MASSACHVSETTS INSTITVTE OF TECHNOLOGY
Department of Electrical Engineering and Computer Science
6.01—Introduction to EECS I
Spring Semester, 2008

Sample Problem Set Write-Up

Following are a couple of sample questions, and answers of the sort that we would be happy to see. We're distributing this to show you the level of detail you should be aiming for when you write up your homework.

Don't use these particular asnwers as any sort of a template! The questions on your homework are different in content and often different in particular style from the ones here.

Question 1: Write a Python procedure that takes any nested list of numbers, and returns their sum. So, for example, `treeSum([0, [1, 2, 3], [4], [[[[5]]]]])` should return 15.

```
# Returns True if thing is a number and False otherwise
def isNumber(thing):
    return type(thing) == float or type(thing) == int

# Sums the numbers in an arbitrarily nested list.  It relies on the
# fact that sum([]) is 0, to avoid having another base case.
def treeSum(tree):
    if isNumber(tree):
        return tree
    else:
        return sum([treeSum(subTree) for subTree in tree])

#####  Test cases
>>> treeSum([])
0
>>> treeSum(5)
5
>>> treeSum([0, [1, 2, 3], [4], [[[[5]]]]])
15
>>> treeSum([[[[[[[[4]]]]]]]])
4
```

Question 2: Chair legs are often not seen by the sonar sensors. Why might that be? What factors seem to play the biggest role in whether they're seen or not?

Lots of the chair legs in the lab are round, and made of shiny metal. Because the metal is smooth, we might expect the sound to reflect away; but if the legs are round, then there will be a small bit of surface that reflects straight back to the emitted sound.

The biggest problem is that, near the robot, the sonar beams are narrow, and so it's easy for something as thin as a chair leg to be between two sonar cones, and therefore to cause no reflection at all.

Question 3: We command our robot with a forward and rotational velocity, but ultimately, the robot controller has to translate that into velocities (actually, motor voltages) for the left and right wheels. In order to achieve a forward velocity of $v_{forward}$ and a rotational velocity of v_{rot}, what velocities, v_{left} and v_{right} do we need to command? Assume the robot's wheel's have radius r, that the separation between the wheels is L, and that rotational velocities are in radians per second.

We'll start by writing the equations for forward and rotational velocity in terms of the wheel velocities:

$$v_{forward} = \frac{r}{2}(v_{left} + v_{right})$$
$$v_{rot} = \frac{r}{L}(v_{right} - v_{left})$$

These equations make sense in simple cases. When both wheel velocities are positive and equal, we get pure forward motion; when they're equal but opposite in sign, we get pure rotation.

Solving these equations, we have

$$v_{left} = \frac{1}{r}(v_{forward} - \frac{L}{2}v_{rot})$$
$$v_{right} = \frac{1}{r}(v_{forward} + \frac{L}{2}v_{rot})$$