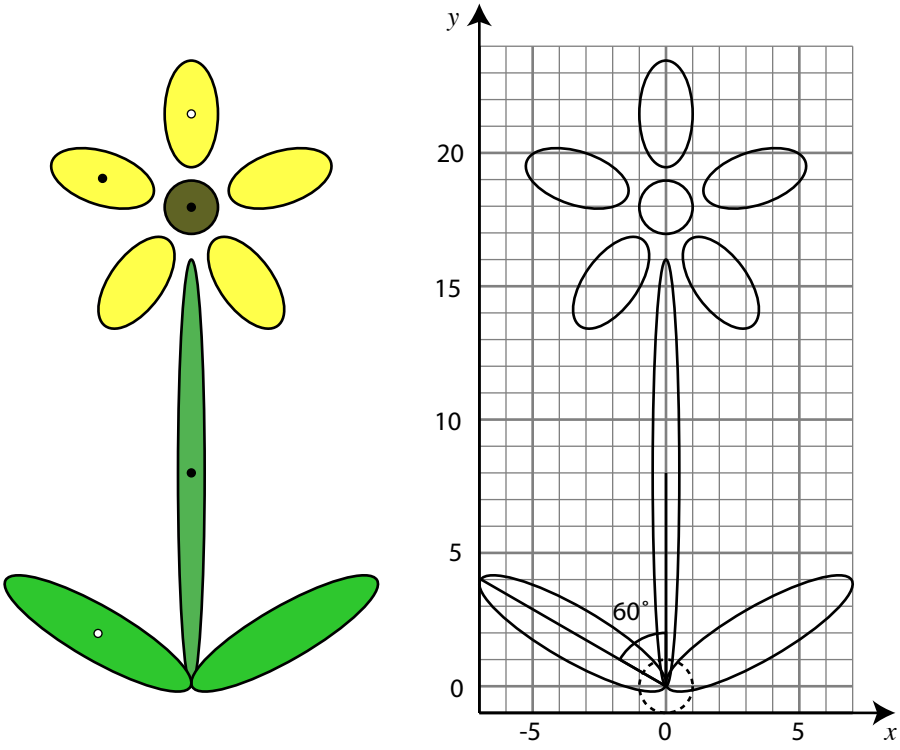
CS 465 Homework 4: 2D Transformations

(revised September 16, 2006)

out: Friday 15 September 2006
due: Friday 22 September 2006



This drawing of a flower is made up of nine ellipses. These shapes can be thought of as instances of the unit circle, each transformed by a different 2D affine transformation. The major and minor diameters of the ellipses are all integers. All the parts centered on the y axis have integer or half-integer center points.

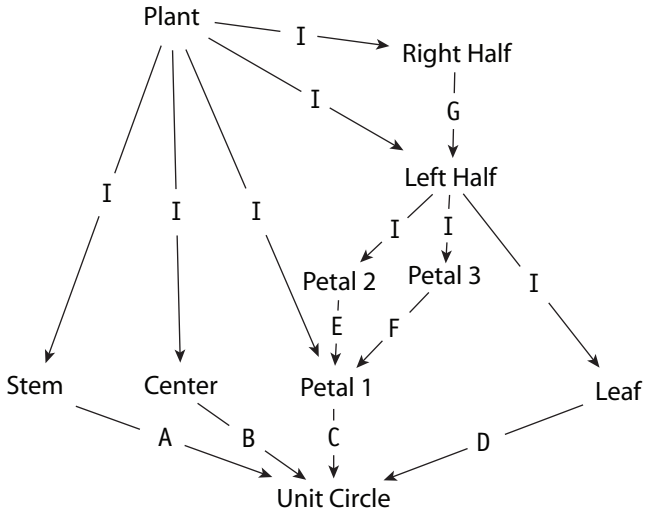
1. What are the 3x3 homogeneous transformation matrices that place each of the five parts marked with a dot into the world coordinate system shown at right?

2. Express the transformations for only the leaf and petal marked with a white dot as

(a) A sequence of transformations consisting of translations, rotations about the origin, and nonuniform scales about the canonical axes.

(b) A single nonuniform scale with respect to an arbitrary center and axis.

This drawing can also be expressed in a more structured way, as a set of grouped and transformed instances of the unit circle according to the following scene graph.



Each edge of this graph has a transformation associated with it.

3. If all the transformations labeled I are identity transformations, describe the lettered transformations $A, \ldots, G$. (You can cross-check against your answer for part 1 by confirming that multiplying the matrices of the transformations along each of the nine paths from "Plant" to "Unit Circle" leads to the matrices that place the nine parts of the drawing in world coordinates.)

For part 1 you should specify the transformations as matrices, but for parts 2 and 3 you should describe them (precisely) in words—for example, "nonuniform scale by 2 in x and 3 in y" or "rotation by 30 degrees around the point $(2, 3)$."