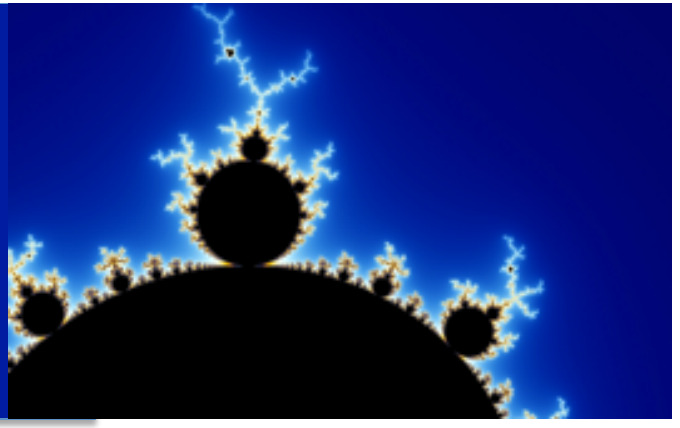
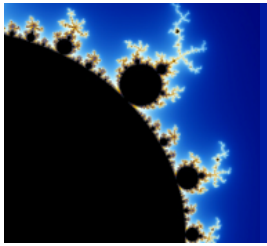
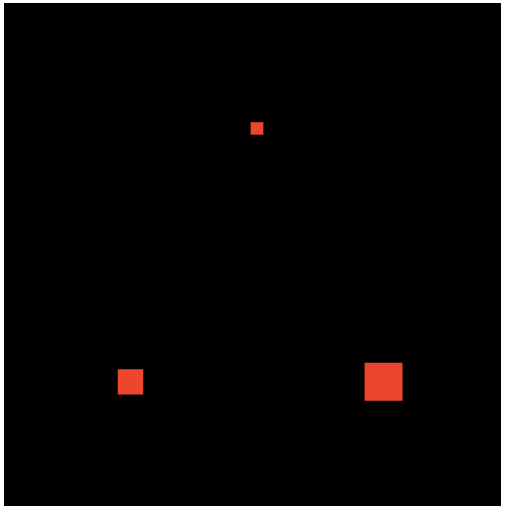
# Computer Graphics



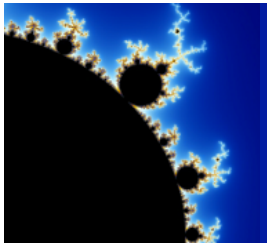
# The Complete Graphics Execution Model



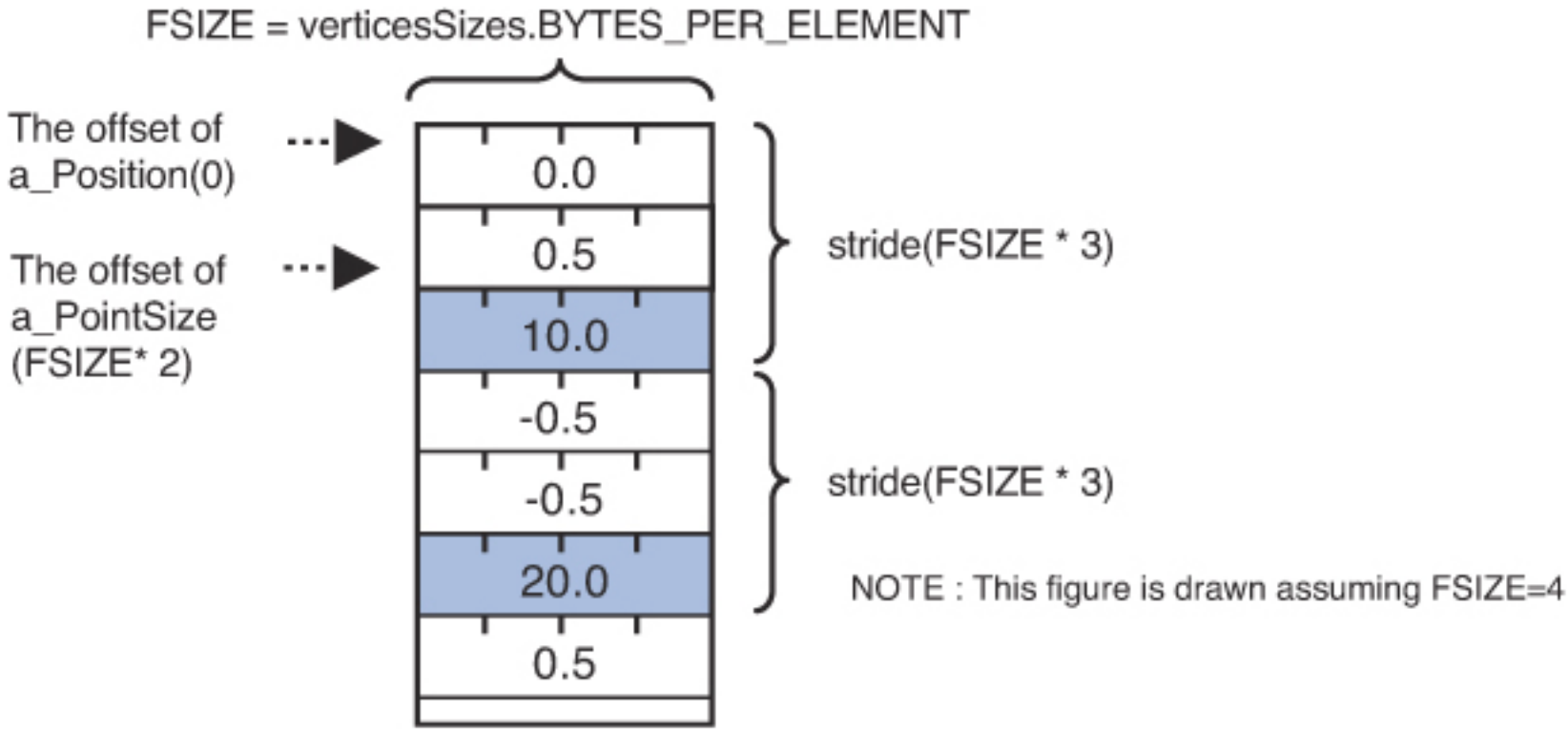
# Interleaving vertex position and size

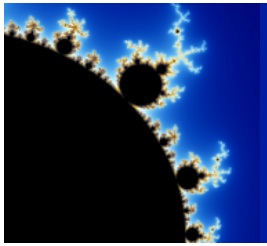


```
function initVertexBuffers(gl) {
  var verticesSizes = new Float32Array([
    // Coordinate and size of points
     0.0,  0.5,  10.0,  // the 1st point
    -0.5, -0.5,  20.0,  // the 2nd point
     0.5, -0.5,  30.0   // the 3rd point
  ]);
  var n = 3; // The number of vertices

  // Create a buffer object
  var vertexSizeBuffer = gl.createBuffer();

  // Bind the buffer object to target
  gl.bindBuffer(gl.ARRAY_BUFFER, vertexSizeBuffer);
  gl.bufferData(gl.ARRAY_BUFFER, verticesSizes, gl.STATIC_DRAW);

  var FSIZE = verticesSizes.BYTES_PER_ELEMENT;
  //Get the storage location of a_Position, assign and enable buffer
  var a_Position = gl.getAttribLocation(gl.program, 'a_Position');
  gl.vertexAttribPointer(a_Position, 2, gl.FLOAT, false, FSIZE * 3, 0);
  gl.enableVertexAttribArray(a_Position);  // Enable the assignment of the buffer object

  // Get the storage location of a_PointSize
  var a_PointSize = gl.getAttribLocation(gl.program, 'a_PointSize');
  gl.vertexAttribPointer(a_PointSize, 1, gl.FLOAT, false, FSIZE * 3, FSIZE * 2);
  gl.enableVertexAttribArray(a_PointSize);  // Enable buffer allocation

  // Unbind the buffer object
  gl.bindBuffer(gl.ARRAY_BUFFER, null);
```



# Passing vertex position and color information together



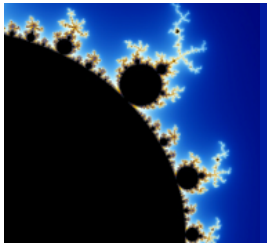


# Passing vertex position and color information together

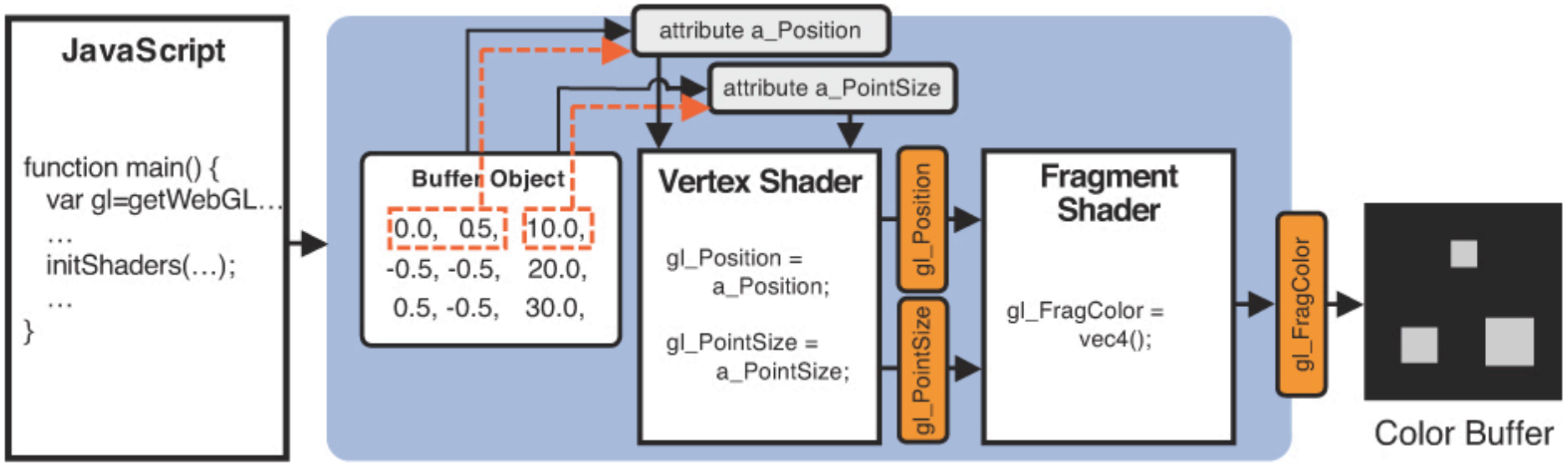
**`gl.vertexAttribPointer(location, size, type, normalized, stride, offset)`**

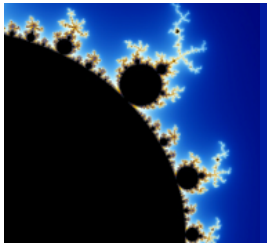
Assign the buffer object bound to `gl.ARRAY_BUFFER` to the attribute variable specified by *location*. The type and format of the data written in the buffer is also specified.

| | | |
|---|---|---|
| **Parameters** | location | Specifies the storage location of the attribute variable. |
| | size | Specifies the number of components per vertex in the buffer object (valid values are 1 to 4). |
| | type | Specifies the data format (in this case, `gl.FLOAT`) |
| | normalized | `true` or `false`. Used to indicate whether non-`float` data should be normalized to [0, 1] or [–1, 1]. |
| | stride | Specifies the stride length (in bytes) to get vertex data; that is, the number of bytes between each vertex element |
| | offset | Specifies the offset (in bytes) in a buffer object to indicate where the vertex data is stored from. If the data is stored from the beginning. then offset is 0. |

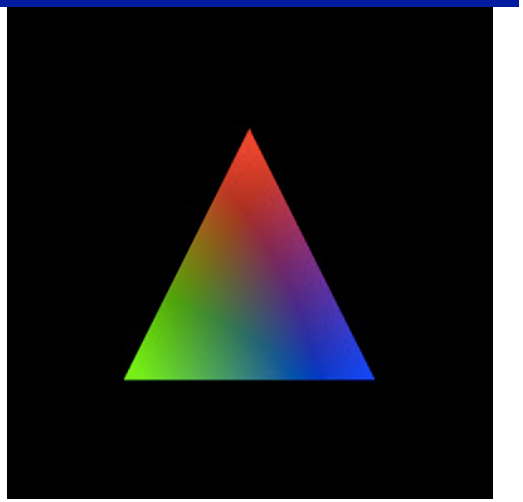


# Passing vertex position and color information together



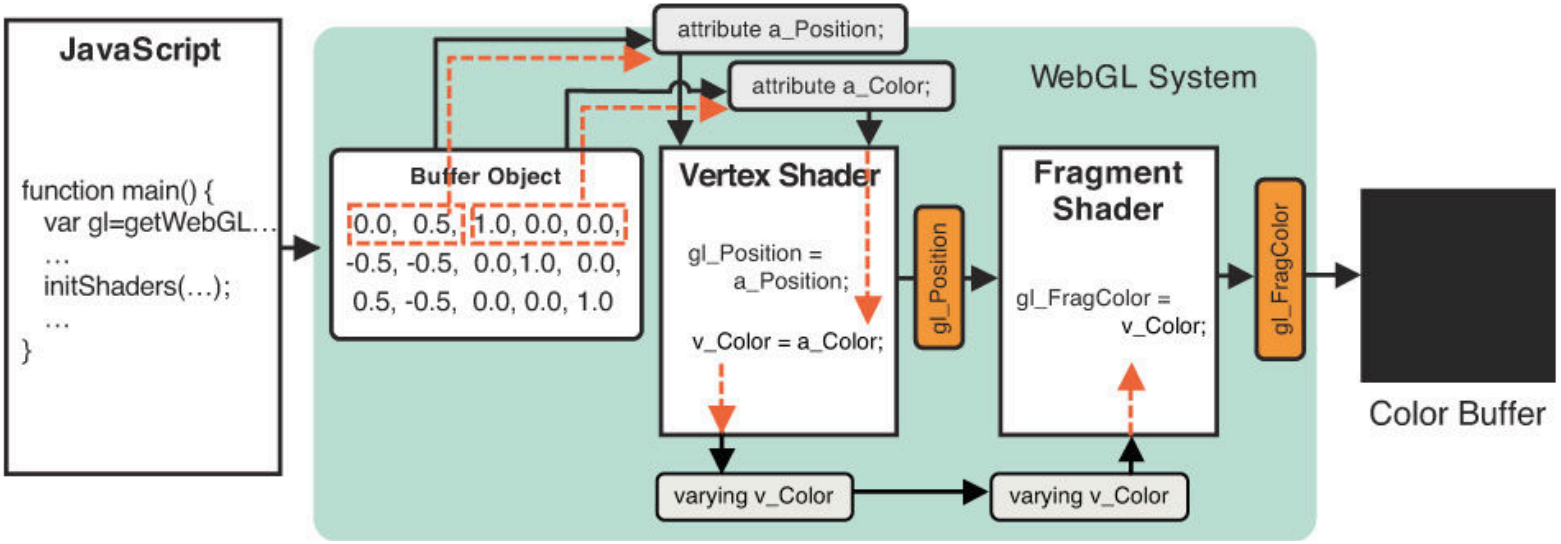


# Interleaving vertex position and color



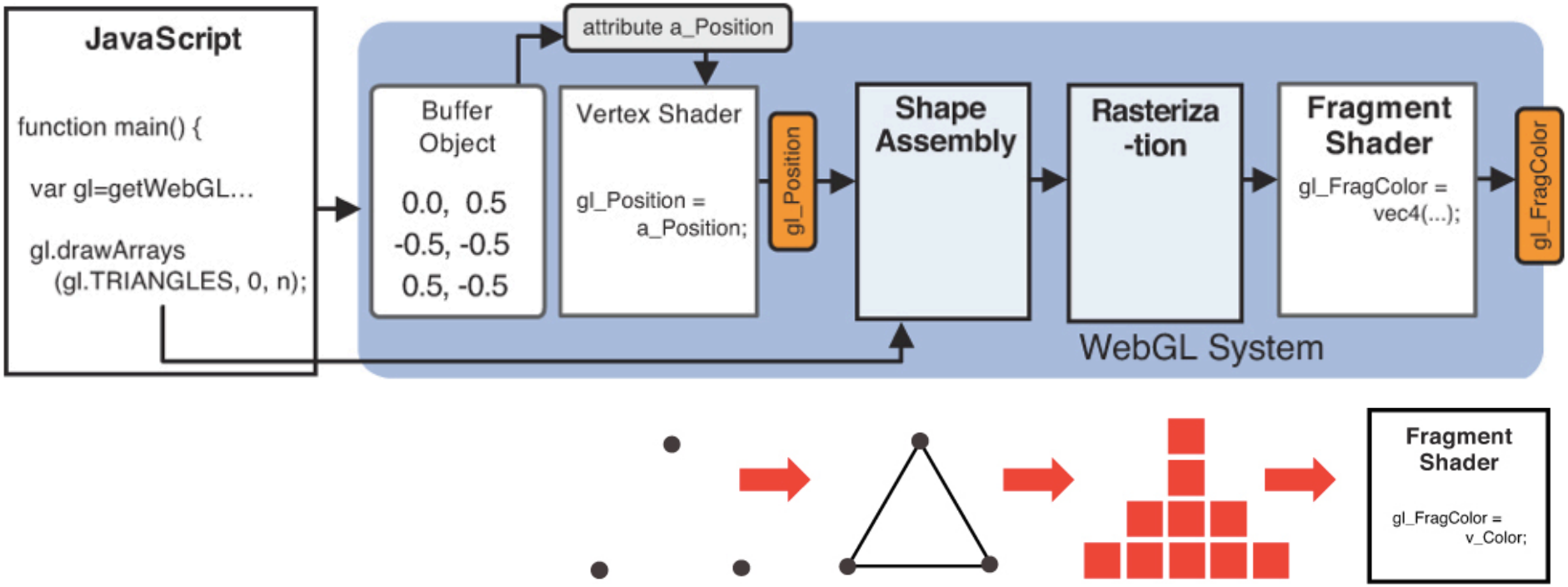
```
var verticesColors = new Float32Array([
  // Vertex coordinates and color
    0.0,  0.5,  1.0,  0.0,  0.0,
   -0.5, -0.5,  0.0,  1.0,  0.0,
    0.5, -0.5,  0.0,  0.0,  1.0,
]);
var n = 3; // The number of vertices

// Create a buffer object
var vertexColorBuffer = gl.createBuffer();

// Write the vertex coordinates and colors to the buffer object
gl.bindBuffer(gl.ARRAY_BUFFER, vertexColorBuffer);
gl.bufferData(gl.ARRAY_BUFFER, verticesColors, gl.STATIC_DRAW);

var FSIZE = verticesColors.BYTES_PER_ELEMENT;
//Get the storage location of a_Position, assign and enable buffer
var a_Position = gl.getAttribLocation(gl.program, 'a_Position');
gl.vertexAttribPointer(a_Position, 2, gl.FLOAT, false, FSIZE * 5, 0);
gl.enableVertexAttribArray(a_Position);  // Enable the assignment of the buffer object

// Get the storage location of a_Position, assign buffer and enable
var a_Color = gl.getAttribLocation(gl.program, 'a_Color');
gl.vertexAttribPointer(a_Color, 3, gl.FLOAT, false, FSIZE * 5, FSIZE * 2);
gl.enableVertexAttribArray(a_Color);  // Enable the assignment of the buffer object
```

# Behavior of varying variable




```
<script id="vertex-shader" type="x-shader/x-vertex">
attribute  vec4 a_Position;
attribute  vec4 a_Color;
varying vec4 v_Color;
void main() {
   gl_Position =  a_Position;
   v_Color = a_Color;
}
</script>
<script id="fragment-shader" type="x-shader/x-fragment">
precision mediump float;
varying vec4 v_Color;
void main() {
   gl_FragColor = v_Color;
}
</script>
```

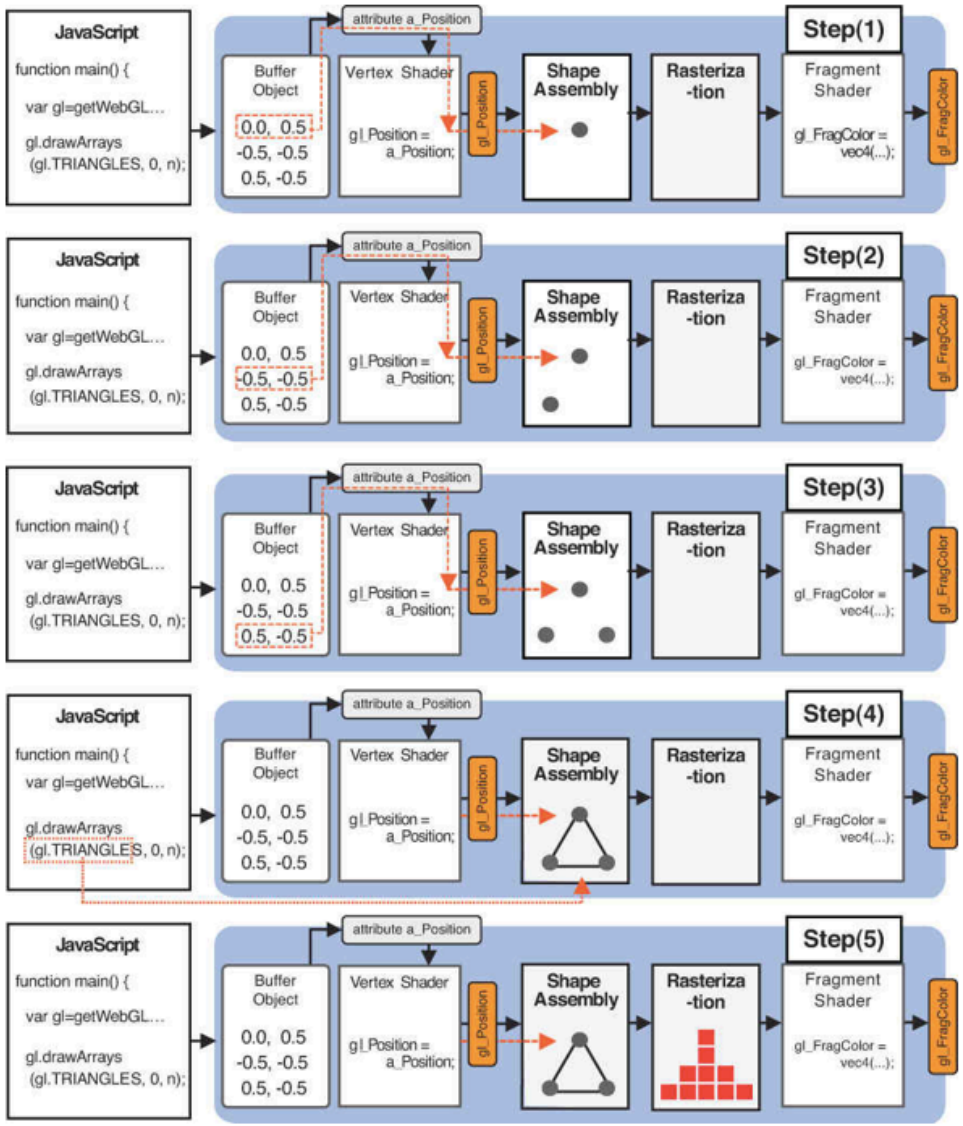
# Two more steps between the vertex and fragment shaders



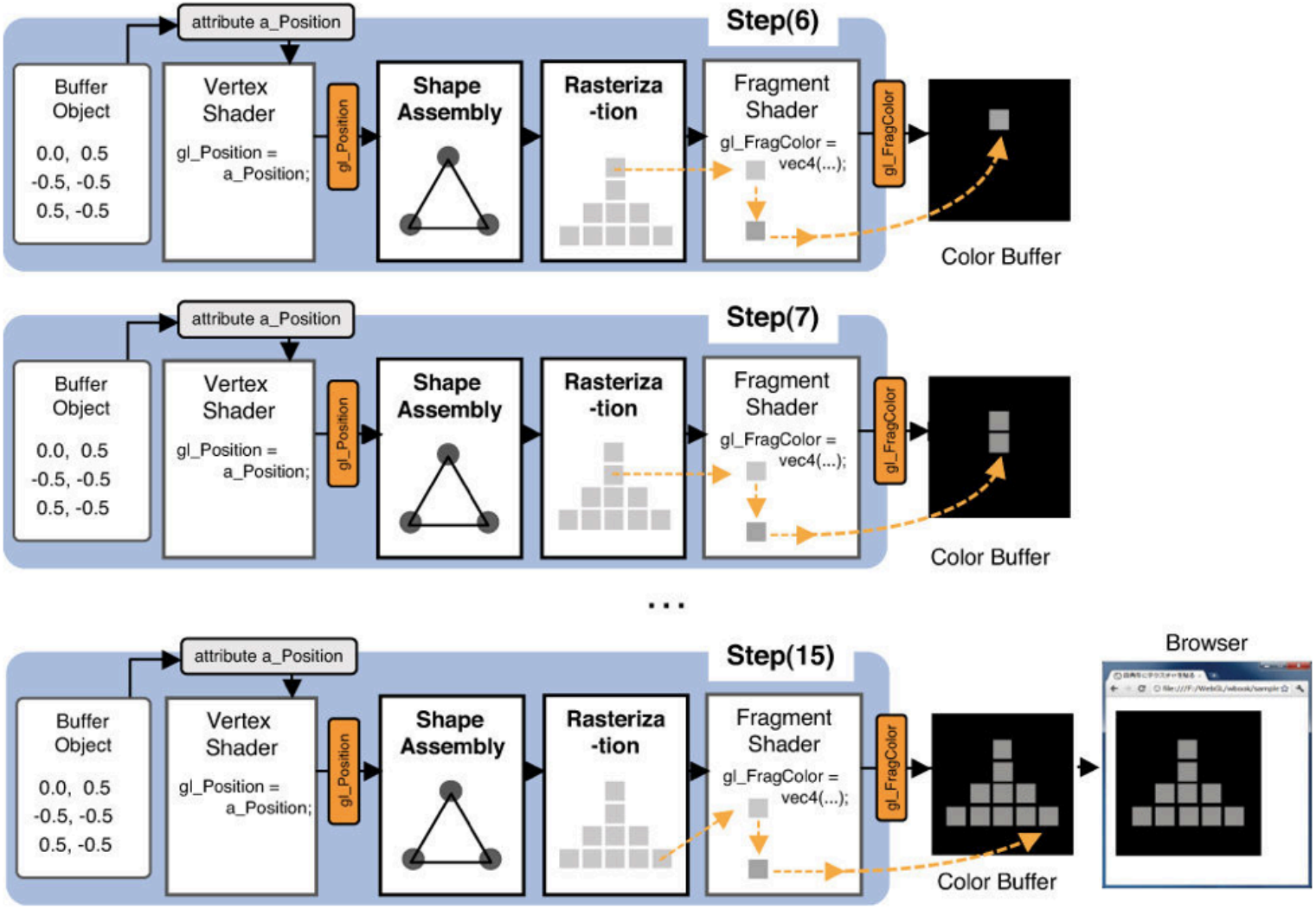

**The geometric shape assembly process**: In this stage, the geometric shape is assembled from the specified vertex coordinates. The first argument of `gl.drawArray()` specifies which type of shape should be assembled.

**The rasterization process**: In this stage, the geometric shape assembled in the geometric assembly process is converted into fragments.

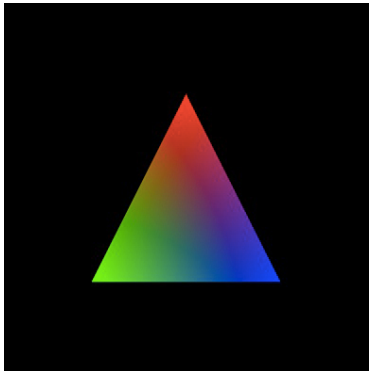
# The processing flow of geometric shape assembly and rasterization

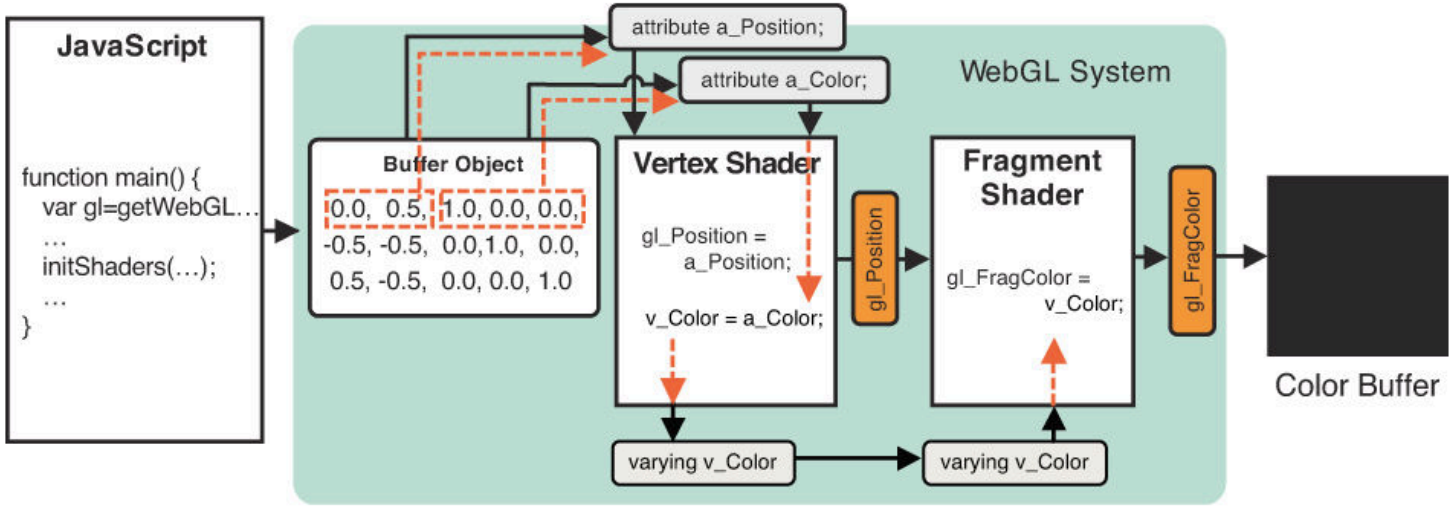


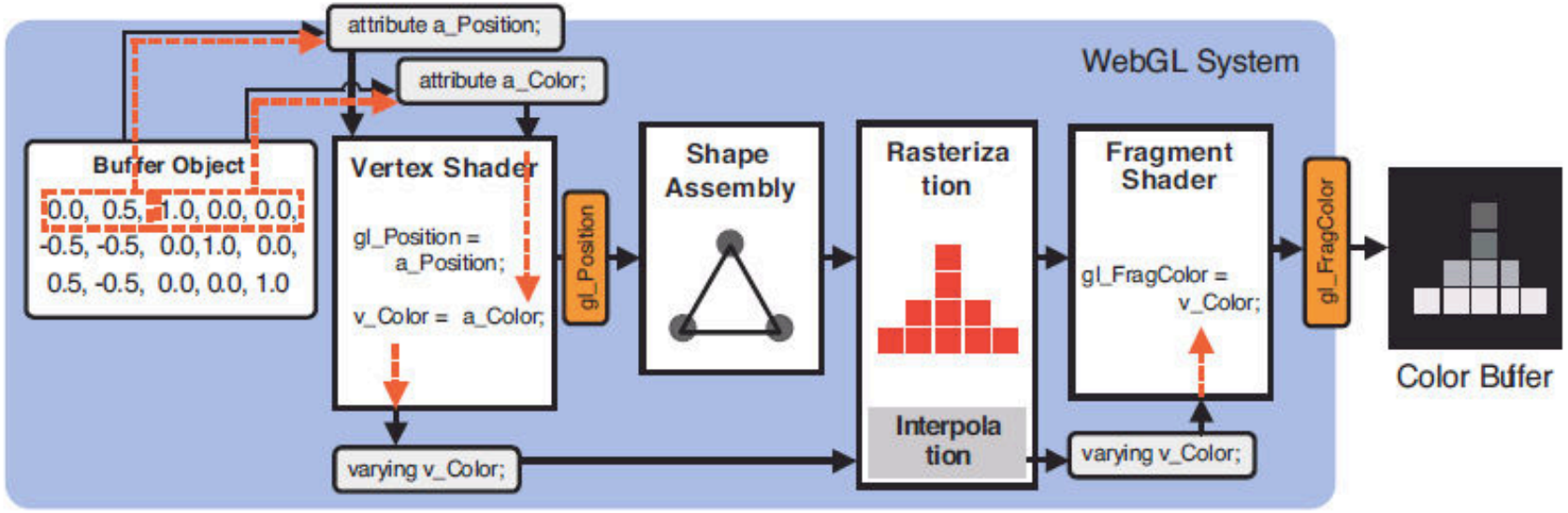
# Fragment Shader Invocations



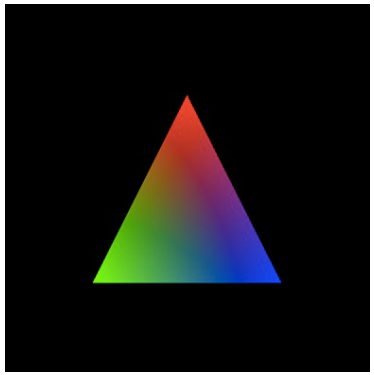
# Interpolation of a varying variable

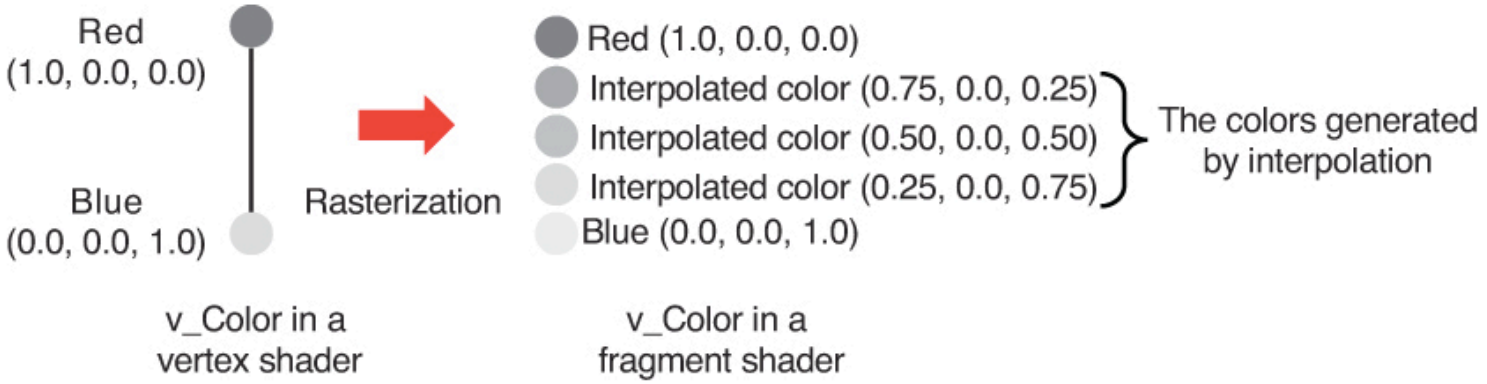


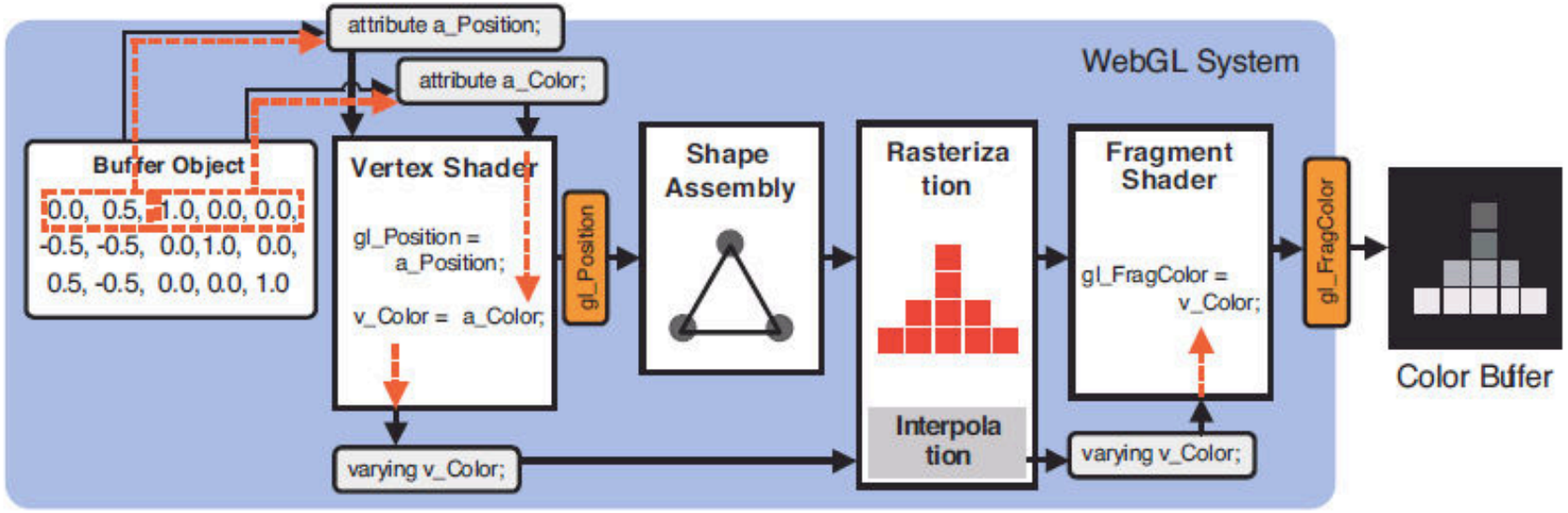


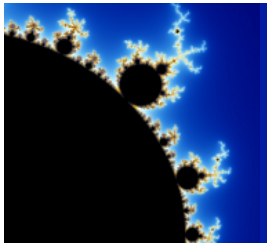



# Interpolation of a varying variable







# Graphics Execution Model