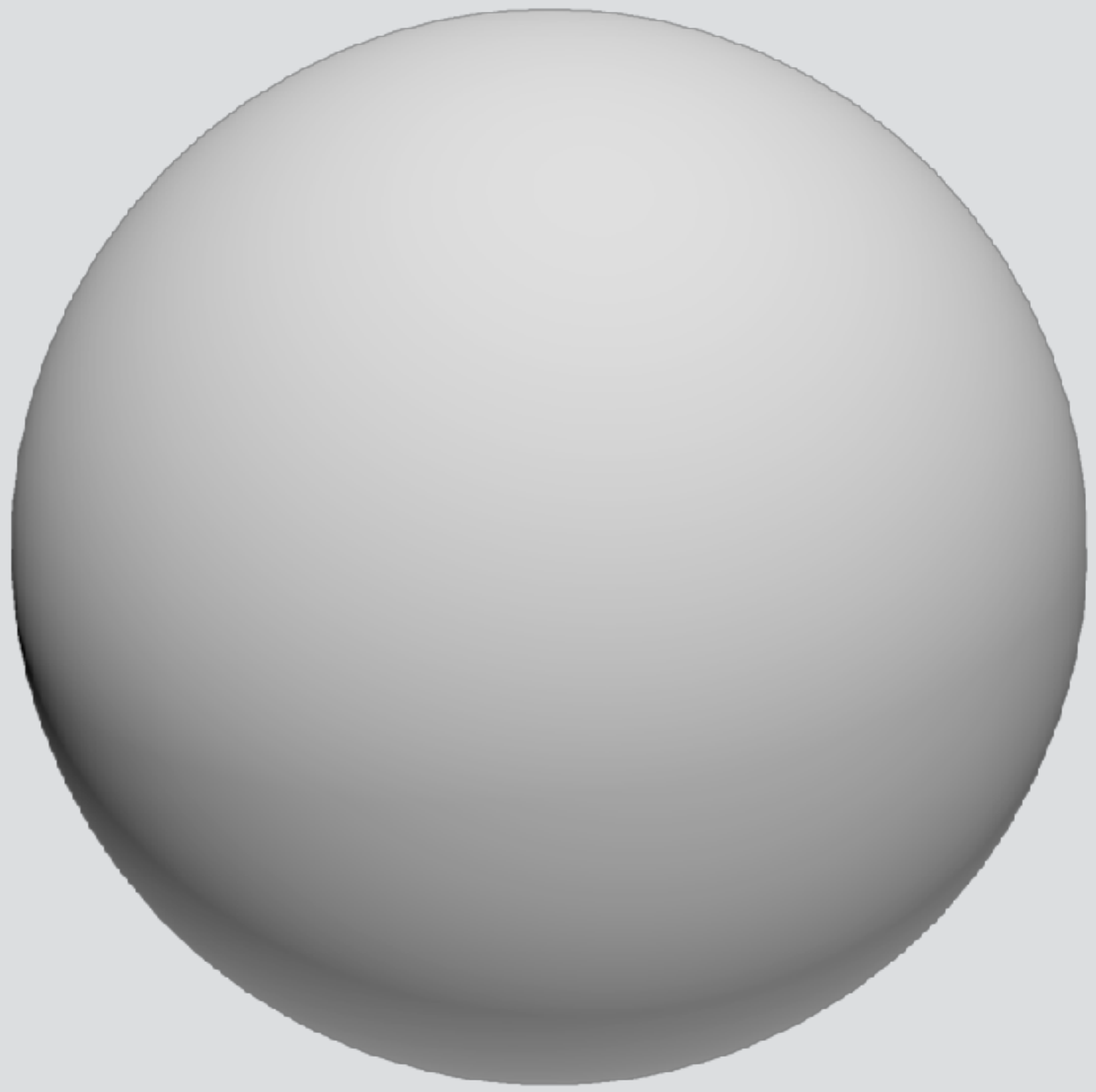
Graphics Foundations

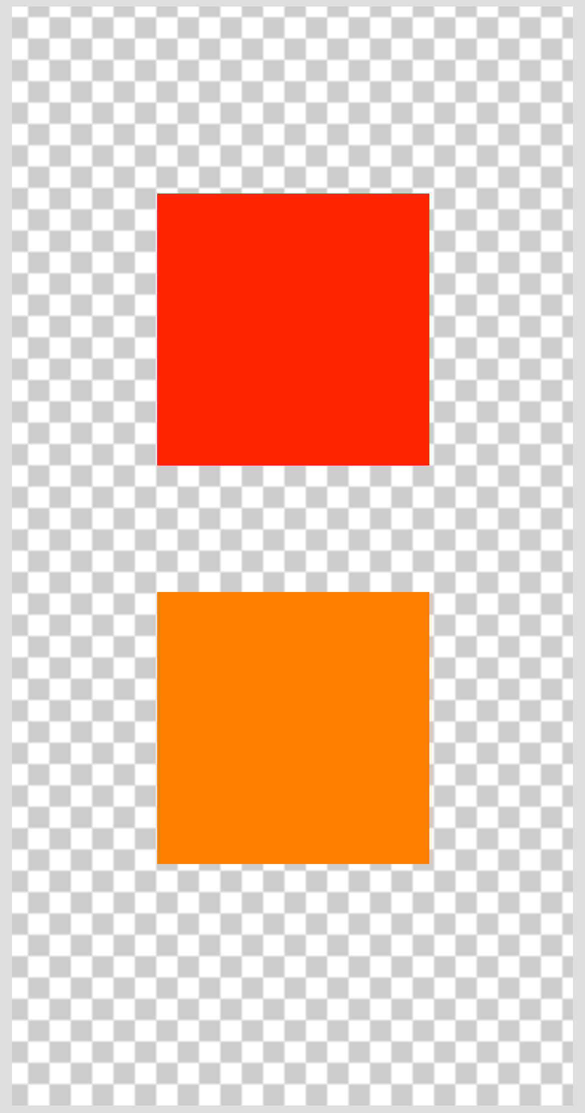


Part 2

Color in OpenGL.

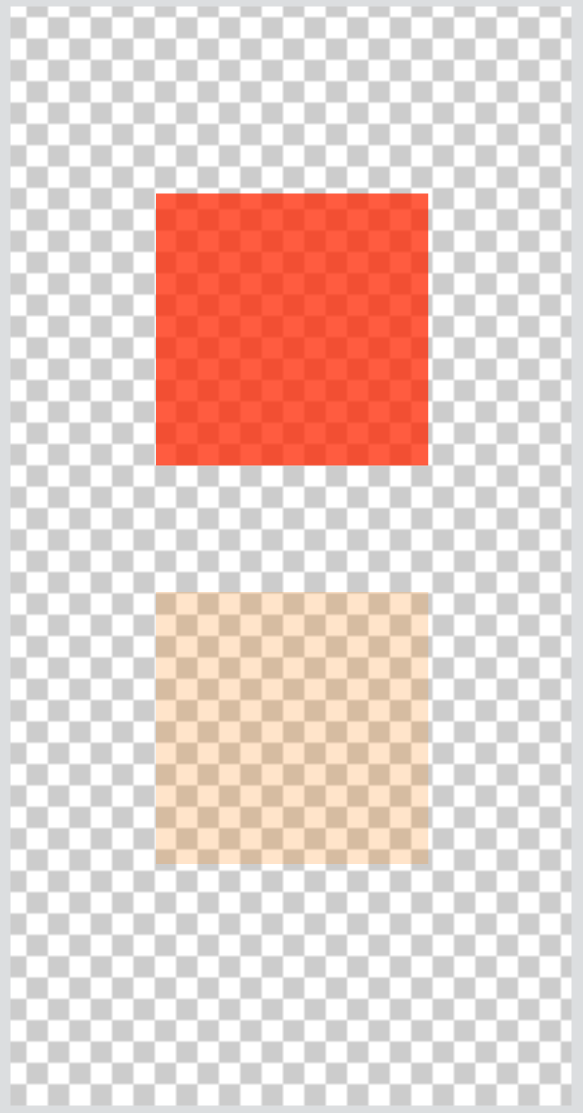
RGB and RGBA colors as 0.0 - 1.0 floating point channels.

RGB



```
1.0,  0.0,  0.0

1.0,  0.5,  0.0
```

RGBA



```
1.0,  0.0,  0.0,  0.7

1.0,  0.5,  0.0,  0.2
```

Clearing the screen.

```
void glClearColor (float red, float green,
float blue, float alpha);
```

Sets the clear color of the screen.

```
 glClearColor(0.4f, 0.2f, 0.4f, 1.0f);
```

```
void glClear (GLbitfield mask);
```

Clears the screen to the set clear color.

```
  glClear(GL_COLOR_BUFFER_BIT);
```

Changing color of untextured polygons.

`void ShaderProgram::SetColor (float red, float green, float blue, float alpha);`

Set color to render polygons with.

```
program.SetColor(0.2f, 0.8f, 0.4f, 1.0f);
```

Textures and images.

Loading an image with STB_image

Include stb_image header.
NOTE: You must define STB_IMAGE_IMPLEMENTATION in one of the files you are including it from!

```
#define STB_IMAGE_IMPLEMENTATION
#include "stb_image.h"
```

Use stbi_load function to load the pixel data from an image file.

```
int w,h,comp;
unsigned char* image = stbi_load(“some_image.png”, &w, &h, &comp, STBI_rgb_alpha);
```

After you are done with the image data, you must free it using the stbi_image_free function.

```
stbi_image_free(image);
```

Textures in OpenGL

Creating a texture

```
void glGenTextures (GLsizei numTextures, GLuint *textures);
```

Generates a new OpenGL texture ID.

```
GLuint textureID;
glGenTextures(1, &textureID);
```

Binding a texture

```
void glBindTexture (GLenum target, GLuint texture);
```

Bind a texture to a texture target.

```
glBindTexture(GL_TEXTURE_2D, textureID);
```

Our texture target is always going to be GL_TEXTURE_2D

Setting texture pixel data

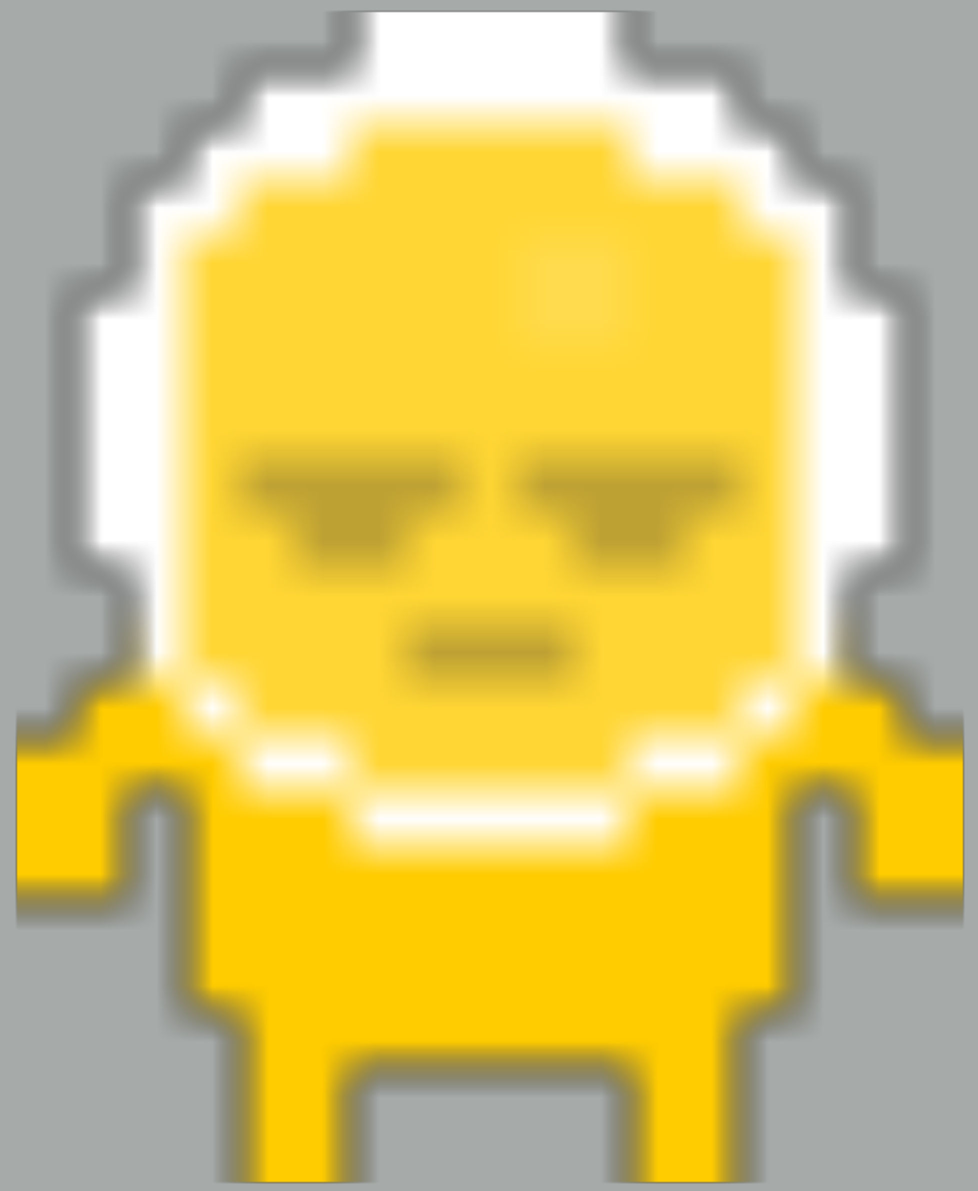
```
void glTexImage2D (GLenum target, GLint level, GLint
internalformat, GLsizei width, GLsizei height, GLint
border, GLenum format, GLenum type, const GLvoid *pixels);
```

Sets the **texture data** of the specified **texture target**. Image format must be **GL_RGBA for RGBA images** or **GL_RGB for RGB images**.

```
glTexImage2D(GL_TEXTURE_2D, 0, GL_RGBA, w, h, 0, GL_RGBA,
GL_UNSIGNED_BYTE, image);
```

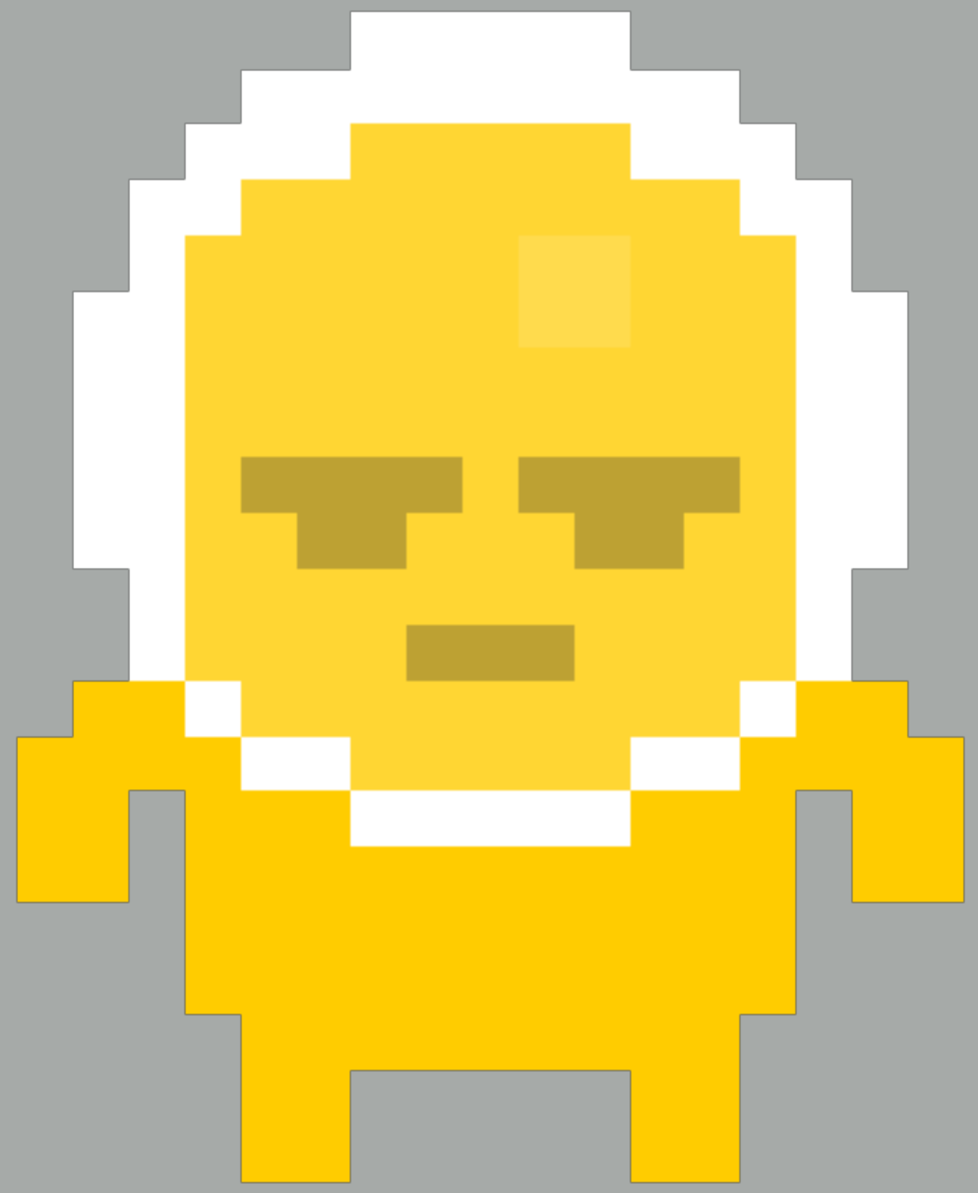
Texture filtering

Texture filtering parameters.



`Linear`

Good for high resolution textures.



`Nearest neighbor`

Good for pixelart.

```
void glTexParameteri (GLenum target, GLenum pname,
GLint param);
```

Sets a texture parameter of the specified texture target.
We MUST set the texture filtering parameters GL_TEXTURE_MIN_FILTER and GL_TEXTURE_MAG_FILTER before the texture can be used.

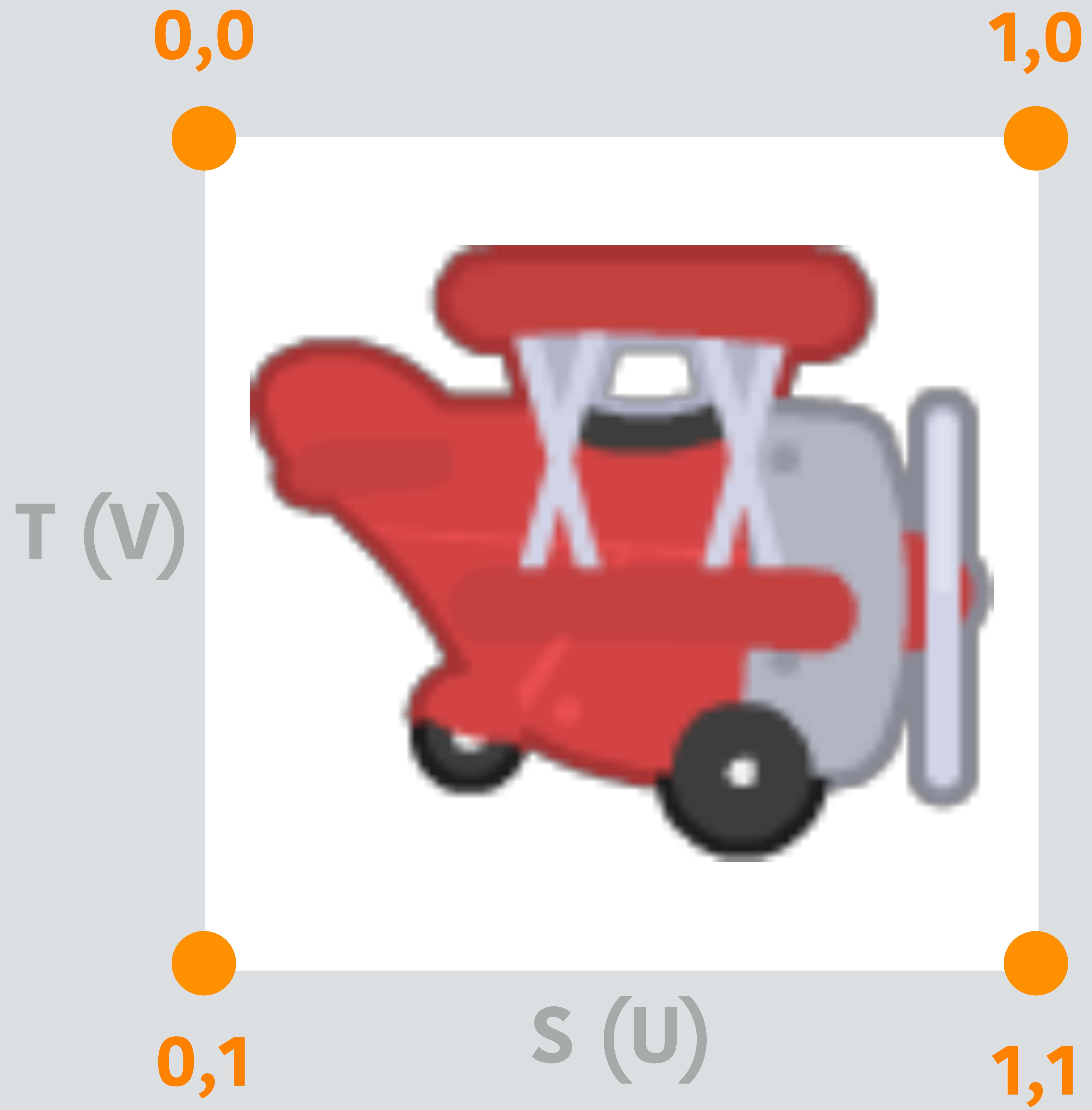
```
glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MIN_FILTER, GL_LINEAR);
glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MAG_FILTER, GL_LINEAR);
```

Use GL_LINEAR for linear filtering and GL_NEAREST for nearest neighbor filtering.

Putting it all together.

```
GLuint LoadTexture(const char *filePath) {
    int w,h,comp;
    unsigned char* image = stbi_load(filePath, &w, &h, &comp, STBI_rgb_alpha);

    if(image == NULL) {
        std::cout << "Unable to load image. Make sure the path is correct\n";
        assert(false);
    }

    GLuint retTexture;
    glGenTextures(1, &retTexture);
    glBindTexture(GL_TEXTURE_2D, retTexture);
    glTexImage2D(GL_TEXTURE_2D, 0, GL_RGBA, w, h, 0, GL_RGBA, GL_UNSIGNED_BYTE, image);

    glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MIN_FILTER, GL_LINEAR);
    glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MAG_FILTER, GL_LINEAR);

    stbi_image_free(image);
    return retTexture;
}
```

Texture coordinates.



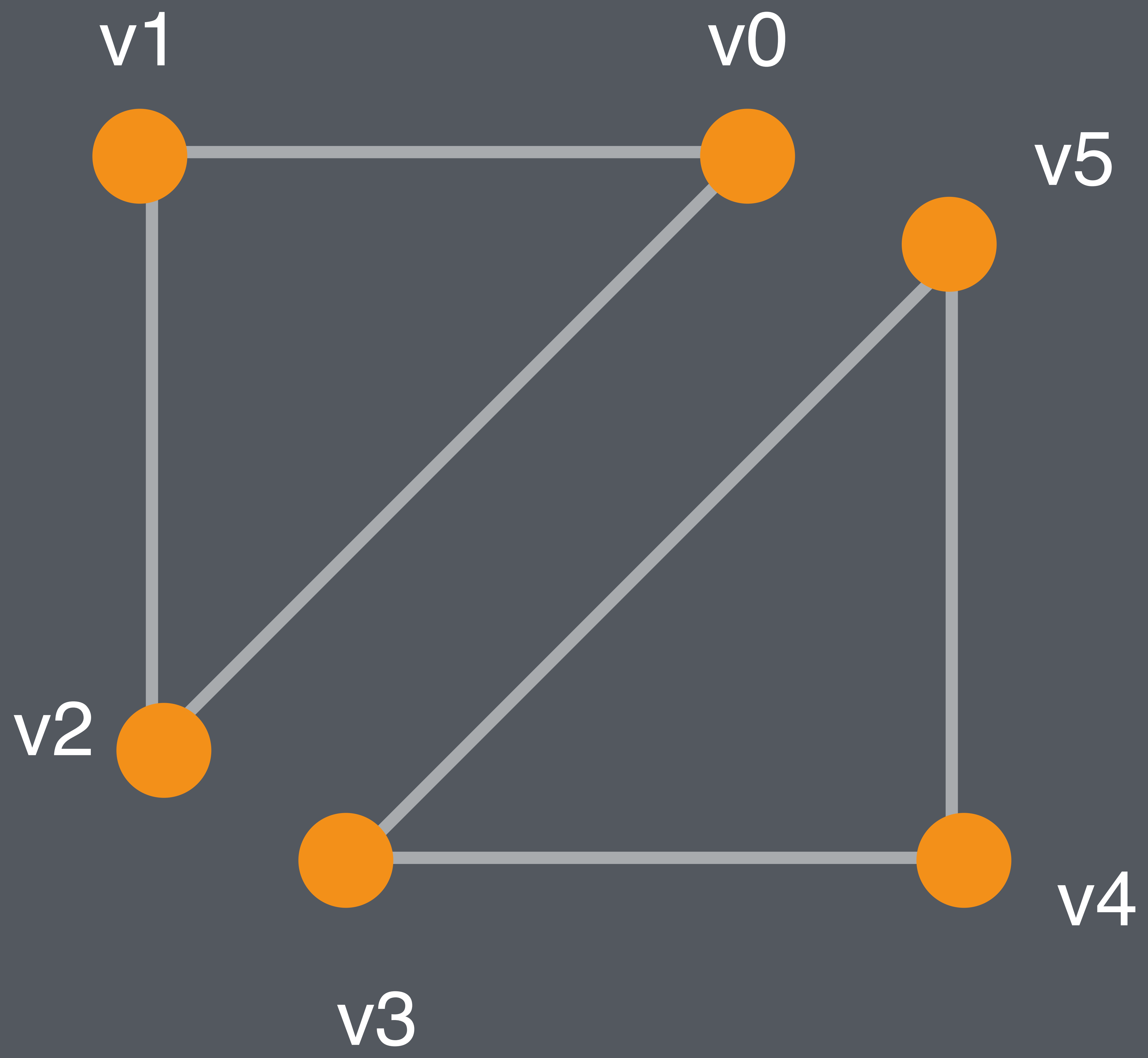
Texture coordinates are defined in 0-1 units called UV coordinates, not pixels!

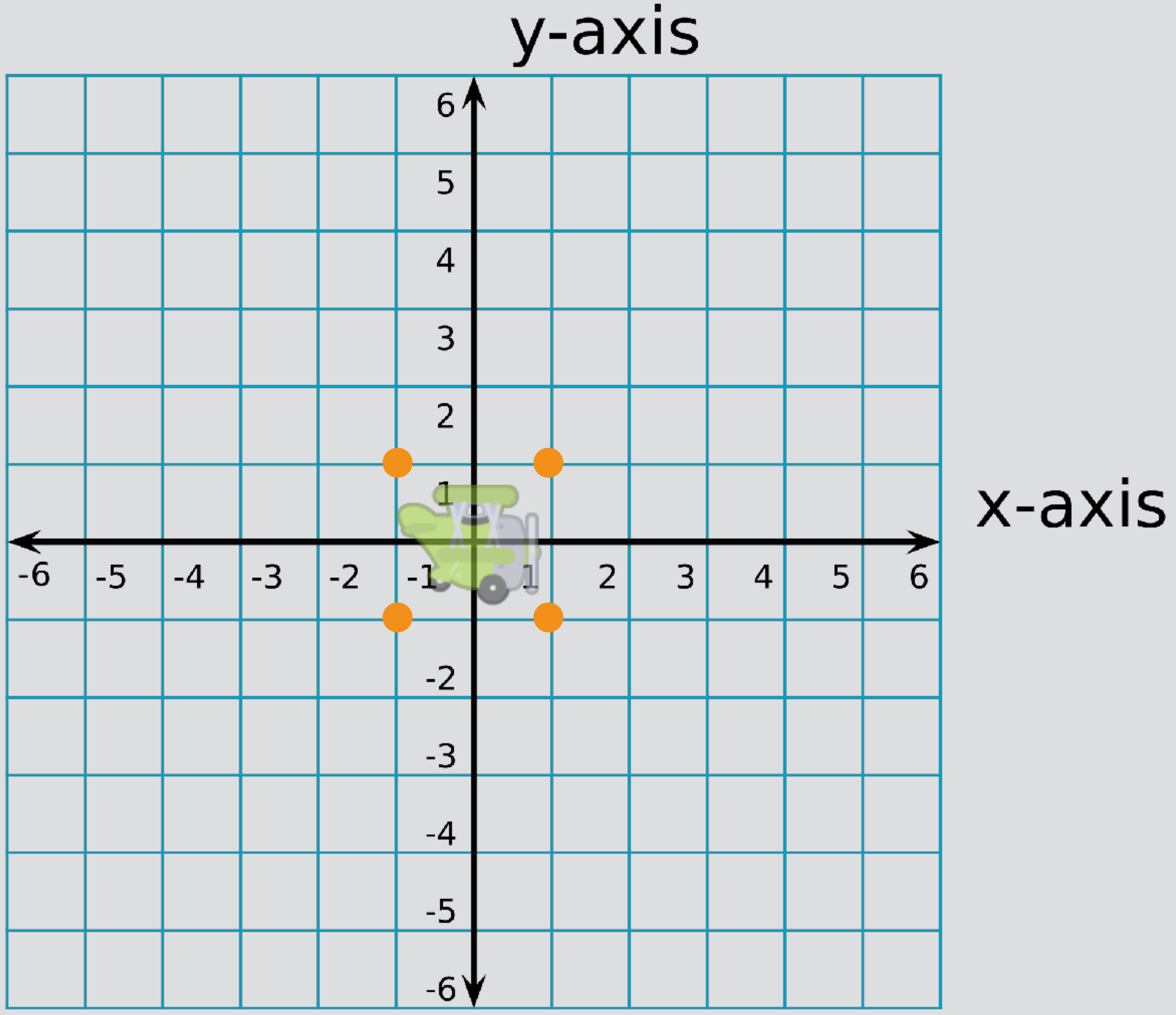
```
void glVertexAttribPointer (GLint index, GLint
size, GLenum type, GLboolean normalized, GLsizei
stride, const GLvoid *pointer);
```

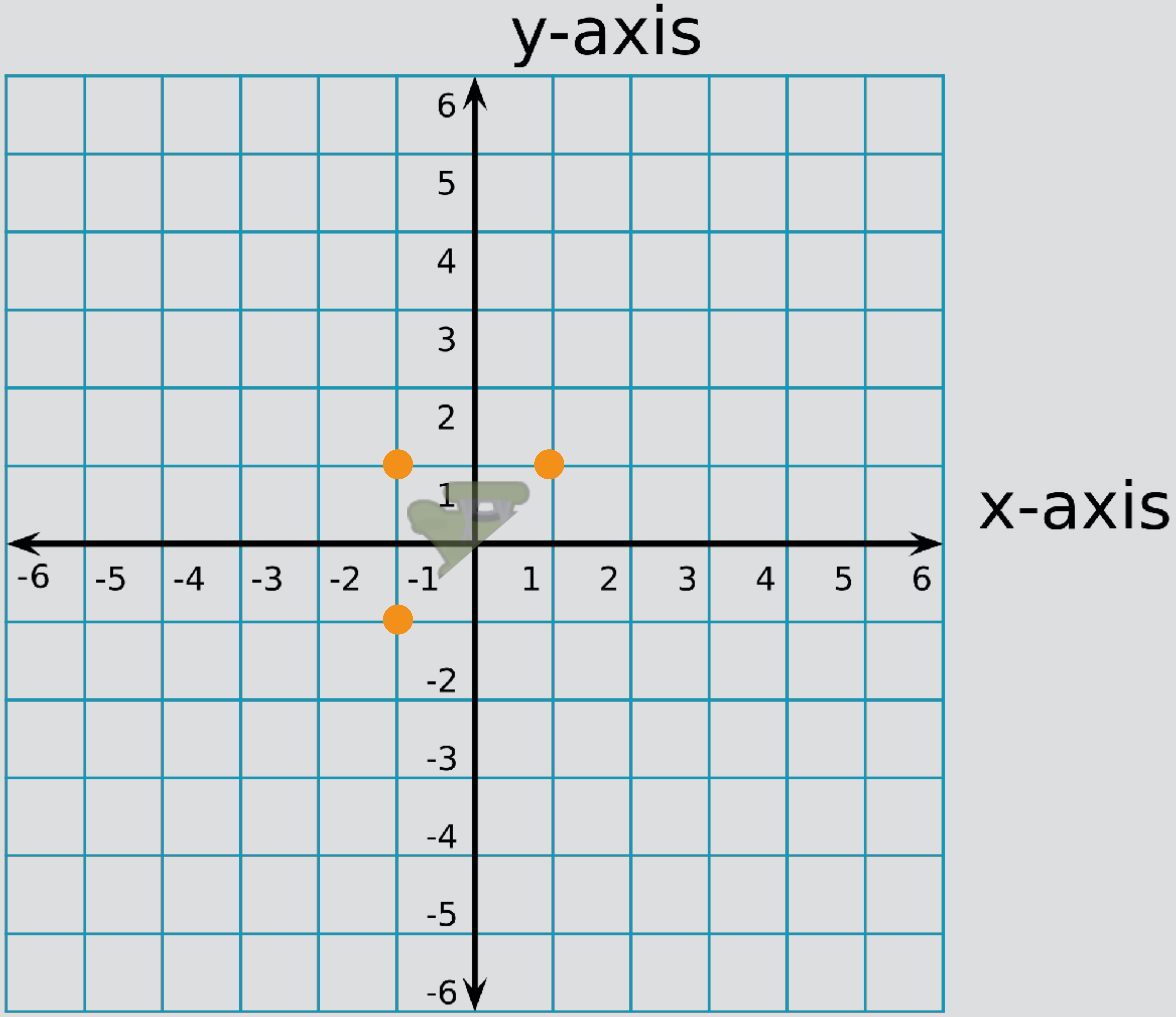
Defines an array of **vertex data**.

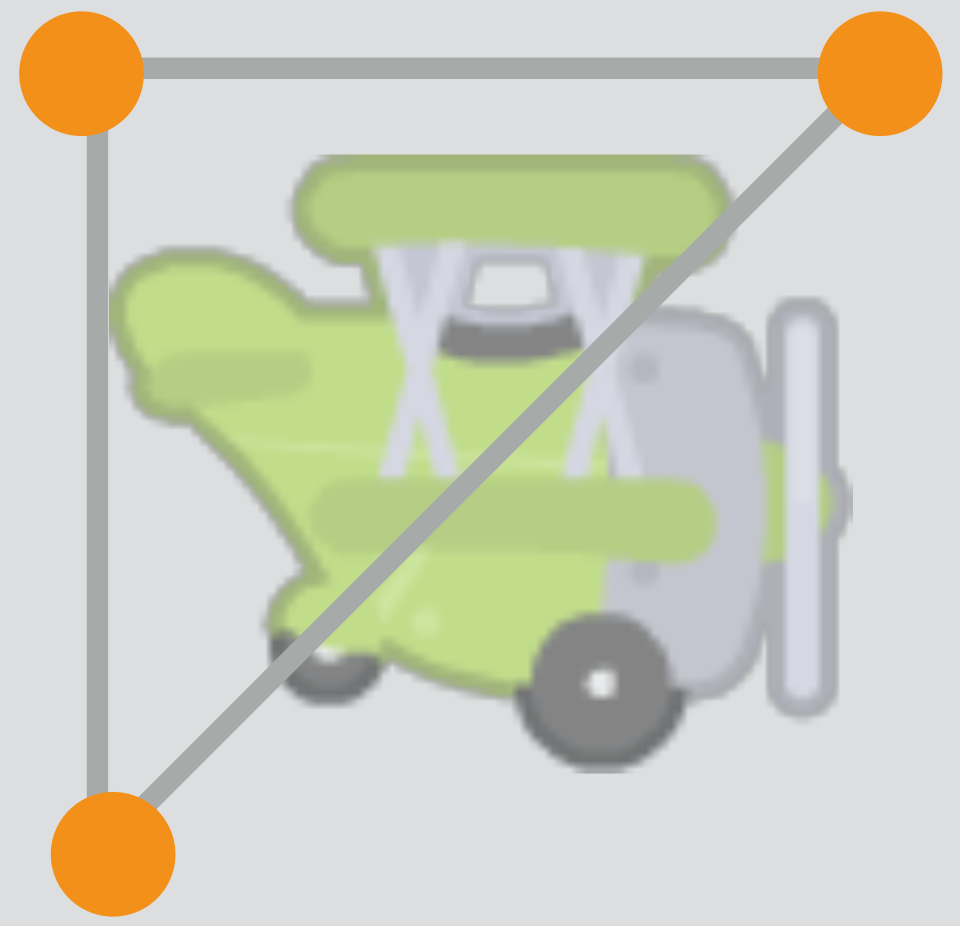
```
float texCoords[] = {0.0f, 1.0f, 1.0f, 0.0f, 0.0f, 0.0f,};

glVertexAttribPointer(program.texCoordAttribute, 2, GL_FLOAT, false, 0, texCoords);
```

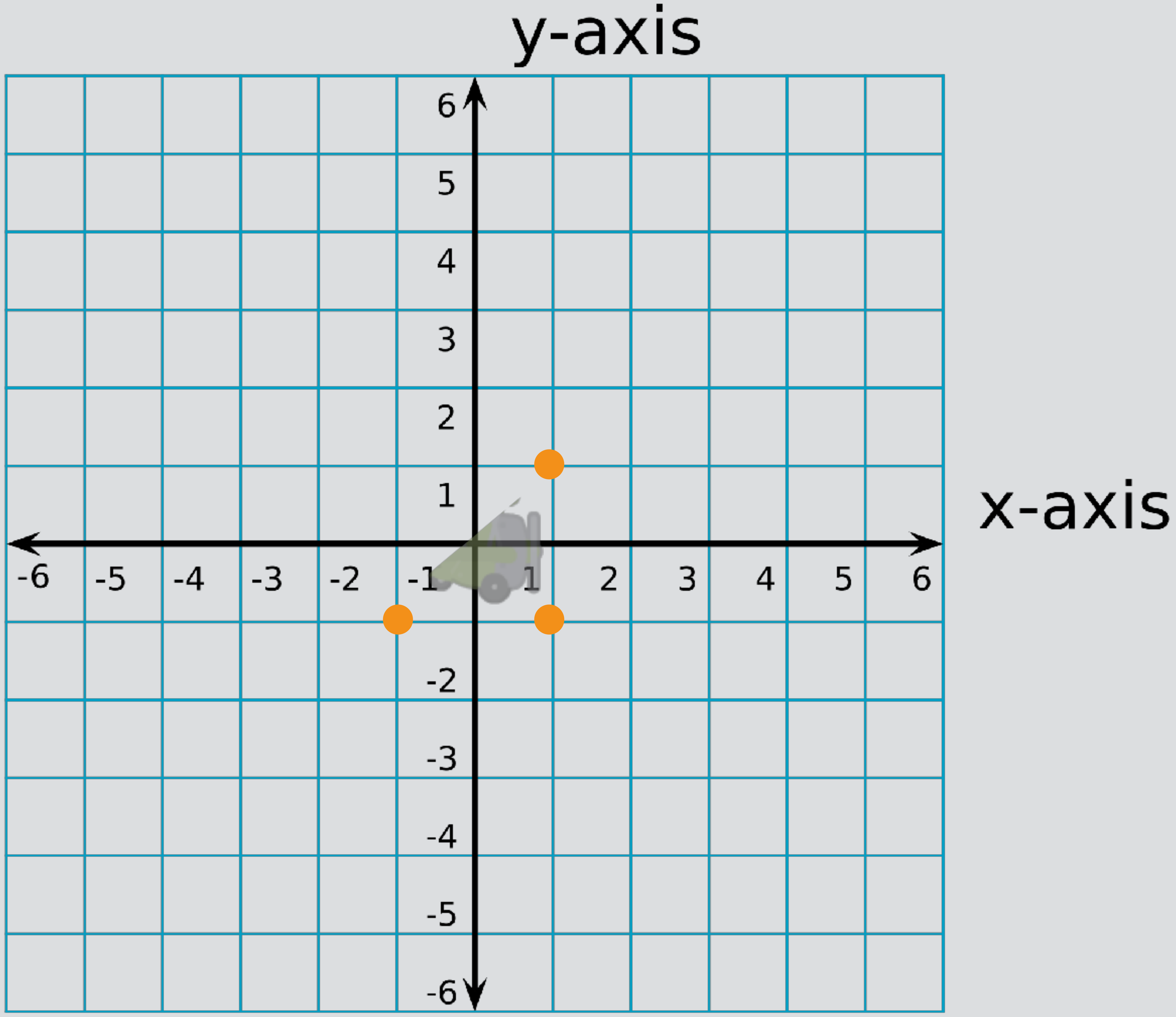
Drawing a sprite.

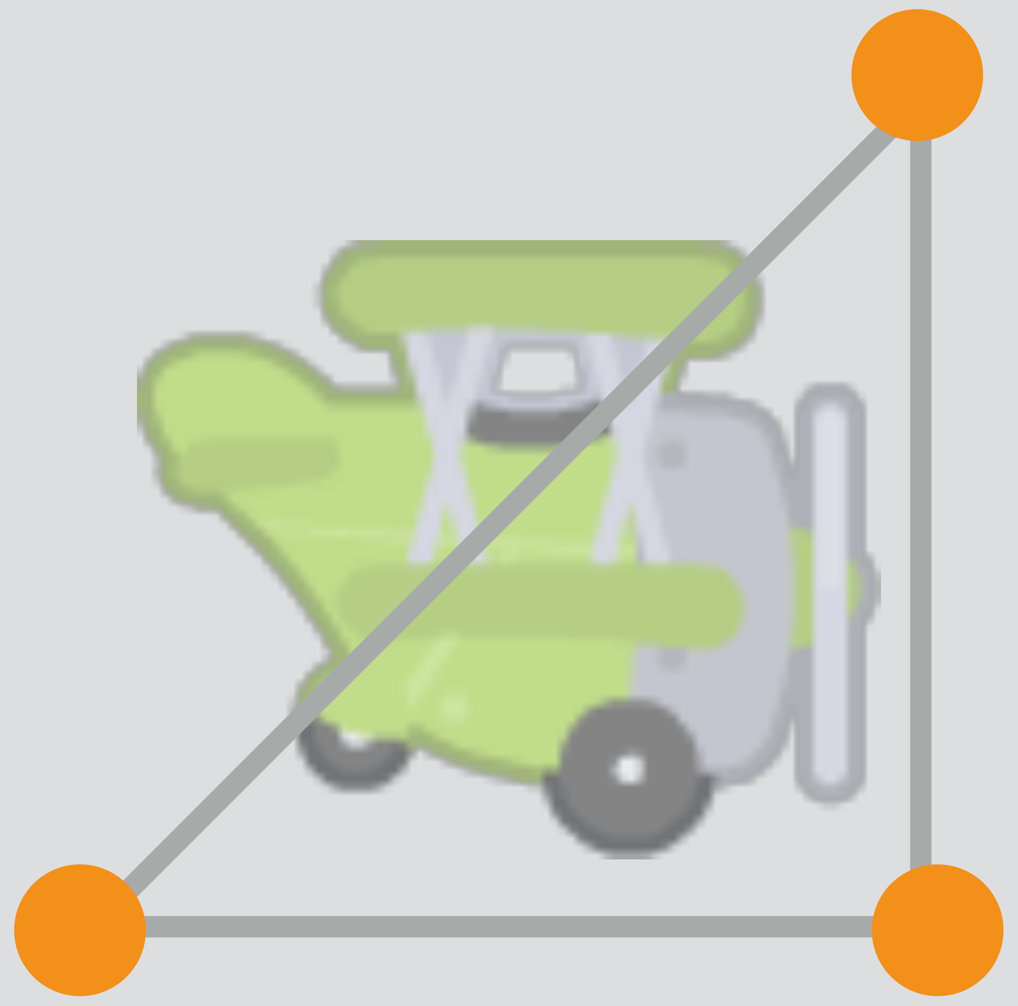

v1
v0
v5
v2
v3
v4


y-axis
x-axis
6
5
4
3
2
1
-2
-3
-4
-5
-6
-6
-5
-4
-3
-2
-1
1
2
3
4
5
6


y-axis
x-axis
6
5
4
3
2
1
-2
-3
-4
-5
-6
-6
-5
-4
-3
-2
-1
1
2
3
4
5
6




y-axis
x-axis
6
5
4
3
2
1
-2
-3
-4
-5
-6
-6
-5
-4
-3
-2
-1
1
2
3
4
5
6



Drawing a sprite.

- Set position attributes for 2 triangles.
- Set texture coordinate attributes for 2 triangles.
- Bind the texture we want to use.
- Draw arrays.
- Disable attribute arrays.

Need to use a shader program that supports textures!

```
ShaderProgram program;
program.Load(RESOURCE_FOLDER"vertex_textured.glsl", RESOURCE_FOLDER"fragment_textured.glsl");
```

Use the vertex.glsl/fragment.glsl for drawing untextured polygons and vertex_textured.glsl/fragment_textured.glsl for drawing textured ones.

You can use both at the same time, just call glUseProgram for the id of the program you want to use before drawing with it.

Putting it all together.

Setup (before the loop)

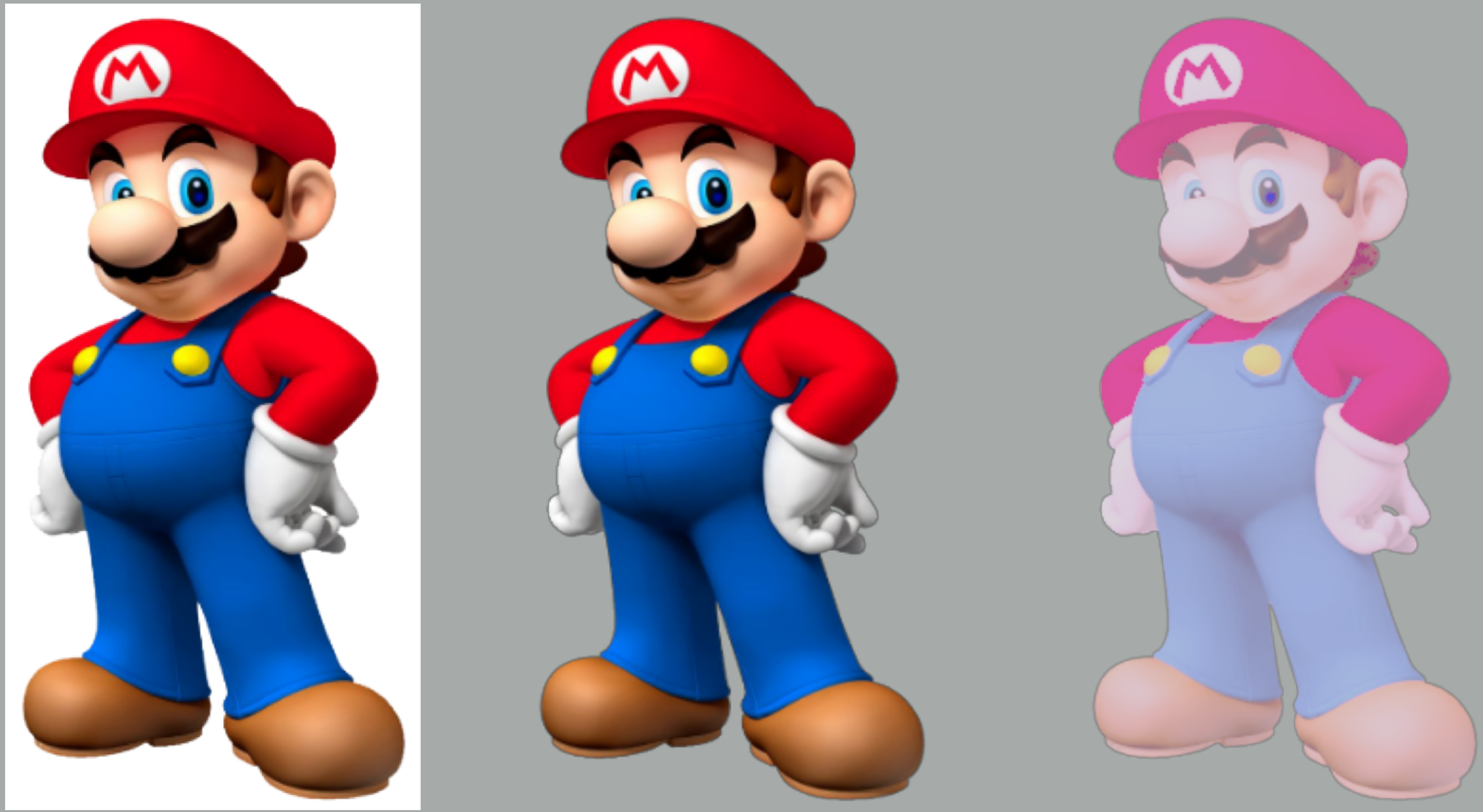
```
 glViewport(0, 0, 640, 360);

 ShaderProgram program;
 program.Load(RESOURCE_FOLDER”vertex_textured.glsl”, RESOURCE_FOLDER"fragment_textured.glsl");

 GLuint emojiTexture = LoadTexture(RESOURCE_FOLDER"emoji.png");

glm::mat4 projectionMatrix = glm::mat4(1.0f);
glm::mat4 modelMatrix = glm::mat4(1.0f);
glm::mat4 viewMatrix = glm::mat4(1.0f);

 projectionMatrix = glm::ortho(-1.777f, 1.777f, -1.0f, 1.0f, -1.0f, 1.0f);

 glUseProgram(program.programID);
```

Drawing (in your game loop)

```
glClear(GL_COLOR_BUFFER_BIT);

program.SetModelMatrix(modelMatrix);
program.SetProjectionMatrix(projectionMatrix);
program.SetViewMatrix(viewMatrix);

glBindTexture(GL_TEXTURE_2D, emojiTexture);

float vertices[] = {-0.5, -0.5, 0.5, -0.5, 0.5, 0.5, -0.5, -0.5, 0.5, 0.5, -0.5, 0.5};

glVertexAttribPointer(program.positionAttribute, 2, GL_FLOAT, false, 0, vertices);
glEnableVertexAttribArray(program.positionAttribute);

float texCoords[] = {0.0, 1.0, 1.0, 1.0, 1.0, 0.0, 0.0, 1.0, 1.0, 0.0, 0.0, 0.0};
glVertexAttribPointer(program.texCoordAttribute, 2, GL_FLOAT, false, 0, texCoords);
glEnableVertexAttribArray(program.texCoordAttribute);

glDrawArrays(GL_TRIANGLES, 0, 6);

glDisableVertexAttribArray(program.positionAttribute);
glDisableVertexAttribArray(program.texCoordAttribute);

SDL_GL_SwapWindow(displayWindow);
```

Blending

Blending



Enabling blending

```
glEnable(GL_BLEND);
```

Set alpha blending function.

```
glBlendFunc(GL_SRC_ALPHA, GL_ONE_MINUS_SRC_ALPHA);
```

Keeping time.

In **setup**

```
float lastFrameTicks = 0.0f;
```

In **game loop**

```
float ticks = (float)SDL_GetTicks()/1000.0f;
float elapsed = ticks - lastFrameTicks;
lastFrameTicks = ticks;
```

elapsed is how many seconds **elapsed since last frame**.

We will use this value to **move everything** in our game.

Basic time-based animation.

```
angle += elapsed;

// rotate matrix by angle
// draw sprite
```

Assignment #1

- Create a simple 2D scene using textured and untextured polygons.
- You can use any images you want, but feel free to use the assets in the class github repo.
- You must use at least 3 different textures.
- Commit the source to your github repository and email me the link.