WebGl

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- **Hello world** - WebGL
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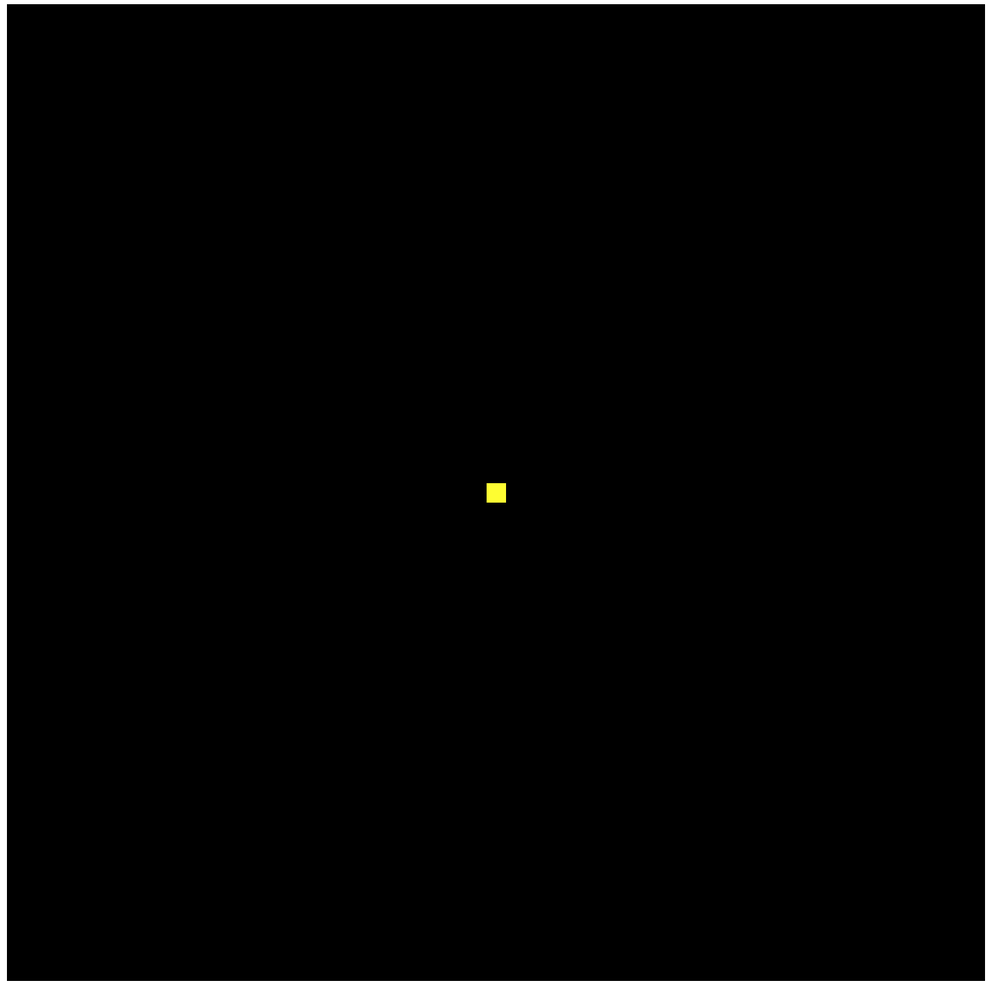
Hello World



index.ts

```
import { createProgramFromSource } from "../../utils";
import vertSource from "./index.vert";
import fragSource from "./index.frag";

function start() {
  const canvas = document.querySelector("canvas");
  canvas.width = 500;
  canvas.height = 500;

  //   webgl
  const gl = canvas.getContext("webgl2");

  //  canvas
  gl.clearColor(0.0, 0.0, 0.0, 1.0);
  //   canvas
  gl.clear(gl.COLOR_BUFFER_BIT);

  //         webgl program
  const program = createProgramFromSource(gl, vertSource, fragSource);
  gl.useProgram(program);

  //
  gl.drawArrays(gl.POINTS, 0, 1);
}
```

createShader

```
export function createShader(
  gl: WebGL2RenderingContext,
  type: number,
  source: string
) {
  const shader = gl.createShader(type);
  gl.shaderSource(shader, source);
  gl.compileShader(shader);

  const isOk = gl.getShaderParameter(shader, gl.COMPILE_STATU

  if (isOk) return shader;

  console.log(
    `create ${type === gl.VERTEX_SHADER ? "vert" : "frag"} Sh
    gl.getShaderInfoLog(shader)
  );
  gl.deleteShader(shader);
}
```

createProgram

```
export function createProgram(
  gl: WebGL2RenderingContext,
  vertexShader: WebGLShader,
  fragmentShader: WebGLShader
) {
  const program = gl.createProgram();
  gl.attachShader(program, vertexShader);
  gl.attachShader(program, fragmentShader);

  gl.linkProgram(program);

  const isOk = gl.getProgramParameter(program, gl.LINK_STATUS

  if (isOk) return program;

  console.log("createProgram failed:", gl.getProgramInfoLog(p
  gl.deleteProgram(program);
  gl.deleteShader(vertexShader);
  gl.deleteShader(fragmentShader);
}
```

createProgramFromSource

```
export function createProgramFromSource(
  gl: WebGL2RenderingContext,
  vertSource: string,
  fragSource: string
) {
  const vertShader = createShader(gl, gl.VERTEX_SHADER, vertSource);
  const fragShader = createShader(gl, gl.FRAGMENT_SHADER, fragSource);

  return createProgram(gl, vertShader, fragShader);
}
```

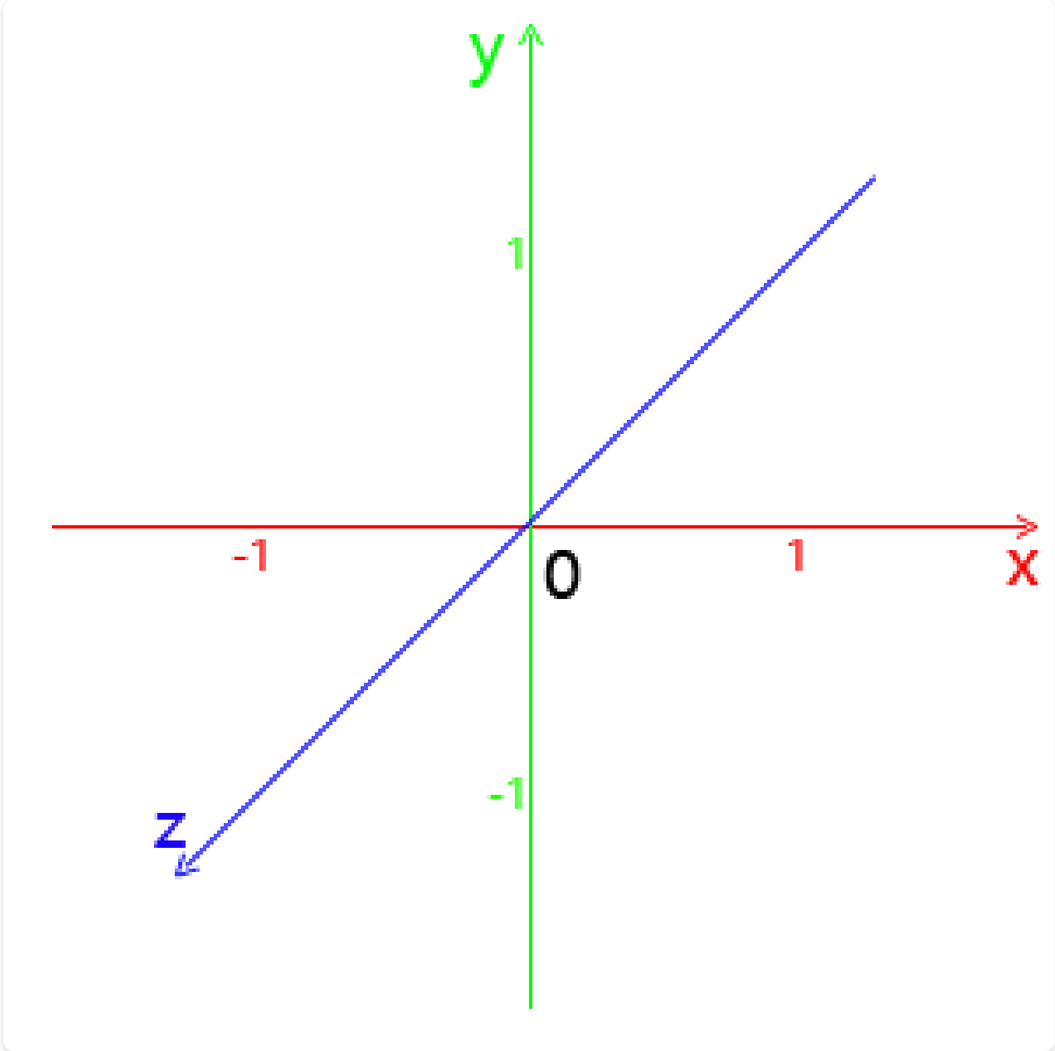
index.vert

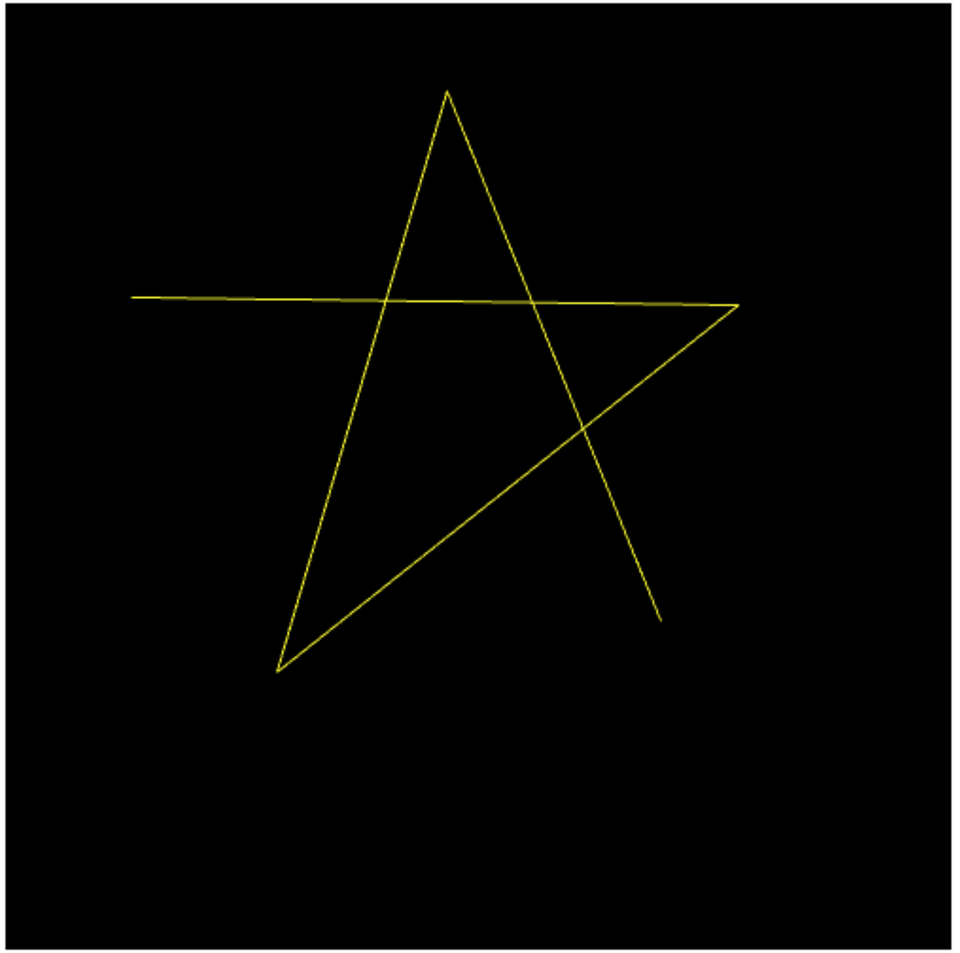
```
#version 300 es

void main() {

  gl_Position = vec4(0, 0, 0, 1);
  gl_PointSize = 10.0;
}
```

index.frag

```
#version 300 es

precision highp float;

out vec4 outColor;

void main() {

  outColor = vec4(1, 1, 0, 1);
}
```

WebGL





```
#version 300 es

in vec4 a_Position;

void main() {
  gl_Position = a_Position;
  gl_PointSize = 10.0;
}
```

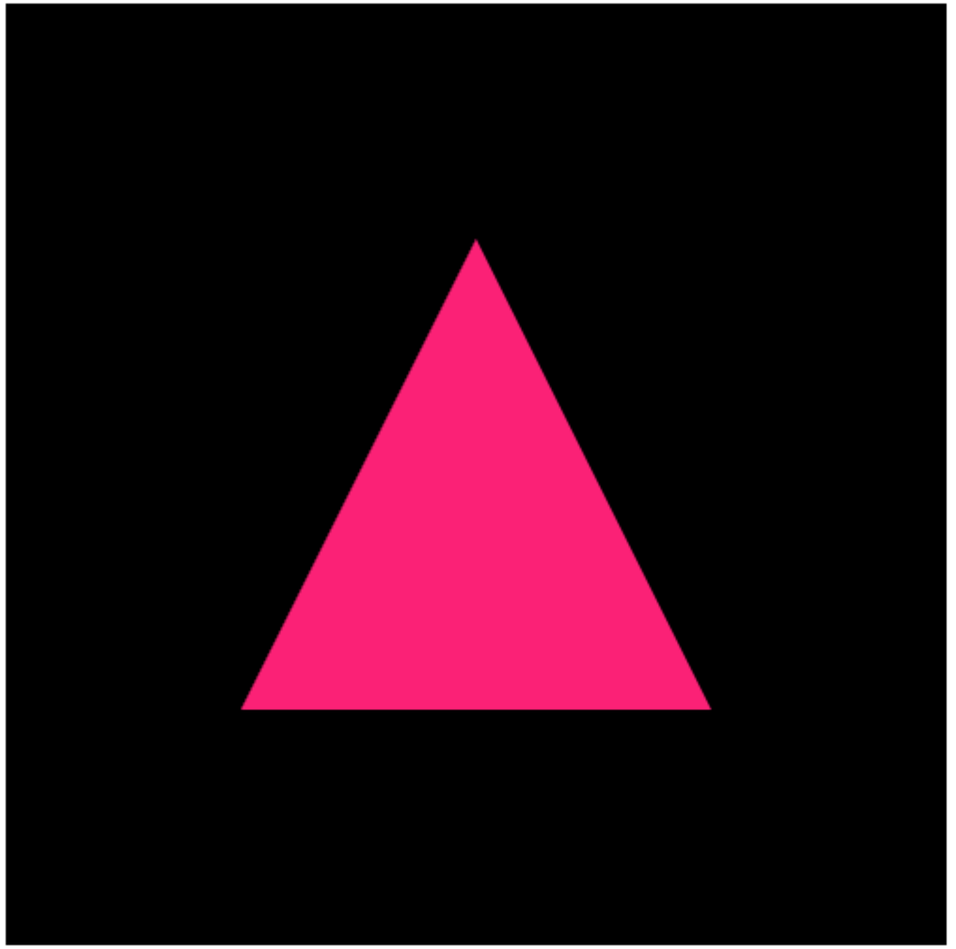
start

```
function start() {
  const canvas = document.querySelector("canvas");
  const gl = canvas.getContext("webgl2");

  const program = createProgramFromSource(gl, vertSource, fra
  gl.useProgram(program);

  const buffer = gl.createBuffer();
  gl.bindBuffer(gl.ARRAY_BUFFER, buffer);

  const a_Position = gl.getAttribLocation(program, "a_Positio

  gl.vertexAttribPointer(a_Position, 2, gl.FLOAT, false, 0, 0
  gl.enableVertexAttribArray(a_Position);

  gl.clearColor(0.0, 0.0, 0.0, 1.0);
  gl.clear(gl.COLOR_BUFFER_BIT);

  const points = [];

  canvas.addEventListener("click", (e) => {
    handleClick(e, points, gl);
  });
}
```

handleClick

```
function handleClick(
  e: MouseEvent,
  points: number[],
  gl: WebGL2RenderingContext
) {
  const { clientX, clientY } = e;
  const canvas = e.target as HTMLCanvasElement;
  const { left, top } = canvas.getBoundingClientRect();

  const x = ((clientX - left) / canvas.width) * 2 - 1;
  const y = (((clientY - top) / canvas.height) * 2 - 1) * -1;
  points.push(x);
  points.push(y);
  const pointsLen = Math.floor(points.length / 2);

  const data = new Float32Array(points);
  gl.bufferData(gl.ARRAY_BUFFER, data, gl.STATIC_DRAW);
  gl.clear(gl.COLOR_BUFFER_BIT);

  if (pointsLen < 2) {
    gl.drawArrays(gl.POINTS, 0, pointsLen);
  } else {
    gl.drawArrays(gl.LINE_STRIP, 0, pointsLen);
  }
}
```

1. : `gl.createBuffer`
2. `gl.bindBuffer`
3. `gl.bufferData`
4. attribute `gl.vertexAttribPointer`
5. attribute `gl.enableVertexAttribArray`

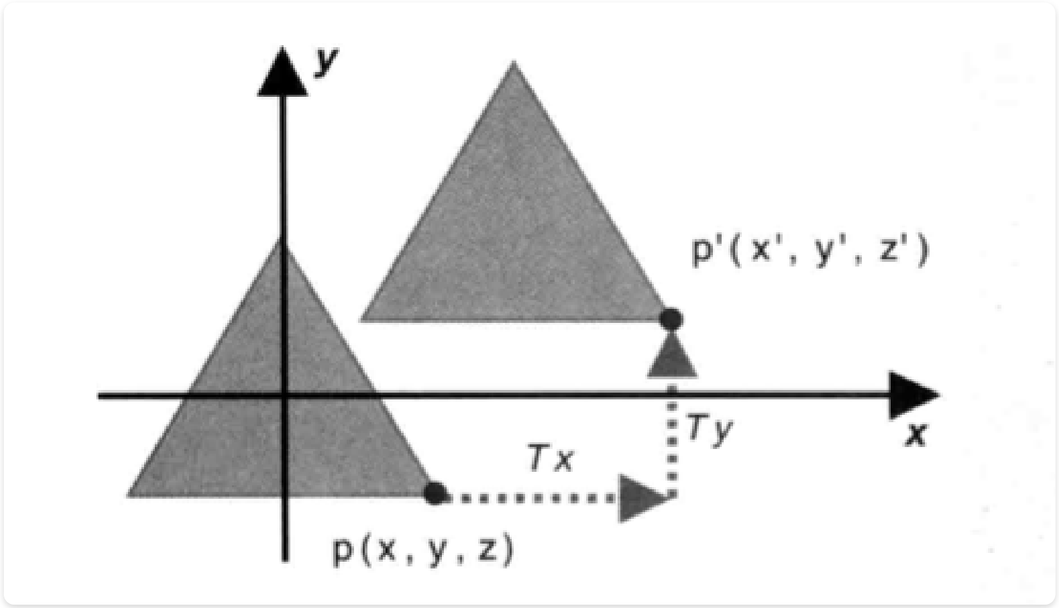


class Triangle

```
class Triangle {
  readonly defaultPositionData = [
    { x: -0.5, y: -0.5 },
    { x: 0.5, y: -0.5 },
    { x: 0, y: 0.5 },
  ];

  xTranslateCount = 0;
  yTranslateCount = 0;
  rotate = 0;
  gl: WebGL2RenderingContext;

  constructor(shaderSource: { vertSource: string; fragSource:

  init() {}

  handleTranslateX() {}

  handleTranslateY() {}

  handleRotate() {}

  draw() {}
}
```

method draw

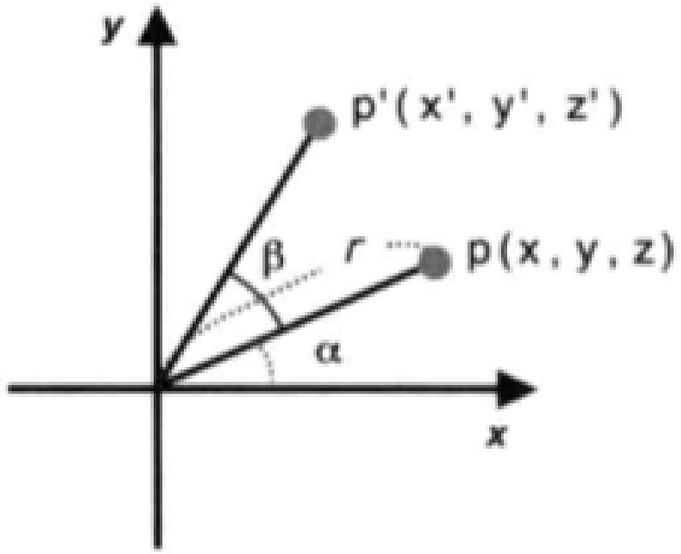
```
draw() {
    const finalData = this.defaultPositionData
      .map(({ x, y }) => ({
        x: x * Math.cos(this.rotate) - y * Math.sin(this.rota
        y: x * Math.sin(this.rotate) + y * Math.cos(this.rota
      }))
      .map(({ x, y }) => ({
        x: x + this.xTranslateCount,
        y: y + this.yTranslateCount,
      }))
      .reduce((all, { x, y }) => [...all, x, y], []);

    const gl = this.gl;

    gl.bufferData(gl.ARRAY_BUFFER, new Float32Array(finalData

    gl.clear(gl.COLOR_BUFFER_BIT);
    gl.drawArrays(gl.TRIANGLES, 0, 3);



  }
```



- $x' = x + Tx$
- $y' = y + Ty$
- $z' = z + Tz$

```
handleTranslateX() {
    const xInput = document.querySelector<HTMLInputElement>("
    xInput.addEventListener("input", (e: Event) => {
      const el = e.target as HTMLInputElement;
      const value = +el.value;

      this.xTranslateCount = value;

      this.draw();
    });
  }
```

```
map(({ x, y }) => ({
        x: x + this.xTranslateCount,
        y: y + this.yTranslateCount,
      }))
```



- $x = r\ cos\,\alpha$
- $y = r\ sin\,\alpha$

- $x' = r\ cos\,(\alpha + \beta)$
- $y' = r\ sin\,(\alpha + \beta)$

- $sin(a \pm b) = sin\,a\ cos\,b \pm cos\,a\ sin\,b$
- $cos(a \pm b) = cos\,a\ cos\,b \pm sin\,a\ sin\,b$

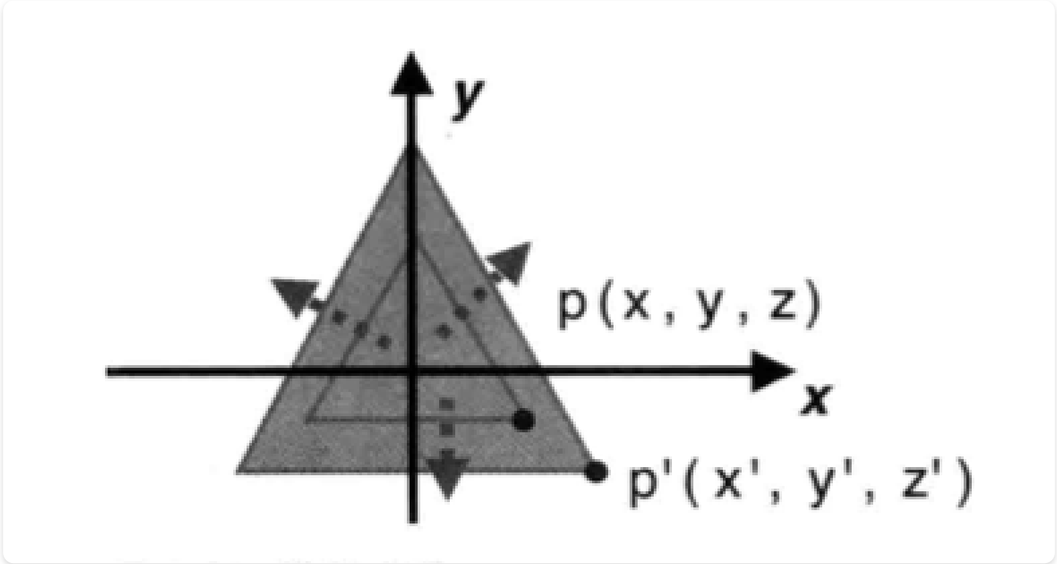
- $x' = x\ cos\,\beta - y\ sin\,\beta$
- $y' = x\ sin\,\beta + y\ cos\,\beta$

handleRotate

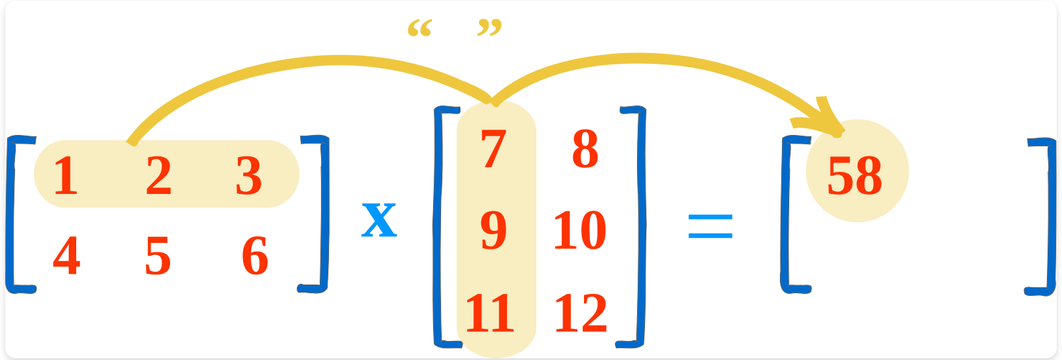
```
handleRotate() {
    const rInput = document.querySelector<HTMLInputElement>("#rotate");
    rInput.addEventListener("input", (e: Event) => {
      const el = e.target as HTMLInputElement;
      const value = +el.value;

      this.rotate = value * (Math.PI / 180);

      this.draw();
    });
  }
```

draw

```
map(({ x, y }) => ({
        x: x * Math.cos(this.rotate) - y * Math.sin(this.rotate),
        y: x * Math.sin(this.rotate) + y * Math.cos(this.rotate),
      }))
```



- $x' = S_x \times x$
- $y' = S_y \times y$
- $z' = S_z \times z$



$$(1, 2, 3) \bullet (7, 9, 11) = 1\times7 + 2\times9 + 3\times11 = 58$$

$$\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix} \times \begin{bmatrix} 7 & 8 \\ 9 & 10 \\ 11 & 12 \end{bmatrix} = \begin{bmatrix} 58 & 64 \\ 139 & 154 \end{bmatrix}$$

✓

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$$\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix} \times \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

- $x' = ax + by + cz$
- $y' = dx + ey + fz$
- $z' = gx + hy + iz$

$$a = cos\beta \qquad b = -sin\beta \qquad c = 0$$

$$d = sin\beta \qquad e = cos\beta \qquad f = 0$$

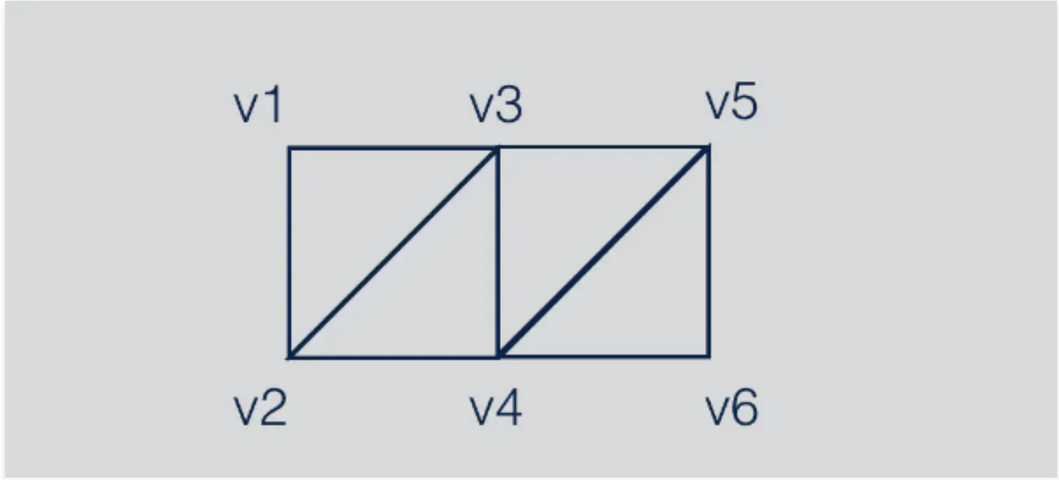
$$g = 0 \qquad h = 0 \qquad i = 1$$

$$\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} cons\beta & -sin\beta & 0 \\ sin\beta & cos\beta & 0 \\ 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

- $x' = x\ cos\,\beta - y\ sin\,\beta$
- $y' = x\ sin\,\beta + y\ cos\,\beta$
- $z' = z$

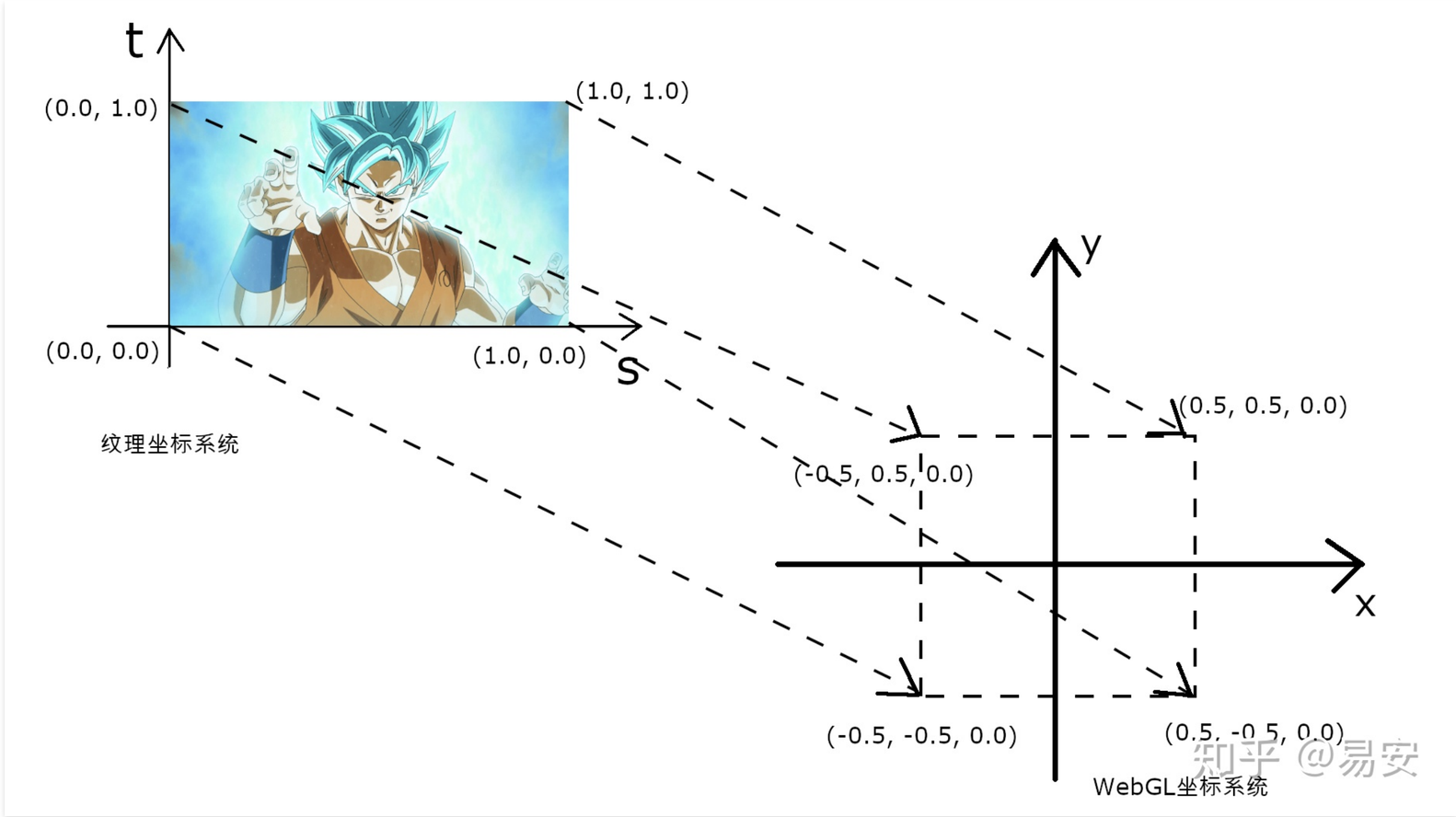

LESTAY

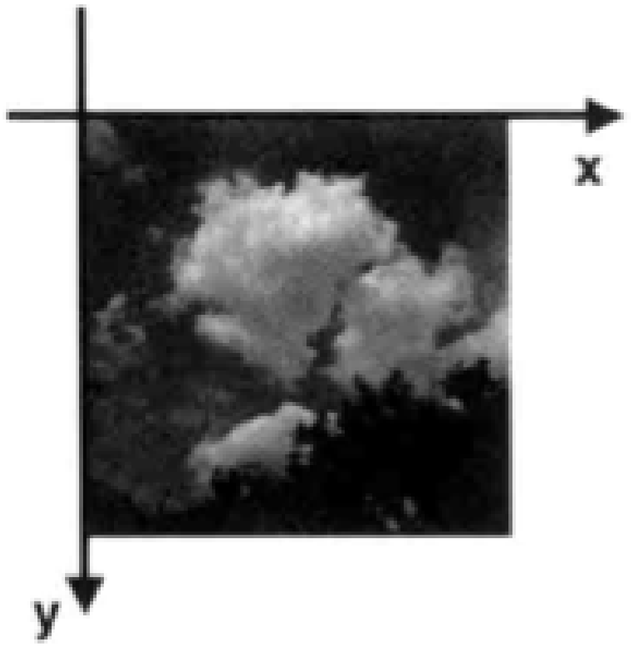
TRIANGLE_STRIP



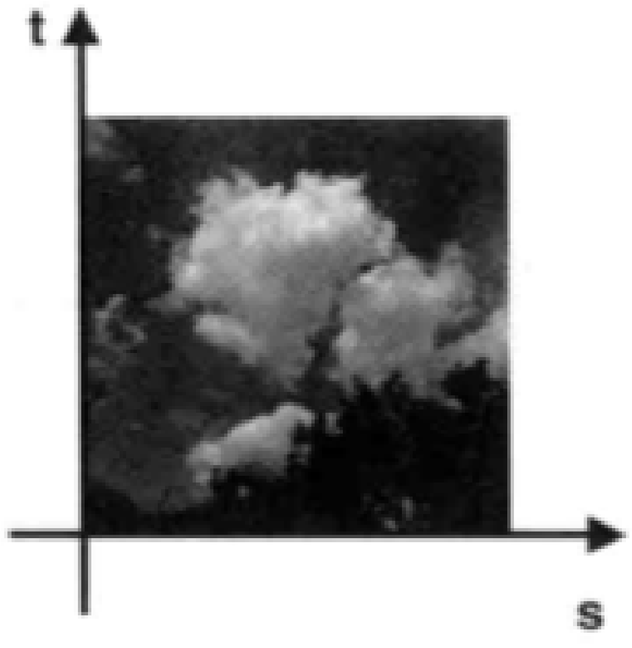

```
const data = new Float32Array([-1.0, 1.0, -1.0, -1.0, 1.0, 1.0, 1.0, -1.0]);
gl.bufferData(gl.ARRAY_BUFFER, data, gl.STATIC_DRAW);

// .......

gl.drawArrays(gl.TRIANGLE_STRIP, 0, 4);
```

webgl


t
(0.0, 1.0)
(1.0, 1.0)
(0.0, 0.0)
(1.0, 0.0)
s
纹理坐标系统
y
(0.5, 0.5, 0.0)
(-0.5, 0.5, 0.0)
x
(-0.5, -0.5, 0.0)
(0.5, -0.5, 0.0)
WebGL坐标系统
知乎 @易安



图片坐标系统



WebGL 纹理坐标系统

```
#version 300 es

in vec4 a_position;
in vec2 a_texCoord;
out vec2 v_texCoord;

void main() {

  gl_Position = a_position;

  v_texCoord = a_texCoord;
}
```

```
#version 300 es

precision highp float;

uniform sampler2D u_image;

in vec2 v_texCoord;

out vec4 outColor;

void main() {
  outColor = texture(u_image, v_texCoord);
}
```

```
class ImageAdjust {
  initPosition(program: WebGLProgram) {
    const gl = this.gl;

    const data = new Float32Array([-1.0, 1.0, -1.0, -1.0, 1.0, 1.0, 1.0, -1.0]);

    // ...

    gl.bufferData(gl.ARRAY_BUFFER, data, gl.STATIC_DRAW);
  }

  initTexCoord(program: WebGLProgram) {
    const gl = this.gl;

    const data = new Float32Array([0.0, 1.0, 0.0, 0.0, 1.0, 1.0, 1.0, 0.0]);

    //...
    gl.bufferData(gl.ARRAY_BUFFER, data, gl.STATIC_DRAW);
  }

}
```

```
class ImageAdjust {
  initTexture(program: WebGLProgram, image: HTMLImageElement) {
    const gl = this.gl;

    const texture = gl.createTexture();
    gl.pixelStorei(gl.UNPACK_FLIP_Y_WEBGL, 1);
    gl.activeTexture(gl.TEXTURE0);
    gl.bindTexture(gl.TEXTURE_2D, texture);

    gl.texParameteri(gl.TEXTURE_2D, gl.TEXTURE_MIN_FILTER, gl.LINEAR);

    gl.texImage2D(gl.TEXTURE_2D, 0, gl.RGB, gl.RGB, gl.UNSIGNED_BYTE, image);

    const imageLocation = gl.getUniformLocation(program, "u_image");

    gl.uniform1i(imageLocation, 0);
  }

}
```

1. RGB, HSL, HSV
2.

- WebGL
- webgl2fundamentals
- The Book of Shaders
- webgl water