CS100M Spring 2008 Project 2 due Thursday 2/14 at 6pm

You must work either on your own or with one partner. You may discuss background issues and general solution strategies with others, but the project you submit must be the work of just you (and your partner). If you work with a partner, you and your partner must first register as a group in CMS and then submit your work as a group.

Objectives

Completing this project will help you learn about loops, combining loops and conditionals, nested loops, graphics, and breaking down a problem into manageable *sub*problems.

Do not use arrays. Do not use `break`.

1 Flip an unfair coin

Ann and Bob flip an unfair coin in a game—tails shows up twice as often as heads. In each trial of the game, Ann and Bob each flips the coin twice—four flips in each trial. In each trial, Ann wins if her two flips are the same while Bob wins if he gets at least one heads. If there is a tie, then neither player wins that trial. The game stops when one player has won three trials more than the other player or after 40 trials, whichever happens first. Write a script `coinGame` to simulate this game. The output should include the total number of trials played and the number of trials won by each player.

Think about the problem in steps! There are three main tasks:

1. Represent the unfair coin. Function `rand` gives a value in interval (0,1). How do you use this interval so that "tails happens twice as often as heads"?
2. In *one* trial, determine who is the winner (if there is one).
3. Repeat the trials until the stopping criterion is reached. What values does the program need to keep track of?

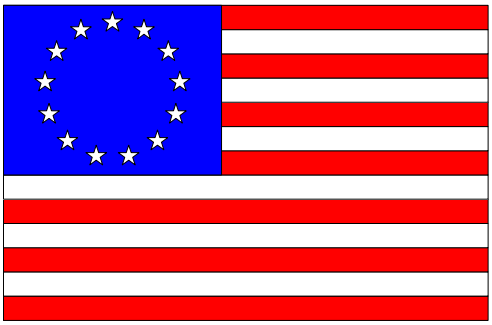
Thought Question (i.e., you don't have to submit an answer): Each coin flip is unfair; is the game unfair? Do Ann and Bob have the same likelihood of winning?

2 Betsy Ross Flag

During the American Revolutionary War, the Marine Committee of the Second Continental Congress passed a resolution on June 14, 1777, establishing a flag design:

> Resolved, that the flag of the United States be thirteen stripes, alternate red and white; that the union be thirteen stars, white in a blue field representing a new constellation.

Neither the exact proportions nor the arrangement of the stars were specified. As a result, the earliest Colonial armies served under several different flags. The most recognizable flag was the "Betsy Ross Flag," which arranged the thirteen stars in a circle so that "no one colony would be viewed above another."



Complete the script `betsyRossFlag` to draw this 13-star flag. Functions `drawRect` and `drawStar`, along with the skeleton file `betsyRossFlag.m`, are given on the *Programming Assignments* page of the course web site. Read the comments in the given functions to find out how to use them.

Before you start writing code, you need to solve a design problem! There are five design parameters: the length of the flag, the length of the blue corner, the width of each stripe, the radius of the star circle, and the radius of each star. Use reasonable values, similar to those used in the example shown above, or you may refer to the Standard Proportions of the United States Flag (see `http://www.usflag.org/flagspecs.html`).

The next decision that you need to make is the *order* in which you draw the objects of the flag (the blue corner, the stars, and the stripes). You can order the drawing tasks in such a way that the flag is "easy" to draw.

As you develop the program, *test* it frequently! For example, test your program after you have written the code for drawing each (group of) object on the flag. Frequent intermediate testing reveals "bugs" early and helps prevent confounding errors—new bugs on top of already buggy code.

Hints

- If you let the stripes be of unit height, then there are just four other parameters. Furthermore, the y-coordinate of the top of each stripe is then conveniently 1:13 (if the lower left corner of the flag is (0,0)).
- With respect to the positioning of the stars, we observe that if $N \geq 2$ is an integer, $\theta = 2\pi/N$ and $0 \leq \phi \leq 2\pi$, then the points

  $$(x_c + r\cos(k\theta + \phi), y_c + r\sin(k\theta + \phi)) \qquad k = 0 : N - 1$$

  are uniformly spaced around the circle $(x - x_c)^2 + (y - y_c)^2 = r^2$. Noting that one of the points is $(x_c + r\cos(\phi), y_c + r\sin(\phi))$ you can use ϕ to fix the location of one of the stars. Observe that there is a star at the top of the circle (12 o'clock).
- You can draw one object on top of another.

3 Pythagoras rules (!)

A Pythagorean triple is a set of three numbers, a, b, and c such that

$$a^2 + b^2 = c^2$$

Write a script `pythTriples` to display and count all the *integer* Pythagorean triples with $a \leq M$ and $b \leq M$, $M = 100$. Consider $a = 3$, $b = 4$, $c = 5$ and $a = 4$, $b = 3$, $c = 5$ to be different triples.

Hint: Check all possible combinations of a and b. You may find the functions `sqrt` and `floor` useful. In developing your program, work with a small M value. After you make sure that your program is correct, set M to the specified value (100). Below is our example output for $M = 15$.

```
    a      b      c
 --------------------
    3      4      5
    4      3      5
    5     12     13
    6      8     10
    8      6     10
    8     15     17
    9     12     15
   12      5     13
   12      9     15
   15      8     17
Allowing duplicates, there are 10 Pythagorean triples
  with a and b less than or equal to 15.
```

Looking ahead [not for credit]: Can you modify your program to exclude the "duplicates"? For example, count the first two triples in the table above as the same and display only one of them. Be sure to modify any associated print statements and comments.