

**Statis 697G Survival Analysis HW #2**  
Due on Wednesday, February 24, 2016

Note: Your computer output is just for references for your answers. You must write down your answer for each question asked (cut and paste is fine, but specify the title for the values presented). Attach your computer program at the end.

Consider the following clinical trial data (times in days):

42, 56, 73, 98, 105, 132, 132, 133, 133, 133, 133, 139, 140, 161, 180, 180, 196, 196, 223, 104+, 244+

Assume the data set is from a survival function  $S(t)$ .

1. Find the Kaplan-Meier estimates for  $S(t)$  at those failure times.  
(Present in a neat table using results from computer output.) Draw a graph of the  $\hat{S}(t)$  function.
2. Use a hand-calculator to find the MLE of the hazard rate if

$$S(t) = e^{-\lambda t} \quad t \geq 0$$

3. If  $S(t)$  is the exponential survival function specified in the previous problem,
  - (a) use a computer package (e.g. SAS) to find an estimate of the  $\lambda$ , [See page 173 of the book for coding and explanations.]; and write down the estimate of  $S(t)$ .
  - (b) compute the estimates of  $S(t)$  for those failure times for the exponential model and present them here. [These values will be used later.]
4. Now suppose the data is from a Weibull distribution with

$$S(t) = \exp[-(\lambda t)^\gamma] \quad t \geq 0, \gamma > 0, \lambda > 0$$

- (a) use a computer package to find estimates of  $\lambda$  and  $\gamma$ , respectively, [See page 180, Example 7.9, of the book for coding and explanations.]; and write down the estimate of  $S(t)$ .
  - (b) compute the estimates of  $S(t)$  for those failure times under the Weibull model, and present them here. [These values will be used later.]
5. You must present the answers of this problem clearly in a separate sheet, with no noise. (Cut and paste is fine.)
  - (a) Create a table with four columns.
    - 1st column: failure times
    - 2nd column: Kaplan-Meier estimates of  $S(t)$
    - 3rd column: values of  $\hat{S}(t)$  under the exponential model
    - 4th column: values of  $\hat{S}(t)$  under the Weibull model
  - (b) Compute the sum of squares of differences between estimates of the true survival function at those failure times, for (i) the K-P estimates versus the estimates under the exponential model, and (ii) the K-P estimates versus the estimates under the Weibull model.
  - (c) By comparing the two sum of squares in the previous problem, which model will you choose, the exponential or Weibull model?
6. Use computer to draw then present a graph with one frame including three curves corresponding to the three estimates of  $S(t)$ : (i) the K-P step function, (ii) the smooth curve using estimated survival function under the exponential model, and (iii) the smooth curve using estimated survival function under the Weibull model. [Similar to Figure 6.7, page 142 of the book, but with step function and two smooth curves.]