ADVANCED DATA ANALYSIS

HW7

Fan Yang
UNI: fy2232
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Problem 1

(20pt) The data below show survival times in months of patients with Hodgkin's disease who were treated with nitrogen mustard. Group A patients received little or no prior therapy whereas Group B patients received heavy prior therapy. Starred are observations are censoring times.

Group A :

$1.25, 1.41, 4.98, 5.25, 5.38, 6.92, 8.89, 10.98, 11.18, 13.11, 13.21, 16.33, 19.77, 21.08, 21.84^{+}, 2$

Group B :

$1.05, 2.92, 3.61, 4.20, 4.49, 6.72, 7.31, 9.08, 9.11, 14.49^{+}, 16.85, 18.82^{+}, 26.59^{+}, 30.26^{+}, 41.34^{+}$

load data first.

In [1]:

```
library(survival)
timeA <- c(1.25, 1.41, 4.98, 5.25, 5.38,
           6.92, 8.89, 10.98, 11.18, 13.11,
           13.21, 16.33, 19.77, 21.08, 21.84,
           22.07, 31.38, 32.61, 37.18, 42.92)
deltaA <- c(1,1,1,1,1,
            1,1,1,1,1,
            1,1,1,1,0,
            1,0,0,0,1)
timeB <- c(1.05, 2.92, 3.61, 4.20, 4.49,
           6.72, 7.31, 9.08, 9.11, 14.49,
           16.85, 18.82, 26.59, 30.26, 41.34)
deltaB <- c(1,1,1,1,1,
            1,1,1,1,0,
            1,0,0,0,0)
```

(a)

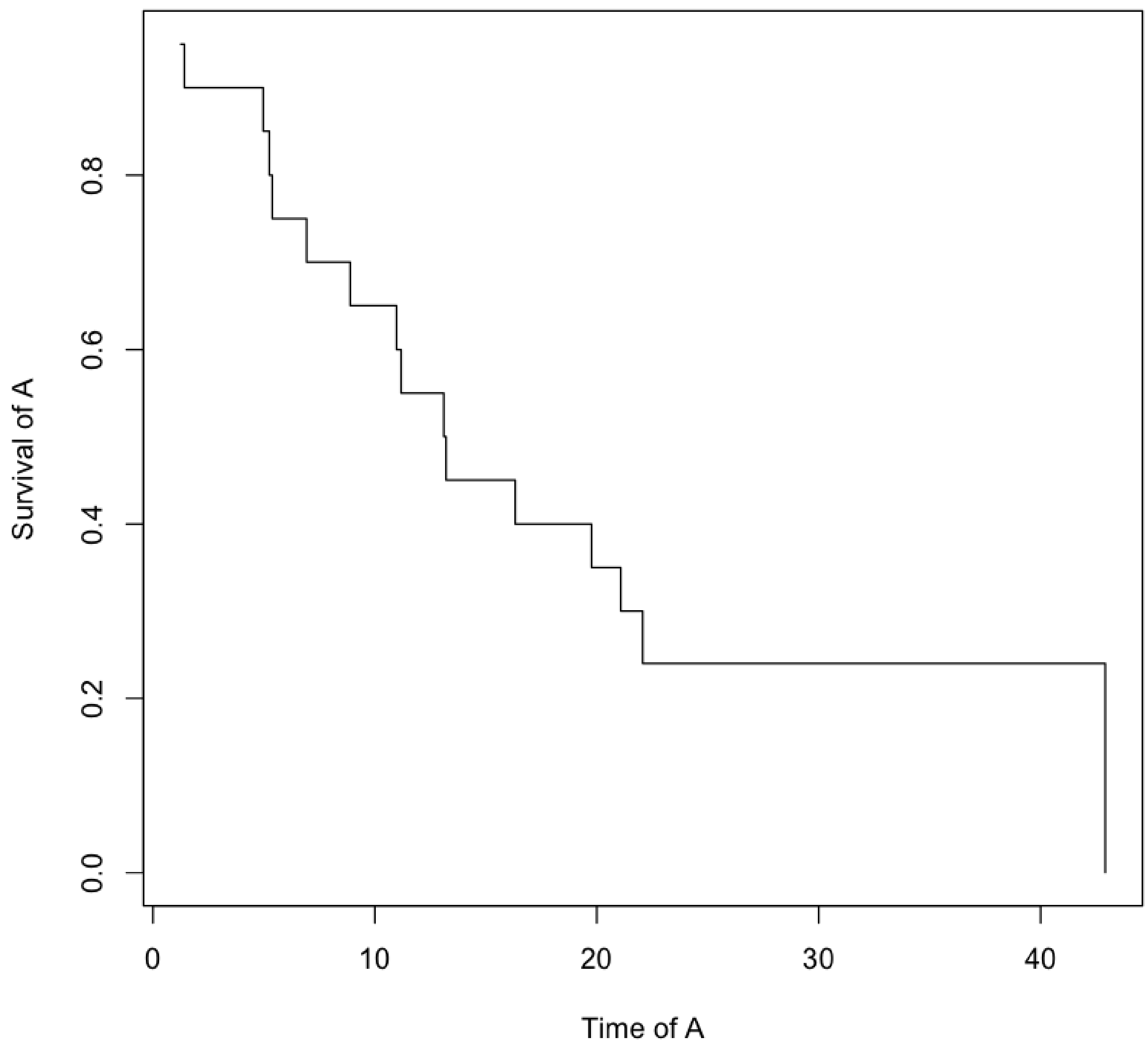
(a) (5pt) Obtain and plot the Kaplan Meier estimates of S_A and S_B , the survival functions of Group A and Group B, respectively.

In [2]:

```
kmA <- survfit(Surv(timeA, deltaA)~1,type="kaplan-meier")
kmA$surv
```

0.95 0.9 0.85 0.8 0.75 0.7 0.65 0.6 0.55 0.5 0.45 0.4 0.35 0.3 0.3 0.24 0.24 0.24 0.24 0

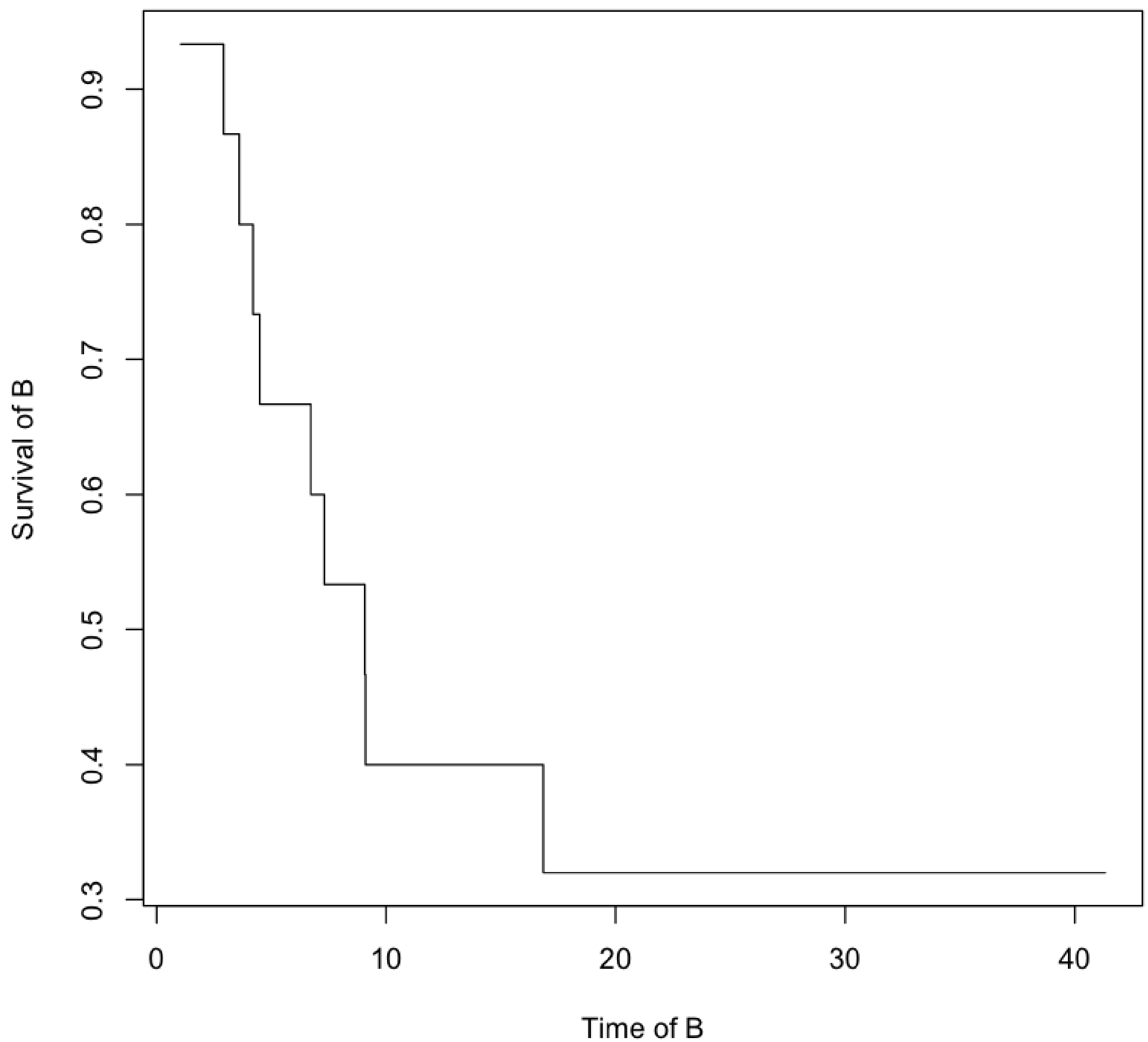
In [3]:
```
plot(kmA$time,kmA$surv, type="s",xlab="Time of A",ylab="Survival of A")
```



In [4]:
```
kmB <- survfit(Surv(timeB, deltaB)~1,type="kaplan-meier")
kmB$surv
```

0.933333333333333 0.866666666666667 0.8 0.733333333333333 0.666666666666667 0.6 0.533333333333333 0.466666666666667 0.4 0.4 0.32 0.32 0.32 0.32 0.32

In [5]:
```
plot(kmB$time,kmB$surv, type="s",xlab="Time of B",ylab="Survival of B")
```



(b)

(b) (2.5pt) Estimate $S_A(10)$ and $S_B(10)$ using a 95% confidence interval.

In [6]:
```
summary(kmA)
```

```
Call: survfit(formula = Surv(timeA, deltaA) ~ 1, type = "kaplan-meier")

  time n.risk n.event survival std.err lower 95% CI upper 95% CI
  1.25     20       1     0.95  0.0487        0.859        1.000
  1.41     19       1     0.90  0.0671        0.778        1.000
  4.98     18       1     0.85  0.0798        0.707        1.000
  5.25     17       1     0.80  0.0894        0.643        0.996
  5.38     16       1     0.75  0.0968        0.582        0.966
  6.92     15       1     0.70  0.1025        0.525        0.933
  8.89     14       1     0.65  0.1067        0.471        0.897
 10.98     13       1     0.60  0.1095        0.420        0.858
 11.18     12       1     0.55  0.1112        0.370        0.818
 13.11     11       1     0.50  0.1118        0.323        0.775
 13.21     10       1     0.45  0.1112        0.277        0.731
 16.33      9       1     0.40  0.1095        0.234        0.684
 19.77      8       1     0.35  0.1067        0.193        0.636
 21.08      7       1     0.30  0.1025        0.154        0.586
 22.07      5       1     0.24  0.0980        0.108        0.534
 42.92      1       1     0.00     NaN           NA           NA
```

From the above result, we can get the 95% confidence interval for $S_A(10)$ to be [0.420,0.858]

In [7]:
```
summary(kmB)
```

```
Call: survfit(formula = Surv(timeB, deltaB) ~ 1, type = "kaplan-meier")

  time n.risk n.event survival std.err lower 95% CI upper 95% CI
  1.05     15       1    0.933  0.0644        0.815        1.000
  2.92     14       1    0.867  0.0878        0.711        1.000
  3.61     13       1    0.800  0.1033        0.621        1.000
  4.20     12       1    0.733  0.1142        0.540        0.995
  4.49     11       1    0.667  0.1217        0.466        0.953
  6.72     10       1    0.600  0.1265        0.397        0.907
  7.31      9       1    0.533  0.1288        0.332        0.856
  9.08      8       1    0.467  0.1288        0.272        0.802
  9.11      7       1    0.400  0.1265        0.215        0.743
 16.85      5       1    0.320  0.1239        0.150        0.684
```

From the above result, we can get the 95% confidence interval for $S_B(10)$ to be [0.215,0.743]

(c)

***(5pt)Test** $H_0 : S_A = S_B$ **against** $H_a : S_A \neq S_B$**, Use** $\alpha = 0.05$.*

reshape data:

In [8]:
```
data <- data.frame(time = c(timeA,timeB),
                   delta = c(deltaA,deltaB),
                   group = c(rep(1,length(timeA)), rep(2,length(timeB))))
head(data)
survdiff(Surv(time,delta)~group,rho=0 , data = data )
```

time	delta	group
1.25	1	1
1.41	1	1
4.98	1	1
5.25	1	1
5.38	1	1
6.92	1	1

```
Call:
survdiff(formula = Surv(time, delta) ~ group, data = data, rho = 0)

         N Observed Expected (O-E)^2/E (O-E)^2/V
group=1 20       16    16.66    0.0261    0.0749
group=2 15       10     9.34    0.0466    0.0749

 Chisq= 0.1  on 1 degrees of freedom, p= 0.784
```

In the test $H_0 : S_A = S_B$ against $H_a : S_A \neq S_B$ under $\alpha = 0.05$, we got the p-value equals to 0.784.
Therefore we fail to reject the null hypothesis that the two survival functions are equal.

(d)

(5pt) Assume that it appropriate to use Cox proportional hazard model to these data. That is assume that

$$\lambda(t|x) = \lambda_0(t)e^{\beta x}$$

where x = 0 if group A and x = 1 if group 1. Estimate the hazard ratio using a 95% confidence interval. Interpret your result.

In [9]:
```
fitphm <- coxph(Surv(time,delta)~factor(group), data = data)
fitphm
confint(fitphm)
exp(confint(fitphm))
```

```
Call:
coxph(formula = Surv(time, delta) ~ factor(group), data = data)

                 coef exp(coef) se(coef)    z    p
factor(group)2 0.112     1.119    0.410 0.27 0.78

Likelihood ratio test=0.07  on 1 df, p=0.785
n= 35, number of events= 26
```

	2.5 %	97.5 %
factor(group)2	-0.6907948	0.9148215

	2.5 %	97.5 %
factor(group)2	0.5011776	2.49633

From this output, we found that the estimated coefficient or β is **0.112**, with a confidence interval **[-0.6907948, 0.9148215]**

While the hazard ratio comparing x=1 to x=0 is defined as e^{β}. Therefore the confidence interval is **[0.5011776, 2.49633]**

The hazard ratio tells us how much more likely one individual is to die than another at any particular point in time.

(e)

(2.5pt)Test $H_0 : \beta = 0$ ***against*** $H_a : \beta \neq 0$ ***using*** $\alpha = 0.05$***.***

In [10]:
```
summary(fitphm)
```

```
Call:
coxph(formula = Surv(time, delta) ~ factor(group), data = data)

  n= 35, number of events= 26 

                  coef exp(coef) se(coef)     z Pr(>|z|)
factor(group)2 0.1120    1.1185   0.4096 0.273    0.784

               exp(coef) exp(-coef) lower .95 upper .95
factor(group)2     1.119      0.894    0.5012     2.496

Concordance= 0.539  (se = 0.054 )
Rsquare= 0.002   (max possible= 0.987 )
Likelihood ratio test= 0.07  on 1 df,   p=0.7853
Wald test            = 0.07  on 1 df,   p=0.7845
Score (logrank) test = 0.07  on 1 df,   p=0.7844
```

In our test $H_0 : \beta = 0$ against $H_a : \beta \neq 0$ under $\alpha = 0.05$. We found that the Z statistic is 0.271 with p-value 0.784.
Therefore we fail to reject the null hypothesis and conclude that $\beta = 0$.