Quiz 2 and Final Project

ECE 313

Probability with Engineering Applications

Lecture 24

Professor Ravi K. Iyer

Dept. of Electrical and Computer Engineering

University of Illinois at Urbana Champaign

Today's Topics

- **Quiz 2**
- **In-class Review:**
  - Covariance and Variance

Quiz 2 – Problem 1

- **Part a)** A component has a constant hazard/failure rate. Which distribution best models the time to failure of the component? Write the failure density function *f(t)* and reliability function *R(t)*.

- **Part b)** We have three components in series, each with a constant failure rate of λ, define the failure rate, the reliability function , and the hazard function of the system. **Hint:** Recall from your notes: $h(t) = \frac{f(t)}{R(t)}$

Quiz 2 – Problem 2

- Remember the following properties for the hazard functions:

Density Function	*Hazard Rate*
f(t) for $0 < t \leq \infty$ Density function is defined for all positive time	z(x) for $0 < t \leq \infty$ Hazard rate is defined for all positive time
$f(t) \geq 0$ f(t) is never negative	$z(t) \geq 0$ z(t) is never negative
$\int_0^\infty f(t)dt = 1$ Probability of sample space is unity	$\int_0^\infty z(t)dt = \infty$ Equivalent to condition on f(t)

- **Part a)** Which of the following functions can serve as valid hazard models? Explain your answer mathematically.

$e^{(-at)}$ $e^{(+at)}$ At^{3} Bt^{-2} $\frac{e^{(+at)}}{t^{2}}$

- **Part b)** For one of the suitable models found in part a, derive the corresponding failure density function using the reliability function .

Quiz 2 – Problem 3

- A 10,000-hr life test on a sample group of 15 electric motors produced the following data:

Motor Number	Hours of Operation
1-6	10,000
7-10	8,000
11	10,000
12-14	6,000
15	2,000

- **Part a –** Assuming that all the motors have failed by the end of the test, construct a table showing for each time interval, the failure density per hour $f_d(t)$ and the hazard rate per hour $z_d(t)$ for the data. Plot $f_d(t)$ and $z_d(t)$ in one graph. **Hint:** Lecture 20 examples.

- **Part b (Bonus) –** Assuming that any motor with 10,000 hours of operation doesn't fail until the end of the test, what can you say about $f_d(t)$ and $z_d(t)$? Plot them again in one graph and compare to part a.

Final Project Topics

Group Name	Project Topic
Alpha	Analysis of Database Query Performance
Beta	Analysis of Pacemaker Adverse Events Data from the FDA
Gamma	Analysis of Blue Waters Supercomputers Failure Data
Delta	Analysis of EWS Workload Data
Epsilon	FDA Adverse Event Data Analysis
Zeta	Analysis of Failures in a Software-as-a-Service (SaaS) System
Eta	Analysis of WiFi Data using WireShark
Theta	Analysis of performance of different guest operating systems
Iota	Analysis of performance of virtual machines on a cloud server
Lambda	Analysis of Un-employment Data from U.S. Bureau of Labor

Final Project Timeline

- **Project Summary: Saturday, Nov. 16, 5:00pm**
  - Submit a one-paragraph summary of your goals and overall plans
- **Short Progress Reports: Every Tuesday, starting Nov. 19.**
  - A short paragraph (3-4 lines) on what progress you made and what is the plan for the next week

- **First Presentation, this Thursday, Nov. 21, in the class**
  - 2 slides showing your overall plan, timeline, the division of tasks, and techniques are your going to use.
- **Intermediate Presentation, Tuesday, Dec. 3, in the class**
  - Reporting on your progress

- **Final Presentation, Saturday, Dec. 14, in the class**
- **Final Exam Review Session, Monday, Dec. 16, Time: TBD**
- **Final Project Report, December 19, 5:00pm.**

First Presentation

- This Thursday, Nov. 21, 11:00am – 12:20pm, in the class
- Presentation: 5-6 mins, Questions: 2-3 mins => 2-3 slides
- Graded by the instructor, the TA, and the other students
- **Grading Scheme:**
  - **Presentation**
  - **Idea:**
    - What techniques or concepts from the class?
  - **Plan:**
    - Timeline
    - Division of tasks
  - **Content:**
    - Show a sample of your data with description
    - Show one or two graphs/histograms on your data & some insights
    - Show the data collection techniques and tools your are using.