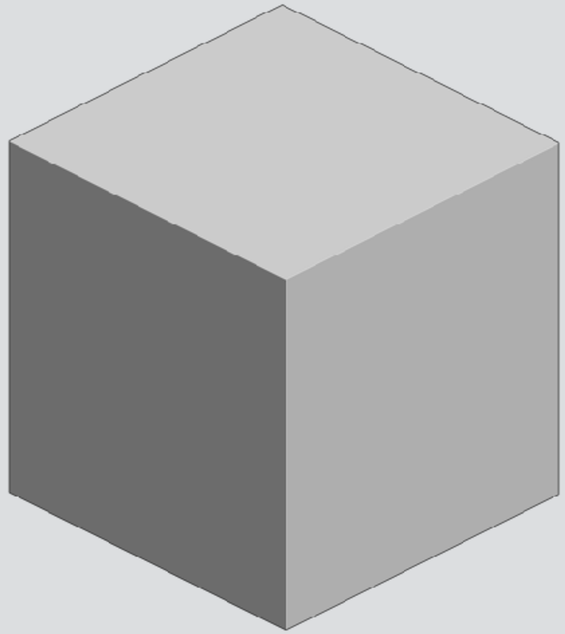
3D Graphics

Part 2




x 10
x 0
x 16

PICKED UP 4 SHOTGUN SHELLS.

14 AMMO

59% HEALTH

2 3 4
5 6 7
ARMS

0% ARMOR

BULL 42 / 200
SHEL 14 / 50
ROKT 0 / 50
CELL 0 / 300

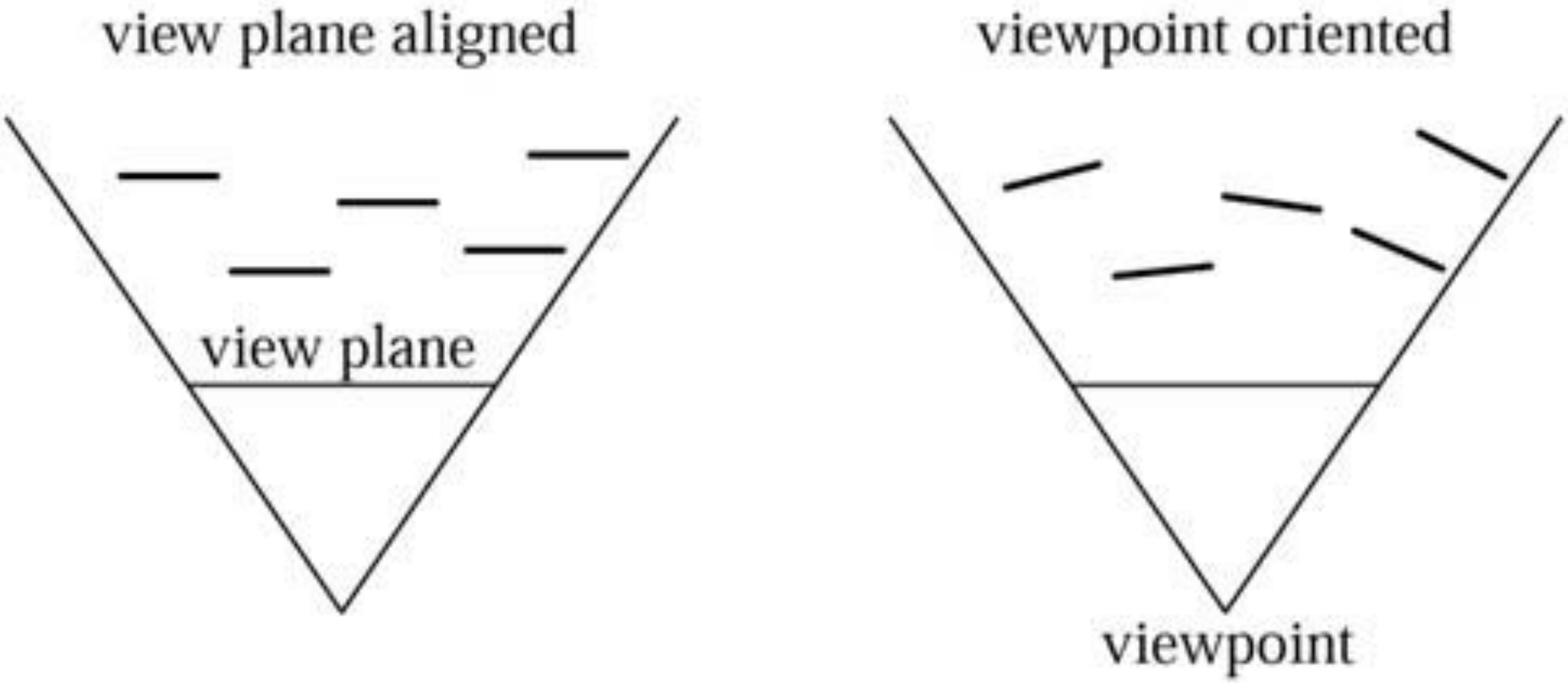

+88
20

Billboards.

Billboards

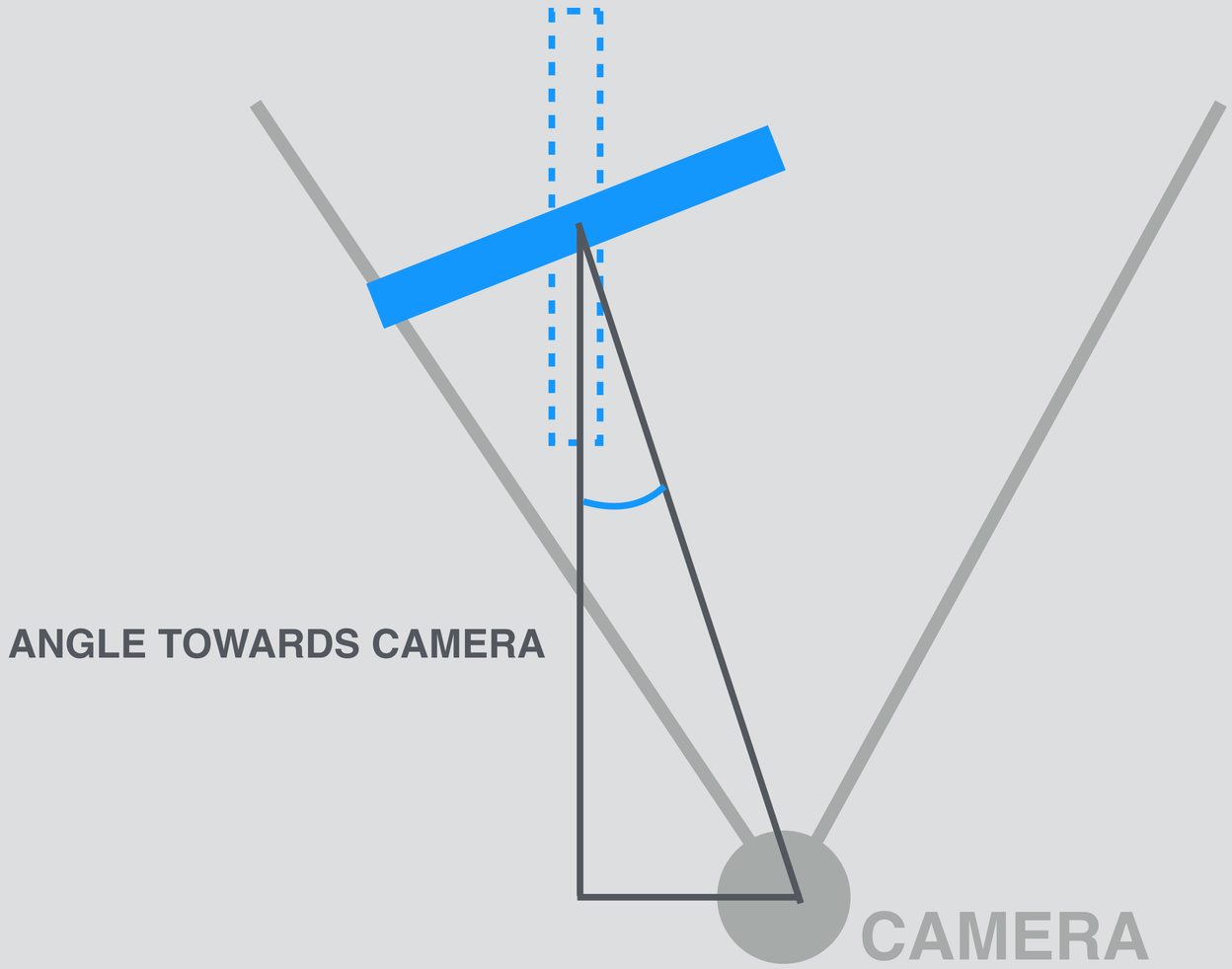
=

Sprites that always face the camera.


view plane aligned
view plane
viewpoint oriented
viewpoint

Method #1 - Rotate all billboards towards camera.

Viewpoint oriented

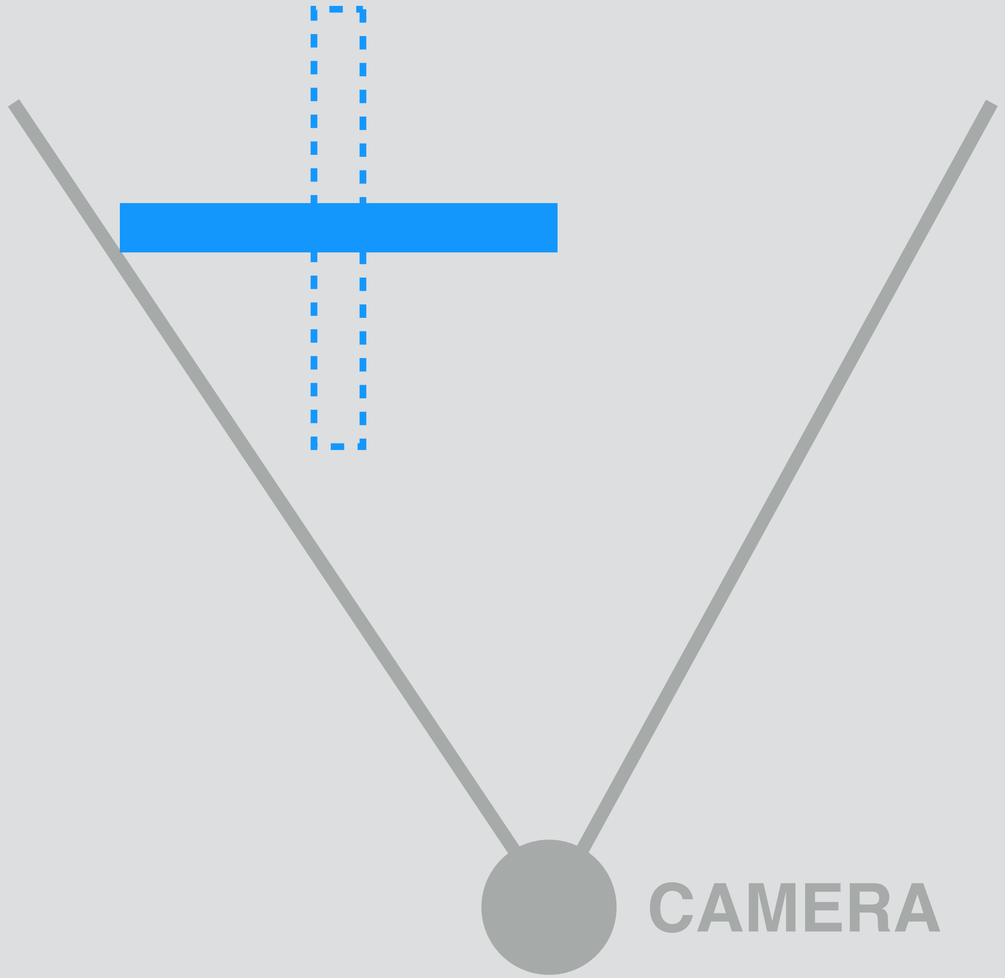


Method #1 - Rotate all billboards towards camera.
Viewpoint oriented

```
for(int i=0; i < entities.size(); i++) {

    if(entities[i]->billboard) {

        float directionX = entities[i]->position.x - camera->position.x;
        float directionZ = entities[i]->position.z - camera->position.z;

        entities[i]->rotation.y = atan2f(directionX, directionZ);
    }

    entities[i]->Render();
}
```

Method #2 - Remove all rotation from the modelview matrix.

Viewplane aligned

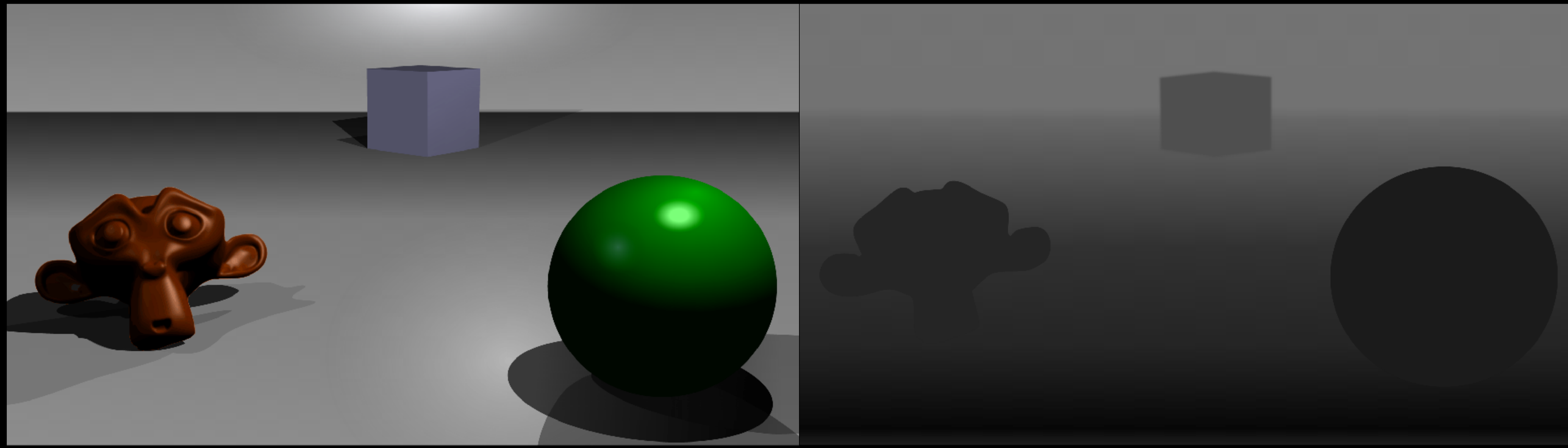


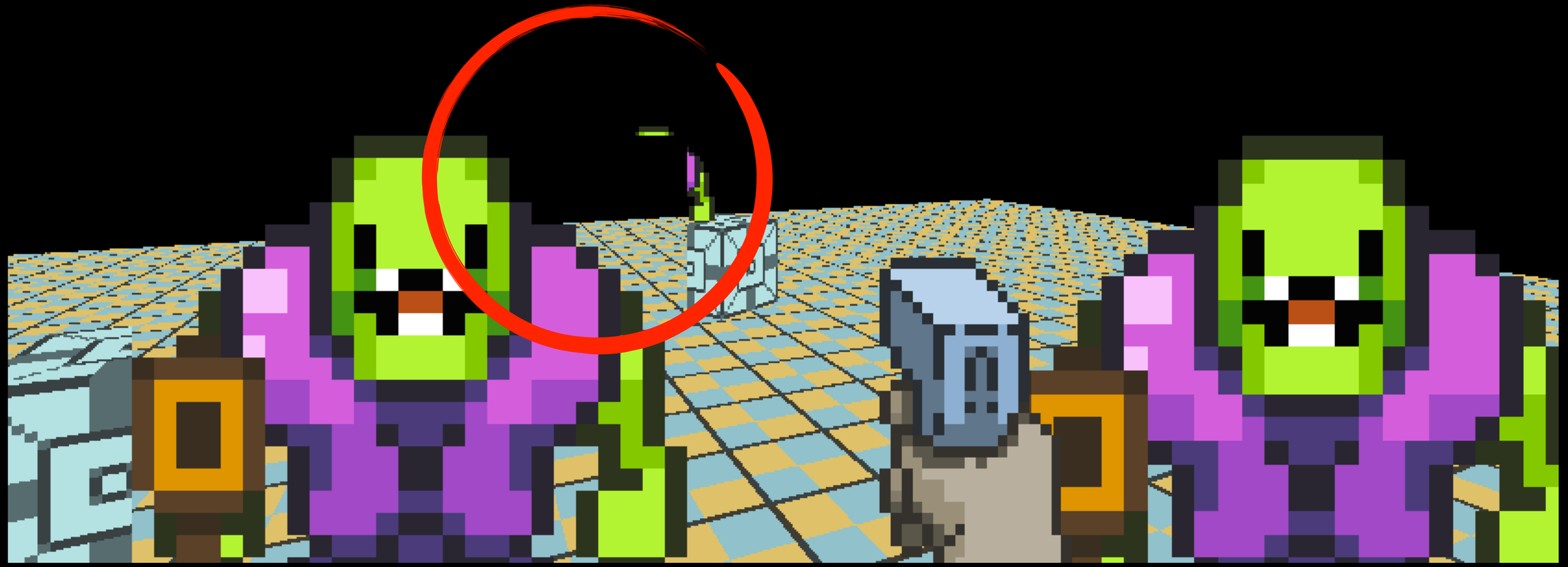
Method #2 - Remove all rotation from the modelview matrix.

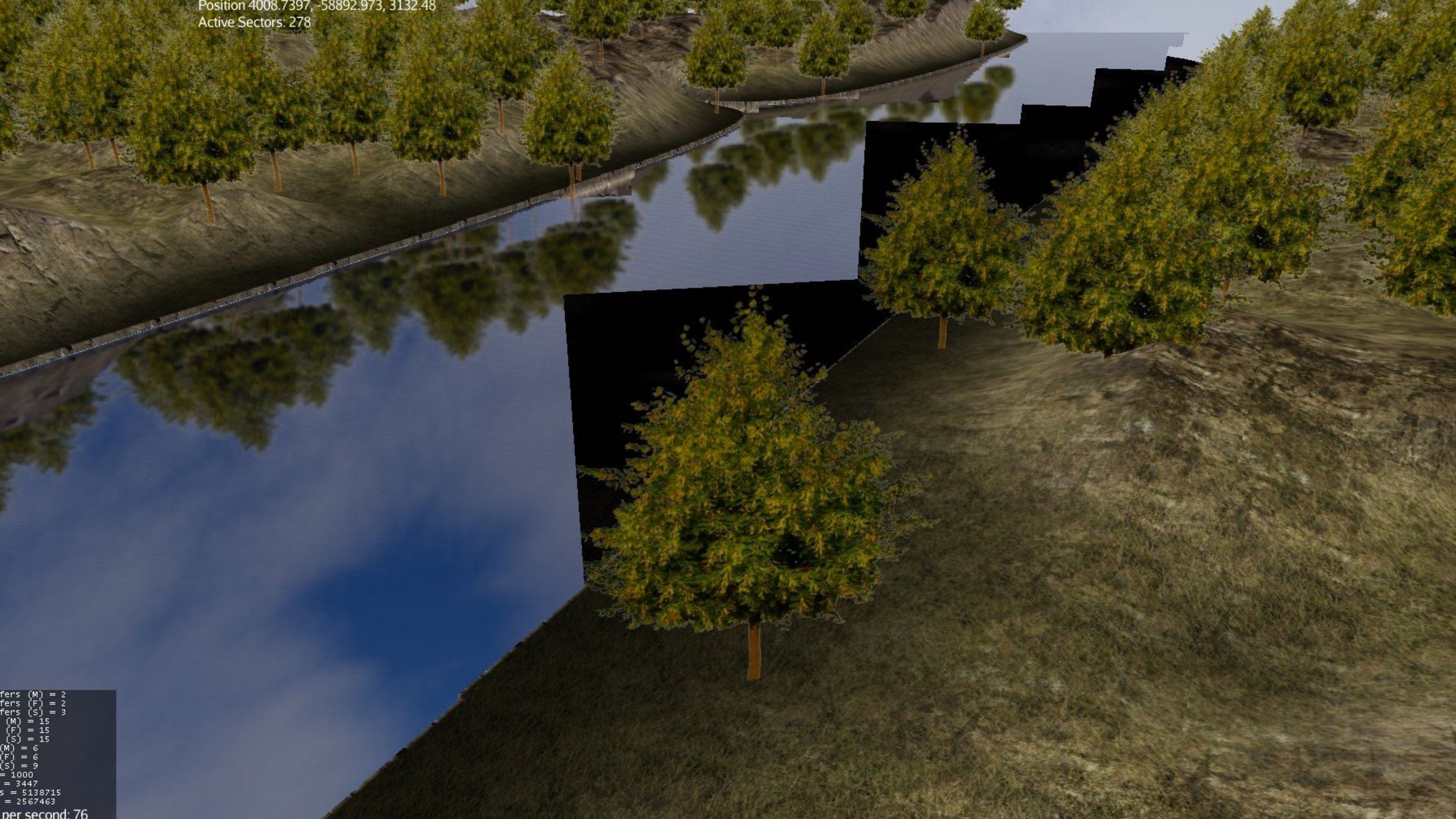
Viewplane aligned

```
attribute vec4 position;
attribute vec2 texCoord;

uniform mat4 modelMatrix;
uniform mat4 viewMatrix;
uniform mat4 projectionMatrix;

varying vec2 texCoordVar;
void main()
{
    mat4 modelViewMatrix = viewMatrix * modelMatrix;

    modelViewMatrix[0][0] = 1.0;
    modelViewMatrix[0][1] = 0.0;
    modelViewMatrix[0][2] = 0.0;

    modelViewMatrix[1][0] = 0.0;
    modelViewMatrix[1][1] = 1.0;
    modelViewMatrix[1][2] = 0.0;

    modelViewMatrix[2][0] = 0.0;
    modelViewMatrix[2][1] = 0.0;
    modelViewMatrix[2][2] = 1.0;

    vec4 p =  modelViewMatrix * position;
    texCoordVar = texCoord;
    gl_Position = projectionMatrix * p;
}
```

Blending and the Z-Buffer






Position 4008.7397, -58892.973, 3132.48
Active Sectors: 278
fers (M) = 2
fers (F) = 2
fers (S) = 3
(M) = 15
(F) = 15
(S) = 15
(M) = 6
(F) = 6
(S) = 9
= 1000
= 3447
s = 5138715
= 2567463
ner second: 76

Discarding fragments.

Discard fragment if alpha value is 0.

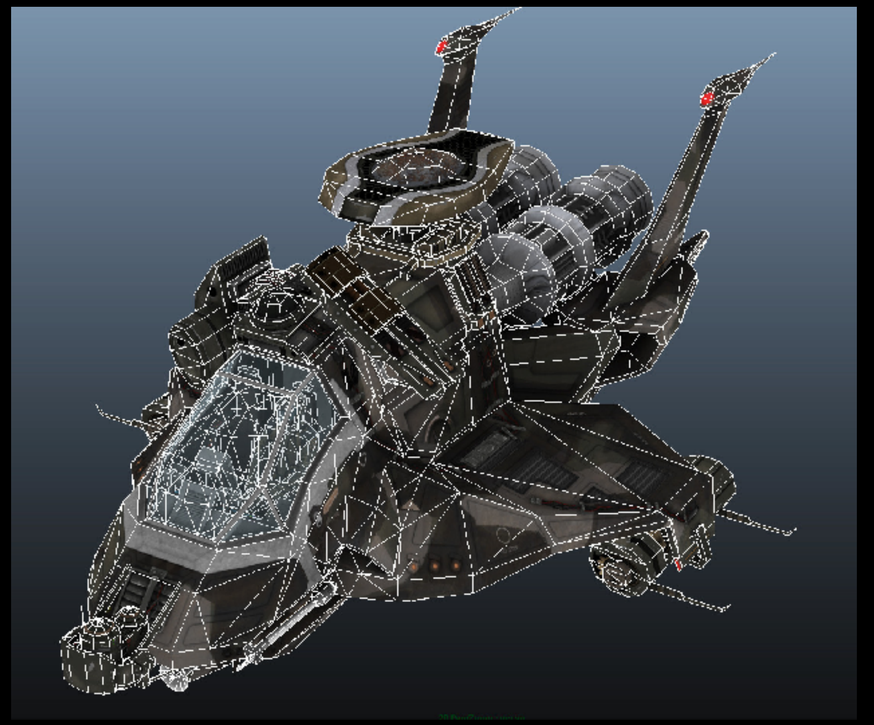
```
uniform sampler2D diffuse;
varying vec2 texCoordVar;

void main()
{
    gl_FragColor = texture2D(diffuse, texCoordVar);
    if(gl_FragColor.a == 0.0) {
        discard;
    }
}
```

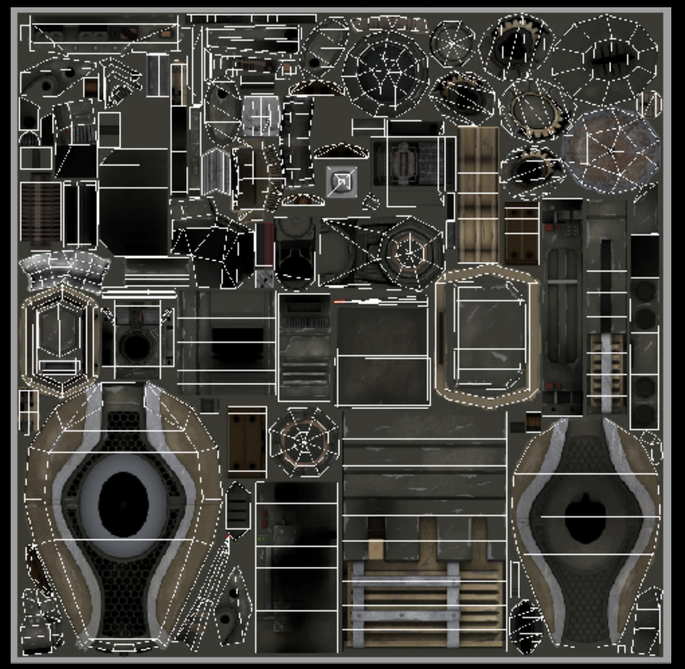
Working with 3D meshes.

Position coordinates.

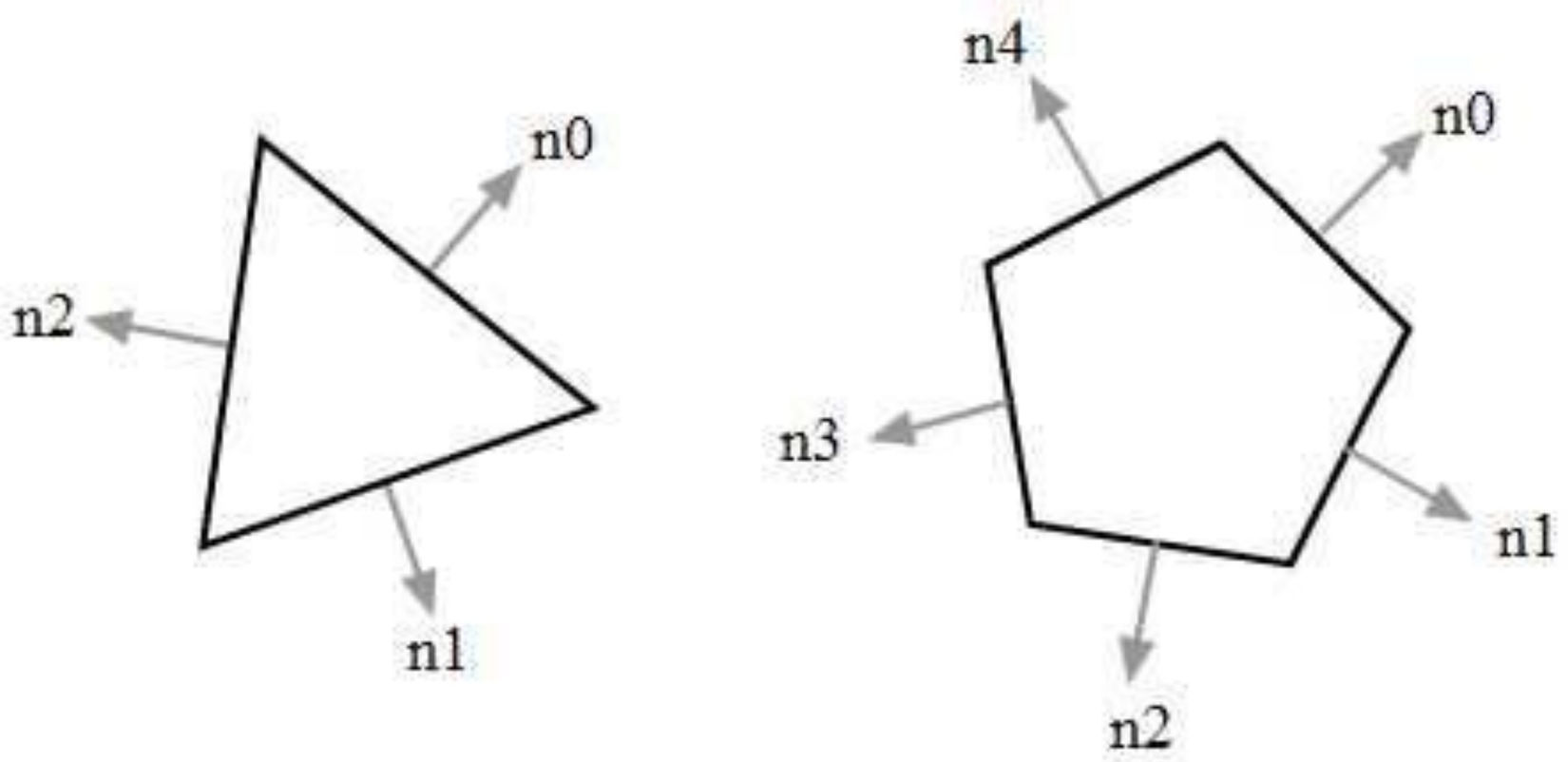
Texture coordinates.

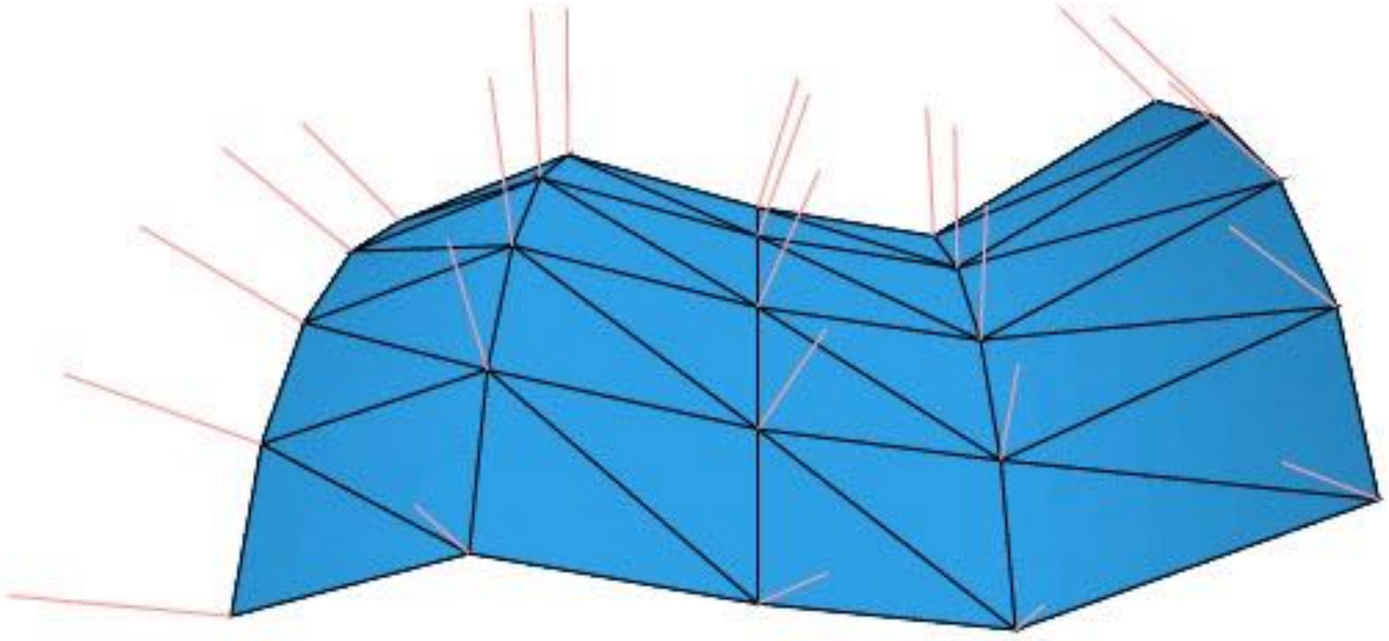

0,1
1,1
T (V)
S (U)
0,0
1,0

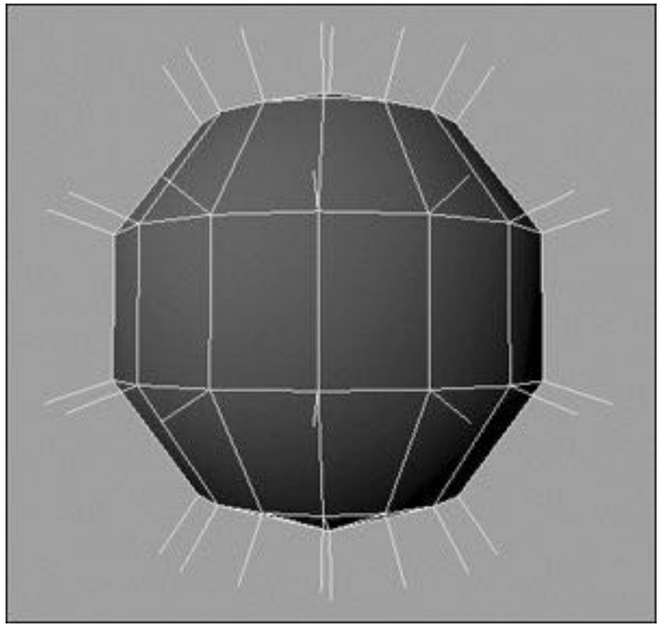




Vertex normals.


n0
n2
n1
n4
n0
n3
n1
n2





```
class Mesh {
    public:

        void Render(ShaderProgram *program);
        void loadOBJ(const char *fileName);

        std::vector<float> positions;
        std::vector<float> texcoords;
        std::vector<float> normals;
};
```

```
void Mesh::Render(ShaderProgram *program) {

    glVertexAttribPointer(program->positionAttribute, 3, GL_FLOAT, false, 0, positions.data());
    glEnableVertexAttribArray(program->positionAttribute);

    glVertexAttribPointer(program->texCoordAttribute, 2, GL_FLOAT, false, 0, texcoords.data());
    glEnableVertexAttribArray(program->texCoordAttribute);

    glDrawArrays(GL_TRIANGLES, 0, positions.size()/3);

    glDisableVertexAttribArray(program->positionAttribute);
    glDisableVertexAttribArray(program->texCoordAttribute);
}
```

Loading meshes from OBJ files.

Basic OBJ file structure

Indexes are **1-based**, V is **inverse in Texture Coordinates**.

```
# comment

# vertex
v -0.436826 -0.208037 1.060532

# texture coordinate
vt 0.859375 0.500000

# vertex normal
vn 0.707 0.000 0.707

# indices
# can reference vertex
# or vertex / texture coordinate
# or vertex / texture coordinate / normal
f 21/10/3 16/11/5 1/7/2
```

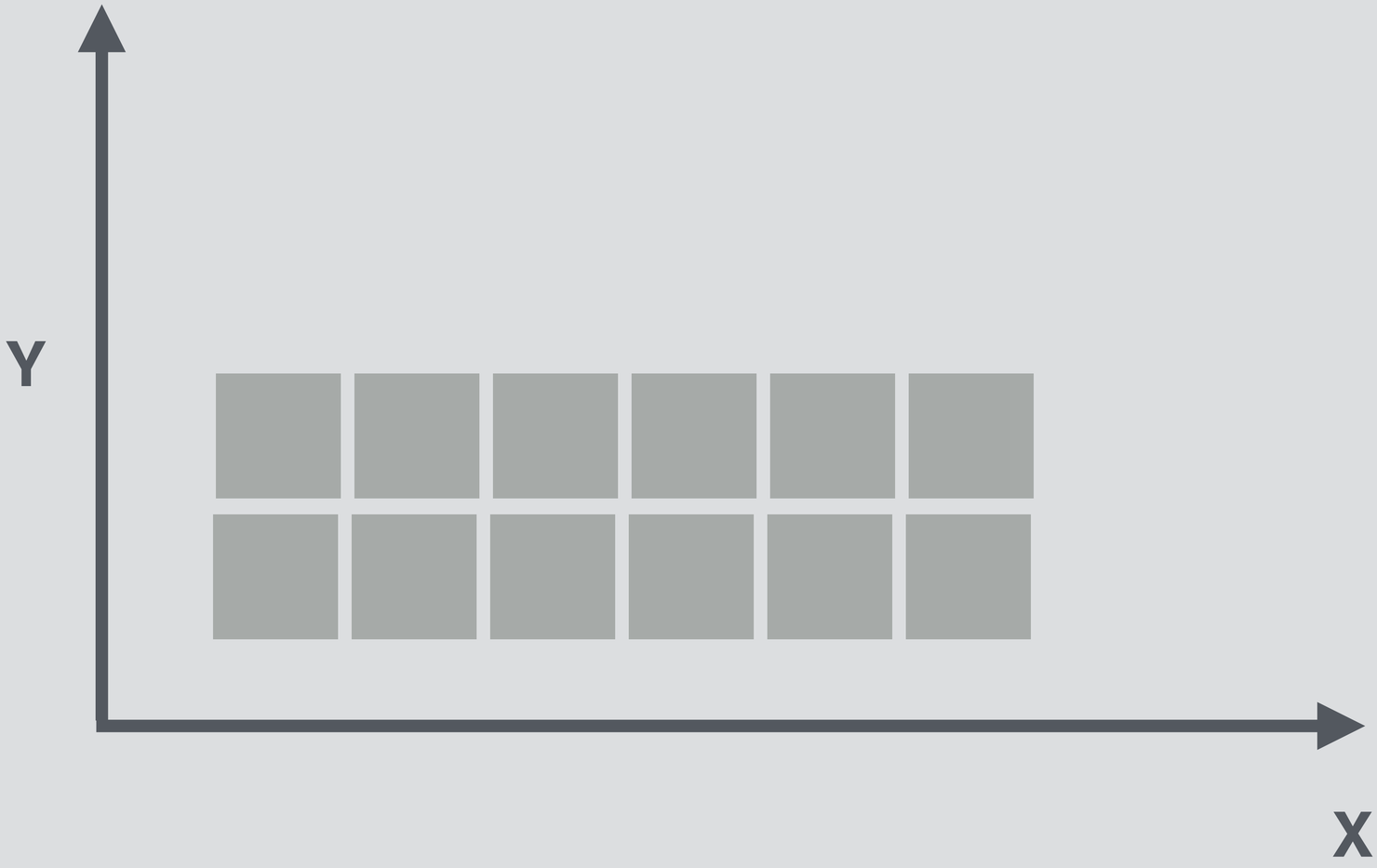
Using tinyOBJLoader

```
#define TINYOBJLOADER_IMPLEMENTATION
#include "tiny_obj_loader.h"
```

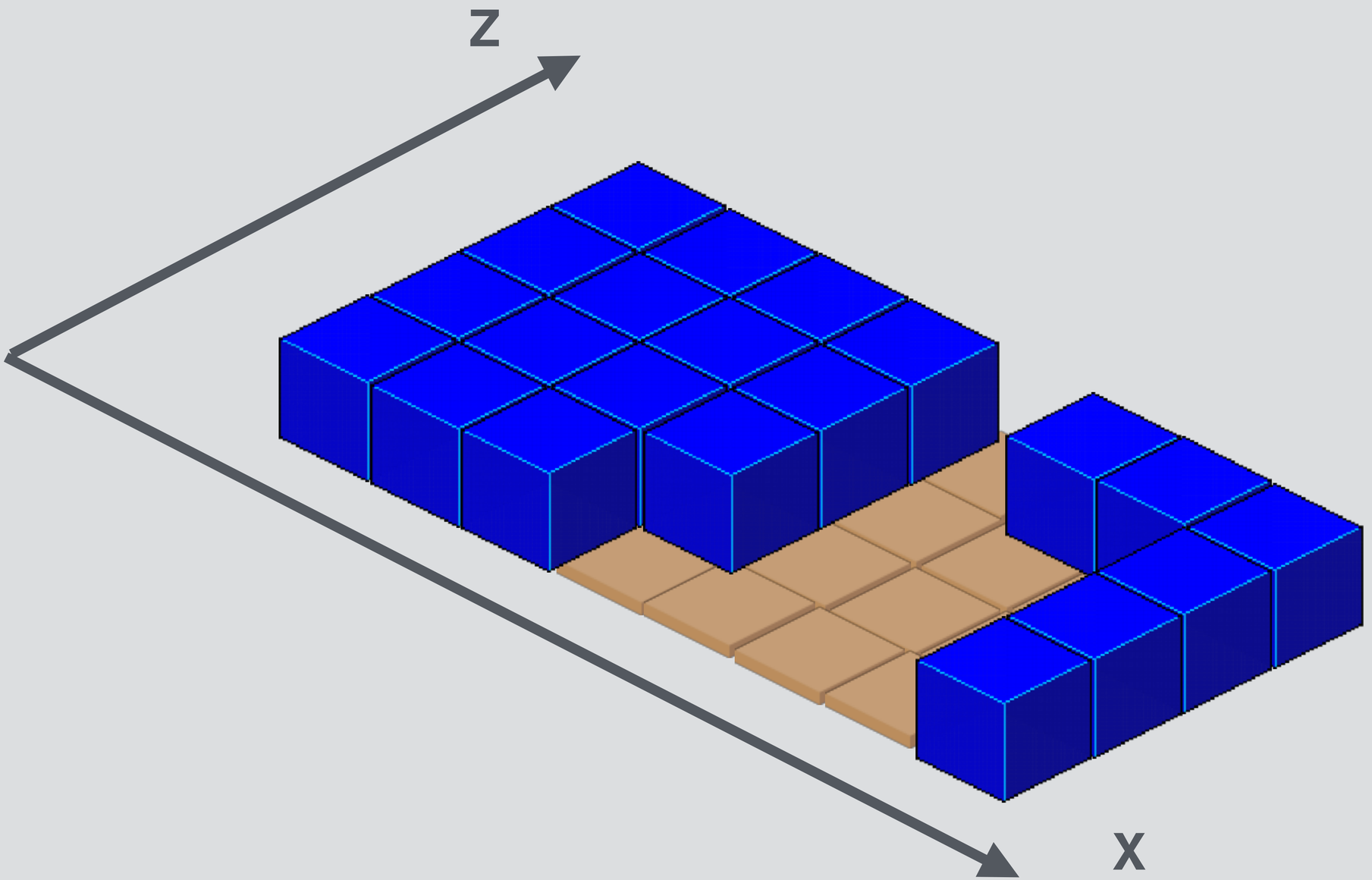
```
void Mesh::loadOBJ(const char *fileName) {
    tinyobj::attrib_t attrib;
    std::vector<tinyobj::shape_t> shapes;
    std::vector<tinyobj::material_t> materials;
    std::string err;

    bool ret = tinyobj::LoadObj(&attrib, &shapes, &materials, &err, fileName, NULL, true);

    if(ret) {
        for(int i=0; i < shapes.size(); i++) {
            for(int j=0; j < shapes[i].mesh.indices.size(); j++) {

                unsigned int vertexOffset = shapes[i].mesh.indices[j].vertex_index * 3;
                unsigned int normalOffset = shapes[i].mesh.indices[j].normal_index * 3;
                unsigned int texOffset = shapes[i].mesh.indices[j].texcoord_index * 2;

                positions.push_back(attrib.vertices[vertexOffset]);
                positions.push_back(attrib.vertices[vertexOffset+1]);
                positions.push_back(attrib.vertices[vertexOffset+2]);

                normals.push_back(attrib.normals[normalOffset]);
                normals.push_back(attrib.normals[normalOffset+1]);
                normals.push_back(attrib.normals[normalOffset+2]);

                texcoords.push_back(attrib.texcoords[texOffset]);
                texcoords.push_back(1.0f - attrib.texcoords[texOffset+1]);
            }
        }
    } else {
        std::cout << err << std::endl;
        assert(false);
    }
}
```

Loading a 2D tilemap level in 3D

In 2D



In 3D

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