SOLUTIONS

Practical: RISK PREDICTION
Advanced Statistical Analysis

2. Change working directory

3. Open the dataset "**Prediction-data.dta**"

[click 'File > Open' then choose "Prediction-data.dta"]

Data exploration

4. Have a look at the data.

summarize

```
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
          id |      2,000      1000.5    577.4946          1       2000
         age |      2,000      60.451    11.54423         40         80
         sbp |      2,000    120.3289    10.18013       76.6      152.2
         bmi |      2,000      25.188    2.982409       15.5       35.6
         sex |      2,000        .511     .500004          0          1
-------------+---------------------------------------------------------
        dead |      2,000       .2545    .4356887          0          1
```

How many participants die?

tab dead

```
       event |      Freq.     Percent        Cum.
-------------+-----------------------------------
       Alive |      1,491       74.55       74.55
        Dead |        509       25.45      100.00
-------------+-----------------------------------
       Total |      2,000      100.00
```

What proportion are female?

tab sex

```
         sex |      Freq.     Percent        Cum.
-------------+-----------------------------------
      Female |        978       48.90       48.90
```

```
       Male |      1,022       51.10      100.00
------------+-----------------------------------
      Total |      2,000      100.00
```

What ages are these participants?

summ age

```
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
         age |      2,000      60.451    11.54423         40         80
```

Randomly split data into training and validation parts

5. Create a variable S = 0/1 that separates the data into two equal halves:

set seed 1111

gen rvar = runiform()

sort rvar

gen S = 0

replace S = 1 if _n > 1000

```
(1,000 real changes made)
```

[No output, except a newly created indicator variable S]

Fit model in training data and predict risks

6. For the S=0 dataset, estimate the model using logistic regression. Include all measured variables as predictors.

logistic dead c.age i.sex c.sbp c.bmi if S==0

```
Logistic regression                                     Number of obs     =      1,000
                                                        LR chi2(4)        =     205.31
                                                        Prob > chi2       =     0.0000
Log likelihood = -452.99024                             Pseudo R2         =     0.1848

------------------------------------------------------------------------------
        dead | Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         age |   1.093615   .0088335    11.08   0.000     1.076438    1.111066
             |
         sex |
        Male |   1.076061    .177804     0.44   0.657     .7783727    1.487599
         sbp |   1.066765   .0094303     7.31   0.000     1.048441    1.085409
         bmi |   1.044692   .0286565     1.59   0.111     .9900095    1.102395
       _cons |   1.43e-07   2.13e-07   -10.60   0.000     7.76e-09    2.64e-06
------------------------------------------------------------------------------
Note: _cons estimates baseline odds.
```

7. Predict the risk of death for all individuals (i.e. those with S=0 and those with S=1).

predict m2pr

bysort dead: summ m2pr

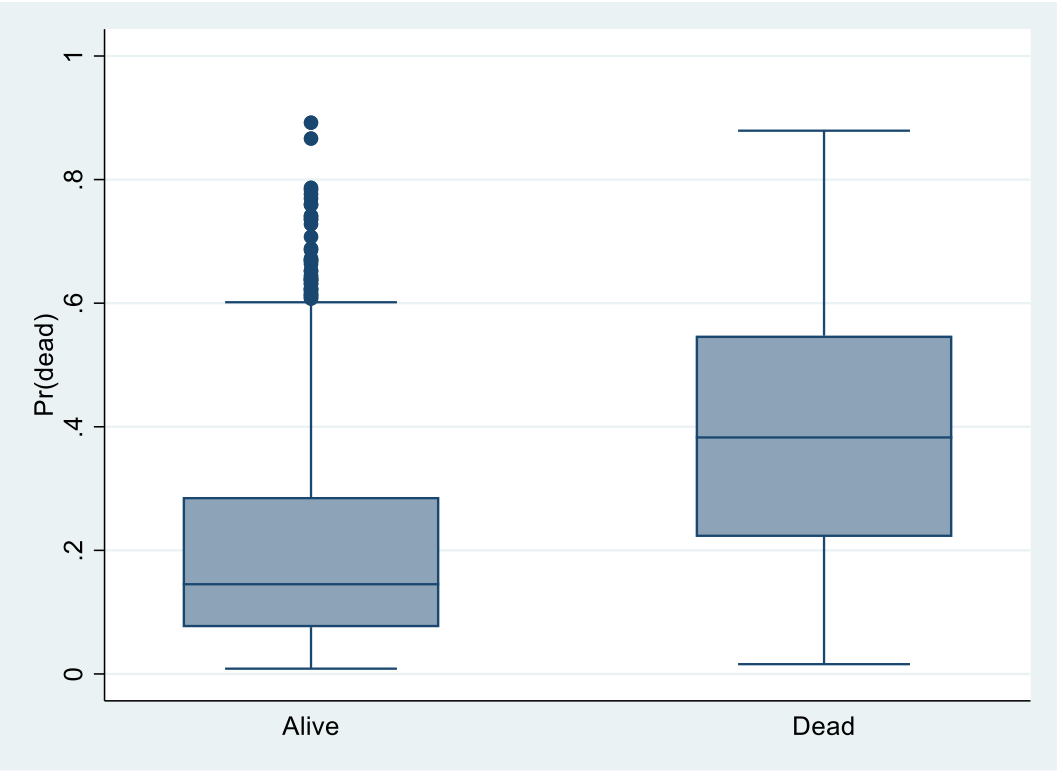
```
-> dead = Alive

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
        m2pr |      1,491    .1984497    .1615049   .0085352   .8920841

-> dead = Dead

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
        m2pr |        509    .3901502    .2043112   .0158026   .8791203
```

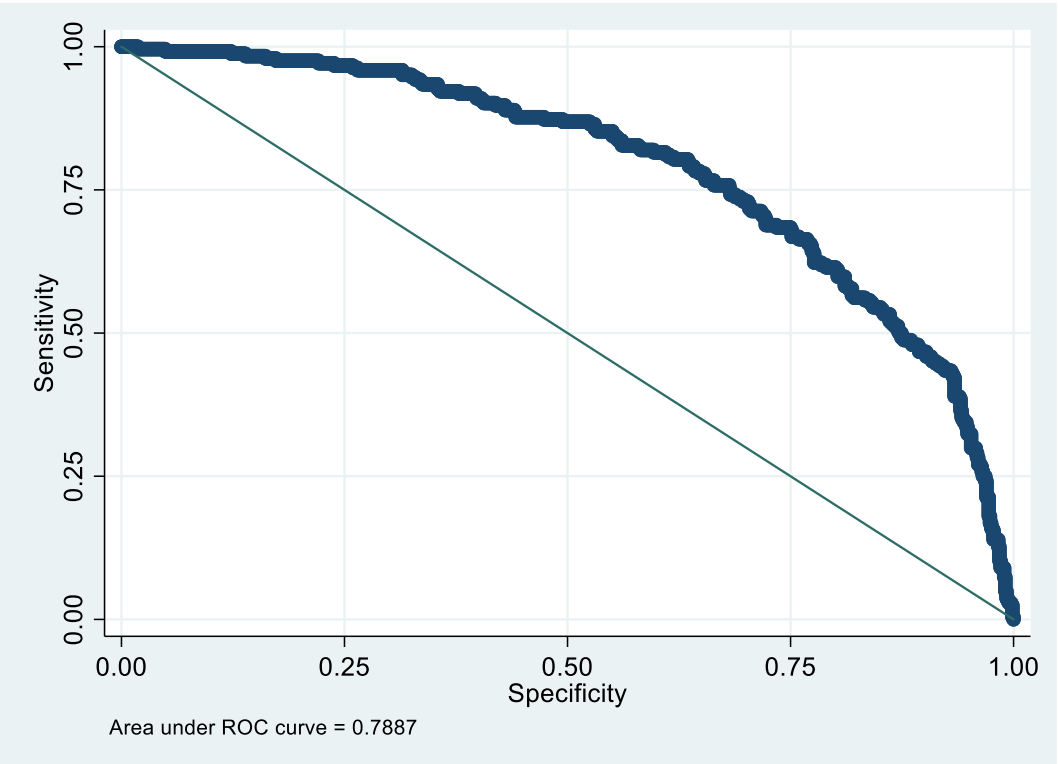
graph box m2pr, over(dead)



Validation

8. Draw an ROC curve in the S=0 dataset.

```
roctab dead m2pr if S==0, graph specificity
```

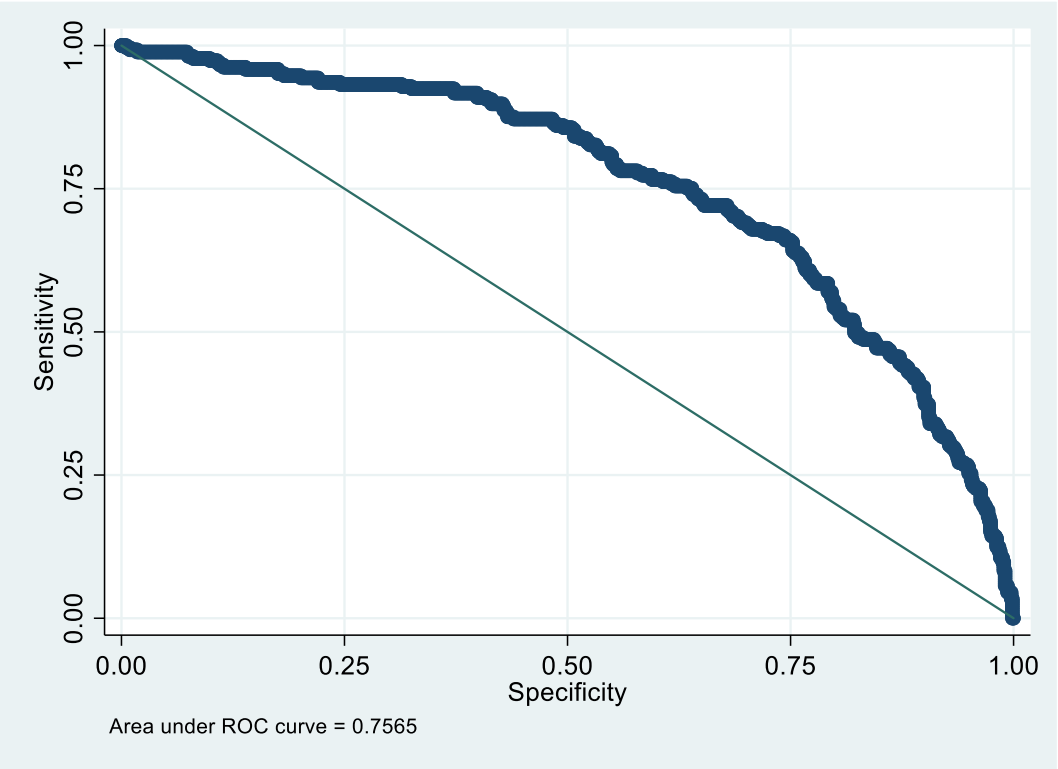


What is the AUC? Interpret this number.

In the training set, the ROC is 79%. This means that a person who did die has a 79% probability of having a higher predicted risk (of dying) than someone who did not. This shows the model has fairly good discrimination (ability to separate those who did and did not experience the event of interest).

Now repeat for the S=1 dataset.

```
roctab dead m2pr if S==1, graph specificity
```



Are the two ROC curves very different?

9. Create a Hosmer-Lemeshow goodness of fit table for the S=0 and the S=1 datasets.

estat gof if S==0, group(10) table

Logistic model for dead, goodness-of-fit test

(Table collapsed on quantiles of estimated probabilities)

Group	Prob	Obs_1	Exp_1	Obs_0	Exp_0	Total
1	0.0470	3	3.1	97	96.9	100
2	0.0725	5	6.0	95	94.0	100
3	0.0992	11	8.6	89	91.4	100
4	0.1327	12	11.4	88	88.6	100
5	0.1813	14	15.5	86	84.5	100
6	0.2422	23	21.3	77	78.7	100
7	0.3230	27	28.0	73	72.0	100
8	0.4272	32	36.9	68	63.1	100
9	0.5374	48	47.8	52	52.2	100
10	0.8791	69	65.2	31	34.8	100

```
      number of observations =      1000
            number of groups =        10
    Hosmer-Lemeshow chi2(8) =         2.99
                Prob > chi2 =         0.9348
```

estat gof if S==1, group(10) table

Logistic model for dead, goodness-of-fit test

(Table collapsed on quantiles of estimated probabilities)

Group	Prob	Obs_1	Exp_1	Obs_0	Exp_0	Total
1	0.0449	10	3.0	90	97.0	100
2	0.0777	8	6.2	92	93.8	100
3	0.1081	4	9.3	96	90.7	100
4	0.1507	15	13.0	85	87.0	100
5	0.1960	25	17.1	75	82.9	100
6	0.2596	21	22.7	79	77.3	100
7	0.3316	32	29.9	68	70.1	100
8	0.4249	36	37.5	64	62.5	100
9	0.5390	49	47.4	51	52.6	100
10	0.8921	65	64.3	35	35.7	100

```
      number of observations =      1000
            number of groups =        10
    Hosmer-Lemeshow chi2(8) =        26.12
                Prob > chi2 =         0.0010
```

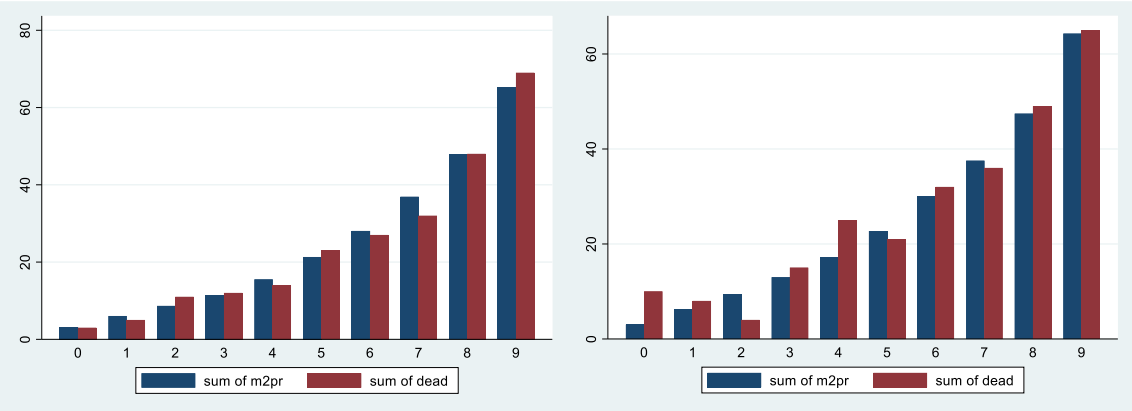
10. Draw a bar graph comparing the predicted and observed risks in the S=0 data.

```
egen m2prg0 = cut(m2pr) if S==0, group(10)
graph bar (sum) m2pr (sum) dead, over(m2prg0)
```

Repeat for the S=1 dataset.

```
egen m2prg1 = cut(m2pr) if S==1, group(10)
graph bar (sum) m2pr (sum) dead, over(m2prg1)
```

S=0 (Training) **S=1 (Validation)**



11. If you have time, see if you can write a short do-file to repeatedly split the data, calculate the AUC from the S=0 and S=1 datasets and store the results.