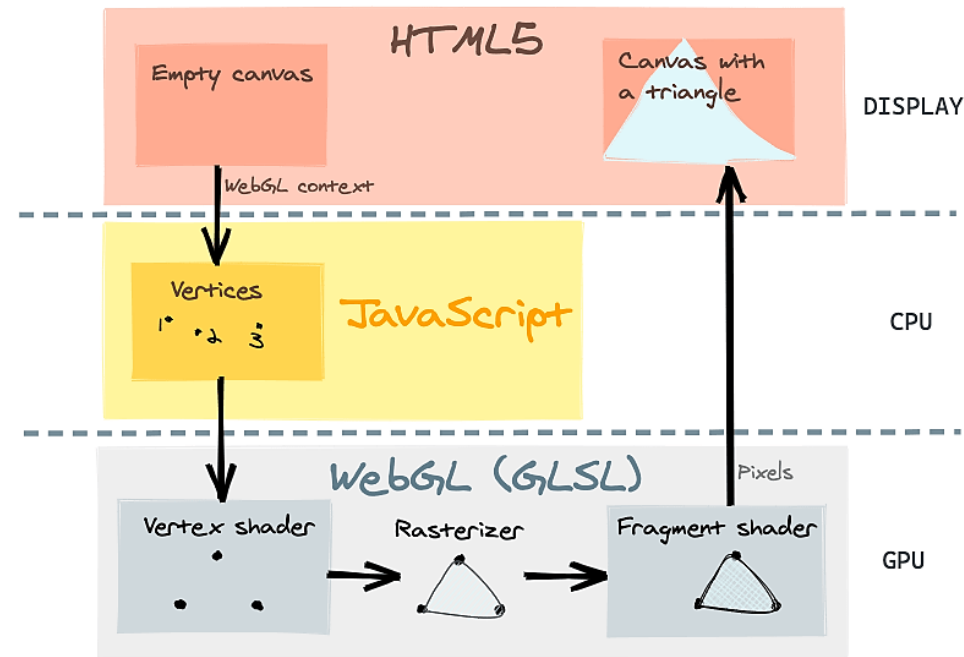


# CSE4204

## LAB-2 : GLSL – Attribute, Uniform, Varying and More

Mohammad Imrul Jubair

# Recap



Source: <https://www.h5w3.com/44328.html>

Canvas and WebGL context

Create and Compile Shaders

Associate the shader variable

Define geometry + color and store it in buffer

Draw object

```
var canvas = document.getElementById("webglcanvas");
var gl = canvas.getContext("webgl");
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var vertexShaderSource =
`attribute vec3 a_coords;
void main() {
    gl_Position = vec4(a_coords, 1.0); }`;
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var vsh = gl.createShader( gl.VERTEX_SHADER );
gl.shaderSource( vsh, vertexShaderSource );
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var prog = gl.createProgram();
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gl.attachShader( prog, vsh );
gl.attachShader( prog, fsh );
gl.linkProgram( prog );
gl.useProgram( prog );
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```
var a_coords_location = gl.getAttribLocation( prog, "a_coords" );
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var coords = new Float32Array( [0.0, 0.0, 0.0,
                                0.0, 0.5, 0.0,
                                0.5, 0.0, 0.0] );
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var a_coords_buffer = gl.createBuffer();
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gl.bindBuffer( gl.ARRAY_BUFFER, a_coords_buffer );
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gl.vertexAttribPointer( a_coords_location, 3, gl.FLOAT, false, 0, 0 );
gl.enableVertexAttribArray( a_coords_location );
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gl.clearColor( 0.75, 0.75, 0.75, 1.0 );
gl.clear( gl.COLOR_BUFFER_BIT );
gl.drawArrays( gl.TRIANGLES, 0, 3 );
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# Recap | Drawing a Triangle

Get the code:

[rb.gy/zgu5ub](https://rb.gy/zgu5ub)

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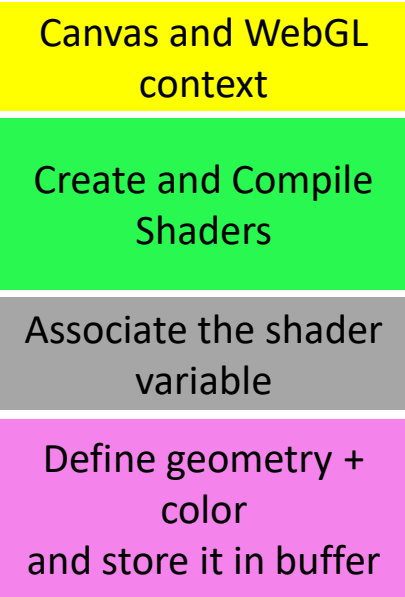
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```

# Problem – 1

- We want to send color information from CPU → GPU
  - Not specified inside the shader

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var fragmentShaderSource =  
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var fragmentShaderSource =  
  
`precision mediump float;  
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    gl_FragColor = vec4(u_color, 1.0);  
}`;
```

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var u_color_location = gl.getUniformLocation(prog, "u_color");
```



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var u_color_location = gl.getUniformLocation(prog, "u_color");
```

```
var color = new Float32Array( [0.5, 0.7, 0.3] );  
gl.uniform3fv(u_color_location, color);
```

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variable

Define geometry +  
color  
and store it in buffer

Draw object

```
void gl.uniform1f(Location, v0);  
void gl.uniform1fv(Location, value);  
void gl.uniform1i(Location, v0);  
void gl.uniform1iv(Location, value);
```

```
var fragme
```

```
precis
```

```
uniform
```

```
void m
```

```
gl_FragColor = vec4(u_color, 1.0);
```

```
};
```

```
var u_color_location = gl.getUniformLocation(prog, "u_color");
```

```
var color = new Float32Array( [0.5, 0.7, 0.3] );  
gl.uniform3fv(u_color_location, color);
```

gl.uniform\*: <https://developer.mozilla.org/en-US/docs/Web/API/WebGLRenderingContext/uniform>  
<https://developer.mozilla.org/en-US/docs/Web/API/WebGLRenderingContext/uniformMatrix>

# Problem – 1 | Uniform variable

Get the code:

[rb.gy/nbuyoz](https://rb.gy/nbuyoz)

# Uniform

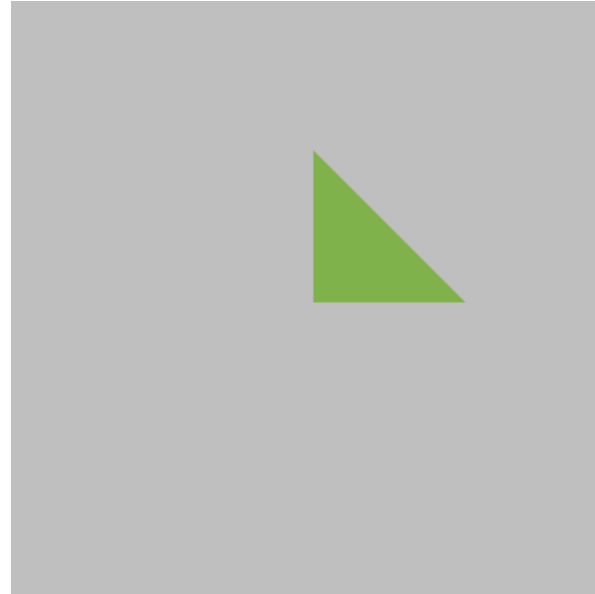
Canvas and WebGL  
context

Create and Compile  
Shaders

Associate the shader  
variable

Define geometry +  
color  
and store it in buffer

Draw object



```
var canvas = document.getElementById("webglcanvas");  
var gl = canvas.getContext("webgl");
```

```
var vertexShaderSource =  
`attribute vec3 a_coords;  
void main() {  
    gl_Position = vec4(a_coords, 1.0); }`;
```

```
var fragmentShaderSource =  
`precision mediump float;  
uniform vec3 u_color;  
void main() {  
    gl_FragColor = vec4(u_color, 1.0);  
};`;
```

```
var vsh = gl.createShader( gl.VERTEX_SHADER );  
gl.shaderSource( vsh, vertexShaderSource );  
gl.compileShader( vsh );
```

```
var fsh = gl.createShader( gl.FRAGMENT_SHADER );  
gl.shaderSource( fsh, fragmentShaderSource );  
gl.compileShader( fsh );  
var prog = gl.createProgram();  
gl.attachShader( prog, vsh );  
gl.attachShader( prog, fsh );  
gl.linkProgram( prog );  
gl.useProgram(prog);
```

```
var a_coords_location = gl.getAttribLocation(prog, "a_coords");  
var coords = new Float32Array( [0.0, 0.0, 0.0,  
                                0.0, 0.5, 0.0,  
                                0.5, 0.0, 0.0] );
```

```
var a_coords_buffer = gl.createBuffer();  
gl.bindBuffer(gl.ARRAY_BUFFER, a_coords_buffer);  
gl.bufferData(gl.ARRAY_BUFFER, coords, gl.STATIC_DRAW);  
gl.vertexAttribPointer(a_coords_location, 3, gl.FLOAT, false, 0, 0);  
gl.enableVertexAttribArray(a_coords_location);
```

```
var u_color_location = gl.getUniformLocation(prog, "u_color");  
var color = new Float32Array( [0.5, 0.7, 0.3] );  
gl.uniform3fv(u_color_location, color);
```

```
gl.clearColor(0.75, 0.75, 0.75, 1.0);  
gl.clear(gl.COLOR_BUFFER_BIT);  
gl.drawArrays(gl.TRIANGLES, 0, 3);
```

# Problem – 2

- We want to shift the triangle via mouse clicking.

# Clicking

Canvas and WebGL  
context

```
var canvas = document.getElementById("webglcanvas");  
var gl = canvas.getContext("webgl");
```

Create and Compile  
Shaders

```
var vertexShaderSource =  
`attribute vec3 a_coords;  
uniform float u_shift;  
void main() {  
    // gl_Position = vec4(a_coords, 1.0);  
    gl_Position = vec4(a_coords.x + u_shift, a_coords.y, a_coords.z, 1.0);  
};
```

Associate the shader  
variable

```
var fragmentShaderSource =  
`precision mediump float;  
uniform vec3 u_color;  
void main() {  
    gl_FragColor = vec4(u_color, 1.0);  
};
```

Define geometry +  
color  
and store it in buffer

```
var vsh = gl.createShader( gl.VERTEX_SHADER );  
gl.shaderSource( vsh, vertexShaderSource );  
gl.compileShader( vsh );
```

```
var fsh = gl.createShader( gl.FRAGMENT_SHADER );  
gl.shaderSource( fsh, fragmentShaderSource );  
gl.compileShader( fsh );
```

Draw object

```
var prog = gl.createProgram();
```

```
gl.attachShader( prog, vsh );  
gl.attachShader( prog, fsh );  
gl.linkProgram( prog );  
gl.useProgram(prog);
```

```
var canvas = document.getElementById("webglcanvas");  
var gl = canvas.getContext("webgl");
```

```
var a_coords_location = gl.getAttribLocation(prog, "a_coords");
```

```
var coords = new Float32Array( [0.0, 0.0, 0.0,  
                                0.0, 0.5, 0.0,  
                                0.5, 0.0, 0.0] );
```

```
var a_coords_buffer = gl.createBuffer();  
gl.bindBuffer(gl.ARRAY_BUFFER, a_coords_buffer);  
gl.bufferData(gl.ARRAY_BUFFER, coords, gl.STATIC_DRAW);  
gl.vertexAttribPointer(a_coords_location, 3, gl.FLOAT, false, 0, 0);  
gl.enableVertexAttribArray(a_coords_location);
```

```
var u_color_location = gl.getUniformLocation(prog, "u_color");  
var color = new Float32Array( [0.5, 0.7, 0.3] );  
gl.uniform3fv(u_color_location, color);
```

```
var u_shift_location = gl.getUniformLocation(prog, "u_shift");  
var shift = 0.0;  
gl.uniform1f(u_shift_location, shift);
```

```
gl.clearColor(0.75, 0.75, 0.75, 1.0);  
gl.clear(gl.COLOR_BUFFER_BIT);  
gl.drawArrays(gl.TRIANGLES, 0, 3);
```

```
canvas.onmousedown = function ()  
{  
    shift = shift + 0.1;  
    gl.uniform1f(u_shift_location, shift);  
    gl.clearColor(0.75, 0.75, 0.75, 1.0);  
    gl.clear(gl.COLOR_BUFFER_BIT);  
    gl.drawArrays(gl.TRIANGLES, 0, 3);  
};
```

# Clicking

Canvas and WebGL  
context

```
var canvas = document.getElementById("webglcanvas");  
var gl = canvas.getContext("webgl");
```

Create and Compile  
Shaders

```
var vertexShaderSource =  
`attribute vec3 a_coords;  
uniform float u_shift;  
void main() {  
    // gl_Position = vec4(a_coords, 1.0);  
    gl_Position = vec4(a_coords.x + u_shift, a_coords.y, a_coords.z, 1.0);  
};
```

Associate the shader  
variable

```
var fragmentShaderSource =  
`precision mediump float;  
uniform vec3 u_color;  
void main() {  
    gl_FragColor = vec4(u_color, 1.0);  
};
```

Define geometry +  
color  
and store it in buffer

```
var vsh = gl.createShader( gl.VERTEX_SHADER );  
gl.shaderSource( vsh, vertexShaderSource );  
gl.compileShader( vsh );
```

```
var fsh = gl.createShader( gl.FRAGMENT_SHADER );  
gl.shaderSource( fsh, fragmentShaderSource );  
gl.compileShader( fsh );
```

Draw object

```
var prog = gl.createProgram();
```

```
gl.attachShader( prog, vsh );  
gl.attachShader( prog, fsh );  
gl.linkProgram( prog );  
gl.useProgram(prog);
```

```
var canvas = document.getElementById("webglcanvas");  
var gl = canvas.getContext("webgl");
```

```
var a_coords_location = gl.getAttribLocation(prog, "a_coords");
```

```
var coords = new Float32Array( [0.0, 0.0, 0.0,  
                                0.0, 0.5, 0.0,  
                                0.5, 0.0, 0.0] );
```

```
var a_coords_buffer = gl.createBuffer();  
gl.bindBuffer(gl.ARRAY_BUFFER, a_coords_buffer);  
gl.bufferData(gl.ARRAY_BUFFER, coords, gl.STATIC_DRAW);  
gl.vertexAttribPointer(a_coords_location, 3, gl.FLOAT, false, 0, 0);  
gl.enableVertexAttribArray(a_coords_location);
```

```
var u_color_location = gl.getUniformLocation(prog, "u_color");  
var color = new Float32Array( [0.5, 0.7, 0.3] );  
gl.uniform3fv(u_color_location, color);
```

```
var u_shift_location = gl.getUniformLocation(prog, "u_shift");
```

```
var shift = 0.0;
```

```
gl.uniform1f(u_shift_location, shift);
```

```
gl.clearColor(0.75, 0.75, 0.75, 1.0);
```

```
gl.clear(gl.COLOR_BUFFER_BIT);
```

```
gl.drawArrays(gl.TRIANGLES, 0, 3);
```

```
canvas.onmousedown = function ()  
{  
    shift = shift + 0.1;  
    gl.uniform1f(u_shift_location, shift);  
    gl.clearColor(0.75, 0.75, 0.75, 1.0);  
    gl.clear(gl.COLOR_BUFFER_BIT);  
    gl.drawArrays(gl.TRIANGLES, 0, 3);  
};
```

# Clicking

Canvas and WebGL  
context

```
var canvas = document.getElementById("webglcanvas");  
var gl = canvas.getContext("webgl");
```

Create and Compile  
Shaders

```
var vertexShaderSource =  
`attribute vec3 a_coords;  
uniform float u_shift;  
void main() {  
    // gl_Position = vec4(a_coords, 1.0);  
    gl_Position = vec4(a_coords.x + u_shift, a_coords.y, a_coords.z, 1.0);  
};
```

Associate the shader  
variable

```
var fragmentShaderSource =  
`precision mediump float;  
uniform vec3 u_color;  
void main() {  
    gl_FragColor = vec4(u_color, 1.0);  
};
```

Define geometry +  
color  
and store it in buffer

```
var vsh = gl.createShader( gl.VERTEX_SHADER );  
gl.shaderSource( vsh, vertexShaderSource );  
gl.compileShader( vsh );
```

```
var fsh = gl.createShader( gl.FRAGMENT_SHADER );  
gl.shaderSource( fsh, fragmentShaderSource );  
gl.compileShader( fsh );
```

Draw object

```
var prog = gl.createProgram();
```

```
gl.attachShader( prog, vsh );  
gl.attachShader( prog, fsh );  
gl.linkProgram( prog );  
gl.useProgram(prog);
```

```
var canvas = document.getElementById("webglcanvas");  
var gl = canvas.getContext("webgl");
```

```
var a_coords_location = gl.getAttribLocation(prog, "a_coords");
```

```
var coords = new Float32Array( [0.0, 0.0, 0.0,  
                                0.0, 0.5, 0.0,  
                                0.5, 0.0, 0.0] );
```

```
var a_coords_buffer = gl.createBuffer();  
gl.bindBuffer(gl.ARRAY_BUFFER, a_coords_buffer);  
gl.bufferData(gl.ARRAY_BUFFER, coords, gl.STATIC_DRAW);  
gl.vertexAttribPointer(a_coords_location, 3, gl.FLOAT, false, 0, 0);  
gl.enableVertexAttribArray(a_coords_location);
```

```
var u_color_location = gl.getUniformLocation(prog, "u_color");  
var color = new Float32Array( [0.5, 0.7, 0.3] );  
gl.uniform3fv(u_color_location, color);
```

```
var u_shift_location = gl.getUniformLocation(prog, "u_shift");  
var shift = 0.0;  
gl.uniform1f(u_shift_location, shift);
```

```
gl.clearColor(0.75, 0.75, 0.75, 1.0);  
gl.clear(gl.COLOR_BUFFER_BIT);  
gl.drawArrays(gl.TRIANGLES, 0, 3);
```

```
canvas.onmousedown = function ()  
{  
    shift = shift + 0.1;  
    gl.uniform1f(u_shift_location, shift);  
    gl.clearColor(0.75, 0.75, 0.75, 1.0);  
    gl.clear(gl.COLOR_BUFFER_BIT);  
    gl.drawArrays(gl.TRIANGLES, 0, 3);  
};
```



# Problem – 2 | Mouse Interaction

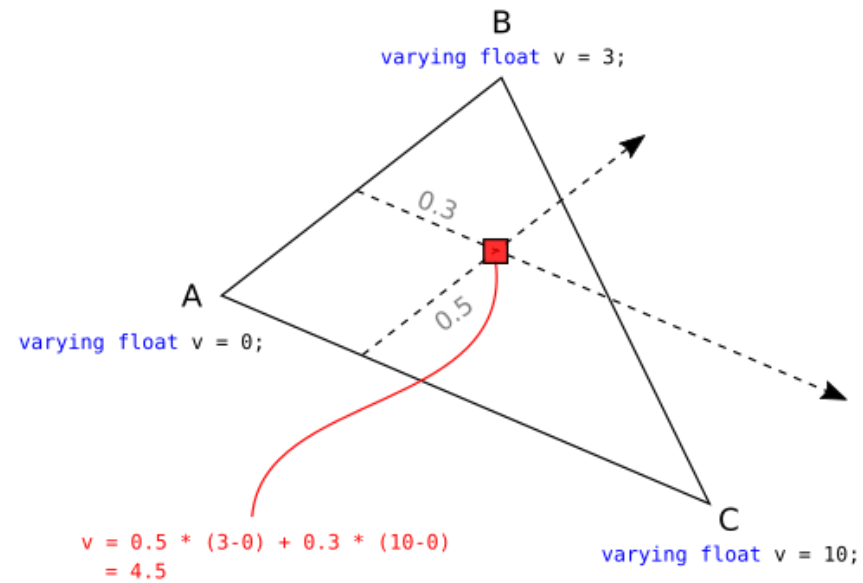
Get the code:

[rb.gy/ddbnlv](https://rb.gy/ddbnlv)

# Problem – 3

- We want different color in different vertices and the color of the face will be blended accordingly.

# Interpolation



Source: <https://stackoverflow.com/questions/17537879/in-webgl-what-are-the-differences-between-an-attribute-a-uniform-and-a-varying>

# Varying

```
var vertexShaderSource =  
    `attribute vec3 a_coords;  
    attribute vec3 a_colors;  
    uniform float u_shift;  
    varying vec3 v_color;  
  
    void main() {  
        gl_Position = vec4(a_coords.x + u_shift, a_coords.y, a_coords.z, 1.0);  
        v_color = a_colors;  
    }`;
```

```
var fragmentShaderSource =  
    `precision mediump float;  
    varying vec3 v_color;  
    void main() {  
        gl_FragColor = vec4(v_color, 1.0);  
    }`;
```

# Varying

red •  
• green  
• blue

```
var vertexShaderSource =  
`attribute vec3 a_coords;  
attribute vec3 a_colors;  
uniform float u_shift;  
varying vec3 v_color;  
  
void main() {  
    gl_Position = vec4(a_coords.x + u_shift, a_coords.y, a_coords.z, 1.0);  
    v_color = a_colors;  
}`;
```

```
var fragmentShaderSource =  
`precision mediump float;  
varying vec3 v_color;  
void main() {  
    gl_FragColor = vec4(v_color, 1.0);  
}`;
```

# Varying

• green  
• blue  
red •

```
var vertexShaderSource =  
`attribute vec3 a_coords;  
attribute vec3 a_colors;  
uniform float u_shift;  
varying vec3 v_color;  
  
void main() {  
    gl_Position = vec4(a_coords.x + u_shift, a_coords.y, a_coords.z, 1.0);  
    v_color = a_colors;  
}`;
```

```
var fragmentShaderSource =  
`precision mediump float;  
varying vec3 v_color;  
void main() {  
    gl_FragColor = vec4(v_color, 1.0);  
}`;
```

# Varying

.green  
red.  
.blue

```
var vertexShaderSource =  
`attribute vec3 a_coords;  
attribute vec3 a_colors;  
uniform float u_shift;  
varying vec3 v_color;  
  
void main() {  
    gl_Position = vec4(a_coords.x + u_shift, a_coords.y, a_coords.z, 1.0);  
    v_color = a_colors;  
}`;
```

```
var fragmentShaderSource =  
`precision mediump float;  
varying vec3 v_color;  
void main() {  
    gl_FragColor = vec4(v_color, 1.0);  
}`;
```

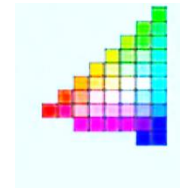
Interpolation

# Varying

• green  
• red  
• blue

```
var vertexShaderSource =  
`attribute vec3 a_coords;  
attribute vec3 a_colors;  
uniform float u_shift;  
varying vec3 v_color;  
  
void main() {  
    gl_Position = vec4(a_coords.x + u_shift, a_coords.y, a_coords.z, 1.0);  
    v_color = a_colors;  
}`;
```

```
var fragmentShaderSource =  
`precision mediump float;  
varying vec3 v_color;  
void main() {  
    gl_FragColor = vec4(v_color, 1.0);  
}`;
```





# Varying

```
a_colors_location = gl.getAttribLocation(prog, "a_colors");  
var colors = new Float32Array( [1.0, 0.0, 0.0,  
                                0.0, 1.0, 0.0,  
                                0.0, 0.0, 1.0] );  
  
a_colors_buffer = gl.createBuffer();  
gl.bindBuffer(gl.ARRAY_BUFFER, a_colors_buffer);  
gl.bufferData(gl.ARRAY_BUFFER, colors, gl.STATIC_DRAW);  
gl.vertexAttribPointer(a_colors_location, 3, gl.FLOAT, false, 0, 0);  
gl.enableVertexAttribArray(a_colors_location);
```

Canvas and WebGL  
context

Create and Compile  
Shaders

Associate the shader  
variable

Define geometry +  
color  
and store it in buffer

Draw object

# Problem – 3 | Varying Variable

Get the code:

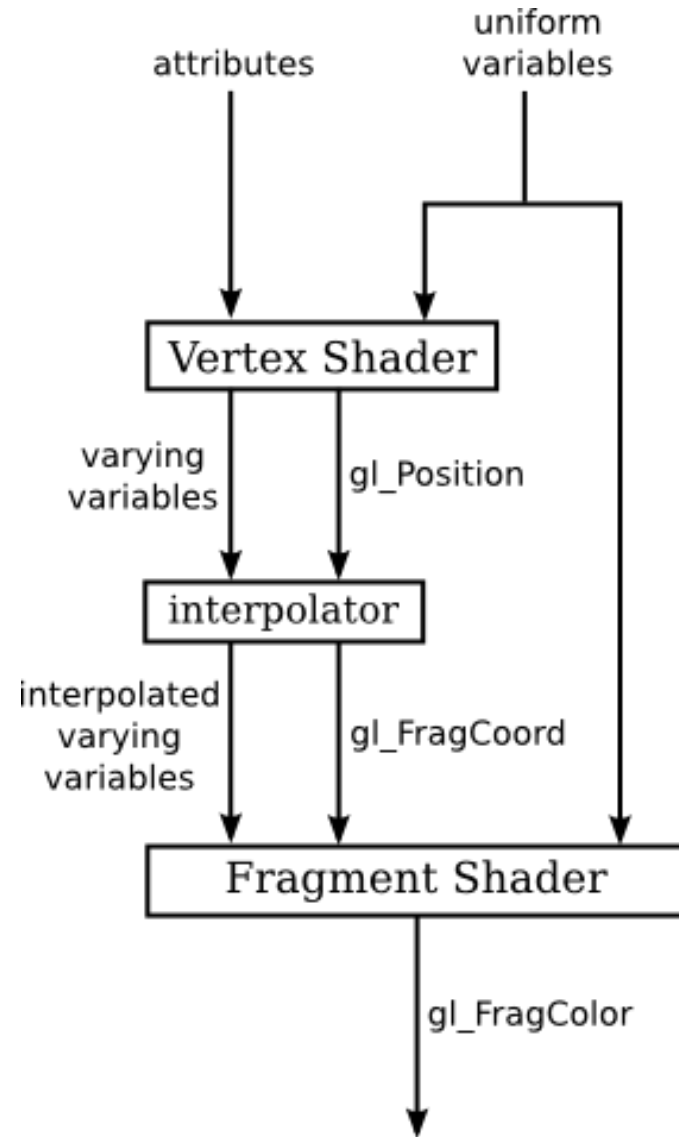
[rb.gy/p7u46l](https://rb.gy/p7u46l)

# Uniform vs Attribute vs Varying

- uniform are per-primitive parameters
  - constant during an entire draw call
- attribute are per-vertex parameters
  - typically : positions, normals, colors, UVs, ...
- varying are per-fragment (or per-pixel) parameters
  - they vary from pixels to pixels

Source: <https://stackoverflow.com/questions/17537879/in-webgl-what-are-the-differences-between-an-attribute-a-uniform-and-a-varying>

# Flow of data



Source: <http://math.hws.edu/graphicsbook/c6/s1.html>

# Notes

- Attribute can only be used in vertex shader. *[why?]*
- Uniform can be used in both vertex and fragment shaders. *[why?]*
- Varying must be used in both vertex and fragment shaders with the same name.
- Uniform, attributes and varying must be declared globally in the shaders.
- It is a convention to use –
  - **a\_** before the name of the attribute variable
  - **u\_** before the name of the uniform variable
  - **v\_** before the name of the varying variable

# Control Statements in GLSL

Question: What will happen here?

```
var vertexShaderSource =
`attribute vec3 a_coords;
attribute vec3 a_colors;
uniform float u_shift;
varying vec3 v_color;

void main() {
    if (u_shift < 0.7)
        gl_Position = vec4(a_coords.x - u_shift,
                           a_coords.y,
                           a_coords.z,
                           1.0);
    else
        gl_Position = vec4(a_coords.x,
                           a_coords.y,
                           a_coords.z,
                           1.0);
    v_color = a_colors;
}`;
```

More on GLSL statements: <https://www.shaderific.com/gsl-statements>

# GLSL If Else

Get the code:

[rb.gy/qdtslu](https://rb.gy/qdtslu)

# Built-in Functions in GLSL

```
void main() {  
    gl_Position = vec4(clamp(a_coords.x - u_shift, -0.5, 1.0),  
                        a_coords.y,  
                        a_coords.z,  
                        1.0);  
}
```

Question: What will happen here?

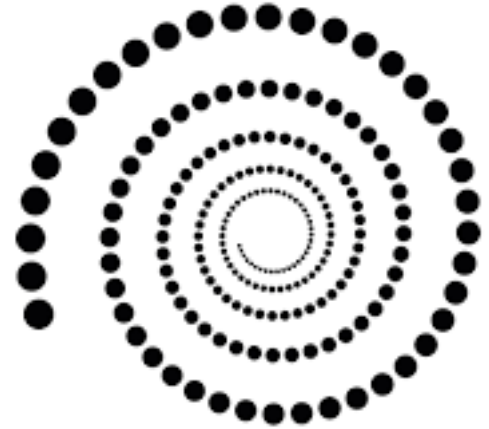
More GLSL built-in functions: <https://www.shaderific.com/glsl-functions>



# Assignment - 1

## Part A

- For each click, a 2D spiral will keep increasing.
  - The every dot will be a pixel.
  - The outer dots will be bigger than the inner ones depending on the distance from the center.



# Assignment - 1

## Part B

- Create a 2D scenario [use your imagination]
  - Minimum 20 triangles
- Apply color [using varying]
- Have a keyboard interaction
  - With control statements and/or built-in function

# Assignment – 1

- Viva