CS 3130 / ECE 3530: Probability and Statistics for Engineers **Due Th 9/28**

Homework 3: Discrete Random Variables

Instructions: Submit a single R Markdown file (.Rmd) of your work on Canvas by 11:59pm on the due date. You may also submit diagrams, drawings, etc. as image files (.png, .jpg, .gif)—they must be formatted into your .Rmd document (we won't look at them separately). **Be sure to show all the work involved in deriving your answers! If you just give a final answer without explanation, you may not receive credit for that question.**

You may discuss the concepts with your classmates, but write up the answers entirely on your own. Do not look at another student's answers, and do not show your answers to anyone.

1. Consider an experiment where you flip three coins. Define the random variable X = "the number of consecutive flips that appear". So, the sequence HHT has two consecutive, HTH has one, HHH has three, etc. What is the probability mass function of X?

2. Using R, simulate the three coin experiment from Problem 1. Estimate the probabilities for the probability mass function. Are they close to the answers you got above?

3. Exercise 4.11. Be sure to **explain** your answer.

4. You write a computer vision application that identifies peoples' faces with an accuracy of 90%. Your software is deployed in a security system that screens 50 people per day. For each of the questions below, please do **BOTH** of the following: (1) give the formula to compute the answer, (2) run the R command that computes the answer and show it's output.

   (a) What is the probability that your system will have exactly 8 errors in a day?

   (b) What is the probability that your system will have 5 or fewer errors in a day?

   (c) What is the probability that your system will have a "perfect day" (no errors)?

5. Simulate the security system in Problem 2, repeated 10,000 times. Using this simulation, estimate the probabilities in (a), (b), (c). Do they match the values you computed above?

6. A couple decide they really want a daughter. So, they decide to start having children and continue until they have their first daughter. Assuming having either a boy or girl is equally likely, answer the following:

   (a) In the end, will the couple be more likely to have more boys or more girls? Explain why.

   (b) Give a formula for the probability that they end up with exactly k boys.

   (c) Now assume that the probability of having a boy is 60%. Reanswer part (a).

   (d) Again assume that the probability of having a boy is 60%. Reanswer part (b).

   Hint: Not required (but recommended), but you might try running an R command to double-check the numbers that you get in this problem.