CSI 422/502 Project 2 Pre-Announcement and Homework 2 Fall 2005
Professor Chaiken Assigned Monday 9/19/05 Due Monday 9/26/05
The Project 2 specification will appear by 9/21 and Project 2 will be due Wednesday, 9/28. The first midterm, based on course material up to this homework and the two projects will be in class on that day, 9/28.

The main objective of Project 2 is to practice programming of linear and translation transformations in 2-d; and then *experiance by seeing* the effects of your work. Secondary but necessary objectives are to code a graphic model data structure, program OpenGL operations with data from the model, and program event-driven user input.

The program to be written will first display simple but non-symmetric 2-d figure built from lines, such as a "**UA**" logo. It should come from a model and 2-d viewing setup that puts it in the middle of the window, like the square from the Red Book `double.c` example. Then, when you press certain keys, the program will respond to certain mouse dragging operations by

- Determining a number from the x or y coordinate change of the drag.
- Calculate the matrix for a particular kind of transformation. The kind is determined by which key was pressed (the "transformation mode") Certain magnitudes within the matrix (such as amount of translation, rotation, etc) will be determined by the number determined from the drag.
- The transformation will be **applied** to the vertex coordinates in the model. The model will then remain transformed.
- Erase the viewport and draw the transformed model.

It is expected that you will sometimes end up with a transformation that moves the model out of the window so you won't see it. Therefore, your program should have a "master version" of the vertex array. When a certain key is pressed, the data from the master should be copied into the to be used (and transformed again). The effect will be that the original display reappears.

Here is a project management outline, with details of the readings and study sections pertaining to them:

1. Start. `double.c` example and discussion from the Red Book. Download it and make sure you can compile and run it...Seek help IMMEDIATELY if you cannot. Study Window and Input Events in Appendix D of the Red Book.
2. Make your own model. Polygon tables in HB 3-15, Vertex Arrays in HB 3-17, Icosahedron model in Ch. 2 of Red Book illustrates the kind of model you should program. Yours should be in 2-d and simpler.
3. Control a gl transformation with the mouse. Interaction: Read HB Ch. 11. Study 11-6. Get `double.c` to rotate the square an amount given by the mouse motion instead of an animation.

4. Develop your own model transformation functions. Read HB Ch. 5 (to study for midterm too). Learn how to apply 2-d transformations and adapt the `transformVerts2D` function of HB 5-15, and the transformations treated in HB 5-5.

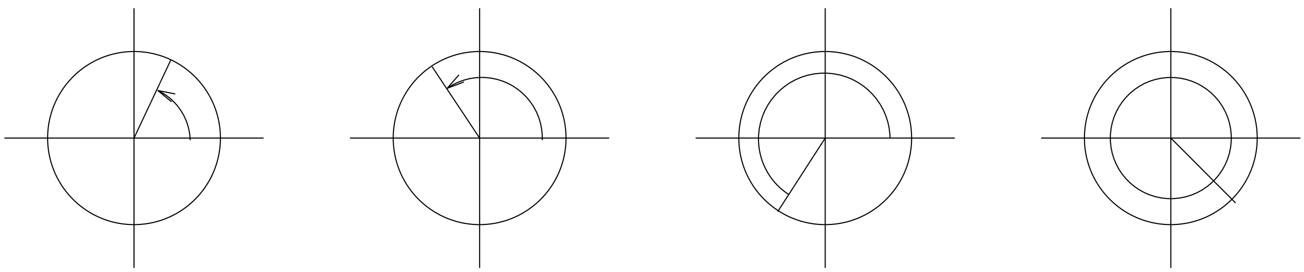
5. Develop the keyboard controls. Read HB Ch. 11, Study 11-6.

6. Integrate (put it together). Test, experiment, adjust transfromation from screen coordinates passed to mouse callback into numbers to control the transformation.

More Math HW..

For help on this material, check Schaum's Linear Algebra Outline or other review materials, such as the popular and well-written "Dummies" books. Make sure to show **all** work.

1. Identify the lines whose lengths are $\sin\Theta$ and $\cos\Theta$ respectively in each of the diagrams below. In each case, the radius of the circle is 1. Under each diagram, state the sign (positive or negative) of $\sin\Theta$ and $\cos\Theta$ respectively.



2. Recall your solutions to each of the following 2 systems of equations from homework 1.

$$\begin{aligned} 4x + 3y &= 1 \\ 1x + 2y &= 0 \end{aligned} \qquad\qquad \begin{aligned} 4x + 3y &= 0 \\ 1x + 2y &= 1 \end{aligned}$$

   (a) Check the answers to both systems. Show your work.

   (b) Call the first system's solution $(x, y) = (x_{11}, x_{21})$ and the second's $(x, y) = (x_{12}, x_{22})$. Form the 2x2 matrix

$$\begin{pmatrix} x_{11} & x_{12} \\ x_{21} & x_{22} \end{pmatrix}$$

   from the solutions. Now matrix multiply:

$$\begin{pmatrix} 4 & 3 \\ 1 & 2 \end{pmatrix} \begin{pmatrix} x_{11} & x_{12} \\ x_{21} & x_{22} \end{pmatrix} = \ ?$$

   (c) Solve this system for x and y:

$$\begin{aligned} 4x + 3y &= a \\ 1x + 2y &= b \end{aligned}$$

   Write the solution in the form (replace P, Q, R, S with numbers)

$$\begin{aligned} x &= Pa + Qb \\ y &= Ra + Sb \end{aligned}$$

(d) A 2x1 matrix is called a column vector. It (on the right) can be multiplied by a 2x2 (actually "anything" x2) matrix on the left. Matrix multiply:

$$\begin{pmatrix} x_{11} & x_{12} \\ x_{21} & x_{22} \end{pmatrix} \begin{pmatrix} a \\ b \end{pmatrix}$$

with the solution to part (c). Check how the result contains the answer to part (d).

3. Suppose function f_1 is defined by $f_1(x) = x^2 + 3x + 2$ and f_2 is defined by $f_2(x) = x - 2$. Obtain and simplify the formula for the function $f_3(x) = f_1(f_2(x))$. Now calculate $f_1(2)$, $f_1(f_2(2))$, and your formula for f_3 applied to 2. Verify that the last two numbers are equal.