Introduction to Computer Graphics with WebGL

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Moving to 3D

Three-dimensional Applications

- In WebGL, two-dimensional applications are a special case of three-dimensional graphics
- Going to 3D
  - Not much changes
  - Use `vec3, gl.uniform3f`
  - Have to worry about the order in which primitives are rendered or use hidden-surface removal

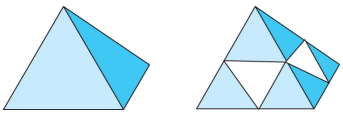
A Tetrahedron

- We can easily make the program three-dimensional by using three dimensional points and starting with a tetrahedron

```
var vertices = [
  vec3(  0.0000,  0.0000, -1.0000 ),
  vec3(  0.0000,  0.9428,  0.3333 ),
  vec3( -0.8165, -0.4714,  0.3333 ),
  vec3(  0.8165, -0.4714,  0.3333 )
];
subdivide each face
```

3D Gasket

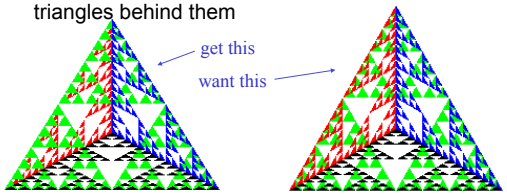
- We can subdivide each of the four faces



- Appears as if we remove a solid tetrahedron from the center leaving four smaller tetrahedra
- Code almost identical to 2D example

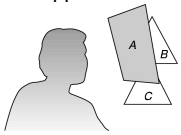
Almost Correct

- Because the triangles are drawn in the order they are specified in the program, the front triangles are not always rendered in front of triangles behind them



Hidden-Surface Removal

- We want to see only those surfaces in front of other surfaces
- OpenGL uses a *hidden-surface* method called the *z*-buffer algorithm that saves depth information as objects are rendered so that only the front objects appear in the image



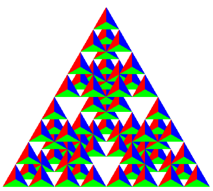
Using the *z*-buffer algorithm

- The algorithm uses an extra buffer, the z-buffer, to store depth information as geometry travels down the pipeline
- Depth buffer is required to be available in WebGL
- It must be
  - Enabled
    - `gl.enable(gl.DEPTH_TEST)`
  - Cleared in for each render
    - `gl.clear(gl.COLOR_BUFFER_BIT | gl.DEPTH_BUFFER_BIT)`

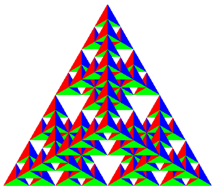
Surface vs Volume Subdvision

- In our example, we divided the surface of each face
- We could also divide the volume using the same midpoints
- The midpoints define four smaller tetrahedrons, one for each vertex
- Keeping only these tetrahedrons removes a *volume* in the middle
- See text for code

Subdivided Tetrahedron



without HSR



with HSR