Roll No: 1703016

Lab Performance Test 2

Lab Task Q1

Question: Show an OpenGL program which will show a triangle whose triangle's color will alternate between a black color and blue color after some time.

Solution (Bold your own written code):

```
// Show an OpenGL program which will show a triangle
whose triangle's color will alternate between a black
color and blue color after some time.
// Roll: 1703016

#include "glad.h"
#include "glfw3.h"

#include "shader_s.h"
#include<math.h>

#include <iostream>

void framebuffer_size_callback(GLFWwindow* window, int
width, int height);
void processInput(GLFWwindow *window);

// settings
const unsigned int SCR_WIDTH = 800;
const unsigned int SCR_HEIGHT = 600;

const char *vertexShaderSource ="#version 330 core\n"
    "layout (location = 0) in vec3 aPos;\n"
    "void main()\n"
    "{\n"
    "   gl_Position = vec4(aPos.x + 0.0, aPos.y, aPos.z,
1.0);\n"
    "}\0";

const char *fragmentShaderSource = "#version 330 core\n"
    "out vec4 FragColor;\n"
    "uniform vec4 ourColor;\n"
    "void main()\n"
    "{\n"
    "   FragColor = ourColor;\n"
    "}\n\0";
```

```
int main()
{
    // glfw: initialize and configure
    // ------------------------------
    glfwInit();
    glfwWindowHint(GLFW_CONTEXT_VERSION_MAJOR, 3);
    glfwWindowHint(GLFW_CONTEXT_VERSION_MINOR, 3);
    glfwWindowHint(GLFW_OPENGL_PROFILE,
GLFW_OPENGL_CORE_PROFILE);

#ifdef __APPLE__
    glfwWindowHint(GLFW_OPENGL_FORWARD_COMPAT, GL_TRUE);
#endif

    // glfw window creation
    // --------------------
    GLFWwindow* window = glfwCreateWindow(SCR_WIDTH,
SCR_HEIGHT, "LearnOpenGL", NULL, NULL);
    if (window == NULL)
    {
        std::cout << "Failed to create GLFW window" <<
std::endl;
        glfwTerminate();
        return -1;
    }
    glfwMakeContextCurrent(window);
    glfwSetFramebufferSizeCallback(window,
framebuffer_size_callback);

    // glad: load all OpenGL function pointers
    // ---------------------------------------
    if
(!gladLoadGLLoader((GLADloadproc)glfwGetProcAddress))
    {
        std::cout << "Failed to initialize GLAD" <<
std::endl;
        return -1;
    }

    // build and compile our shader program
    // ------------------------------------
    // vertex shader
    unsigned int vertexShader =
glCreateShader(GL_VERTEX_SHADER);
    glShaderSource(vertexShader, 1, &vertexShaderSource,
```

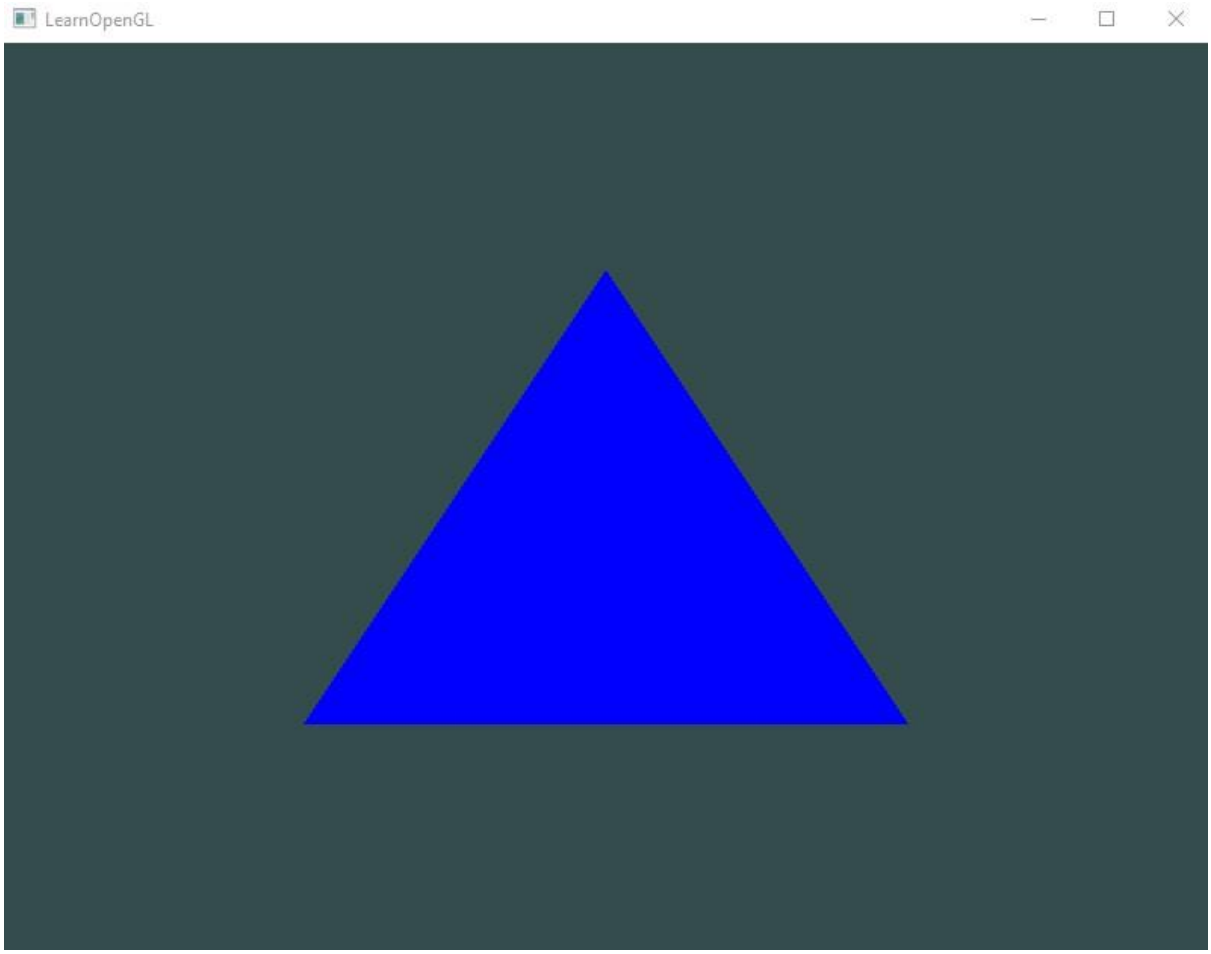
```
NULL);
    glCompileShader(vertexShader);
    // check for shader compile errors
    int success;
    char infoLog[512];
    glGetShaderiv(vertexShader, GL_COMPILE_STATUS,
&success);
    if (!success)
    {
        glGetShaderInfoLog(vertexShader, 512, NULL,
infoLog);
        std::cout <<
"ERROR::SHADER::VERTEX::COMPILATION_FAILED\n" << infoLog
<< std::endl;
    }
    // fragment shader
    unsigned int fragmentShader =
glCreateShader(GL_FRAGMENT_SHADER);
    glShaderSource(fragmentShader, 1,
&fragmentShaderSource, NULL);
    glCompileShader(fragmentShader);
    // check for shader compile errors
    glGetShaderiv(fragmentShader, GL_COMPILE_STATUS,
&success);
    if (!success)
    {
        glGetShaderInfoLog(fragmentShader, 512, NULL,
infoLog);
        std::cout <<
"ERROR::SHADER::FRAGMENT::COMPILATION_FAILED\n" <<
infoLog << std::endl;
    }
    // link shaders
    unsigned int shaderProgram = glCreateProgram();
    glAttachShader(shaderProgram, vertexShader);
    glAttachShader(shaderProgram, fragmentShader);
    glLinkProgram(shaderProgram);
    // check for linking errors
    glGetProgramiv(shaderProgram, GL_LINK_STATUS,
&success);
    if (!success) {
        glGetProgramInfoLog(shaderProgram, 512, NULL,
infoLog);
        std::cout <<
"ERROR::SHADER::PROGRAM::LINKING_FAILED\n" << infoLog <<
std::endl;
```

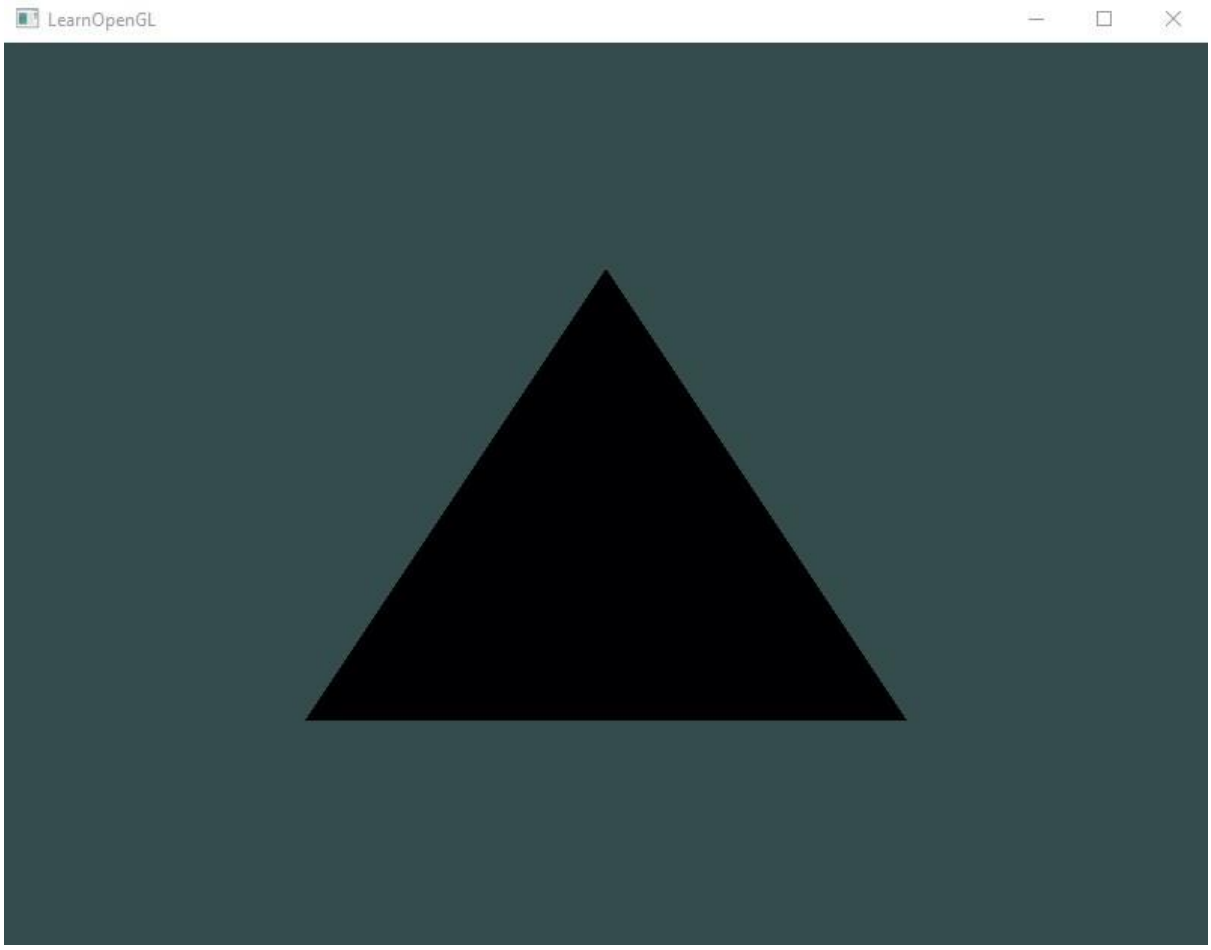
```
    }
    glDeleteShader(vertexShader);
    glDeleteShader(fragmentShader);

    // set up vertex data (and buffer(s)) and configure
vertex attributes
    // ------------------------------------------------
-----------------
    float vertices[] = {
         0.5f, -0.5f, 0.0f,  // bottom right
        -0.5f, -0.5f, 0.0f,  // bottom left
         0.0f,  0.5f, 0.0f   // top
    };

    unsigned int VBO, VAO;
    glGenVertexArrays(1, &VAO);
    glGenBuffers(1, &VBO);
    // bind the Vertex Array Object first, then bind and
set vertex buffer(s), and then configure vertex
attributes(s).
    glBindVertexArray(VAO);

    glBindBuffer(GL_ARRAY_BUFFER, VBO);
    glBufferData(GL_ARRAY_BUFFER, sizeof(vertices),
vertices, GL_STATIC_DRAW);

    glVertexAttribPointer(0, 3, GL_FLOAT, GL_FALSE, 3 *
sizeof(float), (void*)0);
    glEnableVertexAttribArray(0);

    // You can unbind the VAO afterwards so other VAO
calls won't accidentally modify this VAO, but this
rarely happens. Modifying other
    // VAOs requires a call to glBindVertexArray anyways
so we generally don't unbind VAOs (nor VBOs) when it's
not directly necessary.
    // glBindVertexArray(0);


    // bind the VAO (it was already bound, but just to
demonstrate): seeing as we only have a single VAO we can
    // just bind it beforehand before rendering the
respective triangle; this is another approach.
    glBindVertexArray(VAO);
```

```
    // render loop
    // -----------
    while (!glfwWindowShouldClose(window))
    {
        // input
        // -----
        processInput(window);

        // render
        // ------
        glClearColor(0.2f, 0.3f, 0.3f, 1.0f);
        glClear(GL_COLOR_BUFFER_BIT);

        // be sure to activate the shader before any
calls to glUniform
        glUseProgram(shaderProgram);

        // update shader uniform
        double timeValue = glfwGetTime();
        float blueValue =
static_cast<float>(sin(timeValue) / 2.0 + 0.5);
        int vertexColorLocation =
glGetUniformLocation(shaderProgram, "ourColor");
        glUniform4f(vertexColorLocation, 0.0f, 0.0f,
blueValue, 1.0f);

        // render the triangle
        glDrawArrays(GL_TRIANGLES, 0, 3);

        // glfw: swap buffers and poll IO events (keys
pressed/released, mouse moved etc.)
        // -------------------------------------------
-------------------------------
        glfwSwapBuffers(window);
        glfwPollEvents();
    }

    // optional: de-allocate all resources once they've
outlived their purpose:
    // ------------------------------------------------
----------------------
    glDeleteVertexArrays(1, &VAO);
    glDeleteBuffers(1, &VBO);
    glDeleteProgram(shaderProgram);

    // glfw: terminate, clearing all previously
```

```
allocated GLFW resources.
    // ------------------------------------------------
----------------
    glfwTerminate();
    return 0;
}

// process all input: query GLFW whether relevant keys
are pressed/released this frame and react accordingly
// ---------------------------------------------------
-----------------------------------------------
void processInput(GLFWwindow *window)
{
    if (glfwGetKey(window, GLFW_KEY_ESCAPE) ==
GLFW_PRESS)
        glfwSetWindowShouldClose(window, true);
}

// glfw: whenever the window size changed (by OS or user
resize) this callback function executes
// ---------------------------------------------------
---------------------------------------
void framebuffer_size_callback(GLFWwindow* window, int
width, int height)
{
    // make sure the viewport matches the new window
dimensions; note that width and
    // height will be significantly larger than
specified on retina displays.
    glViewport(0, 0, width, height);
}
```

Output:




LearnOpenGL

Lab Task Q2

Question: Show an OpenGL program which will show a 3d pyramid at location (3,10,7) which scaled by 2 and is rotated by 90 degree counter-clockwise.

Solution (Bold your own written code):

```
// Show an OpenGL program which will show a 3d pyramid
at location (3,10,7)  which scaled by 2 and is rotated
by 90 degree counter-clockwise.
// Roll: 1703016
#include "glad.h"
#include "glfw3.h"

#include "glm/glm.hpp"
#include "glm/gtc/matrix_transform.hpp"
#include "glm/gtc/type_ptr.hpp"
#define STB_IMAGE_IMPLEMENTATION
#include "stb_image.h"
#include "shader_m.h"

#include <iostream>

void framebuffer_size_callback(GLFWwindow* window, int
width, int height);
void processInput(GLFWwindow *window);

// settings
const unsigned int SCR_WIDTH = 800;
const unsigned int SCR_HEIGHT = 600;

int main()
{
    // glfw: initialize and configure
    // ------------------------------
    glfwInit();
    glfwWindowHint(GLFW_CONTEXT_VERSION_MAJOR, 3);
    glfwWindowHint(GLFW_CONTEXT_VERSION_MINOR, 3);
    glfwWindowHint(GLFW_OPENGL_PROFILE,
GLFW_OPENGL_CORE_PROFILE);

#ifdef __APPLE__
    glfwWindowHint(GLFW_OPENGL_FORWARD_COMPAT, GL_TRUE);
#endif

    // glfw window creation
    // --------------------
```

```
    GLFWwindow* window = glfwCreateWindow(SCR_WIDTH,
SCR_HEIGHT, "LearnOpenGL", NULL, NULL);
    if (window == NULL)
    {
        std::cout << "Failed to create GLFW window" <<
std::endl;
        glfwTerminate();
        return -1;
    }
    glfwMakeContextCurrent(window);
    glfwSetFramebufferSizeCallback(window,
framebuffer_size_callback);

    // glad: load all OpenGL function pointers
    // ---------------------------------------
    if
(!gladLoadGLLoader((GLADloadproc)glfwGetProcAddress))
    {
        std::cout << "Failed to initialize GLAD" <<
std::endl;
        return -1;
    }

    // configure global opengl state
    // -----------------------------
    glEnable(GL_DEPTH_TEST);

    // build and compile our shader zprogram
    // ------------------------------------
    Shader ourShader("src\\6.2.coordinate_systems.vs",
"src\\6.2.coordinate_systems.fs");

    // set up vertex data (and buffer(s)) and configure
vertex attributes
    // ------------------------------------------------
-----------------
    float vertices[] = {
        -0.5f, -0.5f, -0.5f,  0.0f, 0.0f,
         0.5f, -0.5f, -0.5f,  1.0f, 0.0f,
         0.5f,  0.5f, -0.5f,  1.0f, 1.0f,
         0.5f,  0.5f, -0.5f,  1.0f, 1.0f,
        -0.5f,  0.5f, -0.5f,  0.0f, 1.0f,
        -0.5f, -0.5f, -0.5f,  0.0f, 0.0f,

        -0.5f, -0.5f,  0.5f,  0.0f, 0.0f,
         0.5f, -0.5f,  0.5f,  1.0f, 0.0f,
```

```
         0.5f,  0.5f,  0.5f,  1.0f, 1.0f,
         0.5f,  0.5f,  0.5f,  1.0f, 1.0f,
        -0.5f,  0.5f,  0.5f,  0.0f, 1.0f,
        -0.5f, -0.5f,  0.5f,  0.0f, 0.0f,

        -0.5f,  0.5f,  0.5f,  1.0f, 0.0f,
        -0.5f,  0.5f, -0.5f,  1.0f, 1.0f,
        -0.5f, -0.5f, -0.5f,  0.0f, 1.0f,
        -0.5f, -0.5f, -0.5f,  0.0f, 1.0f,
        -0.5f, -0.5f,  0.5f,  0.0f, 0.0f,
        -0.5f,  0.5f,  0.5f,  1.0f, 0.0f,

         0.5f,  0.5f,  0.5f,  1.0f, 0.0f,
         0.5f,  0.5f, -0.5f,  1.0f, 1.0f,
         0.5f, -0.5f, -0.5f,  0.0f, 1.0f,
         0.5f, -0.5f, -0.5f,  0.0f, 1.0f,
         0.5f, -0.5f,  0.5f,  0.0f, 0.0f,
         0.5f,  0.5f,  0.5f,  1.0f, 0.0f,

        -0.5f, -0.5f, -0.5f,  0.0f, 1.0f,
         0.5f, -0.5f, -0.5f,  1.0f, 1.0f,
         0.5f, -0.5f,  0.5f,  1.0f, 0.0f,
         0.5f, -0.5f,  0.5f,  1.0f, 0.0f,
        -0.5f, -0.5f,  0.5f,  0.0f, 0.0f,
        -0.5f, -0.5f, -0.5f,  0.0f, 1.0f,

        -0.5f,  0.5f, -0.5f,  0.0f, 1.0f,
         0.5f,  0.5f, -0.5f,  1.0f, 1.0f,
         0.5f,  0.5f,  0.5f,  1.0f, 0.0f,
         0.5f,  0.5f,  0.5f,  1.0f, 0.0f,
        -0.5f,  0.5f,  0.5f,  0.0f, 0.0f,
        -0.5f,  0.5f, -0.5f,  0.0f, 1.0f
    };
    unsigned int VBO, VAO;
    glGenVertexArrays(1, &VAO);
    glGenBuffers(1, &VBO);

    glBindVertexArray(VAO);

    glBindBuffer(GL_ARRAY_BUFFER, VBO);
    glBufferData(GL_ARRAY_BUFFER, sizeof(vertices),
vertices, GL_STATIC_DRAW);

    // position attribute
    glVertexAttribPointer(0, 3, GL_FLOAT, GL_FALSE, 5 *
sizeof(float), (void*)0);
```

```
    glEnableVertexAttribArray(0);
    // texture coord attribute
    glVertexAttribPointer(1, 2, GL_FLOAT, GL_FALSE, 5 *
sizeof(float), (void*)(3 * sizeof(float)));
    glEnableVertexAttribArray(1);


    // load and create a texture
    // -------------------------
    unsigned int texture1, texture2;
    // texture 1
    // ---------
    glGenTextures(1, &texture1);
    glBindTexture(GL_TEXTURE_2D, texture1);
    // set the texture wrapping parameters
    glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_WRAP_S,
GL_REPEAT);
    glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_WRAP_T,
GL_REPEAT);
    // set texture filtering parameters
    glTexParameteri(GL_TEXTURE_2D,
GL_TEXTURE_MIN_FILTER, GL_LINEAR);
    glTexParameteri(GL_TEXTURE_2D,
GL_TEXTURE_MAG_FILTER, GL_LINEAR);
    // load image, create texture and generate mipmaps
    int width, height, nrChannels;
    stbi_set_flip_vertically_on_load(true); // tell
stb_image.h to flip loaded texture's on the y-axis.
    unsigned char *data =
stbi_load("src\\container.jpg", &width, &height,
&nrChannels, 0);
    if (data)
    {
        glTexImage2D(GL_TEXTURE_2D, 0, GL_RGB, width,
height, 0, GL_RGB, GL_UNSIGNED_BYTE, data);
        glGenerateMipmap(GL_TEXTURE_2D);
    }
    else
    {
        std::cout << "Failed to load texture" <<
std::endl;
    }
    stbi_image_free(data);
    // texture 2
    // ---------
    glGenTextures(1, &texture2);
```

```
    glBindTexture(GL_TEXTURE_2D, texture2);
    // set the texture wrapping parameters
    glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_WRAP_S,
GL_REPEAT);
    glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_WRAP_T,
GL_REPEAT);
    // set texture filtering parameters
    glTexParameteri(GL_TEXTURE_2D,
GL_TEXTURE_MIN_FILTER, GL_LINEAR);
    glTexParameteri(GL_TEXTURE_2D,
GL_TEXTURE_MAG_FILTER, GL_LINEAR);
    // load image, create texture and generate mipmaps
    data =
stbi_load("src\\resources\\textures\\awesomeface.png",
&width, &height, &nrChannels, 0);
    if (data)
    {
        // note that the awesomeface.png has
transparency and thus an alpha channel, so make sure to
tell OpenGL the data type is of GL_RGBA
        glTexImage2D(GL_TEXTURE_2D, 0, GL_RGB, width,
height, 0, GL_RGBA, GL_UNSIGNED_BYTE, data);
        glGenerateMipmap(GL_TEXTURE_2D);
    }
    else
    {
        std::cout << "Failed to load texture
awesomeface" << std::endl;
    }
    stbi_image_free(data);

    // tell opengl for each sampler to which texture
unit it belongs to (only has to be done once)
    // -------------------------------------------------
-----------------------------------------
    ourShader.use();
    ourShader.setInt("texture1", 0);
    ourShader.setInt("texture2", 1);


    // render loop
    // -----------
    while (!glfwWindowShouldClose(window))
    {
        // input
        // -----
```

```
        processInput(window);

        // render
        // ------
        glClearColor(0.2f, 0.3f, 0.3f, 1.0f);
        glClear(GL_COLOR_BUFFER_BIT |
GL_DEPTH_BUFFER_BIT); // also clear the depth buffer
now!

        // bind textures on corresponding texture units
        glActiveTexture(GL_TEXTURE0);
        glBindTexture(GL_TEXTURE_2D, texture1);
        glActiveTexture(GL_TEXTURE1);
        glBindTexture(GL_TEXTURE_2D, texture2);

        // activate shader
        ourShader.use();

        // create transformations
        glm::mat4 model         = glm::mat4(1.0f); //
make sure to initialize matrix to identity matrix first
        glm::mat4 view          = glm::mat4(1.0f);
        glm::mat4 projection    = glm::mat4(1.0f);
        model = glm::translate(model,
glm::vec3(3.0f,10.0f,7.0f)); // here point update
        model = glm::rotate(model, (float)glm::radians(-
90.0f), glm::vec3(0.0f, 0.0f, 1.0f)); // here angle
update
        model = glm::scale(model, glm::vec3(2.0, 2.0,
2.0)); // here scaling update
        projection =
glm::perspective(glm::radians(45.0f), (float)SCR_WIDTH /
(float)SCR_HEIGHT, 0.1f, 100.0f);
        // retrieve the matrix uniform locations
        unsigned int modelLoc =
glGetUniformLocation(ourShader.ID, "model");
        unsigned int viewLoc  =
glGetUniformLocation(ourShader.ID, "view");
        // pass them to the shaders (3 different ways)
        glUniformMatrix4fv(modelLoc, 1, GL_FALSE,
glm::value_ptr(model));
        glUniformMatrix4fv(viewLoc, 1, GL_FALSE,
&view[0][0]);
        // note: currently we set the projection matrix
each frame, but since the projection matrix rarely
changes it's often best practice to set it outside the
```

```
main loop only once.
        ourShader.setMat4("projection", projection);

        // render box
        glBindVertexArray(VAO);
        glDrawArrays(GL_TRIANGLES, 0, 36);


        // glfw: swap buffers and poll IO events (keys
pressed/released, mouse moved etc.)
        // -------------------------------------------
---------------------------------
        glfwSwapBuffers(window);
        glfwPollEvents();
    }

    // optional: de-allocate all resources once they've
outlived their purpose:
    // ------------------------------------------------
----------------------
    glDeleteVertexArrays(1, &VAO);
    glDeleteBuffers(1, &VBO);

    // glfw: terminate, clearing all previously
allocated GLFW resources.
    // ------------------------------------------------
-----------------
    glfwTerminate();
    return 0;
}

// process all input: query GLFW whether relevant keys
are pressed/released this frame and react accordingly
// -----------------------------------------------------
-------------------------------------------------
void processInput(GLFWwindow *window)
{
    if (glfwGetKey(window, GLFW_KEY_ESCAPE) ==
GLFW_PRESS)
        glfwSetWindowShouldClose(window, true);
}

// glfw: whenever the window size changed (by OS or user
resize) this callback function executes
// -----------------------------------------------------
---------------------------------------
```

```
void framebuffer_size_callback(GLFWwindow* window, int
width, int height)
{
    // make sure the viewport matches the new window
dimensions; note that width and
    // height will be significantly larger than
specified on retina displays.
    glViewport(0, 0, width, height);
}
```

Output: