HW8

Using the crime data set uscrime.txt from Questions 8.2, 9.1, and 10.1, build a regression model using: 1. Stepwise regression 2. Lasso 3. Elastic net For Parts 2 and 3, remember to scale the data first – otherwise, the regression coefficients will be on different scales and the constraint won’t have the desired effect.

For Parts 2 and 3, use the glmnet function in R.

Notes on R: • For the elastic net model, what we called λ in the videos, glmnet calls “alpha”; you can get a range of results by varying alpha from 1 (lasso) to 0 (ridge regression) [and, of course, other values of alpha in between]. • In a function call like glmnet(x,y,family=”mgaussian”,alpha=1) the predictors x need to be in R’s matrix format, rather than data frame format. You can convert a data frame to a matrix using as.matrix – for example, x <- as.matrix(data[,1:n-1]) • Rather than specifying a value of T, glmnet returns models for a variety of values of T.

rm(list = ls())  
uscrime <- read.table("uscrime.txt", stringsAsFactors = FALSE, header = TRUE)

perform backwards selection

set.seed(1)  
backwards\_model <- lm(Crime~., data = uscrime)  
  
step(backwards\_model, direction = "backward")

## Start: AIC=514.65  
## 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 29 1354974 512.65  
## - LF 1 8917 1363862 512.96  
## - Time 1 10304 1365250 513.00  
## - Pop 1 14122 1369068 513.14  
## - NW 1 18395 1373341 513.28  
## - M.F 1 31967 1386913 513.74  
## - Wealth 1 37613 1392558 513.94  
## - Po2 1 37919 1392865 513.95  
## <none> 1354946 514.65  
## - U1 1 83722 1438668 515.47  
## - Po1 1 144306 1499252 517.41  
## - U2 1 181536 1536482 518.56  
## - M 1 193770 1548716 518.93  
## - Prob 1 199538 1554484 519.11  
## - Ed 1 402117 1757063 524.86  
## - Ineq 1 423031 1777977 525.42  
##   
## Step: AIC=512.65  
## Crime ~ M + Ed + Po1 + Po2 + LF + M.F + Pop + NW + U1 + U2 +   
## Wealth + Ineq + Prob + Time  
##   
## Df Sum of Sq RSS AIC  
## - Time 1 10341 1365315 511.01  
## - LF 1 10878 1365852 511.03  
## - Pop 1 14127 1369101 511.14  
## - NW 1 21626 1376600 511.39  
## - M.F 1 32449 1387423 511.76  
## - Po2 1 37954 1392929 511.95  
## - Wealth 1 39223 1394197 511.99  
## <none> 1354974 512.65  
## - U1 1 96420 1451395 513.88  
## - Po1 1 144302 1499277 515.41  
## - U2 1 189859 1544834 516.81  
## - M 1 195084 1550059 516.97  
## - Prob 1 204463 1559437 517.26  
## - Ed 1 403140 1758114 522.89  
## - Ineq 1 488834 1843808 525.13  
##   
## Step: AIC=511.01  
## Crime ~ M + Ed + Po1 + Po2 + LF + M.F + Pop + NW + U1 + U2 +   
## Wealth + Ineq + Prob  
##   
## Df Sum of Sq RSS AIC  
## - LF 1 10533 1375848 509.37  
## - NW 1 15482 1380797 509.54  
## - Pop 1 21846 1387161 509.75  
## - Po2 1 28932 1394247 509.99  
## - Wealth 1 36070 1401385 510.23  
## - M.F 1 41784 1407099 510.42  
## <none> 1365315 511.01  
## - U1 1 91420 1456735 512.05  
## - Po1 1 134137 1499452 513.41  
## - U2 1 184143 1549458 514.95  
## - M 1 186110 1551425 515.01  
## - Prob 1 237493 1602808 516.54  
## - Ed 1 409448 1774763 521.33  
## - Ineq 1 502909 1868224 523.75  
##   
## Step: AIC=509.37  
## Crime ~ M + Ed + Po1 + Po2 + M.F + Pop + NW + U1 + U2 + Wealth +   
## Ineq + Prob  
##   
## Df Sum of Sq RSS AIC  
## - NW 1 11675 1387523 507.77  
## - Po2 1 21418 1397266 508.09  
## - Pop 1 27803 1403651 508.31  
## - M.F 1 31252 1407100 508.42  
## - Wealth 1 35035 1410883 508.55  
## <none> 1375848 509.37  
## - U1 1 80954 1456802 510.06  
## - Po1 1 123896 1499744 511.42  
## - U2 1 190746 1566594 513.47  
## - M 1 217716 1593564 514.27  
## - Prob 1 226971 1602819 514.54  
## - Ed 1 413254 1789103 519.71  
## - Ineq 1 500944 1876792 521.96  
##   
## Step: AIC=507.77  
## Crime ~ M + Ed + Po1 + Po2 + M.F + Pop + U1 + U2 + Wealth + Ineq +   
## Prob  
##   
## Df Sum of Sq RSS AIC  
## - Po2 1 16706 1404229 506.33  
## - Pop 1 25793 1413315 506.63  
## - M.F 1 26785 1414308 506.66  
## - Wealth 1 31551 1419073 506.82  
## <none> 1387523 507.77  
## - U1 1 83881 1471404 508.52  
## - Po1 1 118348 1505871 509.61  
## - U2 1 201453 1588976 512.14  
## - Prob 1 216760 1604282 512.59  
## - M 1 309214 1696737 515.22  
## - Ed 1 402754 1790276 517.74  
## - Ineq 1 589736 1977259 522.41  
##   
## Step: AIC=506.33  
## Crime ~ M + Ed + Po1 + M.F + Pop + U1 + U2 + Wealth + Ineq +   
## Prob  
##   
## Df Sum of Sq RSS AIC  
## - Pop 1 22345 1426575 505.07  
## - Wealth 1 32142 1436371 505.39  
## - M.F 1 36808 1441037 505.54  
## <none> 1404229 506.33  
## - U1 1 86373 1490602 507.13  
## - U2 1 205814 1610043 510.76  
## - Prob 1 218607 1622836 511.13  
## - M 1 307001 1711230 513.62  
## - Ed 1 389502 1793731 515.83  
## - Ineq 1 608627 2012856 521.25  
## - Po1 1 1050202 2454432 530.57  
##   
## Step: AIC=505.07  
## Crime ~ M + Ed + Po1 + M.F + U1 + U2 + Wealth + Ineq + Prob  
##   
## Df Sum of Sq RSS AIC  
## - Wealth 1 26493 1453068 503.93  
## <none> 1426575 505.07  
## - M.F 1 84491 1511065 505.77  
## - U1 1 99463 1526037 506.24  
## - Prob 1 198571 1625145 509.20  
## - U2 1 208880 1635455 509.49  
## - M 1 320926 1747501 512.61  
## - Ed 1 386773 1813348 514.35  
## - Ineq 1 594779 2021354 519.45  
## - Po1 1 1127277 2553852 530.44  
##   
## Step: AIC=503.93  
## Crime ~ M + Ed + Po1 + M.F + U1 + U2 + Ineq + Prob  
##   
## Df Sum of Sq RSS AIC  
## <none> 1453068 503.93  
## - M.F 1 103159 1556227 505.16  
## - U1 1 127044 1580112 505.87  
## - Prob 1 247978 1701046 509.34  
## - U2 1 255443 1708511 509.55  
## - M 1 296790 1749858 510.67  
## - Ed 1 445788 1898855 514.51  
## - Ineq 1 738244 2191312 521.24  
## - Po1 1 1672038 3125105 537.93

##   
## Call:  
## lm(formula = Crime ~ M + Ed + Po1 + M.F + U1 + U2 + Ineq + Prob,   
## data = uscrime)  
##   
## Coefficients:  
## (Intercept) M Ed Po1 M.F U1   
## -6426.10 93.32 180.12 102.65 22.34 -6086.63   
## U2 Ineq Prob   
## 187.35 61.33 -3796.03

perform forwards selection

set.seed(1)  
backwards\_model <- lm(Crime~1., data = uscrime)  
  
step(backwards\_model  
 ,scope = formula(lm(Crime~., data = uscrime))  
 ,direction = "forward")

## Start: AIC=561.02  
## Crime ~ 1  
##   
## Df Sum of Sq RSS AIC  
## + Po1 1 3253302 3627626 532.94  
## + Po2 1 3058626 3822302 535.39  
## + Wealth 1 1340152 5540775 552.84  
## + Prob 1 1257075 5623853 553.54  
## + Pop 1 783660 6097267 557.34  
## + Ed 1 717146 6163781 557.85  
## + M.F 1 314867 6566061 560.82  
## <none> 6880928 561.02  
## + LF 1 245446 6635482 561.32  
## + Ineq 1 220530 6660397 561.49  
## + U2 1 216354 6664573 561.52  
## + Time 1 154545 6726383 561.96  
## + So 1 56527 6824400 562.64  
## + M 1 55084 6825844 562.65  
## + U1 1 17533 6863395 562.90  
## + NW 1 7312 6873615 562.97  
##   
## Step: AIC=532.94  
## Crime ~ Po1  
##   
## Df Sum of Sq RSS AIC  
## + Ineq 1 739819 2887807 524.22  
## + M 1 616741 3010885 526.18  
## + M.F 1 250522 3377104 531.57  
## + NW 1 232434 3395192 531.82  
## + So 1 219098 3408528 532.01  
## + Wealth 1 180872 3446754 532.53  
## <none> 3627626 532.94  
## + Po2 1 146167 3481459 533.00  
## + Prob 1 92278 3535348 533.72  
## + LF 1 77479 3550147 533.92  
## + Time 1 43185 3584441 534.37  
## + U2 1 17848 3609778 534.70  
## + Pop 1 5666 3621959 534.86  
## + U1 1 2878 3624748 534.90  
## + Ed 1 767 3626859 534.93  
##   
## Step: AIC=524.22  
## Crime ~ Po1 + Ineq  
##   
## Df Sum of Sq RSS AIC  
## + Ed 1 587050 2300757 515.53  
## + M.F 1 454545 2433262 518.17  
## + Prob 1 280690 2607117 521.41  
## + LF 1 260571 2627236 521.77  
## + Wealth 1 213937 2673871 522.60  
## + M 1 181236 2706571 523.17  
## + Pop 1 130377 2757430 524.04  
## <none> 2887807 524.22  
## + NW 1 36439 2851369 525.62  
## + So 1 33738 2854069 525.66  
## + Po2 1 30673 2857134 525.71  
## + U1 1 2309 2885498 526.18  
## + Time 1 497 2887310 526.21  
## + U2 1 253 2887554 526.21  
##   
## Step: AIC=515.53  
## Crime ~ Po1 + Ineq + Ed  
##   
## Df Sum of Sq RSS AIC  
## + M 1 239405 2061353 512.37  
## + Prob 1 234981 2065776 512.47  
## + M.F 1 117026 2183731 515.08  
## <none> 2300757 515.53  
## + Wealth 1 79540 2221218 515.88  
## + U2 1 62112 2238646 516.25  
## + Time 1 61770 2238987 516.26  
## + Po2 1 42584 2258174 516.66  
## + Pop 1 39319 2261438 516.72  
## + U1 1 7365 2293392 517.38  
## + LF 1 7254 2293503 517.39  
## + NW 1 4210 2296547 517.45  
## + So 1 4135 2296622 517.45  
##   
## Step: AIC=512.37  
## Crime ~ Po1 + Ineq + Ed + M  
##   
## Df Sum of Sq RSS AIC  
## + Prob 1 258063 1803290 508.08  
## + U2 1 200988 1860365 509.55  
## + Wealth 1 163378 1897975 510.49  
## <none> 2061353 512.37  
## + M.F 1 74398 1986955 512.64  
## + U1 1 50835 2010518 513.20  
## + Po2 1 45392 2015961 513.32  
## + Time 1 42746 2018607 513.39  
## + NW 1 16488 2044865 513.99  
## + Pop 1 8101 2053251 514.19  
## + So 1 3189 2058164 514.30  
## + LF 1 2988 2058365 514.30  
##   
## Step: AIC=508.08  
## Crime ~ Po1 + Ineq + Ed + M + Prob  
##   
## Df Sum of Sq RSS AIC  
## + U2 1 192233 1611057 504.79  
## + Wealth 1 86490 1716801 507.77  
## + M.F 1 84509 1718781 507.83  
## <none> 1803290 508.08  
## + U1 1 52313 1750977 508.70  
## + Pop 1 47719 1755571 508.82  
## + Po2 1 37967 1765323 509.08  
## + So 1 21971 1781320 509.51  
## + Time 1 10194 1793096 509.82  
## + LF 1 990 1802301 510.06  
## + NW 1 797 1802493 510.06  
##   
## Step: AIC=504.79  
## Crime ~ Po1 + Ineq + Ed + M + Prob + U2  
##   
## Df Sum of Sq RSS AIC  
## <none> 1611057 504.79  
## + Wealth 1 59910 1551147 505.00  
## + U1 1 54830 1556227 505.16  
## + Pop 1 51320 1559737 505.26  
## + M.F 1 30945 1580112 505.87  
## + Po2 1 25017 1586040 506.05  
## + So 1 17958 1593098 506.26  
## + LF 1 13179 1597878 506.40  
## + Time 1 7159 1603898 506.58  
## + NW 1 359 1610698 506.78

##   
## Call:  
## lm(formula = Crime ~ Po1 + Ineq + Ed + M + Prob + U2, data = uscrime)  
##   
## Coefficients:  
## (Intercept) Po1 Ineq Ed M Prob   
## -5040.50 115.02 67.65 196.47 105.02 -3801.84   
## U2   
## 89.37

Perform stepwise regression

model\_both <- lm(Crime~., data = uscrime)  
step(model\_both,  
 scope = list(lower = formula(lm(Crime~1., data = uscrime)),  
 upper = formula(lm(Crime~., data = uscrime))),  
 direction = "both")

## Start: AIC=514.65  
## 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 29 1354974 512.65  
## - LF 1 8917 1363862 512.96  
## - Time 1 10304 1365250 513.00  
## - Pop 1 14122 1369068 513.14  
## - NW 1 18395 1373341 513.28  
## - M.F 1 31967 1386913 513.74  
## - Wealth 1 37613 1392558 513.94  
## - Po2 1 37919 1392865 513.95  
## <none> 1354946 514.65  
## - U1 1 83722 1438668 515.47  
## - Po1 1 144306 1499252 517.41  
## - U2 1 181536 1536482 518.56  
## - M 1 193770 1548716 518.93  
## - Prob 1 199538 1554484 519.11  
## - Ed 1 402117 1757063 524.86  
## - Ineq 1 423031 1777977 525.42  
##   
## Step: AIC=512.65  
## Crime ~ M + Ed + Po1 + Po2 + LF + M.F + Pop + NW + U1 + U2 +   
## Wealth + Ineq + Prob + Time  
##   
## Df Sum of Sq RSS AIC  
## - Time 1 10341 1365315 511.01  
## - LF 1 10878 1365852 511.03  
## - Pop 1 14127 1369101 511.14  
## - NW 1 21626 1376600 511.39  
## - M.F 1 32449 1387423 511.76  
## - Po2 1 37954 1392929 511.95  
## - Wealth 1 39223 1394197 511.99  
## <none> 1354974 512.65  
## - U1 1 96420 1451395 513.88  
## + So 1 29 1354946 514.65  
## - Po1 1 144302 1499277 515.41  
## - U2 1 189859 1544834 516.81  
## - M 1 195084 1550059 516.97  
## - Prob 1 204463 1559437 517.26  
## - Ed 1 403140 1758114 522.89  
## - Ineq 1 488834 1843808 525.13  
##   
## Step: AIC=511.01  
## Crime ~ M + Ed + Po1 + Po2 + LF + M.F + Pop + NW + U1 + U2 +   
## Wealth + Ineq + Prob  
##   
## Df Sum of Sq RSS AIC  
## - LF 1 10533 1375848 509.37  
## - NW 1 15482 1380797 509.54  
## - Pop 1 21846 1387161 509.75  
## - Po2 1 28932 1394247 509.99  
## - Wealth 1 36070 1401385 510.23  
## - M.F 1 41784 1407099 510.42  
## <none> 1365315 511.01  
## - U1 1 91420 1456735 512.05  
## + Time 1 10341 1354974 512.65  
## + So 1 65 1365250 513.00  
## - Po1 1 134137 1499452 513.41  
## - U2 1 184143 1549458 514.95  
## - M 1 186110 1551425 515.01  
## - Prob 1 237493 1602808 516.54  
## - Ed 1 409448 1774763 521.33  
## - Ineq 1 502909 1868224 523.75  
##   
## Step: AIC=509.37  
## Crime ~ M + Ed + Po1 + Po2 + M.F + Pop + NW + U1 + U2 + Wealth +   
## Ineq + Prob  
##   
## Df Sum of Sq RSS AIC  
## - NW 1 11675 1387523 507.77  
## - Po2 1 21418 1397266 508.09  
## - Pop 1 27803 1403651 508.31  
## - M.F 1 31252 1407100 508.42  
## - Wealth 1 35035 1410883 508.55  
## <none> 1375848 509.37  
## - U1 1 80954 1456802 510.06  
## + LF 1 10533 1365315 511.01  
## + Time 1 9996 1365852 511.03  
## + So 1 3046 1372802 511.26  
## - Po1 1 123896 1499744 511.42  
## - U2 1 190746 1566594 513.47  
## - M 1 217716 1593564 514.27  
## - Prob 1 226971 1602819 514.54  
## - Ed 1 413254 1789103 519.71  
## - Ineq 1 500944 1876792 521.96  
##   
## Step: AIC=507.77  
## Crime ~ M + Ed + Po1 + Po2 + M.F + Pop + U1 + U2 + Wealth + Ineq +   
## Prob  
##   
## Df Sum of Sq RSS AIC  
## - Po2 1 16706 1404229 506.33  
## - Pop 1 25793 1413315 506.63  
## - M.F 1 26785 1414308 506.66  
## - Wealth 1 31551 1419073 506.82  
## <none> 1387523 507.77  
## - U1 1 83881 1471404 508.52  
## + NW 1 11675 1375848 509.37  
## + So 1 7207 1380316 509.52  
## + LF 1 6726 1380797 509.54  
## + Time 1 4534 1382989 509.61  
## - Po1 1 118348 1505871 509.61  
## - U2 1 201453 1588976 512.14  
## - Prob 1 216760 1604282 512.59  
## - M 1 309214 1696737 515.22  
## - Ed 1 402754 1790276 517.74  
## - Ineq 1 589736 1977259 522.41  
##   
## Step: AIC=506.33  
## Crime ~ M + Ed + Po1 + M.F + Pop + U1 + U2 + Wealth + Ineq +   
## Prob  
##   
## Df Sum of Sq RSS AIC  
## - Pop 1 22345 1426575 505.07  
## - Wealth 1 32142 1436371 505.39  
## - M.F 1 36808 1441037 505.54  
## <none> 1404229 506.33  
## - U1 1 86373 1490602 507.13  
## + Po2 1 16706 1387523 507.77  
## + NW 1 6963 1397266 508.09  
## + So 1 3807 1400422 508.20  
## + LF 1 1986 1402243 508.26  
## + Time 1 575 1403654 508.31  
## - U2 1 205814 1610043 510.76  
## - Prob 1 218607 1622836 511.13  
## - M 1 307001 1711230 513.62  
## - Ed 1 389502 1793731 515.83  
## - Ineq 1 608627 2012856 521.25  
## - Po1 1 1050202 2454432 530.57  
##   
## Step: AIC=505.07  
## Crime ~ M + Ed + Po1 + M.F + U1 + U2 + Wealth + Ineq + Prob  
##   
## Df Sum of Sq RSS AIC  
## - Wealth 1 26493 1453068 503.93  
## <none> 1426575 505.07  
## - M.F 1 84491 1511065 505.77  
## - U1 1 99463 1526037 506.24  
## + Pop 1 22345 1404229 506.33  
## + Po2 1 13259 1413315 506.63  
## + NW 1 5927 1420648 506.87  
## + So 1 5724 1420851 506.88  
## + LF 1 5176 1421398 506.90  
## + Time 1 3913 1422661 506.94  
## - Prob 1 198571 1625145 509.20  
## - U2 1 208880 1635455 509.49  
## - M 1 320926 1747501 512.61  
## - Ed 1 386773 1813348 514.35  
## - Ineq 1 594779 2021354 519.45  
## - Po1 1 1127277 2553852 530.44  
##   
## Step: AIC=503.93  
## Crime ~ M + Ed + Po1 + M.F + U1 + U2 + Ineq + Prob  
##   
## Df Sum of Sq RSS AIC  
## <none> 1453068 503.93  
## + Wealth 1 26493 1426575 505.07  
## - M.F 1 103159 1556227 505.16  
## + Pop 1 16697 1436371 505.39  
## + Po2 1 14148 1438919 505.47  
## + So 1 9329 1443739 505.63  
## + LF 1 4374 1448694 505.79  
## + NW 1 3799 1449269 505.81  
## + Time 1 2293 1450775 505.86  
## - U1 1 127044 1580112 505.87  
## - Prob 1 247978 1701046 509.34  
## - U2 1 255443 1708511 509.55  
## - M 1 296790 1749858 510.67  
## - Ed 1 445788 1898855 514.51  
## - Ineq 1 738244 2191312 521.24  
## - Po1 1 1672038 3125105 537.93

##   
## Call:  
## lm(formula = Crime ~ M + Ed + Po1 + M.F + U1 + U2 + Ineq + Prob,   
## data = uscrime)  
##   
## Coefficients:  
## (Intercept) M Ed Po1 M.F U1   
## -6426.10 93.32 180.12 102.65 22.34 -6086.63   
## U2 Ineq Prob   
## 187.35 61.33 -3796.03

library(glmnet)

## Loading required package: Matrix

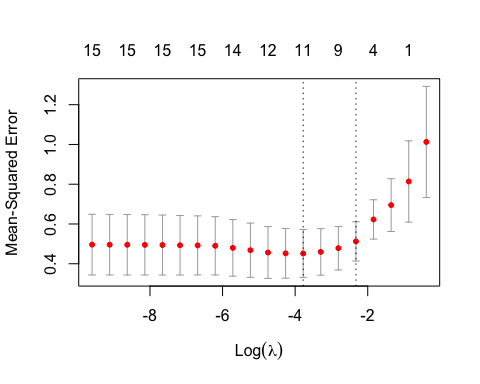
## Loaded glmnet 4.1-2

xscale <-scale(as.matrix(uscrime)[,-16], center = TRUE, scale = TRUE)  
yscale <-scale(as.matrix(uscrime)[,16], center = TRUE, scale = TRUE)

set.seed(1)  
  
lasso\_model <- cv.glmnet(x = xscale,  
 y = yscale,  
 alpha = 1,  
 nfolds = 8,  
 nlambda = 20,  
 type.measure = "mse",  
 family = "gaussian",  
 standardize = TRUE)  
lasso\_model

##   
## Call: cv.glmnet(x = xscale, y = yscale, type.measure = "mse", nfolds = 8, alpha = 1, nlambda = 20, family = "gaussian", standardize = TRUE)   
##   
## Measure: Mean-Squared Error   
##   
## Lambda Index Measure SE Nonzero  
## min 0.02286 8 0.4519 0.12061 11  
## 1se 0.09785 5 0.5124 0.09868 5

plot(lasso\_model)



lasso\_model$lambda.min

## [1] 0.02285517

cbind(lasso\_model$lambda, lasso\_model$cvm, lasso\_model$nzero)

## [,1] [,2] [,3]  
## s0 6.802502e-01 1.0126716 0  
## s1 4.189309e-01 0.8138743 1  
## s2 2.579978e-01 0.6949512 1  
## s3 1.588875e-01 0.6228419 4  
## s4 9.785058e-02 0.5124407 5  
## s5 6.026110e-02 0.4783568 9  
## s6 3.711169e-02 0.4597101 10  
## s7 2.285517e-02 0.4519061 11  
## s8 1.407532e-02 0.4522483 12  
## s9 8.668258e-03 0.4565330 12  
## s10 5.338331e-03 0.4679981 13  
## s11 3.287602e-03 0.4799828 14  
## s12 2.024664e-03 0.4903178 15  
## s13 1.246885e-03 0.4922588 15  
## s14 7.678921e-04 0.4930810 15  
## s15 4.729050e-04 0.4941496 15  
## s16 2.912377e-04 0.4949329 14  
## s17 1.793582e-04 0.4954739 15  
## s18 1.104574e-04 0.4958032 15  
## s19 6.802501e-05 0.4961966 15

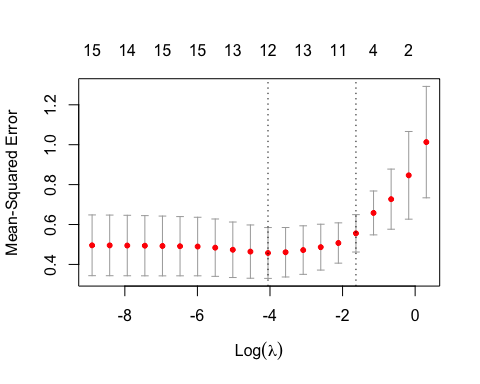
coef(lasso\_model,  
 s = lasso\_model$lambda.min)

## 16 x 1 sparse Matrix of class "dgCMatrix"  
## s1  
## (Intercept) -3.089746e-16  
## M 2.334496e-01  
## So 5.531294e-02  
## Ed 3.626798e-01  
## Po1 7.863851e-01  
## Po2 .   
## LF .   
## M.F 1.438575e-01  
## Pop .   
## NW 1.678996e-02  
## U1 -9.992514e-02  
## U2 1.929343e-01  
## Wealth 1.924784e-02  
## Ineq 5.036536e-01  
## Prob -2.168202e-01  
## Time .

set.seed(1)  
  
elastic\_model <- cv.glmnet(x = xscale,  
 y = yscale,  
 alpha = .5,  
 nfolds = 8,  
 nlambda = 20,  
 type.measure = "mse",  
 family = "gaussian",  
 standardize = TRUE)  
elastic\_model

##   
## Call: cv.glmnet(x = xscale, y = yscale, type.measure = "mse", nfolds = 8, alpha = 0.5, nlambda = 20, family = "gaussian", standardize = TRUE)   
##   
## Measure: Mean-Squared Error   
##   
## Lambda Index Measure SE Nonzero  
## min 0.01734 10 0.4574 0.1274 12  
## 1se 0.19570 5 0.5559 0.0937 7

plot(elastic\_model)



elastic\_model$lambda.min

## [1] 0.01733652

cbind(elastic\_model$lambda, elastic\_model$cvm, elastic\_model$nzero)

## [,1] [,2] [,3]  
## s0 1.3605003718 1.0130444 0  
## s1 0.8378617171 0.8465177 2  
## s2 0.5159956377 0.7271168 2  
## s3 0.3177749893 0.6580569 4  
## s4 0.1957011580 0.5558563 7  
## s5 0.1205222076 0.5073618 11  
## s6 0.0742233857 0.4865615 12  
## s7 0.0457103391 0.4719032 13  
## s8 0.0281506305 0.4610205 14  
## s9 0.0173365154 0.4573775 12  
## s10 0.0106766619 0.4642906 13  
## s11 0.0065752031 0.4733991 13  
## s12 0.0040493271 0.4839607 15  
## s13 0.0024937708 0.4896255 15  
## s14 0.0015357843 0.4913331 15  
## s15 0.0009458100 0.4924957 15  
## s16 0.0005824754 0.4937378 15  
## s17 0.0003587164 0.4947044 14  
## s18 0.0002209149 0.4953866 15  
## s19 0.0001360500 0.4958248 15

coef(elastic\_model,  
 s = elastic\_model$lambda.min)

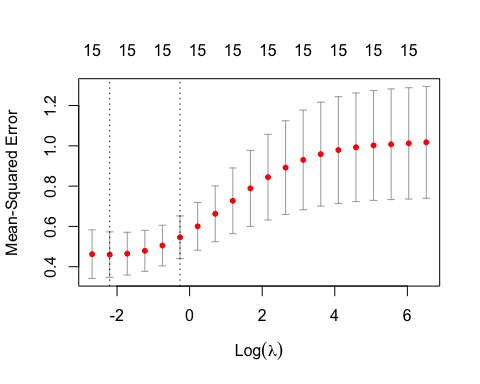
## 16 x 1 sparse Matrix of class "dgCMatrix"  
## s1  
## (Intercept) -3.192164e-16  
## M 2.575374e-01  
## So 4.933362e-02  
## Ed 4.274090e-01  
## Po1 7.404023e-01  
## Po2 .   
## LF .   
## M.F 1.498742e-01  
## Pop -3.405541e-02  
## NW 4.875560e-02  
## U1 -1.790526e-01  
## U2 2.867013e-01  
## Wealth 1.296446e-01  
## Ineq 5.960761e-01  
## Prob -2.328851e-01  
## Time .

ridge\_model

set.seed(1)  
  
ridge\_model <- cv.glmnet(x = xscale,  
 y = yscale,  
 alpha = 0,  
 nfolds = 8,  
 nlambda = 20,  
 type.measure = "mse",  
 family = "gaussian",  
 standardize = TRUE)  
ridge\_model

##   
## Call: cv.glmnet(x = xscale, y = yscale, type.measure = "mse", nfolds = 8, alpha = 0, nlambda = 20, family = "gaussian", standardize = TRUE)   
##   
## Measure: Mean-Squared Error   
##   
## Lambda Index Measure SE Nonzero  
## min 0.1105 19 0.4601 0.1129 15  
## 1se 0.7679 15 0.5462 0.1059 15

plot(ridge\_model)



ridge\_model$lambda.min

## [1] 0.1104574

coef(ridge\_model,  
 s = ridge\_model$lambda.min)

## 16 x 1 sparse Matrix of class "dgCMatrix"  
## s1  
## (Intercept) -3.676699e-16  
## M 2.082296e-01  
## So 1.111465e-01  
## Ed 2.757655e-01  
## Po1 3.814839e-01  
## Po2 2.846264e-01  
## LF 5.728619e-02  
## M.F 1.786883e-01  
## Pop -1.040204e-04  
## NW 8.397962e-02  
## U1 -1.266901e-01  
## U2 2.216036e-01  
## Wealth 9.862503e-02  
## Ineq 3.698863e-01  
## Prob -2.263544e-01  
## Time 1.028360e-02