HW5

William Florez

20 de junio de 2017

Q1

```r
library('caret')
```

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

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

```r
library('glmnet')
```

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

```
## Loading required package: foreach
```

```
## Loaded glmnet 2.0-10
```

```r
library('parallel')
library("MASS")
set.seed(1)
#setwd("C:/Users/ce02144/Documents/HW4")
setwd("~/Dropbox/WILL/DataScience/GT Analytics/Introduction_to_Analytics_Modeling/HW4")

#Reading data
uscrime =  read.table("uscrime.txt", header = TRUE)

#step seleccion
crime.scale = data.frame(scale(uscrime))
model.lm = lm(Crime ~ ., data = crime.scale)
model.step =  step(model.lm, direction = 'both')
```

```
## Start:  AIC=-45.39
## Crime ~ M + So + Ed + Po1 + Po2 + LF + M.F + Pop + NW + U1 +
##     U2 + Wealth + Ineq + Prob + Time
##
##          Df Sum of Sq    RSS     AIC
## - So      1   0.00019 9.0582 -47.384
## - LF      1   0.05961 9.1176 -47.077
## - Time    1   0.06888 9.1269 -47.029
## - Pop     1   0.09441 9.1524 -46.898
## - NW      1   0.12298 9.1810 -46.752
## - M.F     1   0.21371 9.2717 -46.289
## - Wealth  1   0.25145 9.3095 -46.099
## - Po2     1   0.25350 9.3115 -46.088
```

```
## <none>                  9.0580 -45.385
## - U1      1   0.55970  9.6177 -44.567
## - Po1     1   0.96471 10.0227 -42.629
## - U2      1   1.21360 10.2716 -41.476
## - M       1   1.29538 10.3534 -41.103
## - Prob    1   1.33394 10.3920 -40.928
## - Ed      1   2.68821 11.7462 -35.171
## - Ineq    1   2.82803 11.8860 -34.615
##
## Step:  AIC=-47.38
## Crime ~ M + Ed + Po1 + Po2 + LF + M.F + Pop + NW + U1 + U2 +
##     Wealth + Ineq + Prob + Time
##
##           Df Sum of Sq    RSS      AIC
## - Time     1   0.0691  9.1273 -49.027
## - LF       1   0.0727  9.1309 -49.009
## - Pop      1   0.0944  9.1526 -48.897
## - NW       1   0.1446  9.2028 -48.640
## - M.F      1   0.2169  9.2751 -48.272
## - Po2      1   0.2537  9.3119 -48.086
## - Wealth   1   0.2622  9.3204 -48.043
## <none>                  9.0582 -47.384
## - U1       1   0.6446  9.7028 -46.154
## + So       1   0.0002  9.0580 -45.385
## - Po1      1   0.9647 10.0229 -44.628
## - U2       1   1.2692 10.3274 -43.221
## - M        1   1.3042 10.3624 -43.062
## - Prob     1   1.3669 10.4251 -42.779
## - Ed       1   2.6950 11.7532 -37.143
## - Ineq     1   3.2679 12.3261 -34.906
##
## Step:  AIC=-49.03
## Crime ~ M + Ed + Po1 + Po2 + LF + M.F + Pop + NW + U1 + U2 +
##     Wealth + Ineq + Prob
##
##           Df Sum of Sq    RSS      AIC
## - LF       1   0.0704  9.1977 -50.666
## - NW       1   0.1035  9.2308 -50.497
## - Pop      1   0.1460  9.2734 -50.281
## - Po2      1   0.1934  9.3207 -50.042
## - Wealth   1   0.2411  9.3685 -49.802
## - M.F      1   0.2793  9.4067 -49.610
## <none>                  9.1273 -49.027
## - U1       1   0.6112  9.7385 -47.981
## + Time     1   0.0691  9.0582 -47.384
## + So       1   0.0004  9.1269 -47.029
## - Po1      1   0.8967 10.0241 -46.623
## - U2       1   1.2310 10.3584 -45.081
## - M        1   1.2442 10.3715 -45.021
## - Prob     1   1.5877 10.7150 -43.490
## - Ed       1   2.7372 11.8645 -38.700
## - Ineq     1   3.3620 12.4893 -36.288
##
## Step:  AIC=-50.67
```

```
## Crime ~ M + Ed + Po1 + Po2 + M.F + Pop + NW + U1 + U2 + Wealth +
##     Ineq + Prob
##
##          Df Sum of Sq     RSS     AIC
## - NW      1    0.0780  9.2758 -52.269
## - Po2     1    0.1432  9.3409 -51.940
## - Pop     1    0.1859  9.3836 -51.726
## - M.F     1    0.2089  9.4067 -51.610
## - Wealth  1    0.2342  9.4320 -51.484
## <none>                   9.1977 -50.666
## - U1      1    0.5412  9.7389 -49.979
## + LF      1    0.0704  9.1273 -49.027
## + Time    1    0.0668  9.1309 -49.009
## + So      1    0.0204  9.1774 -48.770
## - Po1     1    0.8283 10.0260 -48.613
## - U2      1    1.2752 10.4729 -46.564
## - M       1    1.4555 10.6532 -45.761
## - Prob    1    1.5173 10.7151 -45.489
## - Ed      1    2.7627 11.9604 -40.322
## - Ineq    1    3.3489 12.5466 -38.073
##
## Step:  AIC=-52.27
## Crime ~ M + Ed + Po1 + Po2 + M.F + Pop + U1 + U2 + Wealth + Ineq +
##     Prob
##
##          Df Sum of Sq     RSS     AIC
## - Po2     1    0.1117  9.3875 -53.706
## - Pop     1    0.1724  9.4482 -53.403
## - M.F     1    0.1791  9.4549 -53.370
## - Wealth  1    0.2109  9.4867 -53.212
## <none>                   9.2758 -52.269
## - U1      1    0.5608  9.8365 -51.510
## + NW      1    0.0780  9.1977 -50.666
## + So      1    0.0482  9.2276 -50.514
## + LF      1    0.0450  9.2308 -50.497
## + Time    1    0.0303  9.2455 -50.423
## - Po1     1    0.7912 10.0670 -50.422
## - U2      1    1.3467 10.6225 -47.897
## - Prob    1    1.4491 10.7249 -47.446
## - M       1    2.0671 11.3429 -44.813
## - Ed      1    2.6925 11.9683 -42.291
## - Ineq    1    3.9425 13.2183 -37.622
##
## Step:  AIC=-53.71
## Crime ~ M + Ed + Po1 + M.F + Pop + U1 + U2 + Wealth + Ineq +
##     Prob
##
##          Df Sum of Sq     RSS     AIC
## - Pop     1    0.1494  9.5369 -54.964
## - Wealth  1    0.2149  9.6024 -54.643
## - M.F     1    0.2461  9.6335 -54.490
## <none>                   9.3875 -53.706
## - U1      1    0.5774  9.9649 -52.901
## + Po2     1    0.1117  9.2758 -52.269
```

```
## + NW       1    0.0465  9.3409 -51.940
## + So       1    0.0254  9.3620 -51.834
## + LF       1    0.0133  9.3742 -51.773
## + Time     1    0.0038  9.3836 -51.725
## - U2       1    1.3759 10.7634 -49.278
## - Prob     1    1.4614 10.8489 -48.906
## - M        1    2.0523 11.4398 -46.413
## - Ed       1    2.6039 11.9914 -44.200
## - Ineq     1    4.0688 13.4562 -38.783
## - Po1      1    7.0208 16.4082 -29.461
##
## Step:  AIC=-54.96
## Crime ~ M + Ed + Po1 + M.F + U1 + U2 + Wealth + Ineq + Prob
##
##            Df Sum of Sq     RSS     AIC
## - Wealth   1    0.1771  9.7140 -56.099
## <none>                   9.5369 -54.964
## - M.F      1    0.5648 10.1017 -54.260
## - U1       1    0.6649 10.2018 -53.797
## + Pop      1    0.1494  9.3875 -53.706
## + Po2      1    0.0886  9.4482 -53.403
## + NW       1    0.0396  9.4972 -53.160
## + So       1    0.0383  9.4986 -53.153
## + LF       1    0.0346  9.5023 -53.135
## + Time     1    0.0262  9.5107 -53.093
## - Prob     1    1.3275 10.8643 -50.839
## - U2       1    1.3964 10.9333 -50.542
## - M        1    2.1454 11.6823 -47.427
## - Ed       1    2.5856 12.1225 -45.689
## - Ineq     1    3.9762 13.5130 -40.585
## - Po1      1    7.5360 17.0729 -29.595
##
## Step:  AIC=-56.1
## Crime ~ M + Ed + Po1 + M.F + U1 + U2 + Ineq + Prob
##
##            Df Sum of Sq     RSS     AIC
## <none>                   9.7140 -56.099
## + Wealth   1    0.1771  9.5369 -54.964
## - M.F      1    0.6896 10.4036 -54.876
## + Pop      1    0.1116  9.6024 -54.643
## + Po2      1    0.0946  9.6194 -54.559
## + So       1    0.0624  9.6516 -54.402
## + LF       1    0.0292  9.6847 -54.241
## + NW       1    0.0254  9.6886 -54.222
## + Time     1    0.0153  9.6986 -54.174
## - U1       1    0.8493 10.5633 -54.160
## - Prob     1    1.6578 11.3717 -50.694
## - U2       1    1.7077 11.4216 -50.488
## - M        1    1.9841 11.6981 -49.364
## - Ed       1    2.9802 12.6941 -45.523
## - Ineq     1    4.9353 14.6492 -38.791
## - Po1      1   11.1778 20.8918 -22.107
```

```
#testing ANOVA
model.step.aic = stepAIC(model.lm, direction="both")
```

```
## Start:  AIC=-45.39
## Crime ~ M + So + Ed + Po1 + Po2 + LF + M.F + Pop + NW + U1 +
##     U2 + Wealth + Ineq + Prob + Time
##
##           Df Sum of Sq     RSS     AIC
## - So       1    0.00019  9.0582 -47.384
## - LF       1    0.05961  9.1176 -47.077
## - Time     1    0.06888  9.1269 -47.029
## - Pop      1    0.09441  9.1524 -46.898
## - NW       1    0.12298  9.1810 -46.752
## - M.F      1    0.21371  9.2717 -46.289
## - Wealth   1    0.25145  9.3095 -46.099
## - Po2      1    0.25350  9.3115 -46.088
## <none>                   9.0580 -45.385
## - U1       1    0.55970  9.6177 -44.567
## - Po1      1    0.96471 10.0227 -42.629
## - U2       1    1.21360 10.2716 -41.476
## - M        1    1.29538 10.3534 -41.103
## - Prob     1    1.33394 10.3920 -40.928
## - Ed       1    2.68821 11.7462 -35.171
## - Ineq     1    2.82803 11.8860 -34.615
##
## Step:  AIC=-47.38
## Crime ~ M + Ed + Po1 + Po2 + LF + M.F + Pop + NW + U1 + U2 +
##     Wealth + Ineq + Prob + Time
##
##           Df Sum of Sq     RSS     AIC
## - Time     1    0.0691   9.1273 -49.027
## - LF       1    0.0727   9.1309 -49.009
## - Pop      1    0.0944   9.1526 -48.897
## - NW       1    0.1446   9.2028 -48.640
## - M.F      1    0.2169   9.2751 -48.272
## - Po2      1    0.2537   9.3119 -48.086
## - Wealth   1    0.2622   9.3204 -48.043
## <none>                   9.0582 -47.384
## - U1       1    0.6446   9.7028 -46.154
## + So       1    0.0002   9.0580 -45.385
## - Po1      1    0.9647  10.0229 -44.628
## - U2       1    1.2692  10.3274 -43.221
## - M        1    1.3042  10.3624 -43.062
## - Prob     1    1.3669  10.4251 -42.779
## - Ed       1    2.6950  11.7532 -37.143
## - Ineq     1    3.2679  12.3261 -34.906
##
## Step:  AIC=-49.03
## Crime ~ M + Ed + Po1 + Po2 + LF + M.F + Pop + NW + U1 + U2 +
##     Wealth + Ineq + Prob
##
##           Df Sum of Sq     RSS     AIC
## - LF       1    0.0704   9.1977 -50.666
```

```
## - NW      1    0.1035  9.2308 -50.497
## - Pop     1    0.1460  9.2734 -50.281
## - Po2     1    0.1934  9.3207 -50.042
## - Wealth  1    0.2411  9.3685 -49.802
## - M.F     1    0.2793  9.4067 -49.610
## <none>             9.1273 -49.027
## - U1      1    0.6112  9.7385 -47.981
## + Time    1    0.0691  9.0582 -47.384
## + So      1    0.0004  9.1269 -47.029
## - Po1     1    0.8967 10.0241 -46.623
## - U2      1    1.2310 10.3584 -45.081
## - M       1    1.2442 10.3715 -45.021
## - Prob    1    1.5877 10.7150 -43.490
## - Ed      1    2.7372 11.8645 -38.700
## - Ineq    1    3.3620 12.4893 -36.288
##
## Step:  AIC=-50.67
## Crime ~ M + Ed + Po1 + Po2 + M.F + Pop + NW + U1 + U2 + Wealth +
##     Ineq + Prob
##
##           Df Sum of Sq     RSS     AIC
## - NW      1    0.0780  9.2758 -52.269
## - Po2     1    0.1432  9.3409 -51.940
## - Pop     1    0.1859  9.3836 -51.726
## - M.F     1    0.2089  9.4067 -51.610
## - Wealth  1    0.2342  9.4320 -51.484
## <none>             9.1977 -50.666
## - U1      1    0.5412  9.7389 -49.979
## + LF      1    0.0704  9.1273 -49.027
## + Time    1    0.0668  9.1309 -49.009
## + So      1    0.0204  9.1774 -48.770
## - Po1     1    0.8283 10.0260 -48.613
## - U2      1    1.2752 10.4729 -46.564
## - M       1    1.4555 10.6532 -45.761
## - Prob    1    1.5173 10.7151 -45.489
## - Ed      1    2.7627 11.9604 -40.322
## - Ineq    1    3.3489 12.5466 -38.073
##
## Step:  AIC=-52.27
## Crime ~ M + Ed + Po1 + Po2 + M.F + Pop + U1 + U2 + Wealth + Ineq +
##     Prob
##
##           Df Sum of Sq     RSS     AIC
## - Po2     1    0.1117  9.3875 -53.706
## - Pop     1    0.1724  9.4482 -53.403
## - M.F     1    0.1791  9.4549 -53.370
## - Wealth  1    0.2109  9.4867 -53.212
## <none>             9.2758 -52.269
## - U1      1    0.5608  9.8365 -51.510
## + NW      1    0.0780  9.1977 -50.666
## + So      1    0.0482  9.2276 -50.514
## + LF      1    0.0450  9.2308 -50.497
## + Time    1    0.0303  9.2455 -50.423
## - Po1     1    0.7912 10.0670 -50.422
```

```
## - U2      1    1.3467 10.6225 -47.897
## - Prob    1    1.4491 10.7249 -47.446
## - M       1    2.0671 11.3429 -44.813
## - Ed      1    2.6925 11.9683 -42.291
## - Ineq    1    3.9425 13.2183 -37.622
##
## Step:  AIC=-53.71
## Crime ~ M + Ed + Po1 + M.F + Pop + U1 + U2 + Wealth + Ineq +
##     Prob
##
##            Df Sum of Sq    RSS     AIC
## - Pop     1    0.1494  9.5369 -54.964
## - Wealth  1    0.2149  9.6024 -54.643
## - M.F     1    0.2461  9.6335 -54.490
## <none>                 9.3875 -53.706
## - U1      1    0.5774  9.9649 -52.901
## + Po2     1    0.1117  9.2758 -52.269
## + NW      1    0.0465  9.3409 -51.940
## + So      1    0.0254  9.3620 -51.834
## + LF      1    0.0133  9.3742 -51.773
## + Time    1    0.0038  9.3836 -51.725
## - U2      1    1.3759 10.7634 -49.278
## - Prob    1    1.4614 10.8489 -48.906
## - M       1    2.0523 11.4398 -46.413
## - Ed      1    2.6039 11.9914 -44.200
## - Ineq    1    4.0688 13.4562 -38.783
## - Po1     1    7.0208 16.4082 -29.461
##
## Step:  AIC=-54.96
## Crime ~ M + Ed + Po1 + M.F + U1 + U2 + Wealth + Ineq + Prob
##
##            Df Sum of Sq    RSS     AIC
## - Wealth  1    0.1771  9.7140 -56.099
## <none>                 9.5369 -54.964
## - M.F     1    0.5648 10.1017 -54.260
## - U1      1    0.6649 10.2018 -53.797
## + Pop     1    0.1494  9.3875 -53.706
## + Po2     1    0.0886  9.4482 -53.403
## + NW      1    0.0396  9.4972 -53.160
## + So      1    0.0383  9.4986 -53.153
## + LF      1    0.0346  9.5023 -53.135
## + Time    1    0.0262  9.5107 -53.093
## - Prob    1    1.3275 10.8643 -50.839
## - U2      1    1.3964 10.9333 -50.542
## - M       1    2.1454 11.6823 -47.427
## - Ed      1    2.5856 12.1225 -45.689
## - Ineq    1    3.9762 13.5130 -40.585
## - Po1     1    7.5360 17.0729 -29.595
##
## Step:  AIC=-56.1
## Crime ~ M + Ed + Po1 + M.F + U1 + U2 + Ineq + Prob
##
##            Df Sum of Sq    RSS     AIC
## <none>                 9.7140 -56.099
```

```
## + Wealth  1    0.1771  9.5369 -54.964
## - M.F     1    0.6896 10.4036 -54.876
## + Pop     1    0.1116  9.6024 -54.643
## + Po2     1    0.0946  9.6194 -54.559
## + So      1    0.0624  9.6516 -54.402
## + LF      1    0.0292  9.6847 -54.241
## + NW      1    0.0254  9.6886 -54.222
## + Time    1    0.0153  9.6986 -54.174
## - U1      1    0.8493 10.5633 -54.160
## - Prob    1    1.6578 11.3717 -50.694
## - U2      1    1.7077 11.4216 -50.488
## - M       1    1.9841 11.6981 -49.364
## - Ed      1    2.9802 12.6941 -45.523
## - Ineq    1    4.9353 14.6492 -38.791
## - Po1     1   11.1778 20.8918 -22.107
```

```
model.step.aic$anova
```

```
## Stepwise Model Path
## Analysis of Deviance Table
##
## Initial Model:
## Crime ~ M + So + Ed + Po1 + Po2 + LF + M.F + Pop + NW + U1 +
##     U2 + Wealth + Ineq + Prob + Time
##
## Final Model:
## Crime ~ M + Ed + Po1 + M.F + U1 + U2 + Ineq + Prob
##
##
##         Step Df     Deviance Resid. Df Resid. Dev       AIC
## 1                                   31   9.058009 -45.38542
## 2      - So  1 0.0001910216        32   9.058200 -47.38443
## 3    - Time  1 0.0691288785        33   9.127329 -49.02710
## 4      - LF  1 0.0704156967        34   9.197745 -50.66590
## 5      - NW  1 0.0780466621        35   9.275791 -52.26876
## 6     - Po2  1 0.1116843137        36   9.387476 -53.70625
## 7     - Pop  1 0.1493820171        37   9.536858 -54.96423
## 8 - Wealth  1 0.1771111995        38   9.713969 -56.09938
```

```r
x = as.matrix(crime.scale[-16])
y = as.matrix(crime.scale[16])



# Lasso, ridge, elastic net cross validation

model.lasso = glmnet(x = x, y = y,
                     family = 'gaussian', alpha = 1)



#Results
#Numbers of coefficients upper, lambda x, mse y
plot(model.lasso, xvar = "lambda")
```
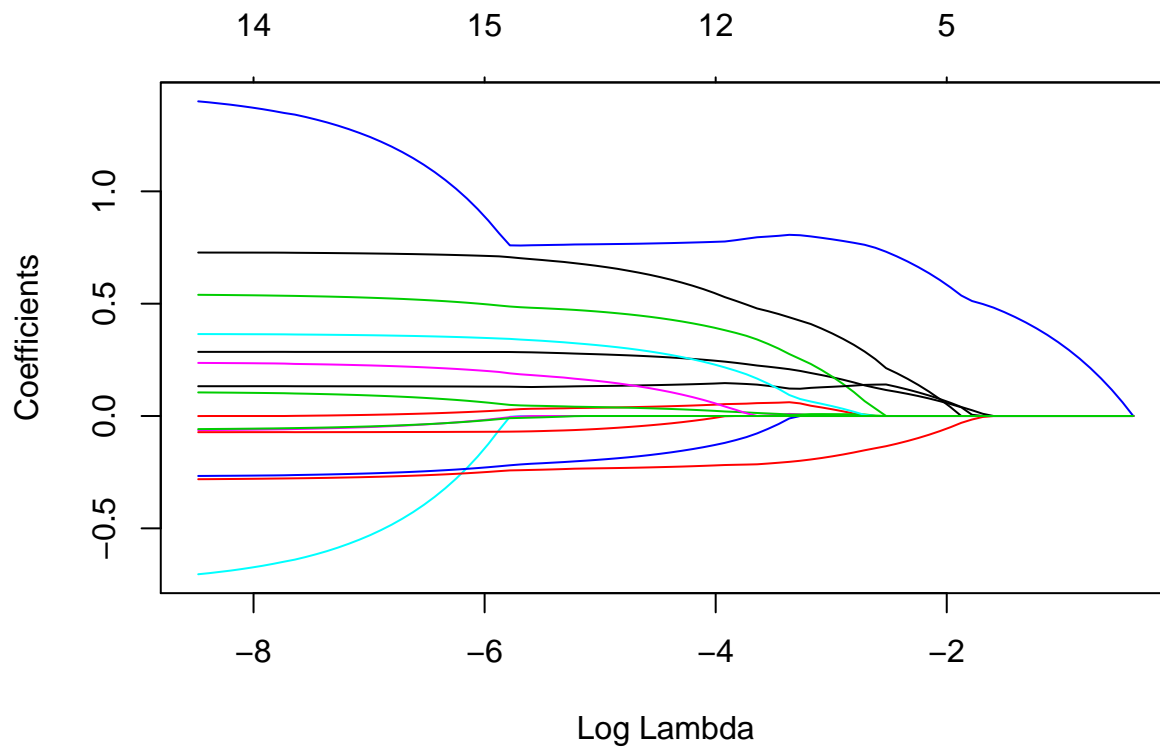
```
coef(model.lasso, s = model.lasso$lambda.min)
```

```
## 16 x 88 sparse Matrix of class "dgCMatrix"
```

```
##     [[ suppressing 88 column names 's0', 's1', 's2' ... ]]
```

```
##
## (Intercept) -1.465841e-16 -1.460278e-16 -1.455209e-16 -1.450591e-16
## M             .             .             .             .
## So            .             .             .             .
## Ed            .             .             .             .
## Po1           .             6.108488e-02  1.167432e-01  1.674569e-01
## Po2           .             .             .             .
## LF            .             .             .             .
## M.F           .             .             .             .
## Pop           .             .             .             .
## NW            .             .             .             .
## U1            .             .             .             .
## U2            .             .             .             .
## Wealth        .             .             .             .
## Ineq          .             .             .             .
## Prob          .             .             .             .
## Time          .             .             .             .
##
## (Intercept) -1.446382e-16 -1.442548e-16 -1.439054e-16 -1.435870e-16
## M             .             .             .             .
## So            .             .             .             .
## Ed            .             .             .             .
## Po1          2.136654e-01  2.557688e-01  2.941319e-01  3.290869e-01
```

```
## Po2            .              .              .              .
## LF             .              .              .              .
## M.F            .              .              .              .
## Pop            .              .              .              .
## NW             .              .              .              .
## U1             .              .              .              .
## U2             .              .              .              .
## Wealth         .              .              .              .
## Ineq           .              .              .              .
## Prob           .              .              .              .
## Time           .              .              .              .
##
## (Intercept) -1.432970e-16 -1.430327e-16 -1.427919e-16 -1.425724e-16
## M              .              .              .              .
## So             .              .              .              .
## Ed             .              .              .              .
## Po1          3.609366e-01  3.899569e-01  4.163991e-01  4.404922e-01
## Po2            .              .              .              .
## LF             .              .              .              .
## M.F            .              .              .              .
## Pop            .              .              .              .
## NW             .              .              .              .
## U1             .              .              .              .
## U2             .              .              .              .
## Wealth         .              .              .              .
## Ineq           .              .              .              .
## Prob           .              .              .              .
## Time           .              .              .              .
##
## (Intercept) -1.423725e-16 -1.421903e-16 -1.487712e-16 -1.617987e-16
## M              .              .              .           5.369483e-03
## So             .              .              .              .
## Ed             .              .              .              .
## Po1          4.624450e-01  4.824475e-01  4.983904e-01  5.117919e-01
## Po2            .              .              .              .
## LF             .              .              .              .
## M.F            .              .           9.947910e-03  2.567674e-02
## Pop            .              .              .              .
## NW             .              .              .              .
## U1             .              .              .              .
## U2             .              .              .              .
## Wealth         .              .              .              .
## Ineq           .              .              .              .
## Prob           .              .          -4.123119e-03 -1.552643e-02
## Time           .              .              .              .
##
## (Intercept) -1.886374e-16 -2.222194e-16 -2.528547e-16 -2.807552e-16
## M            3.870868e-02  5.309193e-02  6.604337e-02  7.798625e-02
## So             .              .              .              .
## Ed             .              .              .              .
## Po1          5.362635e-01  5.723862e-01  6.054400e-01  6.354735e-01
## Po2            .              .              .              .
## LF             .              .              .              .
## M.F          4.018237e-02  5.875653e-02  7.573368e-02  9.116445e-02
```

```
## Pop              .               .               .               .
## NW               .               .               .               .
## U1               .               .               .               .
## U2               .               .               .               .
## Wealth           .               .               .               .
## Ineq             .            3.943430e-02  7.558726e-02  1.083589e-01
## Prob         -3.037812e-02  -4.966918e-02 -6.722508e-02 -8.323537e-02
## Time             .               .               .               .
##
## (Intercept) -3.061654e-16 -3.293185e-16 -3.504148e-16 -3.694731e-16
## M            8.879298e-02  9.864001e-02  1.076123e-01  1.157874e-01
## So               .               .               .               .
## Ed               .               .               .            1.884051e-04
## Po1          6.628522e-01  6.877991e-01  7.105297e-01  7.311501e-01
## Po2              .               .               .               .
## LF               .               .               .               .
## M.F          1.052353e-01  1.180562e-01  1.297381e-01  1.403030e-01
## Pop              .               .               .               .
## NW               .               .               .               .
## U1               .               .               .               .
## U2               .               .               .               .
## Wealth           .               .               .               .
## Ineq         1.382753e-01  1.655342e-01  1.903715e-01  2.130764e-01
## Prob        -9.781545e-02 -1.111003e-01 -1.232049e-01 -1.342423e-01
## Time             .               .               .               .
##
## (Intercept) -3.647061e-16 -3.583455e-16 -3.464805e-16 -3.360968e-16
## M            1.257430e-01  1.364218e-01  1.494782e-01  1.614566e-01
## So               .            7.360847e-04  1.080558e-02  2.082223e-02
## Ed           3.324326e-02  6.651345e-02  1.067465e-01  1.425311e-01
## Po1          7.488734e-01  7.622047e-01  7.709699e-01  7.789440e-01
## Po2              .               .               .               .
## LF               .               .               .               .
## M.F          1.397168e-01  1.385868e-01  1.353634e-01  1.326629e-01
## Pop              .               .               .               .
## NW           2.127491e-03  6.923580e-03  7.823401e-03  8.163900e-03
## U1               .               .               .               .
## U2               .            4.909071e-03  1.919877e-02  3.204789e-02
## Wealth           .               .               .               .
## Ineq         2.532281e-01  2.870115e-01  3.168773e-01  3.431307e-01
## Prob        -1.433736e-01 -1.524170e-01 -1.621758e-01 -1.712377e-01
## Time             .               .               .               .
##
## (Intercept) -3.266856e-16 -3.181104e-16 -3.094884e-16 -2.982973e-16
## M            1.723602e-01  1.822966e-01  1.913769e-01  2.007211e-01
## So           2.985787e-02  3.809355e-02  4.579905e-02  5.617018e-02
## Ed           1.751316e-01  2.048353e-01  2.316164e-01  2.538630e-01
## Po1          7.863357e-01  7.930698e-01  7.994261e-01  8.046182e-01
## Po2              .               .               .               .
## LF               .               .            1.238633e-03  7.469092e-03
## M.F          1.301819e-01  1.279215e-01  1.253784e-01  1.214060e-01
## Pop              .               .               .               .
## NW           8.380552e-03  8.577376e-03  8.439516e-03  6.861683e-03
## U1               .               .               .               .
```

```
## U2            4.374018e-02  5.439408e-02  6.453463e-02  7.576208e-02
## Wealth              .             .             .             .
## Ineq          3.672462e-01  3.892159e-01  4.093795e-01  4.243990e-01
## Prob         -1.794371e-01 -1.869089e-01 -1.934599e-01 -1.992222e-01
## Time               .             .             .             .
##
## (Intercept) -2.943771e-16 -2.983091e-16 -3.016557e-16 -3.046715e-16
## M            2.083090e-01  2.143137e-01  2.197813e-01  2.247676e-01
## So           6.143352e-02  5.938496e-02  5.830696e-02  5.738635e-02
## Ed           2.758070e-01  3.000769e-01  3.213600e-01  3.407168e-01
## Po1          8.063720e-01  8.020148e-01  7.986546e-01  7.955957e-01
## Po2                .             .             .             .
## LF           9.414414e-03  5.762247e-03  2.887387e-03  3.021195e-04
## M.F          1.221930e-01  1.288092e-01  1.345463e-01  1.397577e-01
## Pop                .             .             .             .
## NW           6.355609e-03  9.368004e-03  1.148901e-02  1.340837e-02
## U1          -1.076307e-02 -3.577858e-02 -5.754773e-02 -7.733692e-02
## U2           9.343705e-02  1.207421e-01  1.447435e-01  1.665824e-01
## Wealth             .             .             .             .
## Ineq         4.393192e-01  4.538892e-01  4.669237e-01  4.787490e-01
## Prob        -2.039764e-01 -2.079189e-01 -2.115324e-01 -2.148360e-01
## Time               .             .             .             .
##
## (Intercept) -3.074901e-16 -3.103874e-16 -3.129545e-16 -3.133367e-16
## M            2.309848e-01  2.368530e-01  2.420757e-01  2.465627e-01
## So           5.507658e-02  5.397527e-02  5.295032e-02  5.042014e-02
## Ed           3.569551e-01  3.701484e-01  3.820119e-01  3.933085e-01
## Po1          7.892436e-01  7.825085e-01  7.767127e-01  7.750817e-01
## Po2                .             .             .             .
## LF                 .             .             .             .
## M.F          1.425856e-01  1.447811e-01  1.464657e-01  1.445178e-01
## Pop                .             .            -9.083221e-04 -8.622515e-03
## NW           1.598125e-02  1.822232e-02  2.022464e-02  2.306971e-02
## U1          -9.390151e-02 -1.073457e-01 -1.195053e-01 -1.296086e-01
## U2           1.858803e-01  2.017781e-01  2.162493e-01  2.295687e-01
## Wealth       1.242575e-02  2.782691e-02  4.244624e-02  5.781035e-02
## Ineq         4.961557e-01  5.130815e-01  5.291168e-01  5.479412e-01
## Prob        -2.160509e-01 -2.170651e-01 -2.181077e-01 -2.200107e-01
## Time               .             .             .             .
##
## (Intercept) -3.138094e-16 -3.142308e-16 -3.146152e-16 -3.149655e-16
## M            2.505483e-01  2.541835e-01  2.574941e-01  2.605084e-01
## So           4.850116e-02  4.674977e-02  4.515873e-02  4.371560e-02
## Ed           4.033644e-01  4.125514e-01  4.209180e-01  4.285369e-01
## Po1          7.735709e-01  7.721855e-01  7.709252e-01  7.697799e-01
## Po2                .             .             .             .
## LF                 .             .             .             .
## M.F          1.429518e-01  1.415339e-01  1.402431e-01  1.390686e-01
## Pop         -1.546299e-02 -2.168851e-02 -2.736017e-02 -3.252669e-02
## NW           2.542826e-02  2.758818e-02  2.955422e-02  3.134311e-02
## U1          -1.387641e-01 -1.471333e-01 -1.547556e-01 -1.616968e-01
## U2           2.415699e-01  2.525356e-01  2.625229e-01  2.716181e-01
## Wealth       7.160073e-02  8.411750e-02  9.551875e-02  1.058998e-01
## Ineq         5.647348e-01  5.800000e-01  5.939043e-01  6.065654e-01
```

```
## Prob        -2.217979e-01 -2.234308e-01 -2.249200e-01 -2.262789e-01
## Time          .             .             .             .
##
## (Intercept) -3.152844e-16 -3.155748e-16 -3.158388e-16 -3.160786e-16
## M             2.632526e-01  2.657502e-01  2.680230e-01  2.700905e-01
## So            4.240729e-02  4.122200e-02  4.014910e-02  3.917902e-02
## Ed            4.354745e-01  4.417910e-01  4.475416e-01  4.527764e-01
## Po1           7.687395e-01  7.677946e-01  7.669372e-01  7.661597e-01
## Po2           .             .             .             .
## LF            .             .             .             .
## M.F           1.380001e-01  1.370285e-01  1.361453e-01  1.353429e-01
## Pop          -3.723288e-02 -4.151960e-02 -4.542407e-02 -4.898014e-02
## NW            3.297085e-02  3.445197e-02  3.579975e-02  3.702627e-02
## U1           -1.680174e-01 -1.737725e-01 -1.790121e-01 -1.837816e-01
## U2            2.799004e-01  2.874420e-01  2.943082e-01  3.005588e-01
## Wealth        1.153505e-01  1.239529e-01  1.317809e-01  1.389017e-01
## Ineq          6.180932e-01  6.285875e-01  6.381394e-01  6.468310e-01
## Prob         -2.275193e-01 -2.286519e-01 -2.296865e-01 -2.306323e-01
## Time          .             .             .             .
##
## (Intercept) -3.164261e-16 -3.166270e-16 -3.168075e-16 -3.169715e-16
## M             2.719011e-01  2.736089e-01  2.751650e-01  2.765794e-01
## So            3.830128e-02  3.752564e-02  3.681096e-02  3.616710e-02
## Ed            4.573892e-01  4.617094e-01  4.656575e-01  4.692482e-01
## Po1           7.656205e-01  7.650043e-01  7.644342e-01  7.639208e-01
## Po2           .             .             .             .
## LF            .             .             .             .
## M.F           1.345736e-01  1.339095e-01  1.333085e-01  1.327626e-01
## Pop          -5.233185e-02 -5.528182e-02 -5.796845e-02 -6.041533e-02
## NW            3.796430e-02  3.896378e-02  3.988365e-02  4.071987e-02
## U1           -1.880392e-01 -1.919650e-01 -1.955583e-01 -1.988246e-01
## U2            3.061123e-01  3.112647e-01  3.159763e-01  3.202606e-01
## Wealth        1.456921e-01  1.515767e-01  1.569261e-01  1.617894e-01
## Ineq          6.551871e-01  6.623830e-01  6.689315e-01  6.748882e-01
## Prob         -2.314593e-01 -2.322522e-01 -2.329755e-01 -2.336374e-01
## Time          .             .             .             .
##
## (Intercept) -3.171155e-16 -3.175001e-16 -3.177270e-16 -3.179885e-16
## M             2.780147e-01  2.796905e-01  2.809979e-01  2.823311e-01
## So            3.553718e-02  3.431198e-02  3.381973e-02  3.296149e-02
## Ed            4.724557e-01  4.752143e-01  4.775428e-01  4.798922e-01
## Po1           7.635040e-01  7.622323e-01  7.616035e-01  7.606867e-01
## Po2           .             .             .             .
## LF            .             .             .             .
## M.F           1.320827e-01  1.311250e-01  1.304618e-01  1.297632e-01
## Pop          -6.252660e-02 -6.411680e-02 -6.551911e-02 -6.684162e-02
## NW            4.151610e-02  4.295821e-02  4.393970e-02  4.501316e-02
## U1           -2.018168e-01 -2.049728e-01 -2.075236e-01 -2.101810e-01
## U2            3.242001e-01  3.282070e-01  3.314973e-01  3.348574e-01
## Wealth        1.662041e-01  1.713263e-01  1.748378e-01  1.786966e-01
## Ineq          6.803189e-01  6.858792e-01  6.900246e-01  6.943435e-01
## Prob         -2.344990e-01 -2.361113e-01 -2.375701e-01 -2.388128e-01
## Time         -6.845437e-04 -2.665347e-03 -4.253191e-03 -5.767509e-03
##
```

```
## (Intercept) -3.183098e-16 -3.204461e-16 -3.220302e-16 -3.092099e-16
## M          2.834650e-01  2.842335e-01  2.848985e-01  2.849671e-01
## So         3.230554e-02  3.075310e-02  2.797934e-02  2.457911e-02
## Ed         4.818075e-01  4.841922e-01  4.873763e-01  4.917930e-01
## Po1        7.600610e-01  7.588239e-01  7.595837e-01  8.131146e-01
## Po2        .             .            -3.320027e-03 -6.238935e-02
## LF        -3.670299e-05 -2.174018e-03 -5.012740e-03 -1.052120e-02
## M.F        1.291136e-01  1.297524e-01  1.305851e-01  1.307988e-01
## Pop       -6.808607e-02 -6.890612e-02 -6.947080e-02 -6.987925e-02
## NW         4.583804e-02  4.720623e-02  4.938949e-02  5.442931e-02
## U1        -2.123677e-01 -2.154383e-01 -2.193124e-01 -2.236148e-01
## U2         3.376290e-01  3.402012e-01  3.432623e-01  3.450458e-01
## Wealth     1.822399e-01  1.855857e-01  1.899468e-01  1.960539e-01
## Ineq       6.983460e-01  7.022820e-01  7.068486e-01  7.105986e-01
## Prob      -2.399513e-01 -2.411287e-01 -2.420455e-01 -2.452590e-01
## Time      -7.122194e-03 -8.331078e-03 -9.616500e-03 -1.387851e-02
##
## (Intercept) -2.948081e-16 -2.816649e-16 -2.696963e-16 -2.588104e-16
## M          2.850174e-01  2.850629e-01  2.851044e-01  2.851425e-01
## So         2.203148e-02  1.970874e-02  1.759287e-02  1.566635e-02
## Ed         4.963750e-01  5.005533e-01  5.043592e-01  5.078240e-01
## Po1        8.697180e-01  9.213688e-01  9.684053e-01  1.011193e+00
## Po2       -1.241773e-01 -1.805567e-01 -2.319001e-01 -2.786073e-01
## LF        -1.559049e-02 -2.021373e-02 -2.442477e-02 -2.825770e-02
## M.F        1.309785e-01  1.311417e-01  1.312905e-01  1.314266e-01
## Pop       -7.008828e-02 -7.027856e-02 -7.045199e-02 -7.061020e-02
## NW         5.933925e-02  6.381805e-02  6.789723e-02  7.160930e-02
## U1        -2.278044e-01 -2.316239e-01 -2.351033e-01 -2.382717e-01
## U2         3.469555e-01  3.486953e-01  3.502805e-01  3.517252e-01
## Wealth     1.998966e-01  2.033993e-01  2.065904e-01  2.094966e-01
## Ineq       7.123039e-01  7.138558e-01  7.152704e-01  7.165612e-01
## Prob      -2.486984e-01 -2.518358e-01 -2.546933e-01 -2.572936e-01
## Time      -1.814620e-02 -2.203920e-02 -2.558484e-02 -2.881136e-02
##
## (Intercept) -2.489188e-16 -2.398597e-16 -2.316000e-16 -2.240879e-16
## M          2.851777e-01  2.852090e-01  2.852375e-01  2.852636e-01
## So         1.391290e-02  1.231186e-02  1.085256e-02  9.523711e-03
## Ed         5.109766e-01  5.138564e-01  5.164813e-01  5.188708e-01
## Po1        1.050079e+00  1.085680e+00  1.118139e+00  1.147664e+00
## Po2       -3.210597e-01 -3.599200e-01 -3.953498e-01 -4.275786e-01
## LF        -3.174448e-02 -3.493114e-02 -3.783594e-02 -4.047990e-02
## M.F        1.315512e-01  1.316637e-01  1.317661e-01  1.318597e-01
## Pop       -7.075462e-02 -7.088580e-02 -7.100528e-02 -7.111428e-02
## NW         7.498496e-02  7.807203e-02  8.088625e-02  8.344716e-02
## U1        -2.411558e-01 -2.437884e-01 -2.461876e-01 -2.483724e-01
## U2         3.530420e-01  3.542410e-01  3.553334e-01  3.563290e-01
## Wealth     2.121429e-01  2.145575e-01  2.167582e-01  2.187627e-01
## Ineq       7.177399e-01  7.188097e-01  7.197842e-01  7.206736e-01
## Prob      -2.596583e-01 -2.618208e-01 -2.637921e-01 -2.655859e-01
## Time      -3.174542e-02 -3.442873e-02 -3.687487e-02 -3.910076e-02
##
## (Intercept) -2.172688e-16 -2.110100e-16 -2.053768e-16 -2.001477e-16
## M          2.852878e-01  2.853092e-01  2.853299e-01  2.853472e-01
## So         8.314490e-03  7.209321e-03  6.206800e-03  5.286810e-03
```

```
## Ed              5.210441e-01  5.230317e-01  5.248321e-01  5.264877e-01
## Po1             1.174472e+00  1.199065e+00  1.221220e+00  1.241758e+00
## Po2            -4.568454e-01 -4.836887e-01 -5.078787e-01 -5.302919e-01
## LF             -4.288382e-02 -4.508369e-02 -4.707399e-02 -4.890722e-02
## M.F             1.319456e-01  1.320229e-01  1.320951e-01  1.321586e-01
## Pop            -7.121383e-02 -7.130410e-02 -7.138694e-02 -7.146151e-02
## NW              8.577449e-02  8.790626e-02  8.983206e-02  9.161007e-02
## U1             -2.503607e-01 -2.521771e-01 -2.538257e-01 -2.553373e-01
## U2              3.572366e-01  3.580631e-01  3.588175e-01  3.595036e-01
## Wealth          2.205876e-01  2.222536e-01  2.237668e-01  2.251516e-01
## Ineq            7.214866e-01  7.222232e-01  7.229009e-01  7.235091e-01
## Prob           -2.672159e-01 -2.687090e-01 -2.700575e-01 -2.713027e-01
## Time           -4.112347e-02 -4.297625e-02 -4.464965e-02 -4.619491e-02
## 
## (Intercept)   -1.954954e-16 -1.911923e-16 -1.872435e-16 -1.836398e-16
## M               2.853649e-01  2.853800e-01  2.853933e-01  2.854054e-01
## So              4.455855e-03  3.694865e-03  2.999679e-03  2.366176e-03
## Ed              5.279795e-01  5.293486e-01  5.306007e-01  5.317427e-01
## Po1             1.260060e+00  1.276970e+00  1.292478e+00  1.306629e+00
## Po2            -5.502790e-01 -5.687373e-01 -5.856628e-01 -6.011057e-01
## LF             -5.055463e-02 -5.206854e-02 -5.345359e-02 -5.471652e-02
## M.F             1.322193e-01  1.322731e-01  1.323214e-01  1.323654e-01
## Pop            -7.153032e-02 -7.159242e-02 -7.164868e-02 -7.169979e-02
## NW              9.320336e-02  9.467029e-02  9.601365e-02  9.723896e-02
## U1             -2.567045e-01 -2.579562e-01 -2.590997e-01 -2.601422e-01
## U2              3.601314e-01  3.607022e-01  3.612223e-01  3.616963e-01
## Wealth          2.264050e-01  2.275506e-01  2.285955e-01  2.295468e-01
## Ineq            7.240733e-01  7.245807e-01  7.250399e-01  7.254568e-01
## Prob           -2.724182e-01 -2.734455e-01 -2.743864e-01 -2.752447e-01
## Time           -4.757897e-02 -4.885363e-02 -5.002094e-02 -5.108570e-02
## 
## (Intercept)   -1.804446e-16 -1.774602e-16 -1.747758e-16 -1.731350e-16
## M               2.854180e-01  2.854281e-01  2.854380e-01  2.855739e-01
## So              1.795995e-03  1.271454e-03  7.970977e-04  9.134709e-06
## Ed              5.327702e-01  5.337165e-01  5.345738e-01  5.353907e-01
## Po1             1.319196e+00  1.330915e+00  1.341462e+00  1.348861e+00
## Po2            -6.148298e-01 -6.276202e-01 -6.391342e-01 -6.481716e-01
## LF             -5.584826e-02 -5.689471e-02 -5.784010e-02 -5.889040e-02
## M.F             1.324078e-01  1.324443e-01  1.324785e-01  1.327824e-01
## Pop            -7.174687e-02 -7.178942e-02 -7.182822e-02 -7.166464e-02
## NW              9.833369e-02  9.934853e-02  1.002643e-01  1.013957e-01
## U1             -2.610840e-01 -2.619480e-01 -2.627321e-01 -2.638455e-01
## U2              3.621308e-01  3.625239e-01  3.628835e-01  3.635015e-01
## Wealth          2.304039e-01  2.311926e-01  2.319051e-01  2.334486e-01
## Ineq            7.258424e-01  7.261887e-01  7.265048e-01  7.270515e-01
## Prob           -2.760117e-01 -2.767230e-01 -2.773652e-01 -2.778658e-01
## Time           -5.203669e-02 -5.291889e-02 -5.371492e-02 -5.445790e-02
## 
## (Intercept)   -1.707058e-16 -1.684404e-16 -1.664492e-16 -1.645955e-16
## M               2.855666e-01  2.855471e-01  2.855308e-01  2.855150e-01
## So              .             .             .             .
## Ed              5.361002e-01  5.367345e-01  5.373031e-01  5.378264e-01
## Po1             1.357566e+00  1.365716e+00  1.372886e+00  1.379558e+00
## Po2            -6.576675e-01 -6.664877e-01 -6.742569e-01 -6.814805e-01
```

```
## LF           -5.953043e-02 -6.011408e-02 -6.063445e-02 -6.111482e-02
## M.F           1.327475e-01  1.327229e-01  1.327054e-01  1.326871e-01
## Pop          -7.170476e-02 -7.173601e-02 -7.176329e-02 -7.178871e-02
## NW            1.020210e-01  1.025834e-01  1.030820e-01  1.035436e-01
## U1           -2.643453e-01 -2.647937e-01 -2.652008e-01 -2.655730e-01
## U2            3.637193e-01  3.639081e-01  3.640851e-01  3.642442e-01
## Wealth        2.340725e-01  2.345001e-01  2.348841e-01  2.352350e-01
## Ineq          7.272184e-01  7.272832e-01  7.273472e-01  7.274019e-01
## Prob         -2.784360e-01 -2.789692e-01 -2.794429e-01 -2.798812e-01
## Time         -5.508981e-02 -5.567007e-02 -5.618447e-02 -5.666082e-02
##
## (Intercept) -1.628821e-16 -1.614254e-16 -1.599722e-16 -1.588429e-16
## M            2.854997e-01  2.854881e-01  2.854751e-01  2.854717e-01
## So            .             .             .            -1.272354e-04
## Ed            5.383064e-01  5.387287e-01  5.391318e-01  5.394732e-01
## Po1           1.385723e+00  1.390974e+00  1.396199e+00  1.400532e+00
## Po2          -6.881507e-01 -6.938468e-01 -6.994970e-01 -7.042016e-01
## LF           -6.155628e-02 -6.194199e-02 -6.231340e-02 -6.267794e-02
## M.F           1.326692e-01  1.326590e-01  1.326421e-01  1.326530e-01
## Pop          -7.181216e-02 -7.183203e-02 -7.185201e-02 -7.186545e-02
## NW            1.039684e-01  1.043361e-01  1.046948e-01  1.050429e-01
## U1           -2.659129e-01 -2.662179e-01 -2.665016e-01 -2.667971e-01
## U2            3.643876e-01  3.645229e-01  3.646409e-01  3.647735e-01
## Wealth        2.355529e-01  2.358389e-01  2.361070e-01  2.363407e-01
## Ineq          7.274482e-01  7.274996e-01  7.275368e-01  7.276124e-01
## Prob         -2.802845e-01 -2.806348e-01 -2.809747e-01 -2.812518e-01
## Time         -5.709938e-02 -5.747880e-02 -5.784903e-02 -5.817274e-02
```
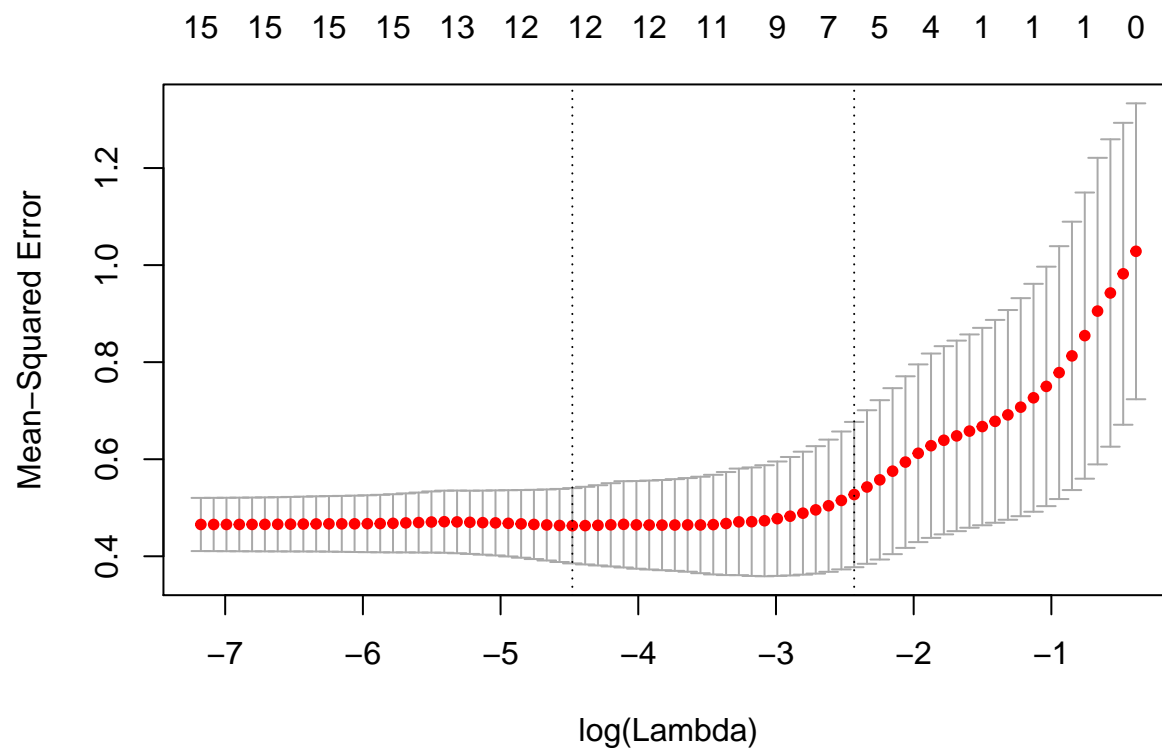
```
# Lasso cross validation

model.lasso.cv =  cv.glmnet(x = x, y = y,
                  family = 'gaussian', alpha = 1, nfolds = 5)



#Results
#suggest between 5 to 12 coerfficients
plot(model.lasso.cv, xvar="lambda")
```

```
model.lasso.cv$lambda.min
```

```
## [1] 0.01134726
```

```
model.lasso.cv$lambda.1se
```

```
## [1] 0.08785769
```

```r
coef(model.lasso.cv, s = model.lasso.cv$lambda.min) #best coefficients
```

```
## 16 x 1 sparse Matrix of class "dgCMatrix"
##                          1
## (Intercept) -3.152844e-16
## M            2.632526e-01
## So           4.240729e-02
## Ed           4.354745e-01
## Po1          7.687395e-01
## Po2          .
## LF           .
## M.F          1.380001e-01
## Pop         -3.723288e-02
## NW           3.297085e-02
## U1          -1.680174e-01
## U2           2.799004e-01
## Wealth       1.153505e-01
## Ineq         6.180932e-01
## Prob        -2.275193e-01
## Time         .
```

```
#alpha comparation


# alpha comparison plots lasso, ridge, elastic net
cv.alpha.0 =  cv.glmnet(x = x, y = y,
                        family = 'gaussian', alpha = 0, nfolds = 5)
cv.alpha.05 =  cv.glmnet(x = x, y = y,
                         family = 'gaussian', alpha = 0.5, nfolds = 5)
cv.alpha.1 = cv.glmnet(x = x, y = y,
                       family = 'gaussian', alpha = 1, nfolds = 5)

# Elastic Net
plot( log(cv.alpha.0$lambda), cv.alpha.0$cvm, pch = 20, col = "red", xlab = "log(Lambda)", ylab = cv.al
points(log(cv.alpha.05$lambda), cv.alpha.05$cvm, pch = 20, col = "blue")
points(log(cv.alpha.1$lambda), cv.alpha.1$cvm, pch = 20, col="green")
legend("topleft", legend = c("alpha 0 - ridge","alpha .5", "alpha 1 - lasso"), pch = 20, col = c("red",
```
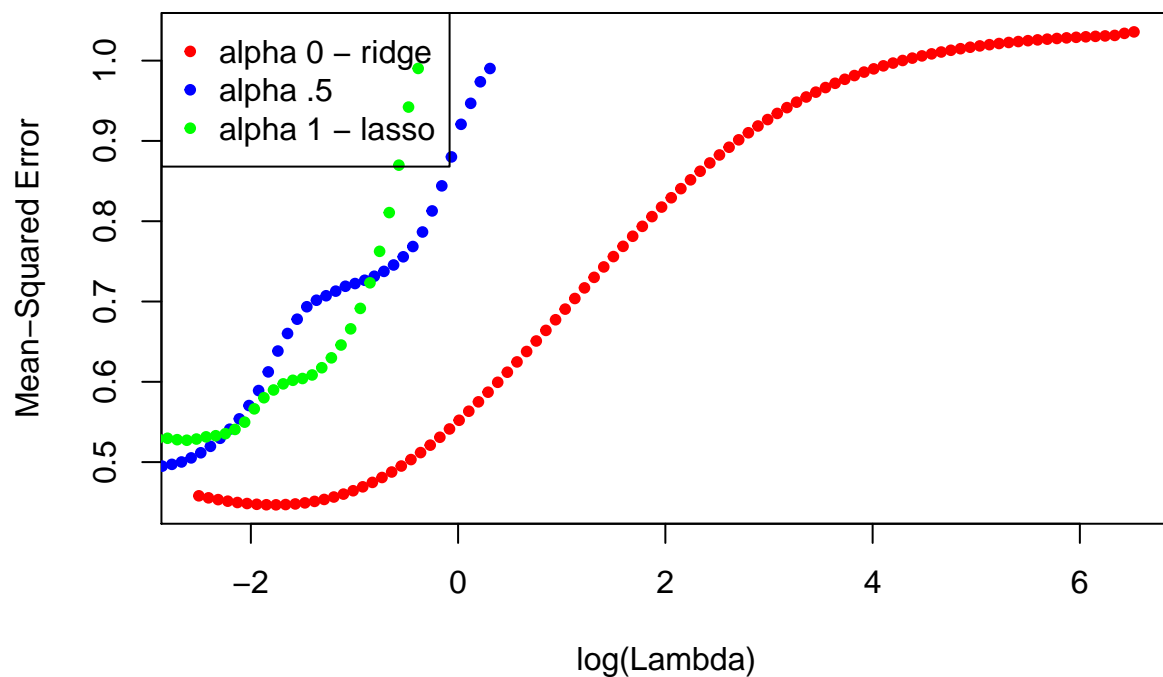

Q2

To determine if which type of music to listen when a person drive to home after work reduce stress. I suggest to evaluate if the driver start drives agressive, temperature, if taking longer than usual to arrive some destination (with gps historial data), car smell. We could evaluate to start playlist to calm down and manipulate car temperature and car smell.

Q3

```
library('FrF2')
```

```
## Loading required package: DoE.base
```

```
## Loading required package: grid

## Loading required package: conf.design

##
## Attaching package: 'DoE.base'

## The following objects are masked from 'package:stats':
##
##     aov, lm

## The following object is masked from 'package:graphics':
##
##     plot.design

## The following object is masked from 'package:base':
##
##     lengths
```

```r
library(knitr)

features <- c('Feature 1','Feature 2','Feature 3','Feature 4','Feature 5', 'Feature 6','Feature 7','Fea

experiment <- FrF2(nruns = 16, factor.names = features, default.levels = c("include", "not include"))

kable(experiment, caption = "Experiment Features")
```

Table 1: Experiment Features

Feature.1	Feature.2	Feature.3	Feature.4	Feature.5	Feature.6	Feature.7	Feature.8	Feature.9
not include	not include	not include	not include	not include	not include	not include	not include	not include
include	include	include	not include	not include	not include	not include	include	not include
not include	include	include	not include	include	include	not include	not include	not include
not include	include	not include	include	include	not include	include	include	not include
not include	include	include	include	include	include	not include	include	include
include	not include	include	not include	include	not include	include	include	include
include	not include	include	include	include	not include	include	not include	not include
include	include	not include	not include	not include	include	include	include	include
include	include	include	include	not include	not include	not include	not include	include
include	not include	not include	not include	include	include	not include	include	not include
not include	not include	include	not include	not include	include	include	not include	include
not include	not include	include	include	not include	include	include	include	not include
include	not include	not include	include	include	include	not include	not include	include
not include	not include	not include	include	not include	not include	not include	include	include
include	include	not include	include	not include	include	include	not include	not include
not include	include	not include	not include	include	not include	include	not include	include

Q4

a. Binomial: The number of successful sales calls

b. Geometric: Expected number of trade win before a bad trade with a robot system

c. Poisson: The daily number of emergency calls in Dallas

d. Exponential: The length of time between arrivals at a service station

e. Weibull