You may not discuss this assignment with anyone but me. You must email me a copy of your program (as an attachment, not pasted into the email body) and answers to the questions posed prior to 3:00pm on the due date. I will run your program, so do not copy it into a Word document.

The most common type of bet made in a craps game is the pass line bet. The pass line rules are given by the algorithm below:

```
IF       come out roll = 2,  3, 12 -> Shooter Loses
ELSEIF   come out roll = 7, 11     -> Shooter Wins
ELSE
    point = come out roll value
    Shooter rolls until the point is rolled (Shooter Wins)
    or a 7 is rolled (Shooter Loses)
ENDIF
```

The shooter controls the dice for as long as they win. Once they lose, the dice pass to the next shooter.

Another type of bet that can be made is a *field* bet. This can be made on any roll of the dice. If a player places a field bet, they win if the roll is 2, 3, 4, 9, 10, 11 or 12. They lose if any other number comes up.

Pass line and field bets both pay even money (*i.e.*, you win the same amount that you bet).

In this assignment, you will write a simulation of pass line and field betting in a craps game. This is known as a Monte Carlo simulation. This name comes from computing probabilities of various casino games before the mathematics of probability was fully understood. Instead, hundreds of games of various types would be played and the results tabulated. These results were used to estimate the probabilities of winning/losing/types of poker hands appearing, *etc.* Monte Carlo simulations are used in situations where the mathematics are too complex for a paper and pencil solution or a paper and pencil solution would not be practical. For example, statisticians often need to compute integrals of the form

$$\int \int \int \cdots \int f(x_1, x_2, x_3, \ldots, x_{100}) \, dx_1 \, dx_2 \, dx_3 \ldots dx_{100}.$$

A Monte Carlo method can be used to compute the value of such integrals more quickly than other methods.

In class we wrote a script that simulates one game of pass line betting in craps. For this assignment, you should use this as a starting point. Write a script that will ask the user to input a value for n and simulates n games of craps. Additionally, your program should

a) Determine the number of dice rolls,

b) Determine the probability of the shooter winning,

c) Determine the probability of the shooter loosing,

d) Determine the probability of the shooter hitting a point, (*i.e.*, the number of times a point is hit divided by the number of times a point is established),

e) Determine the probability of winning a field bet (assume a field bet is made on every roll of the dice).

For items b) and c), compute these probabilities relative to the entire pool of dice rolls (*i.e.*, don't compute the probabilities of the individual shooters).

Sometimes a statement in MATLAB is too long to write on a single line. In the event that you need to break up a statement over two or more lines, you can use the syntax

```
x = (some really long MATLAB statement that you need ...
        to continue onto the next line)
```

Use a sequence of three dots (...) to break the line and continue to the next one.

Once your program is working, run your program for $n = 700,000$ and use the results you compute to answer the following questions

1) How large is the house's advantage over the shooter (*i.e.*, what is the difference between items c) and d) above)?

2) How does this advantage compare with the exact value? You can look up this value online.

3) Does a your simulation reasonably replicate the probabilities involved?

4) Use the house advantage you computed above to determine the casino's annual profit from pass line betting. Assume that the casino has 50 tables and $2,000,000 is bet at each table per month.

5) Suppose that instead of rolling two six-sided dice and adding their totals, you simulate a roll by generating a random number from 2 to 12. How does this change the probability in Question 1?

HINTS:

- The first line in your program (after the `clear` statement) should be

      rng(1)

  This resets the random number generator and ensures that you are using the same sequence of random numbers each time you run your program.

- Don't try and write the entire program all at once. Build it in stages and add new features gradually. Leave off the ; from your statements to monitor the variables in your program.

- Run your program for a small value of n until you think it is working correctly, then run the large value of n.