Assignment 2
DA 241 Statistical Foundations for Data Science
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1. Use your computer to simulate the experiment of rolling two fair dice 10,000 times and recording the sum of the outcomes. Count the number of times you get the sum of 11 and the number of times you get a sum of 12. Use these counts to compute the approximate probability of getting a sum of 11 and that of getting a sum of 12. Check how close these are with the exact probabilities.

2. A random 5-card poker hand is dealt from a standard deck of cards. Find the probability of each of the following possibilities

   a) A full house (The hand is called a full house in poker if it consists of three cards of some rank and two cards of another rank, e.g., three 6's and two 9's (in any order).

   b) A flush (all 5 cards being of the same suit; do not count a royal flush, which is a flush with an ace, king, queen, jack, and 10).

   c) Two pair (e.g., two 3's, two 7's, and an ace).

3. Using the probbaility axioms, prove the following (use Venn diagrams):

   a) $\mathbb{P}(A^c) = 1 - \mathbb{P}(A)$

   b) If $A \subset B$, $\mathbb{P}(A) \leqslant \mathbb{P}(B)$

   c) $\mathbb{P}(A \cup B) = \mathbb{P}(A) + \mathbb{P}(B) - \mathbb{P}(A \cap B)$

4. In a well shuffled deck of cards labelled 1 to n, find an approximation to the probability that atleast one card matches using simulation. A match is considered when the ith card in the shuffled deck is numbered i. Use n = 100 to do the simulations. Will the probability increase or decrease if the number of cards are increased?

5. Mr. and Mrs. Arora have two children. You randomly run into one of the two, and learn that she is a girl. Assume that the gender is binary and $\mathbb{P}$(boy) = $\mathbb{P}$(girl) and that the gender of two children are independent, what is the conditional probability that both are girls? Also assume that you are equally likely to run into either child, and that which one you run into has nothing to do with gender.

6. You have one fair and one unfair coin which lands Heads with probability 2/3. You pick one of the coins at random and flip it three times. It lands Heads all three times. Given this information, what is the probability that the coin you picked is the fair one?

7. A CBI agent Van Pelt is taking a DA241 Statistical Foundations for Data Science class and at the end of each week she can be either up-to-date or she may have fallen behind. If she is up-to-date in a given week, the probability that she will be up-to-date (or behind) in the next week is 0.8 (or 0.2, respectively). If she is behind in a given week, the probability that she will be up-to-date (or behind) in the next week is 0.4 (or 0.6, respectively). Agent Van Pelt is (by default) up-to-date when she starts the class. What is the probability that she is up-to-date after three weeks?

8. Out of the students in a class, 60 % perform excellently in the exams, 70 % love pizza, and 40 % fall into both categories. Determine the probability that a randomly selected student neither performs excellently nor is a pizza lover.