



**Ramakrishna Mission Vivekananda Educational and Research Institute**

PO Belur Math, Howrah, West Bengal 711 202

**School of Mathematical Sciences**

**Department of Computer Science**

MSc BDA : Batch 2020-22, Semester III, Final Exam

DA312: Time Series & Survival Analysis

Dr. Sudipta Das

Student Name (in block letters):

Date: 20 Jan 2021

Student Roll No:

Max Marks: 100

Signature:

Time: 3hrs

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*Answers must be properly justified to deserve full credits.*

1. (20 points)

The time in days to development of a tumor for rats exposed to a carcinogen follows a Weibull distribution as follows

$$f_X(x) = 0.0032xe^{-0.0016x^2}.$$

- (a) (5 points) What are the probabilities a rat will be tumor free at 30 days and 60 days?
- (b) (5 points) What is the mean time to tumor? (Hint  $\Gamma(0.5) = \sqrt{\pi}$ .)
- (c) (5 points) Find the hazard rates of the time to tumor appearance at 30 days and 60 days.
- (d) (5 points) Find the median time to tumor.

2. (20 points)

A large number of disease-free individuals were enrolled in a study beginning January 1, 1970, and were followed for 30 years to assess the age at which they developed breast cancer. Individuals had clinical exams every 3 years after enrollment. For four selected individuals described below, discuss in detail, the types of censoring and truncation that are represented.

- (a) (2.5 points) A healthy individual, enrolled in the study at age 30, never developed breast cancer during the study.
- (b) (2.5 points) A healthy individual, enrolled in the study at age 40, was diagnosed with breast cancer at the fifth exam after enrollment (i.e., the disease started sometime between 12 and 15 years after enrollment).
- (c) (2.5 points) A healthy individual, enrolled in the study at age 50, died from a cause unrelated to the disease (i.e., not diagnosed with breast cancer at any time during the study) at age 61.
- (d) (2.5 points) An individual, enrolled in the study at age 42, moved away from the community at age 55 and was never diagnosed with breast cancer during the period of observation.
- (e) (10 points) Confining your attention to the four individuals described above, write down the likelihood for this portion of the study.

3. (20 points)

A study was conducted on the effects of ploidy on the prognosis of patients with cancers of the mouth. Follow-up survival data was obtained on each patient.

Death times (in weeks) of patients with cancer of the tongue

Death Times:

1, 3, 3, 4, 10, 13, 13, 16, 16, 24, 26, 27, 28, 30, 30, 32, 41, 51, 65, 67, 70, 72, 73, 77, 91, 93, 96, 100, 104, 157, 167

Censored Observations:

61, 74, 79, 80, 81, 87, 87, 88, 89, 93, 97, 101, 104, 108, 109, 120, 131, 150, 231, 240, 400

- (a) (8 points) Estimate the survival function at one (52 weeks) and two years (104 weeks) after transplant.
- (b) (8 points) Find the standard errors for your estimates.
- (c) (4 points) Find a 95% linear confidence interval for  $S(104)$ .

4. (20 points)

A study was performed to determine the efficacy of boron neutron capture therapy (BNCT) in treating the therapeutically refractory F98 glioma, using boronophenylalanine (BPA) as the capture agent. F98 glioma cells were implanted into the brains of rats. Three groups of rats were studied. One group went untreated, another was treated only with radiation, and the third group received radiation plus an appropriate concentration of BPA. The data for the three groups lists the death times (in days) and is given below:

Untreated: 20, 21, 23, 24, 24, 26, 26, 27, 28, 30

Radiated: 26, 28, 29, 29, 30, 30, 31, 31, 32, 35+

Radiated + BPA: 31, 32, 34, 35, 36, 38, 38, 39, 42+, 42+

Perform any statistical test to check the equality of the hazard rates for the three groups.

5. (20 points)

In the previous exercise, three different treatments were administered to rats who had F98 glioma cells implanted into their brains. The data for the three groups of rats lists the death times (in days) in that exercise. Create two dummy variables,  $Z_1 = 1$  if animal is in the “radiation only” group, 0 otherwise;  $Z_2 = 1$  if animal is in the “radiation plus BPA” group, 0 otherwise. Use the Breslow method of handling ties in the problems below.

- (a) (14 points) Estimate  $\beta_1$  and  $\beta_2$  and their respective standard errors.
- (b) (6 points) Find a 95% confidence interval for the relative risk of death of an animal radiated only compared to an untreated animal.

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This exam has total 5 questions, for a total of 100 points and 0 bonus points.

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*Best of luck!!*