



Implementation: Start Up

Introduction to Computer Graphics

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Library

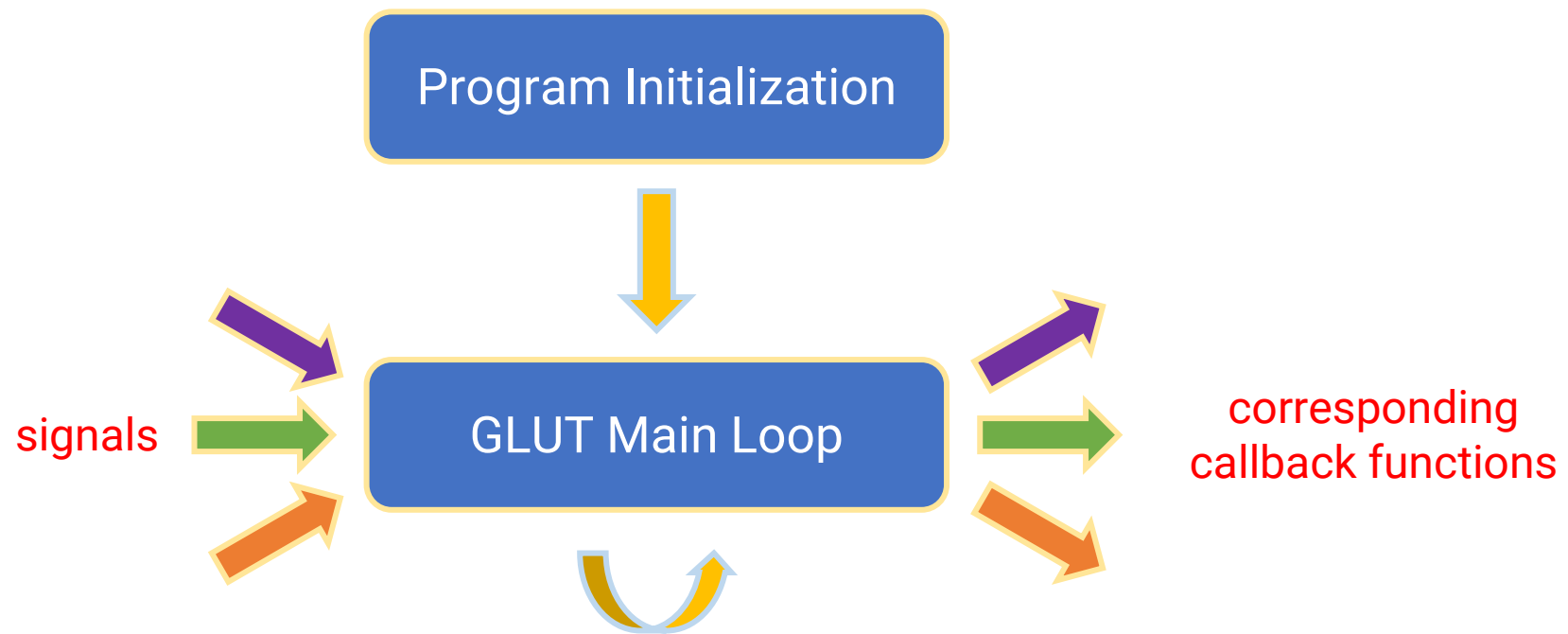
Library

- **GLUT: OpenGL Utility Toolkit ([link](#))**
 - Window system independent
 - Implement a simple window application programming interface (API) for OpenGL
 - Designed for constructing small to medium-sized OpenGL programs
 - For large applications, it is suggested to use a native window system toolkit such as Qt for more sophisticated UI
- **FreeGLUT: Free OpenGL Utility Toolkit ([link](#))**
 - GLUT has gone into stagnation and has some issues with licenses
 - FreeGLUT is intended to be a full replacement for GLUT

Program

Program Structure Overview

- OpenGL programs are event-driven



The First Program

```
// OpenGL and FreeGlut headers.
```

```
#include <freeglut.h>
```

```
int main(int argc, char** argv)
```

```
{
```

```
    // Setting window properties.
```

```
    glutInit(&argc, argv);
```

```
    glutInitDisplayMode(GLUT_DOUBLE | GLUT_RGBA | GLUT_DEPTH);
```

```
    glutInitWindowSize(640, 360);
```

```
    glutInitWindowPosition(100, 100);
```

```
    glutCreateWindow("OpenGL Renderer");
```

create the window
and set window
properties

```
    // Initialization.
```

```
    SetupRenderState();
```

do initialization
jobs

```
    // Register callback functions.
```

```
    glutDisplayFunc(RenderSceneCB);
```

```
    glutIdleFunc(RenderSceneCB);
```

```
    glutReshapeFunc(ReshapeCB);
```

```
    glutSpecialFunc(ProcessSpecialKeysCB);
```

```
    glutKeyboardFunc(ProcessKeysCB);
```

register callback
functions

```
    // Start rendering loop.
```

```
    glutMainLoop();
```

start the
main loop

```
    return 0;
```

```
}
```

Create a OpenGL (GLUT) Window

- *void **glutInit**(int *argc, char **argv);*

- Initialize the GLUT library

```
glutInit(&argc, argv);
```

- *int **glutCreateWindow**(char *name);*

- Create a top-level window

```
glutCreateWindow("OpenGL Renderer");
```

Setting Window Properties

- *void **glutInitWindowSize**(int width, int height);*

- Set the initial window size

- *void **glutInitWindowPosition**(int x, int y);*

- Set the initial window position

```
glutInitWindowSize(640, 360);  
glutInitWindowPosition(100, 100);
```

- *void **glutInitDisplayMode**(unsigned int mode);*

- Set the initial display mode

- <https://www.opengl.org/resources/libraries/glut/spec3/node12.html>

```
glutInitDisplayMode(GLUT_DOUBLE | GLUT_RGBA | GLUT_DEPTH);
```


Setting Callback Functions

- Register the callback functions when receiving events
- Commonly used
 - *glutDisplayFunc*
 - *glutIdleFunc*
 - *glutReshapeFunc*
 - *glutKeyboardFunc* / *glutSpecialFunc*
 - *glutMouseFunc*
 - *glutMenuStatusFunc*
- Each callback function has its own input format
- Please refer to the following page for all possible callback functions
 - <https://www.opengl.org/resources/libraries/glut/spec3/node45.html>

Setting Callback Functions (cont.)

```
void RenderSceneCB()
{
    glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
    // Render something here.
    // TODO.
    glutSwapBuffers();
}
```

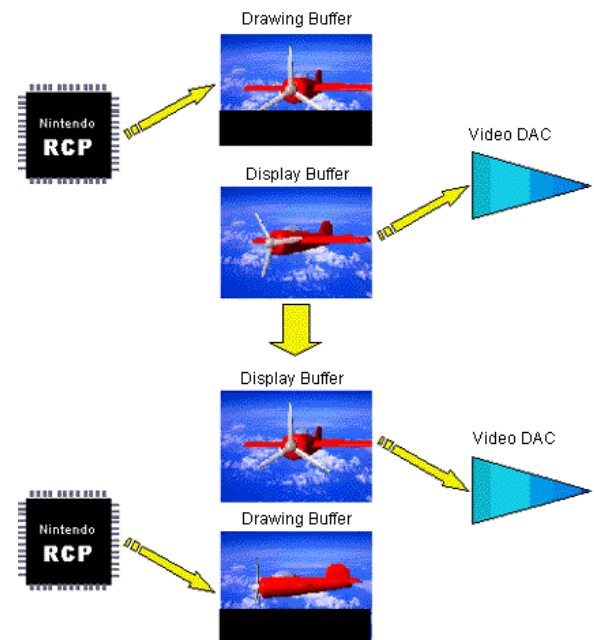
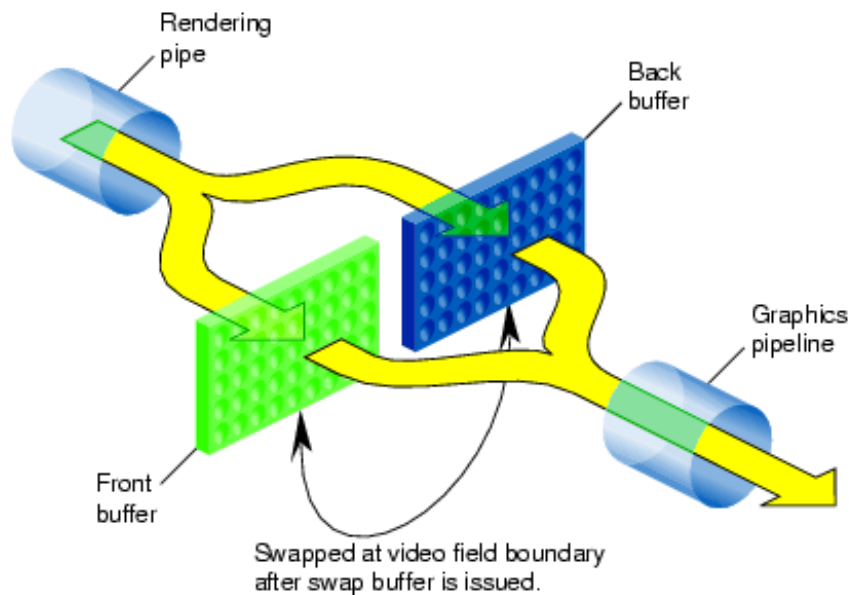
clear the canvas (color buffer & depth buffer)

swap the front (for drawing) and back (for displaying) buffer

```
void ProcessKeysCB(unsigned char key, int x, int y)
{
    // Handle other keyboard inputs those are not defined as special keys.
    if (key == 27) { ESC
        // Release memory allocation if needed.
        exit(0);
    }
}
```

Double Buffers

- Prevent artifacts due to potentially seeing parts of an incomplete frame (that is currently drawn)
 - Set the display mode to **GLUT_DOUBLE** in the **glutInitDisplayMode** function
 - Call **glutSwapBuffers** after rendering finished



Initialization

- *void **glClearColor**(GLfloat red, GLfloat green, GLfloat blue, GLfloat alpha);*
 - Set the color to clear the color buffer

```
void SetupRenderState()
{
    float clearColor[4] = {0.44f, 0.57f, 0.75f, 1.00f};
    glClearColor(
        (GLclampf)(clearColor[0]),
        (GLclampf)(clearColor[1]),
        (GLclampf)(clearColor[2]),
        (GLclampf)(clearColor[3])
    );
}
```

Start the Main Rendering Loop

- *void **glutMainLoop**(void);*
 - Enter the GLUT event processing loop
 - OpenGL programs are event-driven



Build Binaries of FreeGLUT with Visual Studio

FreeGLUT

- Download the source code from <https://github.com/FreeGLUTProject/freeglut>

The screenshot shows the GitHub repository page for FreeGLUTProject/freeglut. The repository is public and has 174 forks and 447 stars. The 'Code' dropdown menu is open, showing options to clone the repository using HTTPS or GitHub CLI, to open it with GitHub Desktop, and to download the ZIP file. The 'Download ZIP' option is highlighted with a red box. The repository's file list is visible on the left, showing folders like .github/workflows, altbuild, android, include/GL, progs, and src, as well as files like .gitignore and AUTHORS. The right sidebar contains information about the repository, including a link to the sourceforge.net page, a README, license, stars, watching, forks, and releases.

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Search / Sign in Sign up

FreeGLUTProject / freeglut Public

Notifications Fork 174 Star 447

<> Code Issues 13 Pull requests 7 Actions Projects Security Insights

master 6 branches 31 tags Go to file Code ▾

Clone ?

HTTPS GitHub CLI

<https://github.com/FreeGLUTProject/freeglut>

Use Git or checkout with SVN using the web URL.

Open with GitHub Desktop

Download ZIP

About

Free implementation of the OpenGL Utility Toolkit (GLUT)

freeglut.sourceforge.net

Readme

View license

447 stars

43 watching

174 forks

Releases 10

freeglut 3.2.2 Latest on 9 Mar

FreeGLUT (cont.)

- Unzip the package

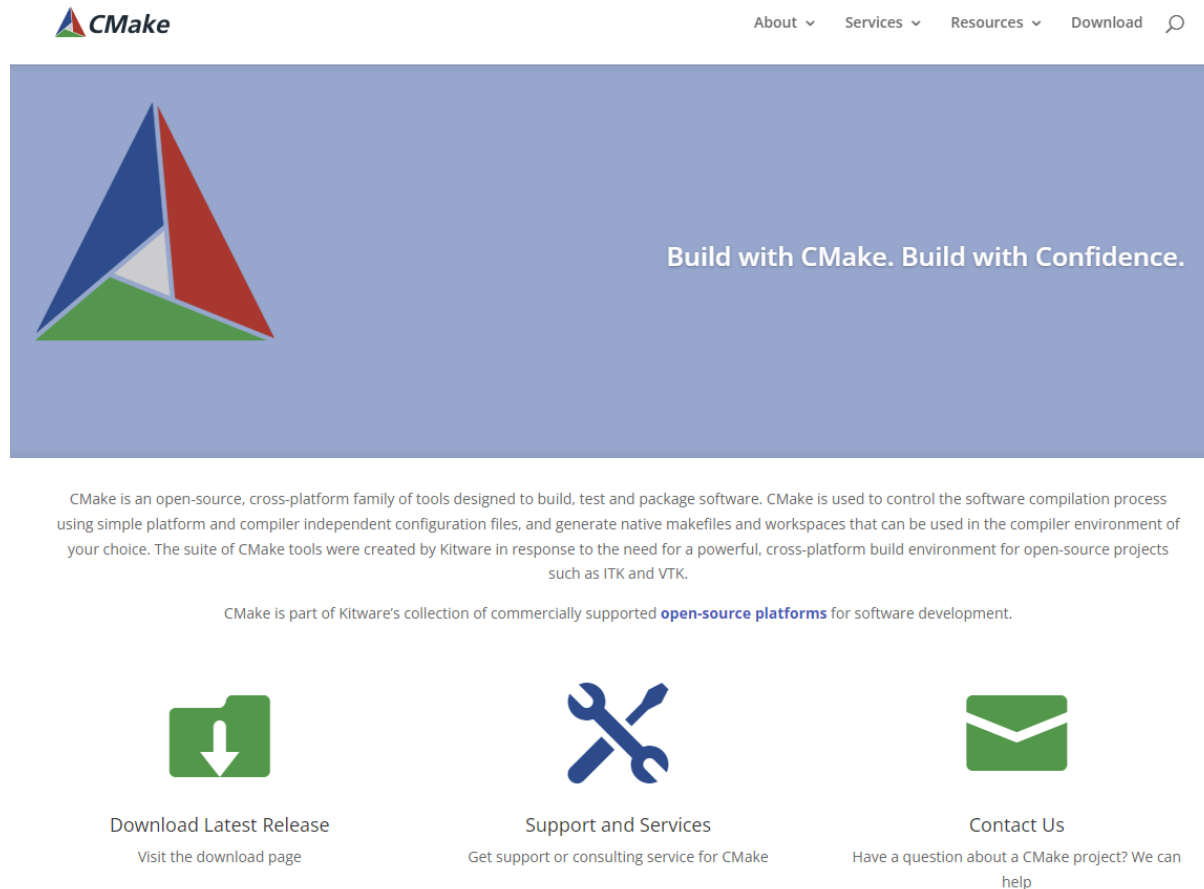
.github	2022/9/11 上午 07:31	檔案資料夾	
altbuild	2022/9/11 上午 07:31	檔案資料夾	
android	2022/9/11 上午 07:31	檔案資料夾	
include	2022/9/11 上午 07:31	檔案資料夾	
progs	2022/9/11 上午 07:31	檔案資料夾	
src	2022/9/11 上午 07:31	檔案資料夾	
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android_toolchain.cmake	2022/9/11 上午 07:31	CMake 來源檔案	1 KB
AUTHORS	2022/9/11 上午 07:31	檔案	2 KB
blackberry.toolchain.cmake	2022/9/11 上午 07:31	CMake 來源檔案	10 KB
ChangeLog	2022/9/11 上午 07:31	檔案	163 KB
CMakeLists.txt	2022/9/11 上午 07:31	文字文件	24 KB
config.h.in	2022/9/11 上午 07:31	IN 檔案	1 KB
COPYING	2022/9/11 上午 07:31	檔案	2 KB
freeglut.pc.in	2022/9/11 上午 07:31	IN 檔案	1 KB
freeglut.rc.in	2022/9/11 上午 07:31	IN 檔案	2 KB
FreeGLUTConfig.cmake.in	2022/9/11 上午 07:31	IN 檔案	1 KB
mingw_cross_toolchain.cmake	2022/9/11 上午 07:31	CMake 來源檔案	1 KB
README.android	2022/9/11 上午 07:31	ANDROID 檔案	1 KB
README.blackberry	2022/9/11 上午 07:31	BLACKBERRY 檔案	2 KB
README.cmake	2022/9/11 上午 07:31	CMake 來源檔案	5 KB
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README.macosx	2022/9/11 上午 07:31	MACOSX 檔案	2 KB
README.md	2022/9/11 上午 07:31	Markdown 來源...	4 KB
README.mingw_cross	2022/9/11 上午 07:31	MINGW_CROSS ...	2 KB
README.win32	2022/9/11 上午 07:31	WIN32 檔案	5 KB

Build the source code
using **CMake**

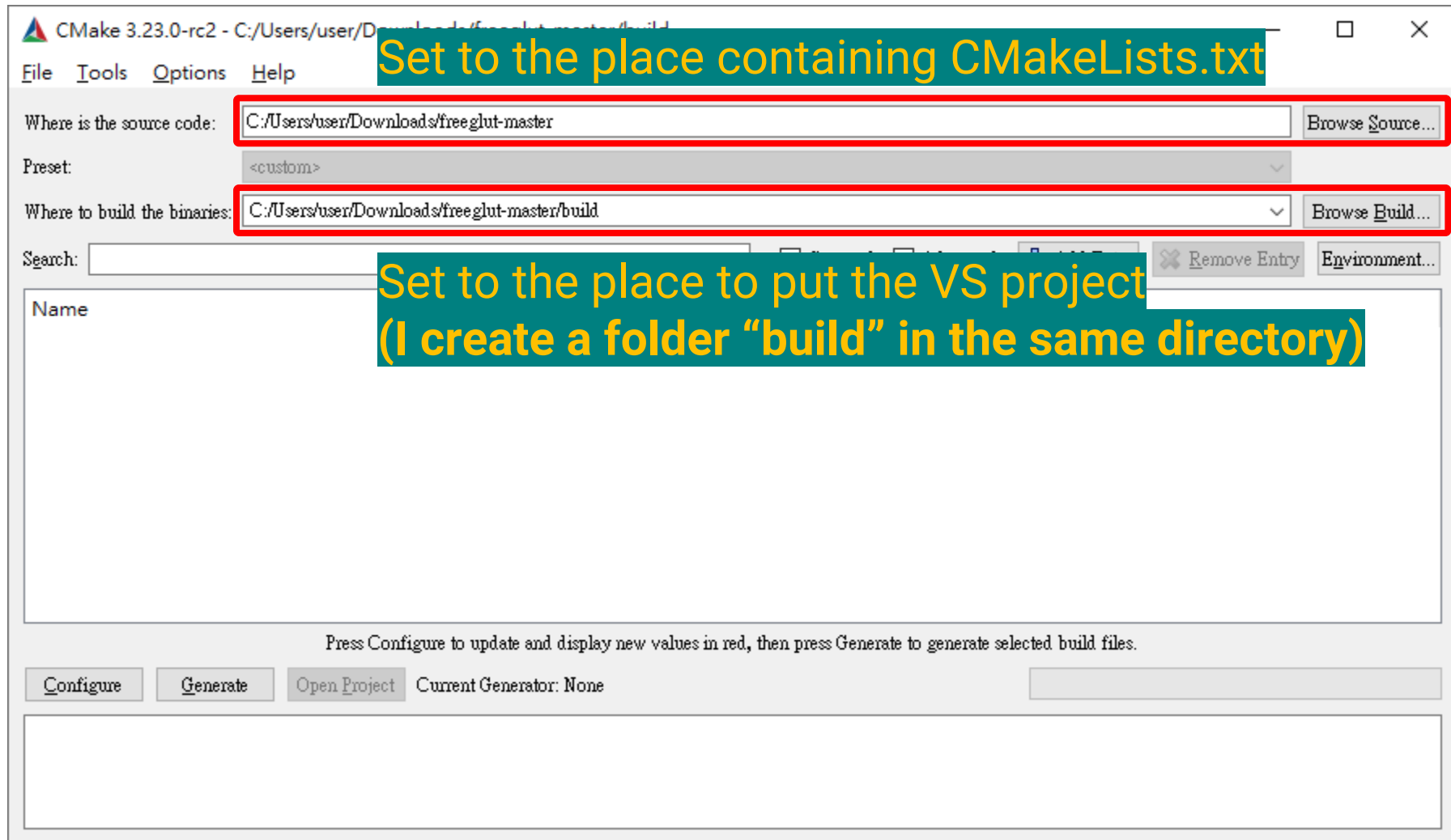


CMake

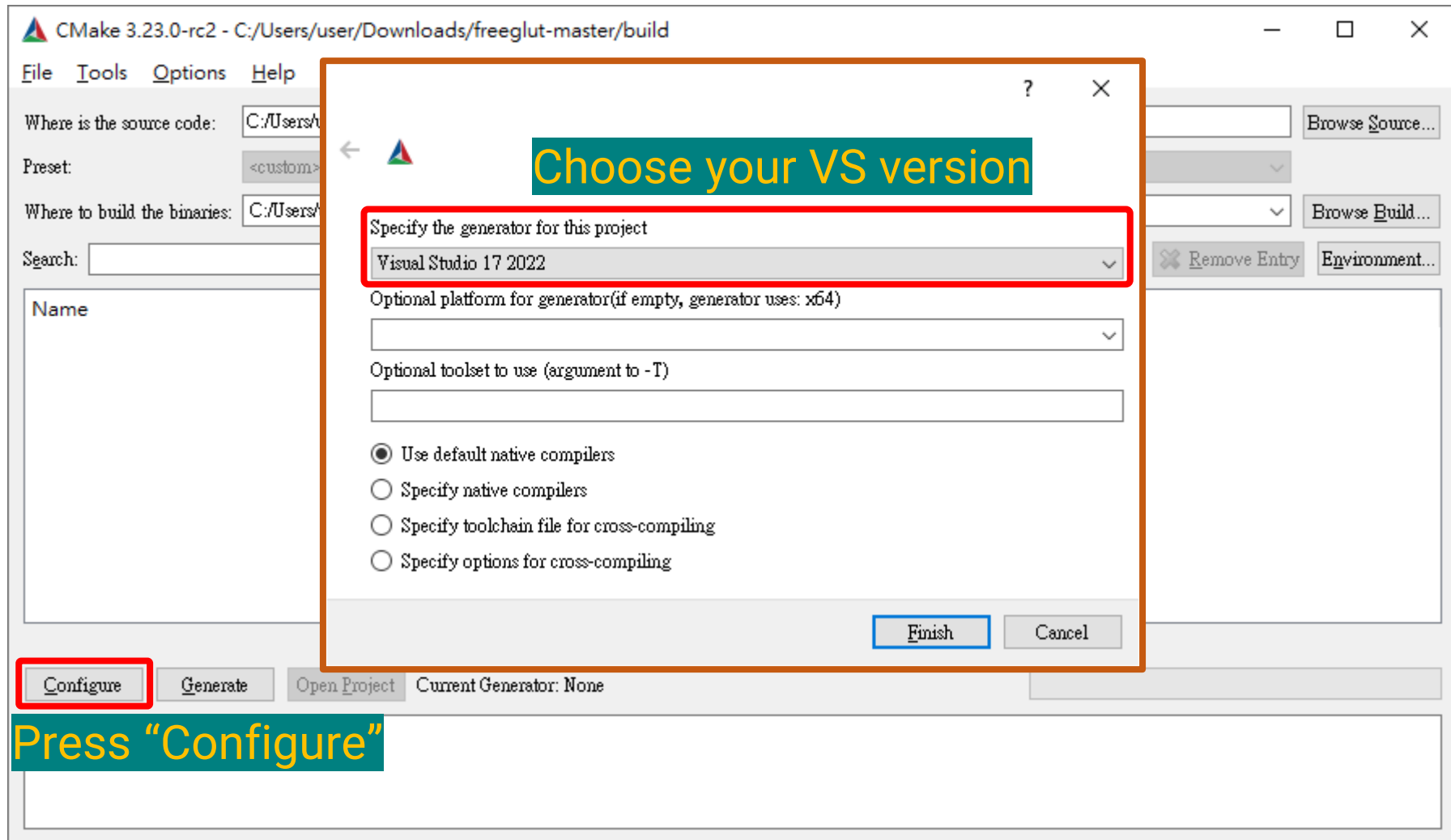
- Download and install CMake: <https://cmake.org/>



Setup CMake for Building FreeGLUT



Configuration



Generate VS Project

CMake 3.23.0-rc2 - C:/Users/user/Downloads/freeglut-master/build

File Tools Options Help

Where is the source code: C:/Users/user/Downloads/freeglut-master Browse Source...

Preset: <custom>

Where to build the binaries: C:/Users/user/Downloads/freeglut-master/build Browse Build...

Search: ☐ Grouped ☐ Advanced + Add Entry ✖ Remove Entry Environment...

Name	Value
CMAKE_CONFIGURATION_TYPES	Debug;Release;MinSizeRel;RelWithDebInfo
CMAKE_INSTALL_PREFIX	C:/Program Files (x86)/freeglut
FREEGLUT_BUILD_DEMOS	<input checked="" type="checkbox"/>
FREEGLUT_BUILD_SHARED_LIBS	<input checked="" type="checkbox"/>
FREEGLUT_BUILD_STATIC_LIBS	<input checked="" type="checkbox"/>
FREEGLUT_GLES	<input type="checkbox"/>
FREEGLUT_PRINT_ERRORS	<input checked="" type="checkbox"/>
FREEGLUT_PRINT_WARNINGS	<input checked="" type="checkbox"/>
FREEGLUT_REPLACE_GLUT	<input type="checkbox"/>
INSTALL_PDB	<input checked="" type="checkbox"/>

Press Configure to update and display new values in red, then press Generate to generate selected build files.

Configure **Generate** Open Project Current Generator: Visual Studio 17 2022

Press "Generate"

```

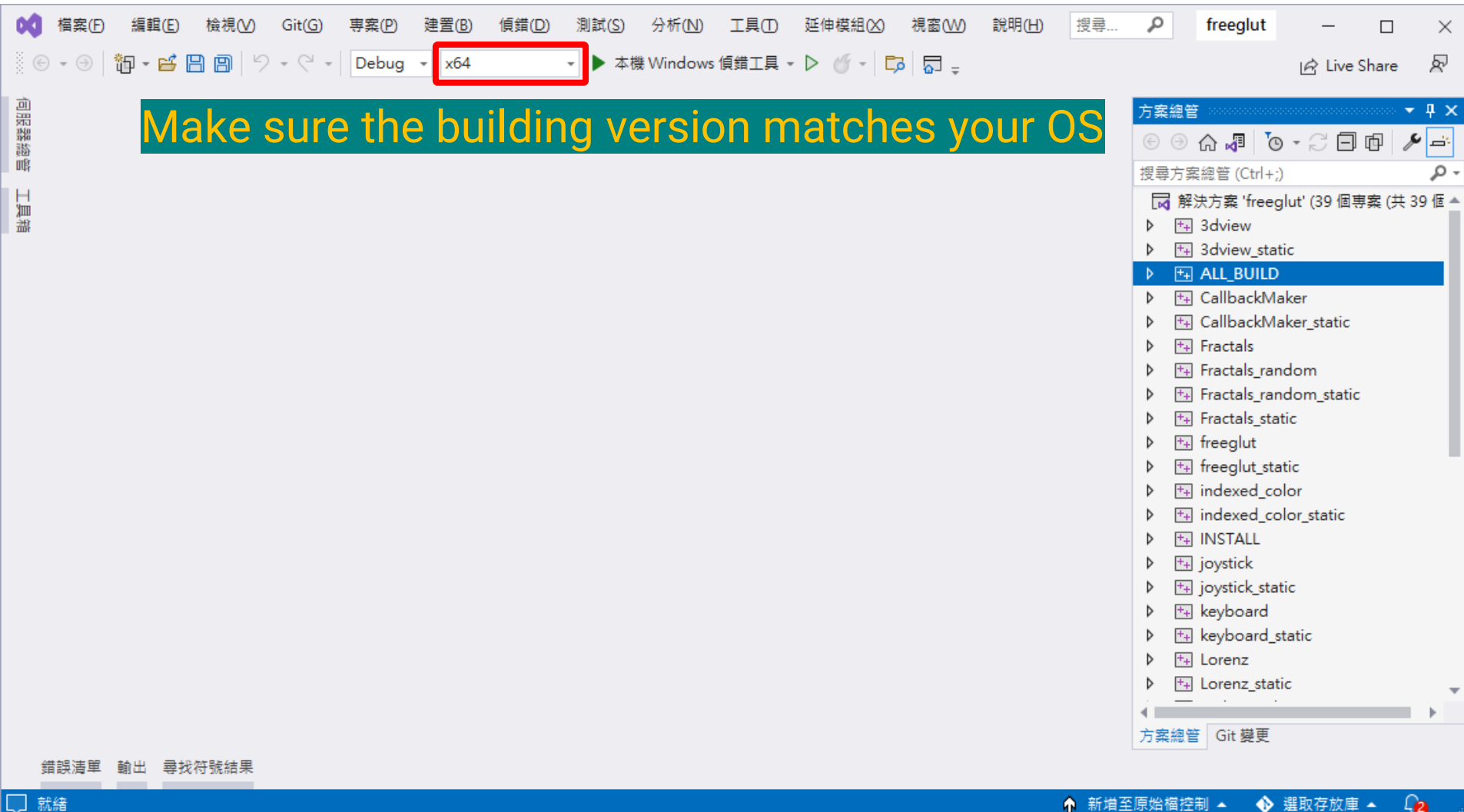
nttypes.h
nttypes.h - found
Configuring done

```

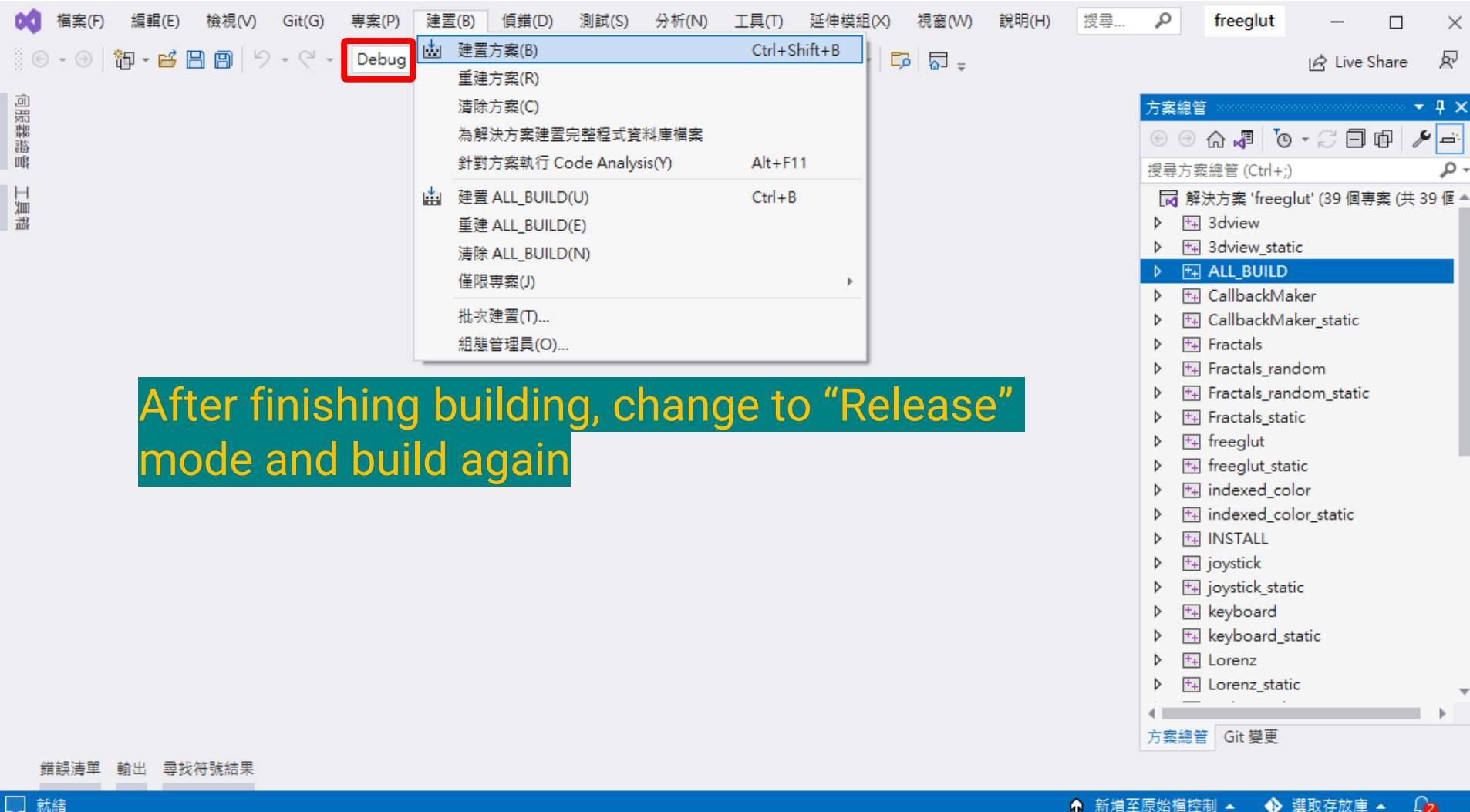
Examine VS Project

-master > build		搜尋 build	
名稱	修改日期	類型	大小
Fractals_random.vcxproj.filters	2022/9/14 下午 03:47	VC++ Project Filt...	1 KB
Fractals_random_static.vcxproj	2022/9/14 下午 03:47	VC++ Project	60 KB
Fractals_random_static.vcxproj.filters	2022/9/14 下午 03:47	VC++ Project Filt...	1 KB
Fractals_static.vcxproj	2022/9/14 下午 03:47	VC++ Project	60 KB
Fractals_static.vcxproj.filters	2022/9/14 下午 03:47	VC++ Project Filt...	1 KB
freeglut.pc	2022/9/14 下午 03:46	PC 檔案	1 KB
freeglut.rc	2022/9/14 下午 03:46	Resource Script	2 KB
freeglut.sln	2022/9/14 下午 03:47	Visual Studio Sol...	43 KB
freeglut.vcxproj	2022/9/14 下午 03:47	VC++ Project	64 KB
freeglut.vcxproj.filters	2022/9/14 下午 03:47	VC++ Project Filt...	8 KB
freeglut_static.vcxproj	2022/9/14 下午 03:47	VC++ Project	59 KB
freeglut_static.vcxproj.filters	2022/9/14 下午 03:47	VC++ Project Filt...	8 KB
indexed_color.vcxproj	2022/9/14 下午 03:47	VC++ Project	59 KB
indexed_color.vcxproj.filters	2022/9/14 下午 03:47	VC++ Project Filt...	1 KB
indexed_color_static.vcxproj	2022/9/14 下午 03:47	VC++ Project	60 KB
indexed_color_static.vcxproj.filters	2022/9/14 下午 03:47	VC++ Project Filt...	1 KB
INSTALL.vcxproj	2022/9/14 下午 03:47	VC++ Project	10 KB
INSTALL.vcxproj.filters	2022/9/14 下午 03:47	VC++ Project Filt...	1 KB
joystick.vcxproj	2022/9/14 下午 03:47	VC++ Project	59 KB
joystick.vcxproj.filters	2022/9/14 下午 03:47	VC++ Project Filt...	1 KB
joystick_static.vcxproj	2022/9/14 下午 03:47	VC++ Project	60 KB
joystick_static.vcxproj.filters	2022/9/14 下午 03:47	VC++ Project Filt...	1 KB
keyboard.vcxproj	2022/9/14 下午 03:47	VC++ Project	59 KB
keyboard.vcxproj.filters	2022/9/14 下午 03:47	VC++ Project Filt...	1 KB
keyboard_static.vcxproj	2022/9/14 下午 03:47	VC++ Project	60 KB
keyboard_static.vcxproj.filters	2022/9/14 下午 03:47	VC++ Project Filt...	1 KB

Open Solution with Visual Studio



Debug/Release Build



The screenshot shows the Visual Studio interface. The 'Build' menu is open, and the 'Debug' option is highlighted with a red box. The 'Solution Explorer' on the right shows the project 'freelut' with a list of files. The 'ALL_BUILD' file is selected. A text box with yellow text on a dark blue background is overlaid on the image.

After finishing building, change to "Release" mode and build again

Examine the Built Binary Files

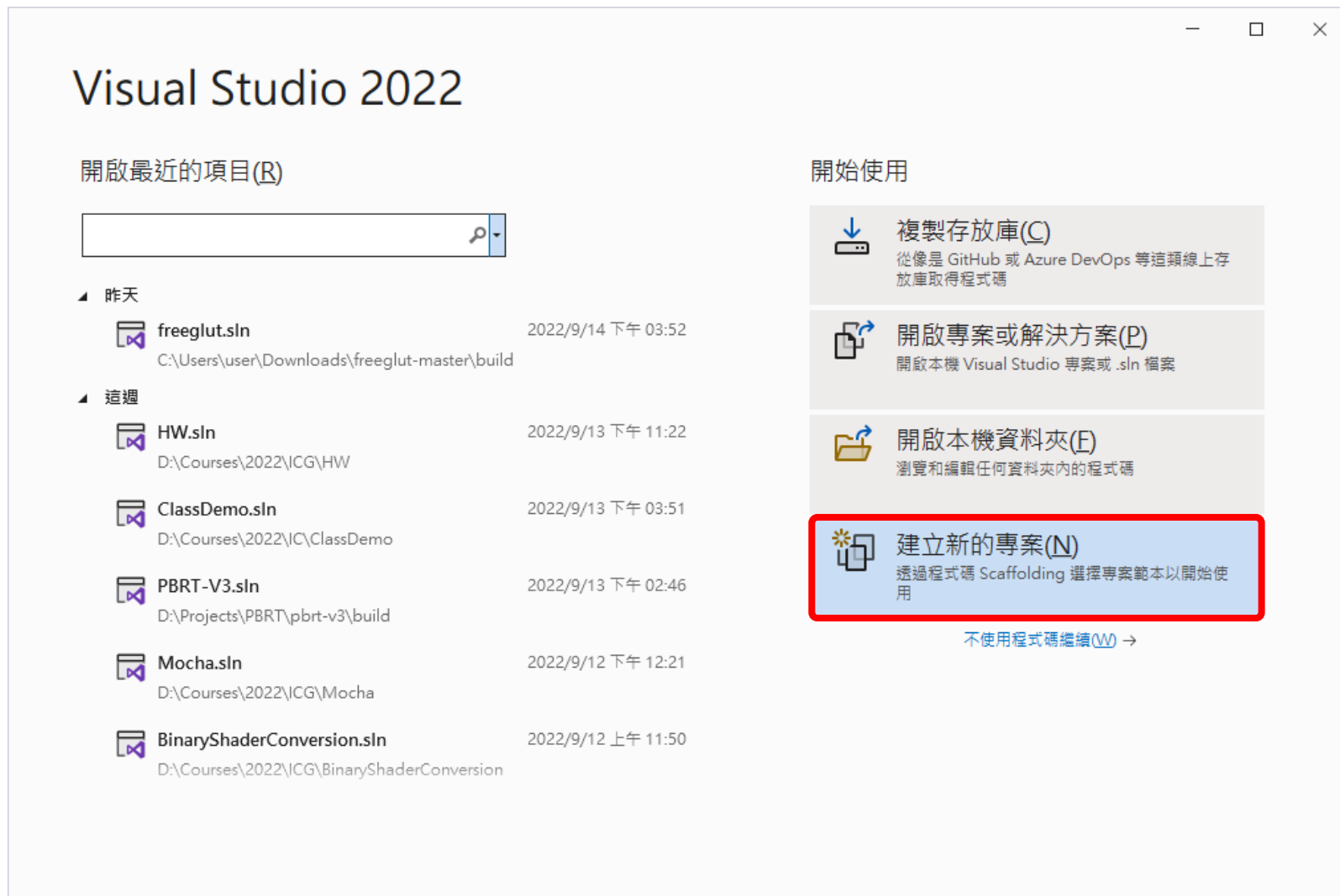
master > build > 🔍 搜尋 build

名稱	修改日期	類型	大小
3dview.dir	2022/9/14 下午 03:57	檔案資料夾	
3dview_static.dir	2022/9/14 下午 03:57	檔案資料夾	
bin	2022/9/14 下午 03:57	檔案資料夾	
CallbackMaker.dir	2022/9/14 下午 03:57	檔案資料夾	
CallbackMaker_static.dir	2022/9/14 下午 03:57	檔案資料夾	
CMakeFiles	2022/9/14 下午 03:57	檔案資料夾	
Fractals.dir	2022/9/14 下午 03:57	檔案資料夾	
Fractals_random.dir	2022/9/14 下午 03:57	檔案資料夾	
Fractals_random_static.dir	2022/9/14 下午 03:57	檔案資料夾	
Fractals_static.dir	2022/9/14 下午 03:57	檔案資料夾	
FreeGLUT	2022/9/14 下午 03:47	檔案資料夾	
freeglut.dir	2022/9/14 下午 03:57	檔案資料夾	
freeglut_static.dir	2022/9/14 下午 03:57	檔案資料夾	
indexed_color.dir	2022/9/14 下午 03:57	檔案資料夾	
indexed_color_static.dir	2022/9/14 下午 03:57	檔案資料夾	
joystick.dir	2022/9/14 下午 03:57	檔案資料夾	
joystick_static.dir	2022/9/14 下午 03:57	檔案資料夾	
keyboard.dir	2022/9/14 下午 03:57	檔案資料夾	
keyboard_static.dir	2022/9/14 下午 03:57	檔案資料夾	
lib	2022/9/14 下午 03:57	檔案資料夾	
Lorenz.dir	2022/9/14 下午 03:57	檔案資料夾	
Lorenz_static.dir	2022/9/14 下午 03:57	檔案資料夾	
multi-touch.dir	2022/9/14 下午 03:57	檔案資料夾	
multi-touch_static.dir	2022/9/14 下午 03:57	檔案資料夾	
One.dir	2022/9/14 下午 03:57	檔案資料夾	
One_static.dir	2022/9/14 下午 03:57	檔案資料夾	

You can find the Debug/Release versions of *.lib (in the lib folder) and *.dll (in the bin folder), respectively

Setup the FreeGLUT Library in Your Visual Studio Project

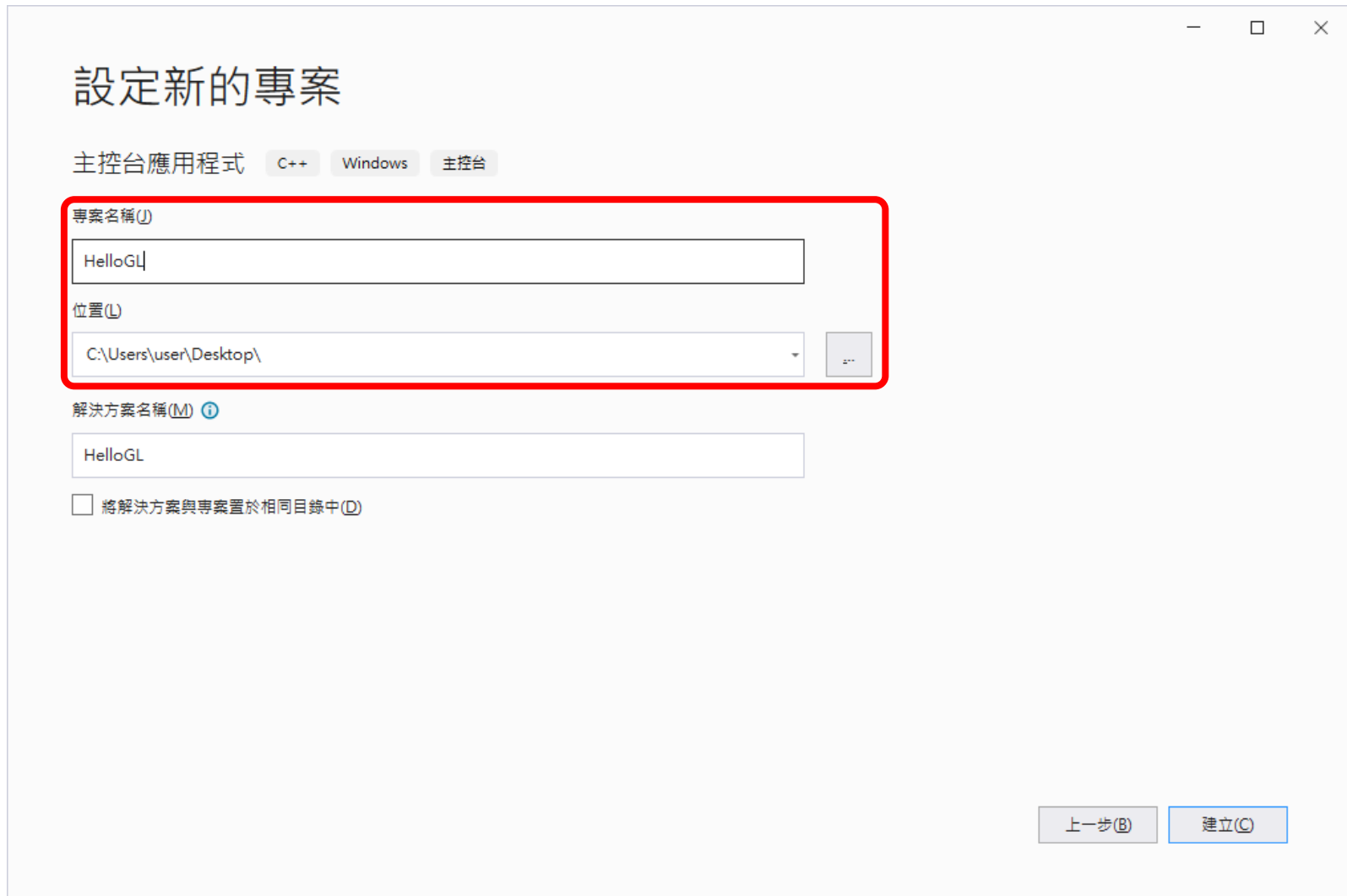
Create a New Project in VS



Create a New Project in VS (cont.)



Create a New Project in VS (cont.)



設定新的專案

主控台應用程式 C++ Windows 主控台

專案名稱 (P)

HelloGL

位置 (L)

C:\Users\user\Desktop\

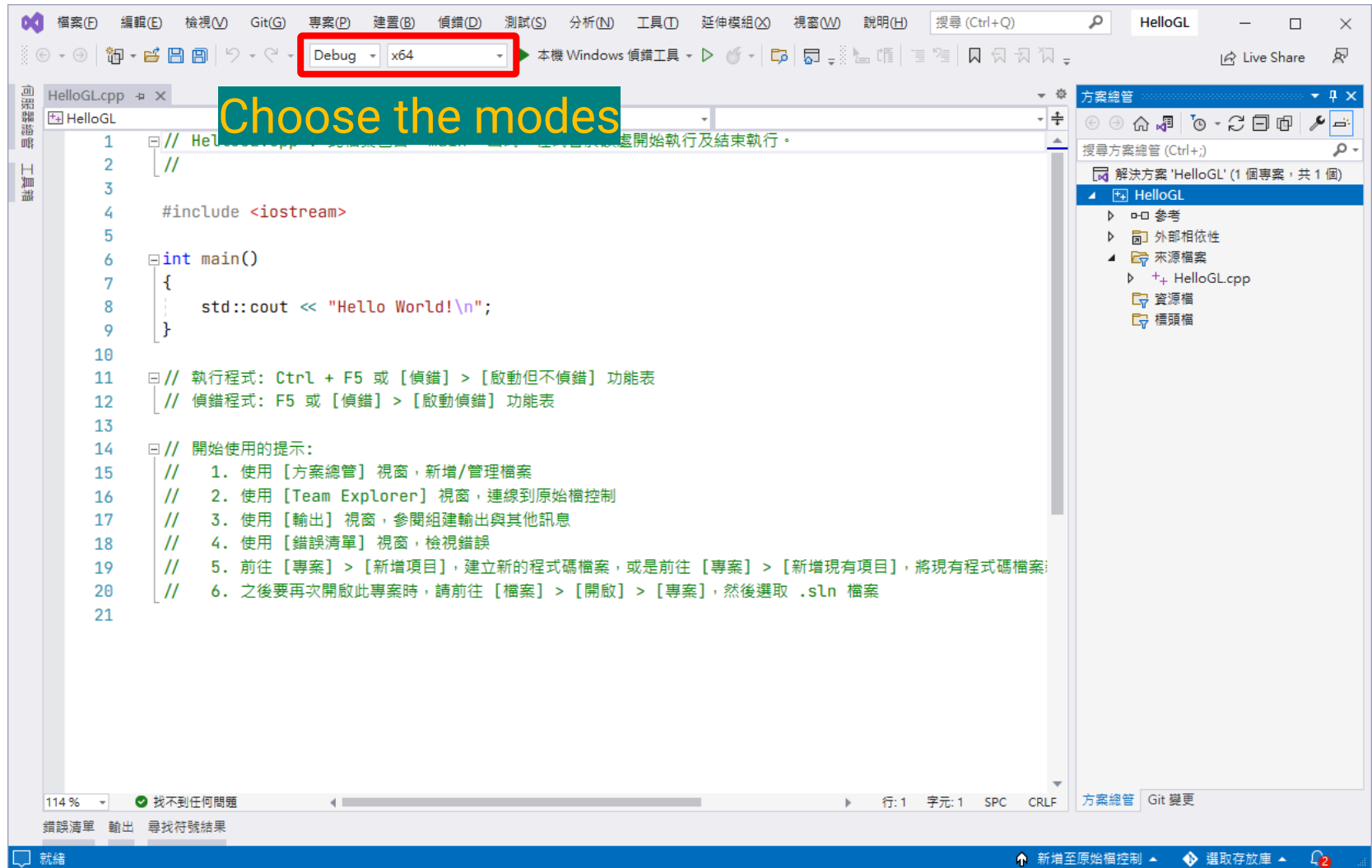
解決方案名稱 (M) ⓘ

HelloGL

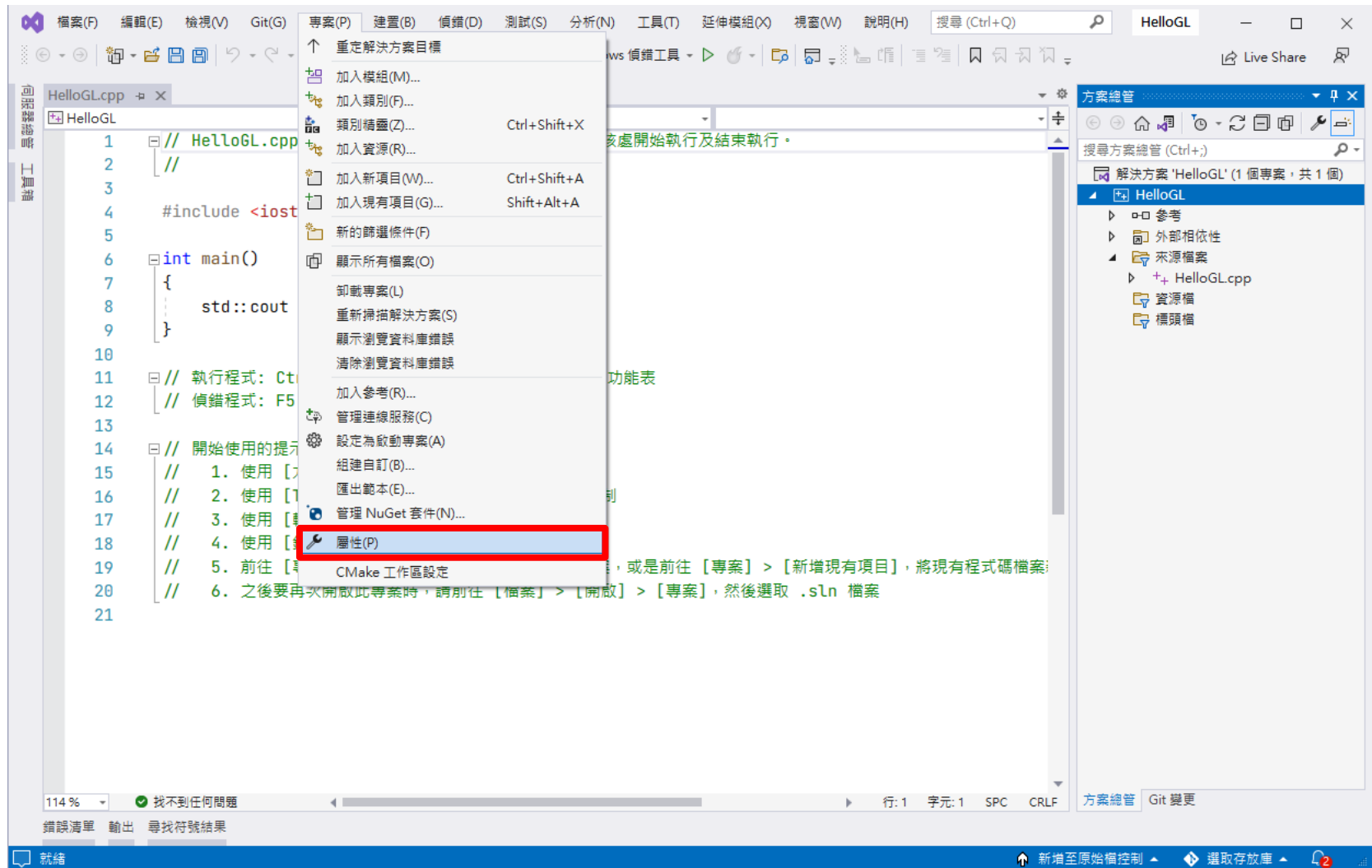
☐ 將解決方案與專案置於相同目錄中 (D)

上一步 (B) 建立 (C)

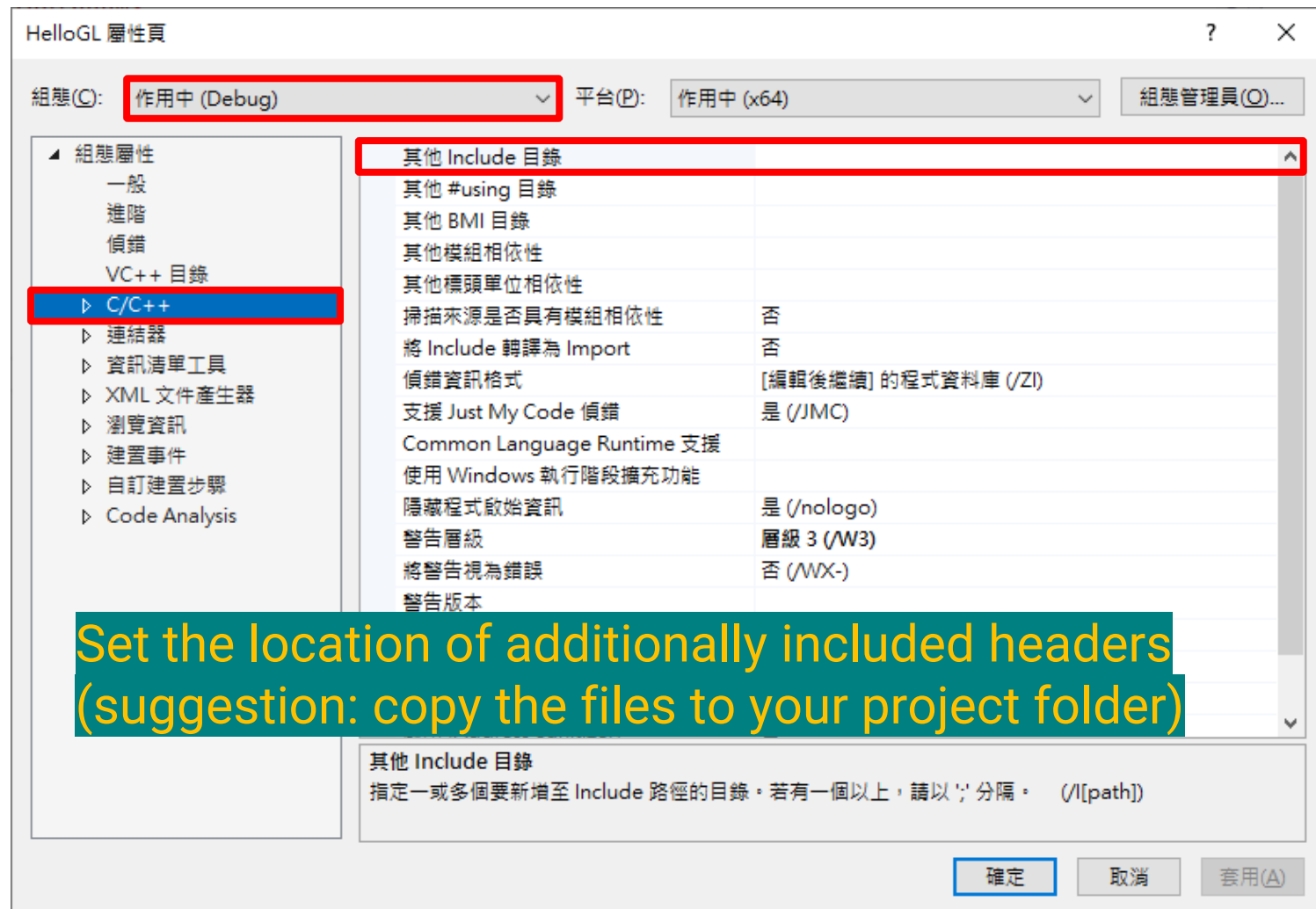
Setup the Project in VS



Setup the Project in VS

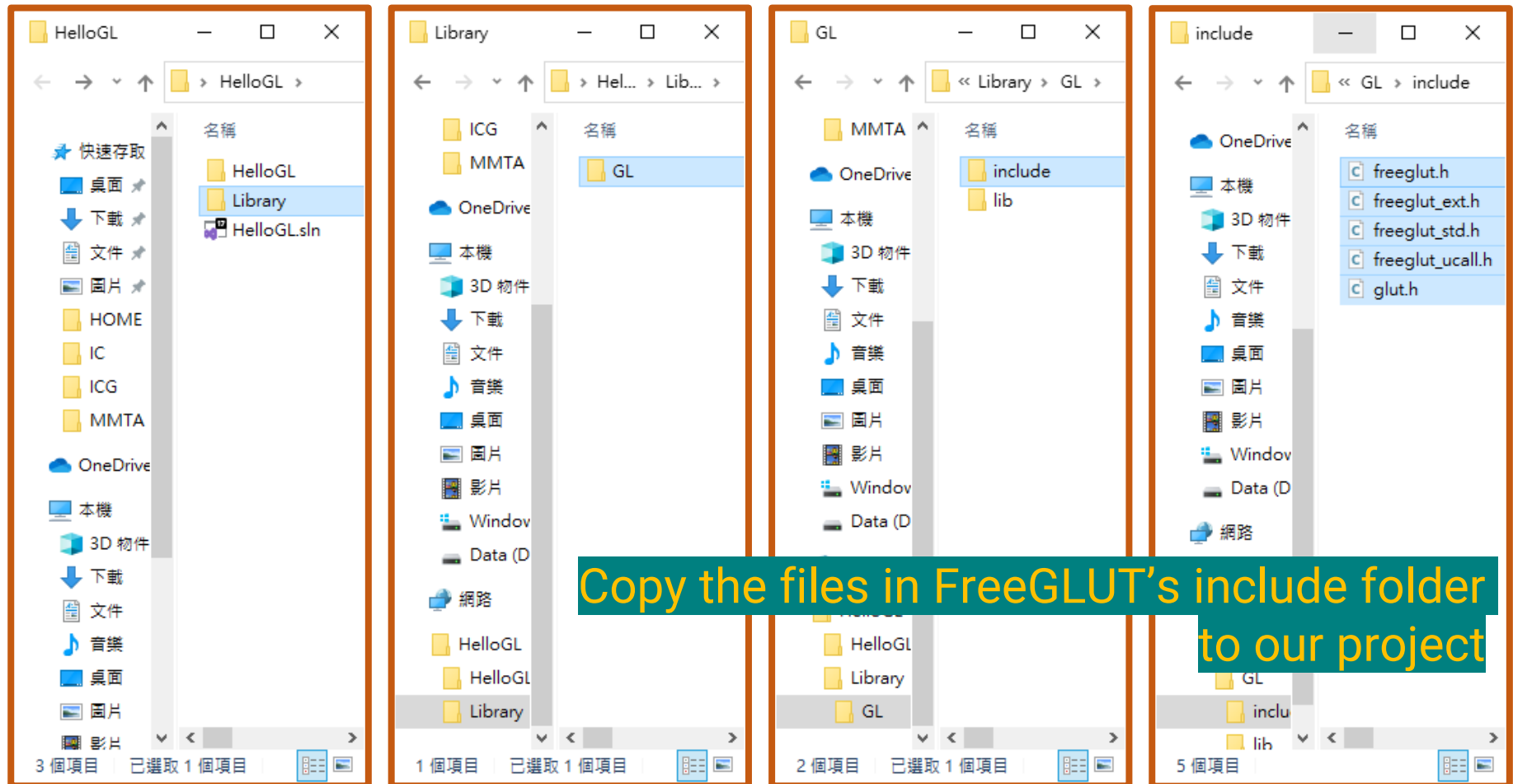


Setup the Project in VS (cont.)

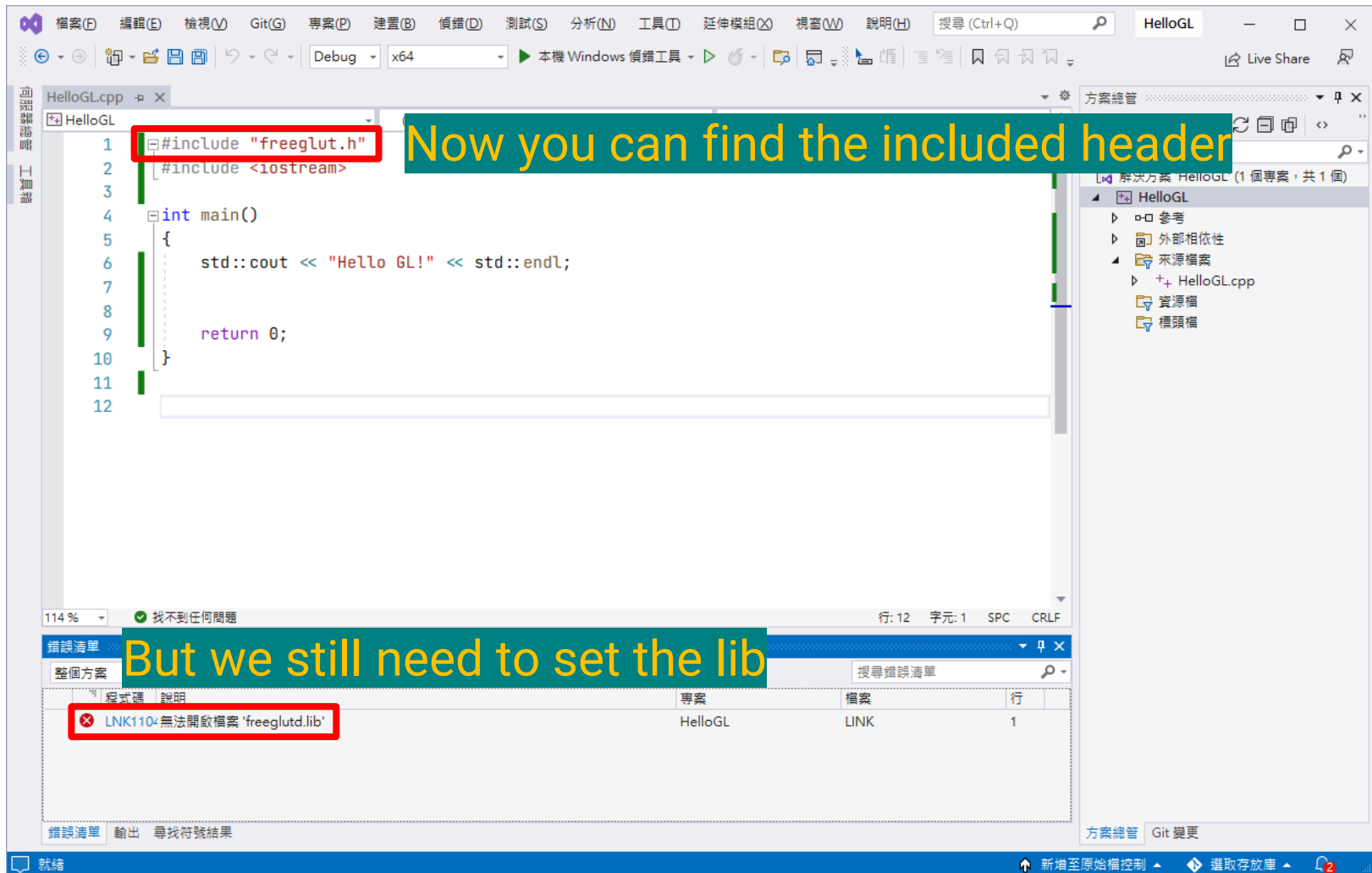


Setup the Project in VS (cont.)

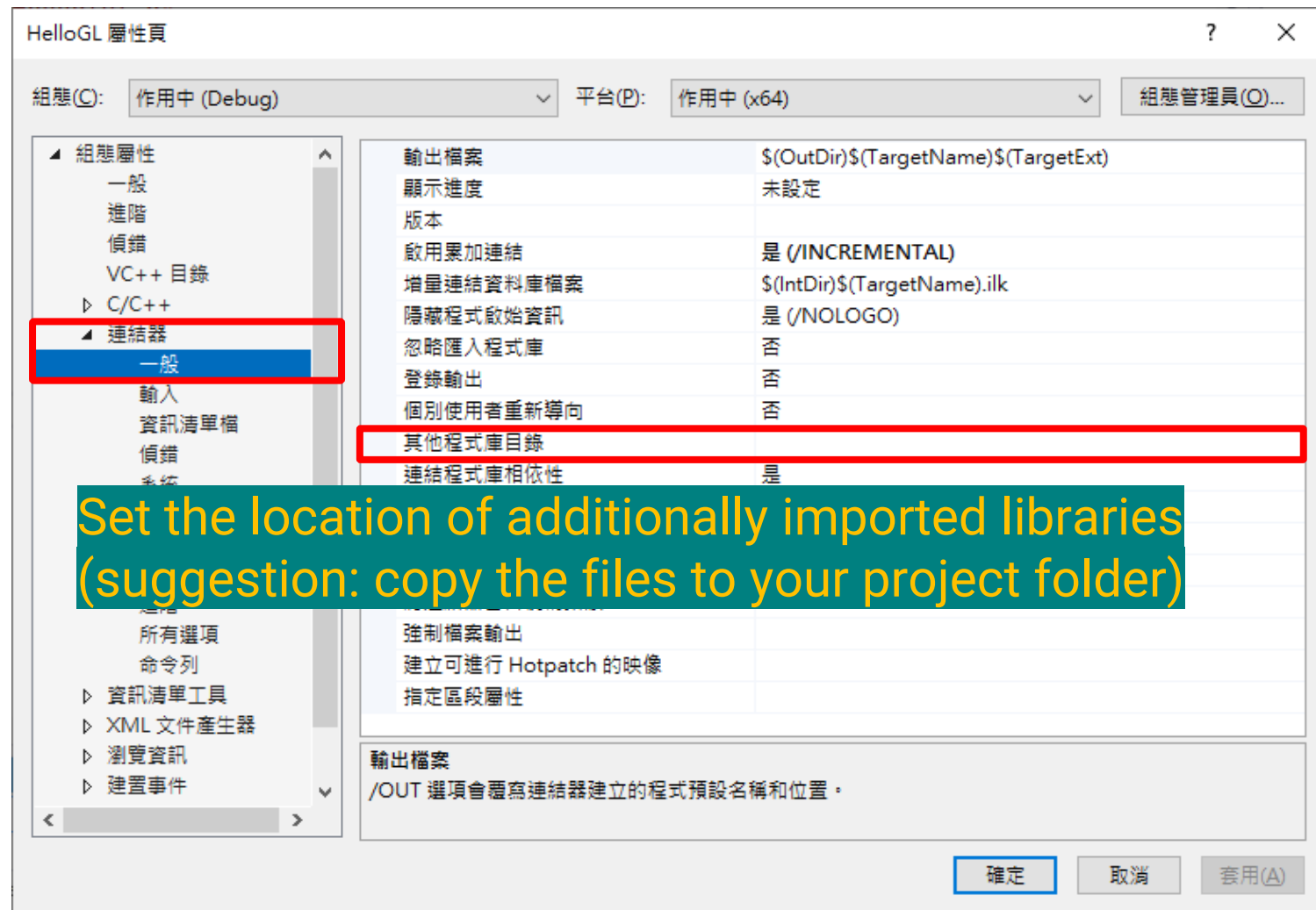
- My setting



Setup the Project in VS (cont.)

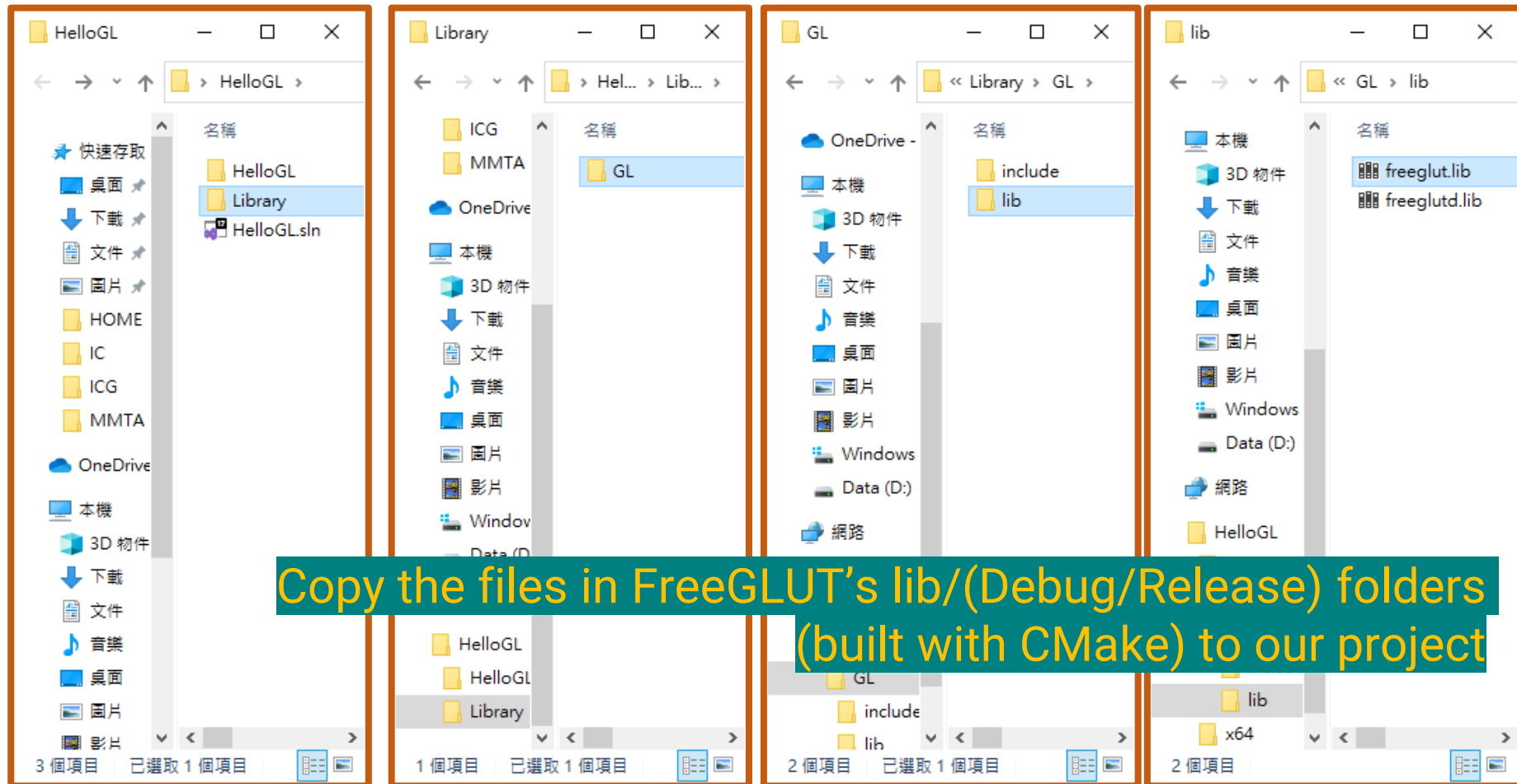


Setup the Project in VS (cont.)

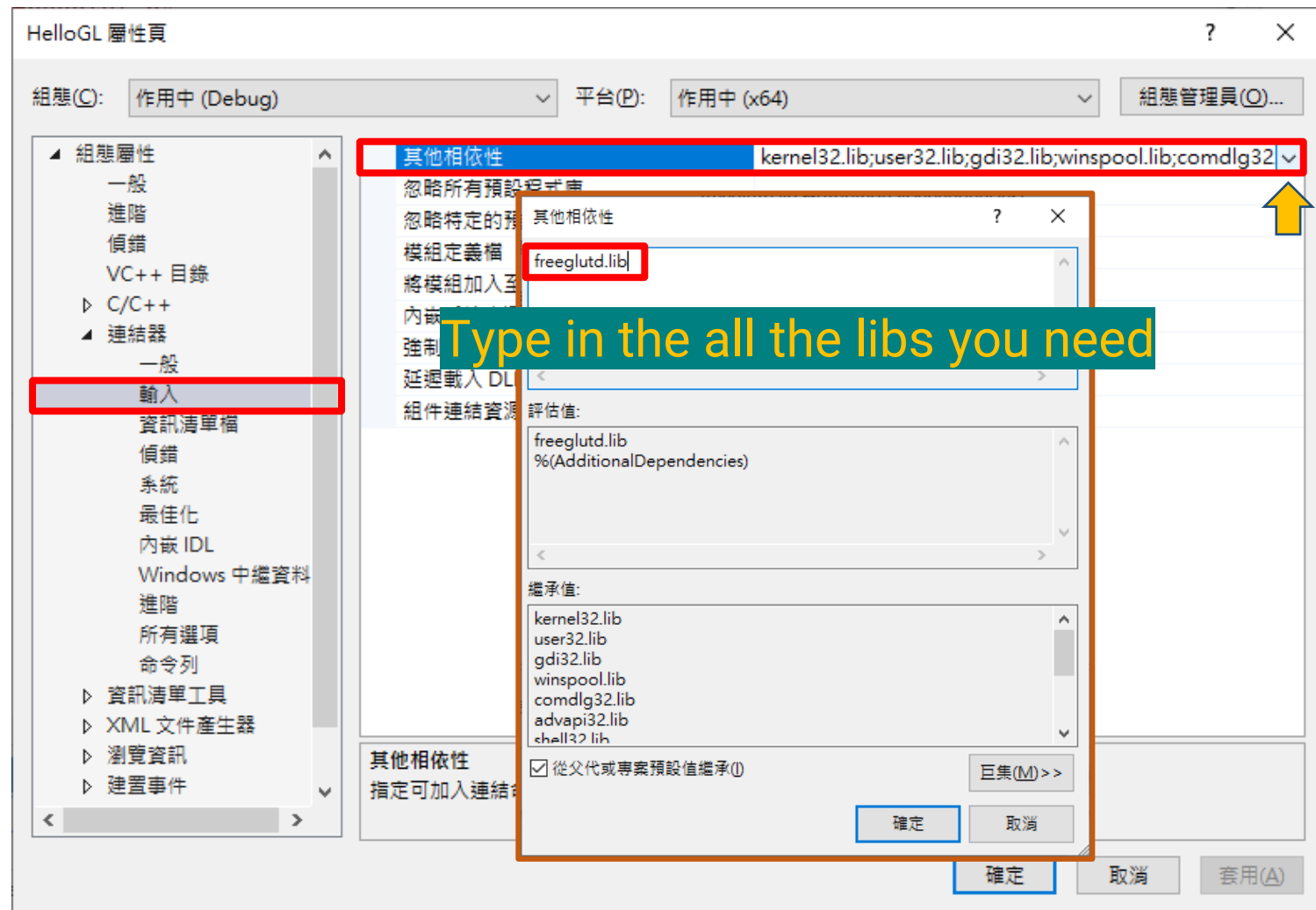


Setup the Project in VS (cont.)

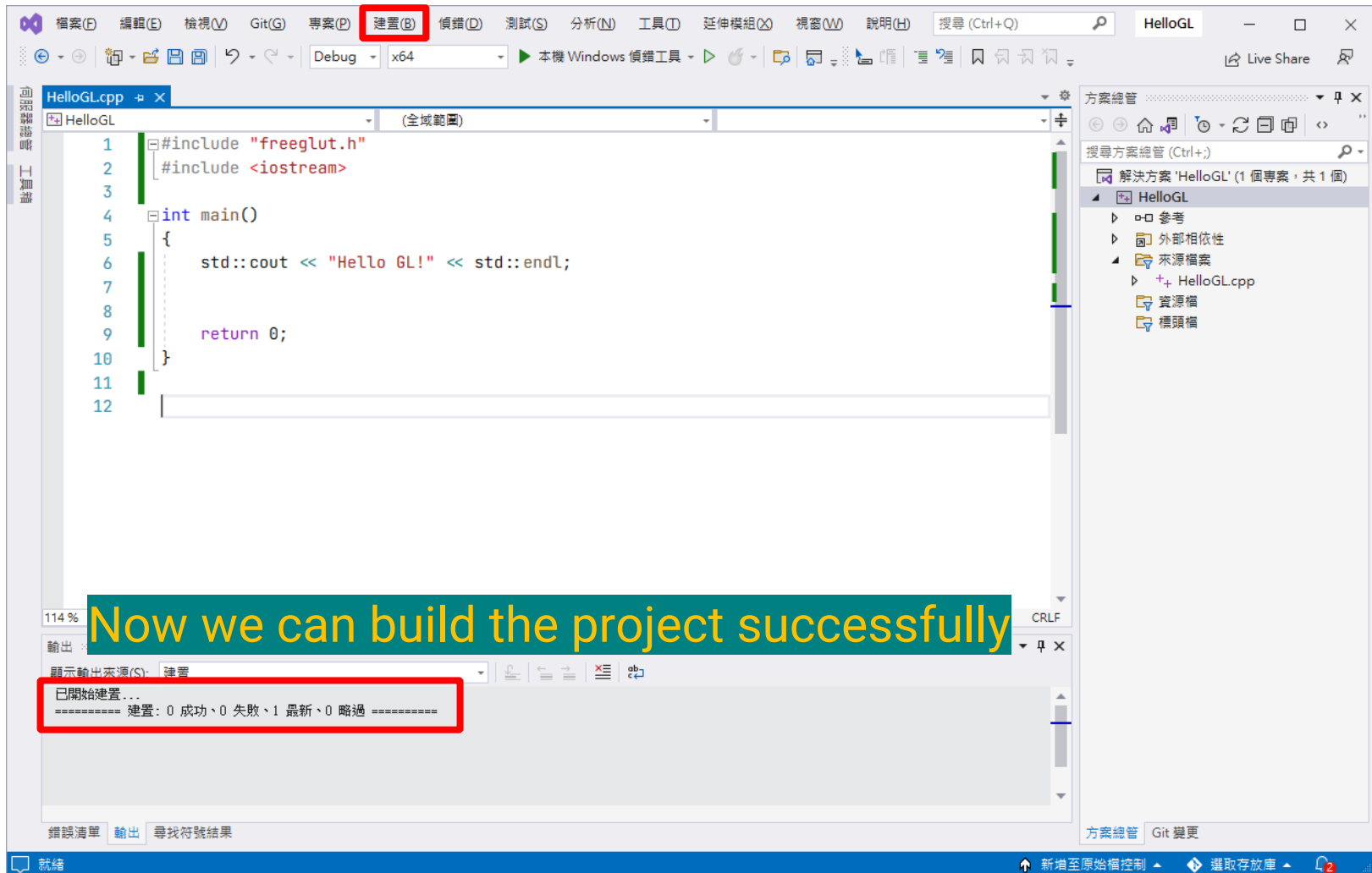
- My setting



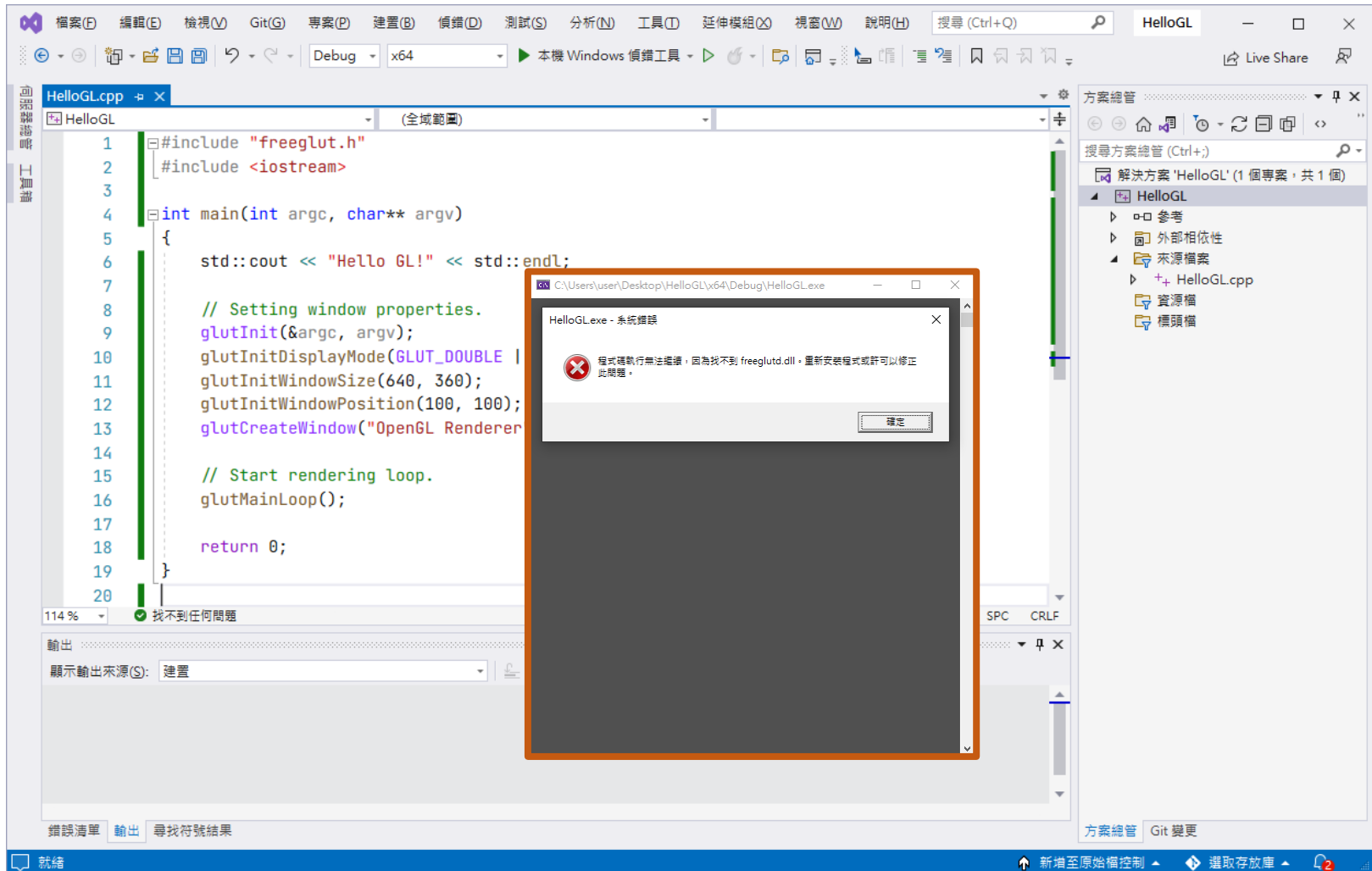
Setup the Project in VS (cont.)



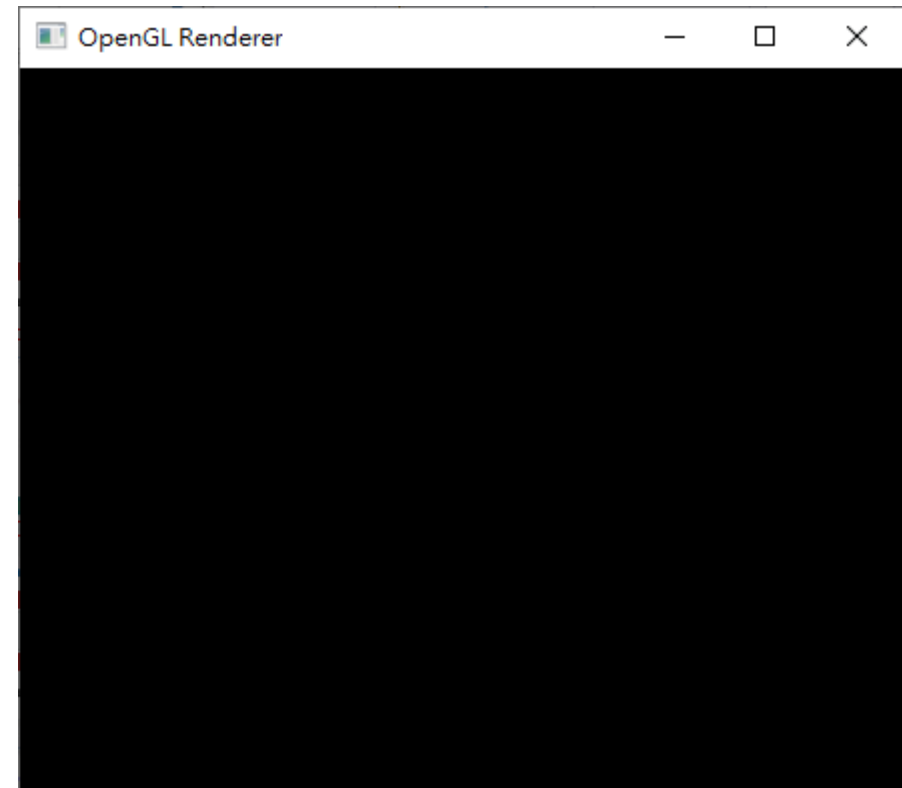
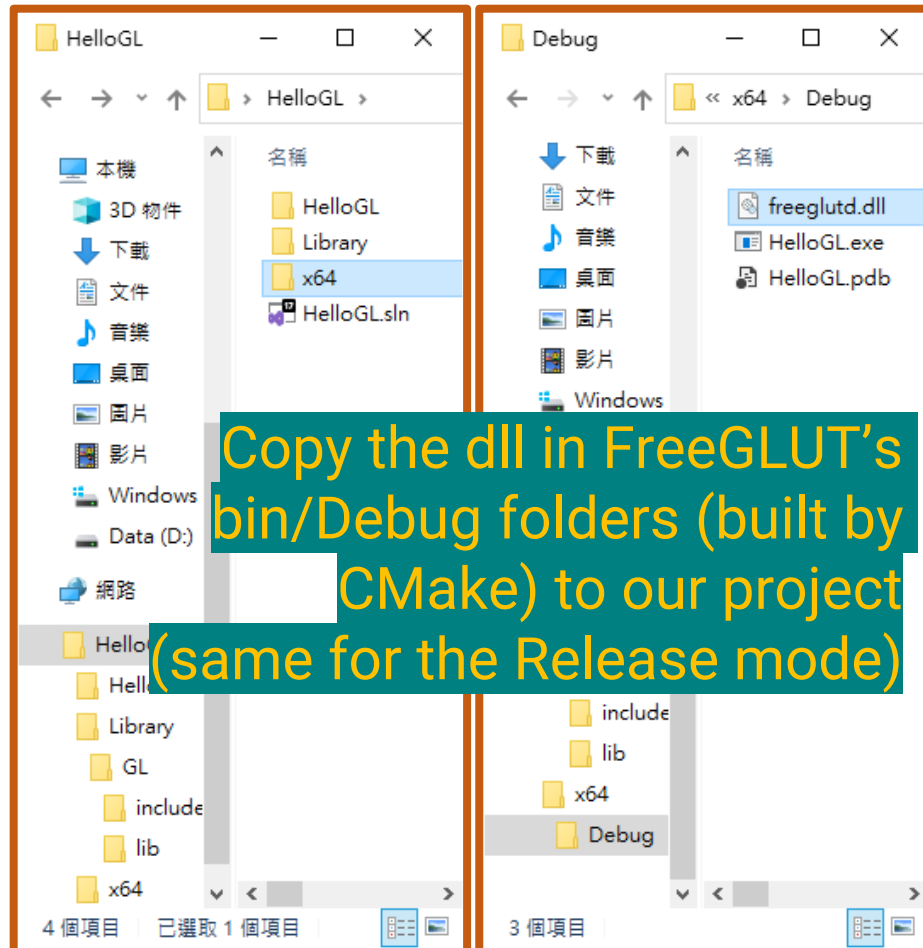
Setup the Project in VS (cont.)



Setup the Project in VS (cont.)



Setup the Project in VS (cont.)



Any Questions?