M319: AP Computer Science Principles
Chapter 6: Modeling and Simulation
Simulation Project

Name: ___________________________________

Date: ______ Teacher: ______________________

Program Requirements

- The first cell of your notebook must be a markdown containing the following:
  - First and last name
  - Class period
  - Problem number and problem text copied
- Single-trial function
  - Similar to the World Series Simulation, break down your trial into steps/stages
  - Define a function that will return the desired result
    - Get this checked <u>prior</u> to running your simulation!
- Simulation of a large number of trials
  - Number of trials is large enough
  - The results are stored in an array
- Display the results of your simulation
  - Visually appealing
  - Provides useful stats/information relating to the question
- Give an answer based off of your simulation results
- Answer **one additional question** of interest (of your choice) using your data from the simulation
  - Did you see any interesting stats?
  - Notice an interesting trend?
  - Answer is data-based and accompanied with a graphic
- Code comments for each cell
  - Divide your work into “steps” or “stages”, with each step/stage in its own cell
  - Describe what is being accomplished in each cell

Instructions:

Your teacher will assign you one of the following problems for your Simulation Project. Be sure to refer to your notes and the project requirements listed above when completing your simulation.

1. Professional tennis players bring multiple racquets to each match. They know that high string tension, the force with which they hit the ball, and occasional ‘racquet abuse’ are all reasons why racquets break during a match. Brian’s coach tells him he has a 15% chance of breaking a racquet in any given match. How many matches, on average, can Brian expect to play until he breaks a racquet and needs to use a backup?

2. A certain game of chance is based on randomly selecting three numbers from 00 to 99, inclusive (allowing repetitions), and adding the numbers. A person wins the game if the resulting sum is a multiple of 5. Use simulation to estimate the proportion of times a person wins the game.

3. A couple plans to have children until they have a girl or until they have four children, whichever comes first. Estimate the likelihood that they will have a girl. Assume that each child has probability 0.5 of being a girl and 0.5 of being a boy, and the sexes of successive children are independent.

4. On a certain day, the blood bank needs 4 donors with Type O blood. How many donors, on average, would they have to see to get exactly four donors with Type O blood, assuming that 45% of the population has Type O blood?

5. A man has ten ties and chooses a tie at random to wear to work each day. His wife complains that he often wears the same tie two or more times in a 5-day week. Design and conduct a simulation to estimate the probability that he wears the same tie more than once in a 5-day work week. Does his wife have a legitimate complaint?

6. A basketball player makes 70% of her free throws in a long season. In a tournament game she shoots 5 free throws late in the game and misses 3 of them. The fans think she was nervous, but the misses may simply be chance. What is the likelihood of her missing 3 or more of the 5 shots?

7. Your company operates a van service from the airport to downtown hotels. Each van carries 7 passengers. Many passengers who reserve seats don't show up – in fact, 25 times out of 100, in the long run, a passenger will fail to appear. Assume that each passenger is independent of one another (in other words, whether a passenger shows up has no relation to any other passenger showing up. If you allow 9 reservations for each van, what is the probability that more than 7 passengers will appear?

8. A baseball player has a .362 batting average (in other words, for every 1000 at bats we would expect him to have 362 hits). In a recent game he comes to bat 4 times and has 3 hits. Is this what we would expect from this player? Use simulation to find the probability that this player would have 3 or 4 hits in 4 times at bat in a single game.

9. A certain brand of cereal is offering free spy toys inside of specially marked boxes. There are five types of toys: a spyglass, a notebook, a compass, a seethrough mirror and an invisible-ink pen. Henry really wants the spyglass and plans to buy cereal boxes until he gets it. On average, how many boxes of cereal would Henry need to buy in order to get the spyglass? Conduct a simulation to answer this question. Assume the distribution of prizes is equal among all cereal boxes at the store where Henry buys his cereal.

10. In the United Kingdom's Lotto game, a player picks six numbers from 1 to 49 for each ticket. Rosemary bought one ticket for herself and one for each of her four adult children. She had the lottery computer randomly select the six numbers on each ticket. When the six winning numbers were drawn, Rosemary was surprised to find that none of these numbers appeared on any of the five Lotto tickets she had bought. Should she be?

11. Robert and Sean insist that there is a higher probability of a tie when playing Rock-Paper-Scissors than of having a winner. Set up a simulation to determine the probability of a winner in a game of Rock-Paper-Scissors. Assume an equal probability of each person choosing either rock, paper or scissors.

12. In NCAA basketball, beginning with the seventh foul of the half, one free throw is awarded; if the player makes the free throw, another is given. This is called shooting a "one-and-one". Jordan has a 60% shooting percentage. What is the most likely number of points scored by Jordan in a one-and-one scenario?