Homework 13

Tauqeer Kasam Rumaney

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Exercise 1: Survival analysis

Choose one other provided dataset in the survival package (or any other suitable dataset) which contains time-to-event data. Use the survfit function to compute the Kaplan-Meier estimate of the survival function and plot it. Then choose a variable with 2 or more categories in the dataset and perform a log-rank test. Interpret the results: is there are difference in survival between the groups?

Load the dataaset

```
library(survival)
```

Survival analysis with the colon dataaset

```
data <- diabetic
head(data)
```

```
##   id laser age   eye trt risk  time status
## 1  5 argon  28  left   0    9 46.23      0
## 2  5 argon  28 right   1    9 46.23      0
## 3 14 xenon  12  left   1    8 42.50      0
## 4 14 xenon  12 right   0    6 31.30      1
## 5 16 xenon   9  left   1   11 42.27      0
## 6 16 xenon   9 right   0   11 42.27      0
```

```
?diabetic
```

```
# compute the Kaplan Meier estimate of the survival function
KM <- survfit(Surv(time, status) ~ 1, data = data)

# Look at the results (in table form)
summary(KM)
```

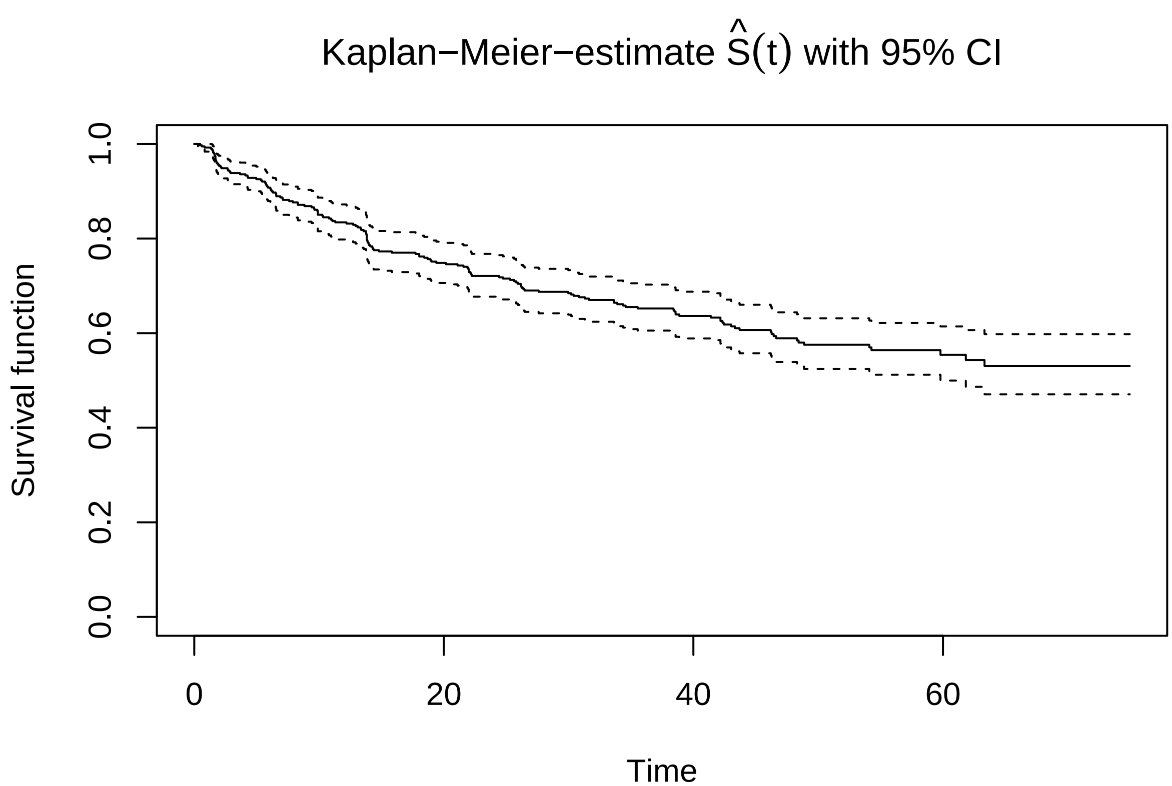
```
## Call: survfit(formula = Surv(time, status) ~ 1, data = data)
##
##   time n.risk n.event survival std.err lower 95% CI upper 95% CI
##   0.30    394       1    0.997 0.00253        0.993        1.000
##   0.60    393       1    0.995 0.00358        0.988        1.000
##   0.83    392       1    0.992 0.00438        0.984        1.000
```

```
##   1.33    391       1    0.990 0.00505        0.980         1.000
##   1.43    390       1    0.987 0.00564        0.976         0.998
##   1.50    385       2    0.982 0.00667        0.969         0.995
##   1.57    383       1    0.980 0.00713        0.966         0.994
##   1.63    382       2    0.974 0.00796        0.959         0.990
##   1.70    380       3    0.967 0.00906        0.949         0.985
##   1.73    377       1    0.964 0.00939        0.946         0.983
##   1.77    376       1    0.962 0.00971        0.943         0.981
##   1.80    375       1    0.959 0.01001        0.940         0.979
##   1.90    374       1    0.957 0.01031        0.937         0.977
##   1.97    373       1    0.954 0.01060        0.933         0.975
##   2.10    372       1    0.951 0.01087        0.930         0.973
##   2.17    371       1    0.949 0.01114        0.927         0.971
##   2.67    370       1    0.946 0.01140        0.924         0.969
##   2.70    369       1    0.944 0.01166        0.921         0.967
##   2.83    367       1    0.941 0.01191        0.918         0.965
##   2.90    366       1    0.939 0.01215        0.915         0.963
##   3.67    365       1    0.936 0.01238        0.912         0.961
##   4.10    363       1    0.933 0.01262        0.909         0.958
##   4.27    362       1    0.931 0.01284        0.906         0.956
##   4.30    361       1    0.928 0.01306        0.903         0.954
##   4.97    360       1    0.926 0.01328        0.900         0.952
##   5.33    359       1    0.923 0.01349        0.897         0.950
##   5.43    358       1    0.921 0.01370        0.894         0.948
##   5.67    357       1    0.918 0.01390        0.891         0.946
##   5.73    356       1    0.915 0.01410        0.888         0.943
##   5.77    355       1    0.913 0.01429        0.885         0.941
##   5.83    354       1    0.910 0.01448        0.882         0.939
##   5.90    353       1    0.908 0.01467        0.879         0.937
##   6.10    350       1    0.905 0.01485        0.876         0.935
##   6.13    349       1    0.902 0.01504        0.873         0.932
##   6.20    348       1    0.900 0.01521        0.871         0.930
##   6.30    347       1    0.897 0.01539        0.868         0.928
##   6.53    346       1    0.895 0.01556        0.865         0.926
##   6.57    345       2    0.889 0.01590        0.859         0.921
##   6.90    343       1    0.887 0.01606        0.856         0.919
##   7.07    342       1    0.884 0.01622        0.853         0.917
##   7.10    341       1    0.882 0.01638        0.850         0.914
##   7.60    339       1    0.879 0.01654        0.847         0.912
##   7.90    338       1    0.877 0.01669        0.844         0.910
##   8.30    335       2    0.871 0.01700        0.839         0.905
##   8.83    333       1    0.869 0.01715        0.836         0.903
##   9.40    332       1    0.866 0.01729        0.833         0.901
##   9.60    331       1    0.863 0.01744        0.830         0.898
##   9.63    330       1    0.861 0.01758        0.827         0.896
##   9.87    328       1    0.858 0.01772        0.824         0.894
##   9.90    326       3    0.850 0.01814        0.815         0.887
##  10.27    323       1    0.848 0.01827        0.813         0.884
##  10.33    322       1    0.845 0.01840        0.810         0.882
##  10.80    316       1    0.842 0.01854        0.807         0.879
##  10.97    315       1    0.840 0.01867        0.804         0.877
##  11.07    314       1    0.837 0.01880        0.801         0.875
##  11.30    313       1    0.834 0.01893        0.798         0.872
##  12.20    312       1    0.832 0.01906        0.795         0.870
```

```
##  12.73    311        1    0.829 0.01918        0.792         0.867
##  12.93    310        1    0.826 0.01931        0.789         0.865
##  13.10    309        1    0.824 0.01943        0.786         0.863
##  13.33    308        1    0.821 0.01955        0.784         0.860
##  13.37    307        1    0.818 0.01967        0.781         0.858
##  13.57    306        1    0.816 0.01978        0.778         0.855
##  13.77    305        2    0.810 0.02001        0.772         0.850
##  13.80    303        1    0.808 0.02012        0.769         0.848
##  13.83    302        4    0.797 0.02056        0.758         0.838
##  13.87    298        1    0.794 0.02066        0.755         0.836
##  13.90    297        1    0.792 0.02076        0.752         0.833
##  13.97    296        1    0.789 0.02086        0.749         0.831
##  14.00    295        1    0.786 0.02096        0.746         0.828
##  14.10    294        1    0.784 0.02106        0.743         0.826
##  14.27    293        1    0.781 0.02116        0.740         0.823
##  14.30    292        1    0.778 0.02126        0.738         0.821
##  14.37    291        1    0.775 0.02135        0.735         0.818
##  14.80    289        1    0.773 0.02144        0.732         0.816
##  15.83    288        1    0.770 0.02154        0.729         0.814
##  17.73    286        1    0.767 0.02163        0.726         0.811
##  18.03    285        2    0.762 0.02181        0.720         0.806
##  18.43    283        1    0.759 0.02190        0.718         0.804
##  18.70    282        1    0.757 0.02199        0.715         0.801
##  18.93    278        1    0.754 0.02207        0.712         0.798
##  19.00    277        1    0.751 0.02216        0.709         0.796
##  19.40    276        1    0.748 0.02225        0.706         0.793
##  20.17    274        1    0.746 0.02233        0.703         0.791
##  21.10    271        1    0.743 0.02242        0.700         0.788
##  21.57    270        1    0.740 0.02251        0.697         0.786
##  21.90    268        1    0.737 0.02259        0.695         0.783
##  21.97    267        1    0.735 0.02267        0.692         0.781
##  22.00    266        2    0.729 0.02284        0.686         0.775
##  22.13    264        1    0.726 0.02292        0.683         0.773
##  22.20    263        1    0.724 0.02300        0.680         0.770
##  22.23    262        1    0.721 0.02307        0.677         0.768
##  24.43    259        1    0.718 0.02315        0.674         0.765
##  24.73    258        1    0.715 0.02323        0.671         0.762
##  25.30    257        1    0.713 0.02331        0.668         0.760
##  25.63    256        1    0.710 0.02338        0.665         0.757
##  25.80    255        1    0.707 0.02345        0.663         0.755
##  25.93    252        1    0.704 0.02353        0.660         0.752
##  26.17    251        1    0.701 0.02360        0.657         0.749
##  26.20    250        1    0.699 0.02367        0.654         0.747
##  26.23    249        1    0.696 0.02374        0.651         0.744
##  26.37    248        1    0.693 0.02381        0.648         0.741
##  26.47    247        1    0.690 0.02388        0.645         0.739
##  27.60    244        1    0.687 0.02395        0.642         0.736
##  29.97    241        1    0.684 0.02402        0.639         0.733
##  30.20    240        1    0.682 0.02409        0.636         0.731
##  30.40    239        1    0.679 0.02416        0.633         0.728
##  30.83    238        1    0.676 0.02422        0.630         0.725
##  31.30    235        1    0.673 0.02429        0.627         0.722
##  31.63    232        1    0.670 0.02436        0.624         0.720
##  33.63    225        2    0.664 0.02450        0.618         0.714
```

```
## 33.90    223      1   0.661 0.02457       0.615        0.711
## 34.37    220      1   0.658 0.02464       0.612        0.708
## 34.57    219      1   0.655 0.02471       0.609        0.705
## 35.53    218      1   0.652 0.02478       0.605        0.703
## 38.40    207      1   0.649 0.02486       0.602        0.700
## 38.47    206      1   0.646 0.02494       0.599        0.697
## 38.57    205      2   0.640 0.02509       0.592        0.691
## 38.87    195      1   0.636 0.02518       0.589        0.688
## 41.40    185      1   0.633 0.02527       0.585        0.684
## 42.17    177      2   0.626 0.02549       0.578        0.678
## 42.33    167      1   0.622 0.02561       0.574        0.674
## 42.43    166      1   0.618 0.02573       0.570        0.671
## 43.03    161      1   0.614 0.02585       0.566        0.667
## 43.33    158      1   0.611 0.02598       0.562        0.664
## 43.70    155      1   0.607 0.02611       0.557        0.660
## 46.20    145      1   0.602 0.02626       0.553        0.656
## 46.27    140      1   0.598 0.02643       0.548        0.652
## 46.43    136      1   0.594 0.02660       0.544        0.648
## 46.63    133      1   0.589 0.02677       0.539        0.644
## 48.30    128      1   0.585 0.02695       0.534        0.640
## 48.43    127      1   0.580 0.02713       0.529        0.636
## 48.87    125      1   0.575 0.02731       0.524        0.631
## 54.10    104      1   0.570 0.02760       0.518        0.627
## 54.27     99      1   0.564 0.02791       0.512        0.622
## 59.80     56      1   0.554 0.02918       0.500        0.614
## 61.83     51      1   0.543 0.03056       0.486        0.606
## 63.33     43      1   0.531 0.03235       0.471        0.598
```

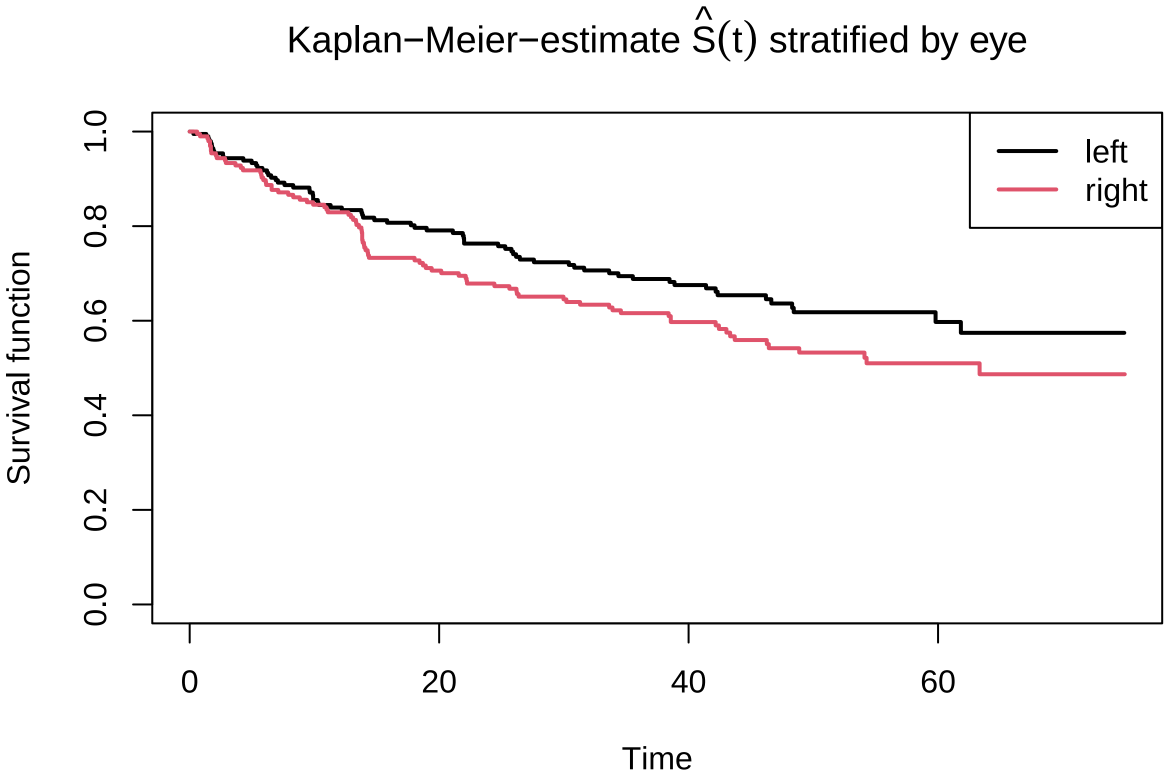
```r
# Look at the plot:
plot(KM, main = expression(paste("Kaplan-Meier-estimate ", hat(S)(t), " with 95% CI")), ylab = "Surviva
```



```r
# Stratify this by eye (1=left, 2=right):
str(data$eye)
```

```
##  Factor w/ 2 levels "left","right": 1 2 1 2 1 2 1 2 1 2 ...
```

```r
KM2 <- survfit(Surv(time, status) ~ eye, data = data)
plot(KM2, main = expression(paste("Kaplan-Meier-estimate ", hat(S)(t), " stratified by eye")), ylab = "S
legend(x="topright", col = 1:2, lwd = 2, legend=c("left", "right"))
```




```r
# perform log-rank test:
logrank <- survdiff(Surv(time, status) ~ eye, data = data)
# results:
logrank
```

```
## Call:
## survdiff(formula = Surv(time, status) ~ eye, data = data)
##
##             N Observed Expected (O-E)^2/E (O-E)^2/V
## eye=left  197       69     79.8      1.47      3.03
## eye=right 197       86     75.2      1.56      3.03
##
##  Chisq= 3  on 1 degrees of freedom, p= 0.08
```

#Conclusion: The Chi-Squared test statistic is 3 with 1 degree of freedom and the corresponding p-value is 0.08. Since this p-value is more than 0.05, we don't reject the null hypothesis i.e. we don't have sufficient evidence to say that there is a statistically significant difference in survival between the two groups (left eye and right eye).

#We can see that the survival curves are slightly different, but the log rank test tells us that the difference is not statistically significant.