CSCI3260
Principles of Computer Graphics

---------Tutorial 1

XU Jiaqi

About this course:

- XU Jiaqi (jqxu@cse.cuhk.edu.hk)
  Office: SHB 1024
  Office hour: Friday 3:30pm-5:30pm
- Tutorial hours:
  Monday 3:30pm-4:15pm
  Thursday 5:30pm-6:15pm
- To download tutorial notes:
  Blackboard system
- Program language:
  OpenGL; C++

Basic schedule:

	Announce on	Due on
• Assignment 1	14/9	4/10
• Assignment 2		
• Course project		
• Mid-term exam		
• Final exam		

OUTLINE

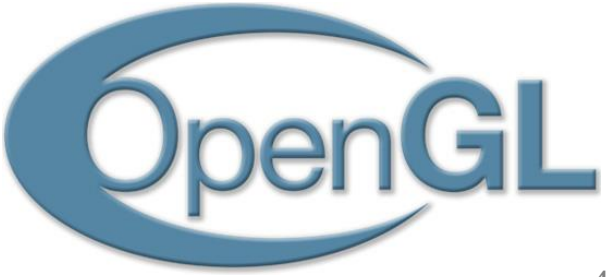
- Introduction to OpenGL
- Setup OpenGL environment

OpenGL (Open Graphics Library):

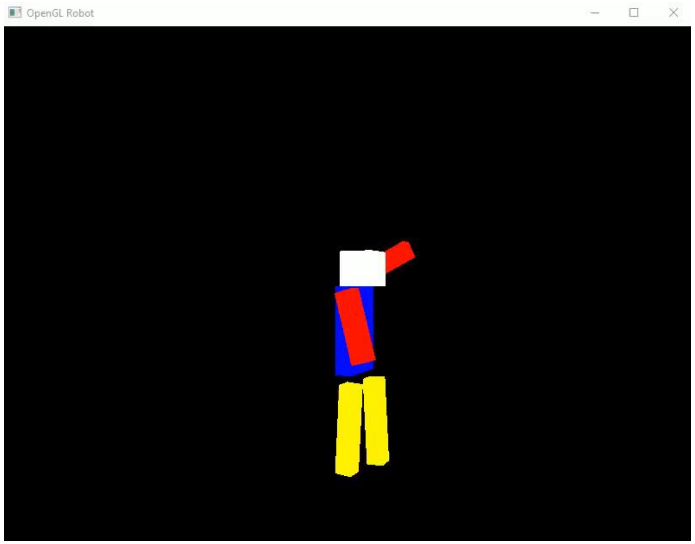
- A cross-language, cross-platform application programming interface (API) for rendering 2D and 3D graphics → communicate with graphic hardware (GPU)
- Official website: *https://www.opengl.org/*
- Silicon Graphics Inc. (SGI) developed OpenGL in 1991, and the latest version is OpenGL 4.6
- Widely used in computer-aided design, virtual reality, visualization, games, etc.

OpenGL vs. DirectX:

- Both 2D/3D graphics API
- OpenGL is multi-platform; DX is for Windows only
- DX is a more complicated API (powerful for sound and video)



Examples programmed by OpenGL:



More about OpenGL:

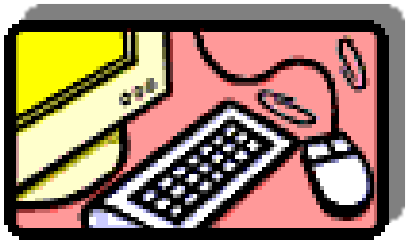
- OpenGL ES (OpenGL for Embedded Systems)
  - A subset of OpenGL
  - For portable devices, like cell phone, computer tablets
  - Multi-platform (iPhone, Android, Windows mobile, …)

More about OpenGL:

- WebGL (Web Graphics Library)
  - A JavaScript API for rendering interactive 3D computer graphics and 2D graphics within any compatible web browser without the use of plug-ins.
  - Multi-platform
  - WebGL is widely supported in modern browsers, including desktop browsers and mobile browsers, such as Google Chrome, Safari, Opera, Internet Explorer, Microsoft Edge, etc.
- WebGL samples: http://webglsamples.org/

What OpenGL (solely) doesn't do:

- In order to run OpenGL under every system, no commands for performing windowing / event system are provided



To develop an interactive graphics application, other OpenGL related utility libraries are required.

OpenGL related libraries:

- **UI library**

  (provide programmers to create and manage windows, as well as handle joystick, keyboard and mouse input)

  - OpenGL Utility Toolkit Library (GLUT) ----- no longer maintained
  - FreeGLUT (*http://freeglut.sourceforge.net/*)
  - GLFW (*http://www.glfw.org/*)
- **Extension library (query and load OpenGL extensions)**
  - OpenGL Extension Wrangler Library (GLEW) (*http://glew.sourceforge.net/*)
- **Mathematical library**
  - OpenGL Mathematics (GLM) (*https://glm.g-truc.net/0.9.9/index.html*)

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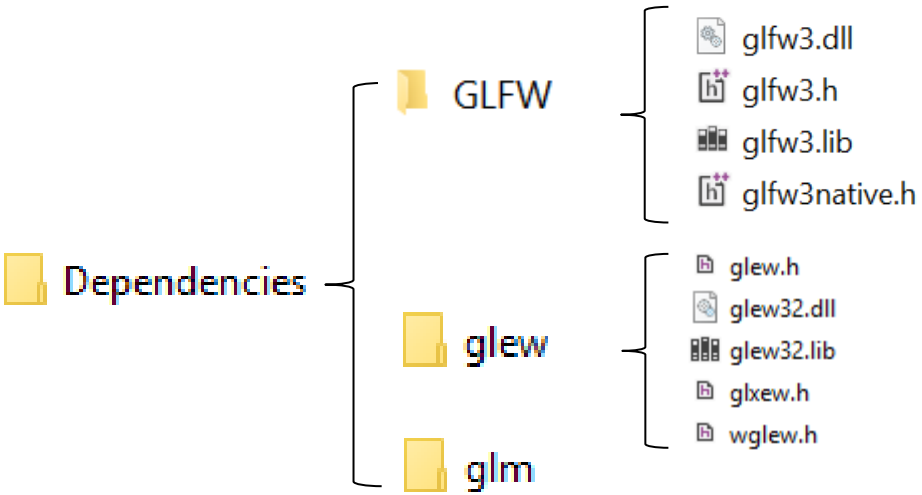
Setup OpenGL environment (for Windows):

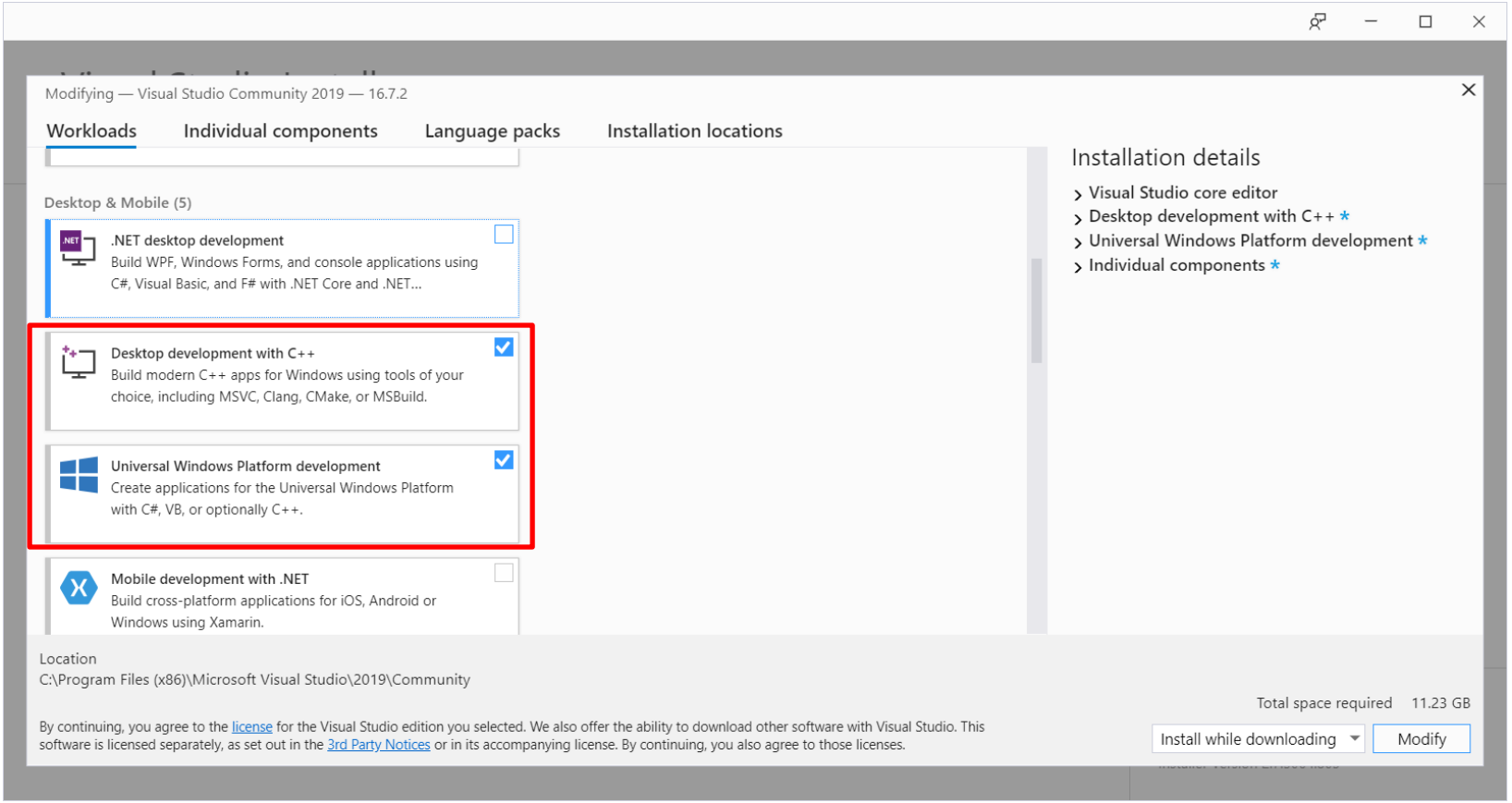
- Programming language: OpenGL & C++ (VS2019 is recommended)
- GLFW & GLEW & GLM

Resources:

- VS2019: https://visualstudio.microsoft.com/downloads/
- GLEW: http://glew.sourceforge.net/ (download precompiled binaries)
- GLFW: https://www.glfw.org/download.html (download precompiled binaries)
- GLM: https://glm.g-truc.net/0.9.9/index.html



Setup OpenGL environment (for Windows):



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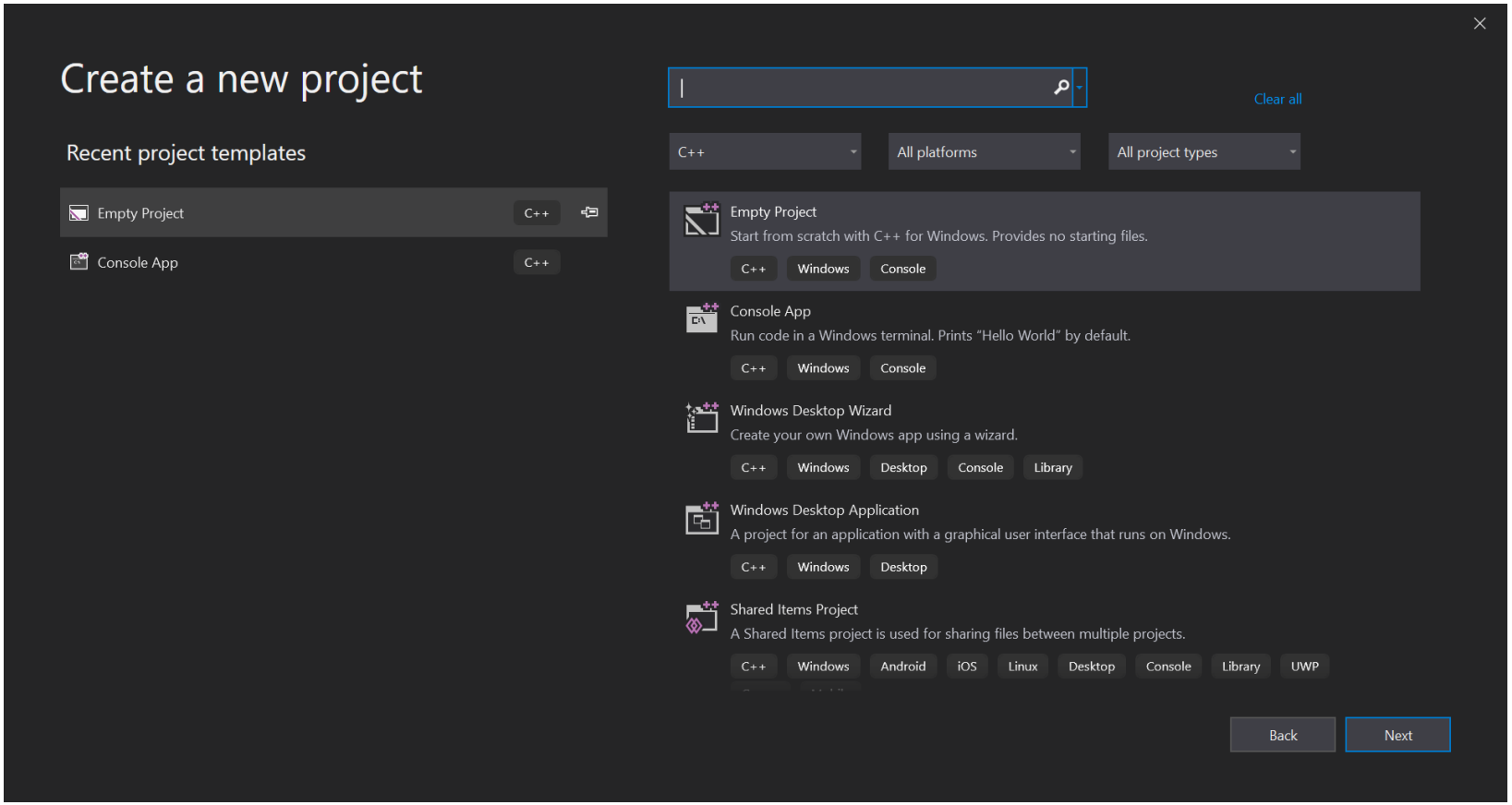
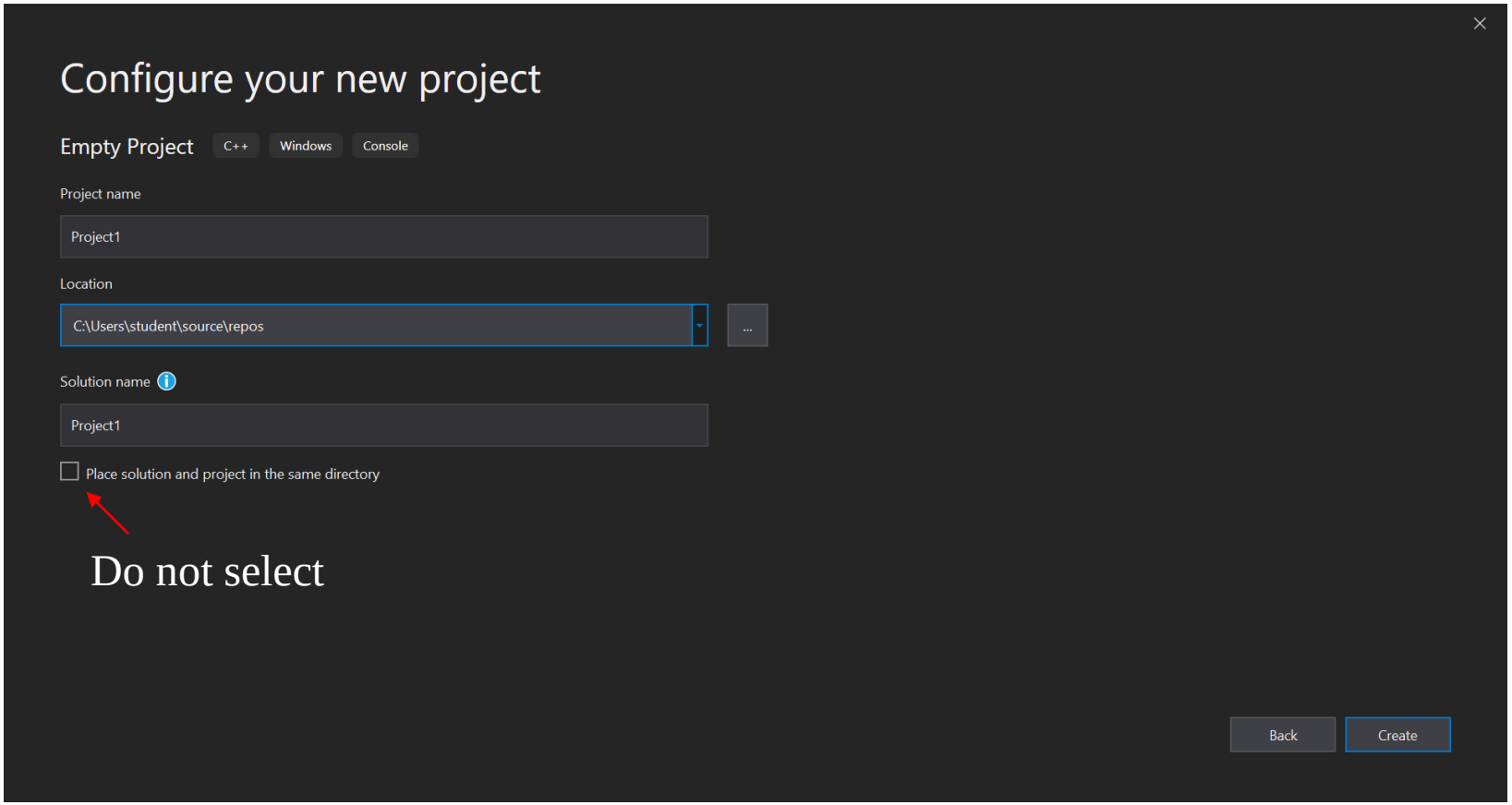
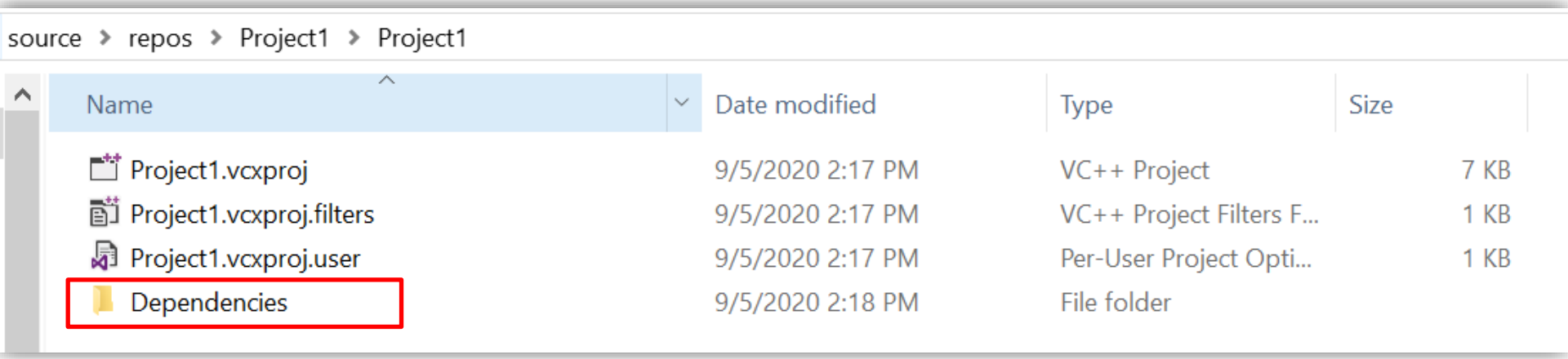


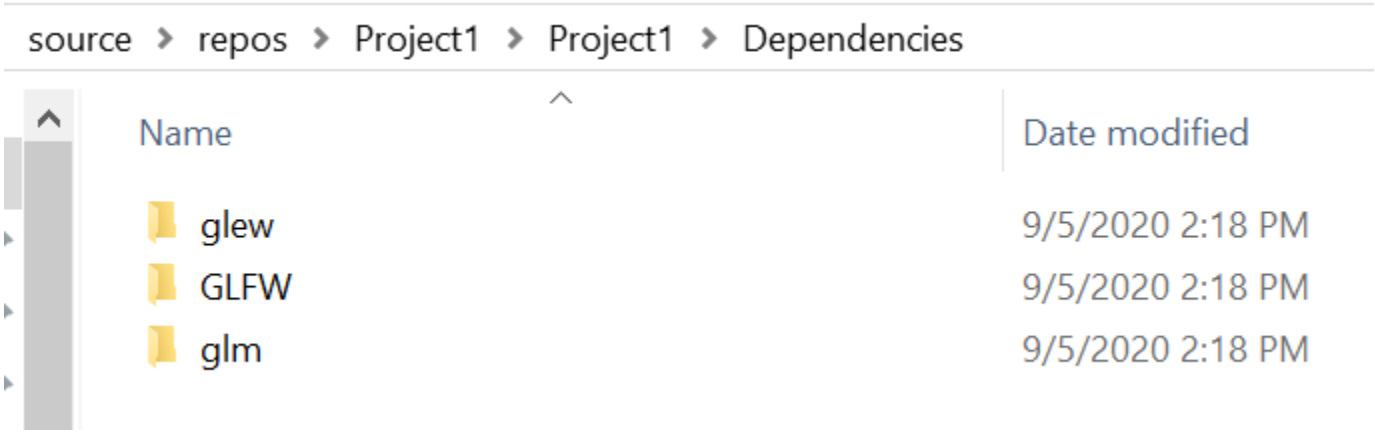
Setup OpenGL environment (for Windows):



Setup OpenGL environment (for Windows):

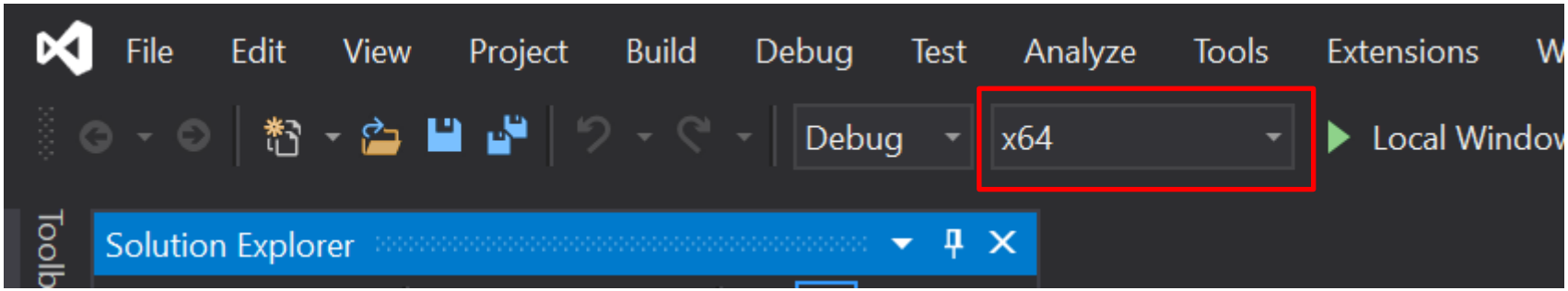
Copy “Dependencies” folder into your project folder.



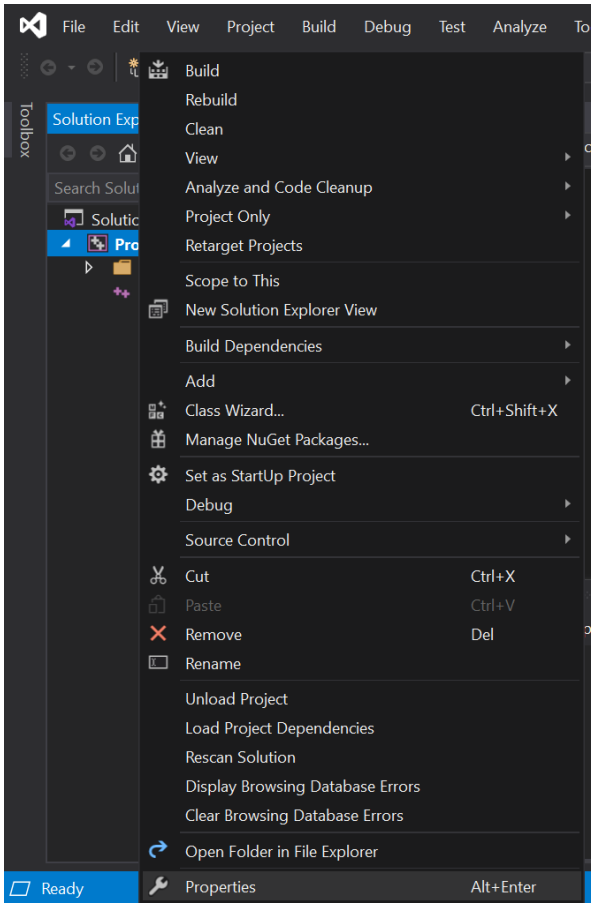


Setup OpenGL environment (for Windows):

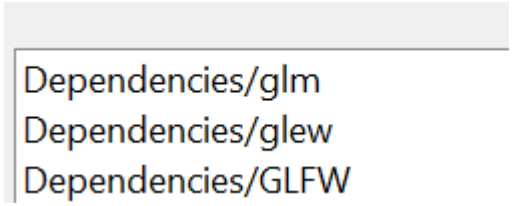
Make sure your platform is ***x64***!



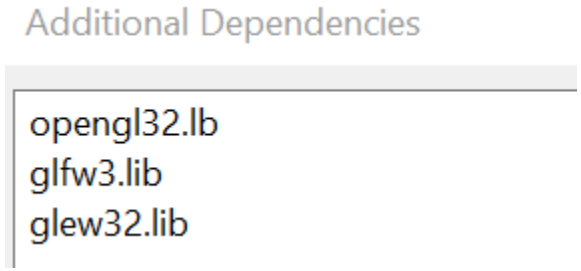
Setup OpenGL environment (for Windows):



1. Right click the project name ⟶ ***Properties***
2. ***Linker ⟶ General ⟶ Additional Library Directories***
3. Add the "GLFW" & "glew" & "glm" folder



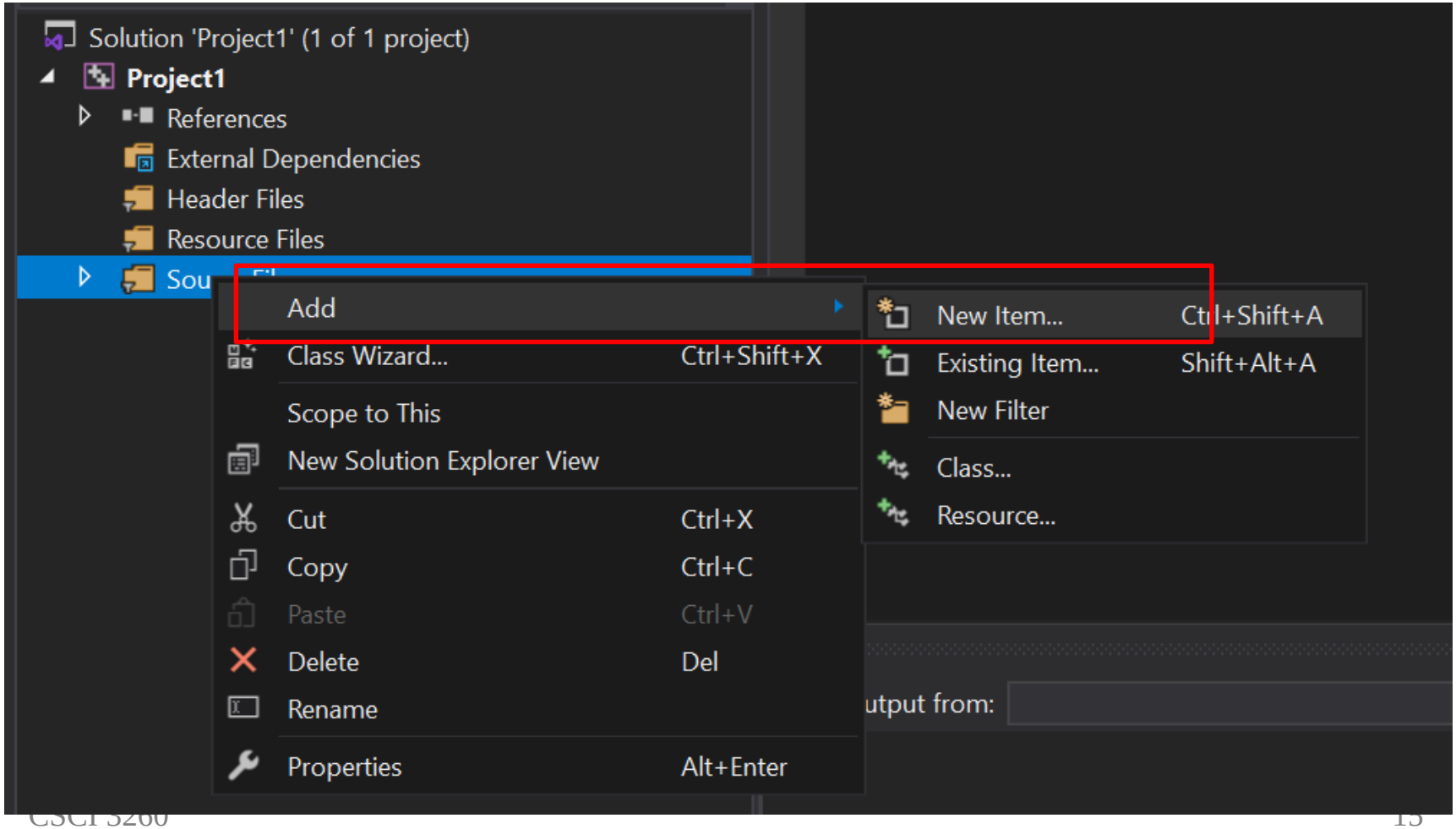
4. ***Linker ⟶ Input ⟶ Additional Dependencies***
5. Add ***"opengl32.lib; glfw3.lib; glew32.lib;"***



6. Press "***Apply***" & "***OK***"

Setup OpenGL environment (for Windows):

Right click *Source Files* ⇒ *Add* ⇒ *New Item* to add a main.cpp.



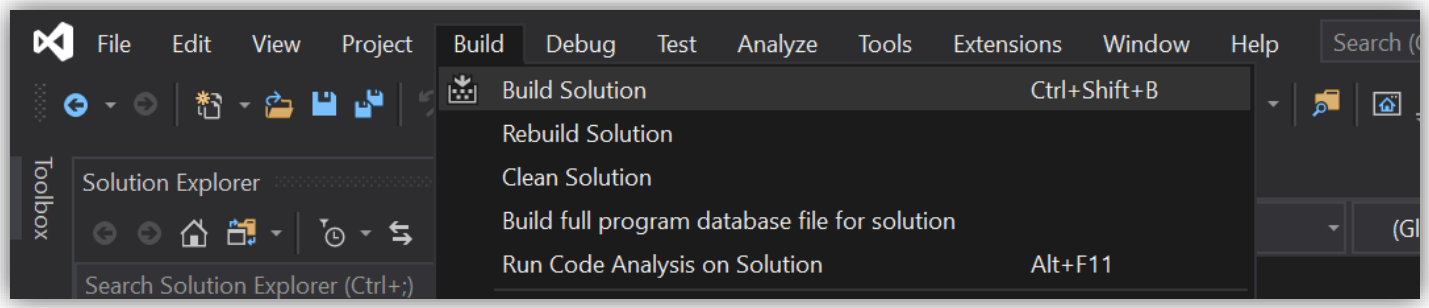
Setup OpenGL environment (for Windows):

Type this short code to test whether the OpenGL environment is setup successfully. Refer to https://www.glfw.org/documentation.html.

```c
#include "Dependencies/glew/glew.h"
#include "Dependencies/GLFW/glfw3.h"


int main(void)
{
    GLFWwindow* window;

    /* Initialize the library */
    if (!glfwInit())
        return -1;

    /* Create a windowed mode window and its OpenGL context */
    window = glfwCreateWindow(640, 480, "InitialTry!", NULL, NULL);
    if (!window)
    {
        glfwTerminate();
        return -1;
    }

    /* Make the window's context current */
    glfwMakeContextCurrent(window);

    /* Loop until the user closes the window */
    while (!glfwWindowShouldClose(window))
    {
        /* Render here */
        glClear(GL_COLOR_BUFFER_BIT);
        glColor3f(0.0f, 1.0f, 0.0f);
        glRectf(-0.5f, -0.5f, 0.5f, 0.5f);

        /* Swap front and back buffers */
        glfwSwapBuffers(window);

        /* Poll for and process events */
        glfwPollEvents();
    }

    glfwTerminate();
    return 0;
}
```

Setup OpenGL environment (for Windows):

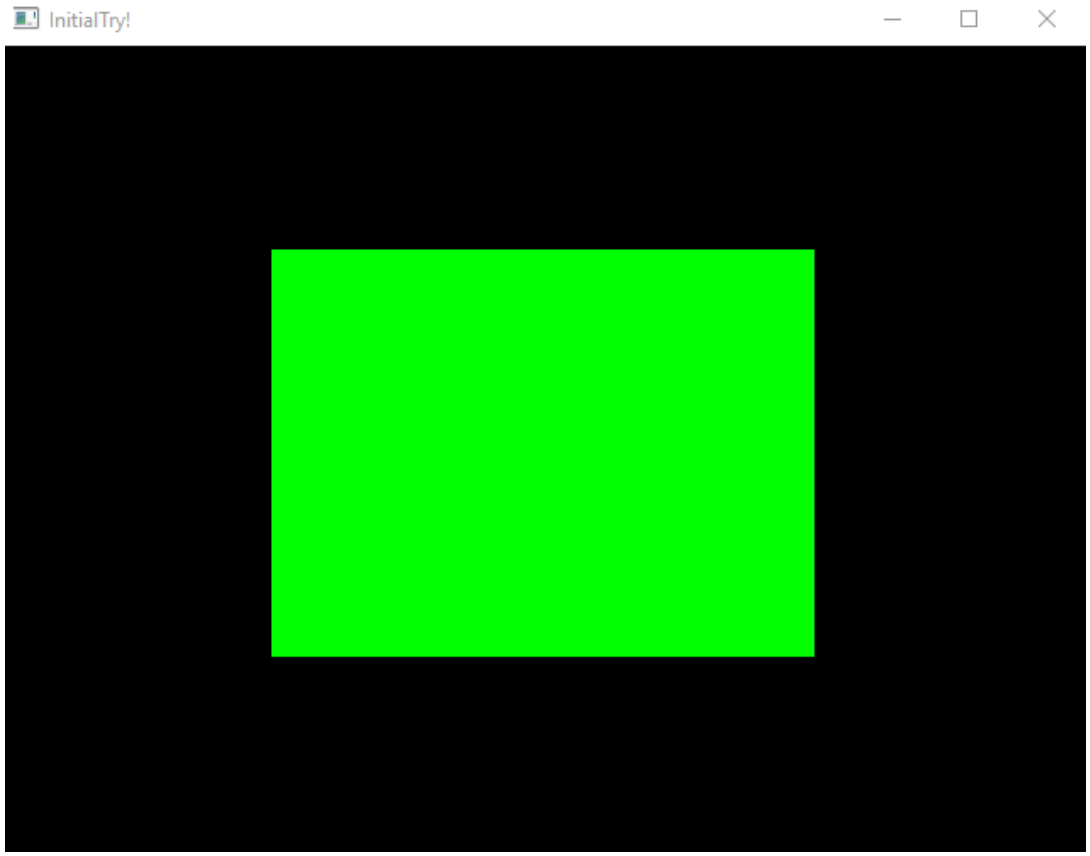
Press *Build* ⇒ *Build Solution.*



If build successfully, the final step is to copy *glew32. dll* to **the Debug folder that contains exe item** (for later tutorial & assignment use).

Press *F*5 to see the output.

Setup OpenGL environment (for Windows):



Output image

Setup OpenGL environment (for MacOS):

1. See the self-study material.

2. YouTube video:
   https://www.youtube.com/watch?v=Tz0dq2krCW8&list=PLRtjMdoYXLf6zUMDJVRZYV-6g6n62vet8&index=1
   https://www.youtube.com/watch?v=VbBePBp_NbY

3. Links (Chinese):
   http://blog.shenyuanluo.com/OpenGLEnvironment.html
   https://www.cnblogs.com/yinxiangnan-charles/p/5002293.html

Summary:

You should know:

- What is OpenGL & related utility toolkit
- How to setup OpenGL environment on your own computer

Next tutorial:

Introduction to basic OpenGL programming