Com S 336
Fall 2022
Homework 1

Here are a few exercises to try out some of the fundamentals we've looked at so far:

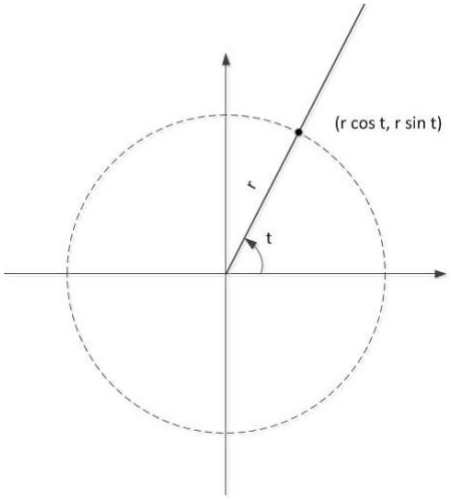
- get comfortable with JavaScript
- carefully read the sample code and know what each line of code is doing
- understand interpolation

None of them is very long in terms of lines of code (e.g. a couple dozen lines at most), but you are bound to get stuck somewhere, so start early and talk to me or Gokul as needed!

Please submit ONE zip archive on Canvas, containing the files indicated at the beginning of each problem. When working from an existing example, do not unnecessarily reformat or otherwise modify the code that does not need to be changed (so that we can diff your submission against the original). All referenced sample code can be found on https://stevekautz.com/

1. (*Please turn in two new files named* **`problem1.html`** *and* **`problem1.js`**.*)*

Modify GL_example1a_with_animation so that instead of shifting the figure from side to side, it moves in a circle of radius 0.75 at a rate of one degree per frame. This is straightforward, you'll just need another uniform variable for the y shift (or use a vec2). To calculate the position, use the sine and cosine functions as pictured below. Trig functions are available in JavaScript as **`Math.cos()`**, **`Math.sin()`**, and of course you might also need **`Math.PI`**. (Remember the JS trig functions expect radian measure! If you wish, you can use the handy function **`toRadians`** in **`util/cs336util.js`**.)



Provide an html text box to adjust the size of the square with a scale factor for the square (another uniform variable in the vertex shader). *Tip*: *scale **first**, then shift the position.*

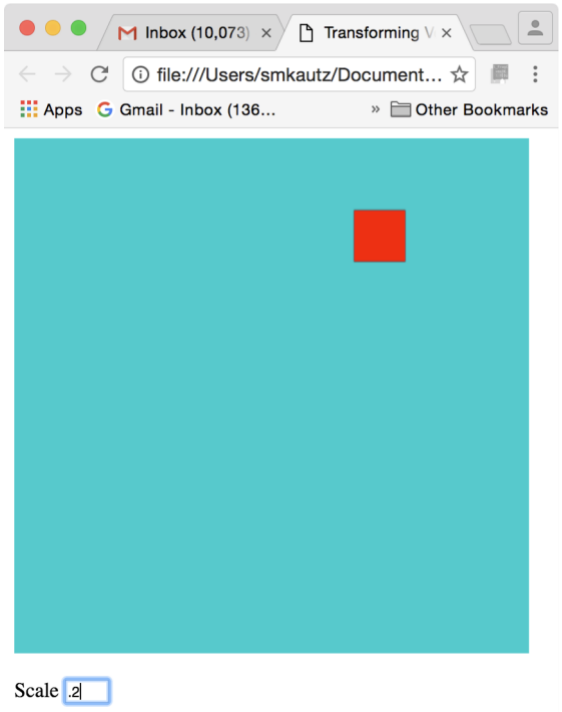
The html code for a text box looks like:

```
Scale: <input id="scaleBox" type="text" value="1.0" size=4/>
```

where **`value`** is the default text and **`size`** is the width. To get the value, use the built-in JS function **`parseFloat`**, e.g.,

```
var scale = parseFloat(document.getElementById("scaleBox").value);
```

See the sample code **`examples/intro/text_box.html`** for an example using a text box and attaching a handler.

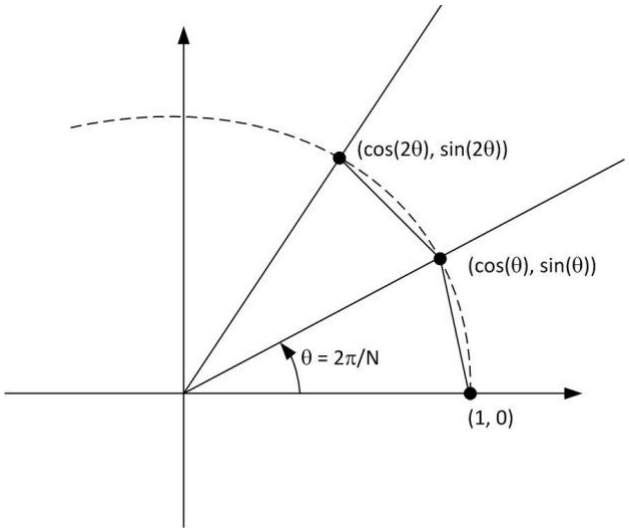


2. (*Please turn in two new files named **`problem2.html`** and **`problem2.js`**.)*

Modify **`GL_Example1a`** to draw a regular N-gon instead of a square. It is not hard to compute the coordinates in a loop using the sine and cosine functions as pictured below. If you have not used JS arrays before, note you can append elements using the **`push()`**

method (like a Java ArrayList). Trig functions are available in JS as **`Math.cos()`**, **`Math.sin()`**, and of course you might also need **`Math.PI`**. Scale the radius down to 0.8 so it's all visible. N should be selectable via an html text box.

You should load the new vertex data into the buffer only when a new value of N is selected, not every frame. See the sample code **`examples/intro/text_box.html`** for an example using a text box and attaching a handler.



Note: Remember that the argument to the constructor **`Float32Array`** or **`Uint16Array`** is a JavaScript array, not a sequence of numbers. That is, we can write

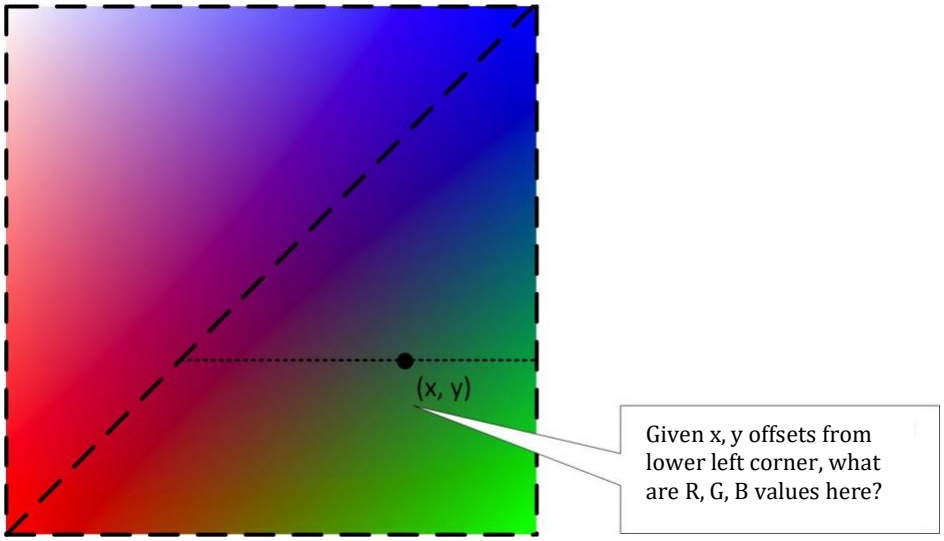
```
var myVertices = new Float32Array([1.0, 2.0, 3.0, 4.0]);
```

but NOT

```
var myVertices = new Float32Array(1.0, 2.0, 3.0, 4.0);
```

3. (*Please turn in your modified version of* **`color_interpolator.js`**.)

Write a JavaScript function that performs interpolation of colors associated with the corners of a rectangle (simulating what is done by the fragment shader in GL_example2). That is, given the *size* of the rectangle, *colors* for the four corners, and an integer x and y *offset* within the rectangle, find the interpolated values for red, green, and blue at (x, y). (Don't worry about alpha here, assume it's always 1.0.) Assume the rectangle consists of two triangles as shown by the dashed line in the example above. (This is important, because interpolation is done **only** within triangles.) The exact signature for the function is in the file **`color_interpolator.js`** along with a definition for a simple type representing an RGBA color.



There are several ways you could do this. One is to use a Fahrenheit-to-Celsius conversion to find interpolated values along the vertical legs of the triangle that contains (x, y), and then do it again to interpolate horizontally between those two values (i.e., along the smaller dashed line in the figure). A slicker and more general solution would be to use *barycentric coordinates*, this is optional. If you are interested, maybe see https://codeplea.com/triangular-interpolation to get started.

4. (*Please turn in the two new files* **`problem4.html`** *and* **`problem4.js`**.)

We have seen in GL_example1 how to use a uniform variable in a shader to shift a figure to the left or right, and we have seen in GL_example2 how to use varying variables to have colors associated with vertices interpolated across a triangle. Based on these examples, create files problem4.js and problem4.html as follows:

a) Draw a colored square, similar to the figure above, shifted to the left side of the canvas and draw a solid colored square shifted to the right side. You'll need a different shader for each figure. The one on the left can use the shader from **`GL_example2_varying_variables`** and the one on the right can use the shader from **`GL_example1a_with_uniform_color`** (you'll need to be able to set the color from your JS code).

b) Add a mouse handler that, when the mouse is clicked on the left square, the handler will ***use your function from problem 3*** to calculate what color will be at that pixel, and the application then draws the right-hand square that color. (A rudimentary color-picker!) You can assume that the square coordinates and left/right shift amounts are

fixed, but you must allow for the fact that the canvas can be resized. That is, if the canvas is 400 x 400 pixels and the triangle's lower left corner is at (-0.5, -0.75), then (linear interpolation!) that location has window (canvas) coordinates (100, 75). But if the canvas width is 600 with height 400 then the same point would have window coordinates (150, 75). In your JS code you can always get the current size of the canvas from its attributes **`canvas.width`** and **`canvas.height`** (where **`canvas`** is assumed to be your JS variable referring to the html canvas element).

See **`examples/intro/mouse.html`** for how to get the mouse coordinates. After you get the mouse coordinates don't forget that the y-value is upside-down so you have to subtract from the canvas height to flip it. (For the mouse, (0, 0) is the upper left corner of the canvas, but for the framebuffer, and for the function from problem 3, (0, 0) is the lower left corner.