APHY / ICSI / CINF 451/551
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Fall 2026
HW #3w (100 points)

This is a WRITTEN HOMEWORK PROBLEM. It will be GRADED.
There are FOUR problems, each worth 25 points.
Email your submission (pdf or scan) to
knuthclass@gmail.com no later than 11:59pm on the Due Date

1. Independent Pair of Fair 6-Sided Dice.
Consider an independent pair of fair 6-sided dice with sides indexed by i and j.

a. Since they are independent, how does $p(i \mid j, I)$ relate to $p(i \mid I)$?

b. What is the probability of rolling $i = 2$ on the first 6-sided die? That is, what is $p(i = 2 \mid I)$?

c. What quantity does $p(i = 2, j = 4 \mid I)$ represent? And what is its value?

d. What is the average value (also called the expected value) of i ?

e. Is it possible to ever observe this expected value? Why or why not?

f. What is the expected value of $i + j$?

g. What is the most probable value of $i + j$?

2. Non-Independent Pair of Dice

Imagine that we have a pair of six-sided dice that are attached to one another with a string, so that they are not independent.

Below is a partially-filled in table of the probabilities for rolling different values indexed by i and j.

$P(i,j\|I)$	$j=1$	$j=2$	$j=3$	$j=4$	$j=5$	$j=6$
$i=1$	0	0	0	0	0	0
$i=2$	0		$\frac{2}{36}$	$\frac{2}{36}$	$\frac{1}{36}$	0
$i=3$	0	$\frac{2}{36}$	$\frac{4}{36}$	$\frac{1}{36}$	$\frac{2}{36}$	0
$i=4$	0	$\frac{2}{36}$	$\frac{1}{36}$	$\frac{4}{36}$	$\frac{2}{36}$	0
$i=5$	0	$\frac{1}{36}$	$\frac{2}{36}$	$\frac{2}{36}$	$\frac{4}{36}$	0
$i=6$	0	0	0	0	0	0

a. Fill in the missing entry in the table above.

b. What is the expected value of $i+j$?

c. What is the probability $p(i \mid I)$ for all values of i ?

$p(i=1 \mid I) =$

$p(i=2 \mid I) =$

$p(i=3 \mid I) =$

$p(i=4 \mid I) =$

$p(i=5 \mid I) =$

$p(i=6 \mid I) =$

d. What is the expected value of i ?

3. Understanding Independence

In the problem #1, we found that $p(i \mid j, I) = p(i \mid I)$ when i and j are independent.

Prove (algebraically using the sum and/or the product rules) that if $p(x, y \mid I) = p(x \mid I)\, p(y \mid I)$ then $p(x \mid y, I) = p(x \mid I)$ meaning that if x and y are independent, then you can just drop any conditioning of x on y.

4. CS Employment

A particular computer science department produces students who have gone into the following areas of employment:

Computer Programmer: 20%
Software Engineers: 25%
Computer Security: 17%
Network Administrator: 10%
Database Administrator: 15%
Web Developer: 13%

a. Only the Network and Database Administrators take positions where they oversee a team of people. What is the probability that a graduating CS student will take a position where they oversee a team of people?

b. Google hires 10% of the software engineers and 5% computer security students produced by the department. What is the probability that a graduating CS student will work for Google?

c. Given that a person is a CS graduate that works for Google, what is the probability that this person is a software engineer?

d. A later survey reveals that among Google employees that one third of their computer security employees and one fourth of their software engineers start a family within three years of starting employment. So, among the CS graduates at Google, what is the probability that a student will start a family within three years?