TD 3

Non parametric Estimation

Course : *Sûreté de fonctionnement & Retour d'Expériences*

(Dependability
and Feedback Data Collection)

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1. Given following 10 failure times in Hours, estimate $f(t), R(t), F(t), \lambda(t)$

What kind of data is it?

Give 90 % confidence interval for MTTF.

15.4, 18.9, 29.3, 72, 20.1, 24.5, 33.9, 48, 54.2, 86.1

2. 70 pumps are observed at 5 month intervals with following number of failures:

   3,7,8,9,13,18 and 12.

Determine $f(t), R(t), \lambda(t)$

3. Following are failure and censor times (in Hours):

150, 340+, 560, 800, 1130+, 1720, 2470+, 4210+, 5230, 6890

a. Determine the empirical reliability curve.

b. Use Rank Adjustment Method (Johnson Method) to derive the same.

Rank Adjustment Method:

$$\text{Rank increment} = \frac{(n+1) - i_{t_{i-1}}}{1 + \text{number of units beyond present censored unit}}$$

$$i_{t_i} = i_{t_{i-1}} + \text{rank increment}$$

$$\hat{R}(t_i) = 1 - \frac{i_{t_i} - 0.3}{n + 0.4}$$

4. 300 motors were installed in 1989 as part of a fan assembly. They have all failed. The following data were collected as their operating history. Estimate the reliability function, density function, hazard rate function, Estimate MT T F and standard deviation of failure times.

Year	Number of failures
1985	15
1986	20
1987	18
1988	27
1989	35
1990	31
1991	45
1992	43
1993	66

5. Estimate the empirical reliability function using Rank adjustment method based on following multiply censored data.

$$5, 12, 15^+, 22, 27, 35^+, 49, 71^+, 73, 81, 112^+, 117.$$