

## Special ITA Tutorial Sessions for Unit-I & Unit-II

Date: 12.09.2024 (Thursday 5<sup>th</sup> & 6<sup>th</sup> Hours)

1. Suppose you are waiting for a train at a train station. According to the train schedule, the train is expected to arrive at 3:00 PM with a time window of  $\pm 10$  minutes. That means the train could arrive anytime between 2:50 PM and 3:10 PM. What is the probability that the train will arrive between 3:00 PM and 3:01 PM?
2. You are at a concert where the lights are scheduled to dim at exactly 9:00 PM. However, the timing can vary slightly, and the lights are expected to dim at  $9:00 \pm 3$  minutes. This means the lights can dim any time between 8:57 PM and 9:03 PM. What is the probability that the lights will dim exactly at 9:00 PM?
3. You have a bag with 3 colored balls: one red, one blue, and one green. Each ball has an equal chance of being picked.
  - The red ball is worth 1 point.
  - The blue ball is worth 2 points.
  - The green ball is worth 3 points.

Determine the following:

- i. What is the arithmetic mean of the points assigned to the balls?
  - ii. What is the expected value (mean) of the points if you pick one ball at random?
4. You have a simple game where you roll a fair six-sided die. Each face of the die shows a different number from 1 to 6. In this game, the number you roll corresponds to the points you win.

Determine the following:

  - i. What is the arithmetic mean of the points on the die?
  - ii. What is the expected value (mean) of the points you will win if you roll the die?
5. In a class, 60% of the students have completed their assignment. Three students are selected at random. It is known that at least one of them has completed their assignment. What is the probability that all three students have completed their assignment?
6. In a video game, 70% of the players successfully complete a level on their first attempt. Five players are randomly selected, and it is known that at least one of them successfully completed the level on their first attempt. What is the probability that all five players completed the level on their first attempt?

7. You are at a party where it's known that 40% of the attendees are wearing hats. You randomly spot three people at the party. It is known that the first person you spot is wearing a hat. What is the probability that the other two people are also wearing hats?
8. You have a lamp that can be turned on by either of two independent switches, S1 and S2. Each switch can be either ON or OFF, and each switch is equally likely to be in either state. The switches are connected in parallel to the lamp. What is the probability that the lamp will be on?
9. You have a lamp that can be turned on by either of two independent switches, S1 and S2. Each switch can be either ON or OFF, and each switch is equally likely to be in either state. The switches are connected in series to the lamp. What is the probability that the lamp will be on?
10. You have a box with 5 colored balls: 2 red, 2 blue, and 1 green. Each ball is equally likely to be selected. You can set the probabilities for each color before the selection.
- How can you achieve the maximum entropy in this selection scenario?
  - How can you achieve the minimum entropy?

11. You have a basket containing 8 fruits:

- 3 Apples
- 3 Bananas
- 2 Oranges

Each fruit is equally likely to be selected. You can set the probabilities for each type of fruit before the selection.

- How can you achieve the maximum entropy in this selection scenario?
- How can you achieve the minimum entropy?

12. You have a bag with 6 balls:

- 3 Red balls
- 2 Blue balls
- 1 Green ball

- Compute Shannon's Entropy.
- Compute Quadratic Renyi's Entropy (Order 2).

13. You have a standard deck of 52 playing cards. Each card is equally likely to be drawn. Calculate the following:
- a) Shannon's Entropy for drawing a card from the deck.
  - b) Quadratic Renyi's Entropy (Order 2) for drawing a card from the deck.
14. Consider 2-input OR gate, AND gate, and X-OR gate. All the input states are equally likely. Which gate has more output entropy and why?
15. You have been given the following sales figures (in thousands of dollars) for a retail store over two consecutive months. Your task is to estimate the Probability Density Function (PDF) of these sales figures using a Gaussian kernel with a standard deviation of 1.

**Sales Data:**

First Month Sales: 40, 45, 38, 50, 42, 55

Second Month Sales: 43, 48, 37, 52, 49, 53

16. Three friends, Alice, Bob, and Carol, work in a different department of a large office building. The office opens at 9 AM. Each friend arrives at the office at a random time between 8:30 AM and 9:00 AM, and they must cross a common corridor that takes exactly 15 minutes to walk through. It has been observed that no one arrives at the office before 8:30 AM.

What is the probability that all three friends will be in the corridor at the same time?

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