

Homework 9

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Problem 1

As

$$h(x) = \frac{2x}{1+x^2} = \frac{d[\ln(1+x^2)]}{dx} = -\frac{d[-\ln(1+x^2)]}{dx}$$
$$\log S(x) = -\ln(1+x^2)$$

survival function is

$$S(x) = e^{-\ln(1+x^2)} = \frac{1}{1+x^2}$$

$$F(x) = 1 - S(x) = \frac{x^2}{1+x^2}$$

so the density function is

$$f(x) = \frac{dF(x)}{dx} = \frac{2x}{(1+x^2)^2}$$

Problem 2

Let $\hat{F}(t)$ be the Fleming-Harrington estimator of $S(t)$. The Kaplan-Meier estimate, the Fleming-Harrington estimate of survival function and the Nelson-Aalen estimate of the cumulative hazard function are shown below.

t_i	n_i	d_i	c_i	$\hat{\lambda}_i$	\hat{S}_t	\tilde{H}_t	\hat{F}_t
1	10	1	0	1/10	0.90	0.10	0.90
2	9	2	0	2/9	0.70	0.32	0.72
4	7	0	1	0/7	0.70	0.32	0.72
5	6	0	1	0/6	0.70	0.32	0.72
6	5	1	0	1/5	0.56	0.52	0.59
7	4	0	1	0/4	0.56	0.52	0.59
8	3	0	1	0/3	0.56	0.52	0.59
9	2	0	1	0/2	0.56	0.52	0.59
10	1	0	1	0/1	0.56	0.52	0.59

Problem 3

```
library(tidyverse)
library(survival)
```

```
library(KMsurv)
data(tongue)
#head(tongue)
```

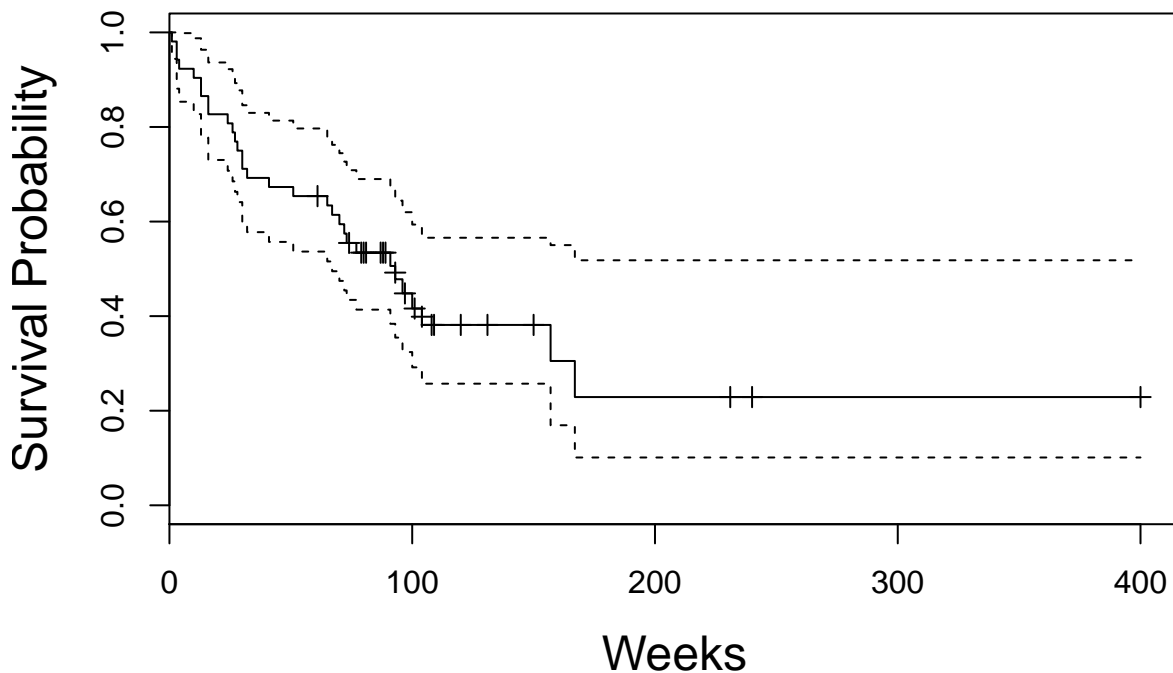
Aneuploid Tumor

```
aneu_data = tongue %>%  
  filter(type == 1)
```

The fitted model and K-M curve of aneuploid tumor are as following:

```
KM1=survfit(Surv(time,delta)~1, data = aneu_data, conf.type='log')  
plot(KM1, mark.time = TRUE,xlab="Weeks", ylab="Survival Probability",  
     main="K-M curve", cex.lab=1.5, cex.main=1.5)
```

K-M curve



```
#plot(KM1)  
#plot(KM1,fun='cumhaz') # cumulative hazard fun
```

Its pointwise 95% confidence interval is:

```
summary(KM1) [9:10]
```

```
## $lower  
## [1] 0.9441432 0.8810191 0.8534195 0.8271685 0.7774159 0.7302341 0.7073724  
## [8] 0.6849189 0.6628317 0.6410776 0.5984672 0.5775712 0.5569274 0.5365233  
## [15] 0.5156073 0.4949392 0.4745101 0.4543127 0.4343412 0.4137057 0.3837502  
## [22] 0.3546085 0.3240114 0.2916674 0.2571797 0.1692469 0.1010963  
##  
## $upper  
## [1] 1.0000000 1.0000000 0.9984199 0.9876318 0.9633075 0.9364144 0.9222396  
## [8] 0.9076572 0.8927093 0.8774289 0.8459729 0.8298369 0.8134500 0.7968243  
## [15] 0.7796580 0.7622454 0.7445954 0.7267155 0.7086117 0.6898696 0.6674945  
## [22] 0.6443177 0.6197713 0.5936554 0.5657292 0.5501796 0.5180988
```

There are 52 weeks only year, so the estimated 1-year survival rate and 95% CI are as following:

```
summary(KM1, times = 52)
```

```
## Call: survfit(formula = Surv(time, delta) ~ 1, data = aneu_data, conf.type = "log")
##
##   time n.risk n.event survival std.err lower 95% CI upper 95% CI
##    52     34     18   0.654   0.066    0.537    0.797
```

So the estimated survival rate is 0.654 and 95% CI is (0.537, 0.797).

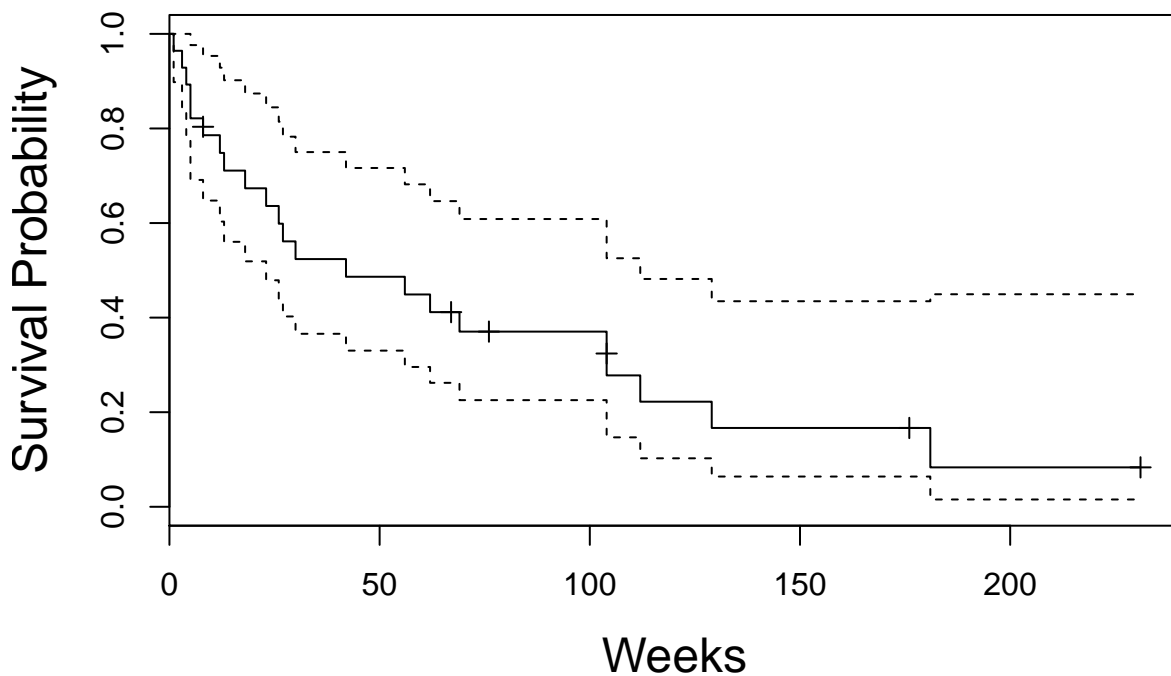
Diploid Tumor

```
dipl_data = tongue %>%
  filter(type == 2)
```

The fitted model and K-M curve of aneuploid tumor are as following:

```
KM2=survfit(Surv(time,delta)~1, data = dipl_data, conf.type='log')
plot(KM2, mark.time = TRUE,xlab="Weeks", ylab="Survival Probability",
     main="K-M curve", cex.lab=1.5, cex.main=1.5)
```

K-M curve



```
#plot(KM2)
#plot(KM2,fun='cumhaz') # cumulative hazard fun
```

Its pointwise 95% confidence interval is:

```
summary(KM2) [9:10]
```

```
## $lower
## [1] 0.89794106 0.83791552 0.78534007 0.69114238 0.64752602 0.60306086
## [7] 0.56028772 0.51897592 0.47896728 0.44015136 0.40245129 0.36581559
## [13] 0.33021322 0.29563090 0.26207206 0.22547787 0.14684585 0.10252765
```

```
## [19] 0.06392014 0.01545456
```

```
##
```

```
## $upper
```

```
## [1] 1.0000000 1.0000000 1.0000000 0.9762748 0.9533933 0.9285164 0.9019590
```

```
## [8] 0.8739539 0.8446615 0.8141954 0.7826361 0.7500403 0.7164452 0.6818728
```

```
## [15] 0.6463316 0.6084952 0.5255596 0.4817510 0.4346587 0.4494376
```

There are 52 weeks only year, so the estimated 1-year survival rate and 95% CI are as following:

```
summary(KM2, times = 52)
```

```
## Call: survfit(formula = Surv(time, delta) ~ 1, data = dipl_data, conf.type = "log")
```

```
##
```

```
##   time n.risk n.event survival std.err lower 95% CI upper 95% CI
```

```
##    52     13      14   0.486  0.0961      0.33      0.716
```

So the estimated survival rate is 0.486 and 95% CI is (0.33, 0.716).