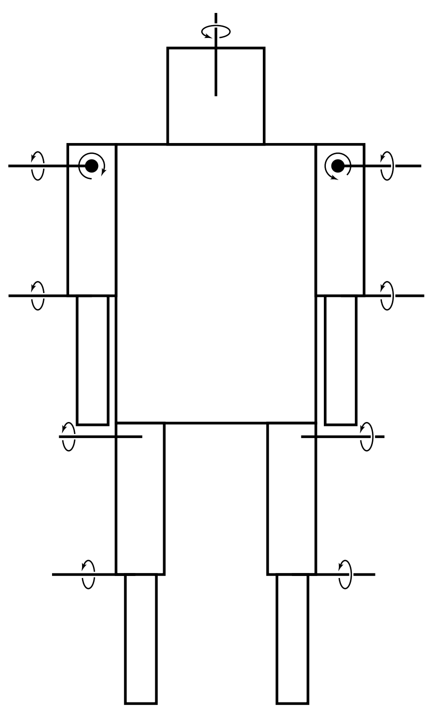
CS 465 Homework 9

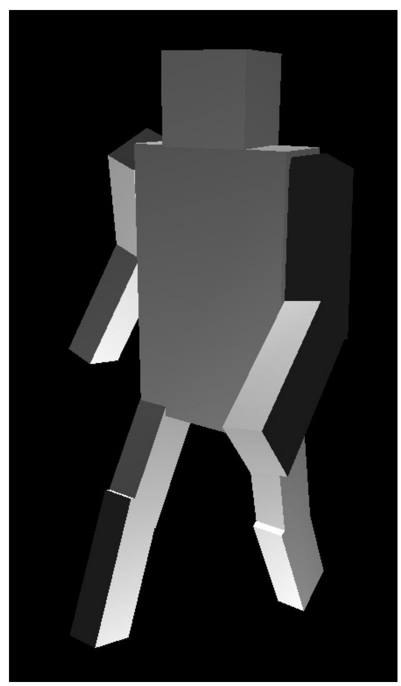
out: Wednesday 17 November 2004
due: Monday 22 November 2004

Problem 13: Transformation hierarchies

Using the modeler you built for Program 4, or using the solution if you prefer, build an articulated model of a humanoid robot out of scaled boxes. The robot is humanoid, with a body, a head, two arms, and two legs, but it doesn't have as many joints or as many degrees of freedom as a person.

The robot is made of 10 scaled cubes and has 11 rotational degrees of freedom: two for each shoulder, one for each hip, one for each elbow and knee, and one to rotate the head. Here is a front view of the robot in its neutral position (with all the rotations set to zero) and a view of the robot in a particular pose.





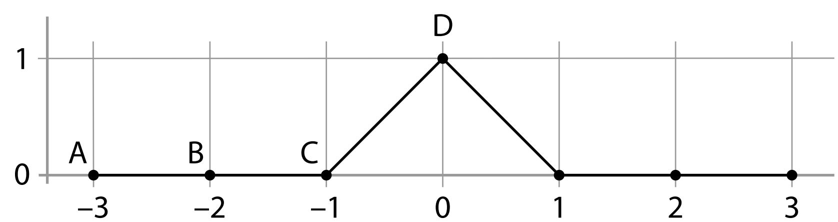
In this picture, all the rotation axes are indicated as lines with arrows indicating the direction of rotation. For most of the joints in the arms and legs, a positive rotation brings the affected part of the body forward; the only exception is the perpendicular joints in the shoulders, for which a positive rotation brings the arm away from the body. For the head, a positive rotation should make the robot look to its left.

The joints for the arms and legs should be arranged hierarchically, so that for instance adjusting the shoulder causes the whole arm to move as a piece. Don't worry about making the dimensions of the parts precise; the point is the hierarchy. There should be exactly 11 rotation nodes in your model, one for each degree of freedom (you'll have to use scales and translations as well, and it's fine if your model contains general transformations).

Turn in your robot by saving a file from the modeler and handing it in via CMS.

Problem 14: Subdivision curves

Consider the following sequence of points to be used as a control polygon for a B-spline subdivision curve:



1. Apply the B-spline subdivision rules twice to this curve to produce a curve that's tessellated four times as finely. For the endpoints, where the subdivision rules don't apply, keep them fixed. Give the result as a list of 2D points, and plot them on a graph. Take advantage of symmetry to reduce the amount of writing.

2. The curve that's produced is a graph of the basis function for point D. How does this basis function compare to the continuous B-spline basis function at points B, C, and D? (That is, compare to the values $f_B(-2)$, $f_B(-1)$, and $f_B(0)$.)

3. Carry out two more levels of subdivision just at point D. Now how does the value compare to $f_B(0)$?

4. This type of subdivision curve will interpolate its endpoints, unlike the regular B-spline. This means the basis functions for the points near the end must be different. Use the same approach as in part 1 (again with just 2 levels of subdivision) to graph the basis functions for points A and B.