Assignment -1

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```
# Loading the required libraries
library(ISLR)
library(dplyr)
```

```
##
## Attaching package: 'dplyr'
```

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

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

```
library(glmnet)
```

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

```
## Loaded glmnet 4.1-6
```

```
library(caret)
```

```
## Loading required package: ggplot2
```

```
## Loading required package: lattice
```

```
# Load the Carseats dataset from ISLR package
data("Carseats")
#The Data() function is used to load the 'dataset' from the ISLR package

# Summarize the Carseats dataset
summary(Carseats)
```

```
##      Sales          CompPrice       Income        Advertising
##  Min.   : 0.000   Min.   : 77   Min.   : 21.00   Min.   : 0.000
##  1st Qu.: 5.390   1st Qu.:115   1st Qu.: 42.75   1st Qu.: 0.000
##  Median : 7.490   Median :125   Median : 69.00   Median : 5.000
```

```
##  Mean   : 7.496   Mean   :125   Mean   : 68.66   Mean   : 6.635
##  3rd Qu.: 9.320   3rd Qu.:135   3rd Qu.: 91.00   3rd Qu.:12.000
##  Max.   :16.270   Max.   :175   Max.   :120.00   Max.   :29.000
##    Population        Price        ShelveLoc        Age          Education
##  Min.   : 10.0   Min.   : 24.0   Bad   : 96   Min.   :25.00   Min.   :10.0
##  1st Qu.:139.0   1st Qu.:100.0   Good  : 85   1st Qu.:39.75   1st Qu.:12.0
##  Median :272.0   Median :117.0   Medium:219   Median :54.50   Median :14.0
##  Mean   :264.8   Mean   :115.8                Mean   :53.32   Mean   :13.9
##  3rd Qu.:398.5   3rd Qu.:131.0                3rd Qu.:66.00   3rd Qu.:16.0
##  Max.   :509.0   Max.   :191.0                Max.   :80.00   Max.   :18.0
##  Urban       US
##  No :118   No :142
##  Yes:282   Yes:258
##
##
##
##
```

```
#'Summary()' function to get a quick summary of the dataset.
```

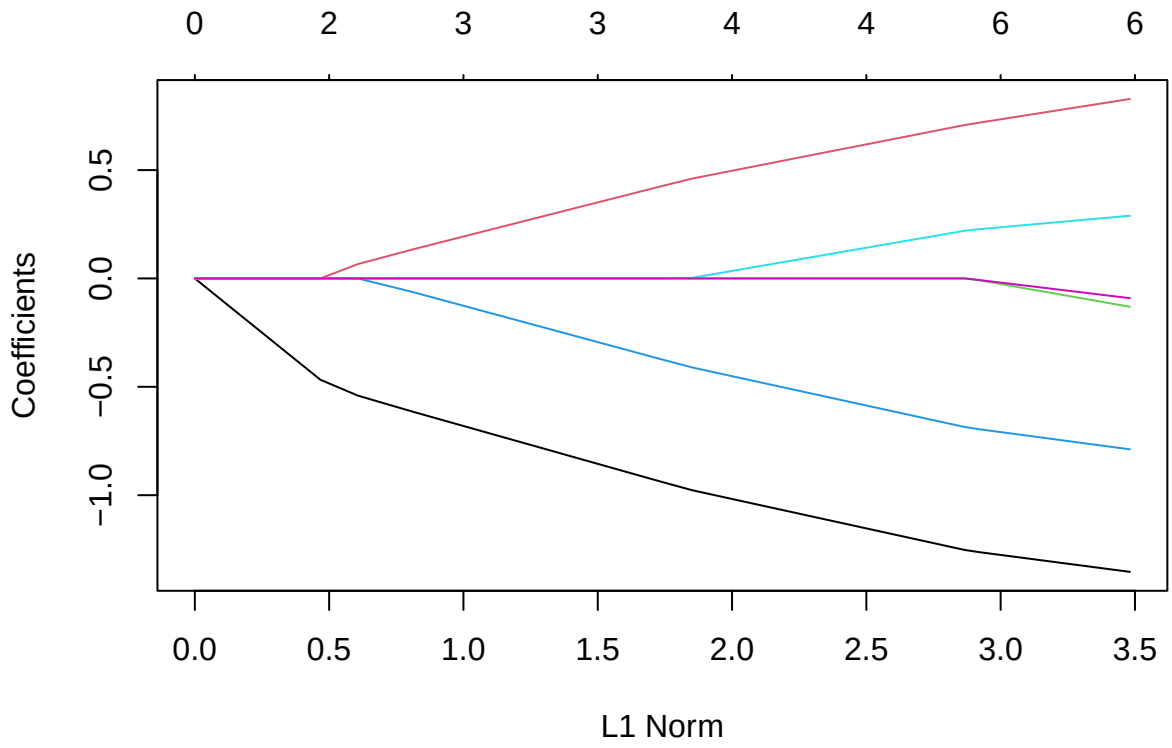
QB1) Build a Lasso regression model to predict Sales based on all other attributes ("Price", "Advertising", "Population", "Age", "Income" and "Education"). What is the best value of lambda for such a lasso model?

```
# Taking all the input attributes into Carseats_Filtered and then scaling the input attributes.
Carseats_Filtered <- Carseats %>% select("Price", "Advertising", "Population", "Age", "Income", "Educati

# using glmnet library to convert the input attributes to matrix format.
x <- Carseats_Filtered

# storing the response variable into y in matrix format
y <- Carseats %>% select("Sales") %>% as.matrix()

## building the model
fit = glmnet(x, y)
summary(fit)
```

```
##           Length Class     Mode
## a0         62    -none-    numeric
## beta      372    dgCMatrix S4
## df         62    -none-    numeric
## dim         2    -none-    numeric
## lambda     62    -none-    numeric
## dev.ratio  62    -none-    numeric
## nulldev     1    -none-    numeric
## npasses     1    -none-    numeric
## jerr        1    -none-    numeric
## offset      1    -none-    logical
```

```
## call        3    -none-    call
## nobs        1    -none-    numeric
```

```
plot(fit)
```




```
print(fit)
```

```
##
## Call:  glmnet(x = x, y = y)
##
##    Df  %Dev  Lambda
## 1   0  0.00 1.25500
## 2   1  3.36 1.14400
## 3   1  6.15 1.04200
## 4   1  8.47 0.94940
## 5   1 10.39 0.86500
## 6   1 11.99 0.78820
## 7   2 14.62 0.71820
## 8   3 18.08 0.65440
## 9   3 21.12 0.59620
## 10  3 23.64 0.54330
## 11  3 25.73 0.49500
## 12  3 27.46 0.45100
## 13  3 28.91 0.41100
## 14  3 30.10 0.37450
```

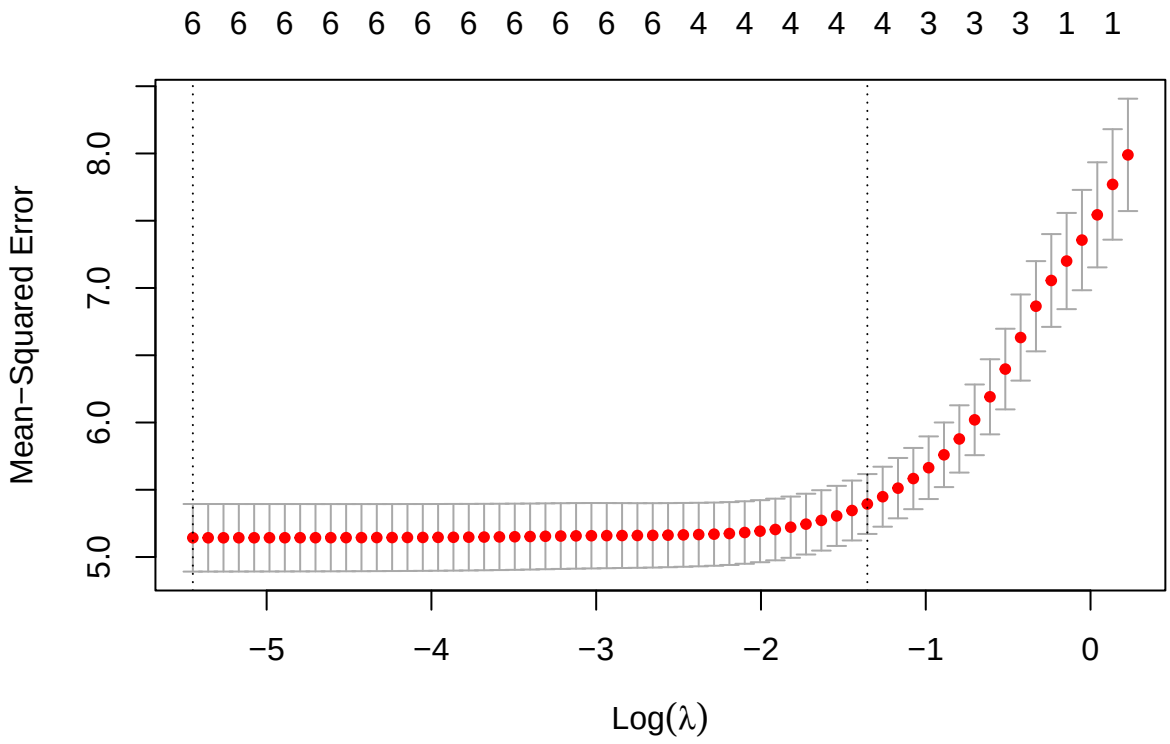
```
## 15  4 31.12 0.34120
## 16  4 32.13 0.31090
## 17  4 32.97 0.28330
## 18  4 33.67 0.25810
## 19  4 34.25 0.23520
## 20  4 34.73 0.21430
## 21  4 35.13 0.19520
## 22  4 35.46 0.17790
## 23  4 35.74 0.16210
## 24  4 35.97 0.14770
## 25  4 36.16 0.13460
## 26  4 36.31 0.12260
## 27  4 36.45 0.11170
## 28  4 36.55 0.10180
## 29  4 36.64 0.09276
## 30  6 36.75 0.08451
## 31  6 36.86 0.07701
## 32  6 36.95 0.07017
## 33  6 37.02 0.06393
## 34  6 37.09 0.05825
## 35  6 37.14 0.05308
## 36  6 37.18 0.04836
## 37  6 37.21 0.04407
## 38  6 37.24 0.04015
## 39  6 37.27 0.03658
## 40  6 37.29 0.03333
## 41  6 37.30 0.03037
## 42  6 37.32 0.02767
## 43  6 37.33 0.02522
## 44  6 37.34 0.02298
## 45  6 37.35 0.02094
## 46  6 37.35 0.01908
## 47  6 37.36 0.01738
## 48  6 37.36 0.01584
## 49  6 37.37 0.01443
## 50  6 37.37 0.01315
## 51  6 37.37 0.01198
## 52  6 37.38 0.01092
## 53  6 37.38 0.00995
## 54  6 37.38 0.00906
## 55  6 37.38 0.00826
## 56  6 37.38 0.00752
## 57  6 37.38 0.00686
## 58  6 37.38 0.00625
## 59  6 37.38 0.00569
## 60  6 37.38 0.00519
## 61  6 37.38 0.00472
## 62  6 37.38 0.00430
```

```r
# performing cross-validation to find the optimal lambda value
cv_fit <- cv.glmnet(x, y, alpha = 1)

# finding the minimum lambda value
best_lambda <- cv_fit$lambda.min
```

```
best_lambda
```

```
## [1] 0.004305309
```

```
# plotting the cross-validation results
plot(cv_fit)
```



So, based on the above findings, we can see that there is only 37.38% variation in the goal variable, sales with regularization, and a best lambda value of 0.0043.

QB2. What is the coefficient for the price (normalized) attribute in the best model (i.e. model with the optimal lambda)?

```
best_model <- glmnet(x, y, alpha = 1, lambda = best_lambda)
coef(best_model)
```

```
## 7 x 1 sparse Matrix of class "dgCMatrix"
##                       s0
## (Intercept)  7.49632500
## Price       -1.35384596
## Advertising  0.82808291
## Population  -0.13062237
```

```
## Age         -0.78855156
## Income       0.28931642
## Education   -0.09102494
```

The Price attribute's coefficient, which has the greatest lambda value, is -1.35384596.

QB3. How many attributes remain in the model if lambda is set to 0.01? How that number changes if lambda is increased to 0.1? Do you expect more variables to stay in the model (i.e., to have non-zero coefficients) as we increase lambda?

```
# Let us see the coefficients of the attributes that are still remaining if lambda is set to 0.01.
best_model <- glmnet(x, y, alpha = 1, lambda = 0.01)
coef(best_model)
```

```
## 7 x 1 sparse Matrix of class "dgCMatrix"
##                      s0
## (Intercept)  7.49632500
## Price       -1.34733223
## Advertising  0.82026088
## Population  -0.12187685
## Age         -0.78190633
## Income       0.28488631
## Education   -0.08502707
```

The independent attribute variable with a lambda value of 0.01. No coefficients are removed in this.

```
# Let us see the coefficients of the attributes that are still remaining if lambda is set to 0.1.
best_model <- glmnet(x, y, alpha = 1, lambda = 0.1)
coef(best_model)
```

```
## 7 x 1 sparse Matrix of class "dgCMatrix"
##                     s0
## (Intercept)  7.4963250
## Price       -1.2447745
## Advertising  0.7007230
## Population   .
## Age         -0.6775428
## Income       0.2139222
## Education    .
```

The above findings show that the values of the independent attributes have shrunk to some degree and that two of the attribute coefficients are eliminated when the lambda is set to 0.1.

```
# Let us see the coefficients of the attributes that are still remaining if lambda is set to 0.3.
best_model <- glmnet(x, y, alpha = 1, lambda = 0.3)
coef(best_model)
```

```
## 7 x 1 sparse Matrix of class "dgCMatrix"
##                      s0
## (Intercept)  7.49632500
## Price       -1.02298693
## Advertising  0.50192192
## Population   .
## Age         -0.45635365
## Income       0.03900787
## Education    .
```

We can see from the findings above that when lambda is 0.3, two of the attribute coefficients are removed, and the independent attributes have shrunk even more.

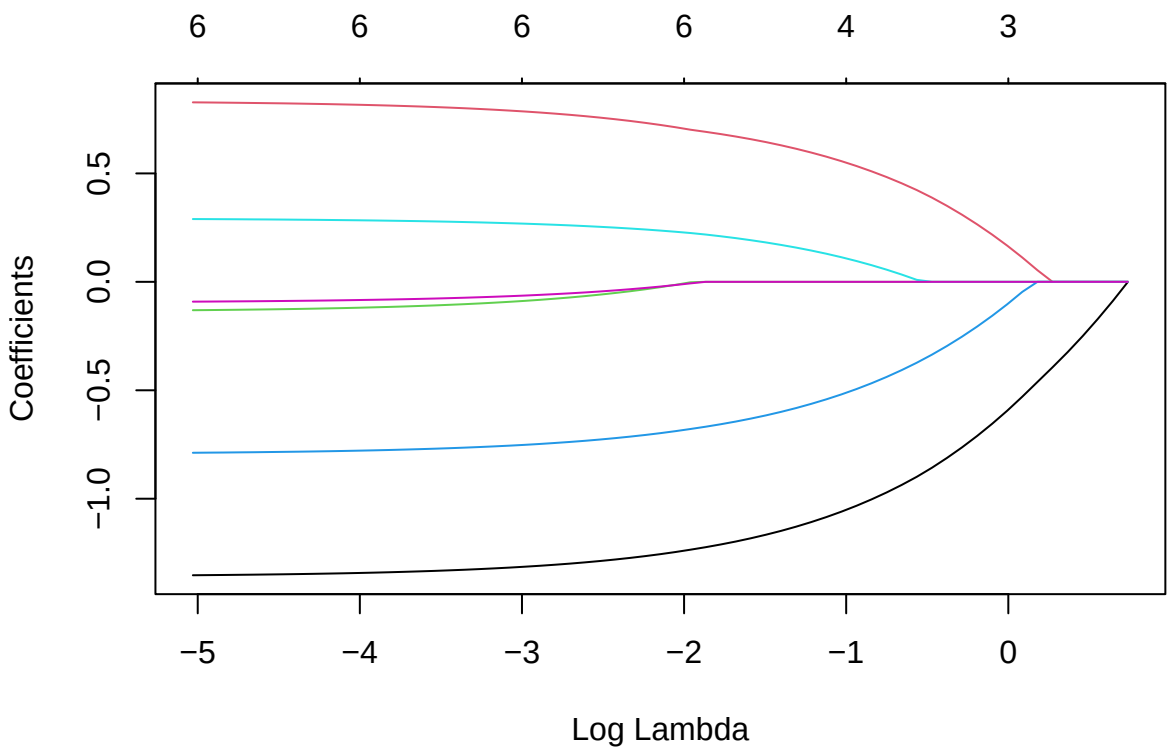
```
# Let us see the coefficients of the attributes that are still remaining if lambda is set to 0.5.
best_model <- glmnet(x, y, alpha = 1, lambda = 0.5)
coef(best_model)
```

```
## 7 x 1 sparse Matrix of class "dgCMatrix"
##                     s0
## (Intercept)  7.4963250
## Price       -0.7929743
## Advertising  0.2947434
## Population   .
## Age         -0.2337276
## Income       .
## Education    .
```

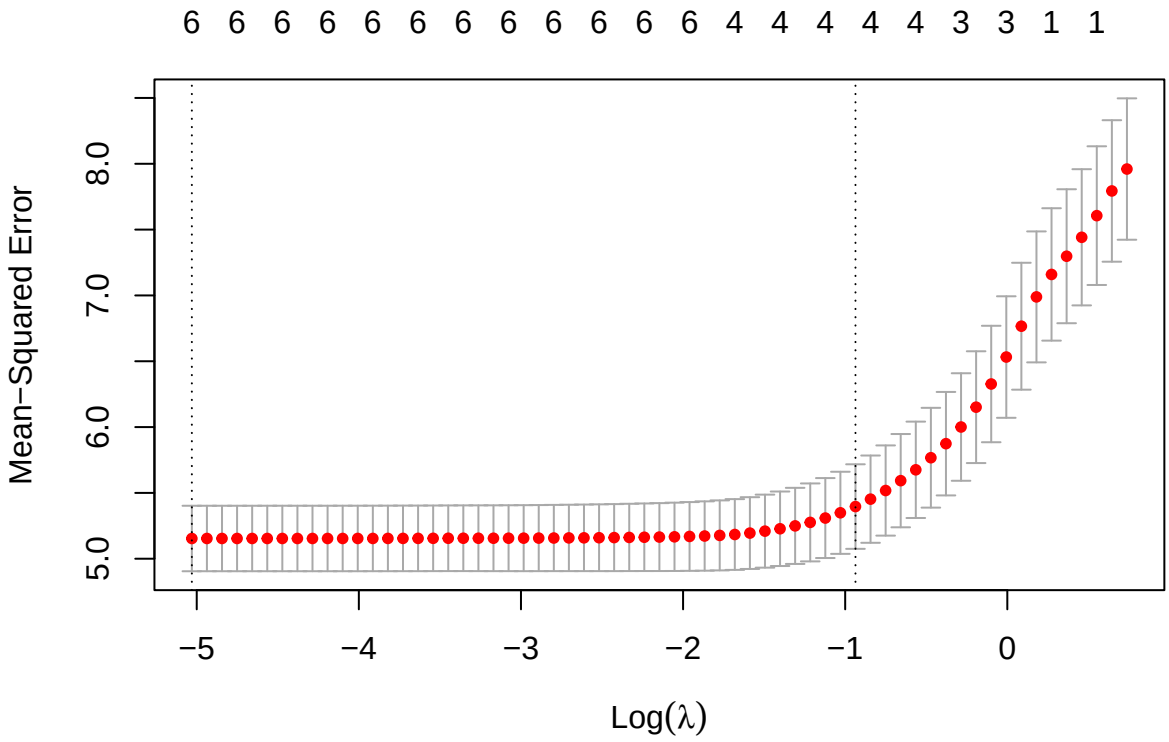
When the lambda number is 0.5, three of the attribute coefficients are removed, and the independent attributes shrink even more.

QB4. Build an elastic-net model with alpha set to 0.6. What is the best value of lambda for such a model?

```
# Building an Elastic Net model with alpha = 0.6
el_net <- glmnet(x, y, alpha = 0.6)

# Plotting coefficients against different values of lambda
plot(el_net, xvar = "lambda")
```




```
# Generating a plot of cross-validation results for the Elastic Net model
plot(cv.glmnet(x, y, alpha = 0.6))
```




```
# Displaying a summary of the Elastic Net model
summary(el_net)
```

```
##           Length Class     Mode
## a0         63    -none-    numeric
## beta      378    dgCMatrix S4
## df         63    -none-    numeric
## dim         2    -none-    numeric
## lambda     63    -none-    numeric
## dev.ratio  63    -none-    numeric
## nulldev     1    -none-    numeric
## npasses     1    -none-    numeric
## jerr        1    -none-    numeric
## offset      1    -none-    logical
## call        4    -none-    call
## nobs        1    -none-    numeric
```

```
# Printing the Elastic Net model
print(el_net)
```

```
##
## Call:  glmnet(x = x, y = y, alpha = 0.6)
##
##    Df  %Dev  Lambda
## 1   0  0.00 2.09200
```

```
## 2   1  2.67 1.90600
## 3   1  5.03 1.73700
## 4   1  7.09 1.58200
## 5   1  8.90 1.44200
## 6   1 10.47 1.31400
## 7   2 12.89 1.19700
## 8   3 16.00 1.09100
## 9   3 18.95 0.99370
## 10  3 21.49 0.90540
## 11  3 23.67 0.82500
## 12  3 25.55 0.75170
## 13  3 27.15 0.68490
## 14  3 28.52 0.62410
## 15  4 29.75 0.56860
## 16  4 30.91 0.51810
## 17  4 31.89 0.47210
## 18  4 32.72 0.43020
## 19  4 33.43 0.39190
## 20  4 34.02 0.35710
## 21  4 34.52 0.32540
## 22  4 34.93 0.29650
## 23  4 35.29 0.27020
## 24  4 35.58 0.24620
## 25  4 35.83 0.22430
## 26  4 36.04 0.20440
## 27  4 36.21 0.18620
## 28  4 36.36 0.16970
## 29  4 36.48 0.15460
## 30  6 36.60 0.14090
## 31  6 36.73 0.12830
## 32  6 36.84 0.11690
## 33  6 36.93 0.10660
## 34  6 37.01 0.09709
## 35  6 37.07 0.08846
## 36  6 37.12 0.08060
## 37  6 37.17 0.07344
## 38  6 37.20 0.06692
## 39  6 37.23 0.06097
## 40  6 37.26 0.05556
## 41  6 37.28 0.05062
## 42  6 37.30 0.04612
## 43  6 37.31 0.04203
## 44  6 37.33 0.03829
## 45  6 37.34 0.03489
## 46  6 37.34 0.03179
## 47  6 37.35 0.02897
## 48  6 37.36 0.02639
## 49  6 37.36 0.02405
## 50  6 37.37 0.02191
## 51  6 37.37 0.01997
## 52  6 37.37 0.01819
## 53  6 37.37 0.01658
## 54  6 37.38 0.01510
## 55  6 37.38 0.01376
```

```
## 56  6 37.38 0.01254
## 57  6 37.38 0.01143
## 58  6 37.38 0.01041
## 59  6 37.38 0.00949
## 60  6 37.38 0.00864
## 61  6 37.38 0.00788
## 62  6 37.38 0.00718
## 63  6 37.38 0.00654
```

We can see from the above findings that the variance in the dependent variable (Sales) is 37.38, which is explained by the provided attributes to implement regularization by putting the alpha value to 0.6 and the best lambda value is 0.00654.