Predicting Labour Wages using Ridge and Lasso Regression

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Contents

Ridge and Lasso Regression

$$RSS(\beta) + \lambda \sum_{j=1}^{p} \beta_j^2$$

$$RSS(\beta) + \lambda \sum_{j=1}^{p} |\beta_j|$$

Read and Understand the data

```
getwd()
```

```
## [1] "/Users/hasifa/Programming"
```

```
labour_data <- read.csv("labour_income.csv")
```

```
str(labour_data)
```

```
## 'data.frame':    3987 obs. of  5 variables:
##  $ wages    : num  10.6 11 17.8 14 8.2 ...
##  $ education: num  15 13.2 14 16 15 13.5 12 14 18 11 ...
##  $ age      : int  40 19 46 50 31 30 61 46 43 17 ...
##  $ sex      : chr  "Male" "Male" "Male" "Female" ...
##  $ language : chr  "English" "English" "Other" "English" ...
```

```
summary(labour_data)
```

```
##      wages         education          age             sex           
##  Min.   : 2.30   Min.   : 0.00   Min.   :16.0   Length:3987       
##  1st Qu.: 9.25   1st Qu.:12.00   1st Qu.:28.0   Class :character  
##  Median :14.13   Median :13.00   Median :36.0   Mode  :character  
##  Mean   :15.54   Mean   :13.34   Mean   :37.1                     
##  3rd Qu.:19.72   3rd Qu.:15.10   3rd Qu.:46.0                     
##  Max.   :49.92   Max.   :20.00   Max.   :69.0                     
##    language        
##  Length:3987       
##  Class :character  
##  Mode  :character  
##                    
##                    
##                    
```

Data Pre-processing

Train-Test Split

- Split the data into train and test

```
set.seed(007)
train_row <- sample(x=seq(1,nrow(labour_data),1),size = 0.7*nrow(labour_data))

train_data <- labour_data[train_row,]
test_data <- labour_data[-train_row,]
```

Standardize the Data

- Standardize the continuous independent variables

```
library(caret)
```

```
## Warning: package 'caret' was built under R version 4.0.2

## Loading required package: lattice

## Loading required package: ggplot2

## Warning: package 'ggplot2' was built under R version 4.0.2
```

```
library(ggplot2)
```

```
library(lattice)
```

```
std_obj <- preProcess(x=train_data[,!colnames(train_data) %in%    c("wages")],
train_std_data <- predict(std_obj , train_data)

test_std_data <- predict(std_obj,test_data)
```

Dummify the Data

- Use the dummyVars() function from caret to convert sex and age into dummy variables

```
dummy_oj <- dummyVars(~., train_std_data)
train_dummy_data <- as.data.frame(predict(dummy_oj,train_std_data))
test_dummy_data <- as.data.frame(predict(dummy_oj,test_std_data))
```

Get the data into a compatible format

- The functions we will be using today from the glmnet package expect a matrix as an input and not our familiar formula structure, so we need to convert our dataframes into a matrix

```
x_train <- as.matrix(train_dummy_data[,-1])
y_train <- as.matrix(train_dummy_data[,1])
x_test <- as.matrix(train_dummy_data[,-1])
y_test <- as.matrix(train_dummy_data[,1])
```

Hyper-parameter Tuning

- Choose an optimal lambda value for the ridge and lasso regression models by using cross validation

Choosing a lambda for Lasso Regression

- The alpha value is 1 for lasso regression

```
library(glmnet)
```

```
## Warning: package 'glmnet' was built under R version 4.0.2
```

```
## Loading required package: Matrix
```

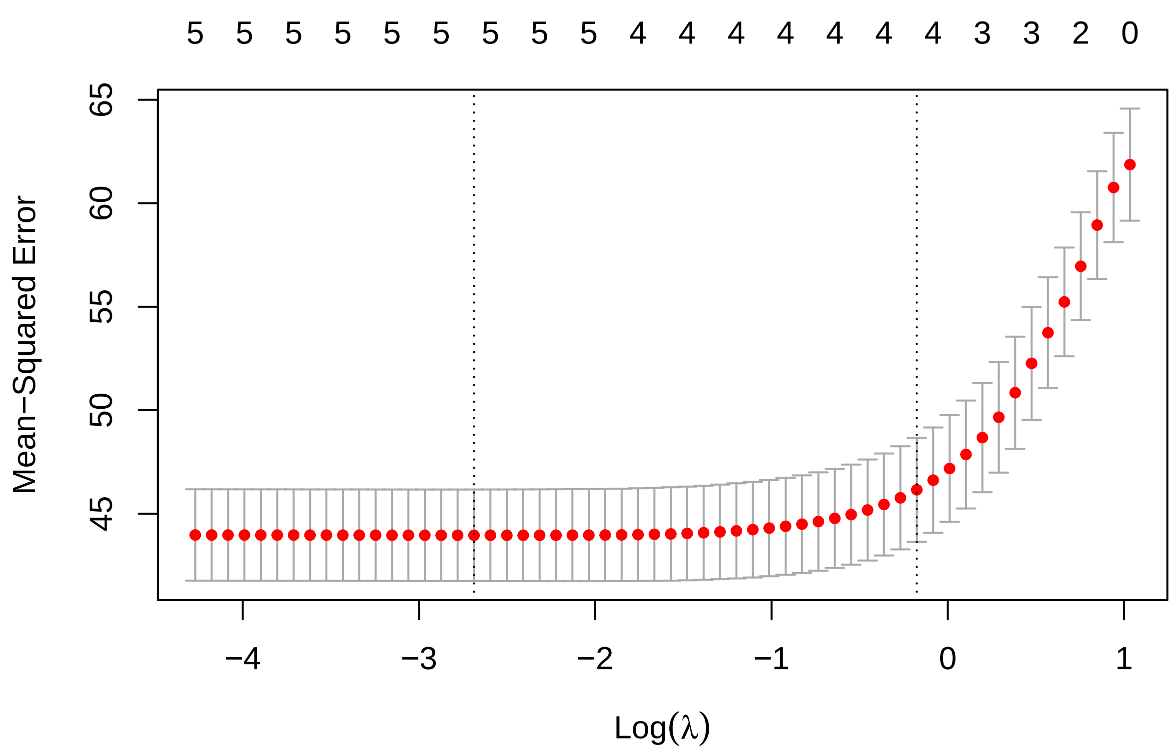
```
## Loaded glmnet 4.0-2
```

```
library(foreach)
```

```
## Warning: package 'foreach' was built under R version 4.0.2
```

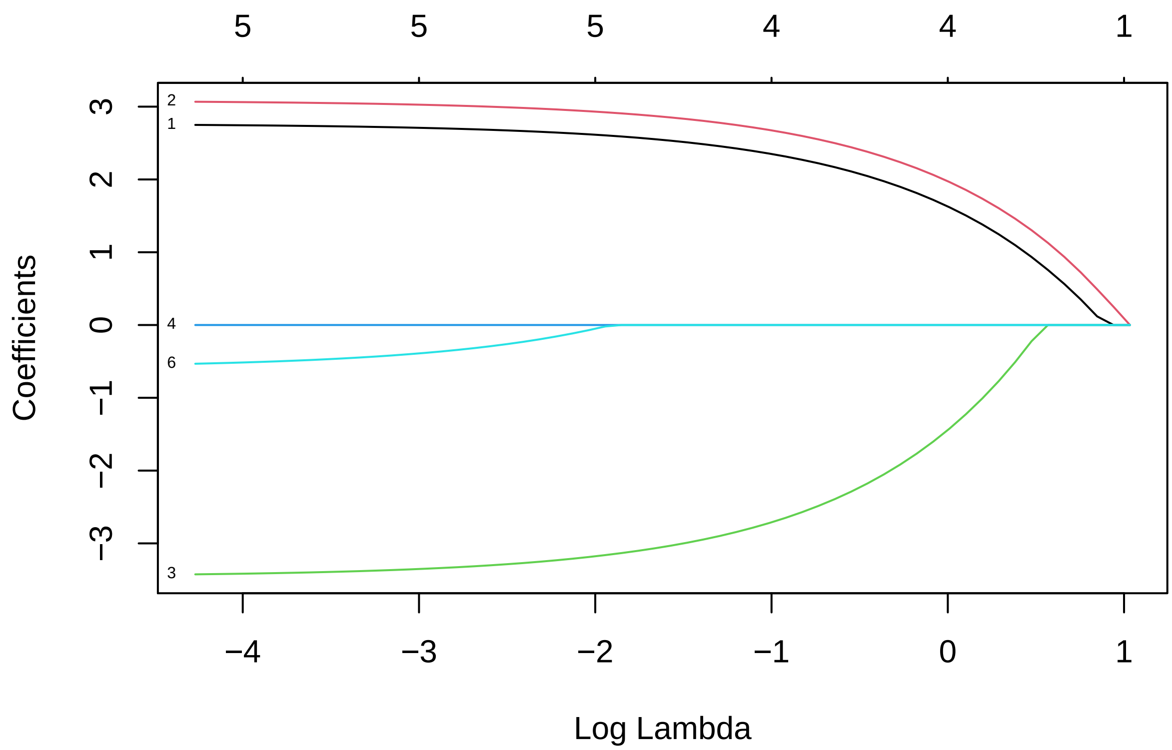
```
library(Matrix)
```

```
cv_lasso <- cv.glmnet(x_train, y_train, alpha =1, type.measure = "mse",nfolds = 4)
plot(cv_lasso)
```



- The object returned form the call to cv.glmnet() function, contains the lambda values of importance
- The coefficients are accessible calling the coef() function on the cv__lasso object

```r
plot(cv_lasso$glmnet.fit,xvar="lambda",label = TRUE)
```




```r
print(cv_lasso$lambda.min)
```

```
## [1] 0.06803175
```

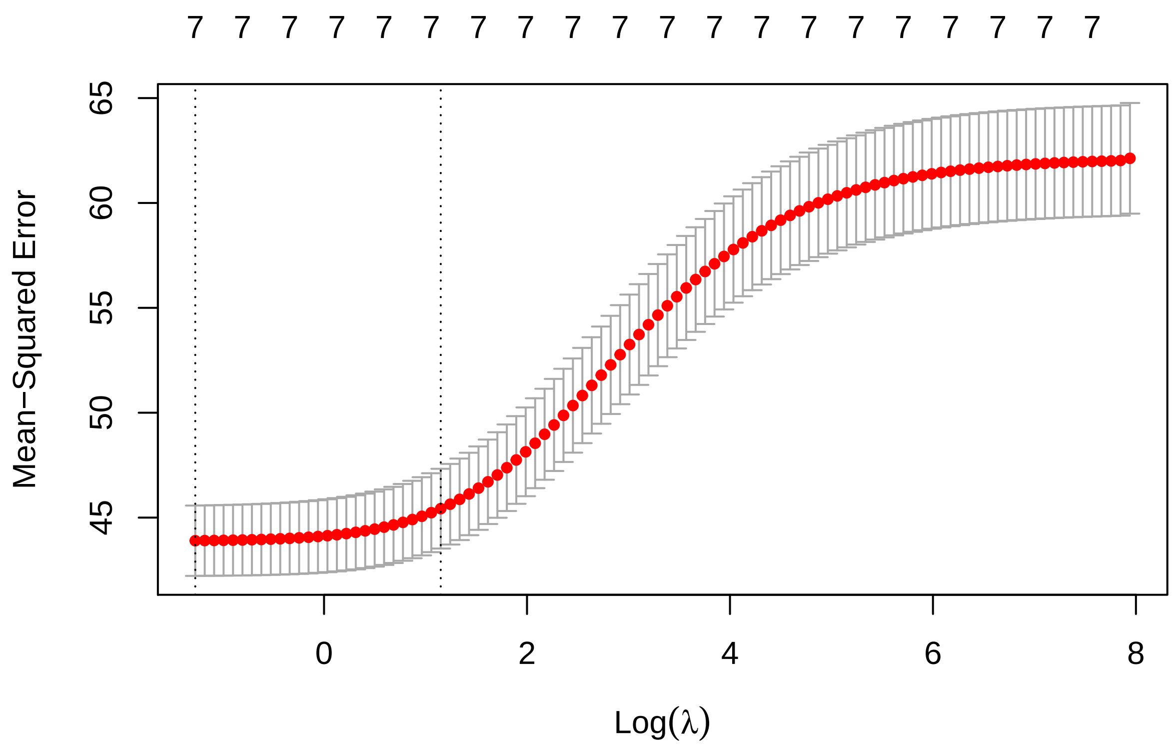
```r
coef(cv_lasso)
```

```
## 8 x 1 sparse Matrix of class "dgCMatrix"
##                             1
## (Intercept)      1.640412e+01
## education        1.812587e+00
## age              2.153717e+00
## sexFemale       -1.766271e+00
## sexMale          8.259089e-14
## languageEnglish  .
## languageFrench   .
## languageOther    .
```

Choosing a lambda for Ridge Regression

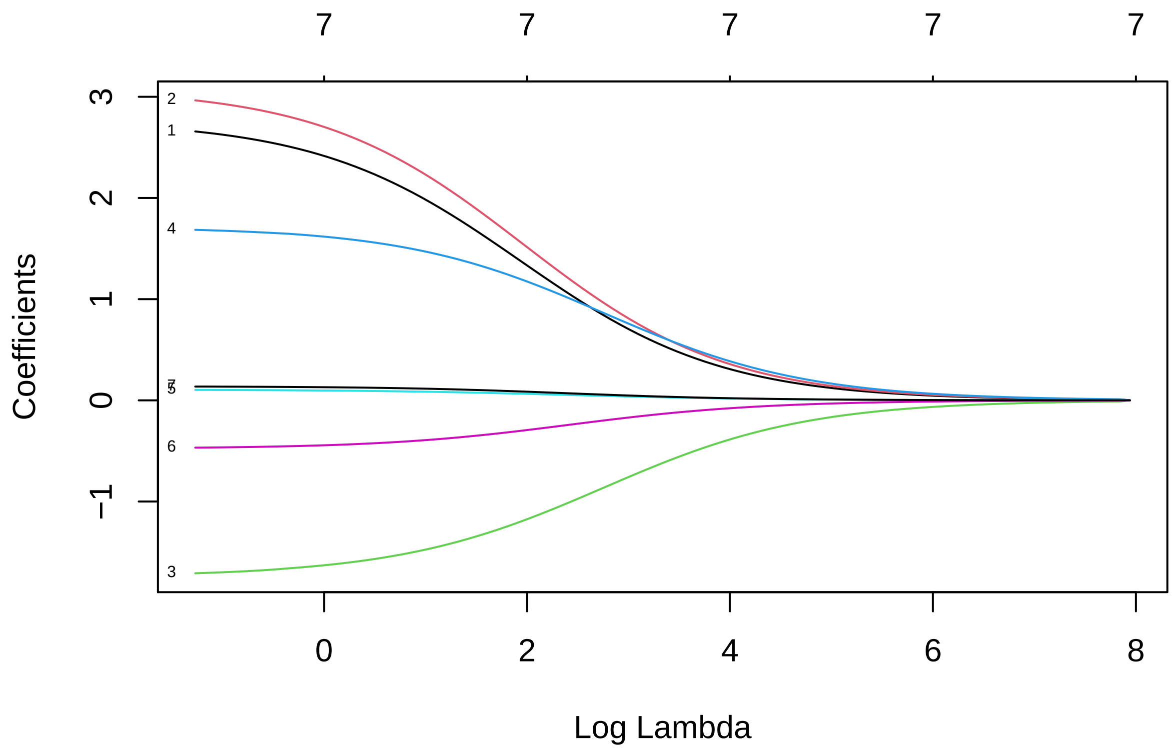
- The alpha value is 0 for ridge regression

```r
cv_ridge<- cv.glmnet(x_train, y_train, alpha =0, type.measure = "mse",nfolds = 4)
plot(cv_ridge)
```



- We can access the lambda and the coefficients as we did before

```r
plot(cv_ridge$glmnet.fit,xvar="lambda",label = TRUE)
```




```r
print(cv_ridge$lambda.min)
```

```
## [1] 0.281108
```

```r
coef(cv_ridge)
```

```
## 8 x 1 sparse Matrix of class "dgCMatrix"
##                           1
## (Intercept)     15.46625297
## education        1.89683861
## age              2.13566648
## sexFemale       -1.44034175
## sexMale          1.43636353
## languageEnglish  0.08263341
## languageFrench  -0.38150197
## languageOther    0.11172119
```

Building The Final Model

- By using the optimal lambda values obtained above, we can build our ridge and lasso models

Building the Final Lasso Regression Model

```
lasso_model <-glmnet(x_train, y_train, lambda = cv_lasso$lambda.min,alpha = 1)
coef(lasso_model)
```

```
## 8 x 1 sparse Matrix of class "dgCMatrix"
##                            s0
## (Intercept)      1.719687e+01
## education        2.689314e+00
## age              3.006946e+00
## sexFemale       -3.314947e+00
## sexMale          2.811204e-13
## languageEnglish  .
## languageFrench  -3.176708e-01
## languageOther    .
```

- Use the model to predict on test data

```
preds_lasso <- predict(lasso_model,x_test)
```

Building the Final Ridge Regression Model

```
ridge_model <-glmnet(x_train, y_train, lambda = cv_ridge$lambda.min,alpha = 0)
coef(ridge_model)
```

```
## 8 x 1 sparse Matrix of class "dgCMatrix"
##                         s0
## (Intercept)     15.5071089
## education        2.6575550
## age              2.9648092
## sexFemale       -1.7573840
## sexMale          1.6383518
## languageEnglish  0.1050676
## languageFrench  -0.4659695
## languageOther    0.1378338
```

- Use the model to predict on test data

```
preds_ridge <- predict(ridge_model,x_test)
```

Model Performance Evaluation

Lasso Regression Model Metrics

```r
library(DMwR)
```

```
## Warning: package 'DMwR' was built under R version 4.0.2
```

```
## Loading required package: grid
```

```
## Registered S3 method overwritten by 'quantmod':
##   method            from
##   as.zoo.data.frame zoo
```

```r
regr.eval(trues = y_test , preds = preds_lasso)
```

```
##        mae        mse       rmse       mape
##  5.0051579 43.6905282  6.6098811  0.4058685
```

Ridge Regression Model Metrics

```r
regr.eval(trues = y_test , preds = preds_ridge)
```

```
##        mae        mse       rmse       mape
##  5.0084714 43.6942827  6.6101651  0.4062369
```