587  33041.08  0.8308952  18598.65
##   0.6    1500.00000  33044.60  0.8308650  18598.71
##   0.7       0.00010  43048.78  0.7437185  20875.10
##   0.7      51.72423  41749.91  0.7535238  20417.03
##   0.7     103.44837  40460.35  0.7636400  20017.13
##   0.7     155.17250  39416.24  0.7721671  19757.55
##   0.7     206.89664  38484.13  0.7799952  19566.04
##   0.7     258.62077  37667.52  0.7870827  19409.08
##   0.7     310.34491  36967.72  0.7933064  19286.59
##   0.7     362.06904  36347.75  0.7989473  19188.91
##   0.7     413.79318  35798.84  0.8040380  19108.73
##   0.7     465.51731  35330.21  0.8084395  19044.24
##   0.7     517.24144  34929.76  0.8122504  18990.84
##   0.7     568.96558  34595.22  0.8154456  18952.04
##   0.7     620.68971  34306.79  0.8182317  18924.56
##   0.7     672.41385  34034.09  0.8209429  18896.62
##   0.7     724.13798  33798.97  0.8233116  18869.30
##   0.7     775.86212  33604.86  0.8252768  18841.65
##   0.7     827.58625  33432.80  0.8270030  18798.72
##   0.7     879.31039  33298.62  0.8283527  18751.87
##   0.7     931.03452  33194.38  0.8293899  18702.98
##   0.7     982.75866  33132.01  0.8300092  18666.71
##   0.7    1034.48279  33089.76  0.8304223  18639.79
##   0.7    1086.20692  33061.39  0.8306993  18619.49
##   0.7    1137.93106  33047.81  0.8308249  18606.39
##   0.7    1189.65519  33044.01  0.8308564  18598.66
##   0.7    1241.37933  33044.73  0.8308474  18594.22
##   0.7    1293.10346  33048.56  0.8308134  18593.84
##   0.7    1344.82760  33055.47  0.8307539  18597.39
##   0.7    1396.55173  33065.15  0.8306703  18605.70
##   0.7    1448.27587  33078.80  0.8305532  18618.23
##   0.7    1500.00000  33093.82  0.8304248  18633.94
##   0.8       0.00010  42968.85  0.7443102  20854.87
##   0.8      51.72423  41651.90  0.7542840  20361.66
##   0.8     103.44837  40320.68  0.7647750  19949.04
##   0.8     155.17250  39220.68  0.7737571  19682.45
##   0.8     206.89664  38243.53  0.7820186  19483.87
##   0.8     258.62077  37405.38  0.7893318  19328.80
##   0.8     310.34491  36669.62  0.7959389  19208.46
##   0.8     362.06904  36026.53  0.8018534  19114.59
##   0.8     413.79318  35475.08  0.8070082  19039.97
##   0.8     465.51731  35006.87  0.8114543  18980.81
##   0.8     517.24144  34617.44  0.8151762  18942.33
##   0.8     568.96558  34275.52  0.8185100  18914.80
##   0.8     620.68971  33960.07  0.8216825  18884.67
##   0.8     672.41385  33700.15  0.8243142  18854.35
##   0.8     724.13798  33479.14  0.8265366  18808.09
##   0.8     775.86212  33311.22  0.8282255  18752.64
##   0.8     827.58625  33186.74  0.8294665  18694.62
```

```
##   0.8    879.31039  33123.02  0.8300962  18656.97
##   0.8    931.03452  33080.26  0.8305135  18628.89
##   0.8    982.75866  33056.51  0.8307385  18609.52
##   0.8   1034.48279  33049.60  0.8307964  18598.63
##   0.8   1086.20692  33048.77  0.8307993  18591.88
##   0.8   1137.93106  33052.06  0.8307687  18589.92
##   0.8   1189.65519  33059.62  0.8307030  18593.80
##   0.8   1241.37933  33071.77  0.8305981  18604.70
##   0.8   1293.10346  33087.79  0.8304608  18620.52
##   0.8   1344.82760  33102.45  0.8303430  18639.71
##   0.8   1396.55173  33117.96  0.8302222  18660.89
##   0.8   1448.27587  33133.47  0.8301071  18683.85
##   0.8   1500.00000  33145.60  0.8300257  18704.30
##   0.9      0.00010  42992.55  0.7441108  20846.34
##   0.9     51.72423  41552.49  0.7550684  20308.92
##   0.9    103.44837  40180.59  0.7659105  19887.40
##   0.9    155.17250  39025.94  0.7753546  19611.52
##   0.9    206.89664  38010.32  0.7839865  19409.57
##   0.9    258.62077  37142.04  0.7916197  19256.73
##   0.9    310.34491  36378.36  0.7985457  19141.09
##   0.9    362.06904  35721.92  0.8046331  19051.63
##   0.9    413.79318  35167.31  0.8098736  18983.32
##   0.9    465.51731  34713.03  0.8142051  18942.61
##   0.9    517.24144  34301.86  0.8182377  18911.38
##   0.9    568.96558  33934.91  0.8219348  18878.96
##   0.9    620.68971  33637.58  0.8249409  18840.90
##   0.9    672.41385  33402.52  0.8273107  18784.72
##   0.9    724.13798  33229.21  0.8290444  18713.55
##   0.9    775.86212  33140.23  0.8299278  18664.12
##   0.9    827.58625  33086.62  0.8304503  18630.11
##   0.9    879.31039  33060.06  0.8306987  18608.05
##   0.9    931.03452  33053.18  0.8307553  18595.65
##   0.9    982.75866  33053.02  0.8307510  18588.79
##   0.9   1034.48279  33057.58  0.8307099  18588.46
##   0.9   1086.20692  33067.81  0.8306200  18596.57
##   0.9   1137.93106  33084.51  0.8304750  18612.26
##   0.9   1189.65519  33100.91  0.8303399  18632.98
##   0.9   1241.37933  33117.16  0.8302130  18656.24
##   0.9   1293.10346  33133.32  0.8300943  18681.32
##   0.9   1344.82760  33147.28  0.8300009  18704.63
##   0.9   1396.55173  33163.85  0.8298872  18732.06
##   0.9   1448.27587  33173.89  0.8298373  18755.70
##   0.9   1500.00000  33183.63  0.8297905  18779.61
##   1.0      0.00010  43012.73  0.7439951  20852.08
##   1.0     51.72423  41457.59  0.7558252  20257.95
##   1.0    103.44837  40043.14  0.7670198  19829.41
##   1.0    155.17250  38834.70  0.7769281  19544.75
##   1.0    206.89664  37788.00  0.7858705  19343.53
##   1.0    258.62077  36881.94  0.7939073  19194.83
##   1.0    310.34491  36097.33  0.8010872  19083.50
```

```
##   1.0     362.06904  35431.66  0.8073168  18999.85
##   1.0     413.79318  34890.68  0.8124535  18950.36
##   1.0     465.51731  34404.90  0.8171951  18916.70
##   1.0     517.24144  33972.28  0.8215560  18881.46
##   1.0     568.96558  33623.54  0.8250768  18835.94
##   1.0     620.68971  33361.40  0.8277180  18767.02
##   1.0     672.41385  33192.23  0.8294144  18692.15
##   1.0     724.13798  33113.95  0.8301817  18645.49
##   1.0     775.86212  33070.48  0.8306008  18615.17
##   1.0     827.58625  33058.27  0.8307032  18598.50
##   1.0     879.31039  33056.75  0.8307080  18588.98
##   1.0     931.03452  33061.20  0.8306661  18587.23
##   1.0     982.75866  33072.55  0.8305672  18596.07
##   1.0    1034.48279  33091.26  0.8304071  18613.90
##   1.0    1086.20692  33107.38  0.8302771  18637.49
##   1.0    1137.93106  33124.92  0.8301398  18664.30
##   1.0    1189.65519  33140.61  0.8300305  18690.61
##   1.0    1241.37933  33159.29  0.8298964  18719.08
##   1.0    1293.10346  33173.32  0.8298126  18746.73
##   1.0    1344.82760  33183.27  0.8297686  18772.97
##   1.0    1396.55173  33194.21  0.8297190  18799.18
##   1.0    1448.27587  33203.09  0.8296895  18823.06
##   1.0    1500.00000  33215.09  0.8296323  18849.75
##
## RMSE was used to select the optimal model using the smallest value.
## The final values used for the model were alpha = 0.6 and lambda = 1396.552
.
```

```
PdEla1<-predict(myEla1, newdata=H_Dummy_Test)
RMSE(log(PdEla1), log(actual))
```

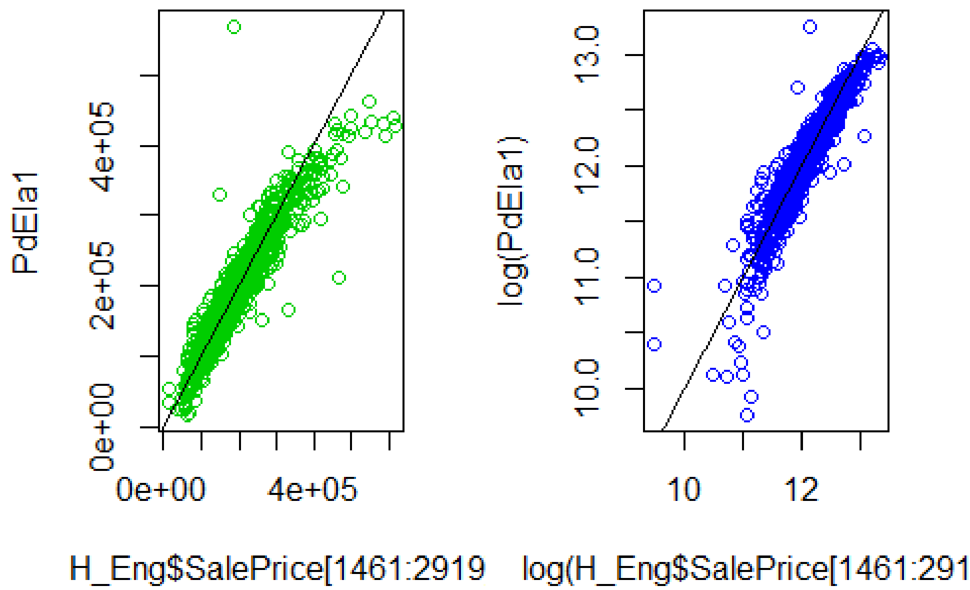
```
## [1] 0.1527468
```

```
PdRMSE(myEla1,H_Dummy_Test,H_Eng$SalePrice[1461:2919])
```

```
## [1] 0.1527468
```

Plot Elasticnet Result

```
par(mfrow=c(1,2))
plot(H_Eng$SalePrice[1461:2919], PdEla1, col=203)
abline(a=0,b=1)
plot(log(H_Eng$SalePrice[1461:2919]), log(PdEla1), col=204)
abline(a=0,b=1)
```


PdEla1
0e+00
2e+05
4e+05
0e+00
4e+05
H_Eng$SalePrice[1461:2919
log(PdEla1)
10.0
11.0
12.0
13.0
10
12
log(H_Eng$SalePrice[1461:291