MAT 258 - CODING ASSIGNMENT #1
due Friday, October 13, 2017 at 11:50PM.

OBJECTIVE: Students will design and implement algorithms to compute probabilities for various events.

GRADING: The assignment is worth 5% of your course grade.

INSTRUCTIONS:

- Students may work individually or in pairs. Each team must submit their own code, but they may ask questions and clarification from classmates and the instructor.
- Students must submit their projects on Moodle.
- Students should include the names of all team members on all files they submit.

SUBMIT THE FOLLOWING:

- An executable. This should be able to run on a clean machine, please compile it accordingly.
- A read-me file explaining how to run your code.
- Answer Sheet with answers to the specific problems.

PROJECT:

1. **Dice Probabilities:** Given nDk compute the probability they add up to a desired sum s.
   - Write a program that does the following:
     (a) Input the size of dice k ($k \geq 2$).
     (b) Input the number of dice n ($n \geq 1$).
     (c) Input the desired sum s ($n \leq s \leq kn$).
     (d) Count how many n tuples with values in $\{1, 2, \cdots, k\}$ add up to s. Output the result.
     (e) Output the probability that a random roll of nDk has a sum s.
   - Test your program for the following values and include the output in the **Answer Sheet.**
     (a) $n = 2$, $k = 6$, $s = 7$
     (b) $n = 10$, $k = 6$, $s = 18$
     (c) $n = 10$, $k = 10$, $s = 10$
     (d) $n = 15$, $k = 4$, $s = 50$

2. **Monty Hall Problem:** You will code variations of the Monty Hall Problem, where a player tries to win a car, hidden behind one of the n doors. This problem will model the situation when the player switches doors after the first selection.

   - Write a program that does the following:
     (a) Input the total number of doors n.

     (b) Input the number of doors to be opened, k ($1 \leq k \leq n-2$).

     (c) The player is assigned Door 1.

     (d) In a loop of at least 100 trials:

     –Randomly assign a door to hide the car, call it Door C (note that it could be Door 1).

     –Randomly open any k doors different than Door 1 and Door C.

     –Randomly assign the player **another** unopened door.

     –Keep count of how many times the player wins the car.

     (e) Output the (estimated) probability that the player wins the car for the pair n and k.
   - Test your program for the following pairs and include the output in the **Answer Sheet.**

     (a) $n = 3$, $k = 1$

     (b) $n = 10$, $k = 1$

     (c) $n = 10$, $k = 8$

     (d) $n = 10$, $k = 4$

3. Gambler's Ruin problem: Suppose you play a game where you start with an amount of money $\$a$, and win \$1 per match with probability p or lose the \$1 with probability $1 - p$. Which happens first: do you lose all money or reach some fixed amount $\$b$?

   Write a program that does the following:

   - Input the starting dollar amount $\$a$.
   - Input the desired winning dollar amount where to stop $\$b$, where $b > a$.
   - Input the probability of winning each match, p.
   - In a loop of at least 100 trials:
     - play the game until you reach \$0 or $\$b$ dollars.
     - record if the player won or lost the game.
   - Output the number of times the player won the game, for the triple $(\$a, \$b, p)$.
   - Test your program for the following values and include the output in the **Answer Sheet.**

     (a) $a = 10$, $b = 20$, $p = 0.5$

     (b) $a = 10$, $b = 20$, $p = 0.1$

     (c) $a = 10$, $b = 100$, $p = 0.5$

     (d) $a = 10$, $b = 100$, $p = 0.9$