Electrical Department

College of Engineering

University of Salahaddin

Subject: Probability and Statistics

Course Book – For 3rd Year

M. Sc. Basheer Abdulrahman Abdullah

Academic Year: 2022/2023

Course Book

1. Course name	**Probability and Statistics**
2. Lecturer in charge	**Basheer Abdulrahman Abdullah**
3. Department/College	**Electrical/College of Engineering**
4. Contact	**e-mail: basheer.akreyi@su.edu.krd** **Tel: (optional)**
5. Time (in hours) per week	**Theory: 3** **Practical: 0**
6. Office hours	**Mon and Thu 9:00 AM – 12:00 PM**
7. Course code	**2127**
8. Teacher's academic profile	**https://academics.su.edu.krd/basheer.akreyi**
9. Keywords	

10. Course overview:

This course is an introduction to probabilistic modeling, including random processes and the basic elements of Statistics. The ability to think probabilistically is a fundamental component of scientific and many other disciplines. In this course students will learn the relevant models, skills, and tools that are the keys to analyzing data and making scientifically sound predictions under uncertainty. We emphasize the basic concepts and methodologies, and include dozens of examples and applications.

11. Course objective:

This course has the following objectives

- Master the basic concepts associated with probability models.
- Be able to translate models described in words to mathematical ones.
- Understand the main concepts and assumptions underlying Bayesian and classical inference.
- Become familiar with basic and common probability distributions.
- Learn how to use conditioning to simplify the analysis of complicated models.
- Have facility manipulating probability mass functions, densities, and expectations

12. Student's obligation

The Probability and Statistics is a semester based course. Students are obligated to take one midterm exam and a final exam. Mid-term exam will be taken at the half of course time, and the final exam will be taken at the end of course. Beside of that, quizzes, homework, assignments may be given students from time to time. The minimum requirement for a passing grade is 50%.

13. Forms of teaching

Computer-generated slide presentations can enhance the effectiveness of classroom lectures. As an instructor, I can emphasize main points and key announcements, and I can

enhance my presentation with graphics. My presentations become more organized and flexible, and are easily updated or rearranged. From a student's perspective, class material is far more legible and interesting than hastily-scribbled notes on an overhead or chalkboard.

In this course I have also implemented the Moodle system which is a blended learning platform for schools that aim to simplify creating, distributing and grading assignments in a paperless way. This system will allow teacher and students to communicate online in an efficient way to support the students.

14. Assessment scheme

The grading of the course will be distributed as follow:

- Midterm exam 20%.
- Quizzes and Homework plus student attendance/activities 20%.
- The average of the students effort will be 40%, and
- Final exam 60%

15. Student learning outcome:

Students who successfully complete this course should be able to demonstrate understanding of :

- Defining the principal concepts about probability
- Expressing the concept of probability and its features.
- Basic probability axioms and expressing the concepts of factorial and the basic principal of counting.
- Solve the problems about permutation, combination and Binomial Theorem.
- Calculating probabilities using Conditional probability, Rule of total probability and Bayes' theorem.
- Explaining the concept of a random variable and the probability distributions.
- How to derive the probability density function of transformations of random variables and use these techniques to generate data from various distributions.
- Calculate the expected value and the moments.
- Explain major distributions of random variables.

16. Course Reading List and References:

- Dimitri P. Bertsekas and John N. Tsitsiklis, Introduction to Probability, 2nd Ed., 2008
- Sheldon Ross, A First Course in Probability, 8th Ed., 2010
- Hossein Pishro-Nik, Introduction to Probability, Statistics, and Random Processes.

17. The Topics:	Lecturer's name
Chapter 1: Basics of Probability This chapter will cover the following topics: • Algebra of Sets • Introduction to probability • Probabilistic Models • Probability Laws and its Properties • Counting Techniques	Basheer Abdulrahman (3 Weeks)
Chapter 2: Conditional Probability and Independence This chapter will cover the following topics: • Conditional Probability • Multiplication Rule • The Law of Total Probability • Bayes' Rule • Independence Events	Basheer Abdulrahman (3 Weeks)
Chapter 3: Discrete Random Variables This chapter will cover the following topics: • Random Variables • Discrete Random Variables • Probability Mass Function (PMF) • Special Distributions • Cumulative Distribution Function (CDF) • Expectation, Variance, and Standard Deviation	Basheer Abdulrahman (3 Weeks)
Chapter 4: Continuous Random Variables This chapter will cover the following topics: • Continuous Random Variables and their Distributions • Probability Density Function (PDF) • Expected Value and Variance • Special Distributions: Uniform Distribution, Exponential Distribution, Normal (Gaussian) Distribution, Gamma Distribution	Basheer Abdulrahman (2 Weeks)
Chapter 5: Joint Distributions: Two Random Variables This chapter will cover the following topics: • Two Discrete Random Variable • Joint PMF and CDF • Conditioning and Independence of Two Discrete Random Variable • Two Continuous Random Variables	Basheer Abdulrahman (2 Weeks)

• Joint PDF and CDF • Conditioning and Independence of Two Continuous Random Variables	
Chapter 6: Statistics This chapter will cover the following topics: • Descriptive Statistics • Inferential Statistics • Population and Samples	Basheer Abdulrahman (2 Weeks)
18. Practical Topics (If there is any)	
None	None

19. Examinations:

Question Example:

Answer the following questions:

1)

A fair 4-sided die is rolled twice and we assume that all sixteen possible outcomes are equally likely. Let X and Y be the result of the 1st and the 2nd roll, respectively. We wish to determine the conditional probability $P(A|B)$ where

$$A = \{\max(X,Y) = m\}, \qquad B = \{\min(X,Y) = 2\},$$

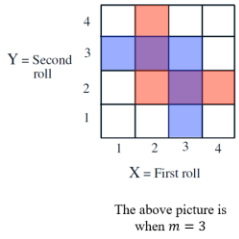
and m takes each of the values 1, 2, 3, 4.

Answer:

We can first determine the probabilities $P(A \cap B)$ and $P(B)$ by counting the number of elements of $A \cap B$ and B, respectively, and dividing by 16.

For different values of m we have

$$P(A|B) = \begin{cases} 2/5 & \text{if } m = 3 \text{ or } m = 4, \\ 1/5 & \text{if } m = 2, \\ 0 & \text{if } m = 1. \end{cases}$$



The above picture is when $m = 3$

2)

If we toss a fair coin twice, and let X be defined as the number of heads we observe. Find the range of X, R_X, as well as its probability mass function P_X.

Answer:

- Here, our sample space is given by

$$S = \{HH, HT, TH, TT\}.$$

- The number of heads will be 0, 1 or 2. Thus

$$R_X = \{0, 1, 2\}.$$

- Since this is a finite (and thus a countable) set, the random variable X is a discrete random variable. Next, we need to find PMF of X. The PMF is defined as

$$P_X(k) = P(X = k) \text{ for } k = 0, 1, 2.$$

- We have

$$P_X(0) = P(X = 0) = P(TT) = \frac{1}{4},$$

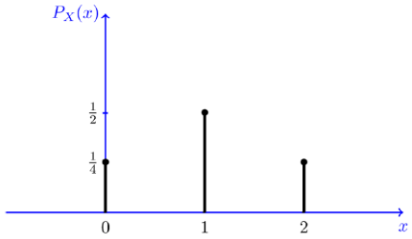
$$P_X(1) = P(X = 1) = P(\{HT, TH\}) = \frac{1}{4} + \frac{1}{4} = \frac{1}{2},$$

$$P_X(2) = P(X = 2) = P(HH) = \frac{1}{4}.$$

- Thus, in general we can write

$$P_X(x) = \begin{cases} P(X = x) & \text{if } x \text{ is in } R_X \\ 0 & \text{otherwise} \end{cases}$$

- And to better visualize the PMF, we can plot it.



20. Extra notes:

None

21. Peer review

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