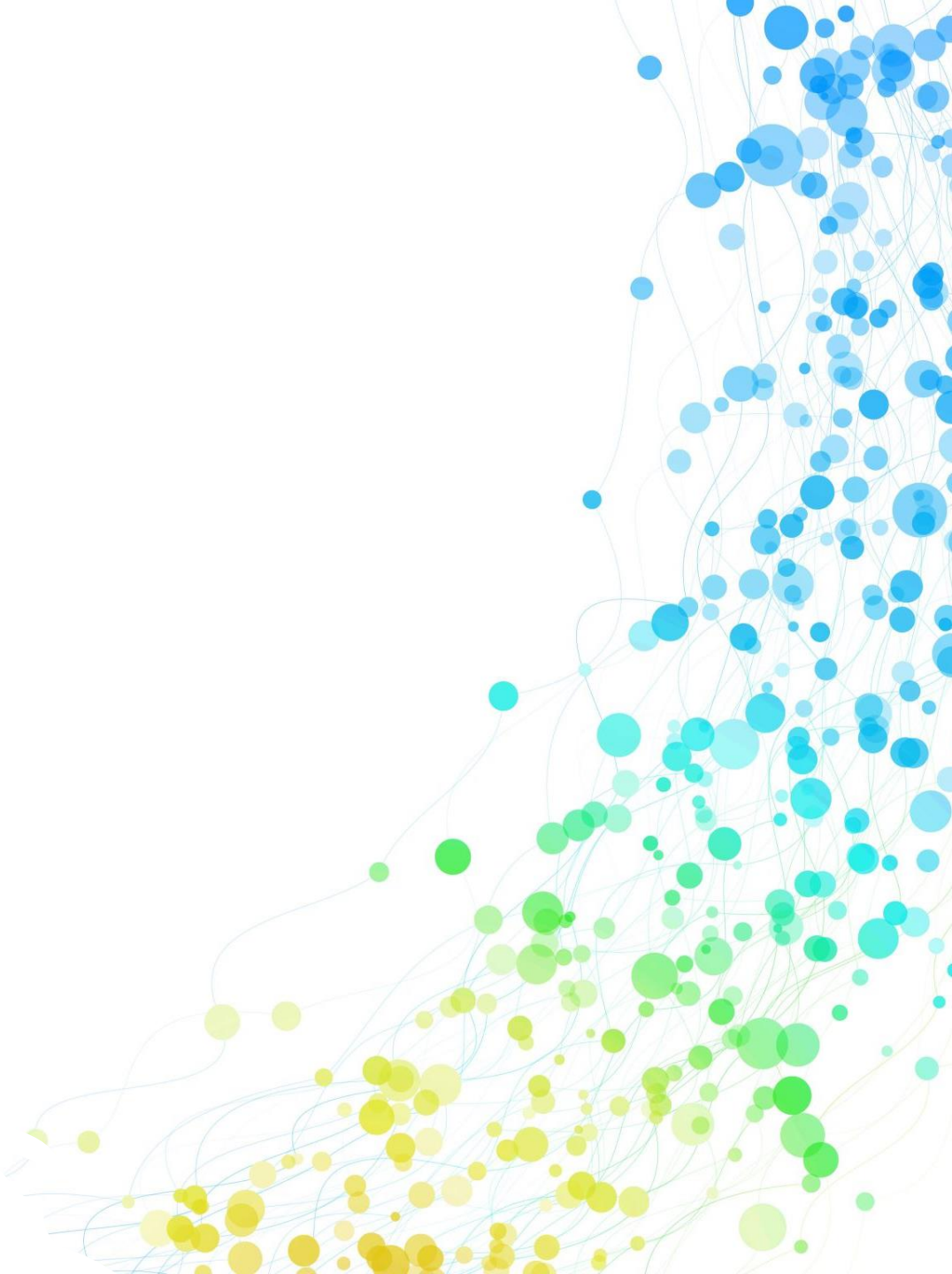
Graphics Programming

3RD WEEK, 2022

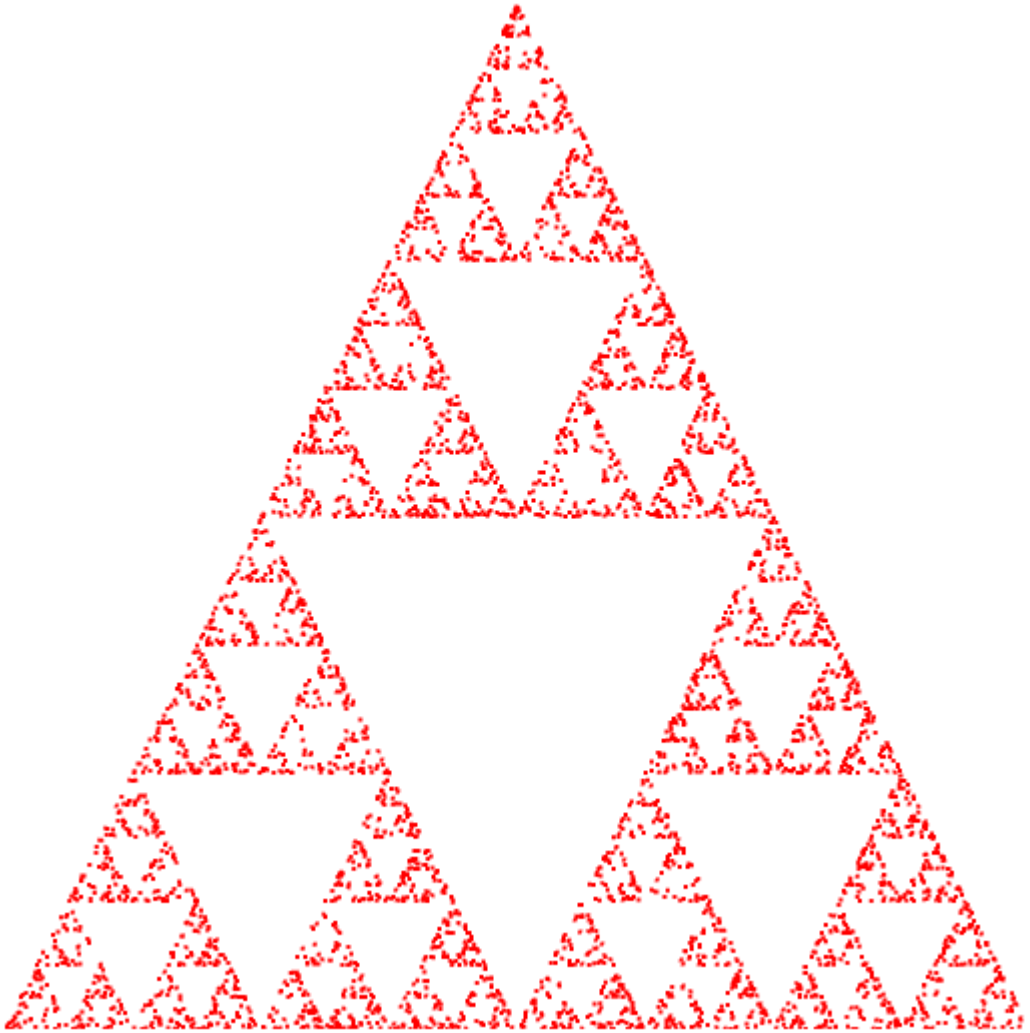


The Sierpinski Gasket (1)

- What is?
  - Interesting shape in area such as fractal geometry
  - Object that can be defined recursively and randomly

반복적인

프랙탈의 한 종류

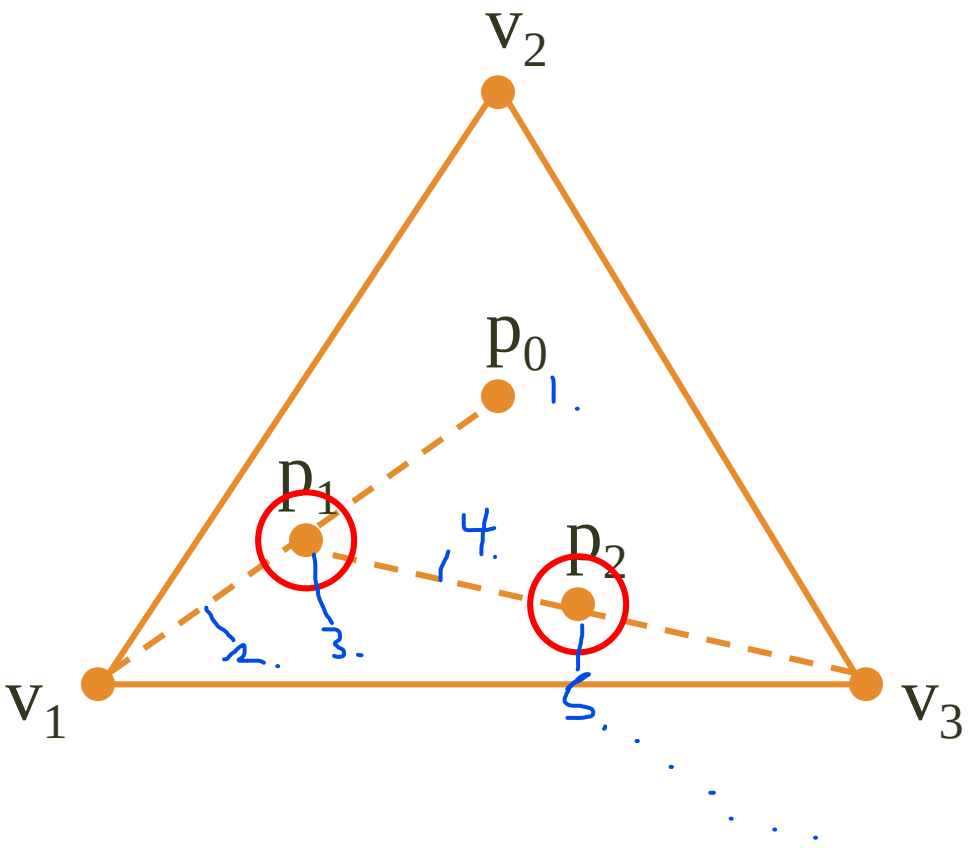


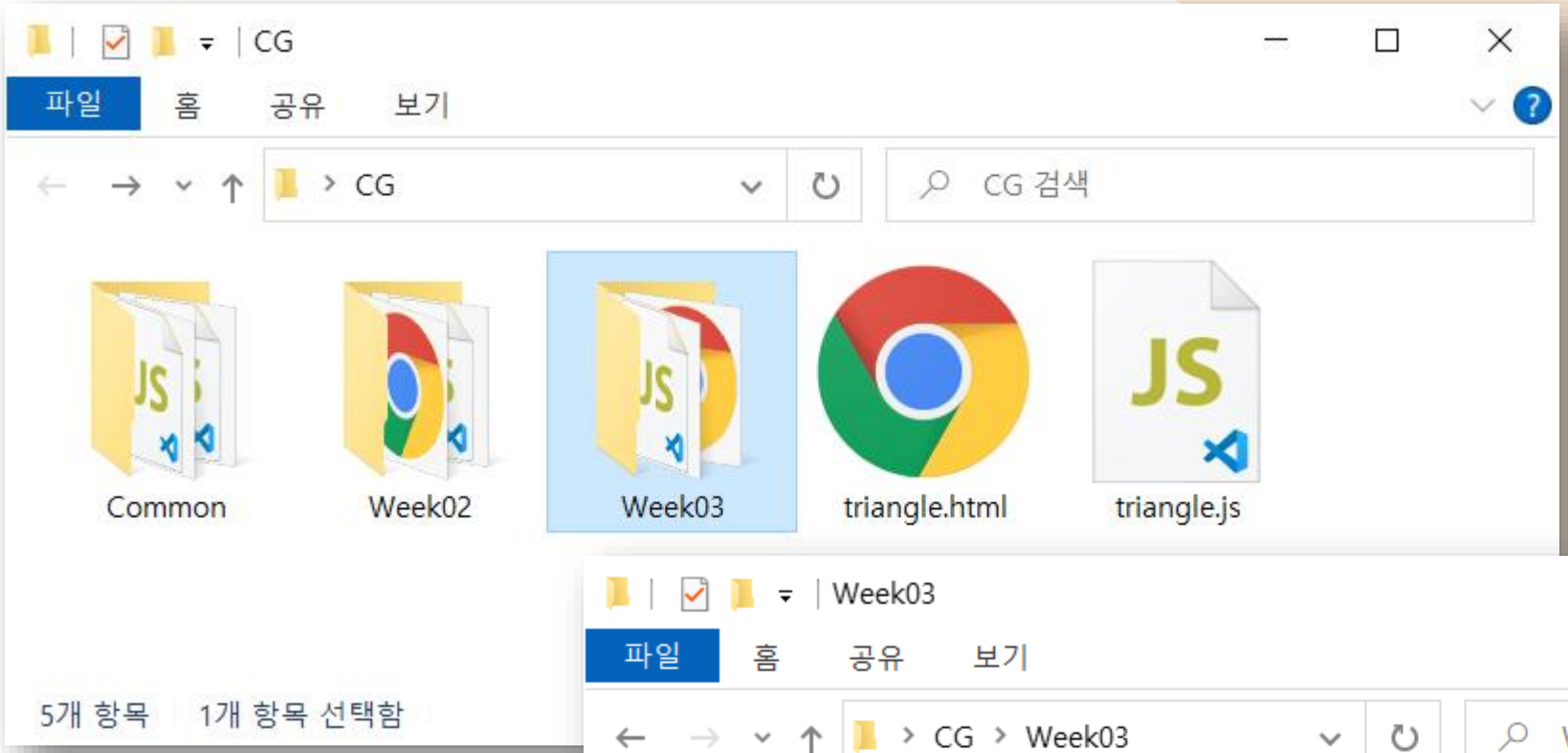
The Sierpinski Gasket (2)

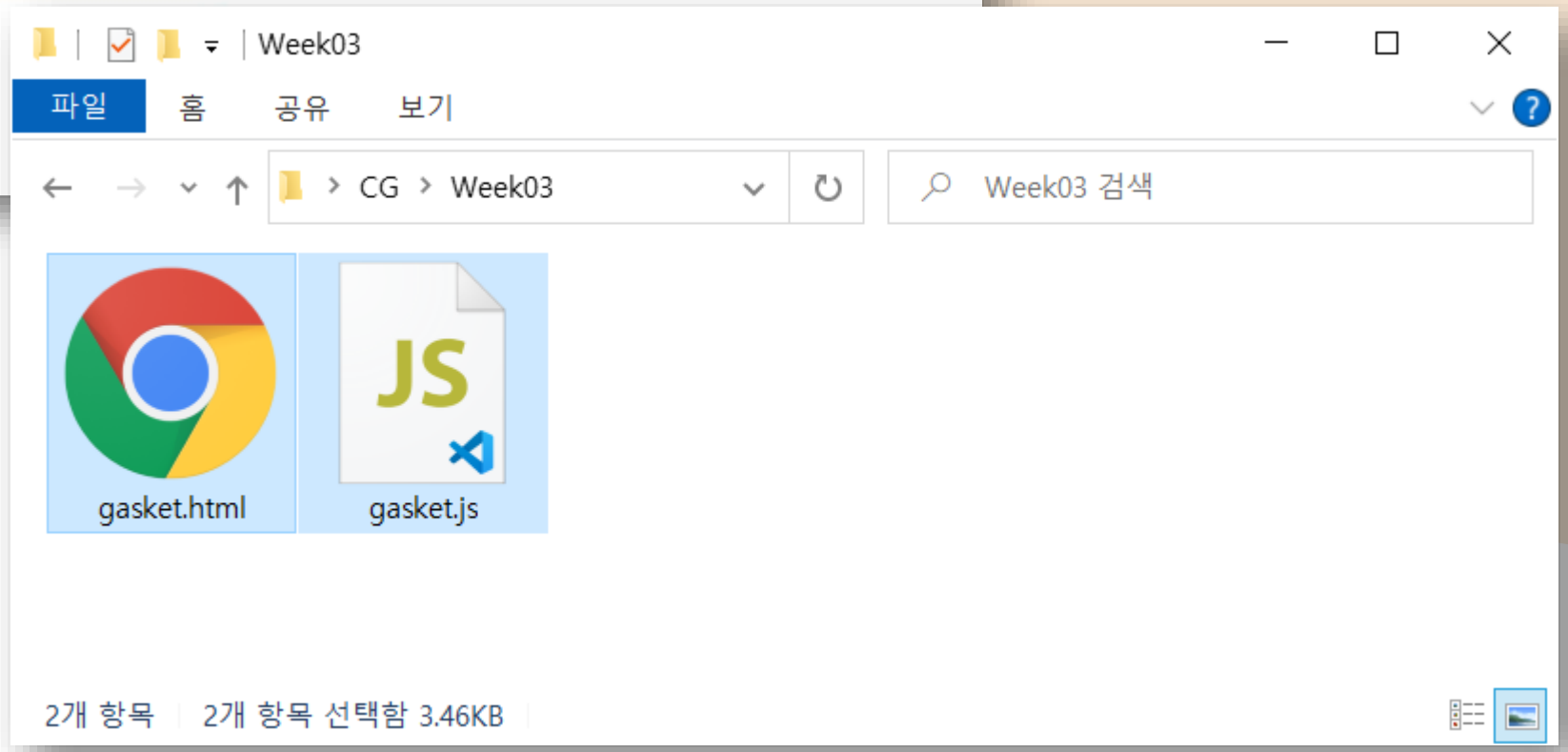
- How to…
  - Start with three vertices in the plane
  1. Pick an initial point at random inside the triangle
  2. Select one of the three vertices at random
  3. Find the point halfway between the initial point and the randomly selected vertex
  4. Display this new point by putting some sort of marker, such as a small circle, at its location
  5. Replace the initial point with this new point
  6. Return to step 2

The Sierpinski Gasket (2)

- How to…




CG
파일
홈
공유
보기
CG
CG 검색
Common
Week02
Week03
triangle.html
triangle.js
5개 항목
1개 항목 선택함


Week03
파일
홈
공유
보기
CG
Week03
Week03 검색
gasket.html
gasket.js
2개 항목
2개 항목 선택함 3.46KB

File Edit Selection View Go Run Terminal Help gasket.html - Visual Studio Code

gasket.html gasket.js

C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > gasket.html > ...

```
<!DOCTYPE html>
<html>
    <head>
        <title>학번 이름 - Sierpinski Gasket</title>
        <script id="vertex-shader" type="x-shader/x-vertex">
        attribute vec4 vPosition;

        void main() {
            gl_PointSize = 2.0;
            gl_Position = vPosition;
        }
        </script>

        <script id="fragment-shader" type="x-shader/x-fragment">
        precision mediump float;

        void main() {
            gl_FragColor = vec4(1.0, 0.0, 0.0, 1.0);
        }
        </script>

        <script type="text/javascript" src="../Common/webgl-utils.js"></script>
        <script type="text/javascript" src="../Common/initShaders.js"></script>
        <script type="text/javascript" src="../Common/MV.js"></script>
        <script type="text/javascript" src="gasket.js"></script>
    </head>
    <body>
        <canvas id="gl-canvas" width="512" height="512">
            Oops... your browser doesn't support the HTML5 canvas element!
        </canvas>
    </body>
</html>
```

Restricted Mode ⊗ 0 ⚠ 0 Ln 1, Col 1 Spaces: 4 UTF-8 CRLF HTML

File Edit Selection View Go Run Terminal Help gasket.js - Visual Studio Code

gasket.html | gasket.js

C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > gasket.js > ...

```
var gl;
var points;
var numPoints = 5000;

window.onload = function init()
{
    var canvas = document.getElementById("gl-canvas");

    gl = WebGLUtils.setupWebGL(canvas);
    if( !gl ) {
        alert("WebGL isn't available!");
    }

    // Sierpinski Gasket
    generatePoints();

    // Configure WebGL
    gl.viewport(0, 0, canvas.width, canvas.height);
    gl.clearColor(1.0, 1.0, 1.0, 1.0);

    // Load shaders and initialize attribute buffers
    var program = initShaders(gl, "vertex-shader", "fragment-shader");
    gl.useProgram(program);

    // Load the data into the GPU
    var bufferId = gl.createBuffer();
    gl.bindBuffer(gl.ARRAY_BUFFER, bufferId);
    gl.bufferData(gl.ARRAY_BUFFER, flatten(points), gl.STATIC_DRAW);

    // Associate our shader variables with our data buffer
    var vPosition = gl.getAttribLocation(program, "vPosition");
    gl.vertexAttribPointer(vPosition, 2, gl.FLOAT, false, 0, 0);
    gl.enableVertexAttribArray(vPosition);

    render();
```

Restricted Mode ⊗ 0 ⚠ 0 Ln 1, Col 1 Spaces: 4 UTF-8 CRLF {} JavaScript

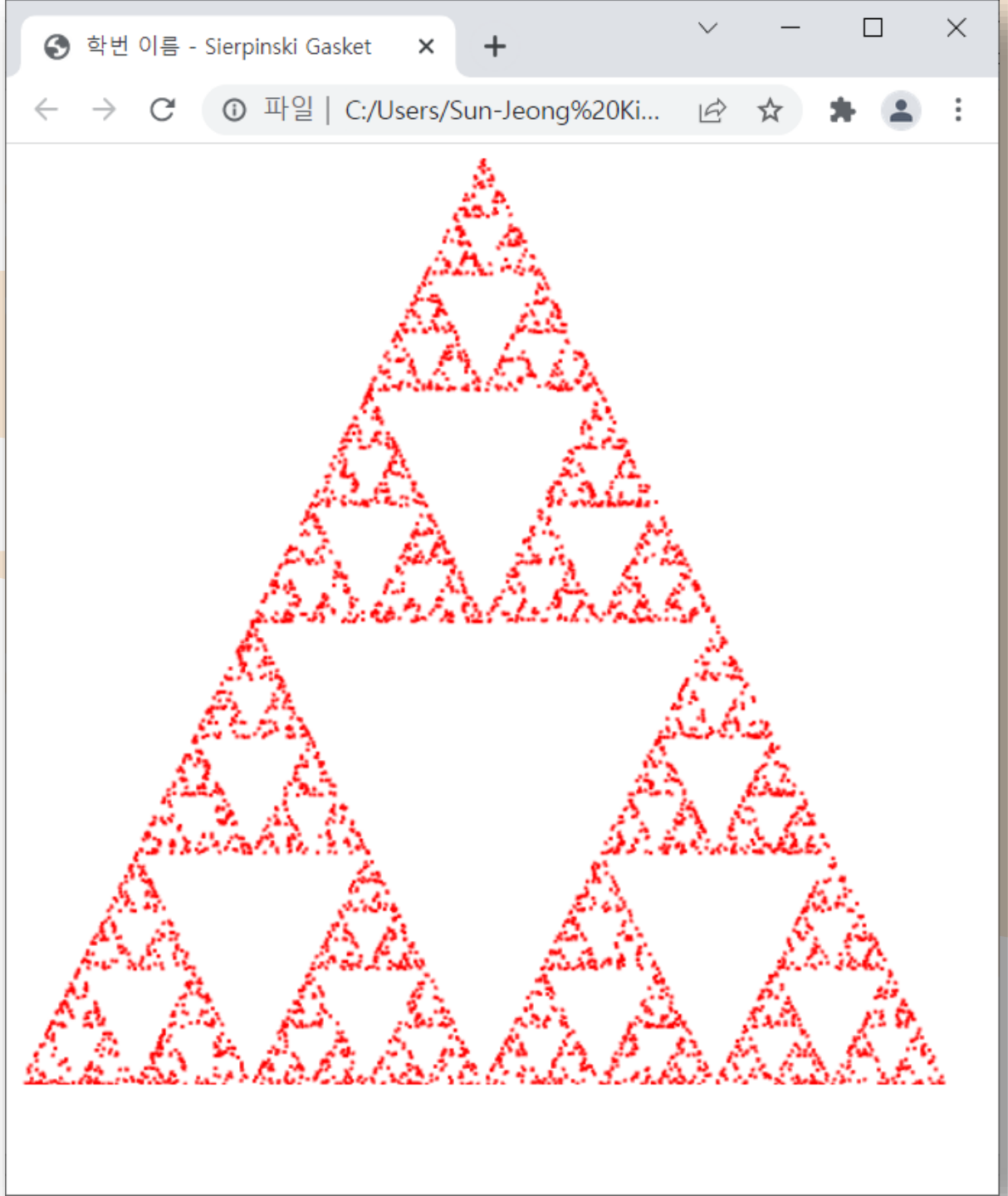
File Edit Selection View Go Run Terminal Help gasket.js - Visual Studio Code

gasket.html | gasket.js

C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > gasket.js > ...

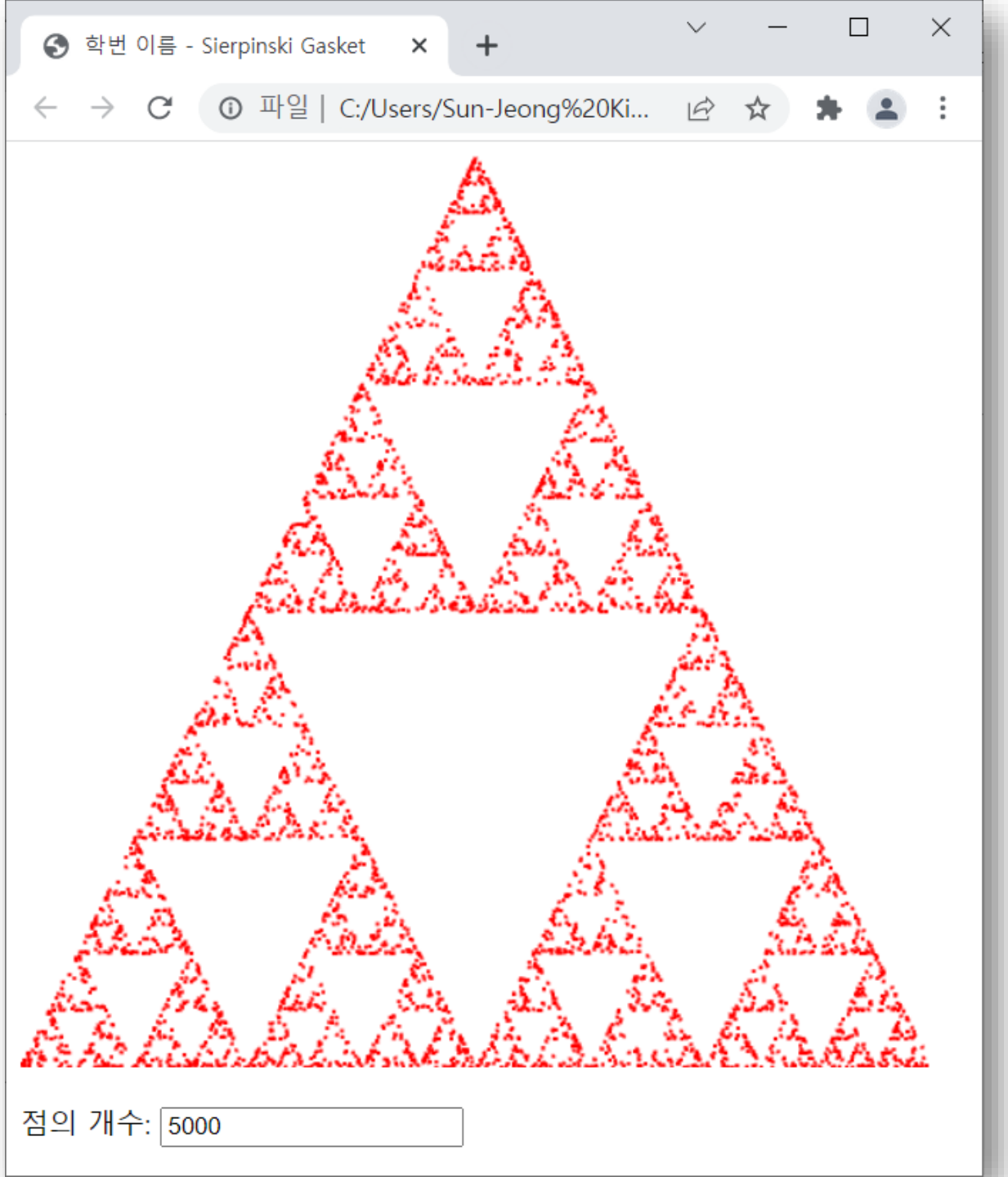
```
36  };
37
38  function render() {
39      gl.clear(gl.COLOR_BUFFER_BIT);
40      gl.drawArrays(gl.POINTS, 0, points.length);
41  }
42
43  function generatePoints() {
44      // Initialize the data for the Sierpinski Gasket
45      // First, initialize the corners of a gasket with three points
46      var vertices = [
47          vec2(-1, -1),
48          vec2(0, 1),
49          vec2(1, -1)
50      ];
51
52      // Specify a starting point p for iterations
53      // p must lie inside any set of three vertices
54      var u = add(vertices[0], vertices[1]);
55      var v = add(vertices[0], vertices[2]);
56      var p = scale(0.25, add(u, v));
57
58      // Add an initial point into the array of points
59      points = [p];
60
61      // Compute the new points
62      // Each new point is located midway between last point and a randomly chosen vertex
63      for (var i=0; points.length<numPoints; i++) {
64          var j = Math.floor(Math.random() * 3);
65          p = add(points[i], vertices[j]);
66          p = scale(0.5, p);
67          points.push(p);
68      }
69  }
70
```

Restricted Mode ⊗ 0 ⚠ 0 Ln 1, Col 1 Spaces: 4 UTF-8 CRLF {} JavaScript


학번 이름 - Sierpinski Gasket
파일 | C:/Users/Sun-Jeong%20Ki...

연습문제 (1)

- Sierpinski Gasket에서 점의 개수를 사용자로부터 입력 받아 그리시오.



File Edit Selection View Go Run Terminal Help gasket.html - Visual Studio Code

gasket.html gasket.js

C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > gasket.html > html > body > p > input#numPoints

```
<!DOCTYPE html>
<html>
    <head>
        <title>학번 이름 - Sierpinski Gasket</title>
        <script id="vertex-shader" type="x-shader/x-vertex">
        attribute vec4 vPosition;

        void main() {
            gl_PointSize = 2.0;
            gl_Position = vPosition;
        }
        </script>

        <script id="fragment-shader" type="x-shader/x-fragment">
        precision mediump float;

        void main() {
            gl_FragColor = vec4(1.0, 0.0, 0.0, 1.0);
        }
        </script>

        <script type="text/javascript" src="../Common/webgl-utils.js"></script>
        <script type="text/javascript" src="../Common/initShaders.js"></script>
        <script type="text/javascript" src="../Common/MV.js"></script>
        <script type="text/javascript" src="gasket.js"></script>
    </head>
    <body>
        <canvas id="gl-canvas" width="512" height="512">
            Oops... your browser doesn't support the HTML5 canvas element!
        </canvas>
        <p>점의 개수: <input type="text" id="numPoints" value="5000" onchange="drawGasket()"></p>
    </body>
</html>
```

Restricted Mode ⊗ 0 ⚠ 0 Ln 31, Col 88 Spaces: 4 UTF-8 CRLF HTML

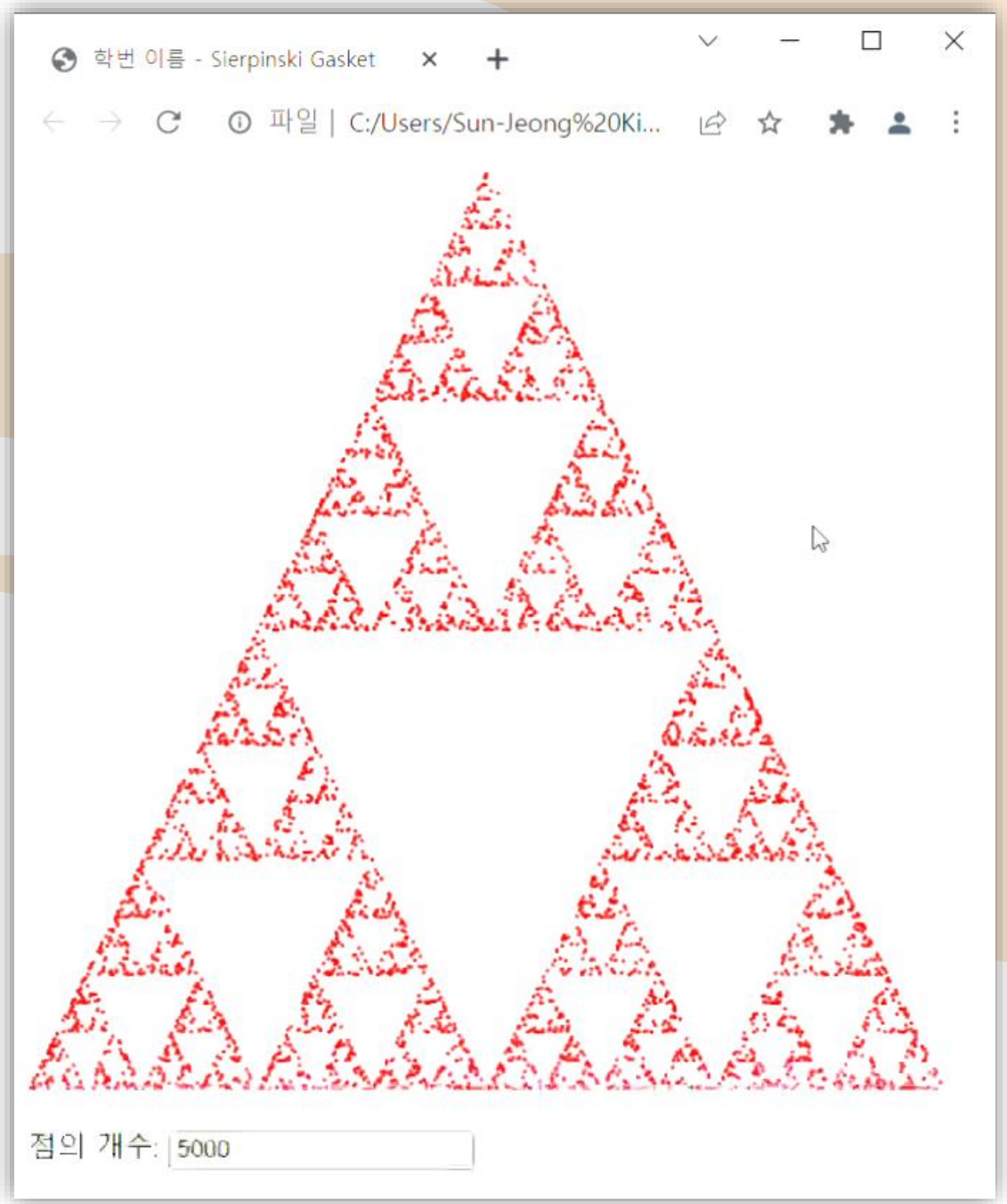
File Edit Selection View Go Run Terminal Help gasket.js - Visual Studio Code

gasket.html | gasket.js

C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > gasket.js > drawGasket

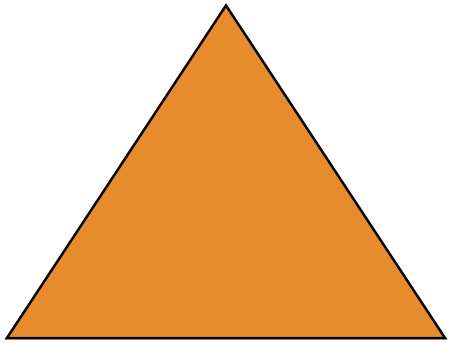
```
52      // Specify a starting point p for iterations
53      // p must lie inside any set of three vertices
54      var u = add(vertices[0], vertices[1]);
55      var v = add(vertices[0], vertices[2]);
56      var p = scale(0.25, add(u, v));
57
58      // Add an initial point into the array of points
59      points = [p];
60
61      // Compute the new points
62      // Each new point is located midway between last point and a randomly chosen vertex
63      for (var i=0; points.length<numPoints; i++) {
64          var j = Math.floor(Math.random() * 3);
65          p = add(points[i], vertices[j]);
66          p = scale(0.5, p);
67          points.push(p);
68      }
69  }
70
71  function drawGasket() {
72      numPoints = parseInt(document.getElementById("numPoints").value);
73
74      if(numPoints > 0 && numPoints <= 50000) {
75          generatePoints();
76
77          gl.bufferData(gl.ARRAY_BUFFER, flatten(points), gl.STATIC_DRAW);
78
79          render();
80      }
81      else {
82          alert("점의 개수는 0보다 크고 50,000보다 작거나 같아야 합니다.");
83      }
84  }
85
```

Restricted Mode ⊗ 0 ⚠ 0 Ln 82, Col 51 Spaces: 4 UTF-8 CRLF {} JavaScript

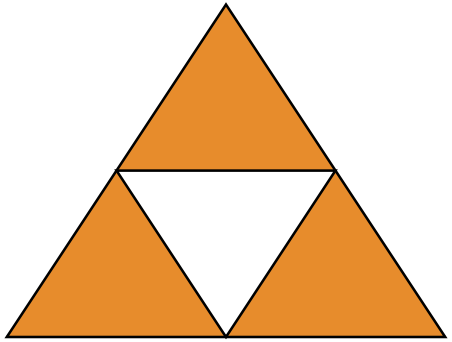

학번 이름 - Sierpinski Gasket
파일 | C:/Users/Sun-Jeong%20Ki...
점의 개수: 5000

Polygons and Recursion

- Start with a triangle



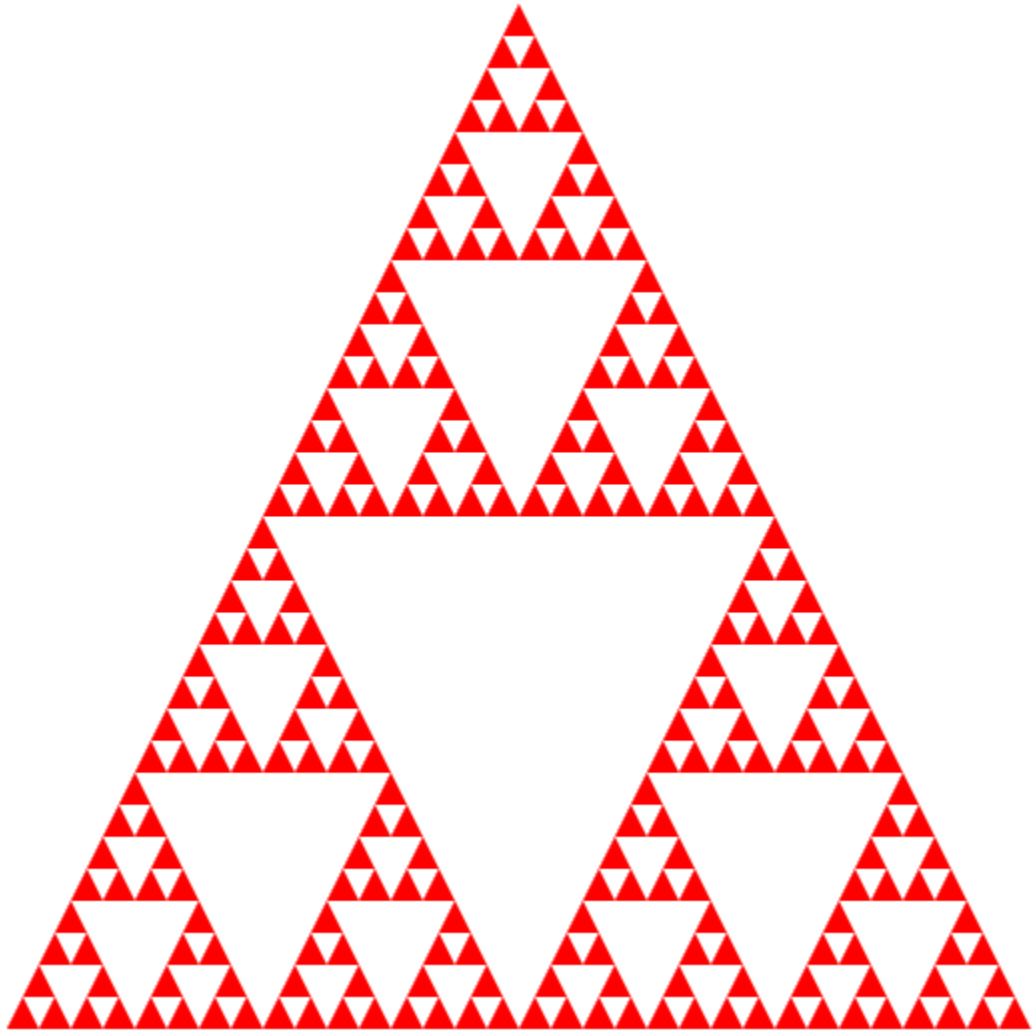
- Connect bisectors of sides and remove central triangle

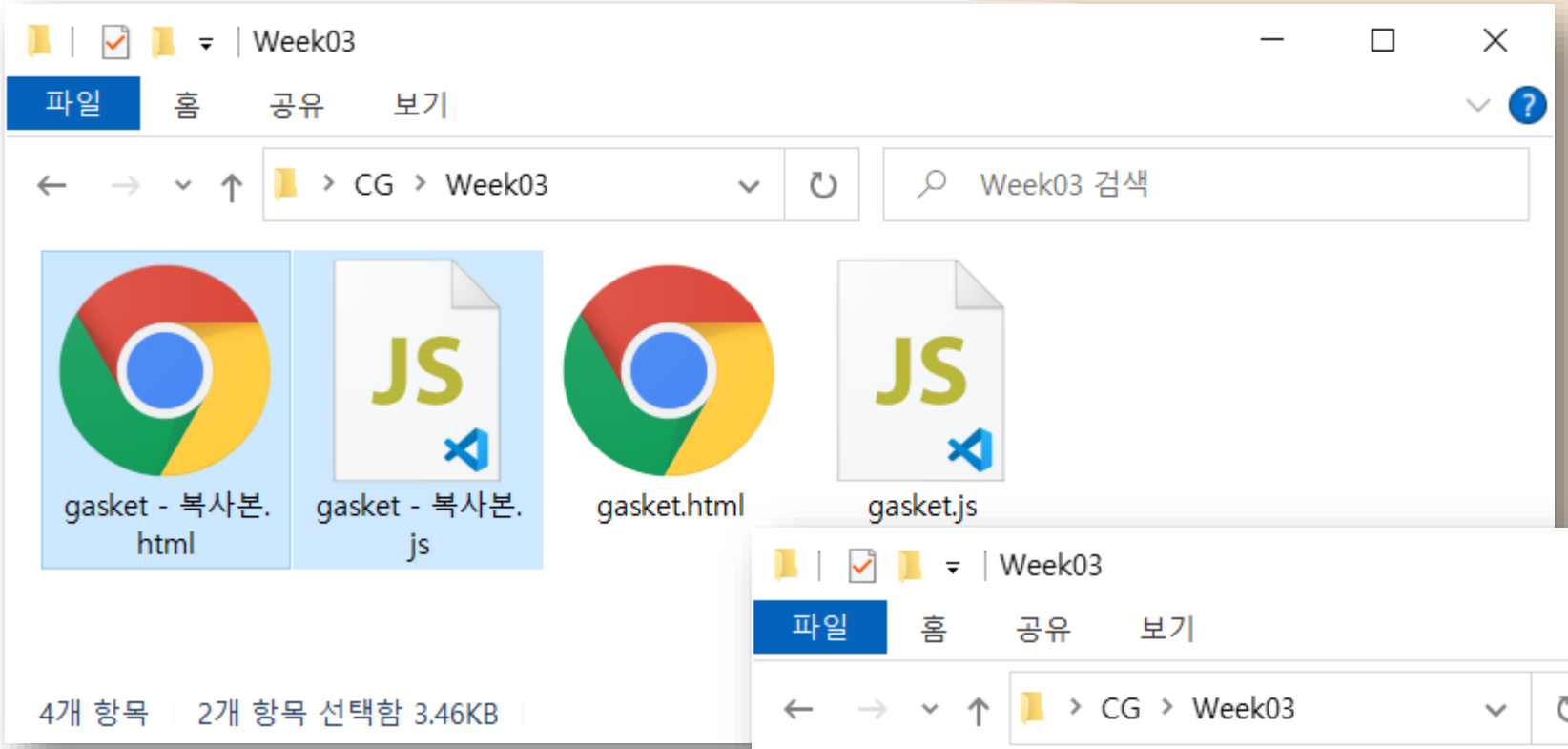


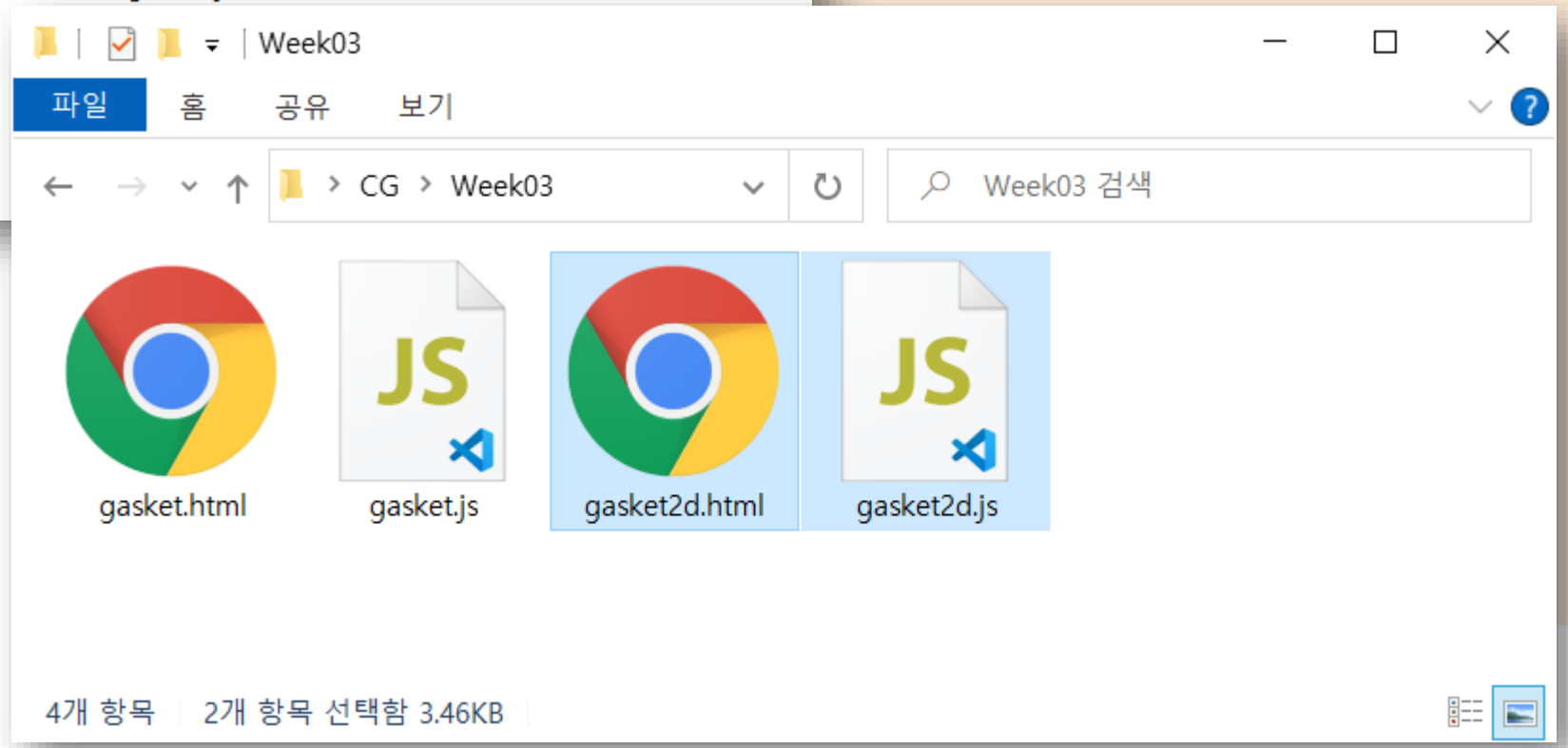
- Repeat

Example

- Five subdivisions




Week03
파일
홈
공유
보기
CG
Week03
Week03 검색
gasket - 복사본.html
gasket - 복사본.js
gasket.html
gasket.js
4개 항목
2개 항목 선택함 3.46KB


Week03
파일
홈
공유
보기
CG
Week03
Week03 검색
gasket.html
gasket.js
gasket2d.html
gasket2d.js
4개 항목
2개 항목 선택함 3.46KB

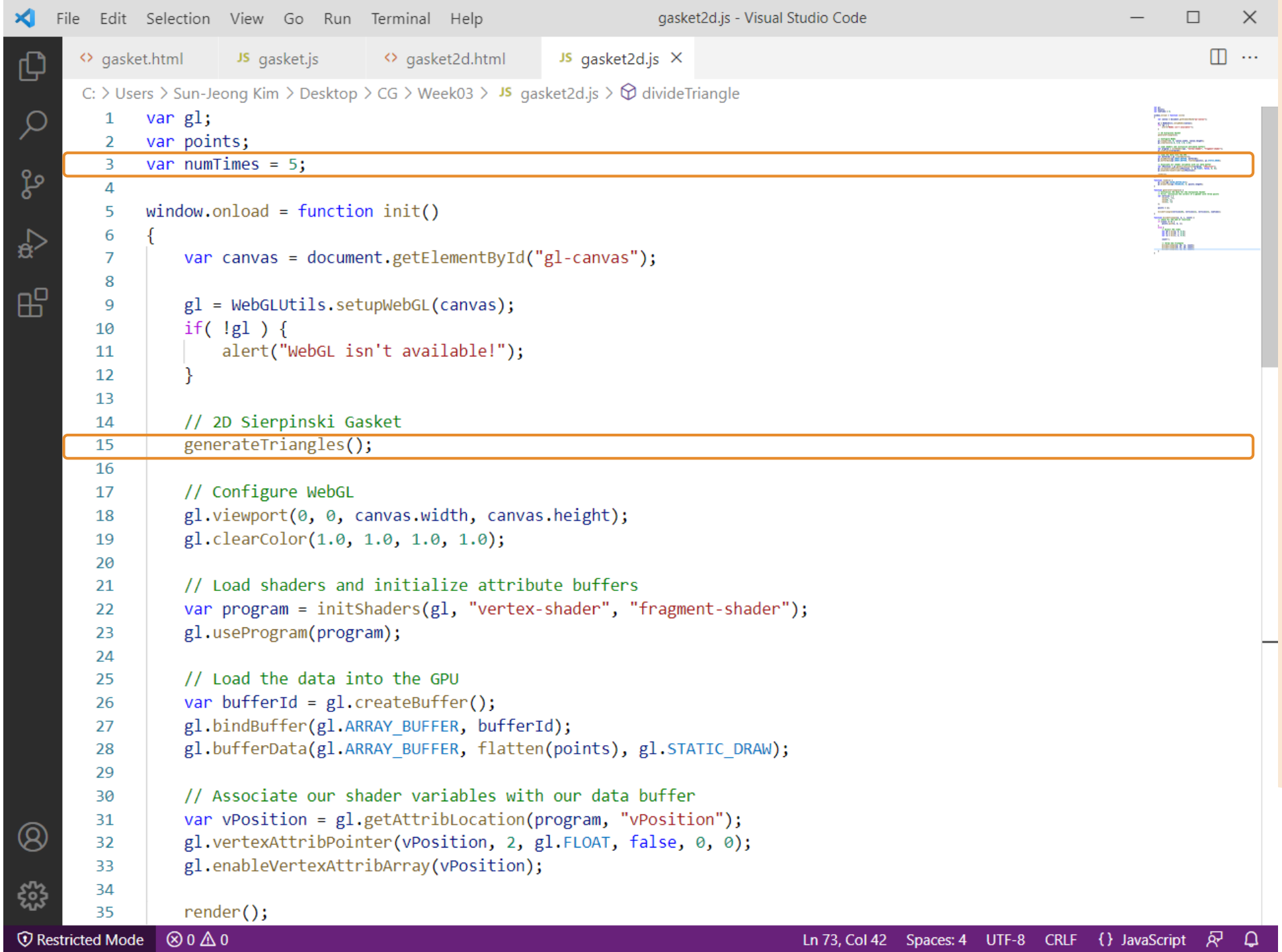
File Edit Selection View Go Run Terminal Help gasket2d.html - Visual Studio Code

gasket.html gasket.js gasket2d.html

C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > gasket2d.html > html > body

```
<!DOCTYPE html>
<html>
    <head>
        <title>학번 이름 - 2D Sierpinski Gasket</title>
        <script id="vertex-shader" type="x-shader/x-vertex">
        attribute vec4 vPosition;

        void main() {
            //gl_PointSize = 2.0;
            gl_Position = vPosition;
        }
        </script>

        <script id="fragment-shader" type="x-shader/x-fragment">
        precision mediump float;

        void main() {
            gl_FragColor = vec4(1.0, 0.0, 0.0, 1.0);
        }
        </script>

        <script type="text/javascript" src="../Common/webgl-utils.js"></script>
        <script type="text/javascript" src="../Common/initShaders.js"></script>
        <script type="text/javascript" src="../Common/MV.js"></script>
        <script type="text/javascript" src="gasket2d.js"></script>
    </head>
    <body>
        <canvas id="gl-canvas" width="512" height="512">
            Oops... your browser doesn't support the HTML5 canvas element!
        </canvas>
        <!--p>점의 개수: <input type="text" id="numPoints" value="5000" onchange="drawGasket()"></p-->
    </body>
</html>
```

Restricted Mode ⊗ 0 ⚠ 0 Ln 31, Col 98 Spaces: 4 UTF-8 CRLF HTML


File Edit Selection View Go Run Terminal Help
gasket2d.js - Visual Studio Code
gasket.html
gasket.js
gasket2d.html
gasket2d.js
C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > gasket2d.js > divideTriangle
var gl;
var points;
var numTimes = 5;
window.onload = function init()
{
var canvas = document.getElementById("gl-canvas");
gl = WebGLUtils.setupWebGL(canvas);
if(!gl) {
alert("WebGL isn't available!");
}
// 2D Sierpinski Gasket
generateTriangles();
// Configure WebGL
gl.viewport(0, 0, canvas.width, canvas.height);
gl.clearColor(1.0, 1.0, 1.0, 1.0);
// Load shaders and initialize attribute buffers
var program = initShaders(gl, "vertex-shader", "fragment-shader");
gl.useProgram(program);
// Load the data into the GPU
var bufferId = gl.createBuffer();
gl.bindBuffer(gl.ARRAY_BUFFER, bufferId);
gl.bufferData(gl.ARRAY_BUFFER, flatten(points), gl.STATIC_DRAW);
// Associate our shader variables with our data buffer
var vPosition = gl.getAttribLocation(program, "vPosition");
gl.vertexAttribPointer(vPosition, 2, gl.FLOAT, false, 0, 0);
gl.enableVertexAttribArray(vPosition);
render();
Restricted Mode
0 0
Ln 73, Col 42
Spaces: 4
UTF-8
CRLF
JavaScript

File Edit Selection View Go Run Terminal Help gasket2d.js - Visual Studio Code

gasket.html | gasket.js | gasket2d.html | gasket2d.js

C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > gasket2d.js > divideTriangle

```
22      var program = initShaders(gl, "vertex-shader", "fragment-shader");
23      gl.useProgram(program);
24
25      // Load the data into the GPU
26      var bufferId = gl.createBuffer();
27      gl.bindBuffer(gl.ARRAY_BUFFER, bufferId);
28      gl.bufferData(gl.ARRAY_BUFFER, flatten(points), gl.STATIC_DRAW);
29
30      // Associate our shader variables with our data buffer
31      var vPosition = gl.getAttribLocation(program, "vPosition");
32      gl.vertexAttribPointer(vPosition, 2, gl.FLOAT, false, 0, 0);
33      gl.enableVertexAttribArray(vPosition);
34
35      render();
36  };
37
38  function render() {
39      gl.clear(gl.COLOR_BUFFER_BIT);
40      gl.drawArrays(gl.TRIANGLES, 0, points.length);
41  }
42
43  function generateTriangles() {
44      // Initialize the data for the Sierpinski Gasket
45      // First, initialize the corners of a gasket with three points
46      var vertices = [
47          vec2(-1, -1),
48          vec2(0, 1),
49          vec2(1, -1)
50      ];
51
52      points = [];
53
54      divideTriangle(vertices[0], vertices[1], vertices[2], numTimes);
55  }
56
```

Restricted Mode ⊗ 0 ⚠ 0 Ln 73, Col 42 Spaces: 4 UTF-8 CRLF {} JavaScript

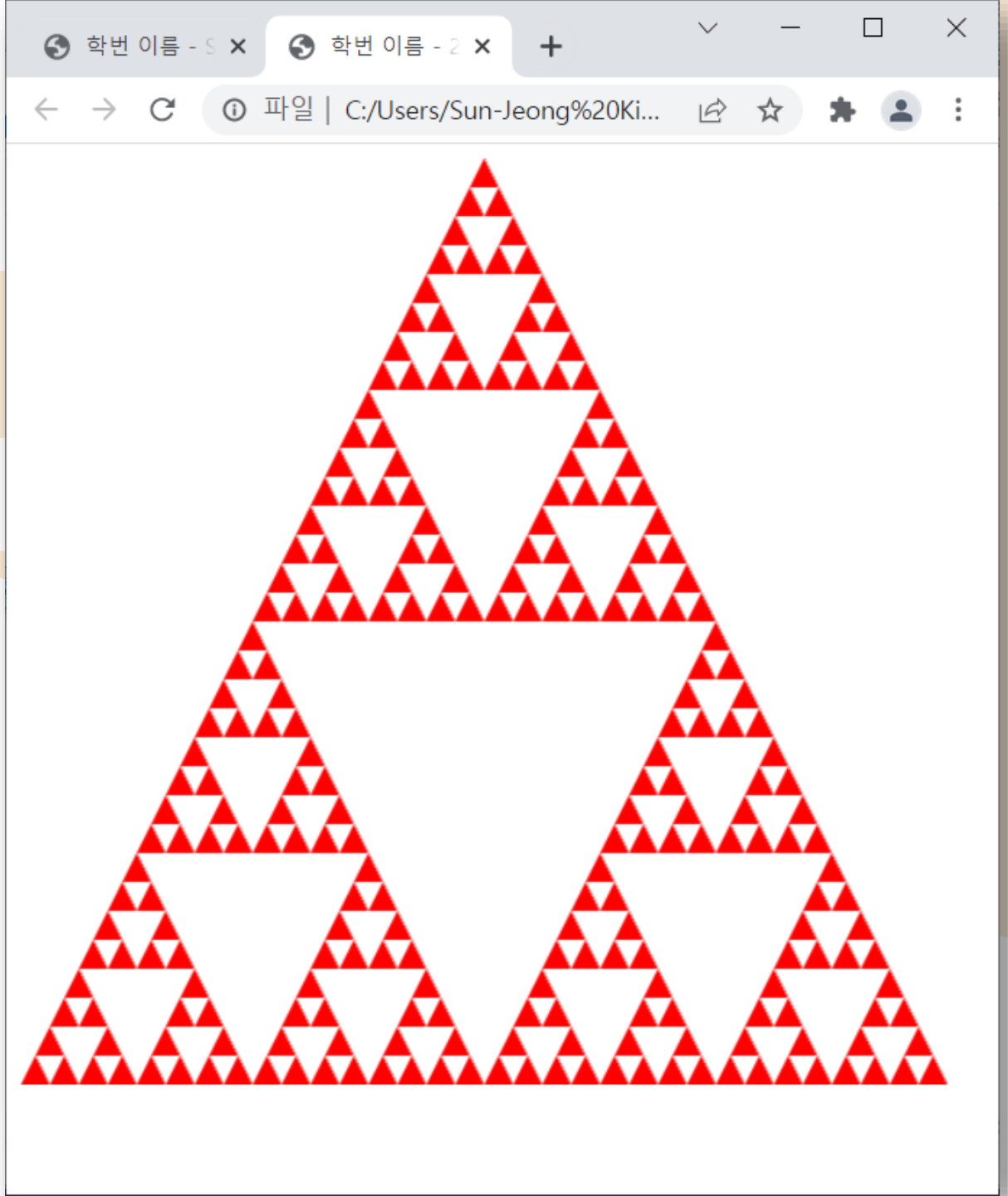
File Edit Selection View Go Run Terminal Help gasket2d.js - Visual Studio Code

gasket.html | gasket.js | gasket2d.html | gasket2d.js

C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > gasket2d.js > divideTriangle

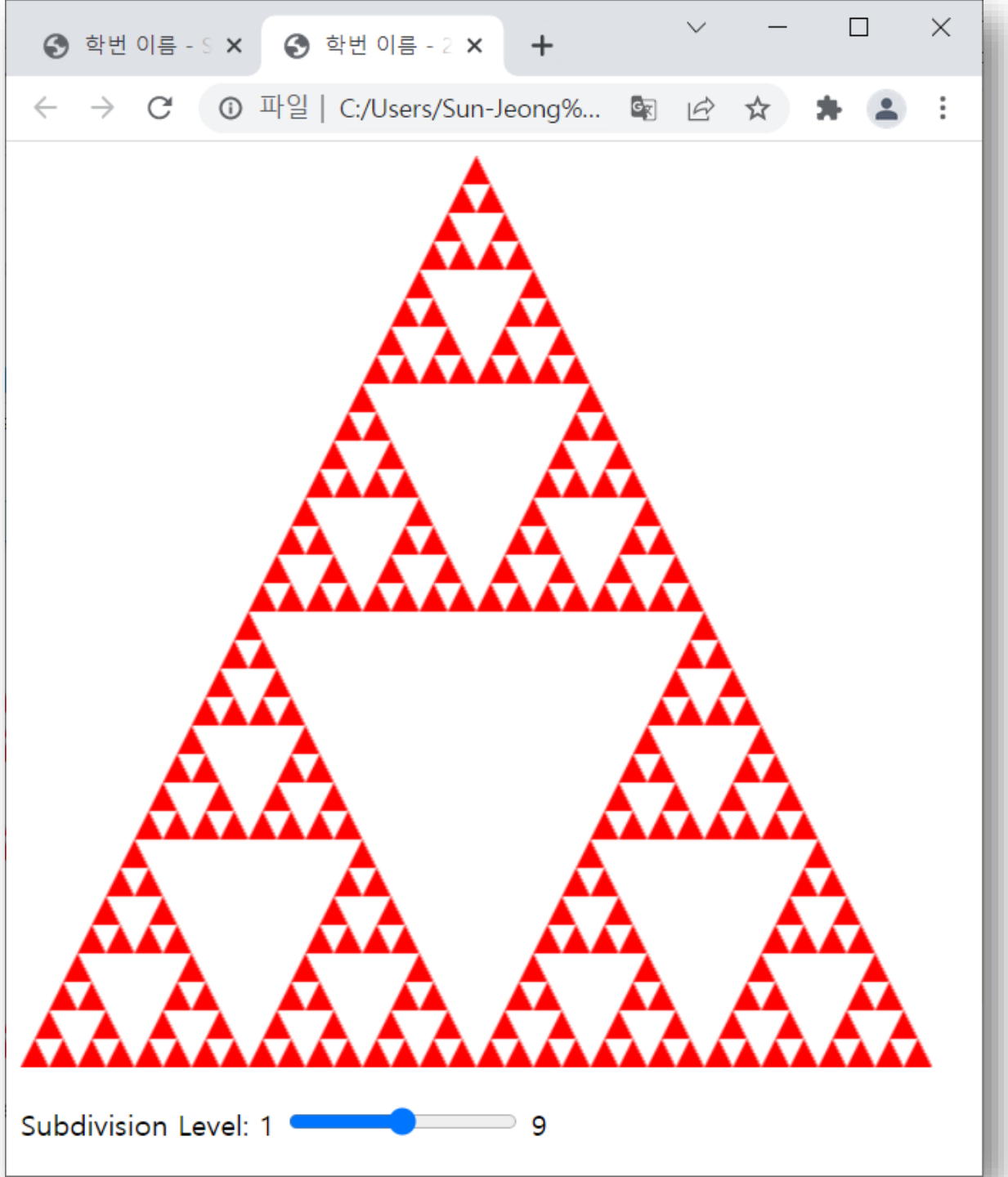
```
43  function generateTriangles() {
44      // Initialize the data for the Sierpinski Gasket
45      // First, initialize the corners of a gasket with three points
46      var vertices = [
47          vec2(-1, -1),
48          vec2(0, 1),
49          vec2(1, -1)
50      ];
51
52      points = [];
53
54      divideTriangle(vertices[0], vertices[1], vertices[2], numTimes);
55  }
56
57  function divideTriangle(a, b, c, count) {
58      // check for the end of recursion
59      if (count == 0) {
60          points.push(a, b, c);
61      }
62      else {
63          // bisect the sides
64          var ab = mix(a, b, 0.5);
65          var bc = mix(b, c, 0.5);
66          var ca = mix(c, a, 0.5);
67
68          count--;
69
70          // three new triangles
71          divideTriangle(a, ab, ca, count);
72          divideTriangle(b, bc, ab, count);
73          divideTriangle(c, ca, bc, count);
74      }
75  }
76
```

Restricted Mode ⊗ 0 ⚠ 0 Ln 73, Col 42 Spaces: 4 UTF-8 CRLF {} JavaScript


학번 이름 - S
학번 이름 - 2
파일 | C:/Users/Sun-Jeong%20Ki...

연습문제 (2)

- Sierpinski Gasket 2D에서 Subdivision 레벨을 사용자로부터 입력 받아 그리시오.



File Edit Selection View Go Run Terminal Help gasket2d.html - Visual Studio Code

gasket.html | gasket.js | gasket2d.html | gasket2d.js

C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > gasket2d.html > html > body > p

```
<!DOCTYPE html>
<html>
    <head>
        <title>학번 이름 - 2D Sierpinski Gasket</title>
        <script id="vertex-shader" type="x-shader/x-vertex">
        attribute vec4 vPosition;

        void main() {
            //gl_PointSize = 2.0;
            gl_Position = vPosition;
        }
        </script>

        <script id="fragment-shader" type="x-shader/x-fragment">
        precision mediump float;

        void main() {
            gl_FragColor = vec4(1.0, 0.0, 0.0, 1.0);
        }
        </script>

        <script type="text/javascript" src="../Common/webgl-utils.js"></script>
        <script type="text/javascript" src="../Common/initShaders.js"></script>
        <script type="text/javascript" src="../Common/MV.js"></script>
        <script type="text/javascript" src="gasket2d.js"></script>
    </head>
    <body>
        <canvas id="gl-canvas" width="512" height="512">
            Oops... your browser doesn't support the HTML5 canvas element!
        </canvas>
        <p>Subdivision Level: 1 <input type="range" id="level" value="5" min="1" max="9" step="1" value="5"> 9</p>
    </body>
</html>
```

Restricted Mode ⊗ 0 ⚠ 0 Ln 31, Col 110 Spaces: 4 UTF-8 CRLF HTML

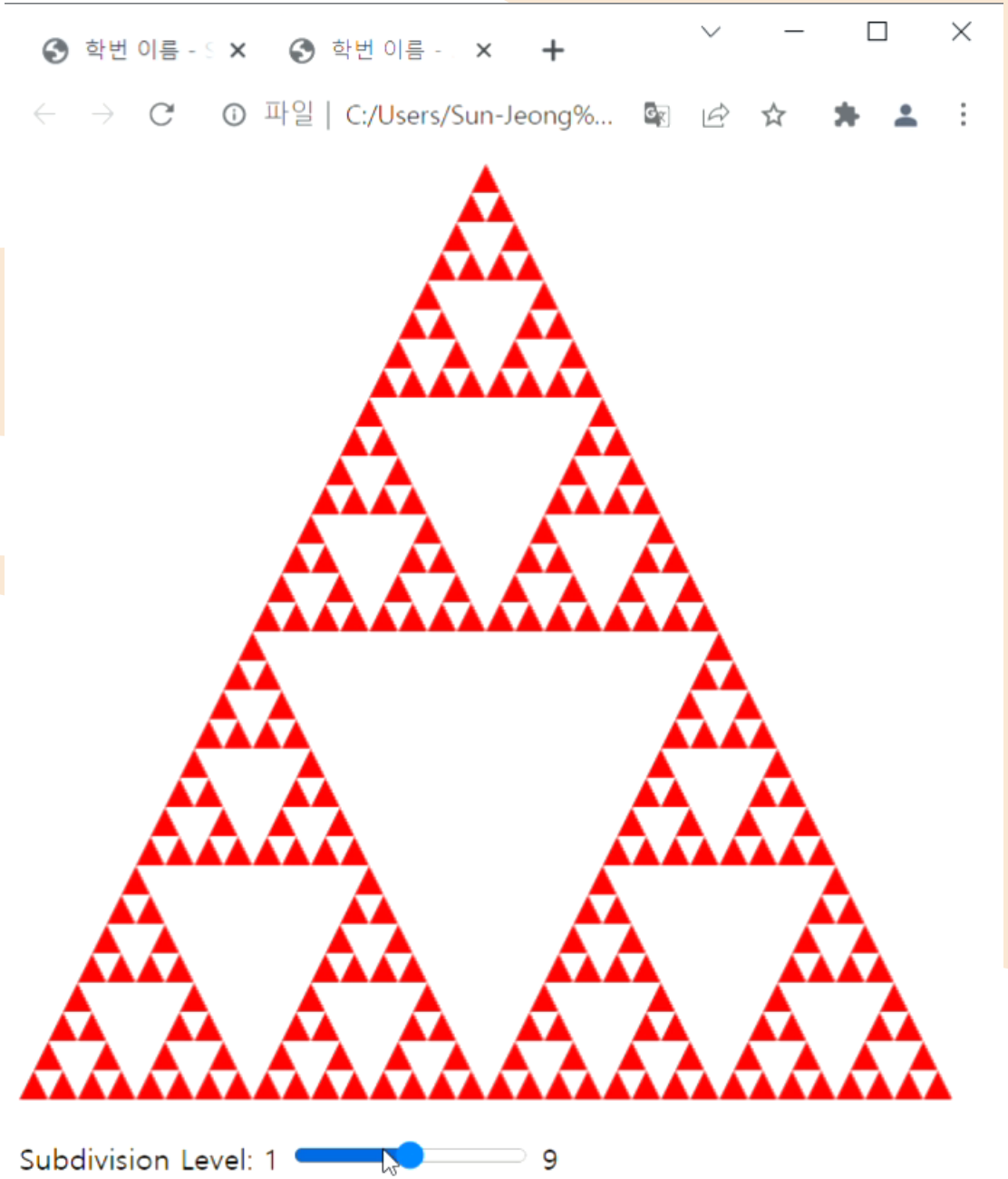
File Edit Selection View Go Run Terminal Help gasket2d.js - Visual Studio Code

gasket.html | gasket.js | gasket2d.html | gasket2d.js

C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > gasket2d.js > init > onchange

```
1   var gl;
2   var points;
3   var numTimes = 5;
4
5   window.onload = function init()
6   {
7       var canvas = document.getElementById("gl-canvas");
8
9       gl = WebGLUtils.setupWebGL(canvas);
10      if( !gl ) {
11          alert("WebGL isn't available!");
12      }
13
14      document.getElementById("level").onchange = function(event) {
15          numTimes = event.target.value;
16
17          generateTriangles();
18
19          gl.bufferData(gl.ARRAY_BUFFER, flatten(points), gl.STATIC_DRAW);
20
21          render();
22      }
23
24      // 2D Sierpinski Gasket
25      generateTriangles();
26
27      // Configure WebGL
28      gl.viewport(0, 0, canvas.width, canvas.height);
29      gl.clearColor(1.0, 1.0, 1.0, 1.0);
30
31      // Load shaders and initialize attribute buffers
32      var program = initShaders(gl, "vertex-shader", "fragment-shader");
33      gl.useProgram(program);
34
35      // Load the data into the GPU
```

Restricted Mode ⊗ 0 ⚠ 0 Ln 21, Col 18 Spaces: 4 UTF-8 CRLF {} JavaScript

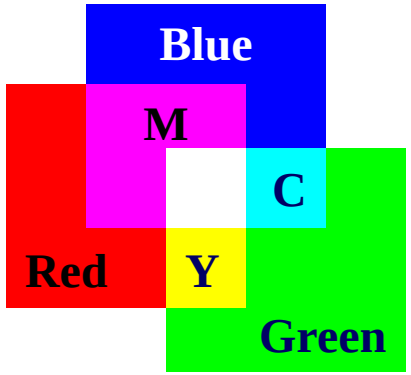

학번 이름 -
학번 이름 -
파일 | C:/Users/Sun-Jeong%...
Subdivision Level: 1
9

Attributes

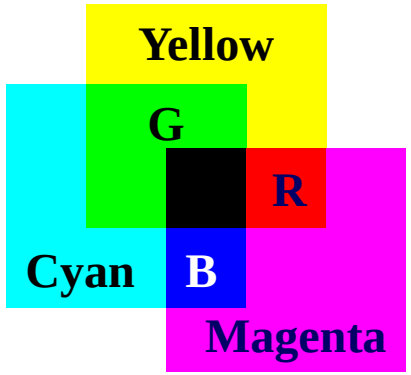
- Properties that determines how to render a geometric primitive (appearance of objects)
  - Color (points, lines, polygons)
  - Size and width (points, lines)
  - Stipple pattern (lines, polygons)
  - Polygon mode
    - Display as filled: solid color or stipple pattern
    - Display edges
    - Display vertices
- Only a few (`gl_PointSize`) are supported by OpenGL functions

Color

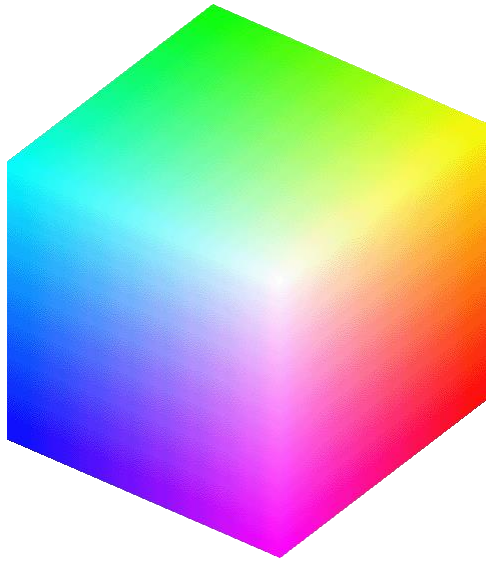
- Three color theory
  - Our brains do not receive the entire color distribution but rather than three values
- Additive color – ex) CRT
- Subtractive color – ex) printing



Additive Color



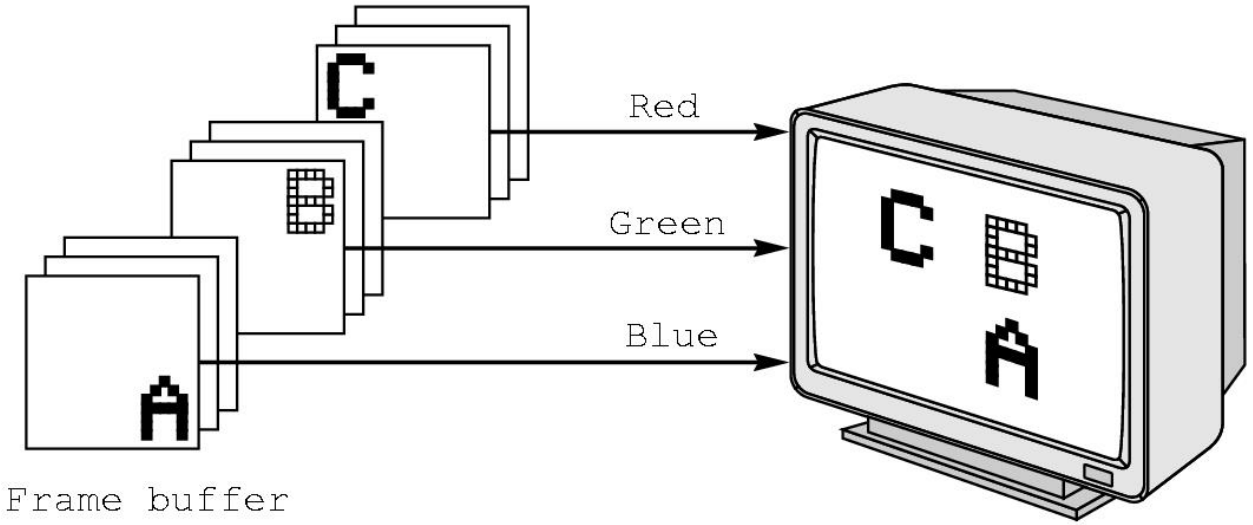
Subtractive Color



Color Solid

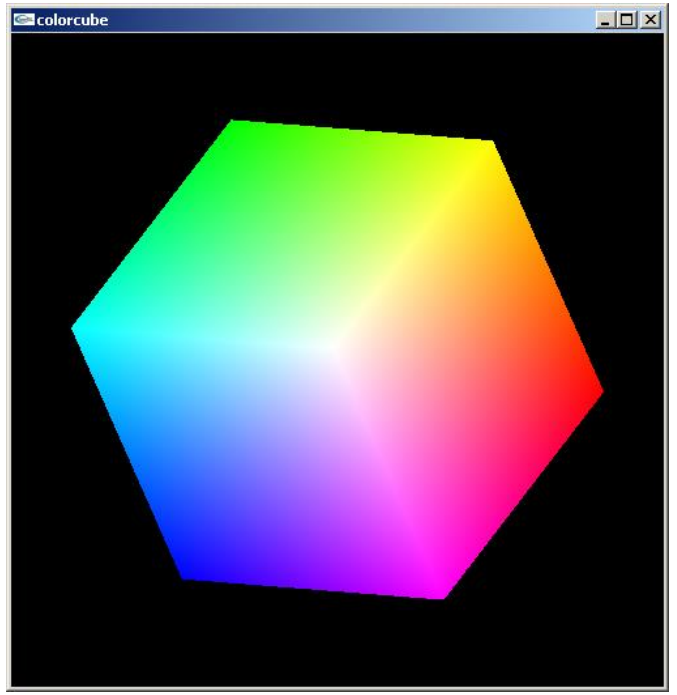
RGB Color

- Each color component is stored separately in the frame buffer
  - Usually 8 bits per component in buffer
  - Color values can range from 0.0 (none) to 1.0 (all) using floats or over the range from 0 to 255 using unsigned bytes



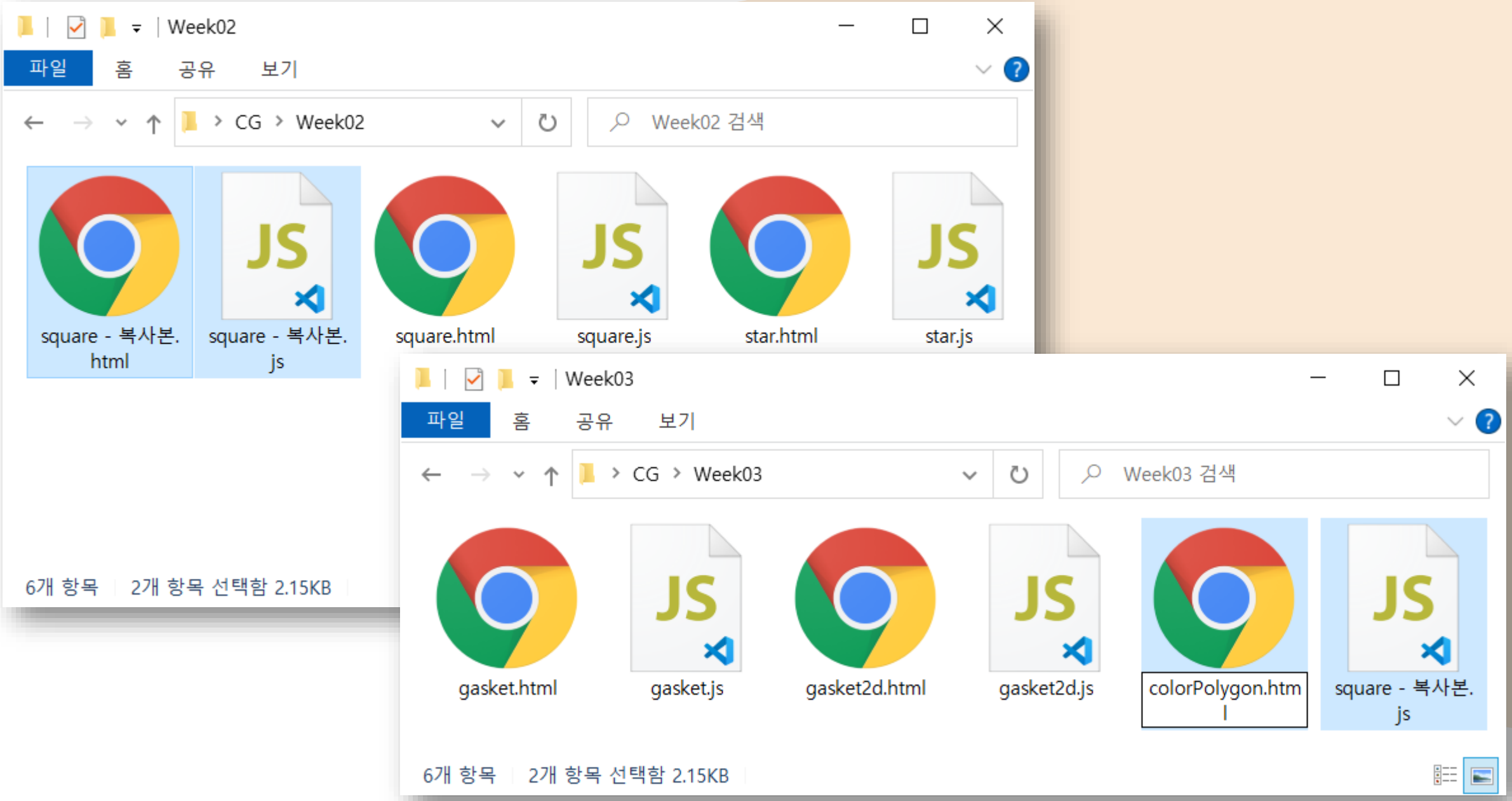
Smooth Color

- Default is smooth shading
  - OpenGL interpolates vertex colors across visible polygons
- Alternative is flat shading
  - Color of first vertex determines fill color
  - Handle in shader



Setting Colors

- Colors are ultimately set in the fragment shader but can be determined in either shader or in the application
- Application color: pass to vertex shader as a uniform variable or as a vertex attribute
- Vertex shader color: pass to fragment shader as varying variable
- Fragment color: can alter via shader code


Week02
파일
홈
공유
보기
CG
Week02
Week02 검색
square - 복사본.html
square - 복사본.js
square.html
square.js
star.html
star.js
6개 항목
2개 항목 선택함 2.15KB
Week03
파일
홈
공유
보기
CG
Week03
Week03 검색
gasket.html
gasket.js
gasket2d.html
gasket2d.js
colorPolygon.html
square - 복사본.js
6개 항목
2개 항목 선택함 2.15KB

File Edit Selection View Go Run Terminal Help colorPolygon.html - Visual Studio Code

gasket.html | gasket.js | gasket2d.html | gasket2d.js | colorPolygon.html | colorPolygon.js

C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > colorPolygon.html > html > head > script

```
<!DOCTYPE html>
<html>
    <head>
        <title>2022 Computer Graphics</title>

        <script id="vertex-shader" type="x-shader/x-vertex">
        attribute vec4 vPosition;

        void main() {
            //gl_PointSize = 5.0;
            gl_Position = vPosition;
        }
        </script>

        <script id="fragment-shader" type="x-shader/x-fragment">
        precision mediump float;

        void main() {
            gl_FragColor = vec4(1.0, 1.0, 0.0, 1.0);
        }
        </script>

        <script type="text/javascript" src="../Common/webgl-utils.js"></script>
        <script type="text/javascript" src="../Common/initShaders.js"></script>
        <script type="text/javascript" src="../Common/MV.js"></script>
        <script type="text/javascript" src="colorPolygon.js"></script>
    </head>
    <body>
        <canvas id="gl-canvas" width="512" height="512">
            Oops... your browser doesn't support the HTML5 canvas element!
        </canvas>
    </body>
</html>
```

Restricted Mode ⊗ 0 ⚠ 0 Ln 26, Col 60 Spaces: 4 UTF-8 CRLF HTML

File Edit Selection View Go Run Terminal Help colorPolygon.js - Visual Studio Code

gasket.html | gasket.js | gasket2d.html | gasket2d.js | colorPolygon.html | colorPolygon.js

C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > colorPolygon.js > render

```
1   var gl;
2
3   window.onload = function init()
4   {
5       var canvas = document.getElementById("gl-canvas");
6
7       gl = WebGLUtils.setupWebGL(canvas);
8       if( !gl ) {
9           alert("WebGL isn't available!");
10      }
11
12      var vertices = [
13          vec2(-0.5, -0.5),
14          vec2(0.5, -0.5),
15          vec2(0, 0.5)
16      ];
17
18      // Configure WebGL
19      gl.viewport(0, 0, canvas.width, canvas.height);
20      gl.clearColor(1.0, 1.0, 1.0, 1.0);
21
22      // Load shaders and initialize attribute buffers
23      var program = initShaders(gl, "vertex-shader", "fragment-shader");
24      gl.useProgram(program);
25
26      // Load the data into the GPU
27      var bufferId = gl.createBuffer();
28      gl.bindBuffer(gl.ARRAY_BUFFER, bufferId);
29      gl.bufferData(gl.ARRAY_BUFFER, flatten(vertices), gl.STATIC_DRAW);
30
31      // Associate our shader variables with our data buffer
32      var vPosition = gl.getAttribLocation(program, "vPosition");
33      gl.vertexAttribPointer(vPosition, 2, gl.FLOAT, false, 0, 0);
34      gl.enableVertexAttribArray(vPosition);
35
```

Restricted Mode ⊗ 0 ⚠ 0 Ln 42, Col 31 Spaces: 4 UTF-8 CRLF {} JavaScript

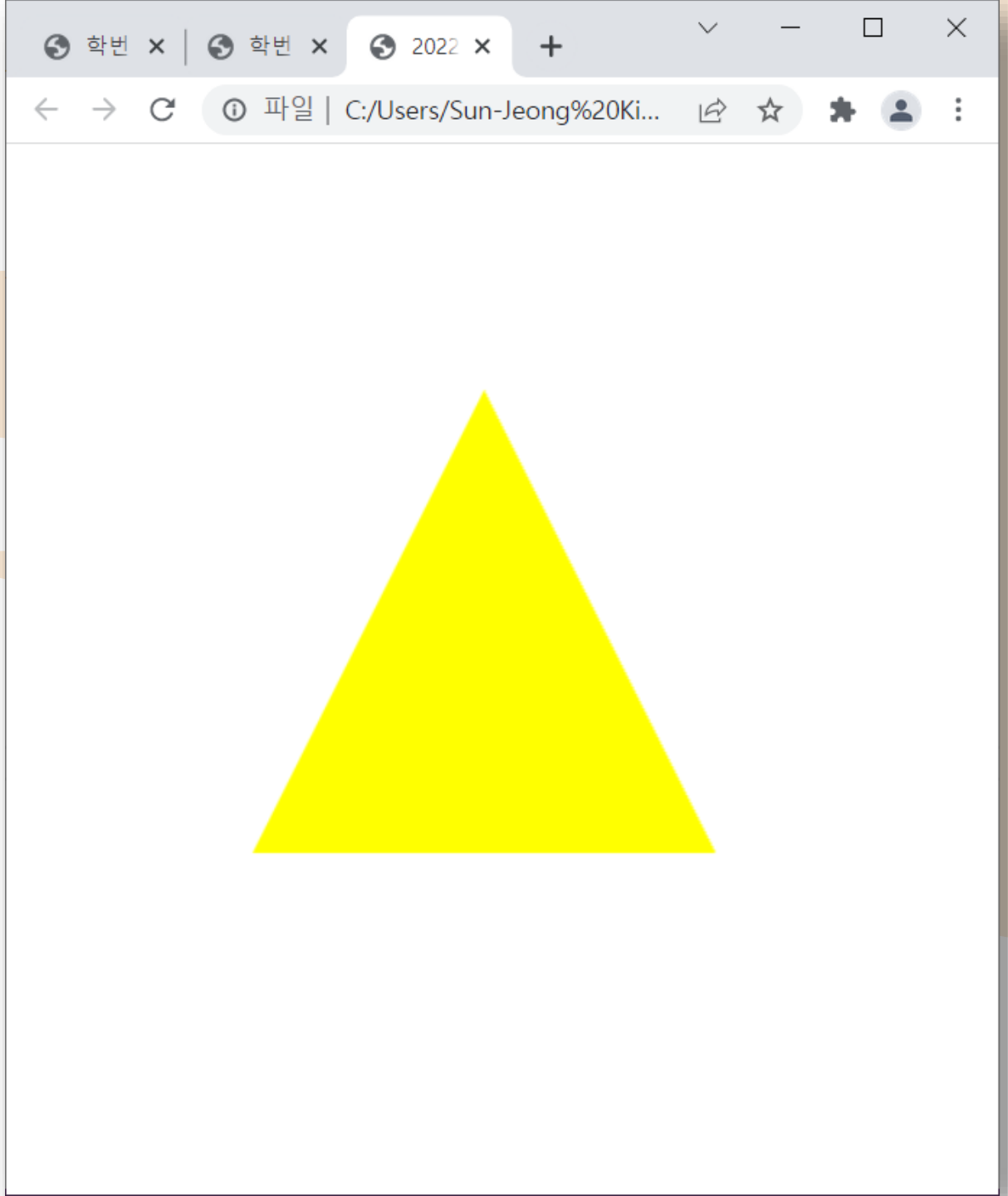
File Edit Selection View Go Run Terminal Help colorPolygon.js - Visual Studio Code

gasket.html | gasket.js | gasket2d.html | gasket2d.js | colorPolygon.html | colorPolygon.js

C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > colorPolygon.js > render

```
11
12      var vertices = [
13          vec2(-0.5, -0.5),
14          vec2(0.5, -0.5),
15          vec2(0, 0.5)
16      ];
17
18      // Configure WebGL
19      gl.viewport(0, 0, canvas.width, canvas.height);
20      gl.clearColor(1.0, 1.0, 1.0, 1.0);
21
22      // Load shaders and initialize attribute buffers
23      var program = initShaders(gl, "vertex-shader", "fragment-shader");
24      gl.useProgram(program);
25
26      // Load the data into the GPU
27      var bufferId = gl.createBuffer();
28      gl.bindBuffer(gl.ARRAY_BUFFER, bufferId);
29      gl.bufferData(gl.ARRAY_BUFFER, flatten(vertices), gl.STATIC_DRAW);
30
31      // Associate our shader variables with our data buffer
32      var vPosition = gl.getAttribLocation(program, "vPosition");
33      gl.vertexAttribPointer(vPosition, 2, gl.FLOAT, false, 0, 0);
34      gl.enableVertexAttribArray(vPosition);
35
36      render();
37  };
38
39  function render()
40  {
41      gl.clear(gl.COLOR_BUFFER_BIT);
42      gl.drawArrays(gl.TRIANGLES, 0, 3);
43  }
44
```

Restricted Mode ⊗ 0 ⚠ 0 Ln 42, Col 31 Spaces: 4 UTF-8 CRLF {} JavaScript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File Edit Selection View Go Run Terminal Help colorPolygon.html - Visual Studio Code

gasket.html | gasket.js | gasket2d.html | gasket2d.js | colorPolygon.html | colorPolygon.js

C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > colorPolygon.html > html > head > script#fragment-shader

```
<!DOCTYPE html>
<html>
    <head>
        <title>2022 Computer Graphics</title>

        <script id="vertex-shader" type="x-shader/x-vertex">
            attribute vec4 vPosition;
            attribute vec4 vColor;
            varying vec4 fColor;

            void main() {
                //gl_PointSize = 5.0;
                gl_Position = vPosition;
                fColor = vColor;
            }
            </script>

            <script id="fragment-shader" type="x-shader/x-fragment">
            precision mediump float;
            varying vec4 fColor;

            void main() {
                gl_FragColor = fColor;
            }
            </script>

        <script type="text/javascript" src="../Common/webgl-utils.js"></script>
        <script type="text/javascript" src="../Common/initShaders.js"></script>
        <script type="text/javascript" src="../Common/MV.js"></script>
        <script type="text/javascript" src="colorPolygon.js"></script>
    </head>
    <body>
        <canvas id="gl-canvas" width="512" height="512">
            Oops... your browser doesn't support the HTML5 canvas element!
        </canvas>
```

Restricted Mode ⊗ 0 ⚠ 0 Ln 23, Col 39 Spaces: 4 UTF-8 CRLF HTML

File Edit Selection View Go Run Terminal Help colorPolygon.js - Visual Studio Code

gasket.html | gasket.js | gasket2d.html | gasket2d.js | colorPolygon.html | colorPolygon.js

C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > colorPolygon.js > init

```
1   var gl;
2
3   window.onload = function init()
4   {
5       var canvas = document.getElementById("gl-canvas");
6
7       gl = WebGLUtils.setupWebGL(canvas);
8       if( !gl ) {
9           alert("WebGL isn't available!");
10      }
11
12      var vertices = [
13          vec2(-0.5, -0.5),
14          vec2(0.5, -0.5),
15          vec2(0, 0.5)
16      ];
17
18      var colors = [
19          vec4(1, 0, 0, 1),
20          vec4(0, 1, 0, 1),
21          vec4(0, 0, 1, 1)
22      ];
23
24      // Configure WebGL
25      gl.viewport(0, 0, canvas.width, canvas.height);
26      gl.clearColor(1.0, 1.0, 1.0, 1.0);
27
28      // Load shaders and initialize attribute buffers
29      var program = initShaders(gl, "vertex-shader", "fragment-shader");
30      gl.useProgram(program);
31
32      // Load the data into the GPU
33      var bufferId = gl.createBuffer();
34      gl.bindBuffer(gl.ARRAY_BUFFER, bufferId);
35      gl.bufferData(gl.ARRAY_BUFFER, flatten(vertices), gl.STATIC_DRAW);
```

Restricted Mode ⊗ 0 ⚠ 0 Ln 50, Col 40 Spaces: 4 UTF-8 CRLF {} JavaScript

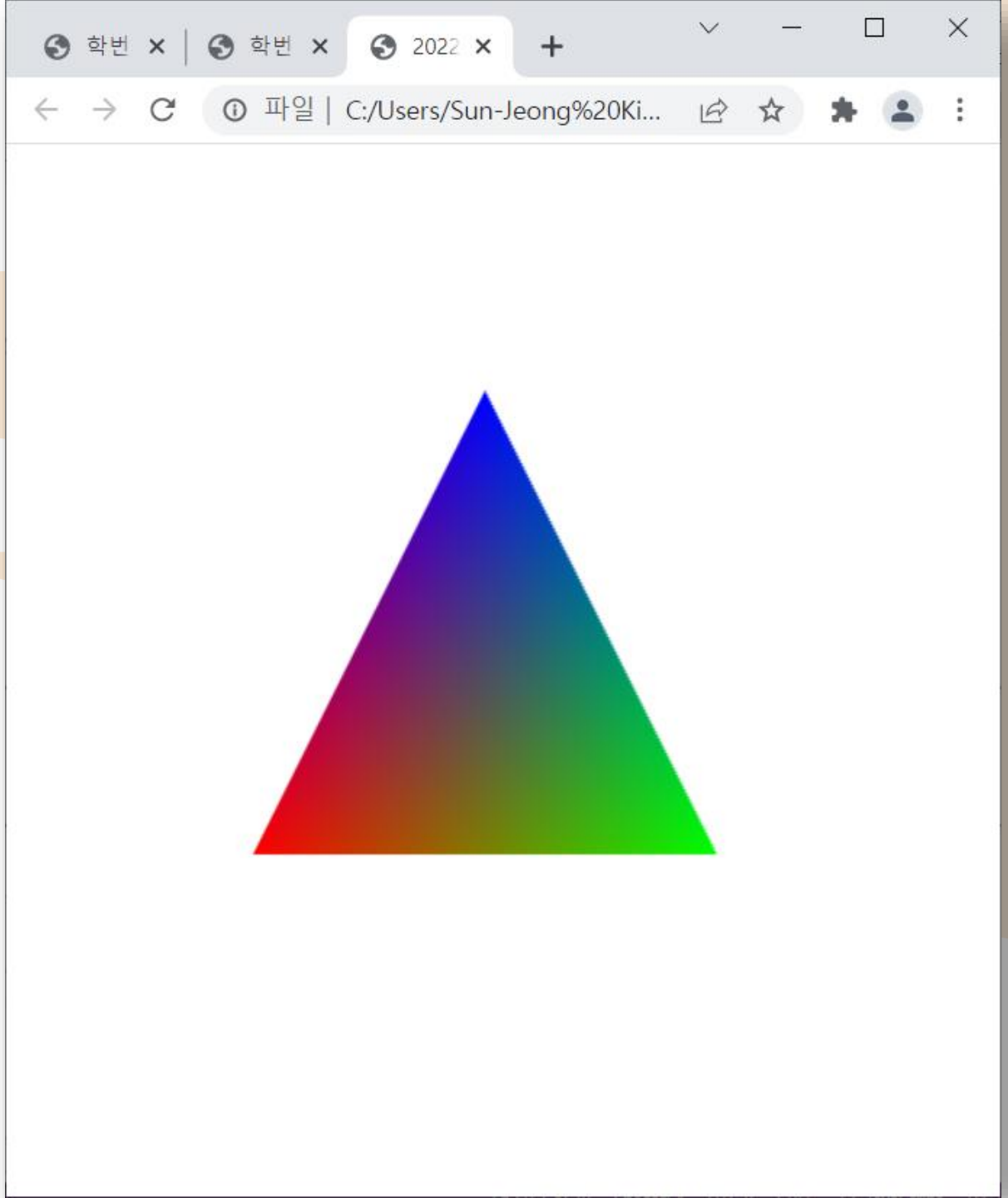
File Edit Selection View Go Run Terminal Help colorPolygon.js - Visual Studio Code

gasket.html | gasket.js | gasket2d.html | gasket2d.js | colorPolygon.html | colorPolygon.js

C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > colorPolygon.js > init

```
27
28      // Load shaders and initialize attribute buffers
29      var program = initShaders(gl, "vertex-shader", "fragment-shader");
30      gl.useProgram(program);
31
32      // Load the data into the GPU
33      var bufferId = gl.createBuffer();
34      gl.bindBuffer(gl.ARRAY_BUFFER, bufferId);
35      gl.bufferData(gl.ARRAY_BUFFER, flatten(vertices), gl.STATIC_DRAW);
36
37      // Associate our shader variables with our data buffer
38      var vPosition = gl.getAttribLocation(program, "vPosition");
39      gl.vertexAttribPointer(vPosition, 2, gl.FLOAT, false, 0, 0);
40      gl.enableVertexAttribArray(vPosition);
41
42      // Create a buffer object, initialize it, and associate it with
43      // the associated attribute variable in our vertex shader
44      var cbufferId = gl.createBuffer();
45      gl.bindBuffer(gl.ARRAY_BUFFER, cbufferId);
46      gl.bufferData(gl.ARRAY_BUFFER, flatten(colors), gl.STATIC_DRAW);
47
48      var vColor = gl.getAttribLocation(program, "vColor");
49      gl.vertexAttribPointer(vColor, 4, gl.FLOAT, false, 0, 0);
50      gl.enableVertexAttribArray(vColor);
51
52      render();
53  };
54
55  function render()
56  {
57      gl.clear(gl.COLOR_BUFFER_BIT);
58      gl.drawArrays(gl.TRIANGLES, 0, 3);
59  }
60
```

Restricted Mode ⊗ 0 ⚠ 0 Ln 50, Col 39 Spaces: 4 UTF-8 CRLF {} JavaScript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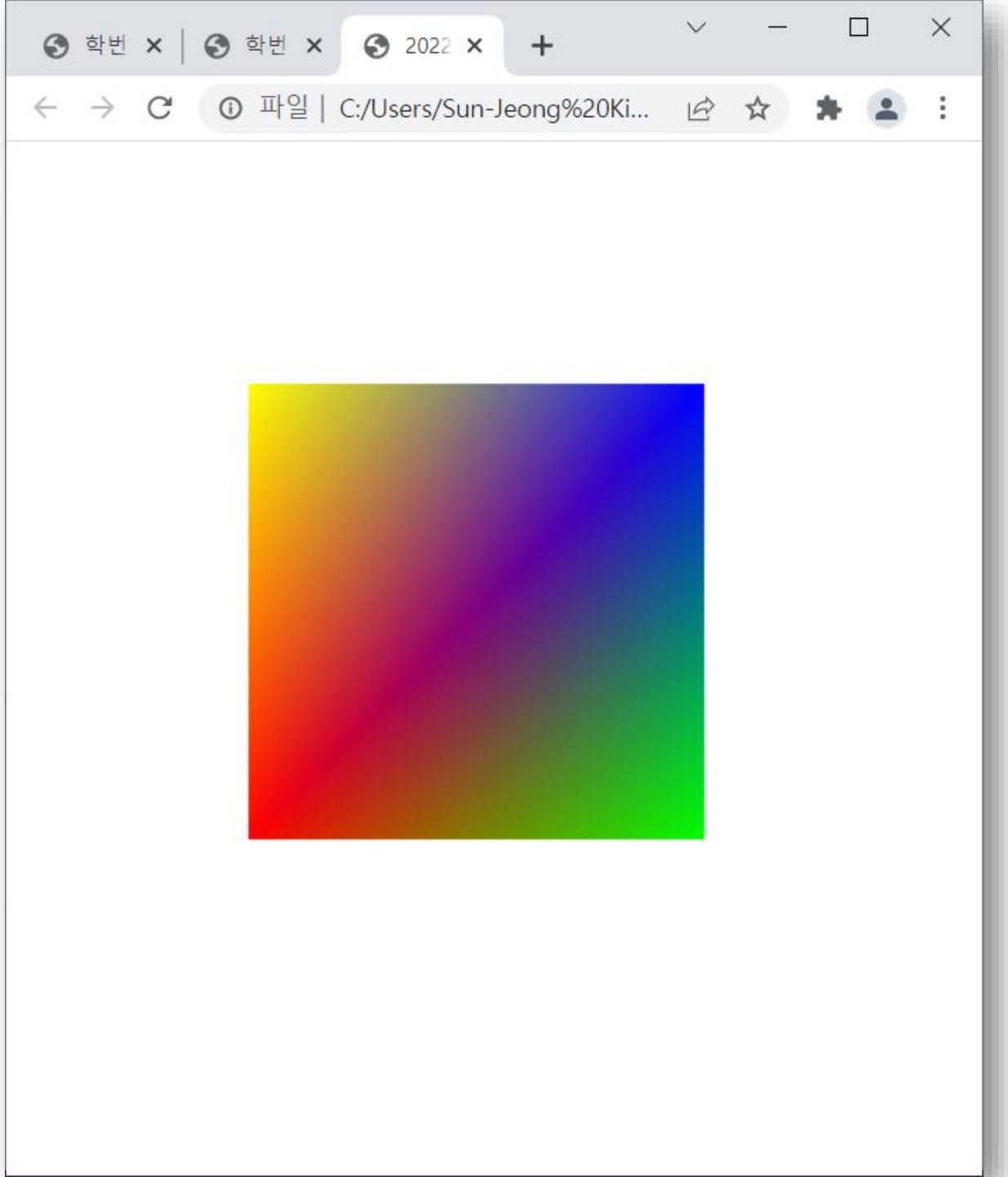
학번
2022
파일 | C:/Users/Sun-Jeong%20Ki...

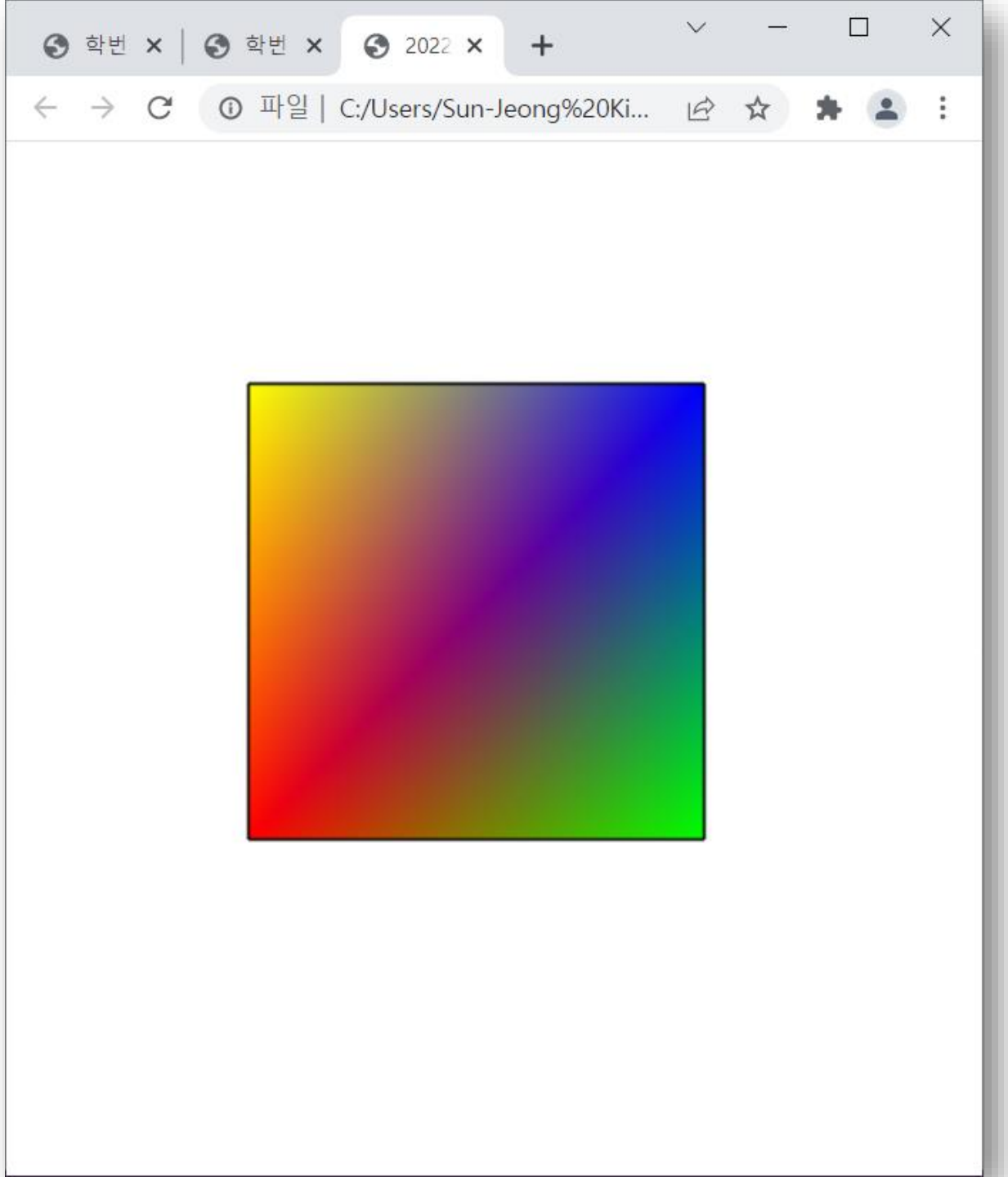
연습문제 (3)

- 오른쪽과 같은 사각형을 그리시오.



연습문제 (4)

- 오른쪽과 같은 사각형의 테두리 선을 그리시오.



File Edit Selection View Go Run Terminal Help colorPolygon.js - Visual Studio Code

gasket.html | gasket.js | gasket2d.html | gasket2d.js | colorPolygon.html | colorPolygon.js

C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > colorPolygon.js > render

```
1   var gl;
2
3   window.onload = function init()
4   {
5       var canvas = document.getElementById("gl-canvas");
6
7       gl = WebGLUtils.setupWebGL(canvas);
8       if( !gl ) {
9           alert("WebGL isn't available!");
10      }
11
12      var vertices = [
13          vec2(-0.5, -0.5),
14          vec2(0.5, -0.5),
15          vec2(0.5, 0.5),
16          vec2(-0.5, 0.5),
17
18          vec2(-0.5, -0.5),
19          vec2(0.5, -0.5),
20          vec2(0.5, 0.5),
21          vec2(-0.5, 0.5)
22      ];
23
24      var colors = [
25          vec4(1, 0, 0, 1),
26          vec4(0, 1, 0, 1),
27          vec4(0, 0, 1, 1),
28          vec4(1, 1, 0, 1),
29
30          vec4(0, 0, 0, 1),
31          vec4(0, 0, 0, 1),
32          vec4(0, 0, 0, 1),
33          vec4(0, 0, 0, 1)
34      ];
35
```

Restricted Mode ⊗ 0 ⚠ 0 Ln 71, Col 31 Spaces: 4 UTF-8 CRLF {} JavaScript

File Edit Selection View Go Run Terminal Help colorPolygon.js - Visual Studio Code

gasket.html | gasket.js | gasket2d.html | gasket2d.js | colorPolygon.html | colorPolygon.js

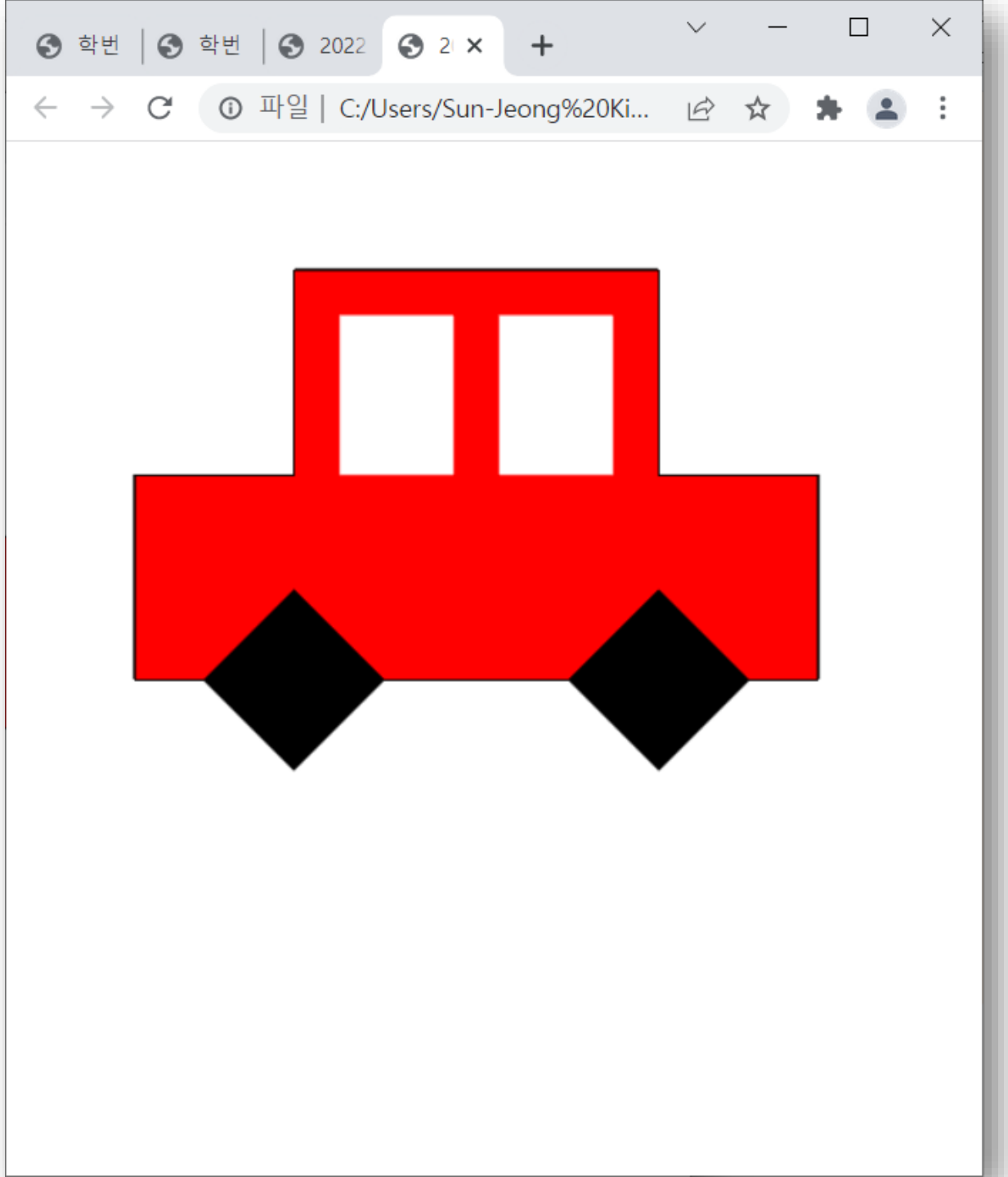
C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > colorPolygon.js > render

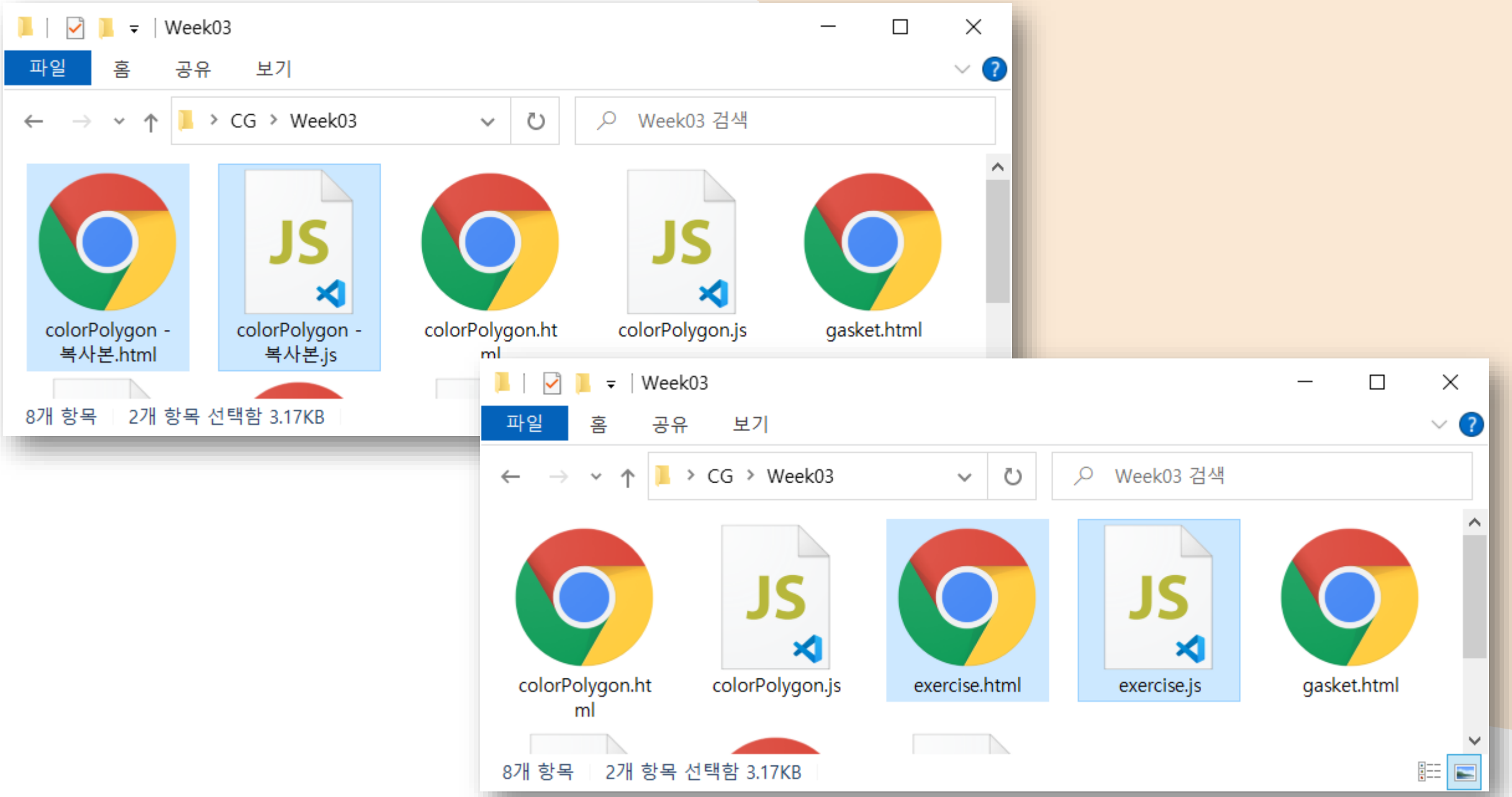
```
40      // Load shaders and initialize attribute buffers
41      var program = initShaders(gl, "vertex-shader", "fragment-shader");
42      gl.useProgram(program);
43
44      // Load the data into the GPU
45      var bufferId = gl.createBuffer();
46      gl.bindBuffer(gl.ARRAY_BUFFER, bufferId);
47      gl.bufferData(gl.ARRAY_BUFFER, flatten(vertices), gl.STATIC_DRAW);
48
49      // Associate our shader variables with our data buffer
50      var vPosition = gl.getAttribLocation(program, "vPosition");
51      gl.vertexAttribPointer(vPosition, 2, gl.FLOAT, false, 0, 0);
52      gl.enableVertexAttribArray(vPosition);
53
54      // Create a buffer object, initialize it, and associate it with
55      // the associated attribute variable in our vertex shader
56      var cbufferId = gl.createBuffer();
57      gl.bindBuffer(gl.ARRAY_BUFFER, cbufferId);
58      gl.bufferData(gl.ARRAY_BUFFER, flatten(colors), gl.STATIC_DRAW);
59
60      var vColor = gl.getAttribLocation(program, "vColor");
61      gl.vertexAttribPointer(vColor, 4, gl.FLOAT, false, 0, 0);
62      gl.enableVertexAttribArray(vColor);
63
64      render();
65  };
66
67  function render()
68  {
69      gl.clear(gl.COLOR_BUFFER_BIT);
70      gl.drawArrays(gl.TRIANGLE_FAN, 0, 4);
71      gl.drawArrays(gl.LINE_LOOP, 4, 4);
72  }
73
```

Restricted Mode ⊗ 0 ⚠ 0 Ln 71, Col 37 Spaces: 4 UTF-8 CRLF {} JavaScript

연습문제 (5)

- 자유 그리기
  - 도형 5개 이상
  - 색상 3개 이상




Week03
파일
홈
공유
보기
CG
Week03
Week03 검색
colorPolygon - 복사본.html
colorPolygon - 복사본.js
colorPolygon.html
colorPolygon.js
gasket.html
8개 항목
2개 항목 선택함 3.17KB
Week03
파일
홈
공유
보기
CG
Week03
Week03 검색
colorPolygon.html
colorPolygon.js
exercise.html
exercise.js
gasket.html
8개 항목
2개 항목 선택함 3.17KB

File Edit Selection View Go Run Terminal Help exercise.html - Visual Studio Code

gasket.html | gasket.js | gasket2d.html | gasket2d.js | colorPolygon.html | colorPolygon.js | exercise.html

C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > exercise.html > html > head > script

```
<!DOCTYPE html>
<html>
    <head>
        <title>2022 Computer Graphics</title>

        <script id="vertex-shader" type="x-shader/x-vertex">
            attribute vec4 vPosition;
            attribute vec4 vColor;
            varying vec4 fColor;

            void main() {
                //gl_PointSize = 5.0;
                gl_Position = vPosition;
                fColor = vColor;
            }
            </script>

            <script id="fragment-shader" type="x-shader/x-fragment">
            precision mediump float;
            varying vec4 fColor;

            void main() {
                gl_FragColor = fColor;
            }
            </script>

        <script type="text/javascript" src="../Common/webgl-utils.js"></script>
        <script type="text/javascript" src="../Common/initShaders.js"></script>
        <script type="text/javascript" src="../Common/MV.js"></script>
        <script type="text/javascript" src="exercise.js"></script>
    </head>
    <body>
        <canvas id="gl-canvas" width="512" height="512">
            Oops... your browser doesn't support the HTML5 canvas element!
        </canvas>
```

Restricted Mode ⊗ 0 ⚠ 0 Ln 30, Col 56 Spaces: 4 UTF-8 CRLF HTML

File Edit Selection View Go Run Terminal Help exercise.js - Visual Studio Code

.html | gasket.js | gasket2d.html | gasket2d.js | colorPolygon.html | colorPolygon.js | exercise.html | exercise.js

C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > exercise.js > render

```
1   var gl;
2
3   window.onload = function init()
4   {
5       var canvas = document.getElementById("gl-canvas");
6
7       gl = WebGLUtils.setupWebGL(canvas);
8       if( !gl ) {
9           alert("WebGL isn't available!");
10      }
11
12      var vertices = [
13          vec2(-0.4, 0.75),   vec2(-0.4, 0.3),
14          vec2(0.4, 0.3),     vec2(0.4, 0.75),
15
16          vec2(-0.75, 0.3),   vec2(-0.75, -0.15),
17          vec2(0.75, -0.15),  vec2(0.75, 0.3)
18      ];
19
20      var colors = [
21          vec4(1, 0, 0, 1),   vec4(1, 0, 0, 1),
22          vec4(1, 0, 0, 1),   vec4(1, 0, 0, 1),
23
24          vec4(1, 0, 0, 1),   vec4(1, 0, 0, 1),
25          vec4(1, 0, 0, 1),   vec4(1, 0, 0, 1)
26      ];
27
28      // Configure WebGL
29      gl.viewport(0, 0, canvas.width, canvas.height);
30      gl.clearColor(1.0, 1.0, 1.0, 1.0);
31
32      // Load shaders and initialize attribute buffers
33      var program = initShaders(gl, "vertex-shader", "fragment-shader");
34      gl.useProgram(program);
35
```

Restricted Mode ⊗ 0 ⚠ 0 Ln 63, Col 40 Spaces: 4 UTF-8 CRLF {} JavaScript

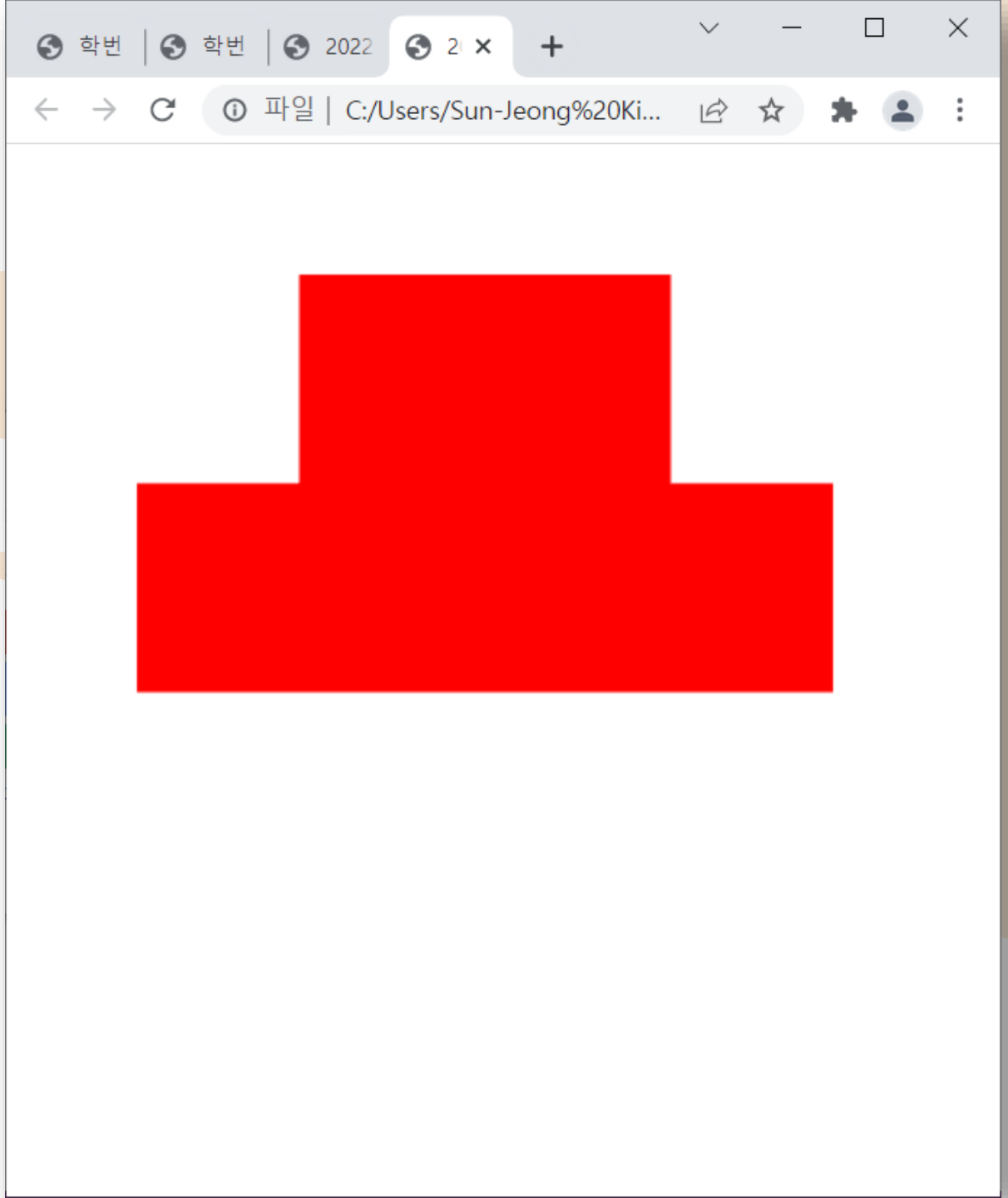
File Edit Selection View Go Run Terminal Help exercise.js - Visual Studio Code

.html | gasket.js | gasket2d.html | gasket2d.js | colorPolygon.html | colorPolygon.js | exercise.html | exercise.js

C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > exercise.js > render

```
36      // Load the data into the GPU
37      var bufferId = gl.createBuffer();
38      gl.bindBuffer(gl.ARRAY_BUFFER, bufferId);
39      gl.bufferData(gl.ARRAY_BUFFER, flatten(vertices), gl.STATIC_DRAW);
40
41      // Associate our shader variables with our data buffer
42      var vPosition = gl.getAttribLocation(program, "vPosition");
43      gl.vertexAttribPointer(vPosition, 2, gl.FLOAT, false, 0, 0);
44      gl.enableVertexAttribArray(vPosition);
45
46      // Create a buffer object, initialize it, and associate it with
47      // the associated attribute variable in our vertex shader
48      var cbufferId = gl.createBuffer();
49      gl.bindBuffer(gl.ARRAY_BUFFER, cbufferId);
50      gl.bufferData(gl.ARRAY_BUFFER, flatten(colors), gl.STATIC_DRAW);
51
52      var vColor = gl.getAttribLocation(program, "vColor");
53      gl.vertexAttribPointer(vColor, 4, gl.FLOAT, false, 0, 0);
54      gl.enableVertexAttribArray(vColor);
55
56      render();
57  };
58
59  function render()
60  {
61      gl.clear(gl.COLOR_BUFFER_BIT);
62      gl.drawArrays(gl.TRIANGLE_FAN, 0, 4);
63      gl.drawArrays(gl.TRIANGLE_FAN, 4, 4);
64  }
65
```

Restricted Mode ⊗ 0 ⚠ 0 Ln 63, Col 40 Spaces: 4 UTF-8 CRLF {} JavaScript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File Edit Selection View Go Run Terminal Help exercise.js - Visual Studio Code

.html | gasket.js | gasket2d.html | gasket2d.js | colorPolygon.html | colorPolygon.js | exercise.html | exercise.js

C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > exercise.js > render

```
1   var gl;
2
3   window.onload = function init()
4   {
5       var canvas = document.getElementById("gl-canvas");
6
7       gl = WebGLUtils.setupWebGL(canvas);
8       if( !gl ) {
9           alert("WebGL isn't available!");
10      }
11
12      var vertices = [
13          vec2(-0.4, 0.75),   vec2(-0.4, 0.3),
14          vec2(0.4, 0.3),     vec2(0.4, 0.75),
15
16          vec2(-0.75, 0.3),   vec2(-0.75, -0.15),
17          vec2(0.75, -0.15),  vec2(0.75, 0.3),
18
19          vec2(-0.4, 0.75),   vec2(-0.4, 0.3),    vec2(-0.75, 0.3),   vec2(-0.75, -0.15),
20          vec2(0.75, -0.15),  vec2(0.75, 0.3),    vec2(0.4, 0.3),     vec2(0.4, 0.75)
21      ];
22
23      var colors = [
24          vec4(1, 0, 0, 1),   vec4(1, 0, 0, 1),
25          vec4(1, 0, 0, 1),   vec4(1, 0, 0, 1),
26
27          vec4(1, 0, 0, 1),   vec4(1, 0, 0, 1),
28          vec4(1, 0, 0, 1),   vec4(1, 0, 0, 1),
29
30          vec4(0, 0, 0, 1),   vec4(0, 0, 0, 1),   vec4(0, 0, 0, 1),   vec4(0, 0, 0, 1),
31          vec4(0, 0, 0, 1),   vec4(0, 0, 0, 1),   vec4(0, 0, 0, 1),   vec4(0, 0, 0, 1)
32      ];
33
34      // Configure WebGL
35      gl.viewport(0, 0, canvas.width, canvas.height);
```

Restricted Mode ⊗ 0 ⚠ 0 Ln 70, Col 37 Spaces: 4 UTF-8 CRLF {} JavaScript

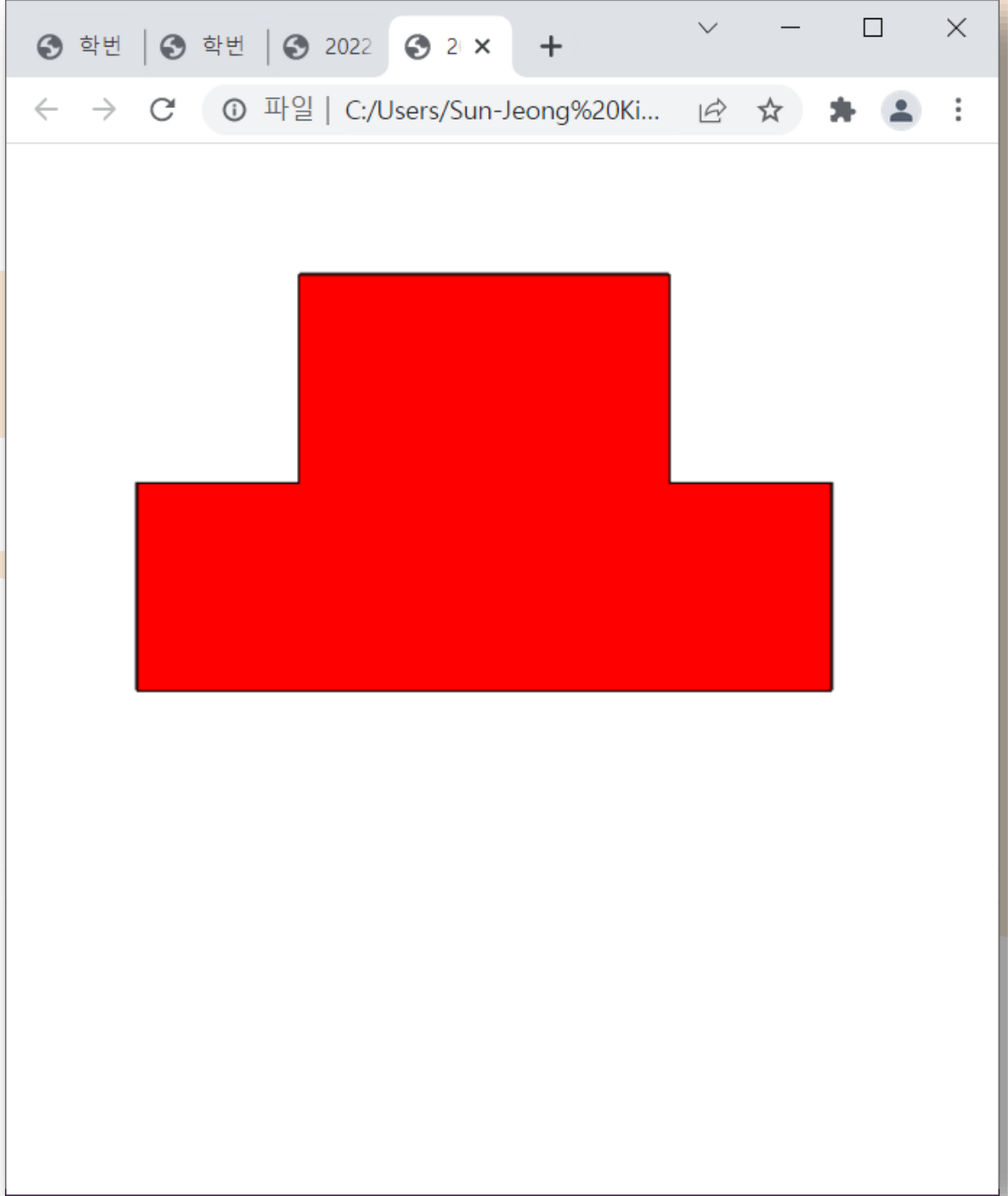
File Edit Selection View Go Run Terminal Help exercise.js - Visual Studio Code

.html | gasket.js | gasket2d.html | gasket2d.js | colorPolygon.html | colorPolygon.js | exercise.html | exercise.js

C: > Users > Sun-Jeong Kim > Desktop > CG > Week03 > exercise.js > render

```
42      // Load the data into the GPU
43      var bufferId = gl.createBuffer();
44      gl.bindBuffer(gl.ARRAY_BUFFER, bufferId);
45      gl.bufferData(gl.ARRAY_BUFFER, flatten(vertices), gl.STATIC_DRAW);
46
47      // Associate our shader variables with our data buffer
48      var vPosition = gl.getAttribLocation(program, "vPosition");
49      gl.vertexAttribPointer(vPosition, 2, gl.FLOAT, false, 0, 0);
50      gl.enableVertexAttribArray(vPosition);
51
52      // Create a buffer object, initialize it, and associate it with
53      // the associated attribute variable in our vertex shader
54      var cbufferId = gl.createBuffer();
55      gl.bindBuffer(gl.ARRAY_BUFFER, cbufferId);
56      gl.bufferData(gl.ARRAY_BUFFER, flatten(colors), gl.STATIC_DRAW);
57
58      var vColor = gl.getAttribLocation(program, "vColor");
59      gl.vertexAttribPointer(vColor, 4, gl.FLOAT, false, 0, 0);
60      gl.enableVertexAttribArray(vColor);
61
62      render();
63  };
64
65  function render()
66  {
67      gl.clear(gl.COLOR_BUFFER_BIT);
68      gl.drawArrays(gl.TRIANGLE_FAN, 0, 4);
69      gl.drawArrays(gl.TRIANGLE_FAN, 4, 4);
70      gl.drawArrays(gl.LINE_LOOP, 8, 8);
71  }
72
```

Restricted Mode ⊗ 0 ⚠ 0 Ln 70, Col 37 Spaces: 4 UTF-8 CRLF {} JavaScript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