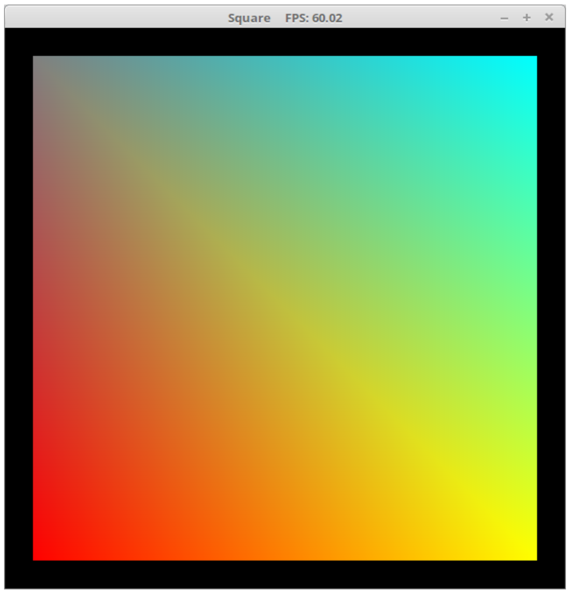
1 Introduction

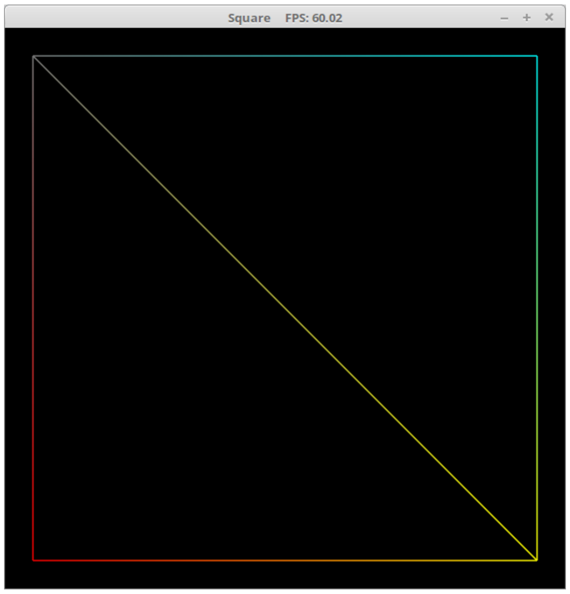
The following exercises are updates of the Hello World of Graphics program. Write each program using either Windows or Linux with the Code::Blocks IDE or on the Mac with XCode, put each project in its own directory and zip the entire set of directories into one zip file. Upload the zip file to the Homework #2 page of the MyClasses site for this class. In these exercises you do not need to update the DoxyGen documentation but you are welcome to do that if you would like.

I have placed Windows executables of these on the MyClasses page for this assignment. For these, the computer they are being run on must have the support software installed. If it does not then there is a set of dll files in the example code for the class that should be placed in the same directory as the demo programs, then they should run. In addition, I moved the shader program to the graphics engine so that only one file was needed, you do not need to do that.

2 Exercises

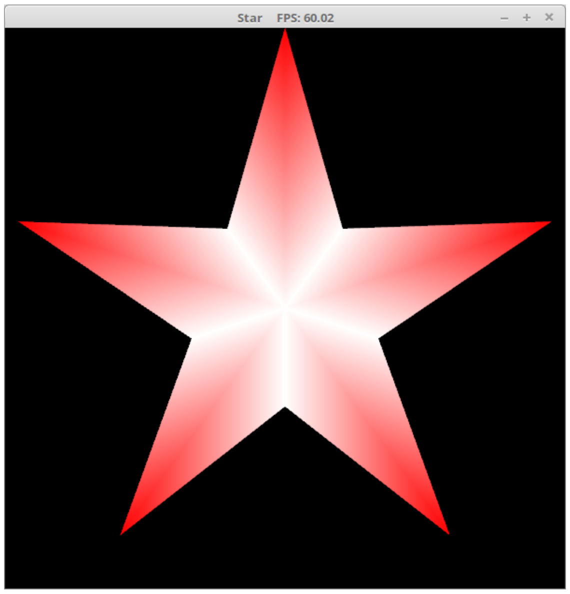
1. For the first program make the initial size of the window 600×600 and make the reset option resize to 600×600 as well. Make the title bar display "Square" and incorporate the FPS tracking in the title bar, you do not need to print the FPS to the console window. Have the image on the screen be a square like the image below. Keep the rest of the features the same as with the triangles program. Hint: A square can be produced using two triangles. Below are two screen shots, one in fill mode and one in line mode.

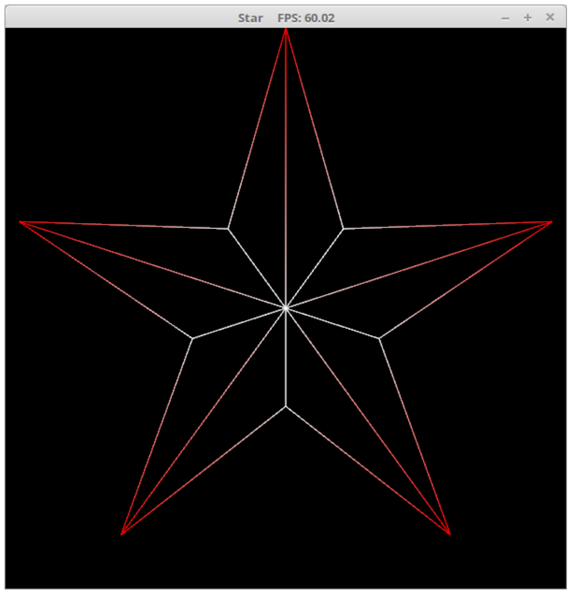




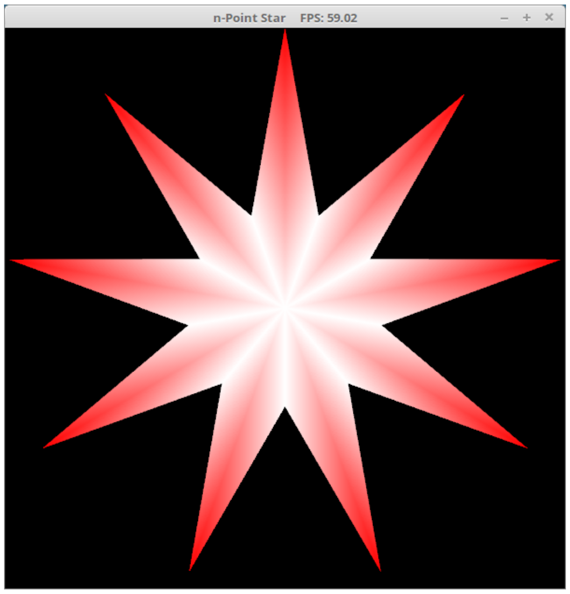
2. Update the triangles program to produce a 5-point star with the coloring of the star being like the image below, that is, red at the points and white in the center. The title bar should also display the title “Star” with FPS in the title bar. As with the previous exercise, make the initial size of the window 600×600 and make the reset option resize to 600×600 as well. Keep the rest of the features the same as with the triangles program. Below are two screen shots, one in fill mode and one in line mode. Note that one point of the star is pointed straight up.

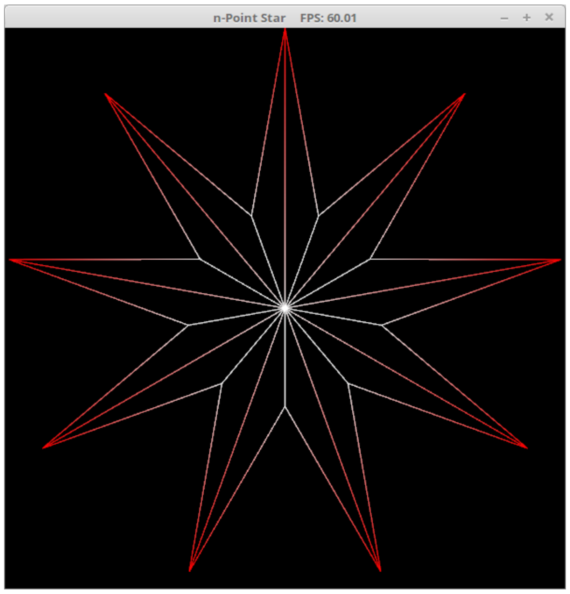
   Hints: Each point of the star can be done with two triangles. Also recall from trigonometry that a point on the unit circle can be represented by $(\cos(\theta), \sin(\theta))$. So if we wanted to space n points around the unit circle evenly we could use the points $(\cos(i \cdot 2\pi/n), \sin(i \cdot 2\pi/n))$ where $0 \leq i < n$. We can also scale the circle by multiplying by a constant. So n evenly spaced points around a circle of radius r would be $(r \cdot \cos(i \cdot 2\pi/n), r \cdot \sin(i \cdot 2\pi/n))$ where $0 \leq i < n$.





3. Update the above star program to produce an n-point star with the coloring of the star being like the image below where n is chosen randomly between 5 and 15. So on each run the number of points to the star could be different. Hint: Use the rand and srand functions from the ctime library and set the seed of the random number generator to the value of the system clock. Then generalize what you did for the 5-point star to the n-point star. Note that one point of the star is pointed straight up.



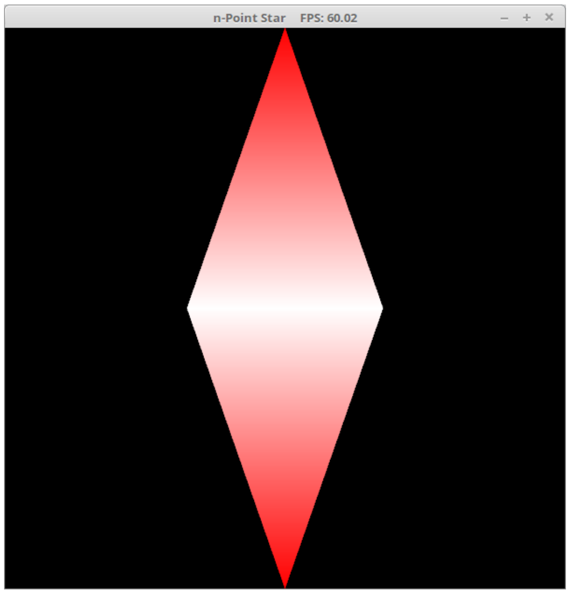


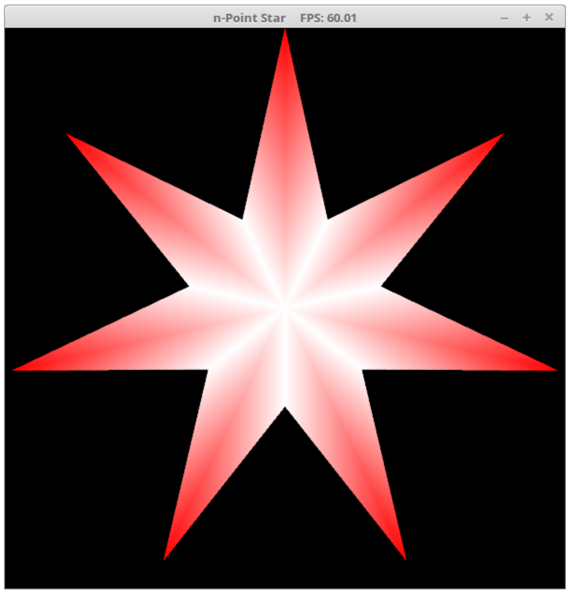
4. Update the above n-star program to add in some user interface from the keyboard. Have the program start by displaying a 5-point star, when the user hits 2 replace the star by a 2-point star, when the user hits 3 replace the star by a 3-point star, when the user hits 4 replace the star by a 4-point star, when the user hits 5 replace the star by a 5-point star, and so on up to 9 creates a 9-point star and 0 produces a 10 point star. I would suggest creating a new function for the graphics engine called `updatePoints(GLint numpts)` which takes in the number of points to be used, creates the star, and loads it to the graphics card.

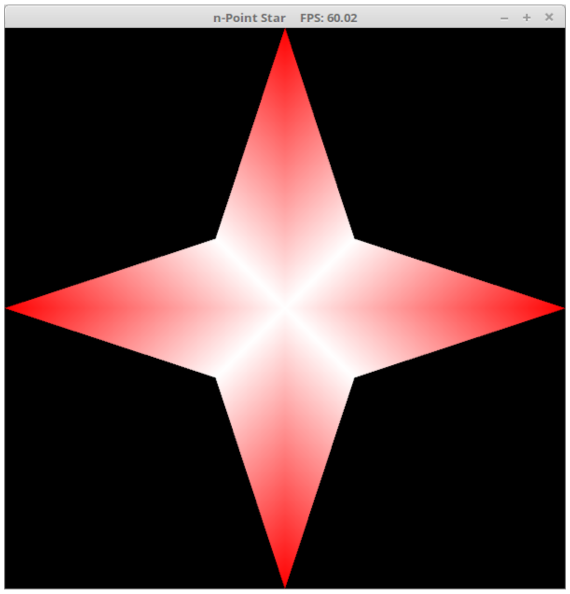
   A note on memory management on the graphics card. If you keep generating new vertex array objects and buffers inside them, it is like doing the new (or malloc) command over and over again. That is, you will have a memory leak on the graphics card. It is unlikely that you will run out of memory with this program but we would like to be as efficient as possible. The first time you call `updatePoints` you will need to generate your arrays and buffers. Then for every subsequent call to `updatePoints` you should delete your VAO and Buffer before you generate another one. This is like doing the delete (or free) command to release the memory locations for use. To do that in OpenGL use the commands,

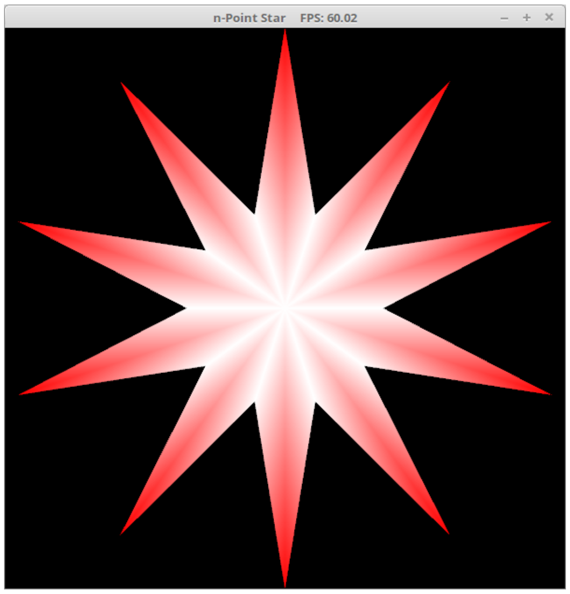
```
glDeleteBuffers(1, &Buffer);
glDeleteVertexArrays(1, &VAO);
```

where VAO and Buffer are holding the handle to the object and buffer. Then when you generate a new VAO and Buffer they will use the same handle. Note, just like the other programs, one point of the star is pointed straight up.


n-Point Star FPS: 60.02


n-Point Star FPS: 60.01


n-Point Star FPS: 60.02


n-Point Star FPS: 60.02