```
> library(glmnet)
> data(QuickStartExample)
> x <- QuickStartExample$x
> y <- QuickStartExample$y
> x
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 [76,]  1.93778118
 [77,]  1.13990744
 [78,] -1.98512730
 [79,]  2.50814660
 [80,]  6.11767177
 [81,] -1.36087870
 [82,]  1.49448021
 [83,]  0.22007890
 [84,]  3.34452840
 [85,] -1.51870398
 [86,]  0.70635477
 [87,]  1.89300410
 [88,] -1.19202558
 [89,]  2.11070842
 [90,]  2.48075147
 [91,] -4.74435304
 [92,] -2.12334158
 [93,] -1.38994117
 [94,] -3.96469666
 [95,]  1.20492093
 [96,] -6.85748504
 [97,] -3.01411434
 [98,] -3.21329757
 [99,]  4.50173294
[100,] -3.31892876
```
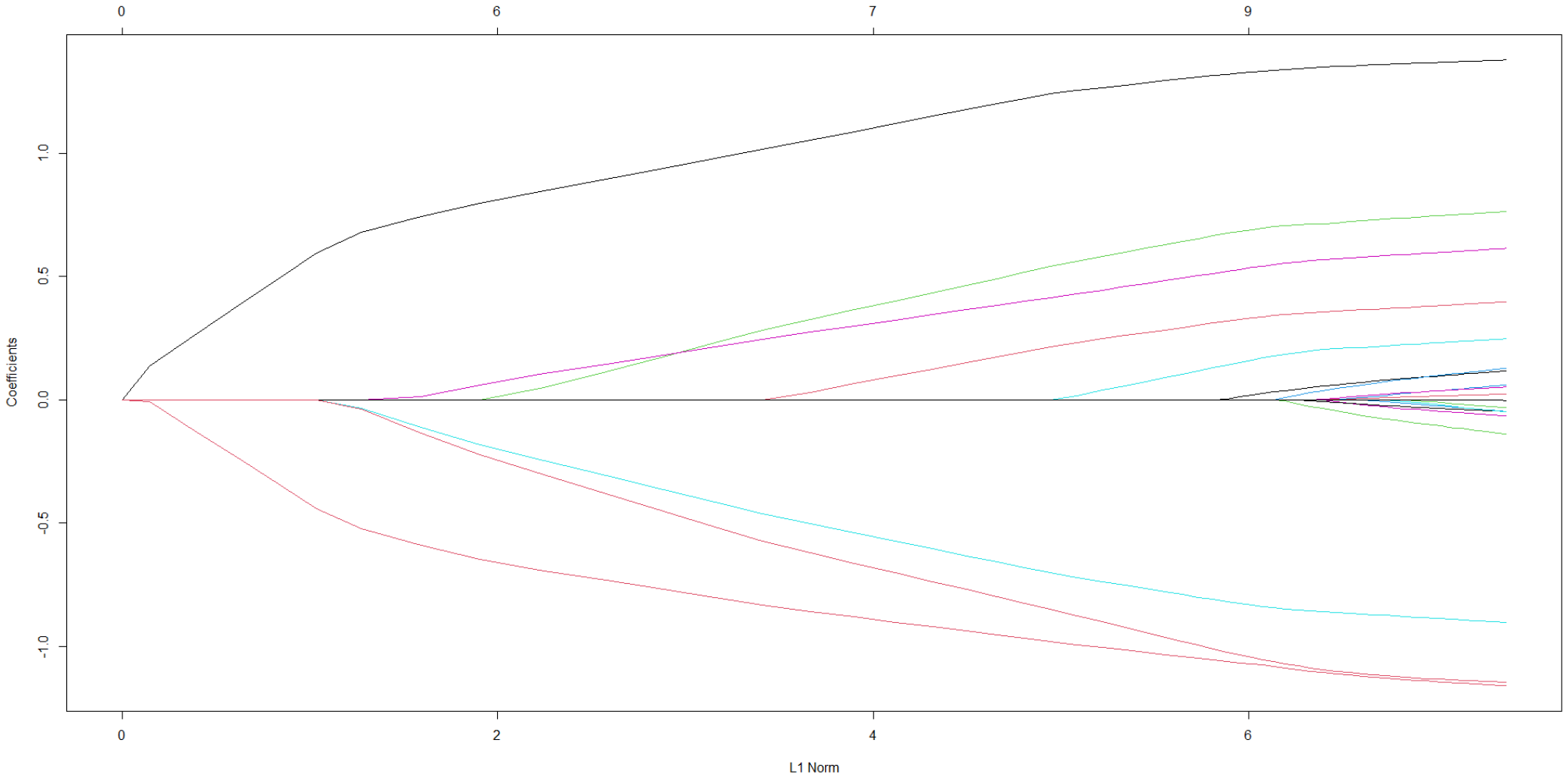

```
> fit <- glmnet(x, y)
#objects: plot, print, coef and predict
>  plot(fit)

#για οπτικη αποτυπωση των εκτιμητων ως προς το L1 Norm όπως προκύπτει ως προς το λ. Πανω=nonzero εκτιμητές
```


0
6
7
9
1.0
0.5
0.0
-0.5
-1.0
Coefficients
0
2
4
6
L1 Norm

> print(fit)

Call: glmnet(x = x, y = y)

	Df	%Dev	Lambda
1	0	0.00	1.63100
2	2	5.53	1.48600
3	2	14.59	1.35400
4	2	22.11	1.23400
5	2	28.36	1.12400
6	2	33.54	1.02400
7	4	39.04	0.93320
8	5	45.60	0.85030
9	5	51.54	0.77470
10	6	57.35	0.70590
11	6	62.55	0.64320
12	6	66.87	0.58610
13	6	70.46	0.53400
14	6	73.44	0.48660
15	7	76.21	0.44330
16	7	78.57	0.40400
17	7	80.53	0.36810
18	7	82.15	0.33540
19	7	83.50	0.30560
20	7	84.62	0.27840
21	7	85.55	0.25370
22	7	86.33	0.23120
23	8	87.06	0.21060
24	8	87.69	0.19190
25	8	88.21	0.17490

26 8 88.65 0.15930
27 8 89.01 0.14520
28 8 89.31 0.13230
29 8 89.56 0.12050
30 8 89.76 0.10980
31 9 89.94 0.10010
32 9 90.10 0.09117
33 9 90.23 0.08307
34 9 90.34 0.07569
35 10 90.43 0.06897
36 11 90.53 0.06284
37 11 90.62 0.05726
38 12 90.70 0.05217
39 15 90.78 0.04754
40 16 90.86 0.04331
41 16 90.93 0.03947
42 16 90.98 0.03596
43 17 91.03 0.03277
44 17 91.07 0.02985
45 18 91.11 0.02720
46 18 91.14 0.02479
47 19 91.17 0.02258
48 19 91.20 0.02058
49 19 91.22 0.01875
50 19 91.24 0.01708

51 19 91.25 0.01557
52 19 91.26 0.01418
53 19 91.27 0.01292
54 19 91.28 0.01178
55 19 91.29 0.01073
56 19 91.29 0.00978
57 19 91.30 0.00891
58 19 91.30 0.00812
59 19 91.31 0.00739
60 19 91.31 0.00674
61 19 91.31 0.00614
62 20 91.31 0.00559
63 20 91.31 0.00510
64 20 91.31 0.00464

65 20 91.32 0.00423
66 20 91.32 0.00386
67 20 91.32 0.00351

 # DF=# of nonzero coefficients, %Dev= % variance explained, Lambda= value of λ

#Η εντολή τρέχει για 100 λ αλλά αν το Dev δεν αλλάζει …σταματάει.

```
fit <- glmnet(x, y, lambda=0.097)    #objects: plot, print, coef and predict
print(fit)
    Df   %Dev   Lambda
1   9     90       0.097
```

```
> coef(fit, s = 0.1)    # s είναι ουσιαστικα η τιμη του lambda
21 x 1 sparse Matrix of class "dgCMatrix"
                    s1
(Intercept)  0.150928072
V1           1.320597195
V2           .
V3           0.675110234
V4           .
V5          -0.817411518
V6           0.521436671
V7           0.004829335
V8           0.319415917
V9           .
```

V10	.
V11	0.142498519
V12	.
V13	.
V14	-1.059978702
V15	.
V16	.
V17	.
V18	.
V19	.
V20	-1.021873704

```
> fit <- glmnet(x, y, lambda=0.0)  #RIDGE
>  print(fit)

Call:  glmnet(x = x, y = y, lambda = 0)

   Df   %Dev  Lambda
1 20   91.32       0
```

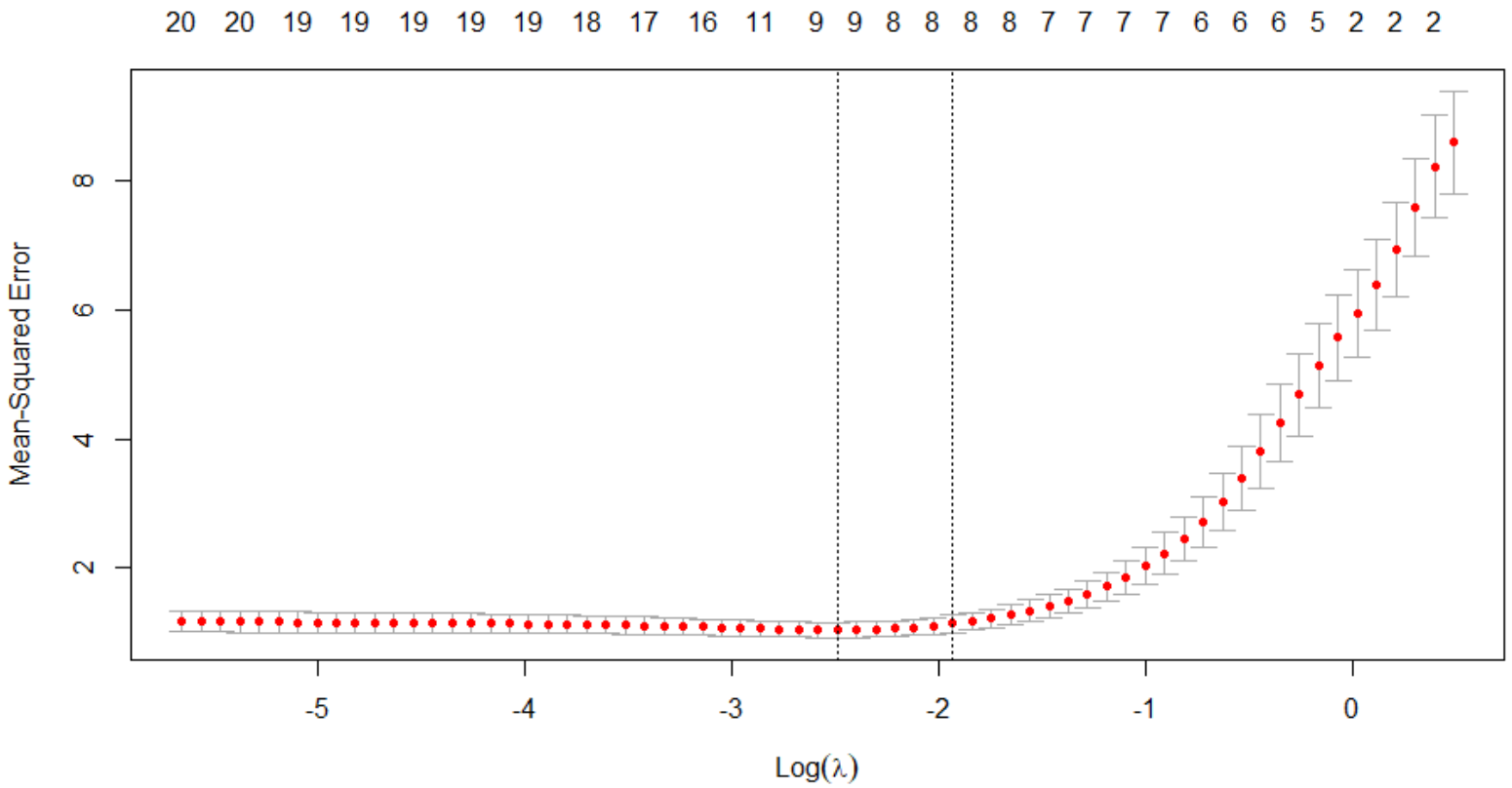
```
>  coef(fit, s = 0)
21 x 1 sparse Matrix of class "dgCMatrix"
                      s1
(Intercept)  0.109141898
V1           1.381019166
V2           0.024930726
V3           0.767532893
V4           0.066640467
V5          -0.906036973
V6           0.618454236
V7           0.124401444
V8           0.401073988
V9          -0.036525873
```

V10	0.136430761
V11	0.251668197
V12	-0.069808266
V13	-0.049472881
V14	-1.163924108
V15	-0.147219566
V16	-0.051608908
V17	-0.055900055
V18	0.057097189
V19	-0.006404363
V20	-1.148557485

GLMNET προσφέρει πολλά μοντέλα και ο ερευνητής επιλέγει.

Η R μπορεί να επιλέξει για τον ερευνητή.

```
> cvfit <- cv.glmnet(x, y)  #cross validation
> plot(cvfit)
```



Type text h

```
>  cvfit$lambda.min #value that minimizes MSE
[1] 0.08307327
> log(0.08307327)
[1] -2.4880320
  cvfit$lambda.1se #Το MSE είναι 1 st.dev. από το MINIMUM
[1] 0.1451729
> log(0.1451729)
[1] -1.92983
```

```
> coef(cvfit, s = "lambda.min") #estimates for the min lambda
21 x 1 sparse Matrix of class "dgCMatrix"
                      s1
(Intercept)  0.14936467
V1           1.32975267
V2           .
V3           0.69096092
V4           .
V5          -0.83122558
V6           0.53669611
V7           0.02005438
V8           0.33193760
V9           .
V10          .
V11          0.16239419
V12          .
```

V13	.
V14	-1.07081121
V15	.
V16	.
V17	.
V18	.
V19	.
V20	-1.04340741

```
> predict(cvfit, newx = x[1:5,], s = "lambda.min")
#predictions for new x
     lambda.min
[1,] -1.3647490
[2,]  2.5686013
[3,]  0.5705879
[4,]  1.9682289
[5,]  1.4964211
```

```
# glmnet(x, y, alpha = 0.2),
# alpha τιμη στο [0,1]
#alpha=1    LASSO – DEFAULT
#alpha=0    RIDGE
#nlambda = αριθμος τιμών λ
```

```
> fit1 <- glmnet(x, y, alpha = 0.2, nlambda = 20)
> print(fit1)

Call:  glmnet(x = x, y = y, alpha = 0.2, nlambda = 20)

   Df  %Dev Lambda
1   0  0.00 8.1540
2   4 16.62 5.0220
3   6 43.50 3.0920
4   7 64.48 1.9050
5   8 77.68 1.1730
6   8 84.85 0.7223
7   9 88.30 0.4448
8  11 89.83 0.2740
9  15 90.66 0.1687
10 19 91.04 0.1039
```

ΘΕΩΡΟΥΜΕ ΟΤΙ ΤΟ ΜΟΝΤΕΛΟ ΕΙΝΑΙ ΑΥΤΟ ΜΕ 2 ΠΑΡΑΜΕΤΡΟΥΣ ΤΟ alpha & το lambda ΕΔΩ ΔΙΝΟΥΜΕ ΤΟ ΕΝΑ ΚΑΙ ΜΑΣ "ΤΡΕΧΕΙ" ΤΟ ΑΛΛΟ

11 19 91.21 0.0640
12 19 91.28 0.0394
13 20 91.30 0.0243
14 20 91.32 0.0150
15 20 91.32 0.0092
16 20 91.32 0.0057
17 20 91.32 0.0035

#ΔΕΝ ΕΤΡΕΞΑΝ 20 ΤΙΜΕΣ ΑΛΛΑ ΜΟΝΟ 17.

```
> cvfit <- cv.glmnet(x, y, type.measure = "mse", nfolds = 20)
```

#20-fold cross validation – default=10

 # 3 επιλογες: mse, deviance, mae

```
> print(cvfit)
```

```
Call:  cv.glmnet(x = x, y = y, type.measure = "mse", nfolds = 20)

Measure: Mean-Squared Error

    Lambda Index  Measure     SE     Nonzero
min 0.07569    34   1.062     0.1132       9
1se 0.14517    27   1.162     0.1600       8
```

```
> cvfit$lambda.min
[1] 0.07569327

> cvfit$lambda.1se
[1] 0.1451729
```

```
> coef(cvfit, s = "lambda.min")
21 x 1 sparse Matrix of class "dgCMatrix"
                      s1
(Intercept)  0.14867414
V1           1.33377821
V2           .
V3           0.69787701
V4           .
V5          -0.83726751
V6           0.54334327
V7           0.02668633
V8           0.33741131
V9           .
```

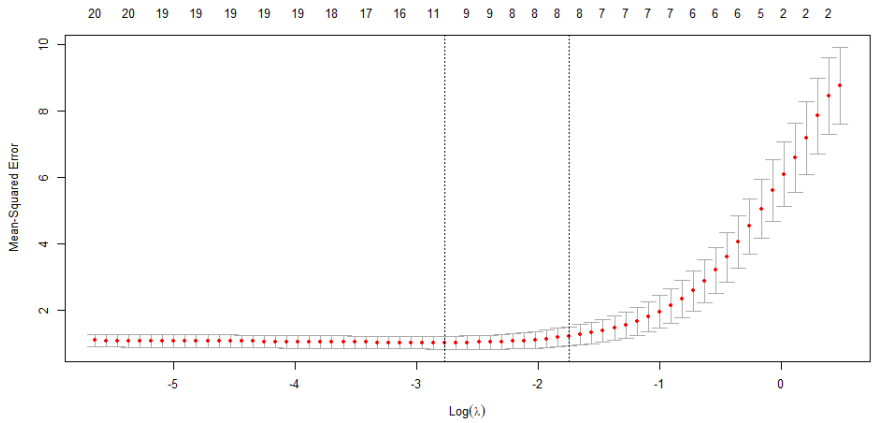
V10	.
V11	0.17105029
V12	.
V13	.
V14	-1.07552680
V15	.
V16	.
V17	.
V18	.
V19	.
V20	-1.05278699

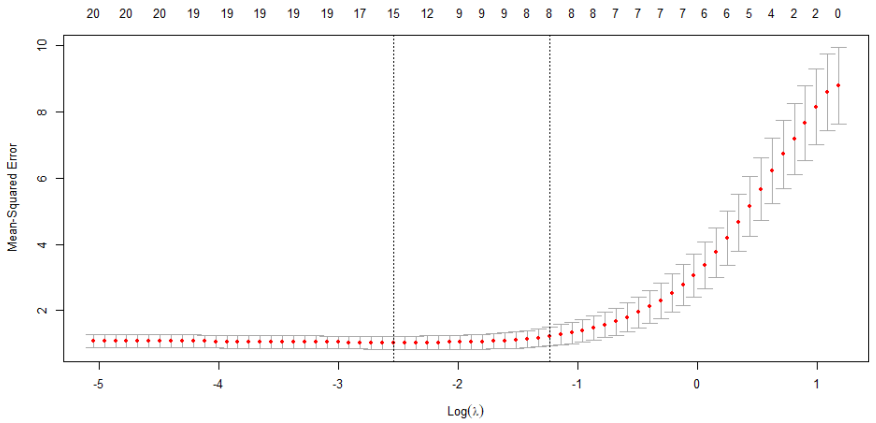
```
> predict(cvfit2, newx = x[1:8,], s = "lambda.min")
    lambda.min
[1,] -1.3638848
[2,]  2.5713428
[3,]  0.5729785
[4,]  1.9881422
[5,]  1.5179882
[6,] -1.0820419
[7,]  2.3415770
[8,]  0.5448265
```

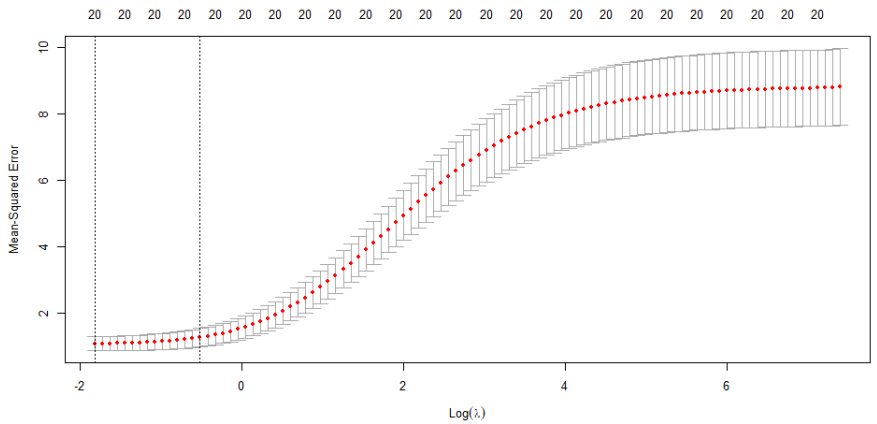
```
> predict(cvfit2, newx = x[1:8,], s = 0.07569327)
           s1
[1,] -1.3638848
[2,]  2.5713428
[3,]  0.5729785
[4,]  1.9881422
[5,]  1.5179882
[6,] -1.0820419
[7,]  2.3415770
[8,]  0.5448265
```

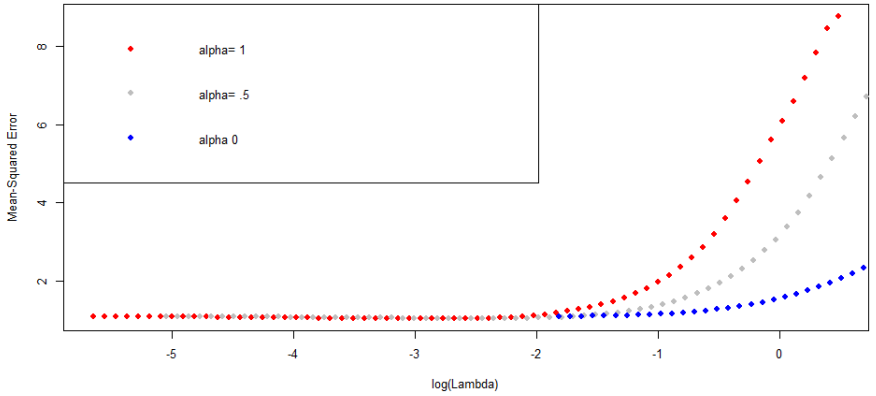
```
> foldid <- sample(1:10, size = length(y), replace = TRUE)  # k=10
>  cv1  <- cv.glmnet(x, y, foldid = foldid, alpha = 1)
>  cv.5 <- cv.glmnet(x, y, foldid = foldid, alpha = 0.5)
>  cv0  <- cv.glmnet(x, y, foldid = foldid, alpha = 0)
> par(mfrow = c(2,2))
>  plot(cv1); plot(cv.5); plot(cv0)
>  plot(log(cv1$lambda)   , cv1$cvm , pch = 19, col = "red",
+      xlab = "log(Lambda)", ylab = cv1$name)
>  points(log(cv.5$lambda), cv.5$cvm, pch = 19, col = "grey")
>  points(log(cv0$lambda) , cv0$cvm , pch = 19, col = "blue")
>  legend("topleft", legend = c("alpha= 1", "alpha= .5", "alpha 0"),
+        pch = 19, col = c("red","grey","blue"))
>
```

#foldid = vector τιμών για το σε πιο fold θα καταχωρηθει κάθε παρατηρηση


20 20 19 19 19 19 19 18 17 16 11 9 9 8 8 8 8 7 7 7 7 6 6 6 5 2 2 2
Mean-Squared Error
2 4 6 8 10
-5 -4 -3 -2 -1 0
Log(λ)


20 20 20 19 19 19 19 19 17 15 12 9 9 9 8 8 8 8 7 7 7 7 6 6 5 4 2 2 0
Mean-Squared Error
2 4 6 8 10
-5 -4 -3 -2 -1 0 1
Log(λ)


20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20
Mean-Squared Error
2 4 6 8 10
-2 0 2 4 6
Log(λ)


alpha= 1
alpha= .5
alpha 0
Mean-Squared Error
2 4 6 8
-5 -4 -3 -2 -1 0
log(Lambda)

Friedman, J., Hastie, T. and Tibshirani, R. (2008) *Regularization Paths for Generalized Linear Models via Coordinate Descent (2010), Journal of Statistical Software, Vol. 33(1), 1-22*, doi:10.18637/jss.v033.i01 .

Simon, N., Friedman, J., Hastie, T. and Tibshirani, R. (2011) *Regularization Paths for Cox's Proportional Hazards Model via Coordinate Descent, Journal of Statistical Software, Vol. 39(5), 1-13*, doi:10.18637/jss.v039.i05 .

https://glmnet.stanford.edu/articles/glmnet.html Intro to glmnet