CPE355 - Real time embedded kernels - Spring'11
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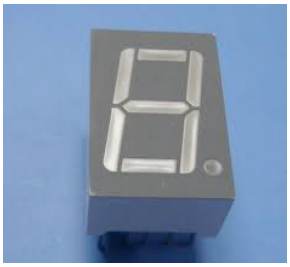
Homework Assignment #5
Due date: 11am, Tuesday, February 7 2012

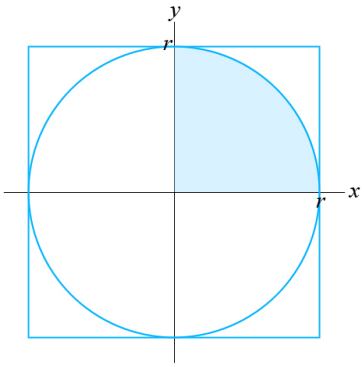
Homework turned in after the deadline, will not be graded.



Question #1 (25 pts)- Go to the S219 lab and pick up one of the available seven-segment display LEDs (such as the one shown to the right). Create a circuit and a program in Arduino that will use the seven-segment display to cycle through every number from 0 to 9.

Deliverables:
- Turn in a digital copy of your code and detailed instructions on how use it.
- Bring your circuit to class on the HW due data and demo your circuit to your instruction.

Question #2 (25 pts)- Suppose you have a circle with radius **R** inside a square with sides **2R**. Now generate a large number of random points inside the square. Call the number of generated points **n**. Logically, a large number of points will also fall inside the circle. Call the points that also fall inside the circle **m**.



By approximation, **n** is the area of the square, while **m** is the area of the circle. Calculating these areas we can see that:

$$\frac{m}{n} = \frac{\pi r^2}{4r^2} = \frac{\pi}{4}$$

So by generating a very large number of random points and checking how many of them fall inside the circle, we can approximate PI. The point is inside the circle of the distance of the point to the origin does not exceed the circles radius ($x^2 + y^2 <= r^2$). Note that, when generating the random points, it is sufficient to only look at one quadrant of the square, in this case the upper-right quadrant.

Deliverables: Turn in a digital copy of your code with detailed instructions on how run it.

Question #3 (50 pts)- One of the duties of being a father consists of baby proofing every room in the house, to make sure nothing dangerous is within reach of my son, Paulo. However, I have a problem I would like you guys to help me out with.

I have a 12x12 room, quite similar to the grid displayed below.

	1										
4	B	2									**xxx**
	3										

Lets say Paulo (shown on the right), when standing occupies exactly 1 grid (1 ft^2). In my room there is a dangerous electrical outlet, which is labeled **xxx** in the above grid. Paulo starts at position B and all doors are locked, so he cannot leave the room (or grid). Also, he can't stay still and every second he must move in any of the four directions. For example, after one second Paulo could be on position 1,2,3 or 4 with equal probability. If he hits a wall, he will be very upset and remain on the same spot for exactly 1 second. Of course there are a ton of places in the room he will eventually end up.

You can actually simulate the many different routes my son will take, by using random numbers. For example if you perform two separate 4 second simulation, my son could go "up-down-up-down" in one simulation, and he could go "left-left (hit the wall and stay on same place)-left (hit the wall again)-right" in the other simulation. Luckily, in both simulations my son would end up in the same starting position.

Now, I would like you to run at least 30,000 simulations in Arduino and tell me the following:

a) If I want to leave Paulo un-attended while I go to the restroom for 30 seconds what is the probability that he will touch (occupy the same position as) the electrical outlet?
b) What is the average number of times my son hits the wall, for each 30 second simulation?
c) How long should my restroom breaks be, so that there is at least 95% chances that my son will NOT touch the outlet?

Deliverables:

- Turn in a digital copy of your code and detailed instructions on how to obtain the results for each of the three simulations.
- Print out a screenshot with the result of each simulation.

Note: The type of simulations shown in question #2 and question #3 are called "Monte-Carlo experiments". In essence you are trying to model real-world occurrences using computer simulations with random numbers.