ARLAB

ME/CprE/ComS 557

# Computer Graphics and Geometric Modeling

Git, Visual Studio, and CMake

August 27, 2015

Rafael Radkowski

VRAC|HCI

IOWA STATE UNIVERSITY

OF SCIENCE AND TECHNOLOGY

# Content

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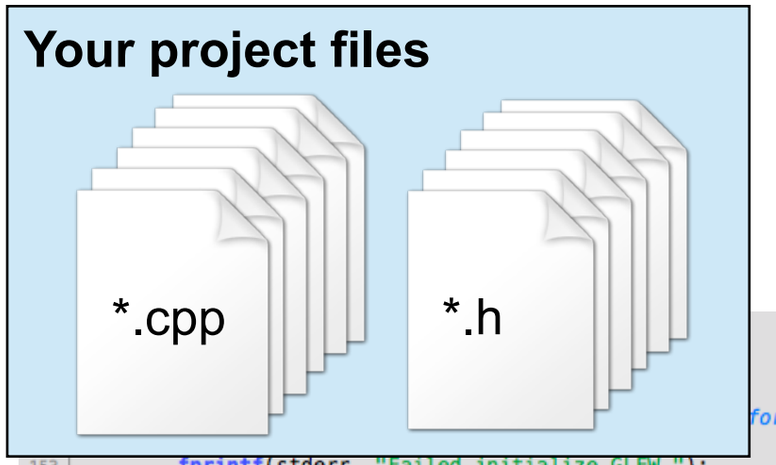
- Compiler, source files, and frameworks
- Introduction to git
- Visual Studio and Visual Studio Solutions / Projects
- CMake
- Installing OpenGL (GLEW, GLM, GLFW)
  - Windows
  - Mac OS X with Homebrew
- Homework: test project

# Software Development




with C/C++

- .h - header files: keep all the declarations
- .cpp - implementation files: keep all the definitions

```
                                                                    for any reason, print it out to STDERR.
153         fprintf(stderr, "Failed initialize GLFW.");
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160     // Set up OpenGL options.
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162     glfwWindowHint(GLFW_CONTEXT_VERSION_MAJOR, 4);
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189     // Makes sure all extensions will be exposed in GLEW and initialize GLEW.
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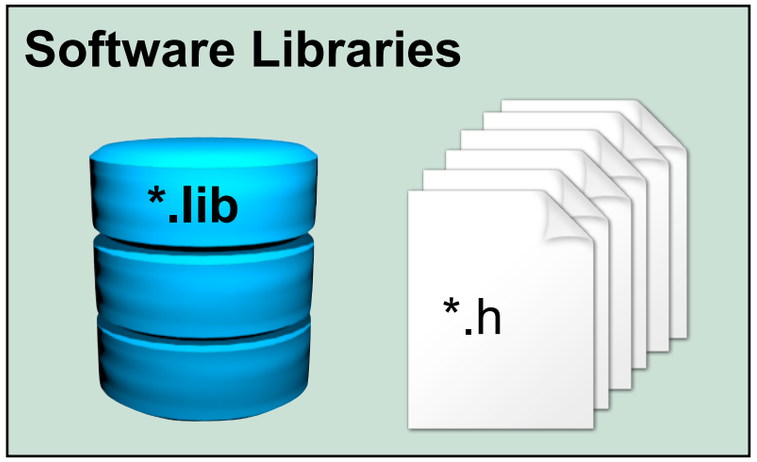
# OpenGL Files (GLEW, GLM, GLFW)

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- GLEW library file: glew32.lib (64bit version)
  The library files provides declarations in machine code
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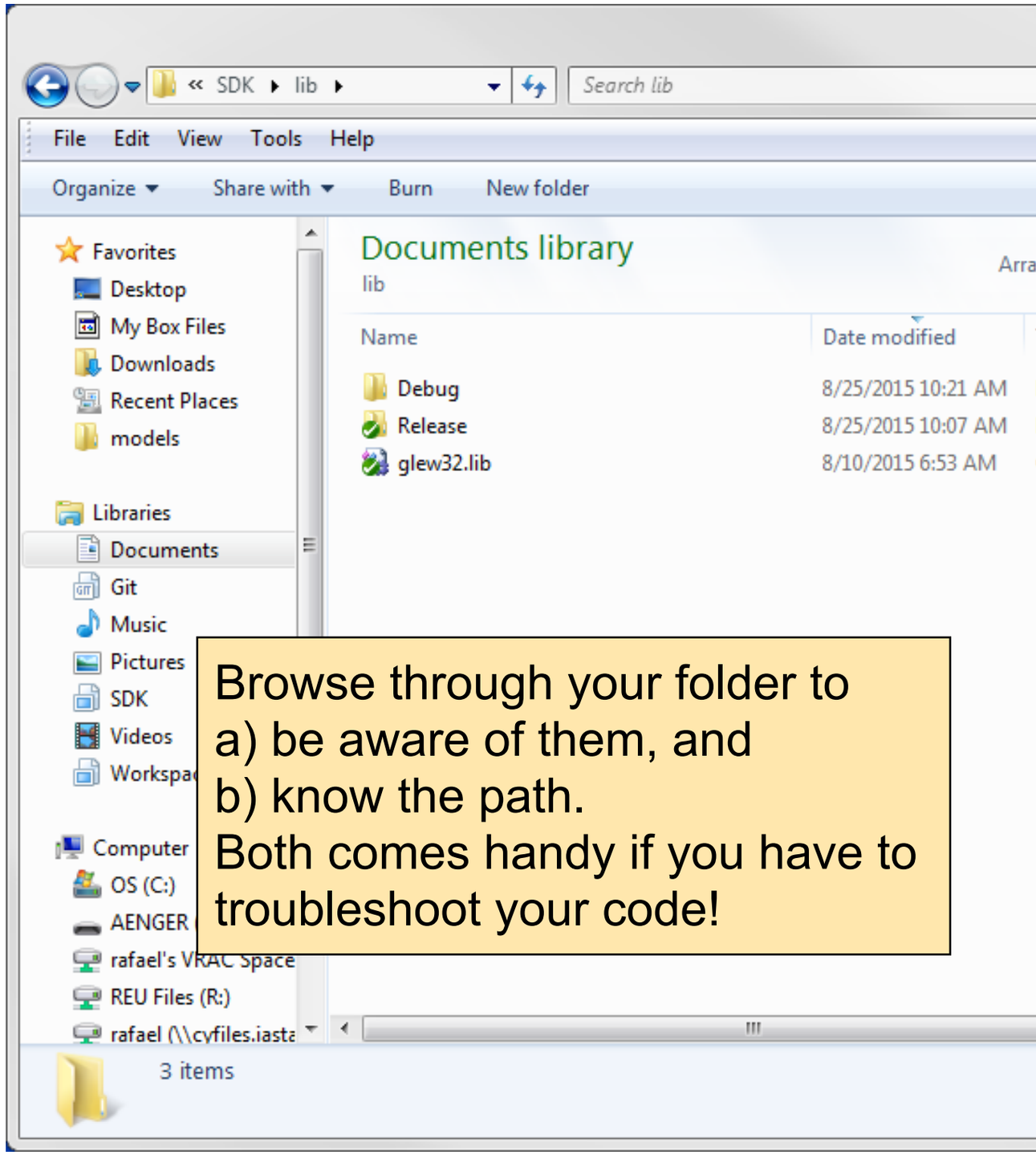
- In addition: GLEW provides a glew32.dll which keeps the code definition in machine code.



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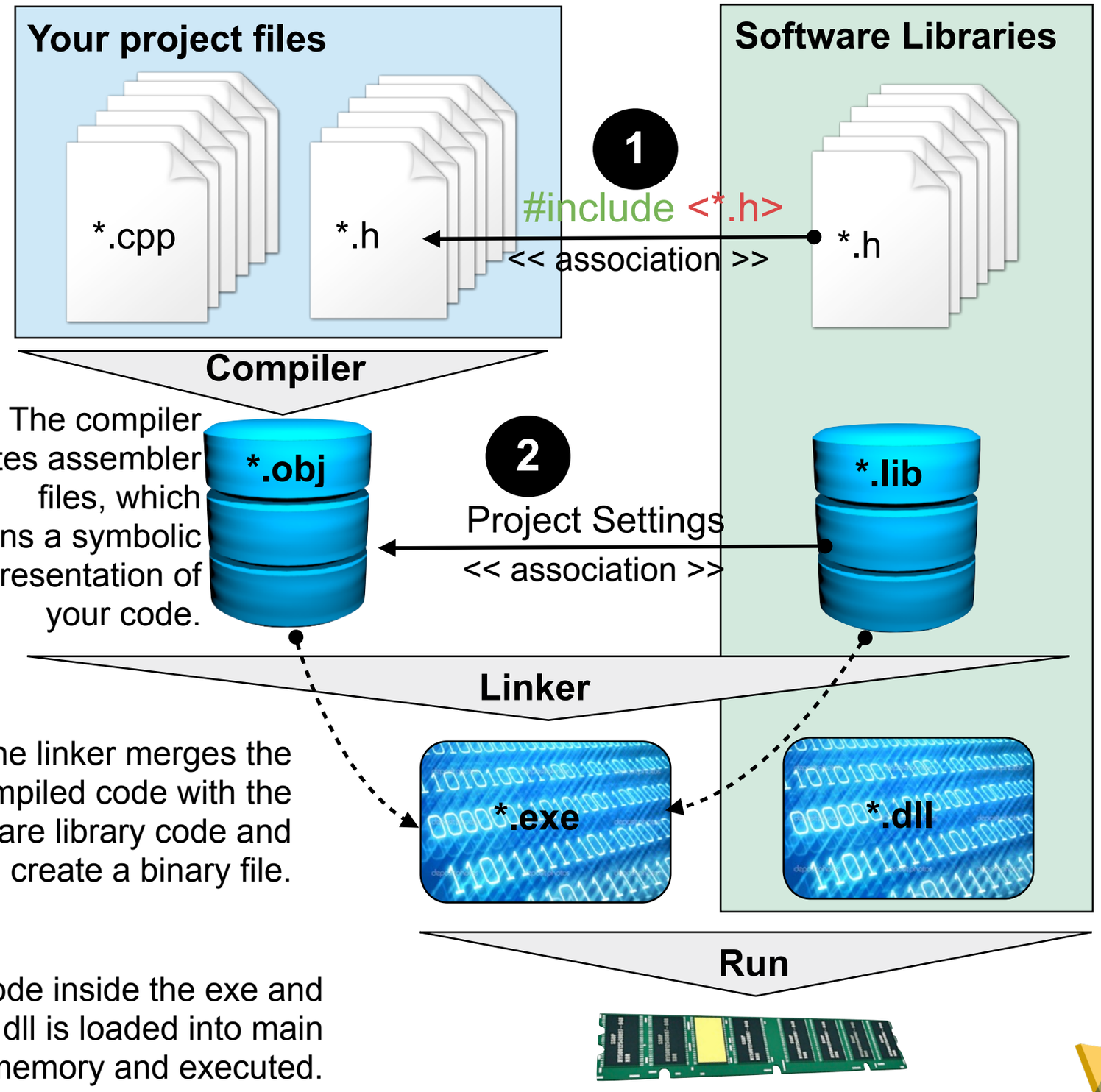


Every software project consists of two set of code: your own code and code from software libraries.

Your project code incorporates a set of cpp-files and header files.

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C/C++ code is generated in two steps.

First, a compiler compiles your project files and generates object files (obj). The contain assembler code. During this step, your code needs to know all the libraries and the provided function. This association is established using the #include command in your header files. The obj files contain a symbolic link to each library function.

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The result is an executable file containing machine code.

During program start, the machine code from the exe and the dll are loaded into computer's main memory. Thus, the program runs.

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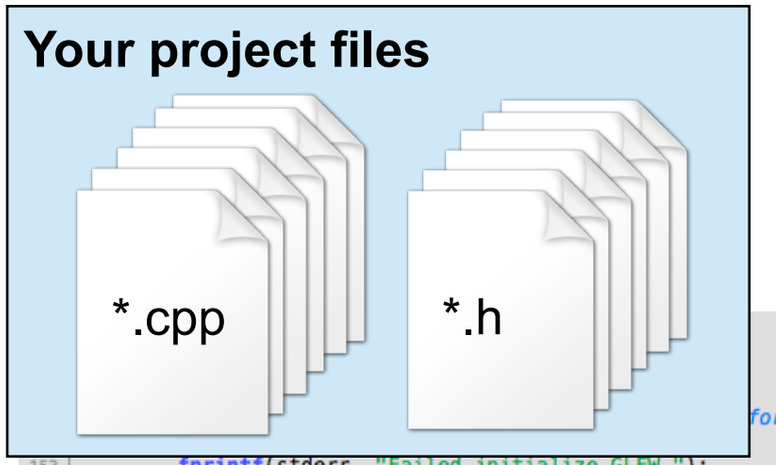


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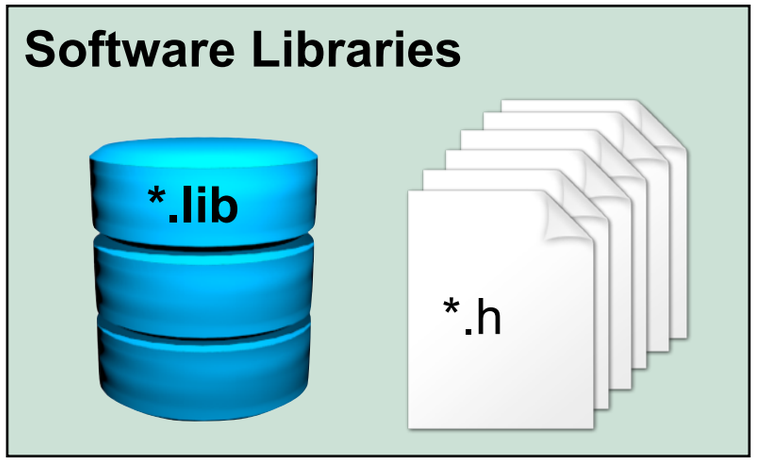


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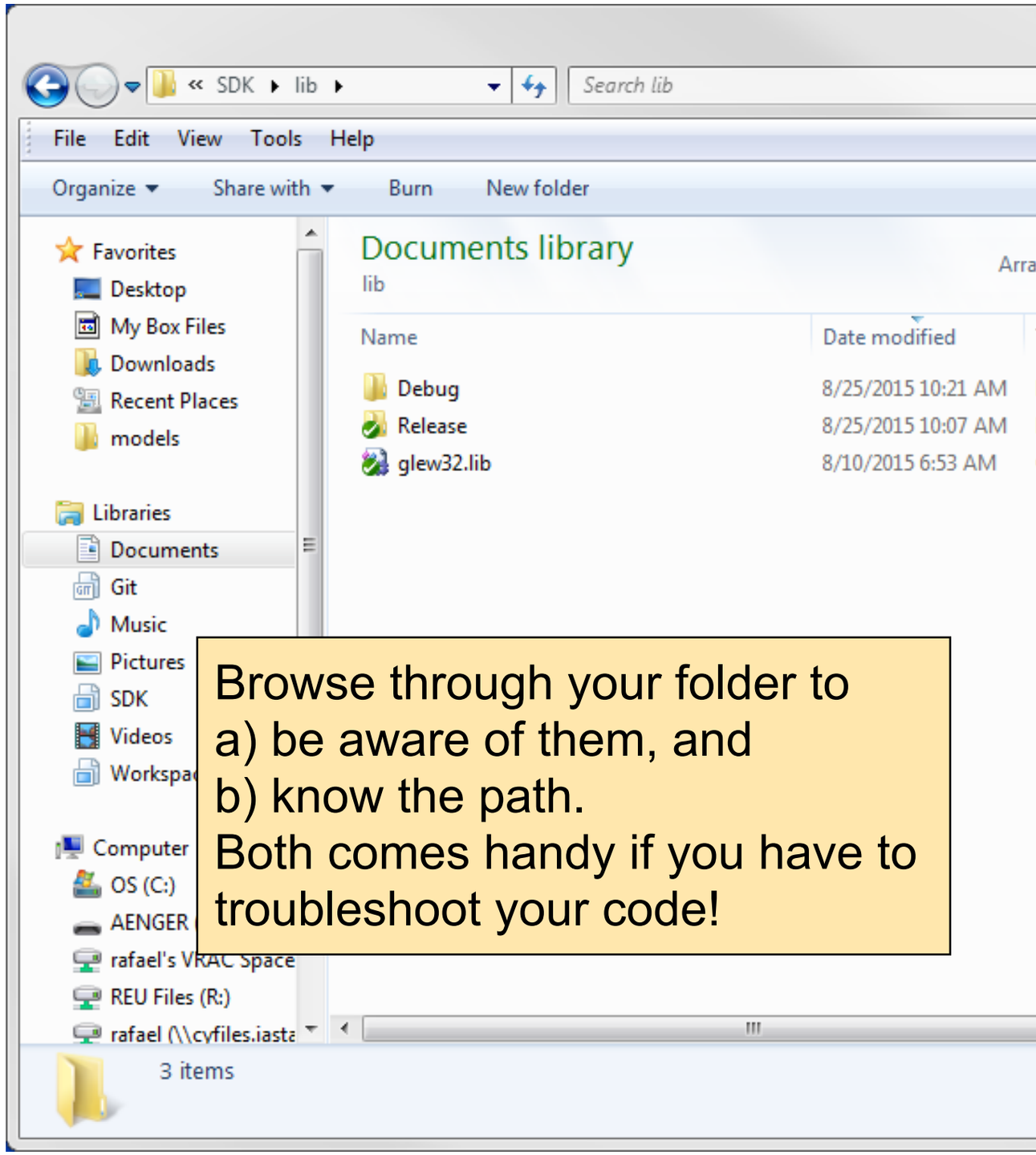

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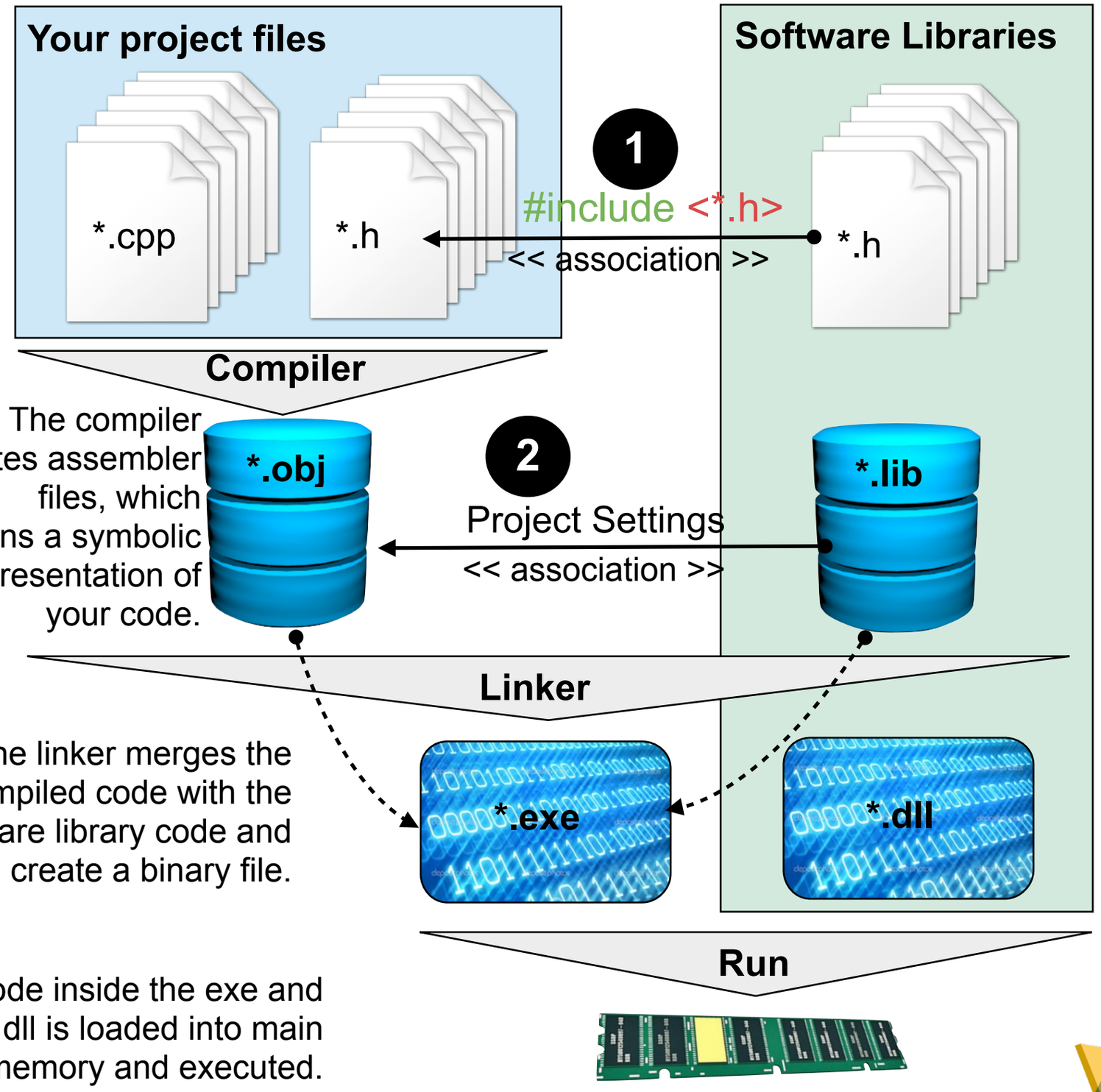


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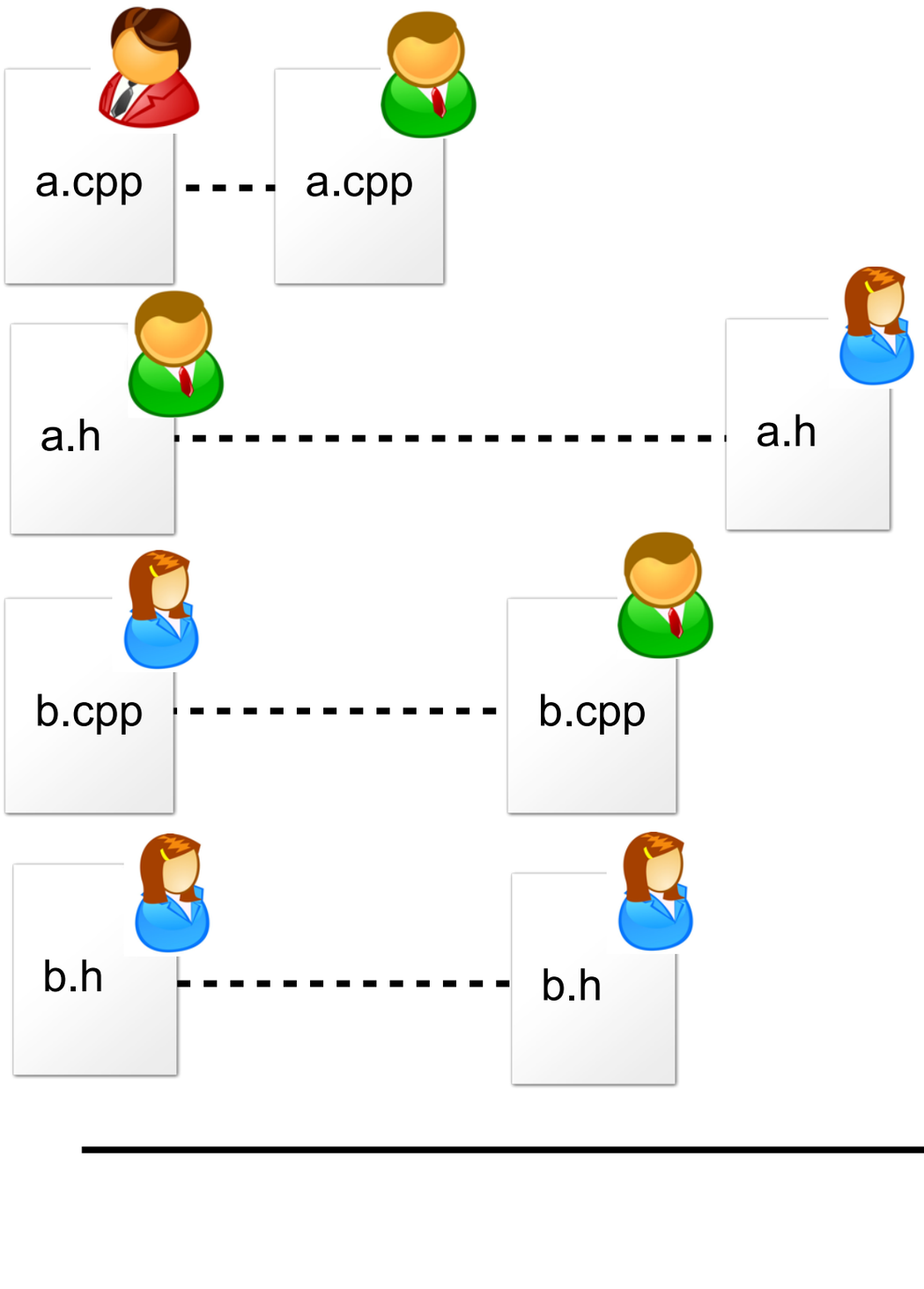
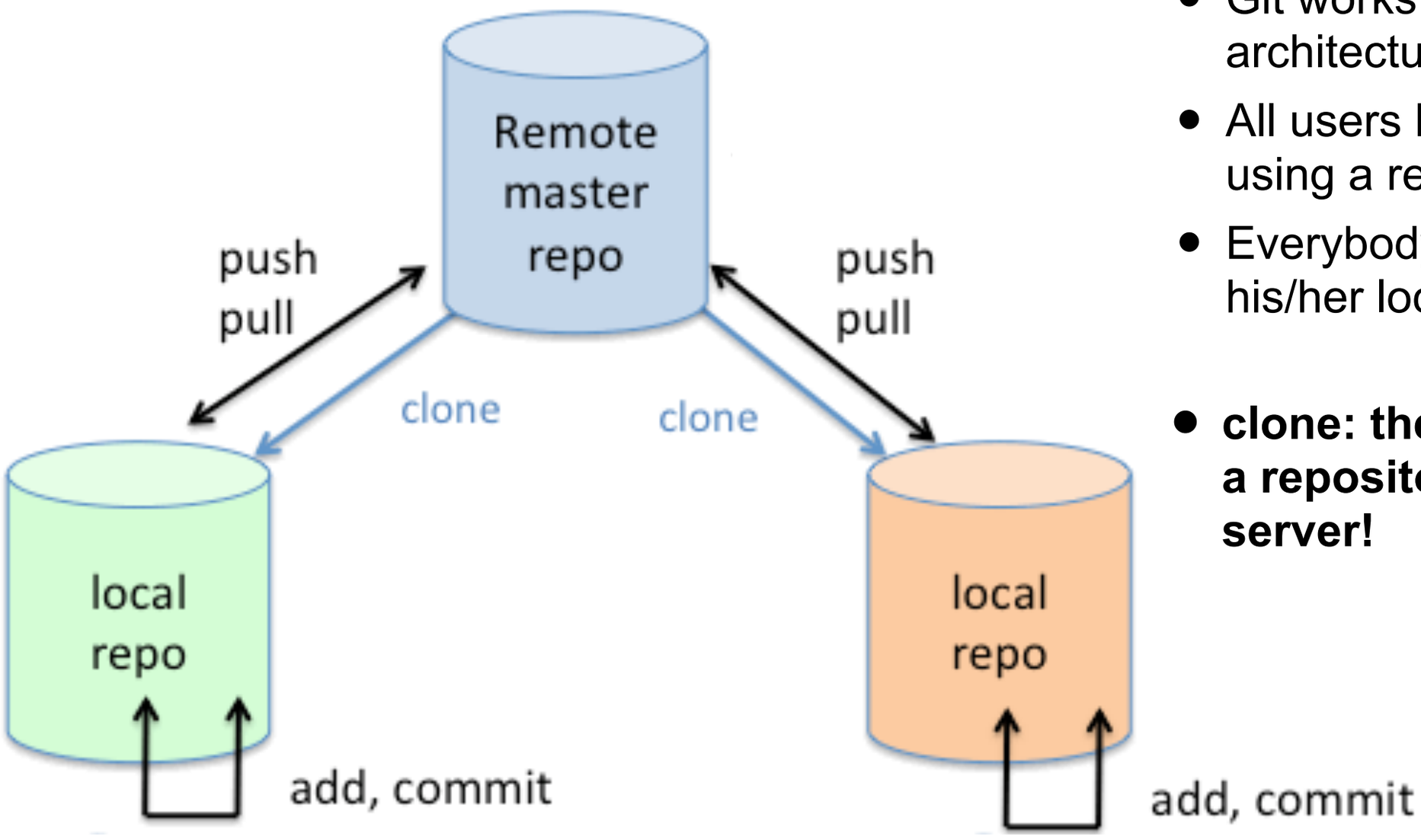
# Code Management




- Keeps track of all code changes
- Identifies conflicts when different users change the same code
- Automatically merges code when no conflicts exist.
- etc.

# Architecture

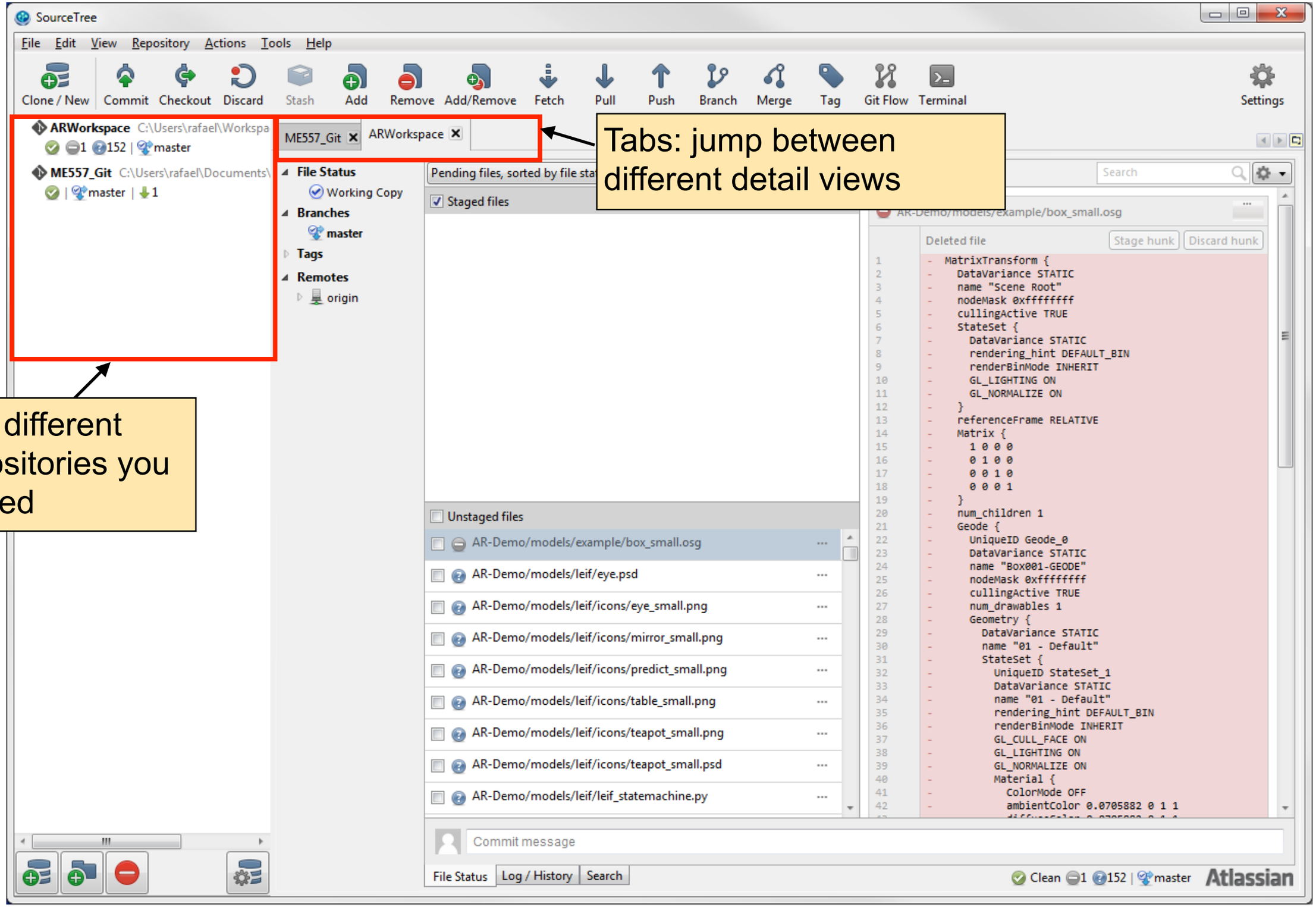



- Git works with a server-based architecture.
- All users have access to code using a remote repository
- Everybody develops using his/her local repository.

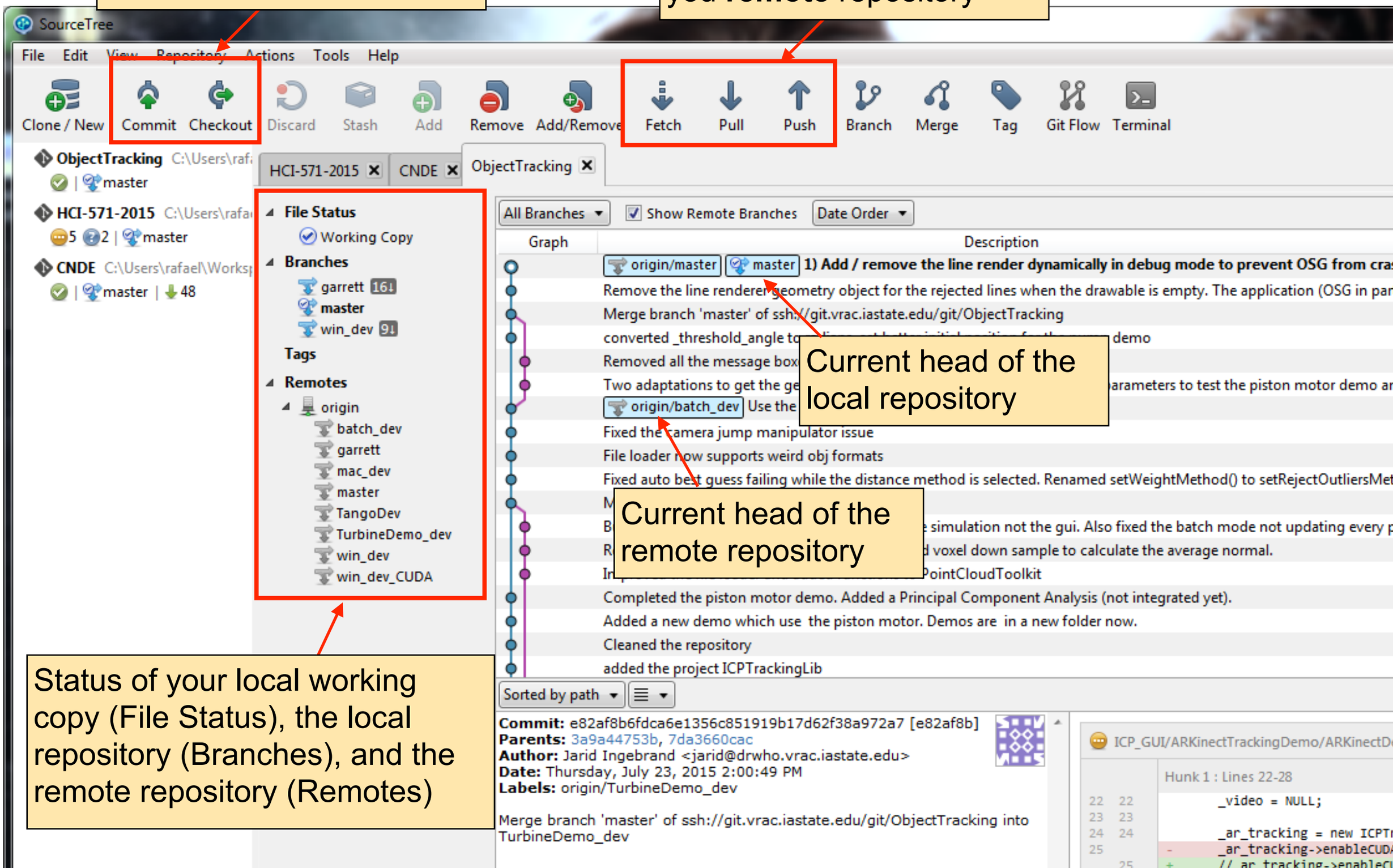
- **clone: the first time you get a repository from the server!**

*Repository structure of a typical git-system*

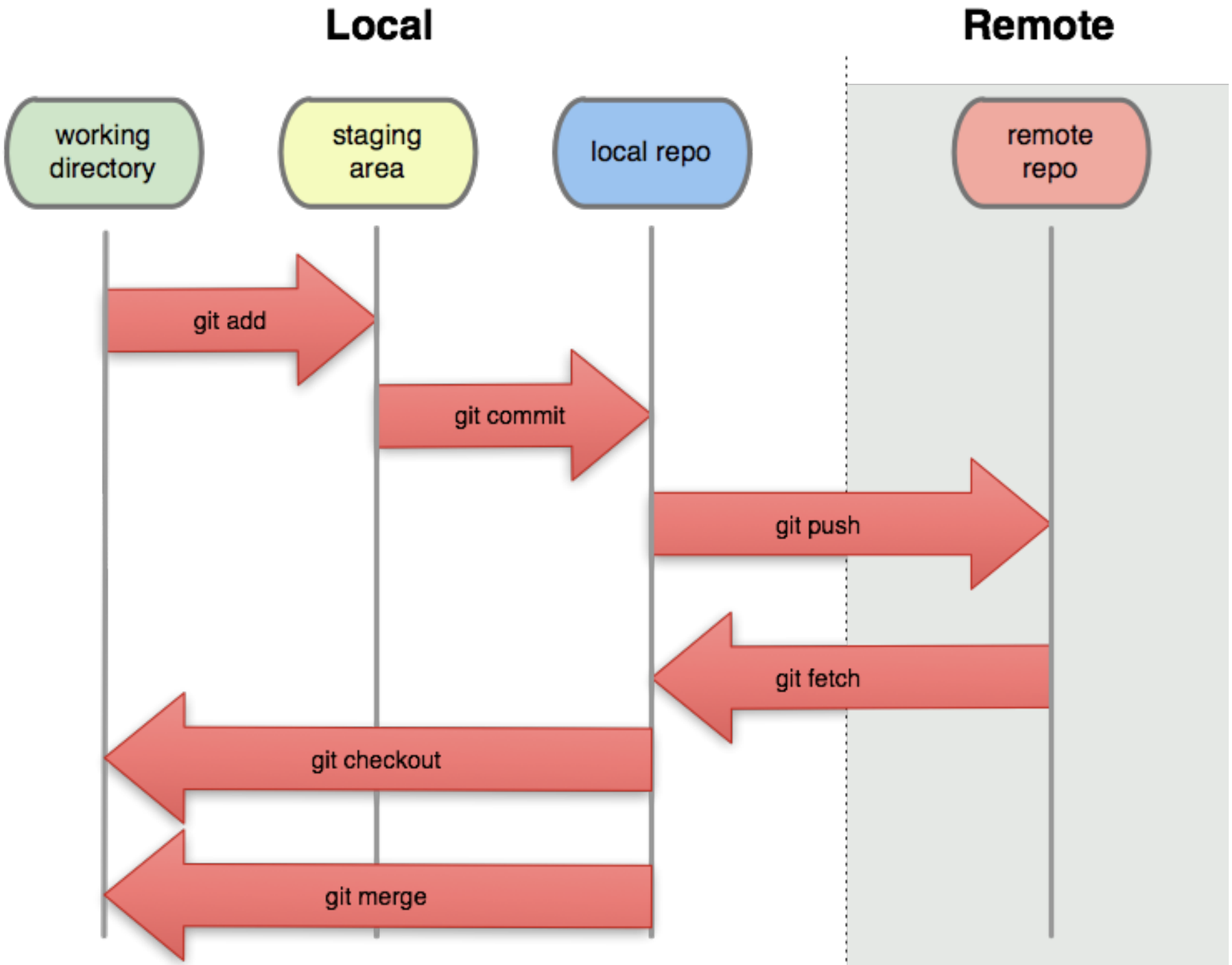
# Source Tree


SourceTree
File Edit View Repository Actions Tools Help
Clone / New
Commit
Checkout
Discard
Stash
Add
Remove
Add/Remove
Fetch
Pull
Push
Branch
Merge
Tag
Git Flow
Terminal
Settings
ARWorkspace C:\Users\rafael\Workspa
1 152 | master
ME557_Git C:\Users\rafael\Documents\
master | 1
ME557_Git
ARWorkspace
Tabs: jump between different detail views
File Status
Working Copy
Branches
master
Tags
Remotes
origin
Pending files, sorted by file sta
Staged files
Search
AR-Demo/models/example/box_small.osg
Deleted file
Stage hunk
Discard hunk
- MatrixTransform {
- DataVariance STATIC
- name "Scene Root"
- nodeMask 0xffffffff
- cullingActive TRUE
- StateSet {
- DataVariance STATIC
- rendering_hint DEFAULT_BIN
- renderBinMode INHERIT
- GL_LIGHTING ON
- GL_NORMALIZE ON
- }
- referenceFrame RELATIVE
- Matrix {
- 1 0 0 0
- 0 1 0 0
- 0 0 1 0
- 0 0 0 1
- }
- num_children 1
- Geode {
- UniqueID Geode_0
- DataVariance STATIC
- name "Box001-GEODE"
- nodeMask 0xffffffff
- cullingActive TRUE
- num_drawables 1
- Geometry {
- DataVariance STATIC
- name "01 - Default"
- StateSet {
- UniqueID StateSet_1
- DataVariance STATIC
- name "01 - Default"
- rendering_hint DEFAULT_BIN
- renderBinMode INHERIT
- GL_CULL_FACE ON
- GL_LIGHTING ON
- GL_NORMALIZE ON
- Material {
- ColorMode OFF
- ambientColor 0.0705882 0 1 1
Unstaged files
AR-Demo/models/example/box_small.osg
AR-Demo/models/leif/eye.psd
AR-Demo/models/leif/icons/eye_small.png
AR-Demo/models/leif/icons/mirror_small.png
AR-Demo/models/leif/icons/predict_small.png
AR-Demo/models/leif/icons/table_small.png
AR-Demo/models/leif/icons/teapot_small.png
AR-Demo/models/leif/icons/teapot_small.psd
AR-Demo/models/leif/leif_statemachine.py
Commit message
File Status
Log / History
Search
Clean 1 152 | master
Atlassian
The different repositories you cloned

# SourceTree


To "copy" code to and from you **local** repository
To "copy" code to and from you **remote** repository
SourceTree
File Edit View Repository Actions Tools Help
Clone / New
Commit
Checkout
Discard
Stash
Add
Remove
Add/Remove
Fetch
Pull
Push
Branch
Merge
Tag
Git Flow
Terminal
ObjectTracking C:\Users\raf
master
HCI-571-2015 C:\Users\rafa
5 2 | master
CNDE C:\Users\rafael\Worksp
master | 48
HCI-571-2015
CNDE
ObjectTracking
File Status
Working Copy
Branches
garrett 16↓
master
win_dev 9↓
Tags
Remotes
origin
batch_dev
garrett
mac_dev
master
TangoDev
TurbineDemo_dev
win_dev
win_dev_CUDA
All Branches
Show Remote Branches
Date Order
Graph
Description
origin/master
master
1) Add / remove the line render dynamically in debug mode to prevent OSG from cra
Remove the line renderer geometry object for the rejected lines when the drawable is empty. The application (OSG in par
Merge branch 'master' of ssh://git.vrac.iastate.edu/git/ObjectTracking
converted _threshold_angle to
demo
Removed all the message box
Two adaptations to get the ge
arameters to test the piston motor demo ar
origin/batch_dev
Use the
Fixed the camera jump manipulator issue
File loader now supports weird obj formats
Fixed auto best guess failing while the distance method is selected. Renamed setWeightMethod() to setRejectOutliersMet
simulation not the gui. Also fixed the batch mode not updating every p
d voxel down sample to calculate the average normal.
PointCloudToolkit
Completed the piston motor demo. Added a Principal Component Analysis (not integrated yet).
Added a new demo which use the piston motor. Demos are in a new folder now.
Cleaned the repository
added the project ICPTrackingLib
Current head of the local repository
Current head of the remote repository
Status of your local working copy (File Status), the local repository (Branches), and the remote repository (Remotes)
Sorted by path
Commit: e82af8b6fdca6e1356c851919b17d62f38a972a7 [e82af8b]
Parents: 3a9a44753b, 7da3660cac
Author: Jarid Ingebrand <jarid@drwho.vrac.iastate.edu>
Date: Thursday, July 23, 2015 2:00:49 PM
Labels: origin/TurbineDemo_dev
Merge branch 'master' of ssh://git.vrac.iastate.edu/git/ObjectTracking into TurbineDemo_dev
ICP_GUI/ARKinectTrackingDemo/ARKinectD
Hunk 1 : Lines 22-28
22 22 _video = NULL;
23 23
24 24 _ar_tracking = new ICPT
25 - _ar_tracking->enableCUD
25 + // ar_tracking->enableC

# Git Command / Functions




*The git command structure*

Remote:

- your server, GitHub, Bitbucket
- Every member of the team has access

Local:

- your computer
- only you have access
- not secured on the server.

# Terminology

- Head: the latest code version on your remote repository
- Base: the code version on the server at which you started to develop (pull)
- Working copy: the local working copy of all files you pulled.
- Staged files: files you edited and marked to commit and push to the local and remote repository.
- Branches: your local version of a remote repository. Note, git allows to start a new development branch, separated from the main branch.
- Remotes: the remote repositories.

Most favorite gotcha: remote repositories and local repositories do not need to share the same name. If you work in a team and you use different branches to develop code, keep track of the names.

# SourceTree

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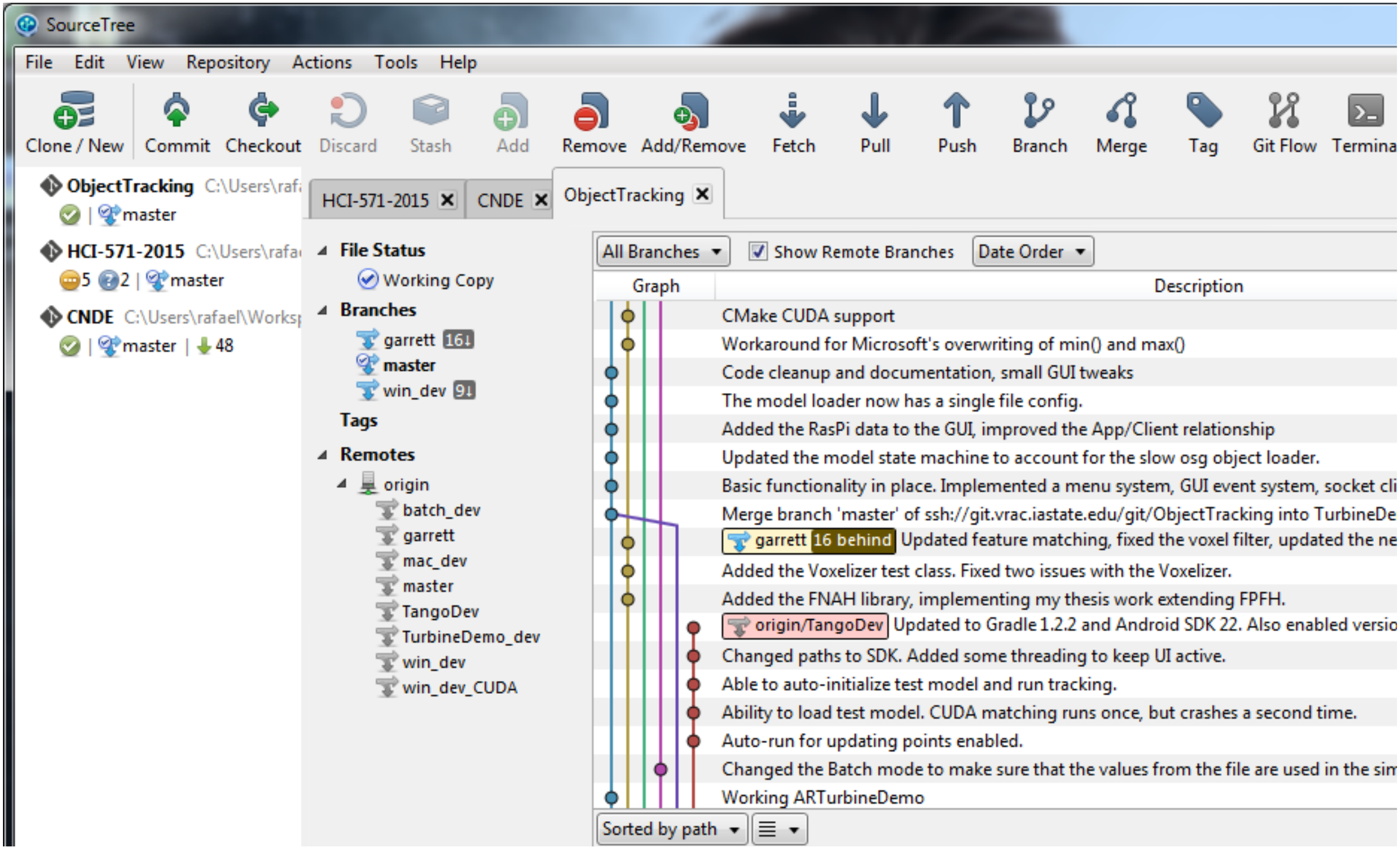
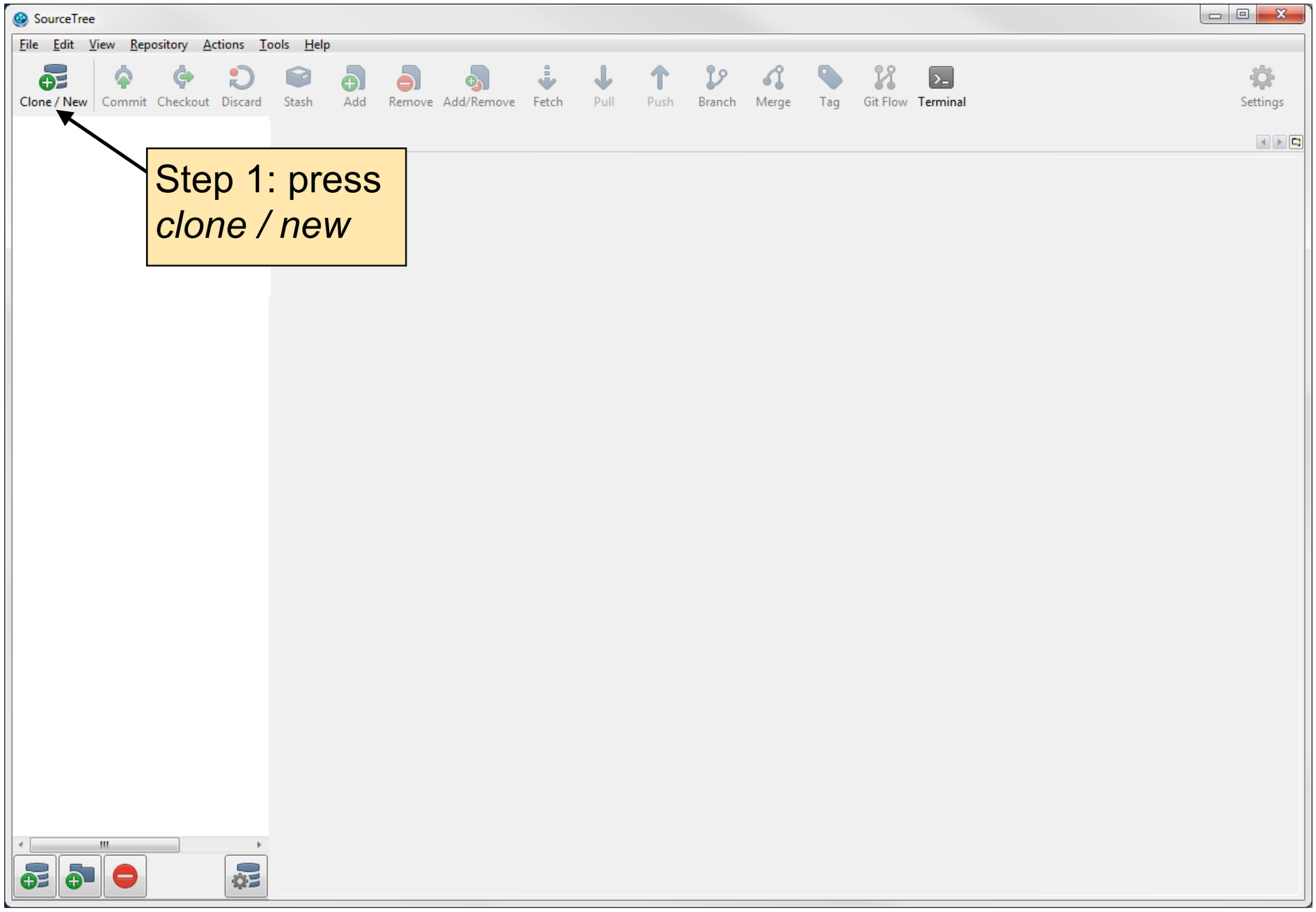


# Example:
# Clone the source code repository for this course

# Clone a Repository

Let's consider you need to clone a remote repository.




*SourceTree main view*

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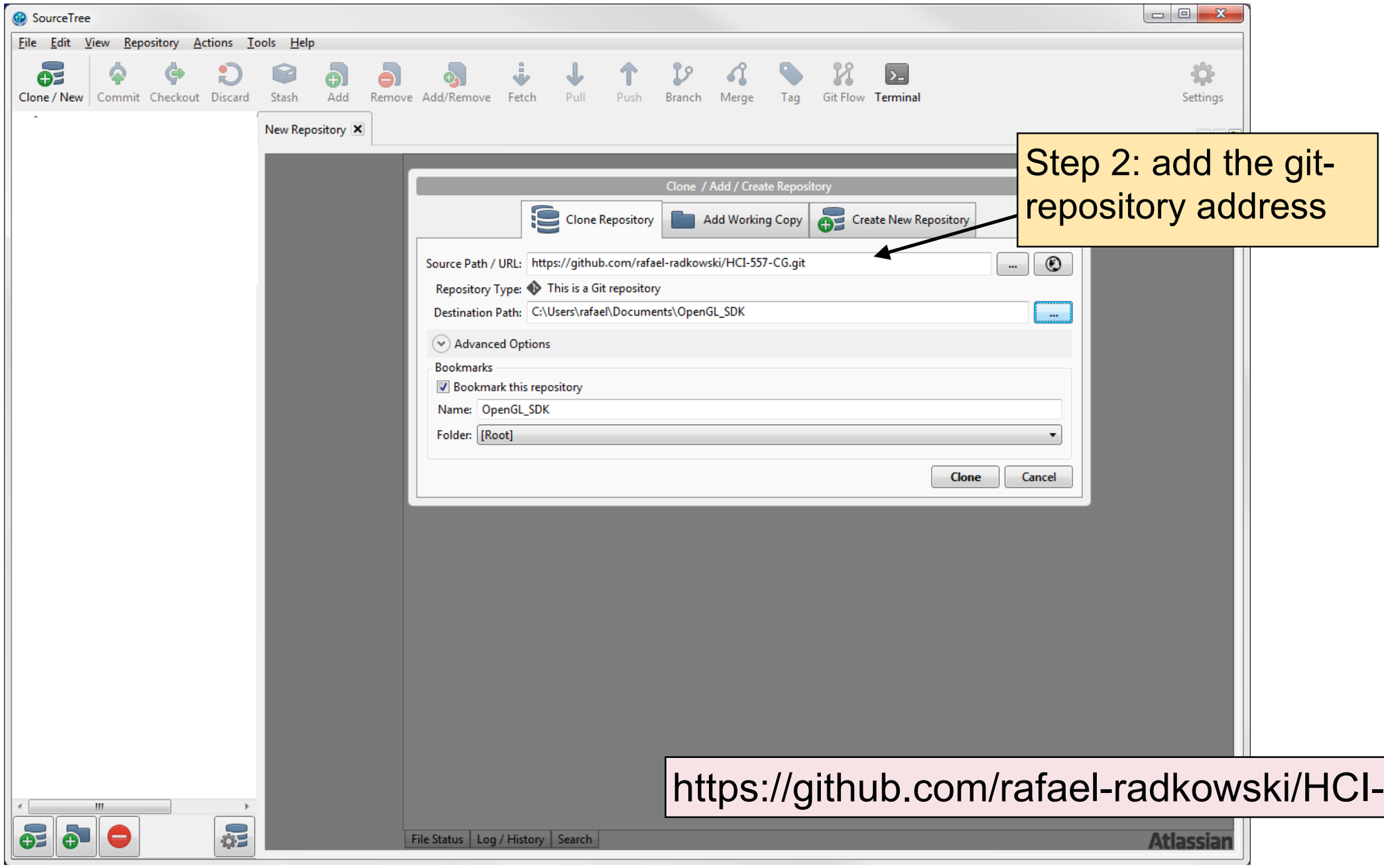


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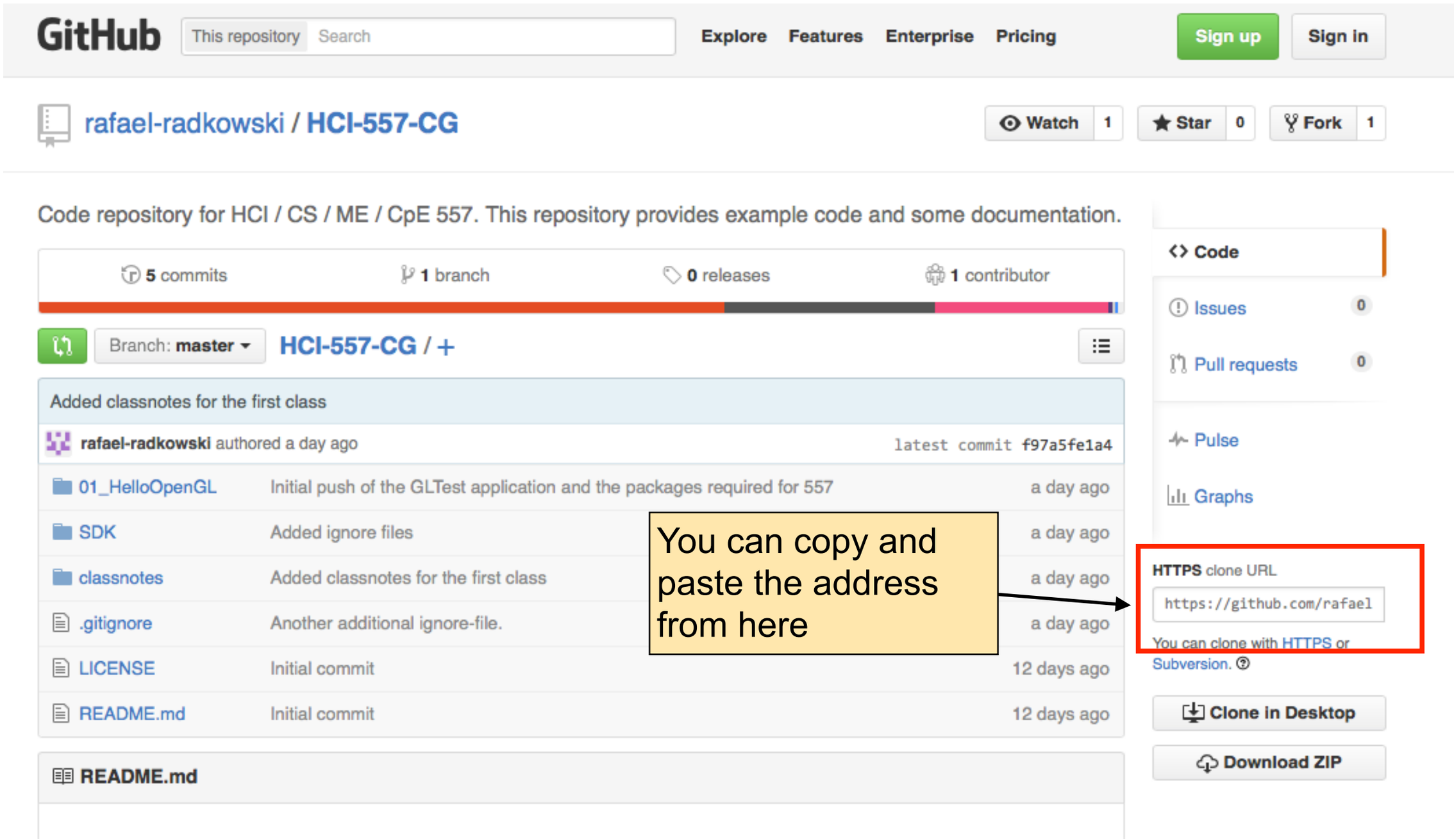
# GitHub

https://github.com/rafael-radkowski/HCI-557-CG

I posted a message on blackboard with the git address and the web page address.



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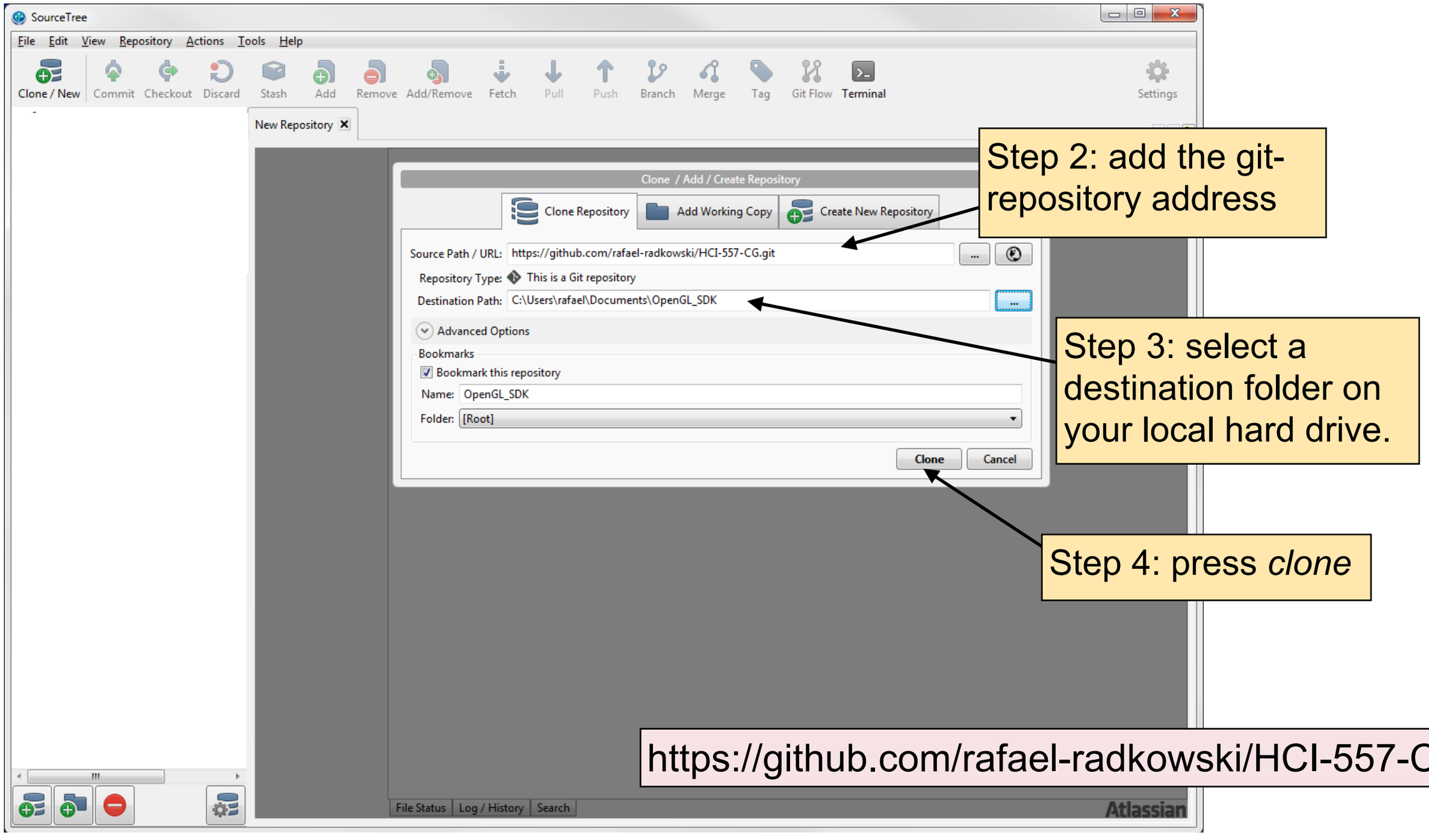


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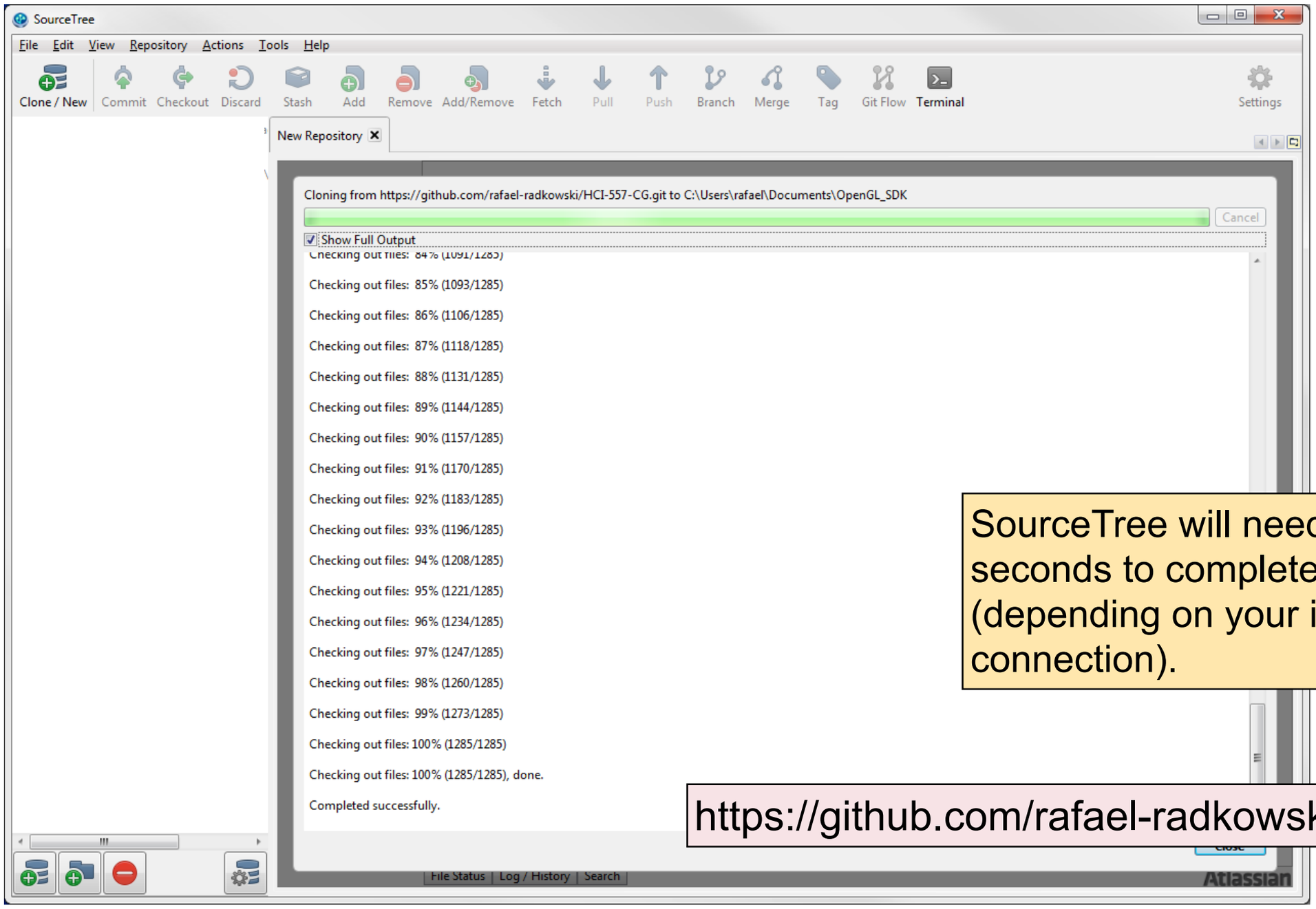


SourceTree will need a few seconds to complete this process (depending on your internet connection).

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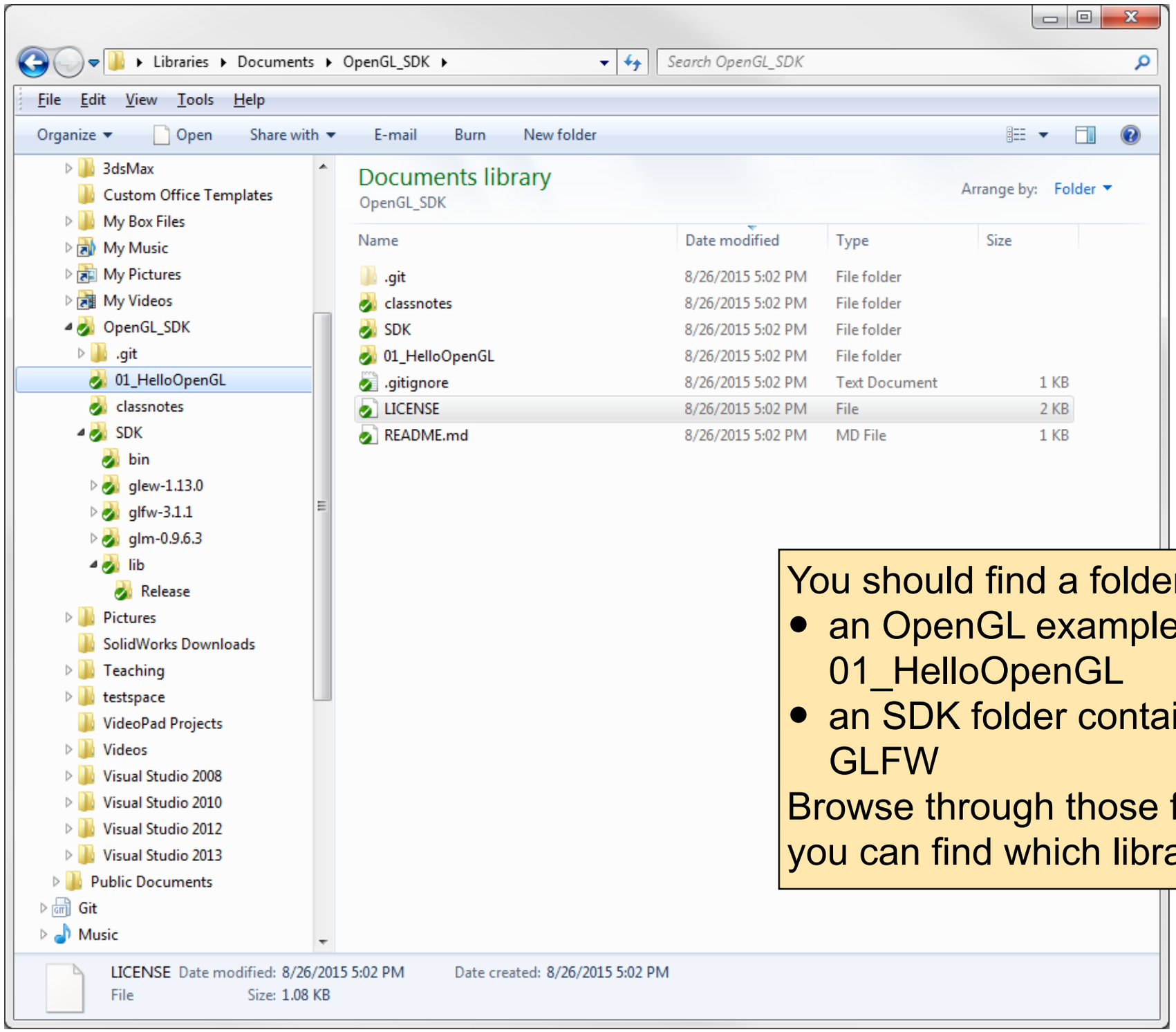


You should find a folder with

- an OpenGL example program 01_HelloOpenGL
- an SDK folder containing GLEW, GLM, and GLFW

Browse through those folders to learn where you can find which libraries.

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# Visual Studio

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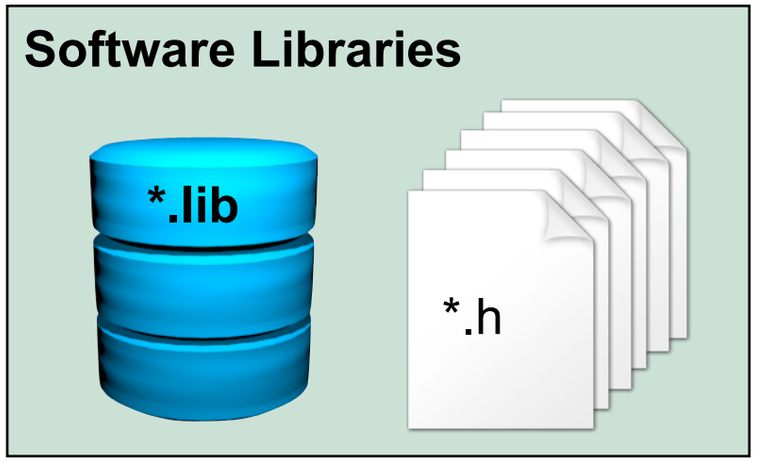


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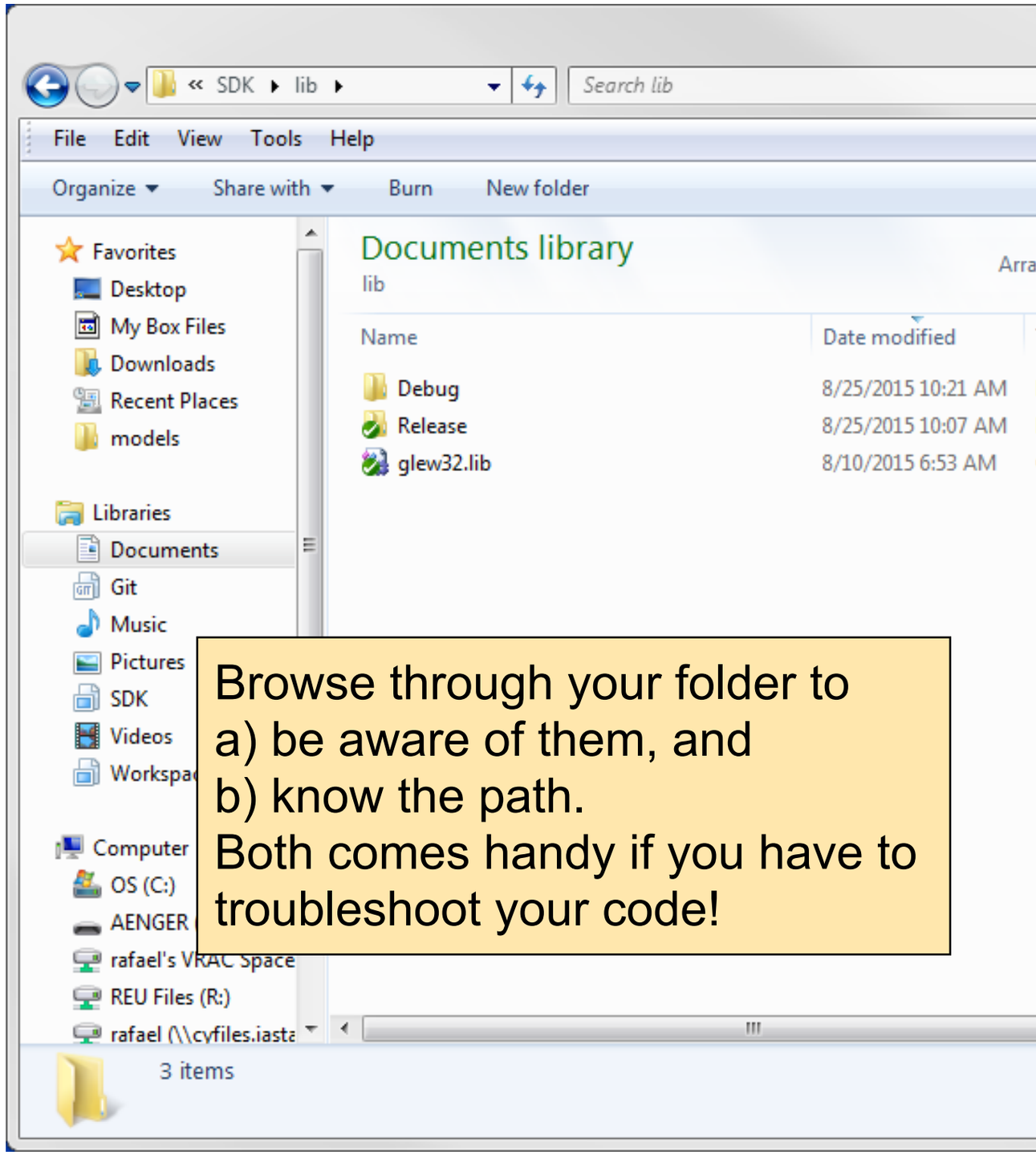
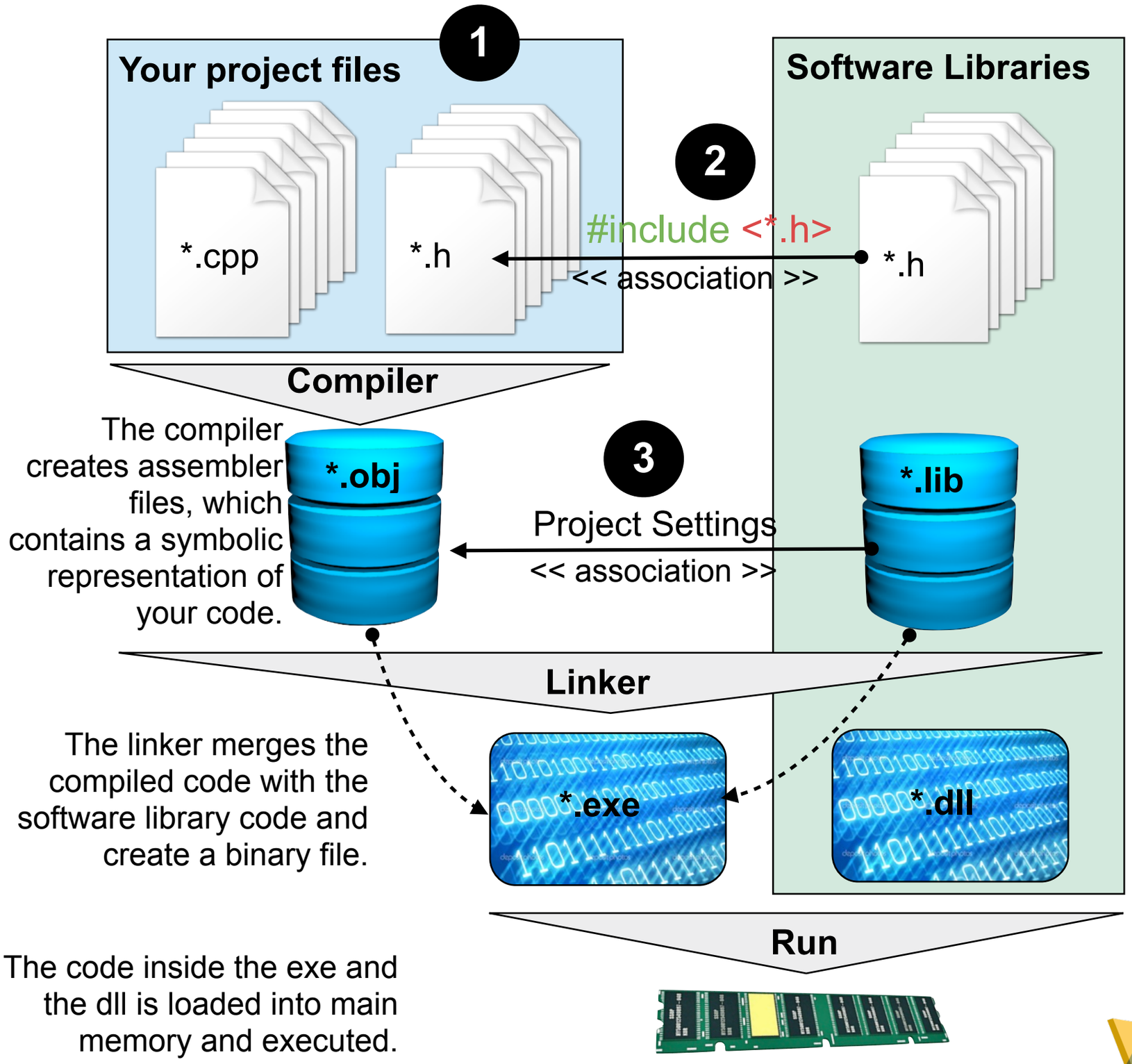


# C/C++ Compiler




Every software project consists of two set of code: your own code and code from software libraries.

Your project code incorporates a set of cpp-files and header files.

The software library incorporates a set of header files, a library (multiple library files), and a binary file (dll), which contains the executables.

C/C++ code is generated in two steps.

First, a compiler compiles your project files and generates object files (obj). The contain assembler code. During this step, your code needs to know all the libraries and the provided function. This association is established using the #include command in your header files. The obj files contain a symbolic link to each library function.

Secondly, the Linker merges the generated obj files to one binary file. During this process, the Linker searches the lib files for the binary code, related to the symbolic links.

The result is an executable file containing machine code.

During program start, the machine code from the exe and the dll are loaded into computer's main memory. Thus, the program runs.

# Microsoft Visual Studio

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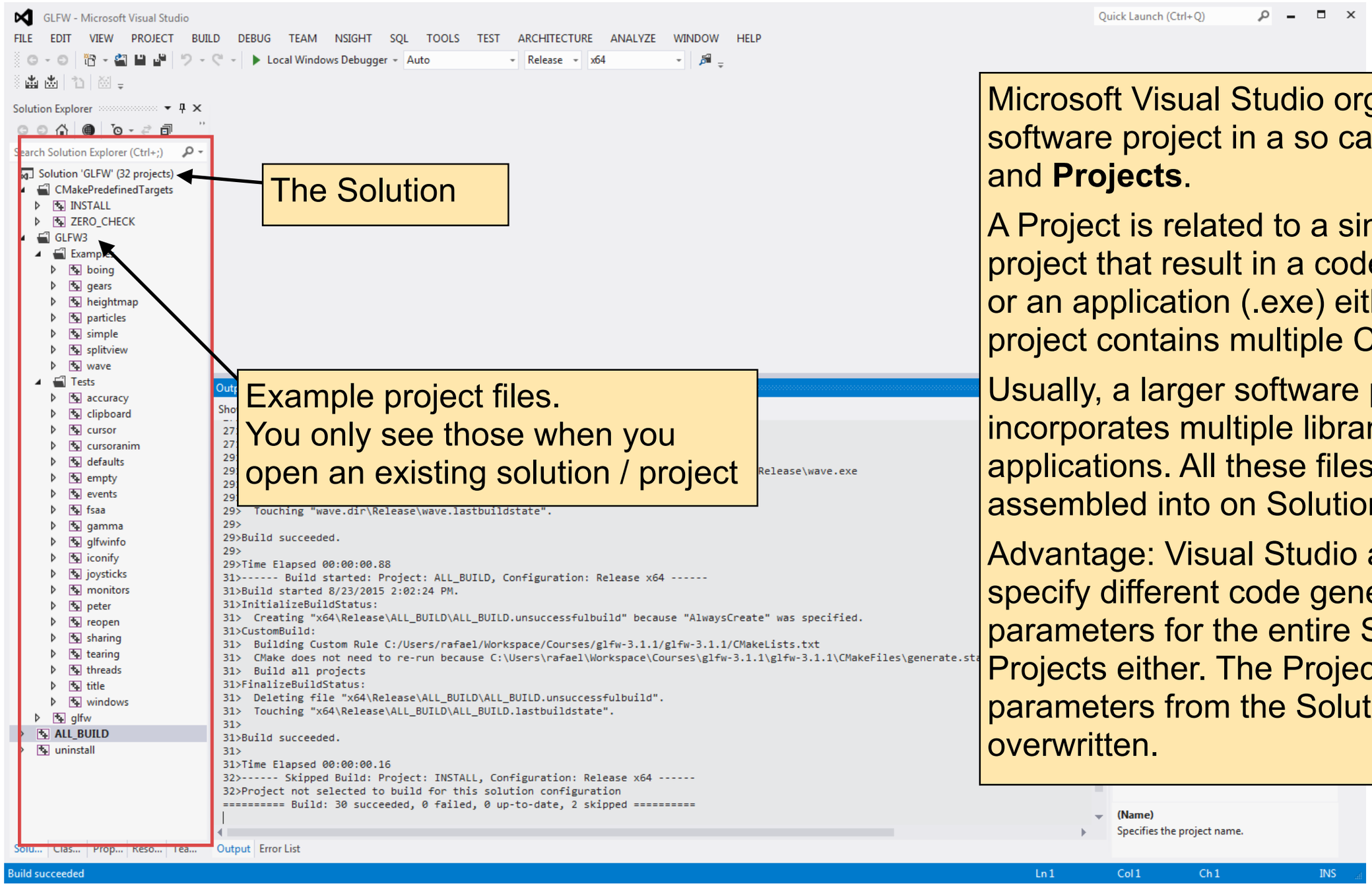
## MS Visual Studio organization




Microsoft Visual Studio organize a software project in a so called **Solution** and **Projects**.

A Project is related to a single code project that result in a code library (.lib) or an application (.exe) either. Each project contains multiple C/C++ files.

Usually, a larger software project incorporates multiple library files and applications. All these files are assembled into on Solution.

Advantage: Visual Studio allows to specify different code generation parameters for the entire Solution or the Projects either. The Projects inherit the parameters from the Solution if not overwritten.

*Microsoft Visual Studio main view*

# Solution / Project Creation

Before you can start to develop code, you have to create a solution along with a project.

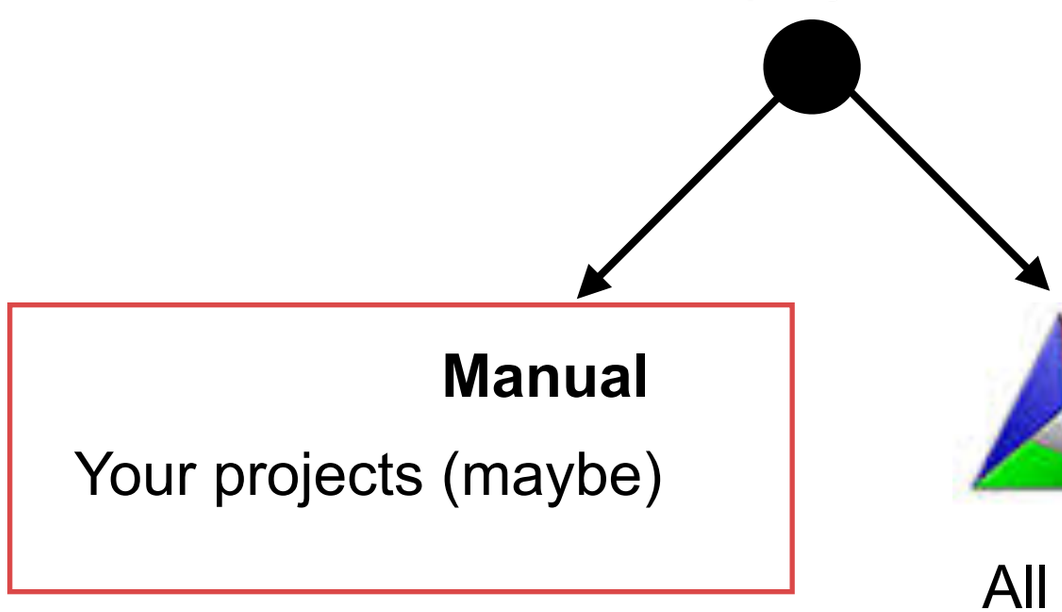
Two ways:

Starting point:

I would like to create a project

*or*

create a solution / project for existing code.




All 557 examples provide cmake files!

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**Next slides:**

**<u>Manual</u> preparation of an "empty" project**

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# Create a Project

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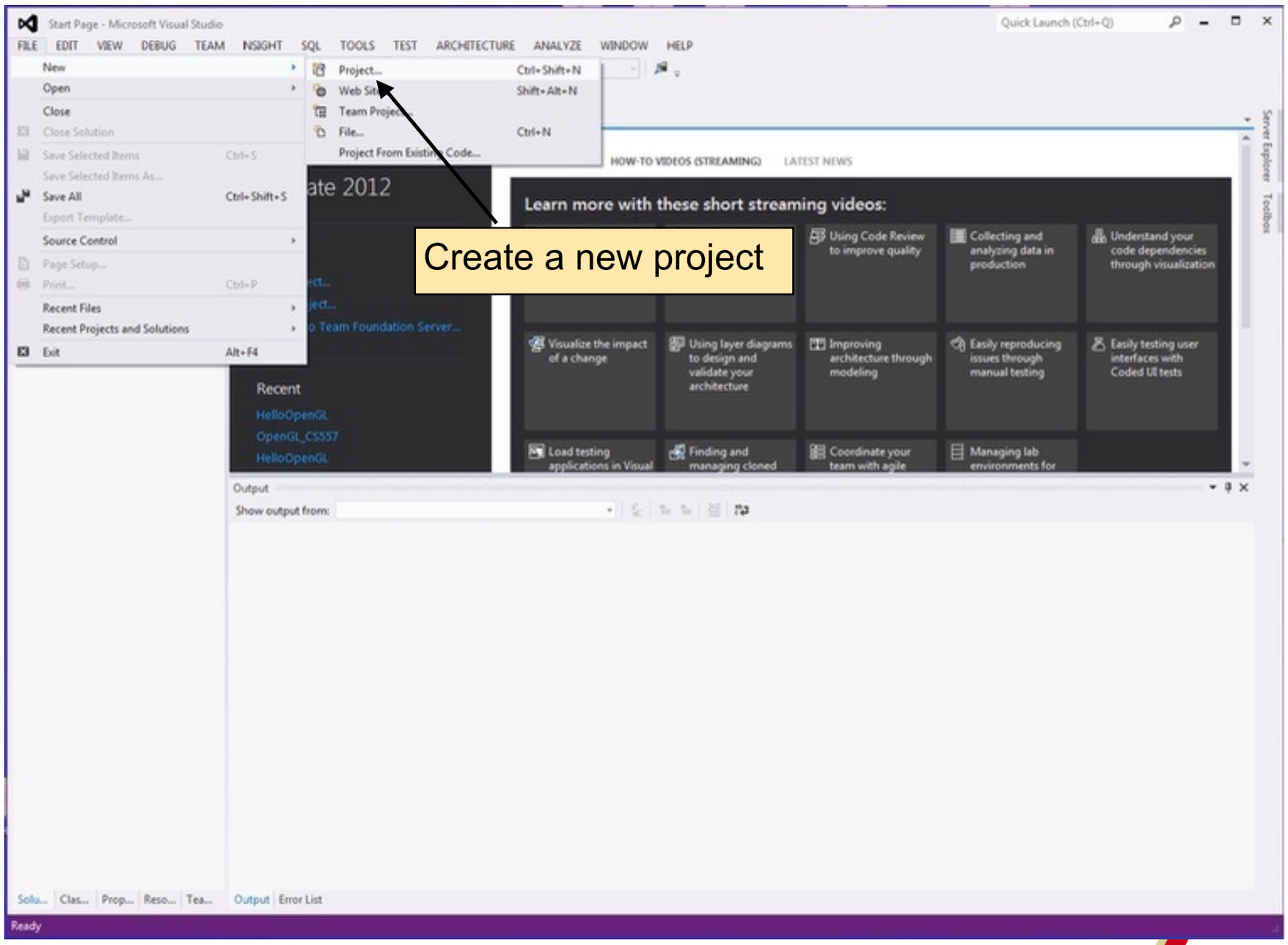
1. Go to File -> New -> Project to create a new code project. The solution is created automatically.




*Microsoft Visual Studio main view*

# Create a Project

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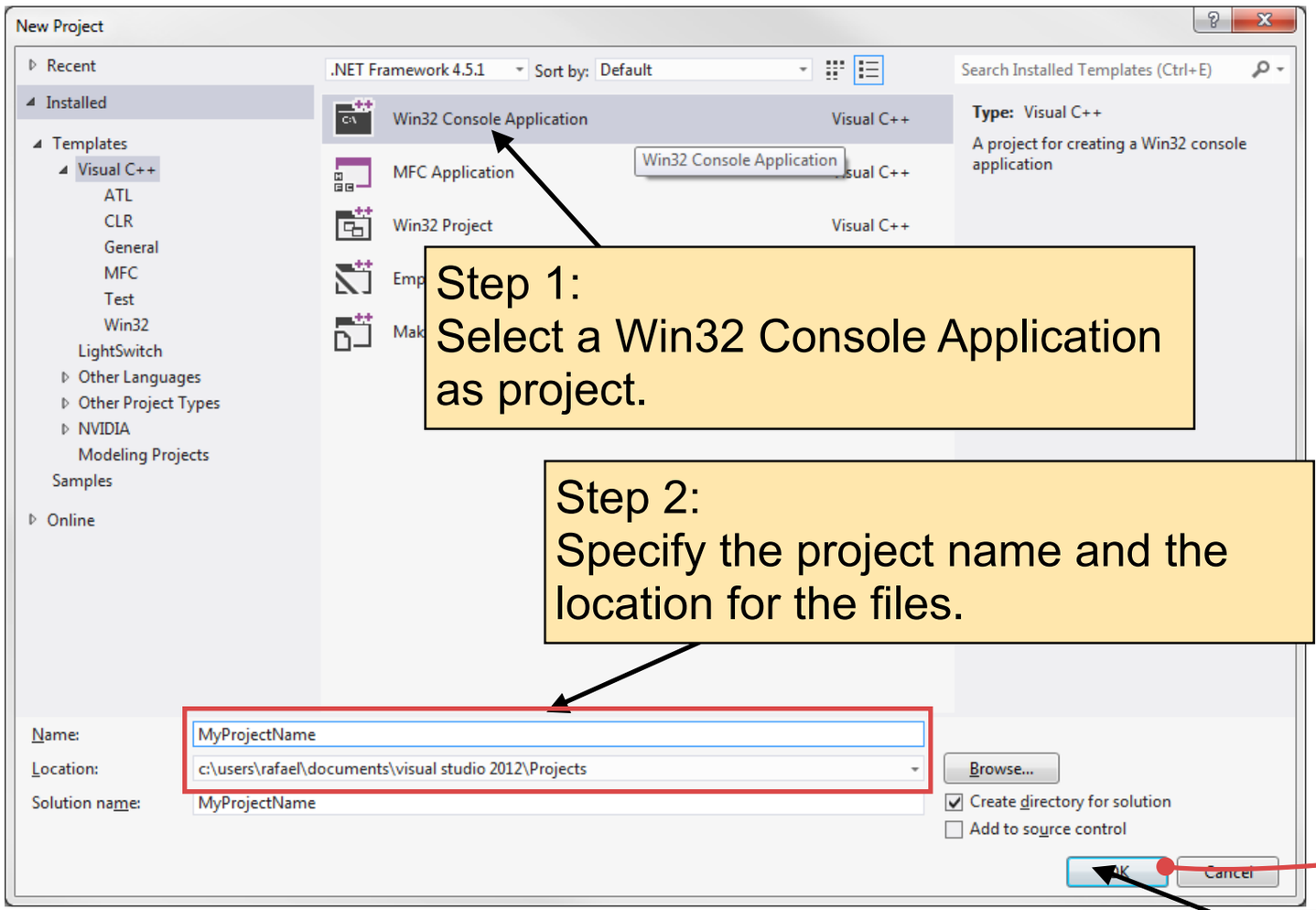
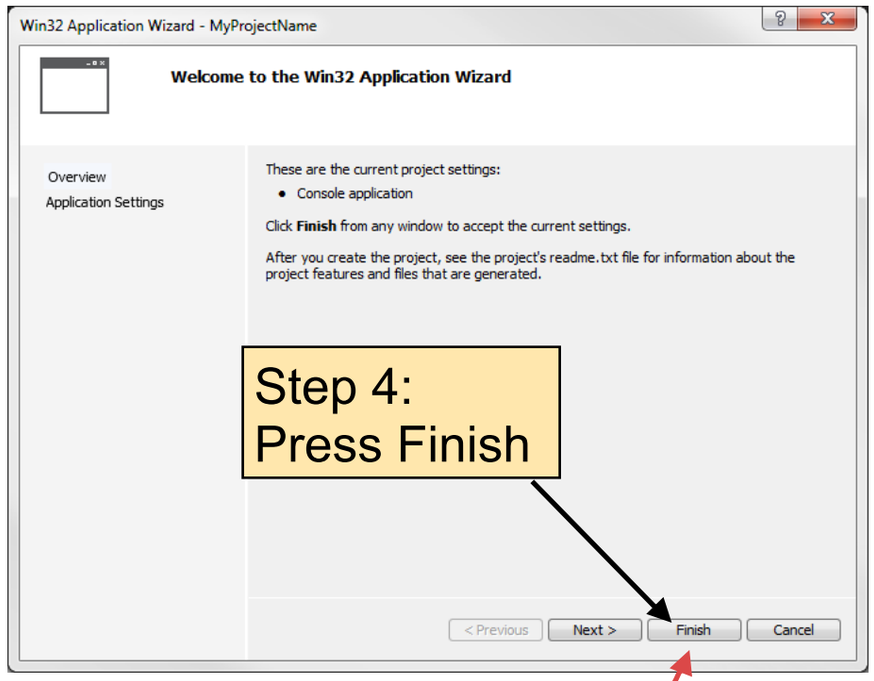
1. A project selection window pops up.
   Step 1: Select a Visual C++ -> Win32 -> Win32 Console Application.
   Step 2: Specify a project name and a project location.




*Microsoft Visual Studio project selection window*




Step 3:
Press OK

A new window opens after OK was pressed.

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# Project Preparation

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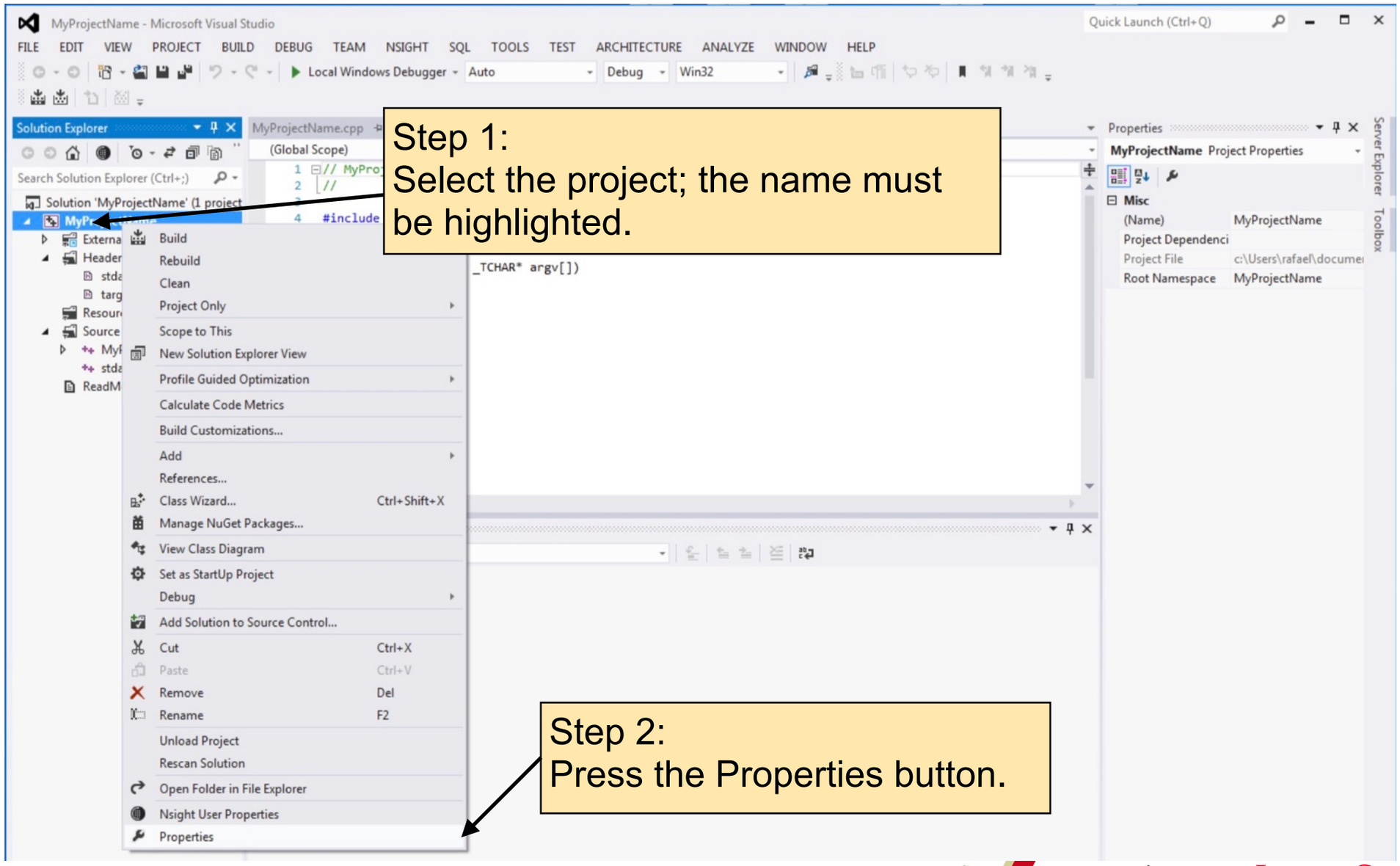
**2** The project must know the libraries and header files you like to use

Step 1: Select the solution (highlighted)

Step 2: Press the Properties button

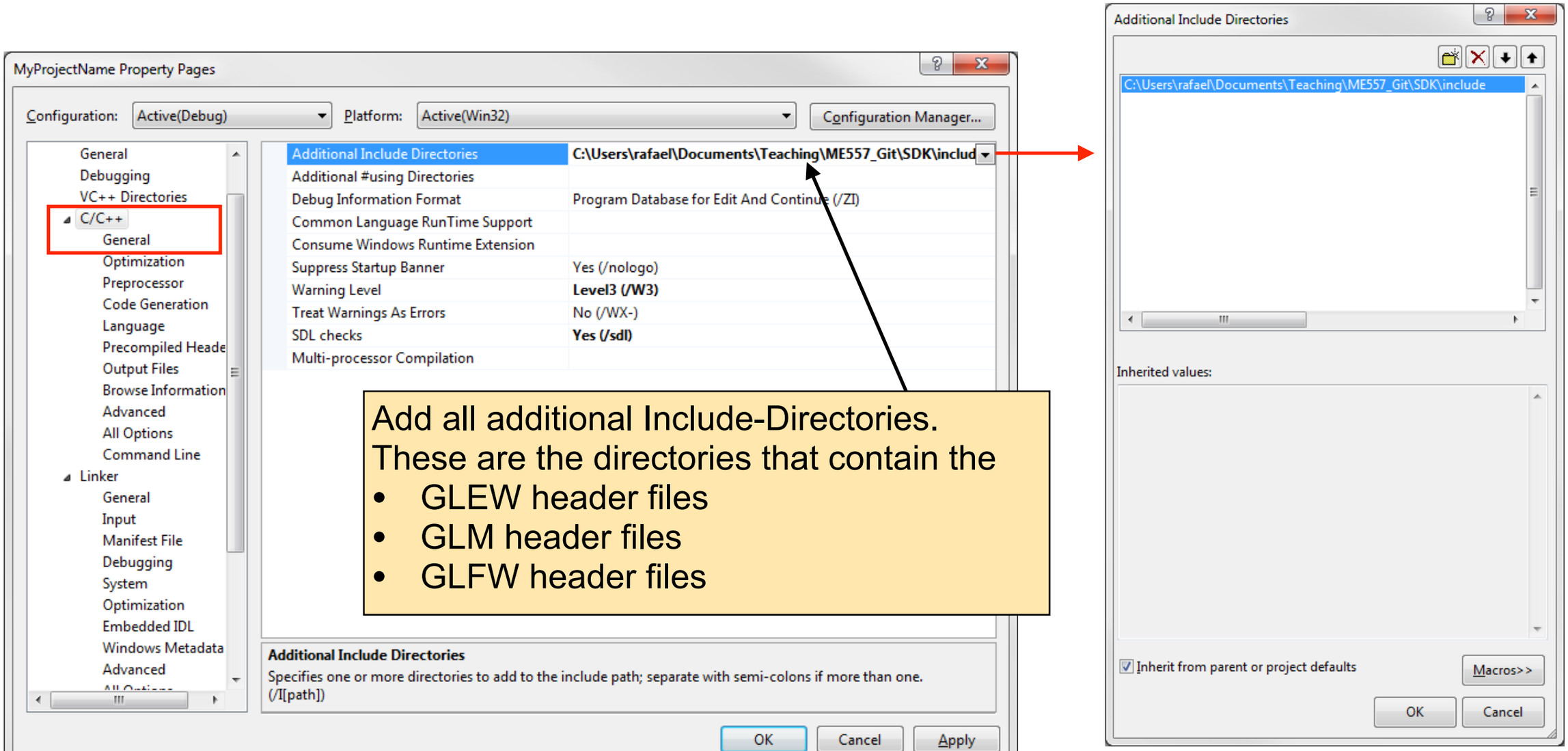



*Microsoft Visual Studio main view*

# Prepare the Compiler

2. Set up the compiler means, tell the compiler where to find the header files of the framework you use (GLEW, GLM, GLFW in our case).

   Go to: *Configuration Properties -> C/C++ -> General* and add the directory.

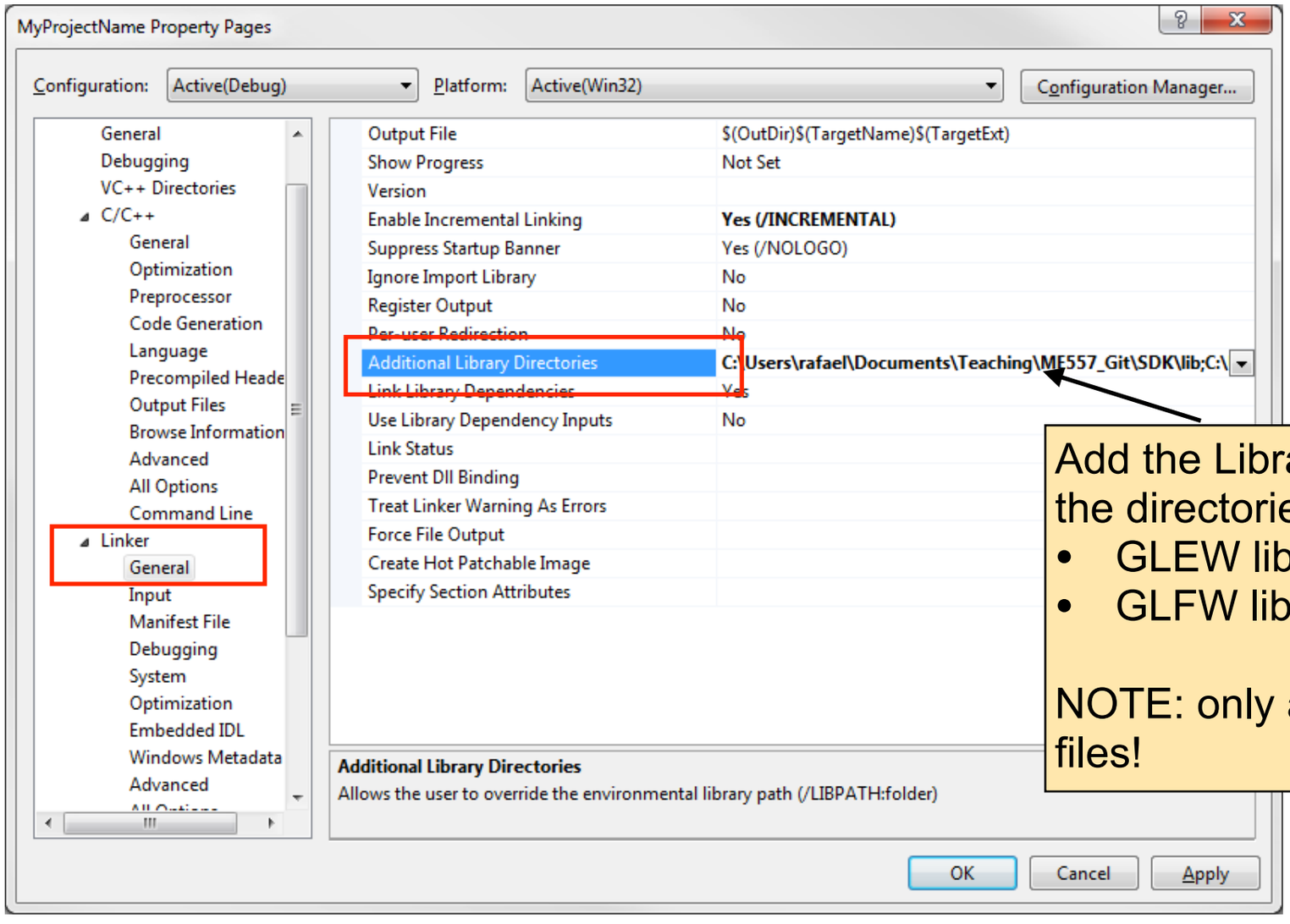



*Microsoft Visual Studio - Project Property Window*

# Setup the Linker

3 Setup the linker means, tell the linker where to find the library files and which library files you want to use.

Go to: *Configuration Properties -> Linker -> General* and add the directory.




Add the Library directories. These are the directories that contain the

- GLEW library file glew32.lib
- GLFW library file glfw.lib

NOTE: only add the path and not the files!

*Microsoft Visual Studio - Project Property Window*

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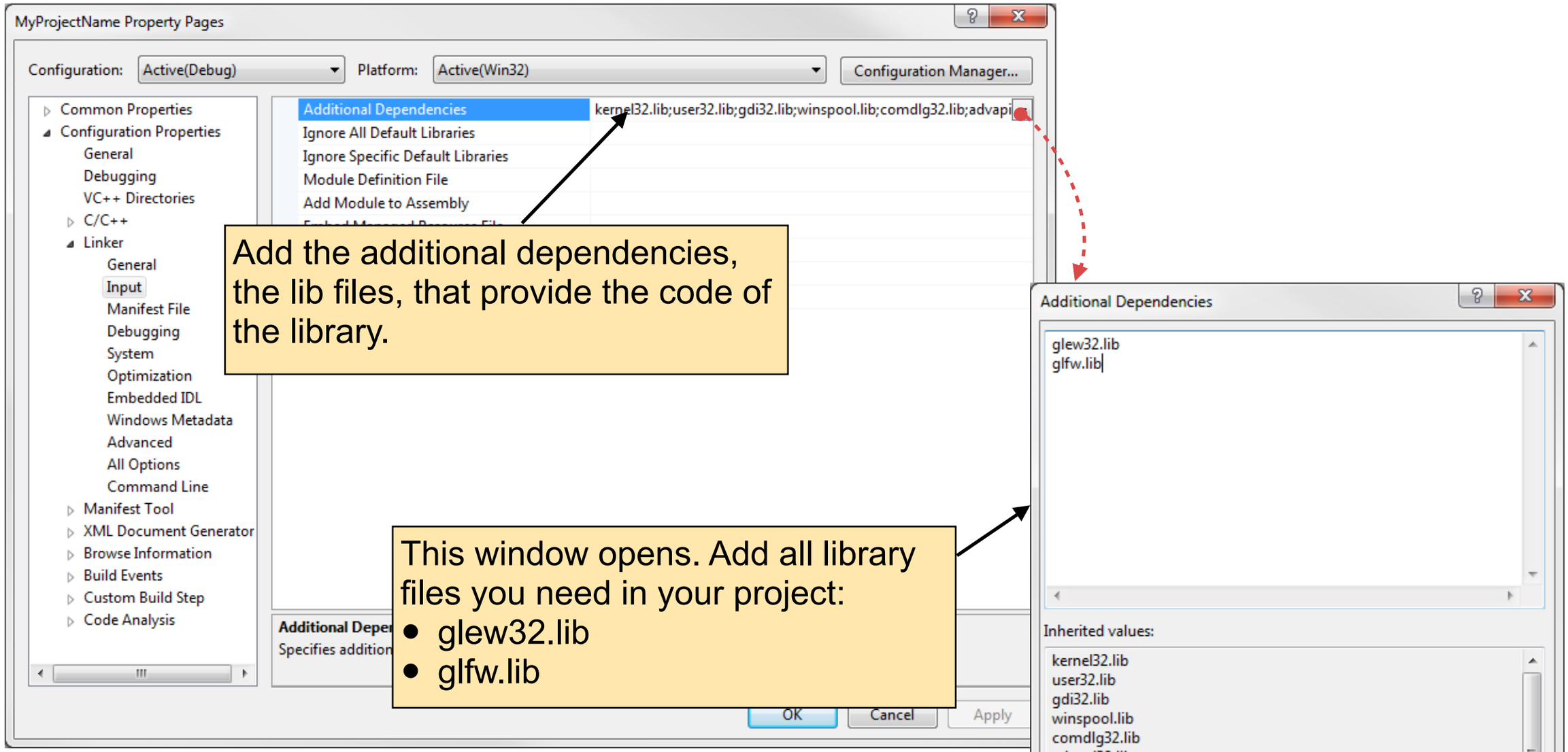
# Add Libraries

3 Setup the linker means, tell the linker where to find the library files and which library files you want to use.

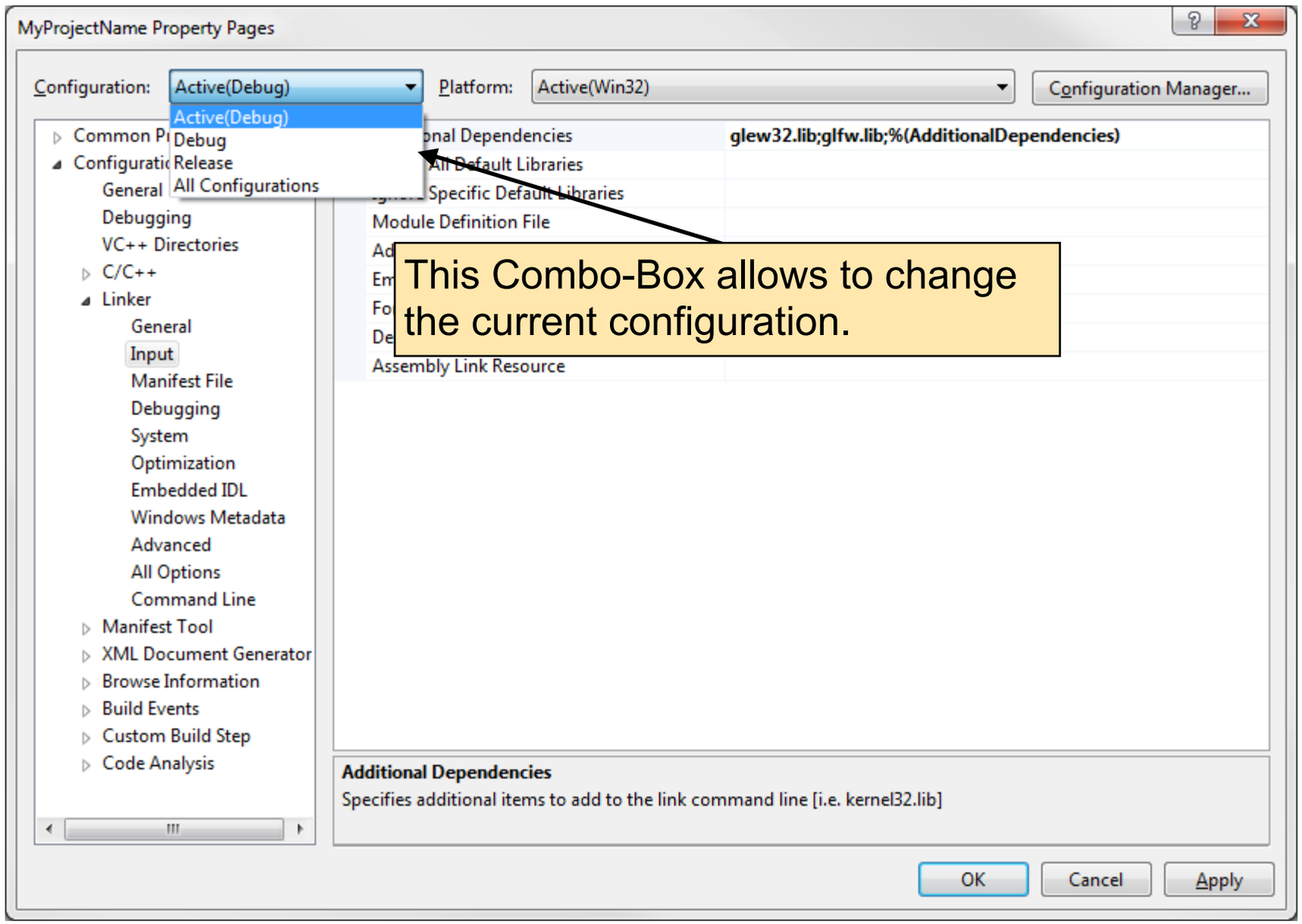
Go to: *Configuration Properties -> Linker -> General* and add the directory.




*Microsoft Visual Studio - Project Property Window*

# Debug and Release

There are different configurations you can generate an executable. **Debug** and **Release** are the default configurations. You need to repeat those settings for all configurations.




*Microsoft Visual Studio - Project Property Window*

**Debug:**

To compiler will add an additional logical layer between your code and the machine code to allow you to retrieve memory information during runtime.

Debug versions are always slow!!!

**Release:**

The code is smaller and faster but you cannot read any variable information from your memory.

# Add some Code

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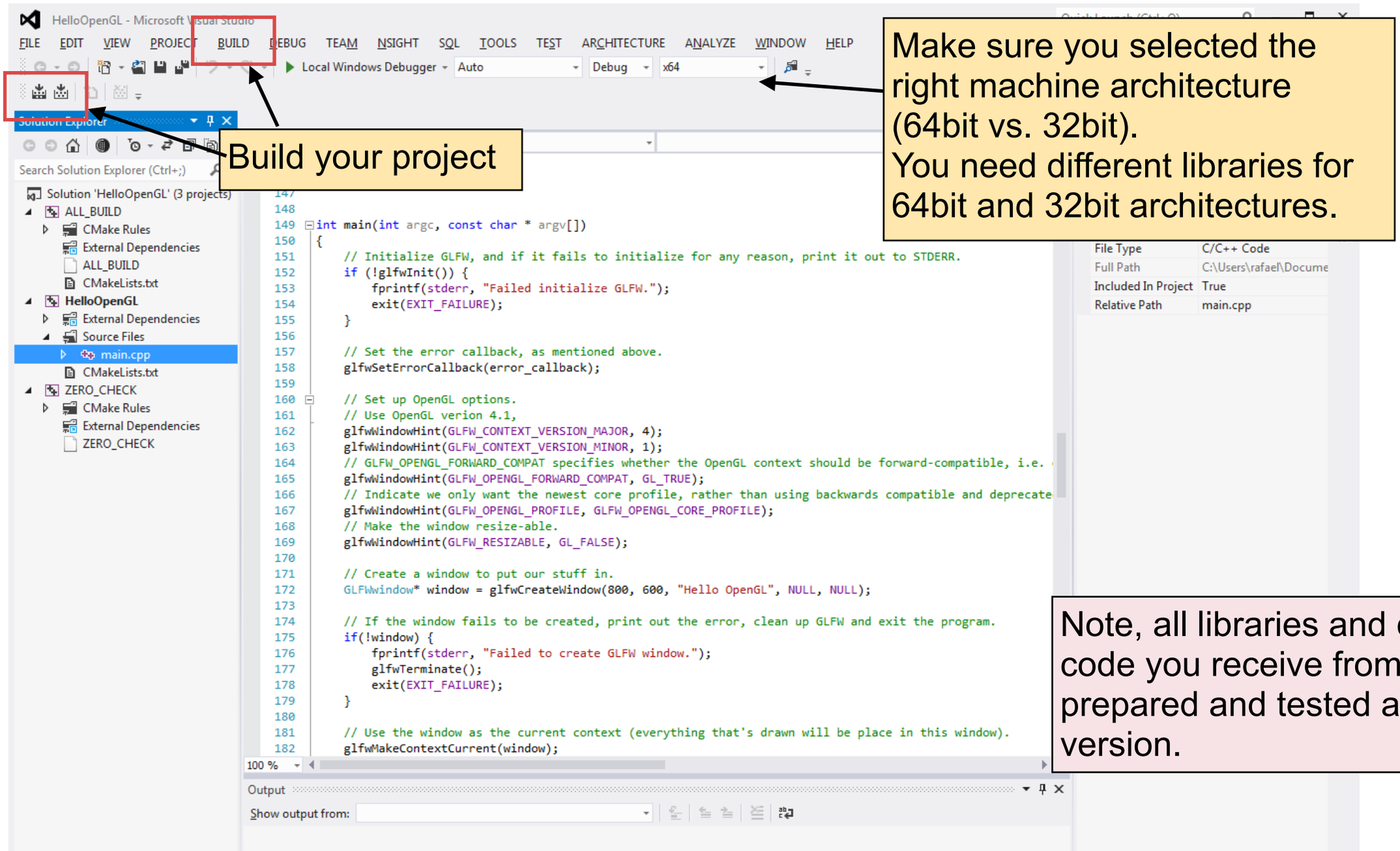
4 Add the example code to your program file and build the code.

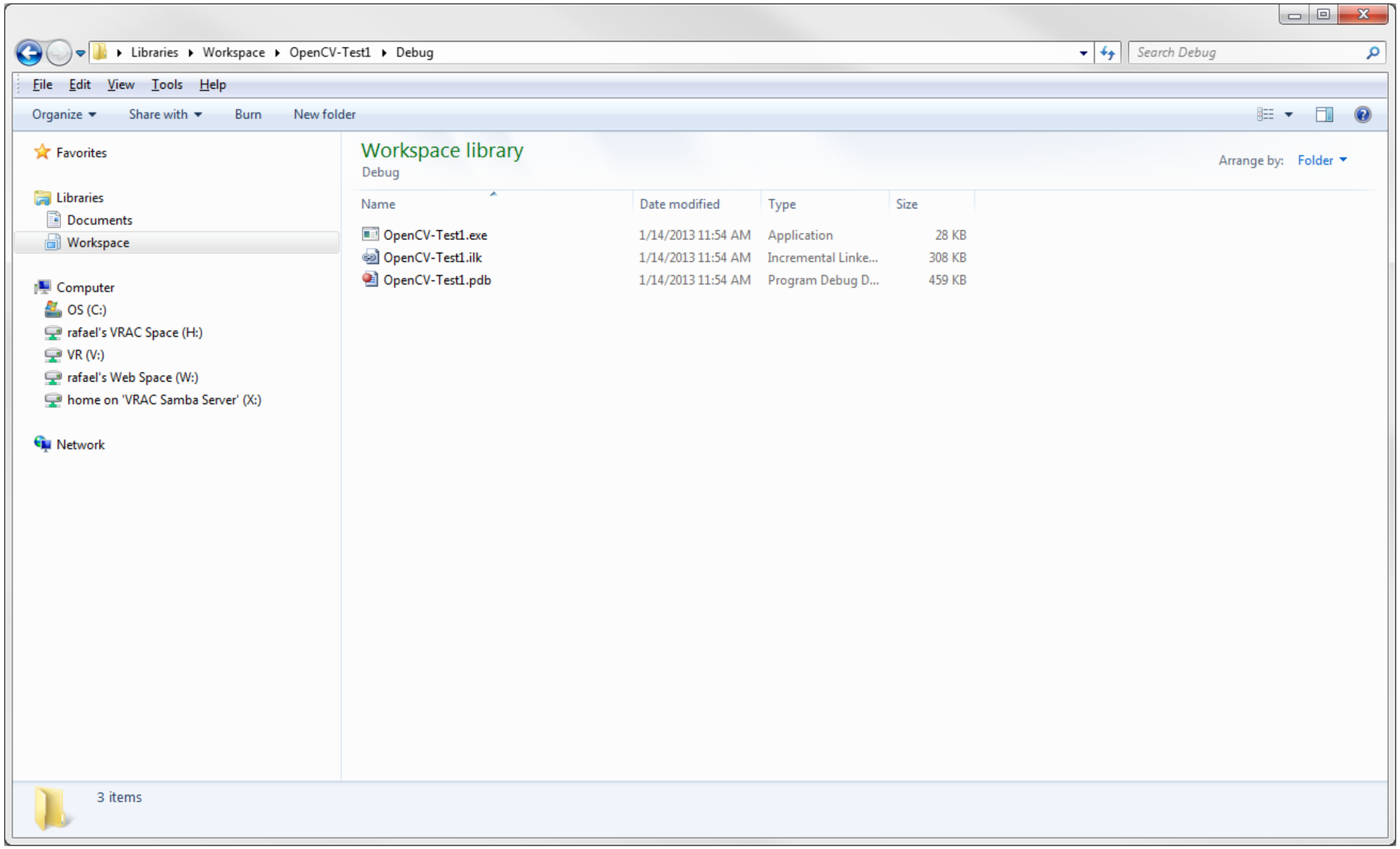



Note, all libraries and cmake code you receive from me is prepared and tested as 64bit version.

*Microsoft Visual Studio main view*

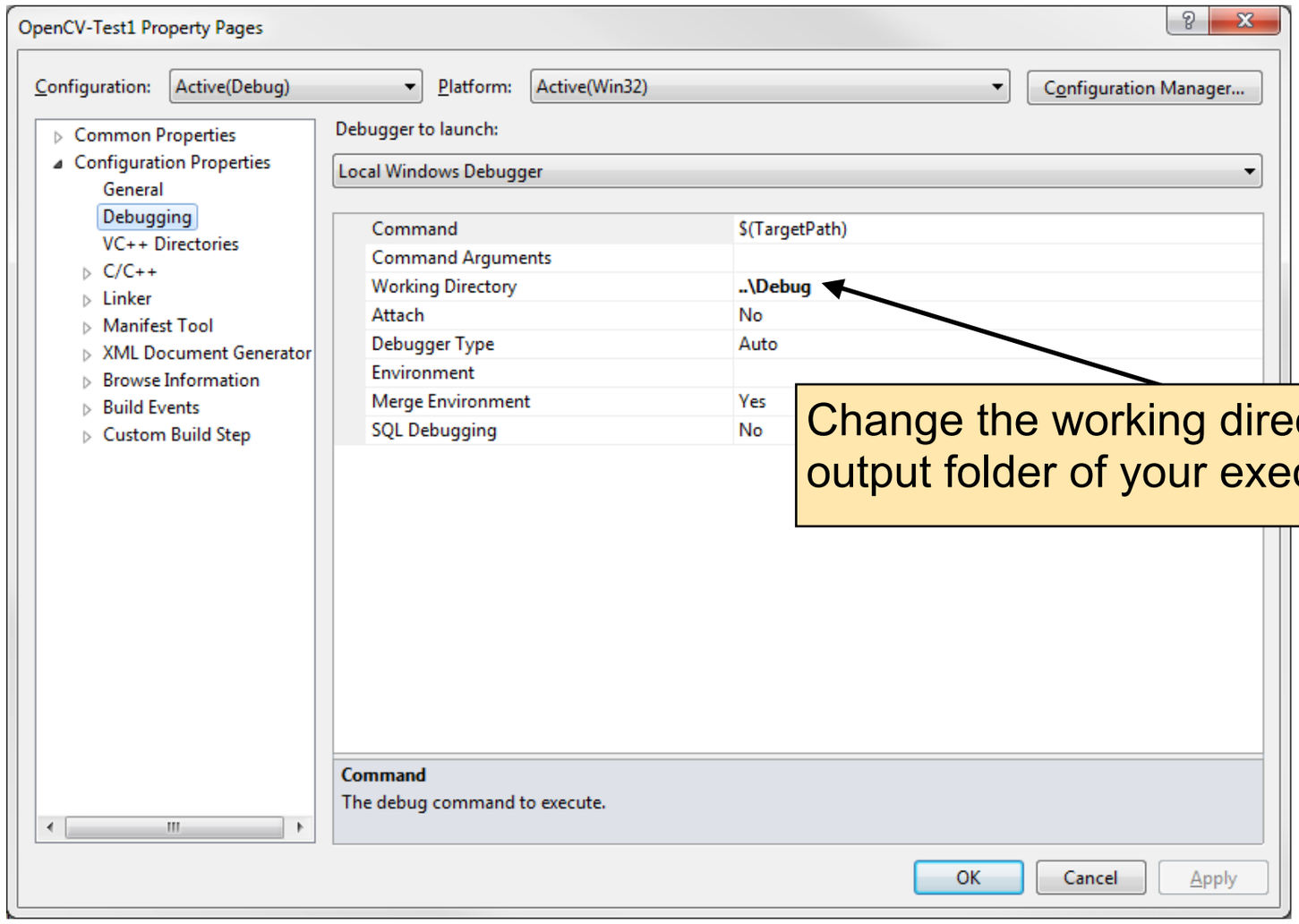
# Output

The output of the build process is an *.exe file, where * is the project name by default.



# Working Directory

The working directory defines the path from which MS Visual Studio start your executable. Specify the **executable output directory** as working path. By default, MS Visual Studio uses the solution path. This is not helpful because - by default- the working path is the executable path when you start a program from the window explorer. Changing the path restores the usual Windows behavior.




*Microsoft Visual Studio - Project Property Window*

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# CMake

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# Solution / Project Creation

Before you can start to develop code, you have to create a solution along with a project.

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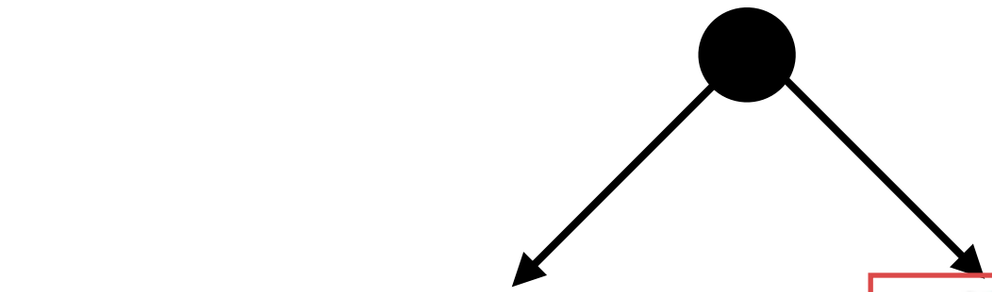

**Manual**

Your projects (maybe)

CMake

All 557 examples provide cmake files!

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# CMake
# "Automatic" preparation of a project file / solution

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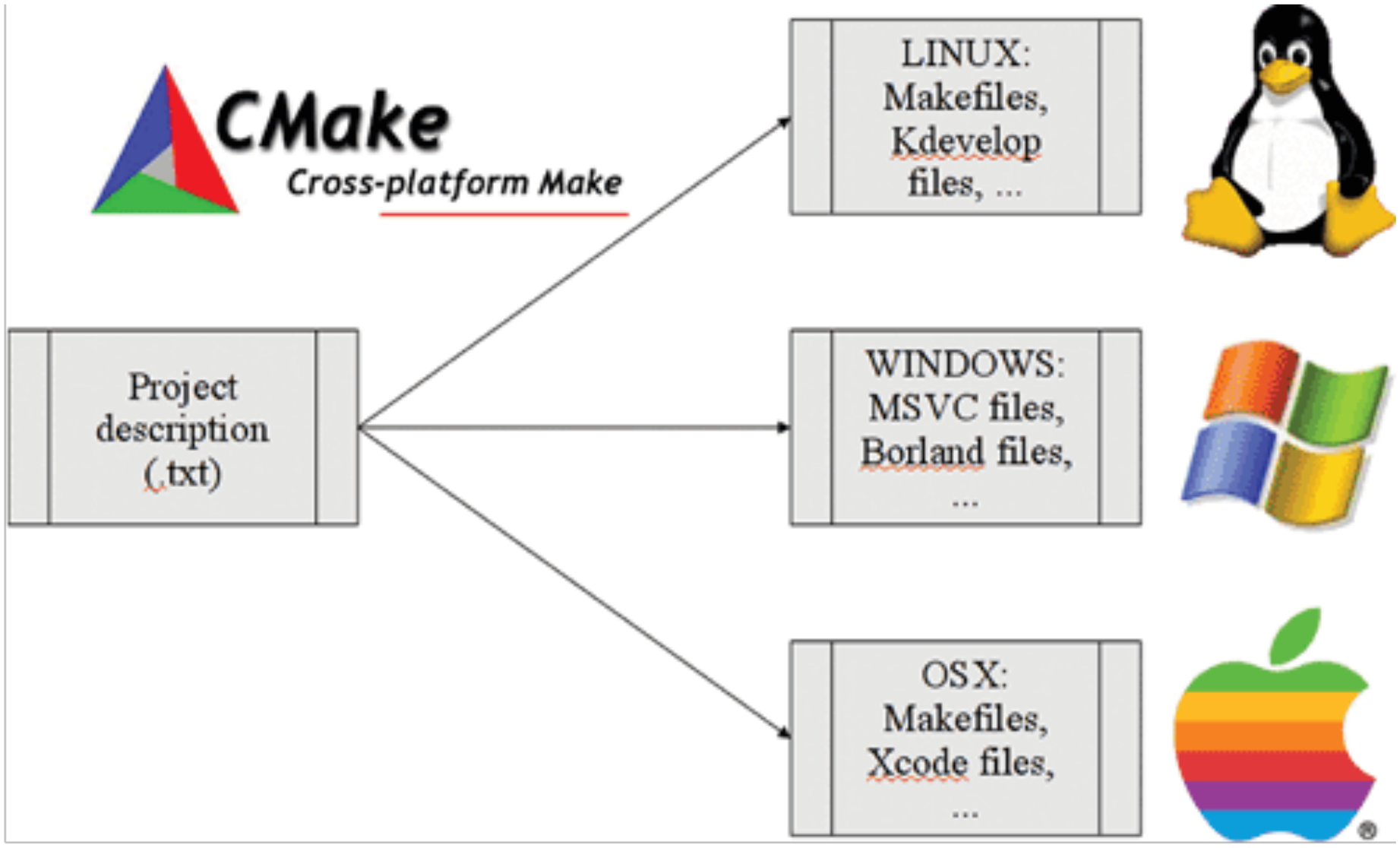
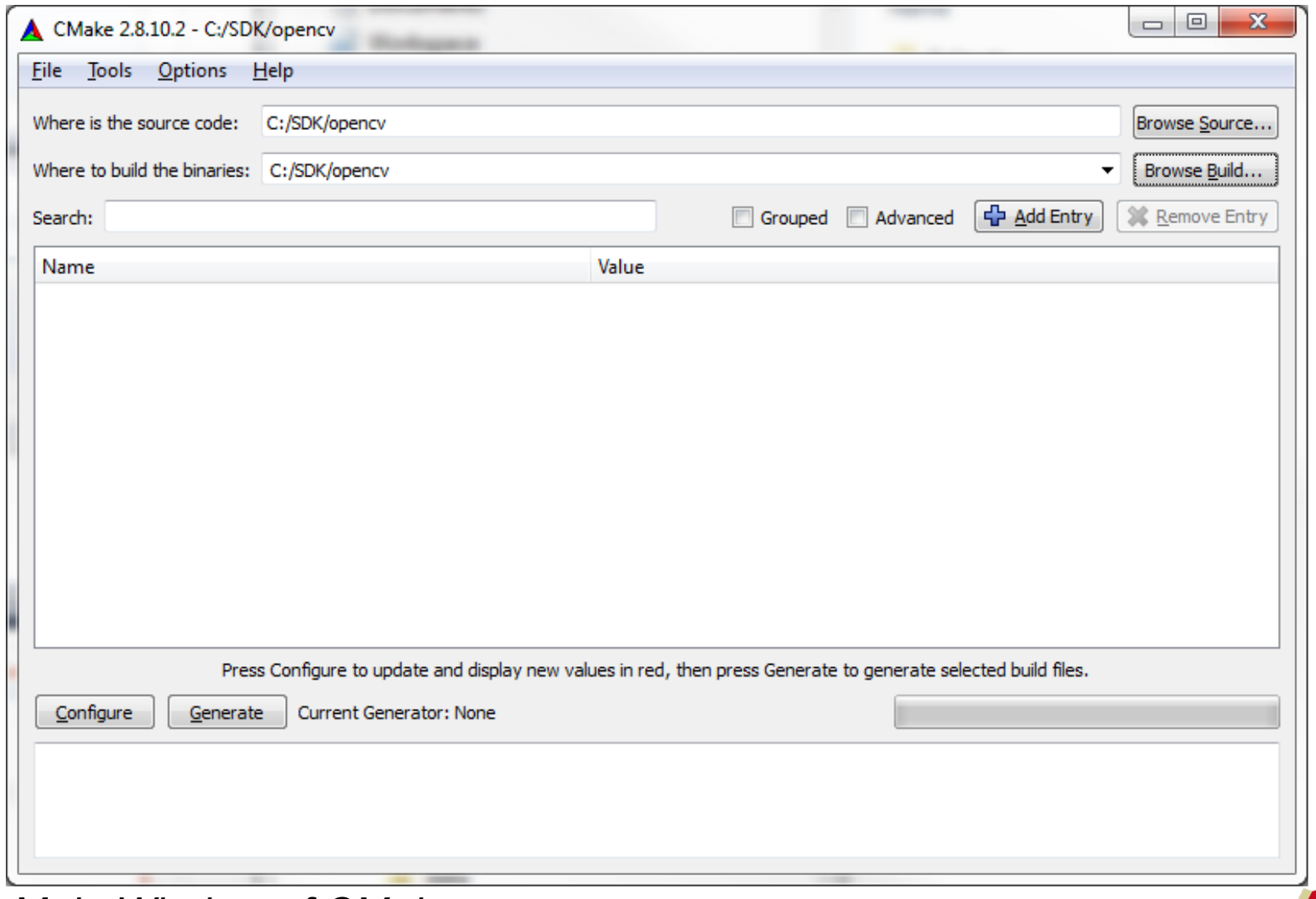
# CMake Basic Idea



# CMake

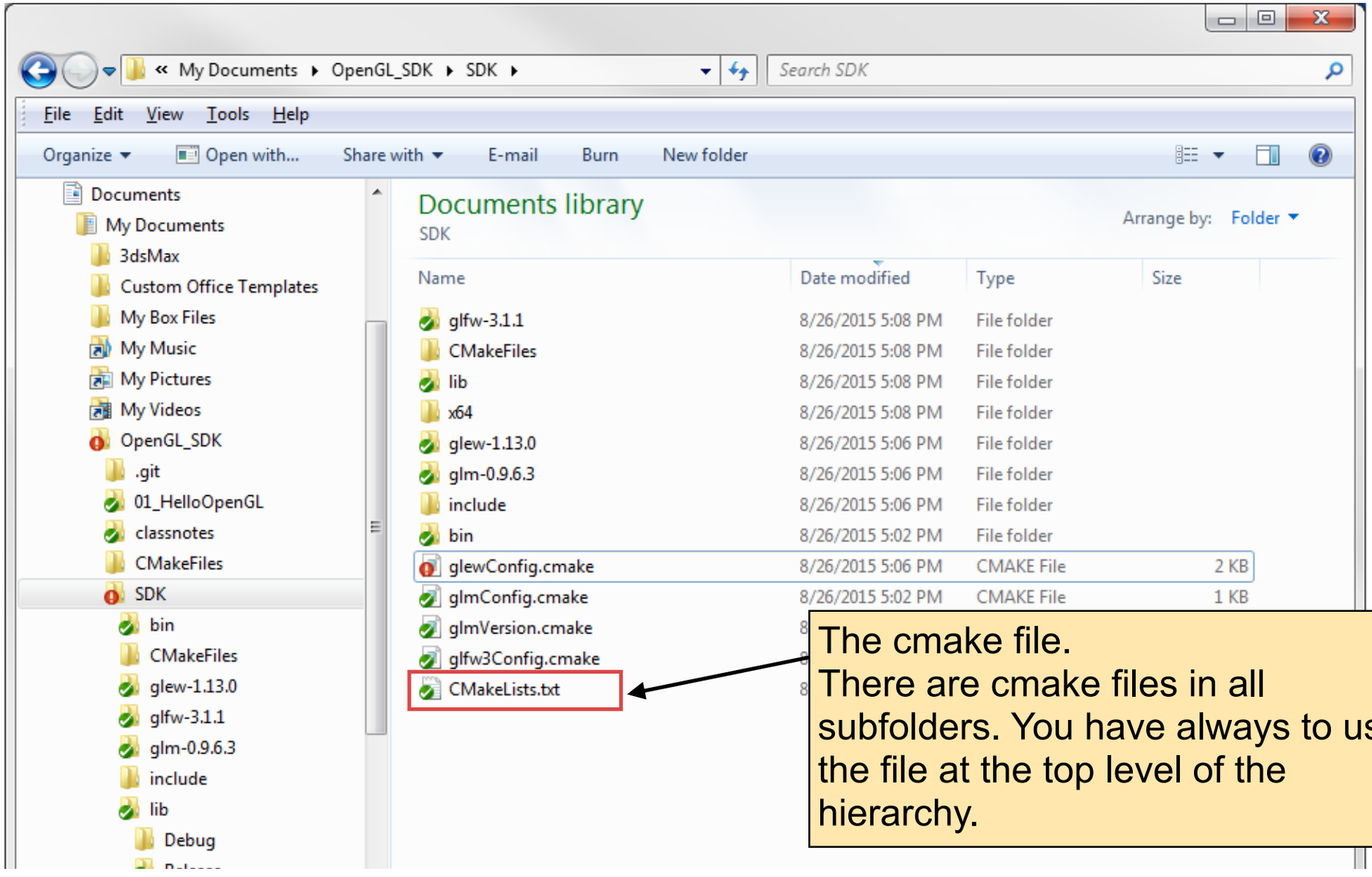
CMake is a cross-platform, open-source build system, designed to build, test and package software. CMake is used to control the software compilation process using simple platform and compiler independent configuration files. CMake generates native makefiles and workspaces that can be used in the compiler environment of your choice.




*Main Window of CMake*

# CMake Project Description

A CMake project is always defined in one or several files with the filename **CMakeLists.txt**. A code project solution / project file can be generate with CMake when this file is available.



# CMake Project Files

H:\Teaching\02_Fall 2013\ME 557\10_Virtual_Trackball\CMakeLists.txt - Notepad++

File Edit Search View Encoding Language Settings Macro Run Plugins Window ?

CMakeLists.txt

```
1  # Main cmake file
2
3  cmake_minimum_required(VERSION 2.6)
4
5  # Main project name is ARMaker
6  project(Virtual_Trackball)
7
8  # Find packages
9  FIND_PACKAGE(OpenGL)
10 FIND_PACKAGE(GLUT)
11
12 # Include dirs
13 include_directories(${OPENGL_INCLUDE_DIR})
14 include_directories(${GLUT_INCLUDE_DIR})
15
16
17 # Add all files to the configuration
18 file(GLOB Virtual_Trackball_SRC
19     "*.h"
20     "*.cpp"
21 )
22
23 # Create an executable
24 add_executable( Virtual_Trackball ${Virtual_Trackball_SRC} )
25
26
27 # Add libraries
28 if(WIN32 AND NOT APPLE)
29     target_link_libraries(Virtual_Trackball ${OPENGL_LIBRARIES} ${GLUT_LIBRARIES} )
30 else()
31     target_link_libraries(Virtual_Trackball ${OPENGL_LIBRARIES} ${GLUT_LIBRARIES} )
32 endif()
33
34 # Set the project architecture for this example
35 set( PROJECT_ARCH "x86" )
36
```

CMAKEFILE | length : 752 lines : 36 | Ln : 1 Col : 1 Sel : 0 | 0 | UNIX | ANSI as UTF-8 | INS

Proiect name

Programming SDKs

Include directories

Code files. In this case: all files

Adds an executable to a project

Add libraries and library paths.

Example CMakeLists.txt file: the file contains script commands that tell CMake how to setup the project

Not part of this course!

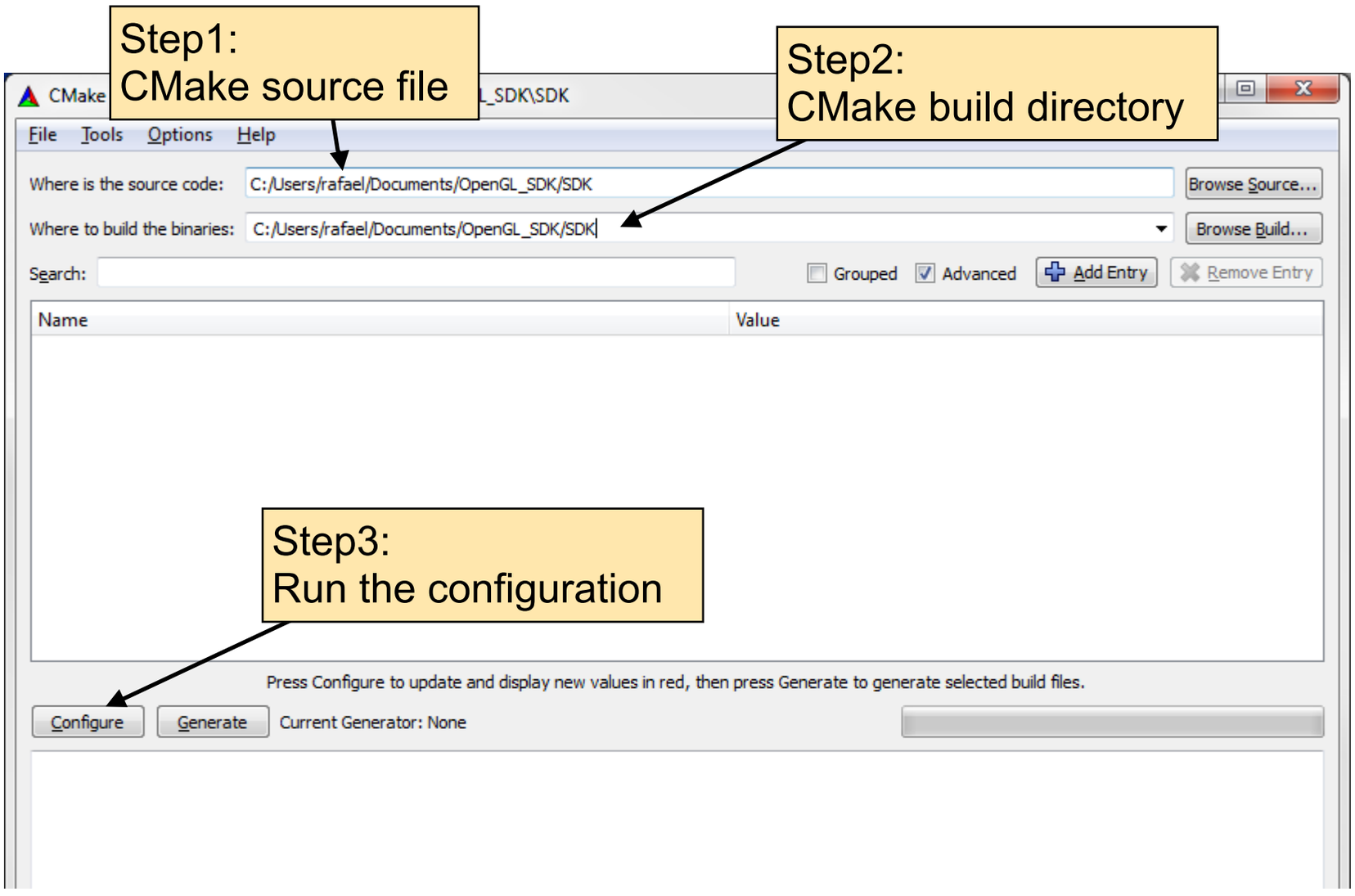
Just to get you an idea when you open those files!

# Create OpenCV project files (1/2)

Step 1: set the source code file; the directory containing the file *CMakeList.txt*.

Step 2: set the build directory; take the same.

Step 3: run the configuration by pressing the *Configure*-Button two times (the second times you press it, all error will be highlighted red).

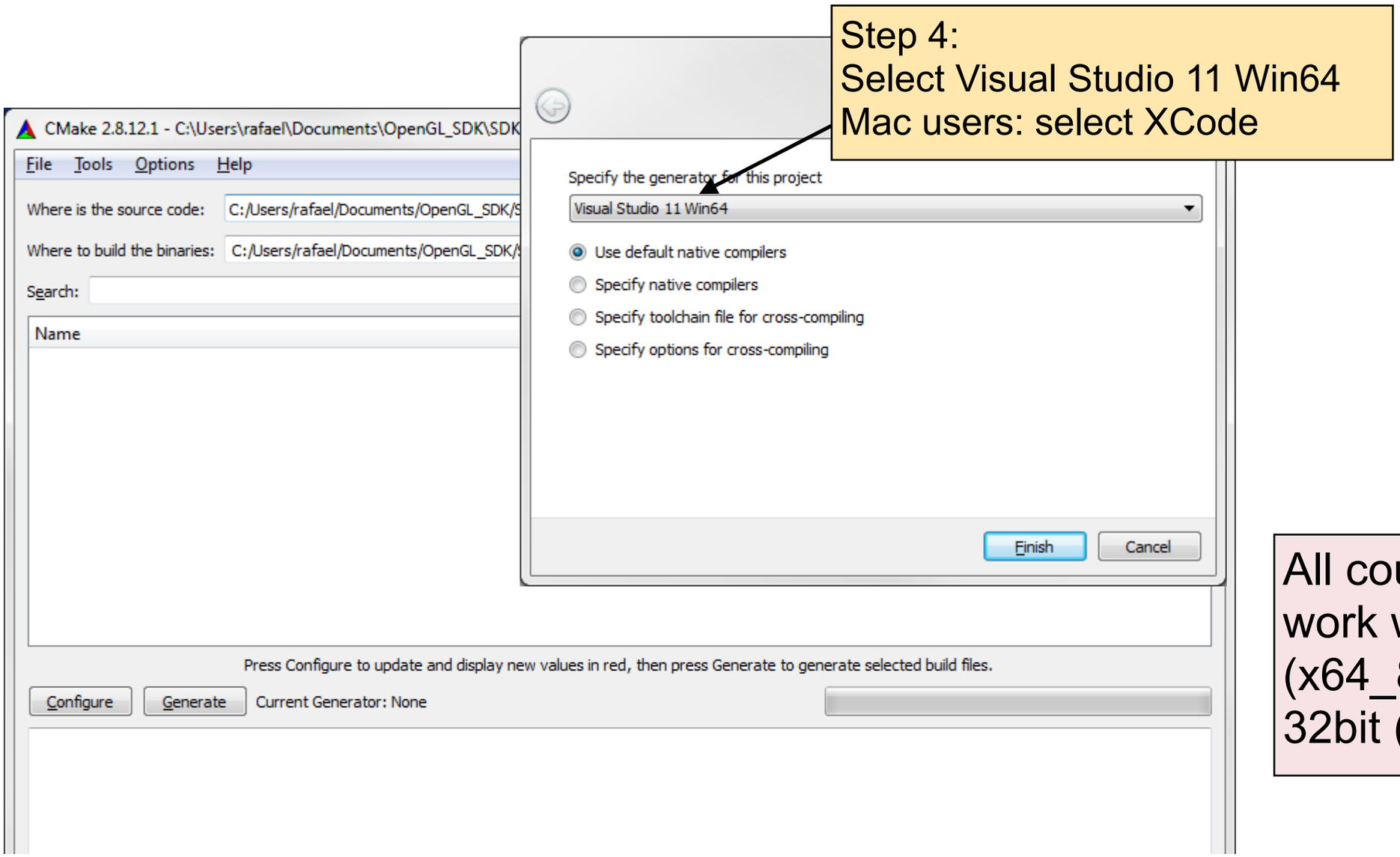



*Main Window of CMake*

# Create OpenCV project files (1/2)

Step 4: specify the generator for this project; select ***Visual Studio 11 Win64*.**

Note: Visual Studio 2012 is Visual Studio Version 11



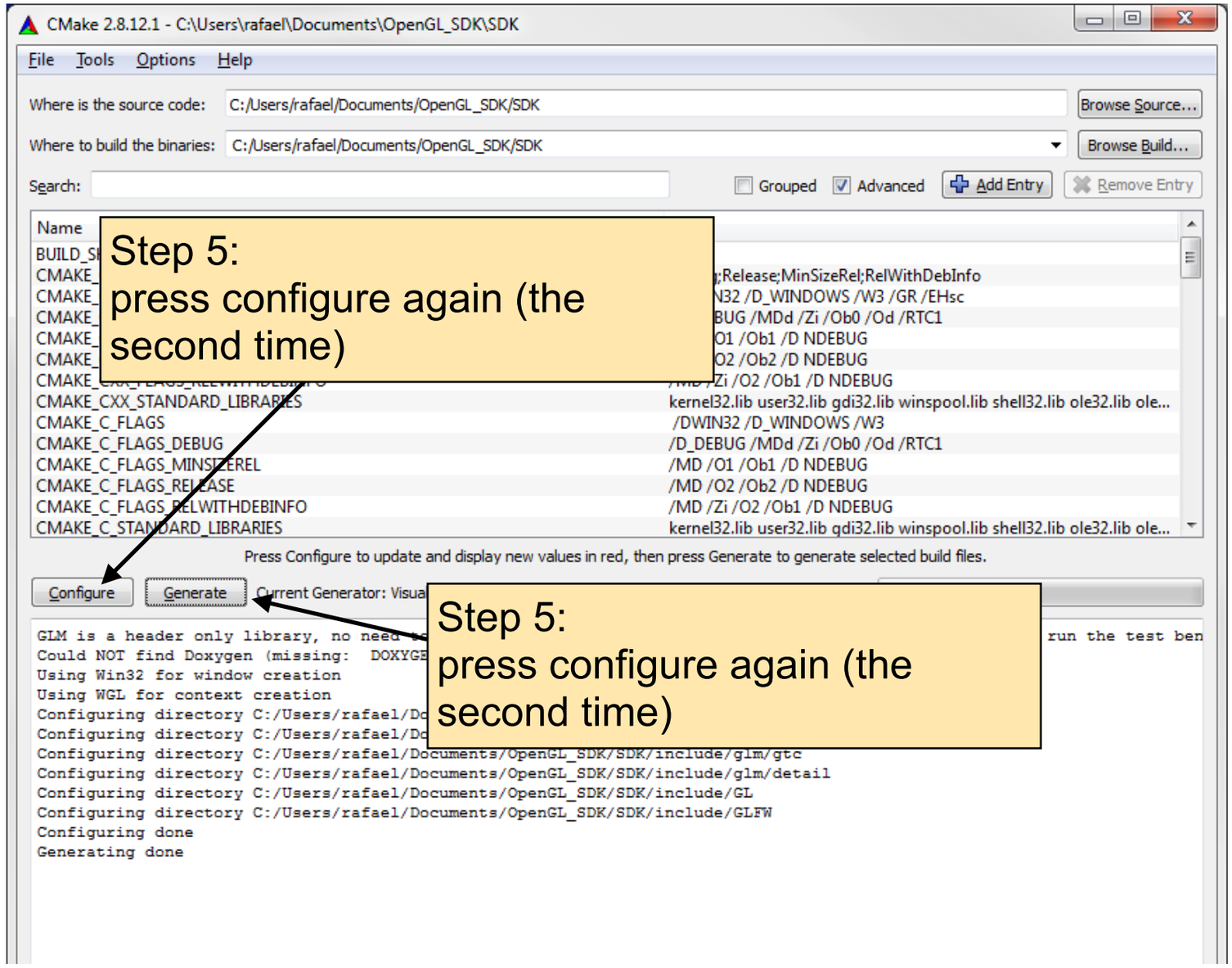

*Main Window of CMake*

All course example work with 64bit (x64_86) and not with 32bit (i386)

# Create OpenCV project files (1/2)

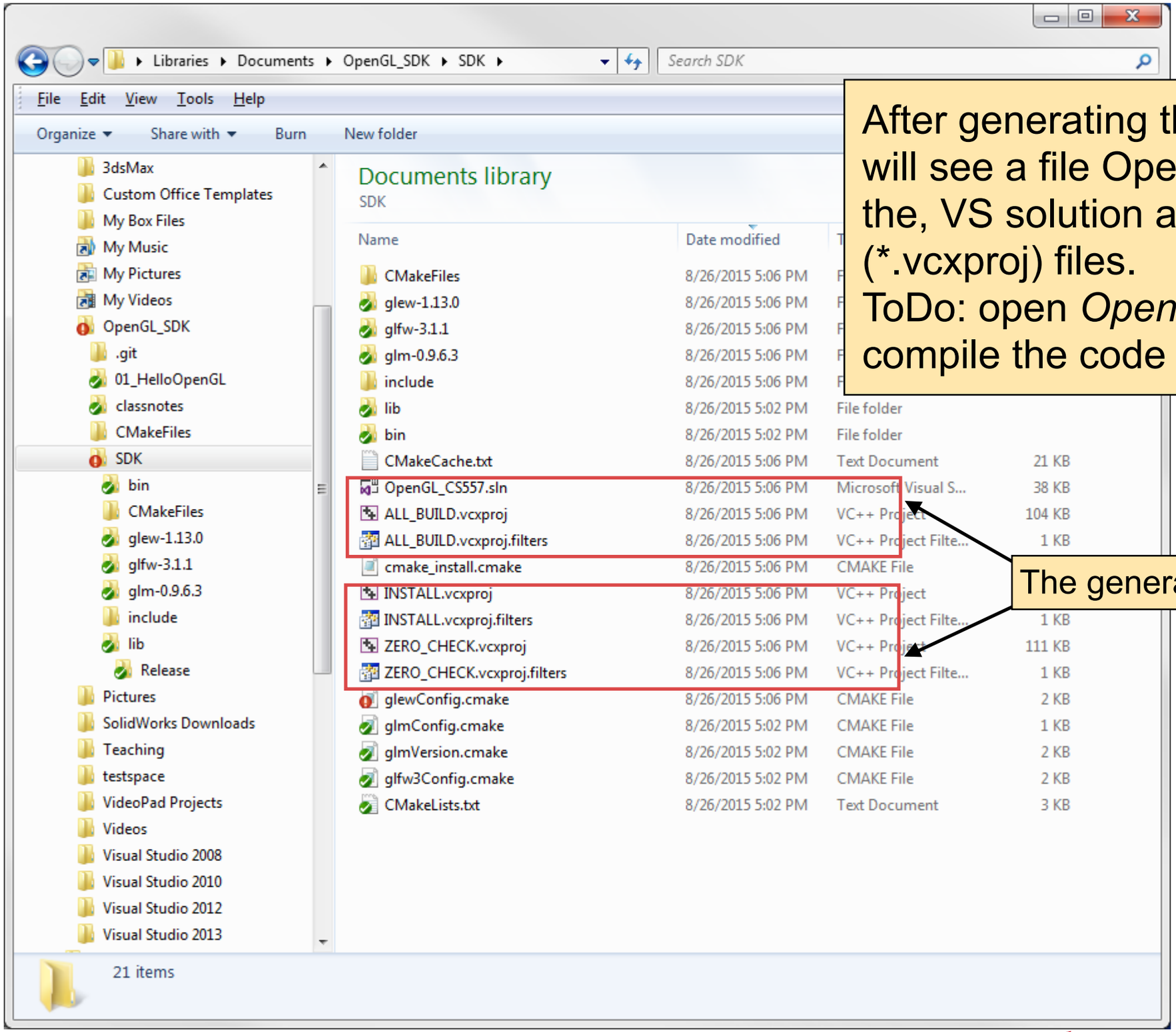
Step 5: press configure a second time.

Step 6: generate the Visual Studio Project files by pressing Generate




*Main Window of CMake*

# SDK-Folder with GLEW, etc.




After generating the project files, you will see a file OpenGL_CS557.sln the, VS solution and multiple project (*.vcxproj) files.
ToDo: open *OpenGL_CS557.sln* and compile the code

The generated files

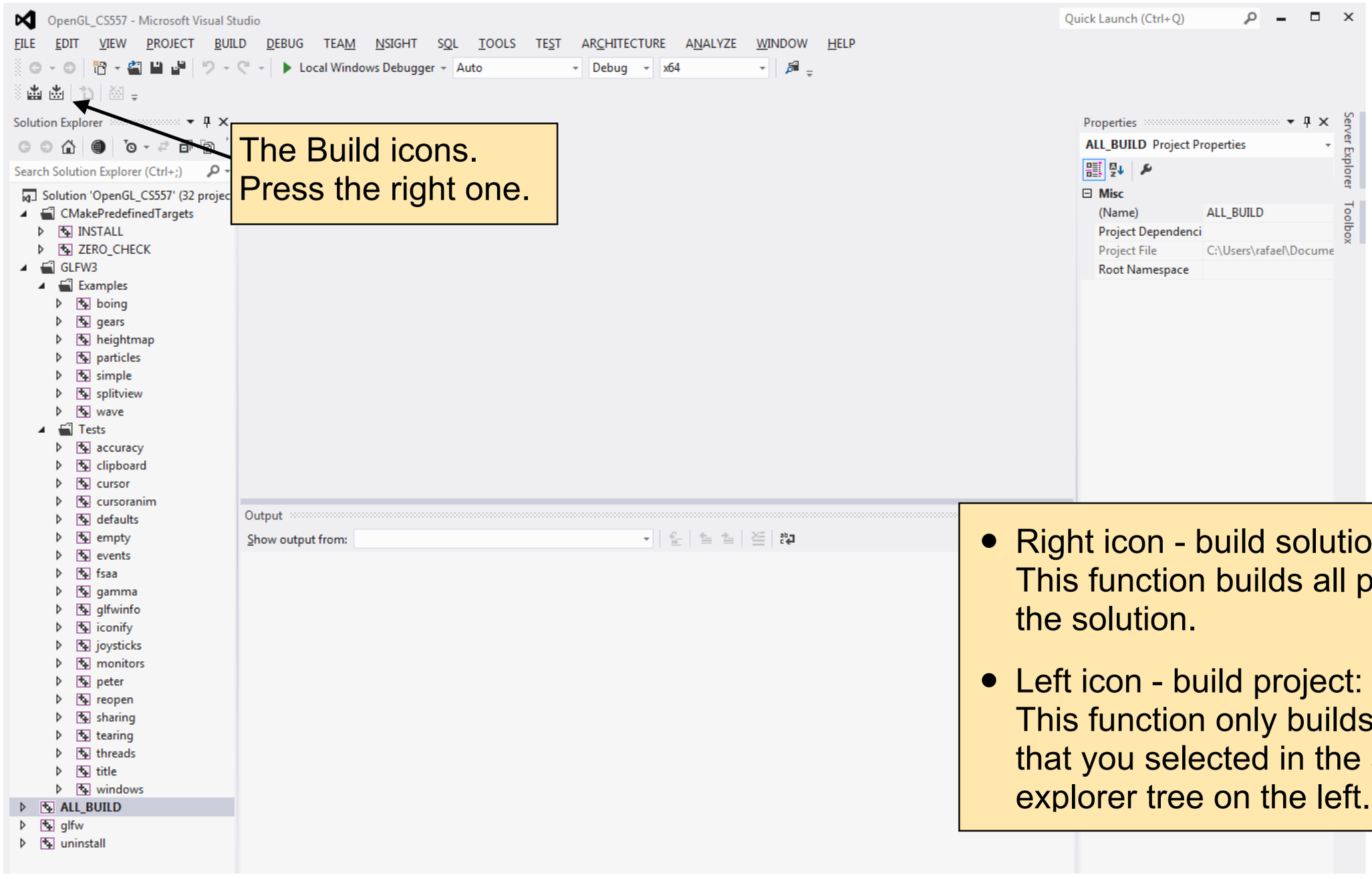
*The SDK folder for this course*

# Install the OpenGL libraries GLEW, GLFW, and GLM

## - Compile GLFW

# Build the GLFW

Open OpenGL_CS557.sln and compile the code




- Right icon - build solution:
  This function builds all projects in the solution.
- Left icon - build project:
  This function only builds the project that you selected in the solution explorer tree on the left.

# Homebrew

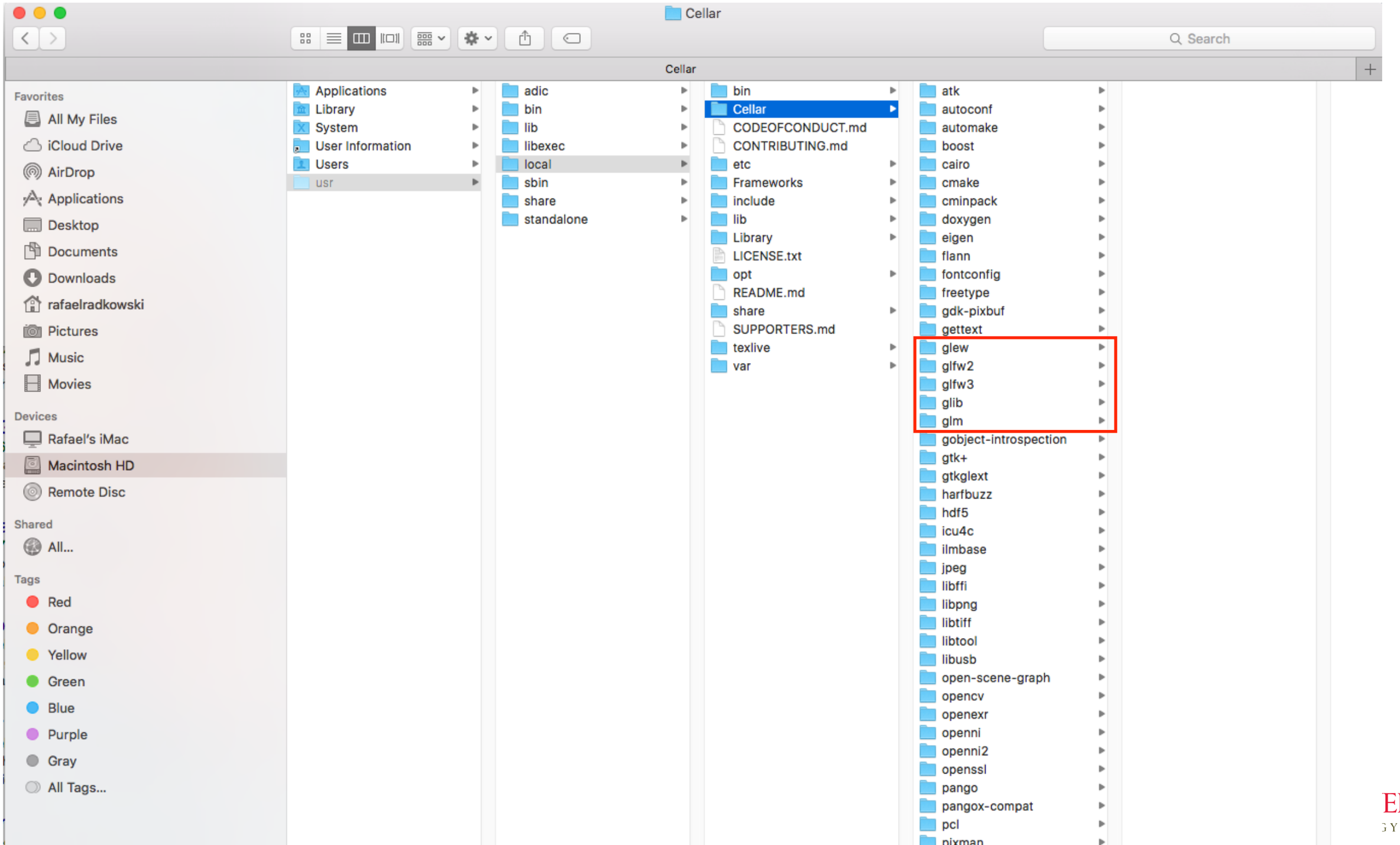
1. Open a terminal window


2. Install GLM (in your terminal, type and press enter): brew install glm
3. Install GLFW (in your terminal, type and press enter): brew install glfw3
4. Install GLEW (in your terminal, type and press enter): brew install glew

**Warning: brew does not support the pre-release of Mac OS X El Captain!**

# Installation

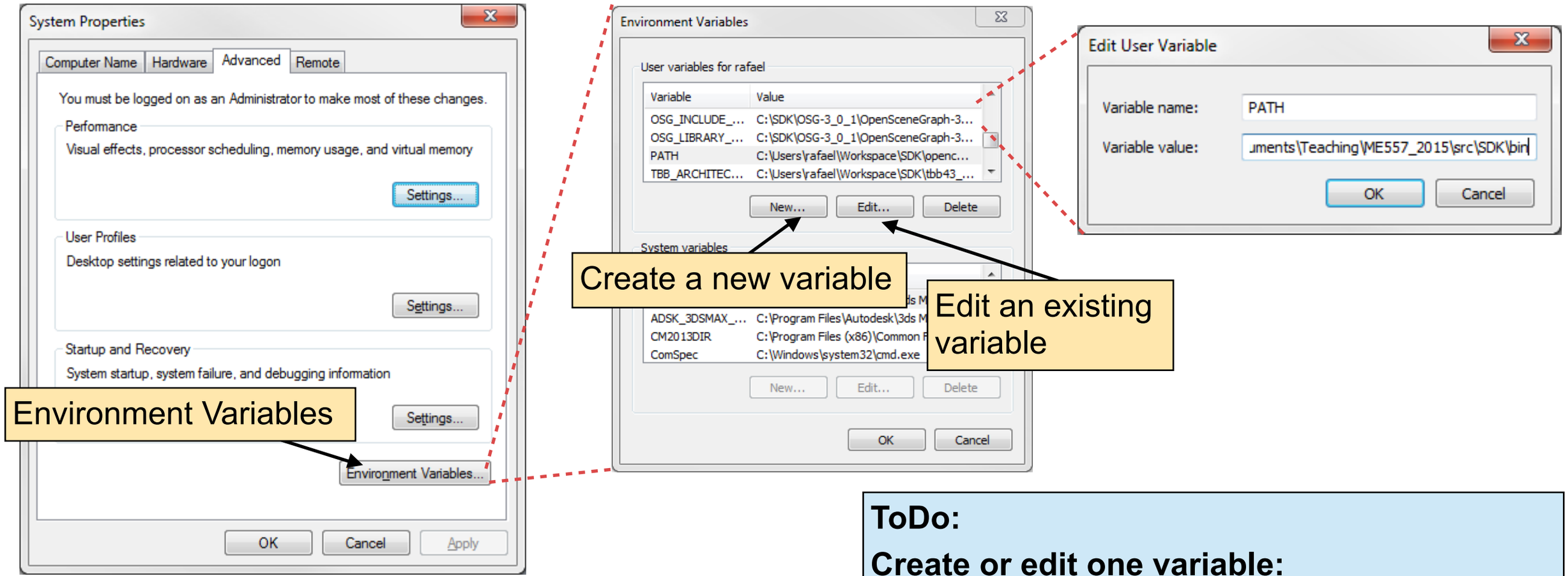
brew installs all files in /usr/local/Cellar



# Setup Environment Variables

Environment variables help Windows and other programs to find files, folders, and programs by using a unique name.

**Control Panel -> System -> Advanced System Settings -> Environment Variables**




*Windows System Properties Window*

**ToDo:**

**Create or edit one variable:**

- Name: PATH
- Value: the path to the folder with **glew32.dll**

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# Demo Code HelloOpenGL

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# Hello OpenGL

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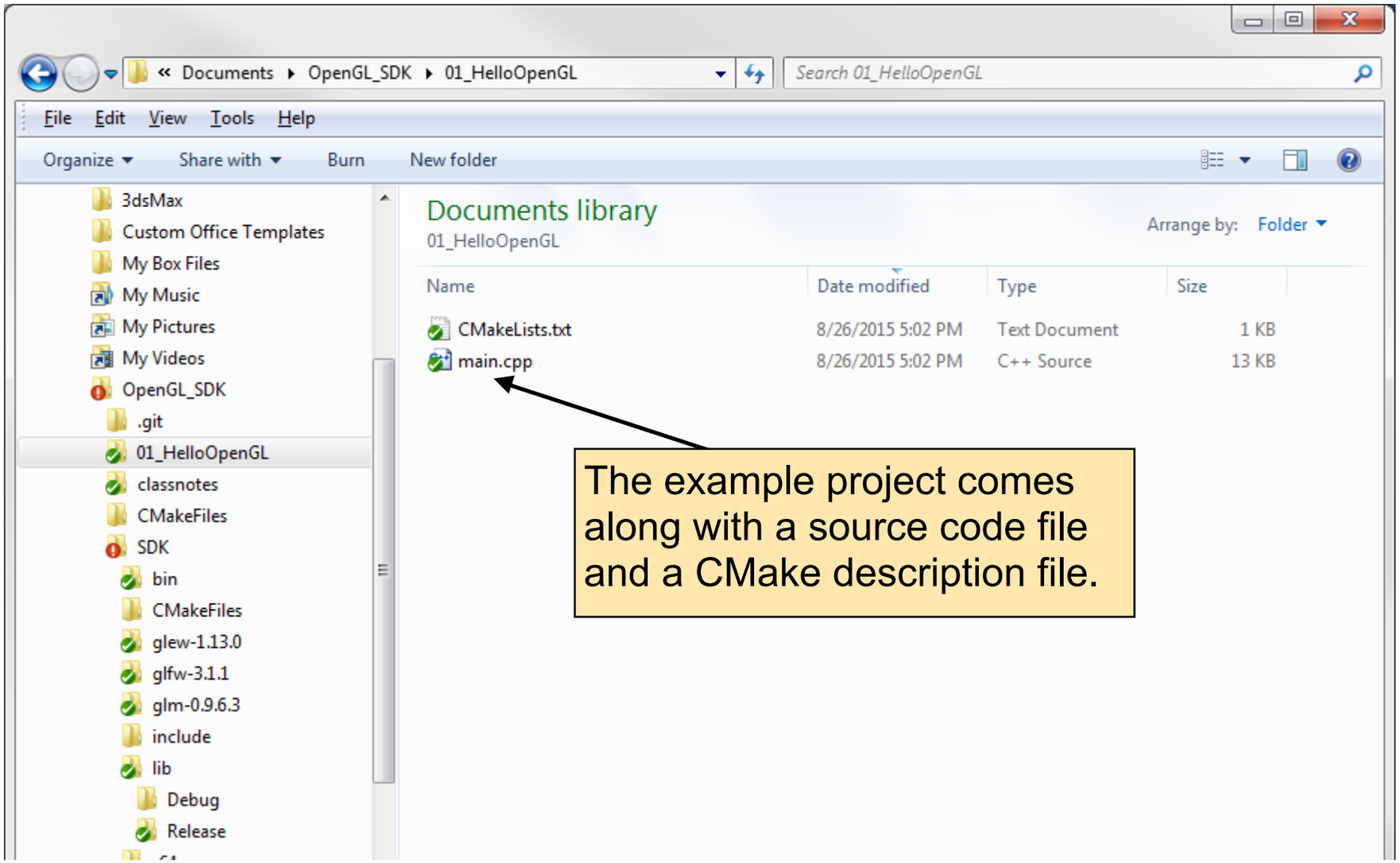
Your homework: download (git), compile, and run the example project 01_Hello_OpenGL




*Windows Explorer*

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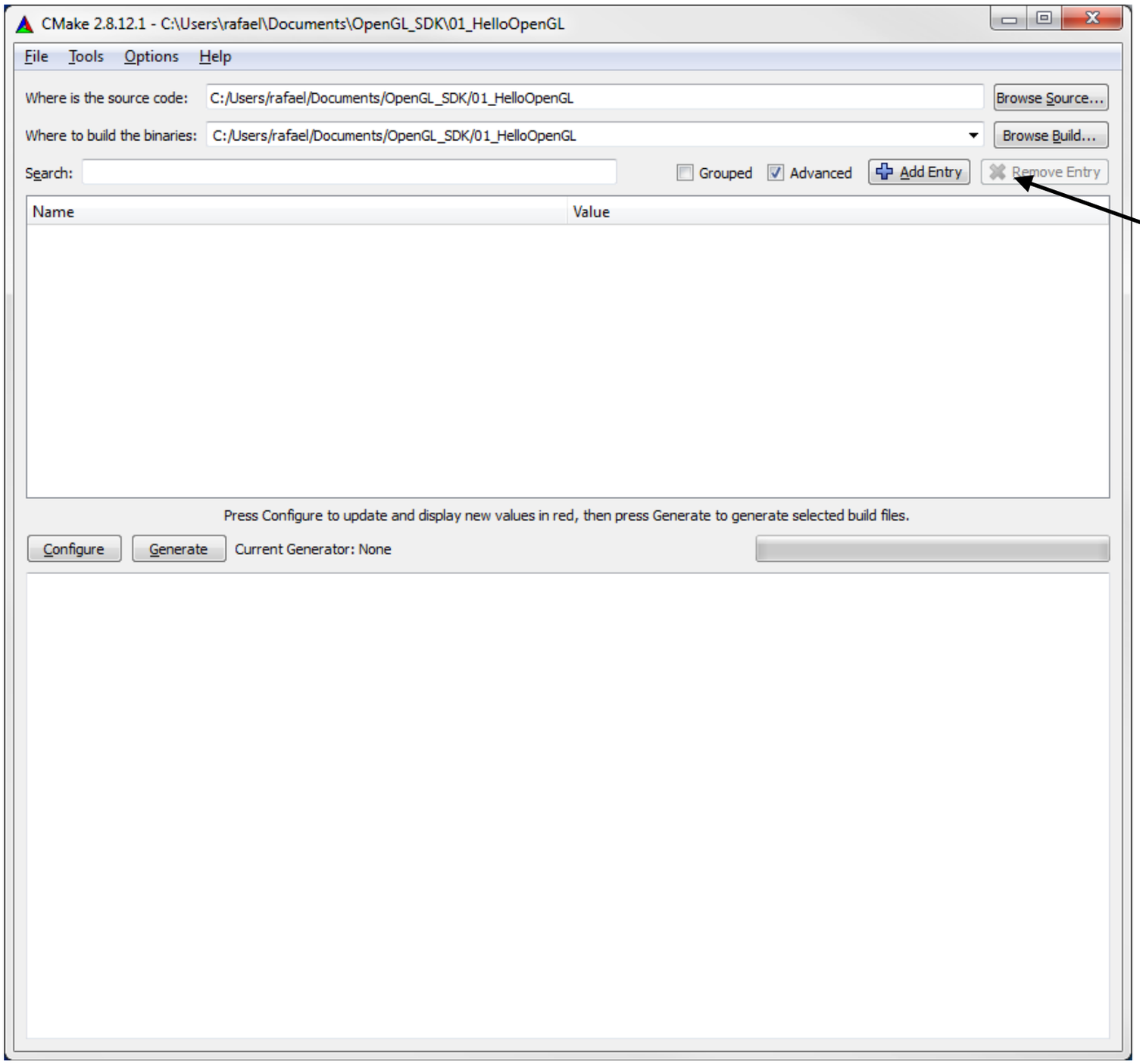
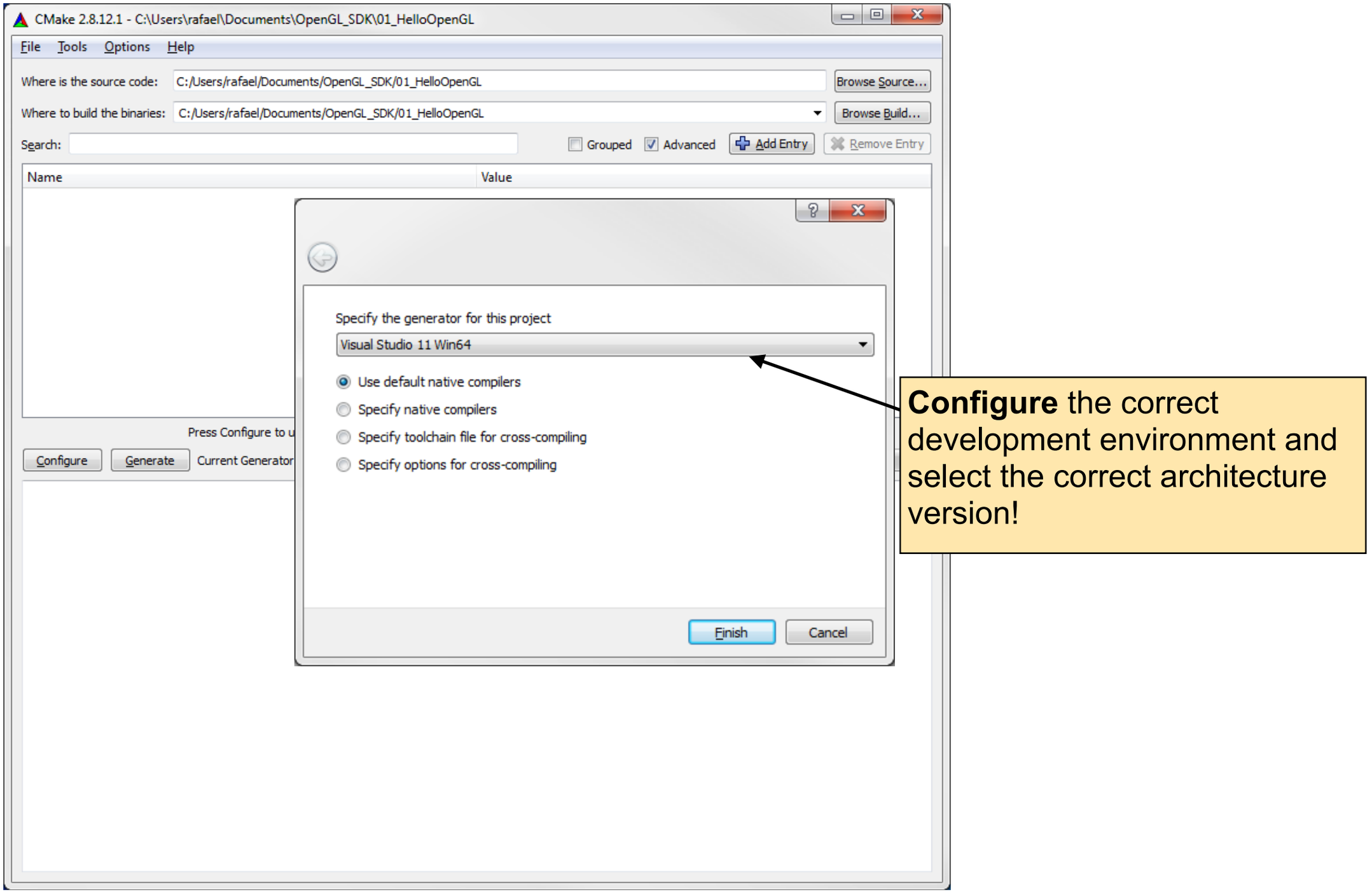
# Generate the Project Files with CMake



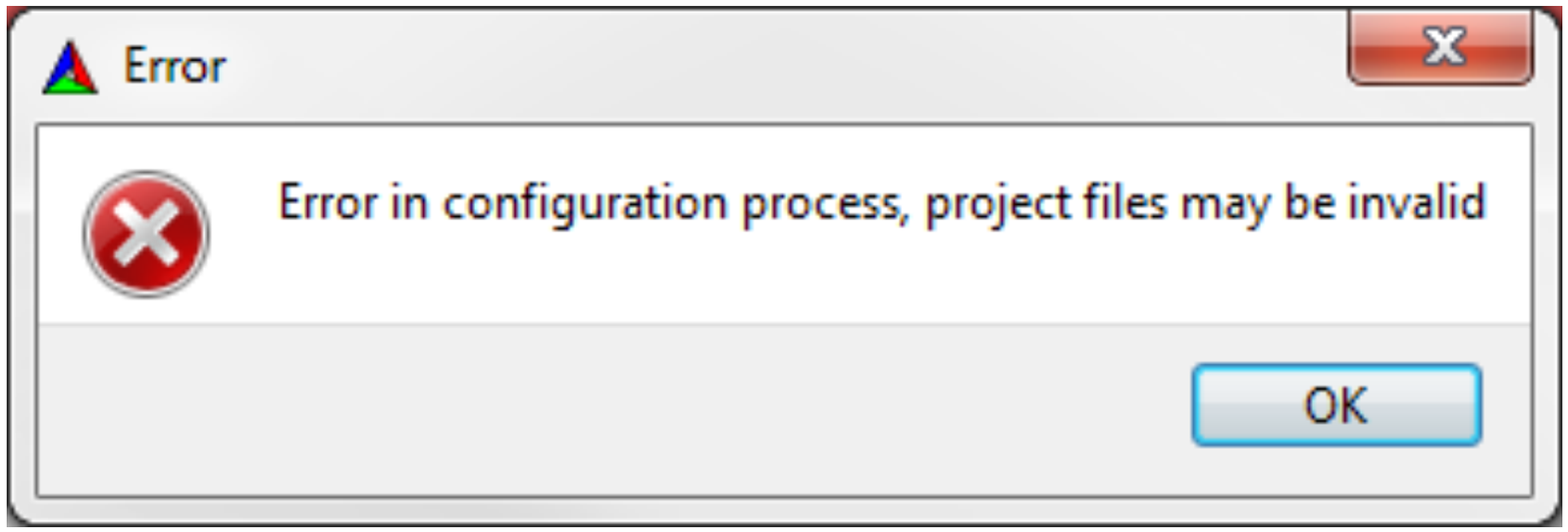

The same procedure we used before.
Select the CMakeLists.txt file and the destination folder.

# Generate the Project Files with CMake

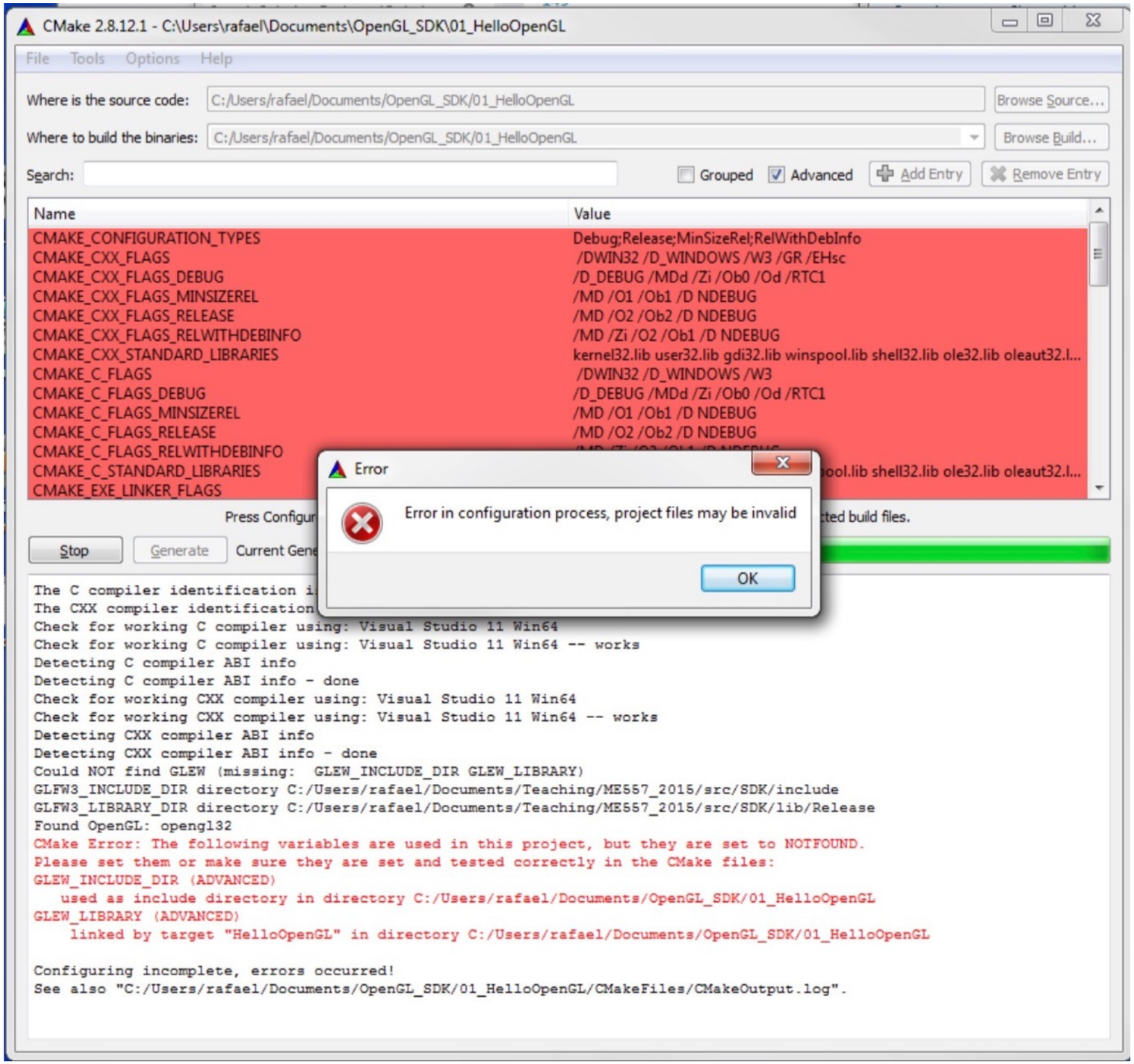



**Configure** the correct development environment and select the correct architecture version!

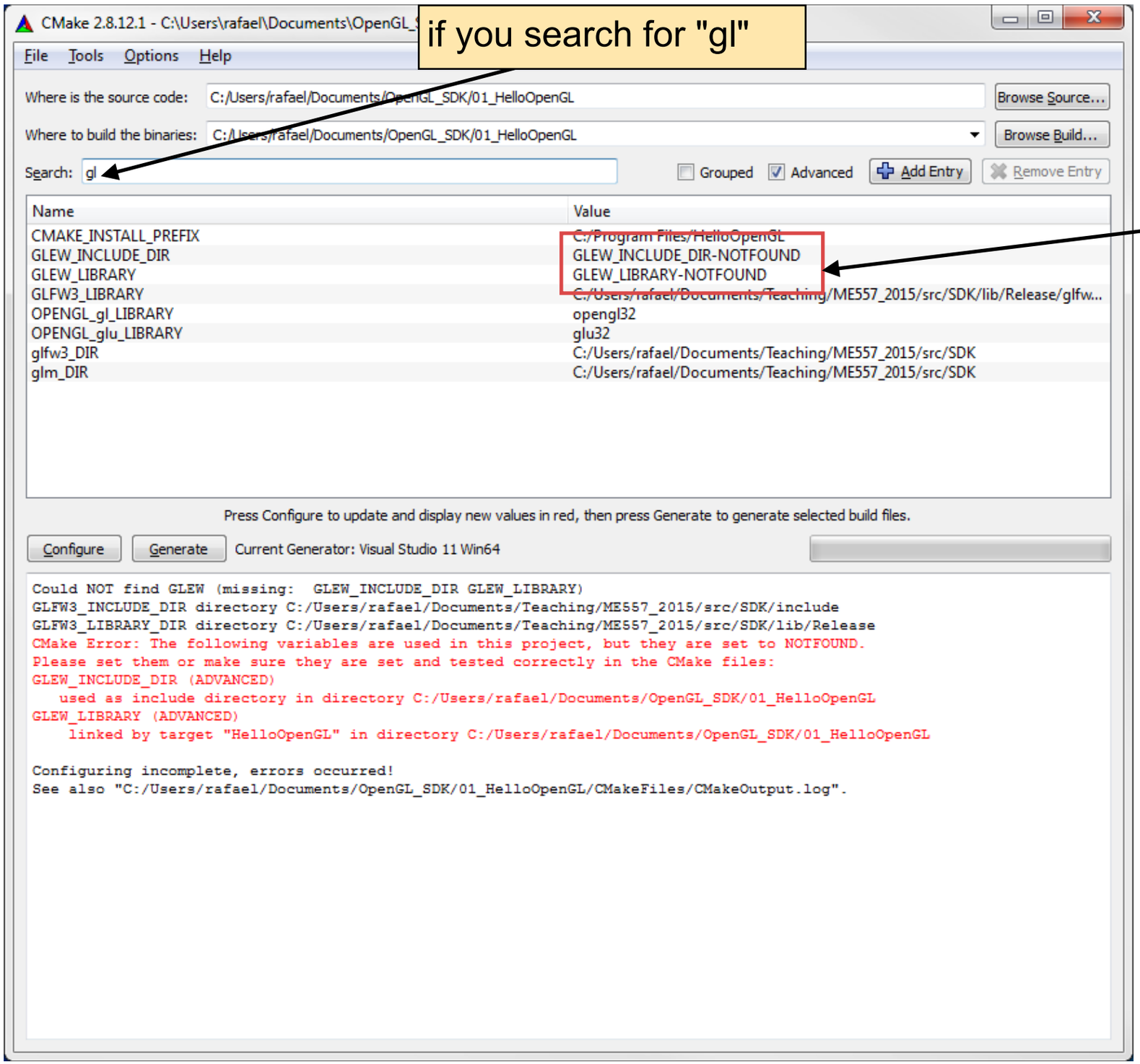
# And now?


Error
Error in configuration process, project files may be invalid
OK

# More Errors


CMake 2.8.12.1 - C:\Users\rafael\Documents\OpenGL_SDK\01_HelloOpenGL
File Tools Options Help
Where is the source code: C:/Users/rafael/Documents/OpenGL_SDK/01_HelloOpenGL
Browse Source...
Where to build the binaries: C:/Users/rafael/Documents/OpenGL_SDK/01_HelloOpenGL
Browse Build...
Search:
Grouped
Advanced
Add Entry
Remove Entry
Name
Value
CMAKE_CONFIGURATION_TYPES Debug;Release;MinSizeRel;RelWithDebInfo
CMAKE_CXX_FLAGS /DWIN32 /D_WINDOWS /W3 /GR /EHsc
CMAKE_CXX_FLAGS_DEBUG /D_DEBUG /MDd /Zi /Ob0 /Od /RTC1
CMAKE_CXX_FLAGS_MINSIZEREL /MD /O1 /Ob1 /D NDEBUG
CMAKE_CXX_FLAGS_RELEASE /MD /O2 /Ob2 /D NDEBUG
CMAKE_CXX_FLAGS_RELWITHDEBINFO /MD /Zi /O2 /Ob1 /D NDEBUG
CMAKE_CXX_STANDARD_LIBRARIES kernel32.lib user32.lib gdi32.lib winspool.lib shell32.lib ole32.lib oleaut32.l...
CMAKE_C_FLAGS /DWIN32 /D_WINDOWS /W3
CMAKE_C_FLAGS_DEBUG /D_DEBUG /MDd /Zi /Ob0 /Od /RTC1
CMAKE_C_FLAGS_MINSIZEREL /MD /O1 /Ob1 /D NDEBUG
CMAKE_C_FLAGS_RELEASE /MD /O2 /Ob2 /D NDEBUG
CMAKE_C_FLAGS_RELWITHDEBINFO
CMAKE_C_STANDARD_LIBRARIES
CMAKE_EXE_LINKER_FLAGS
Press Configur
cted build files.
Stop
Generate
Current Gene
Error
Error in configuration process, project files may be invalid
OK
The C compiler identification i
The CXX compiler identification
Check for working C compiler using: Visual Studio 11 Win64
Check for working C compiler using: Visual Studio 11 Win64 -- works
Detecting C compiler ABI info
Detecting C compiler ABI info - done
Check for working CXX compiler using: Visual Studio 11 Win64
Check for working CXX compiler using: Visual Studio 11 Win64 -- works
Detecting CXX compiler ABI info
Detecting CXX compiler ABI info - done
Could NOT find GLEW (missing: GLEW_INCLUDE_DIR GLEW_LIBRARY)
GLFW3_INCLUDE_DIR directory C:/Users/rafael/Documents/Teaching/ME557_2015/src/SDK/include
GLFW3_LIBRARY_DIR directory C:/Users/rafael/Documents/Teaching/ME557_2015/src/SDK/lib/Release
Found OpenGL: opengl32
CMake Error: The following variables are used in this project, but they are set to NOTFOUND.
Please set them or make sure they are set and tested correctly in the CMake files:
GLEW_INCLUDE_DIR (ADVANCED)
used as include directory in directory C:/Users/rafael/Documents/OpenGL_SDK/01_HelloOpenGL
GLEW_LIBRARY (ADVANCED)
linked by target "HelloOpenGL" in directory C:/Users/rafael/Documents/OpenGL_SDK/01_HelloOpenGL
Configuring incomplete, errors occurred!
See also "C:/Users/rafael/Documents/OpenGL_SDK/01_HelloOpenGL/CMakeFiles/CMakeOutput.log".

# Troubleshooting



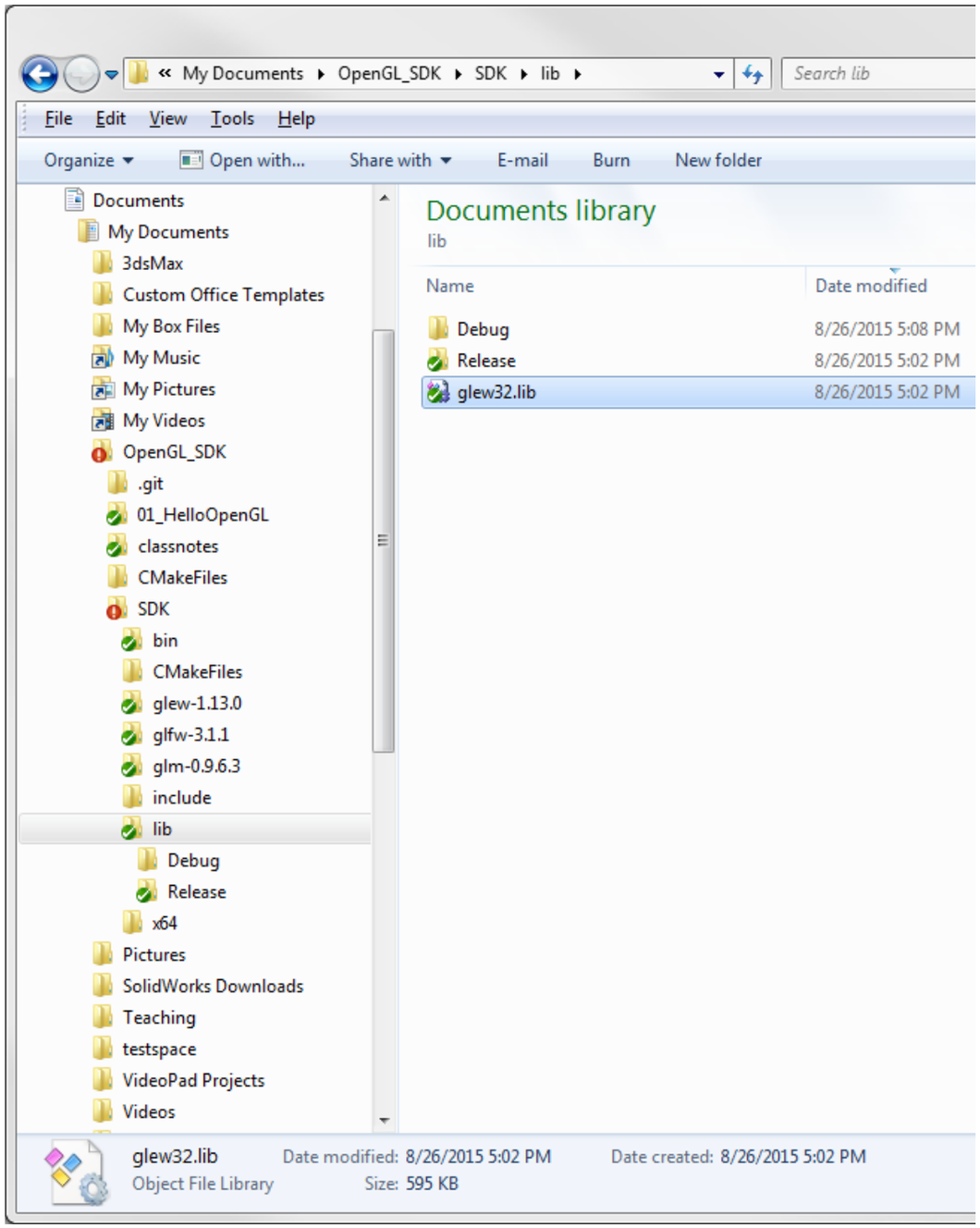

if you search for "gl"

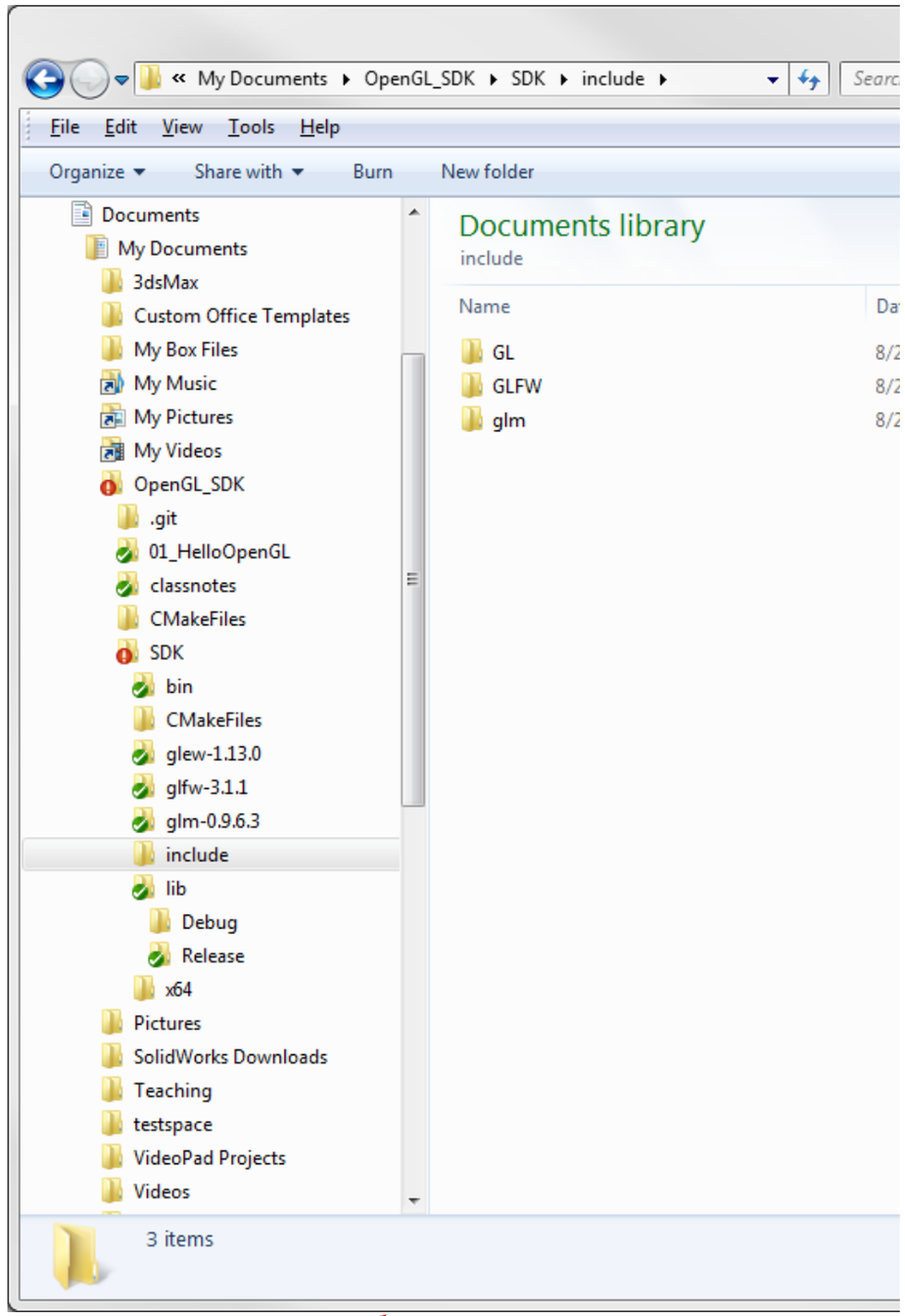
You should notice that CMake cannot find GLEW.

Solution: do it manually

# Troubleshooting

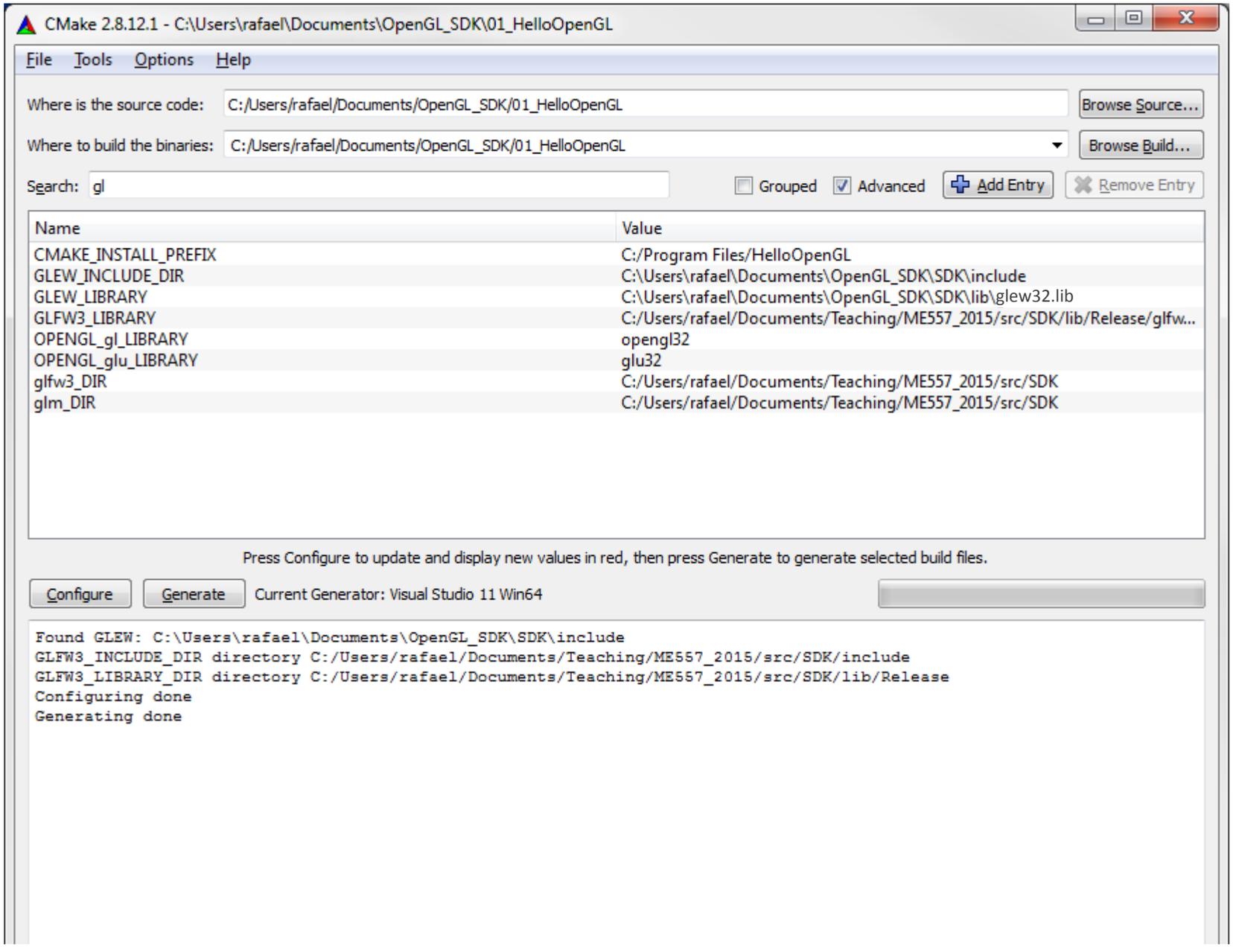
The glew32.lib file and the include-file path are missing!



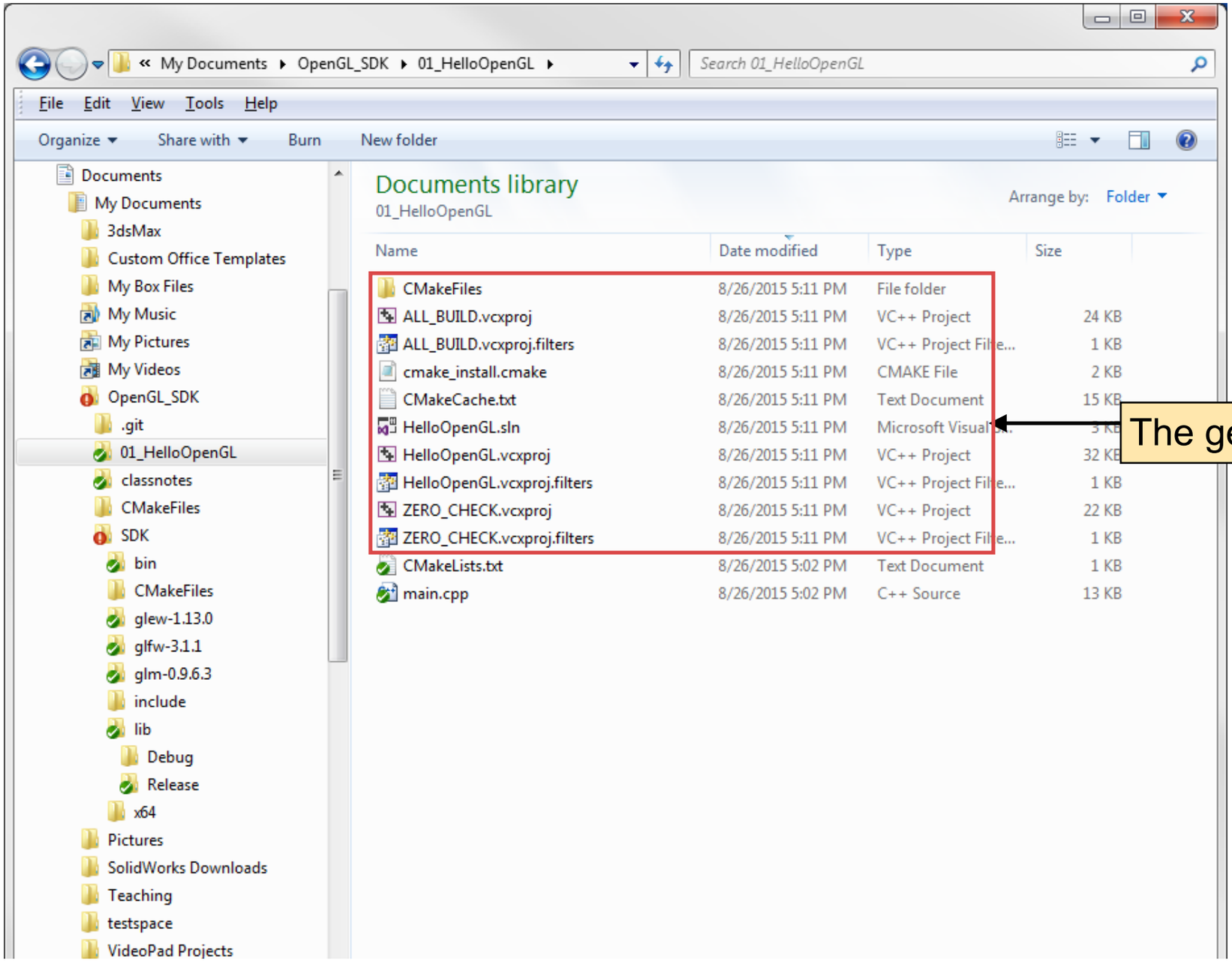
# Troubleshooting

You can add them manually and restart.

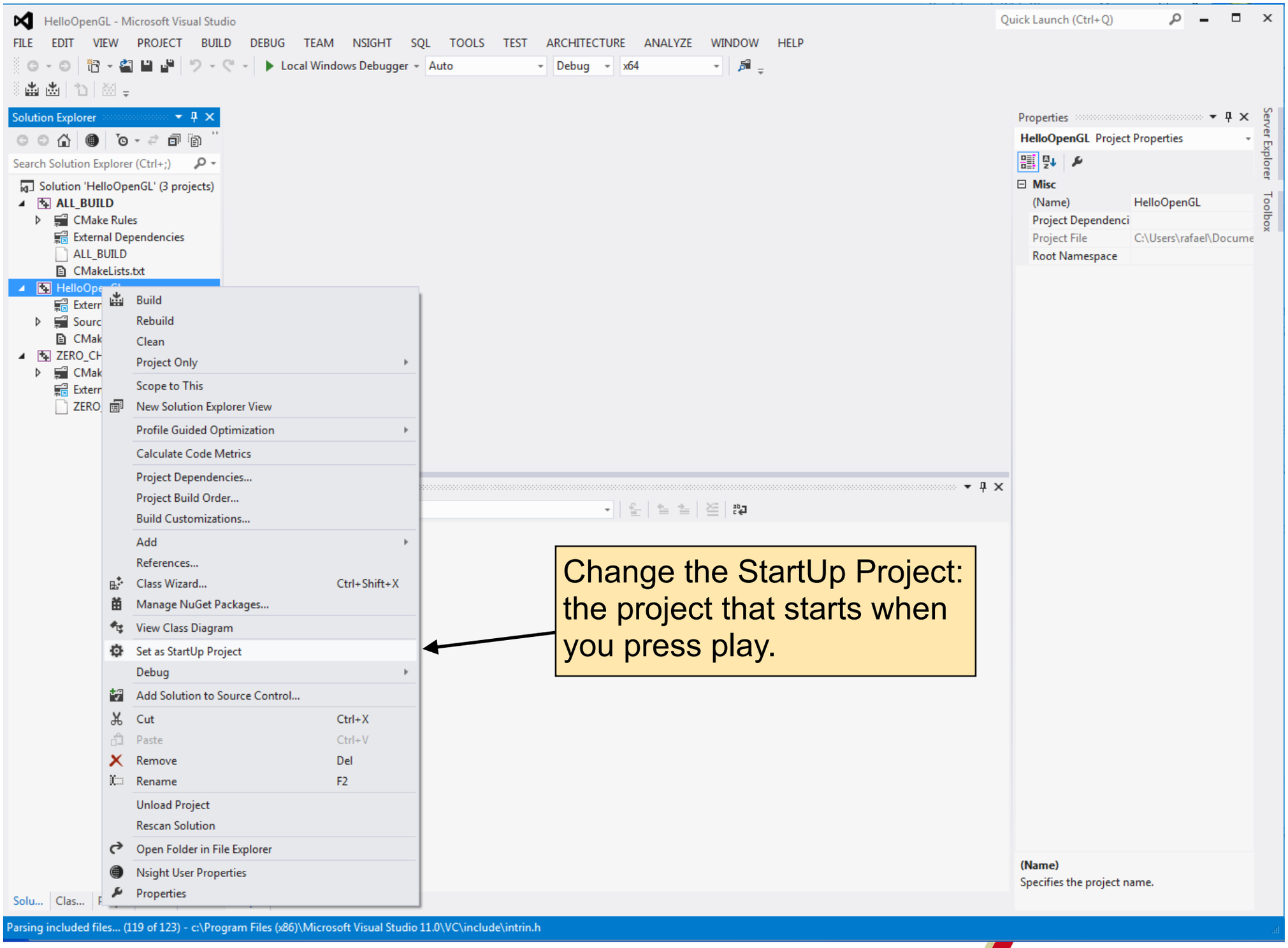


# Result

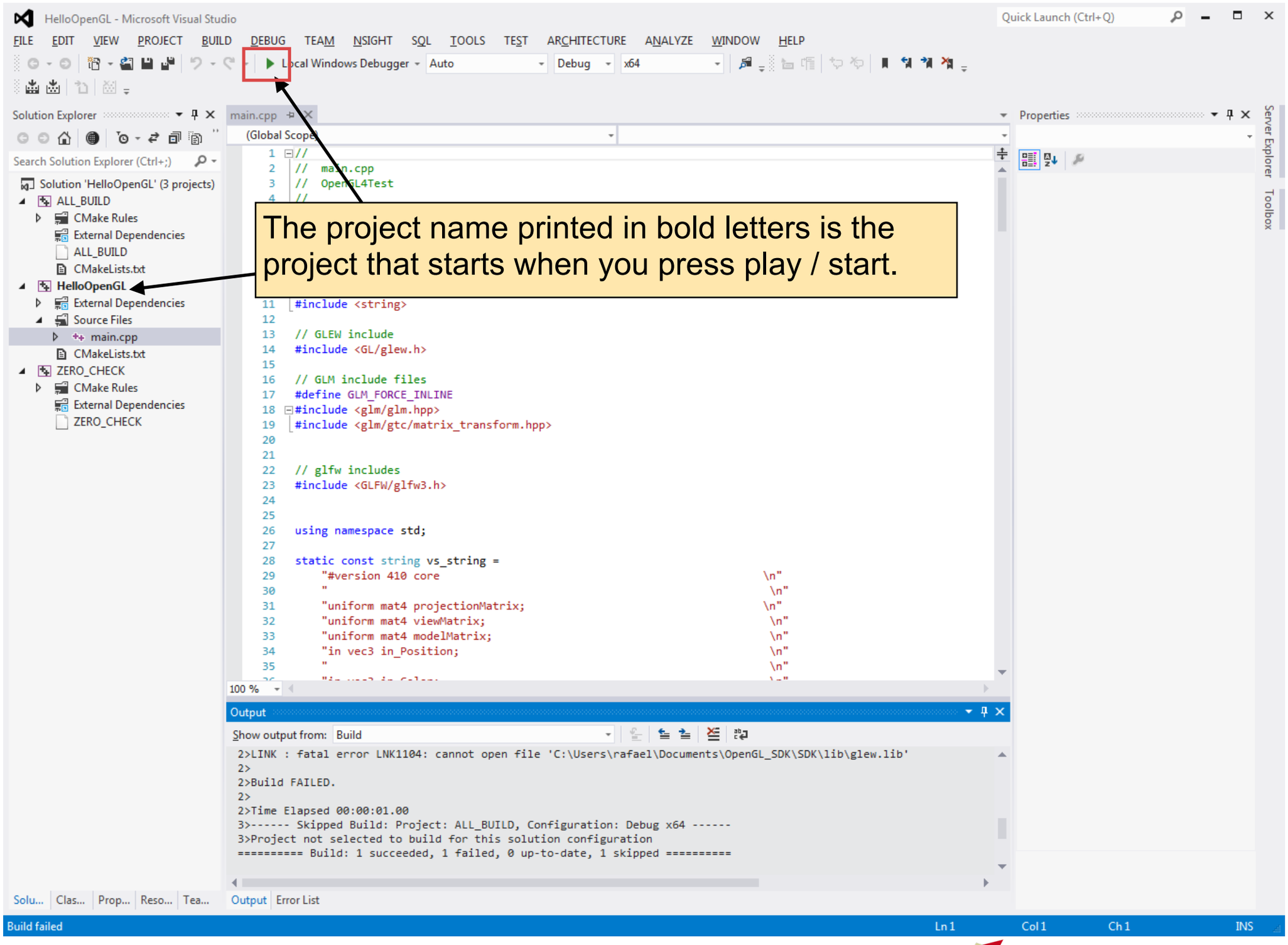
A solution file and the project files should be the outcome



# Change the StartUp Project



# Run the Project




```
1  //
2  //  main.cpp
3  //  OpenGL4Test
4  //
11 #include <string>
12
13 // GLEW include
14 #include <GL/glew.h>
15
16 // GLM include files
17 #define GLM_FORCE_INLINE
18 #include <glm/glm.hpp>
19 #include <glm/gtc/matrix_transform.hpp>
20
21
22 // glfw includes
23 #include <GLFW/glfw3.h>
24
25
26 using namespace std;
27
28 static const string vs_string =
29     "#version 410 core                                          \n"
30     "                                                           \n"
31     "uniform mat4 projectionMatrix;                             \n"
32     "uniform mat4 viewMatrix;                                   \n"
33     "uniform mat4 modelMatrix;                                  \n"
34     "in vec3 in_Position;                                       \n"
35     "                                                           \n"
```

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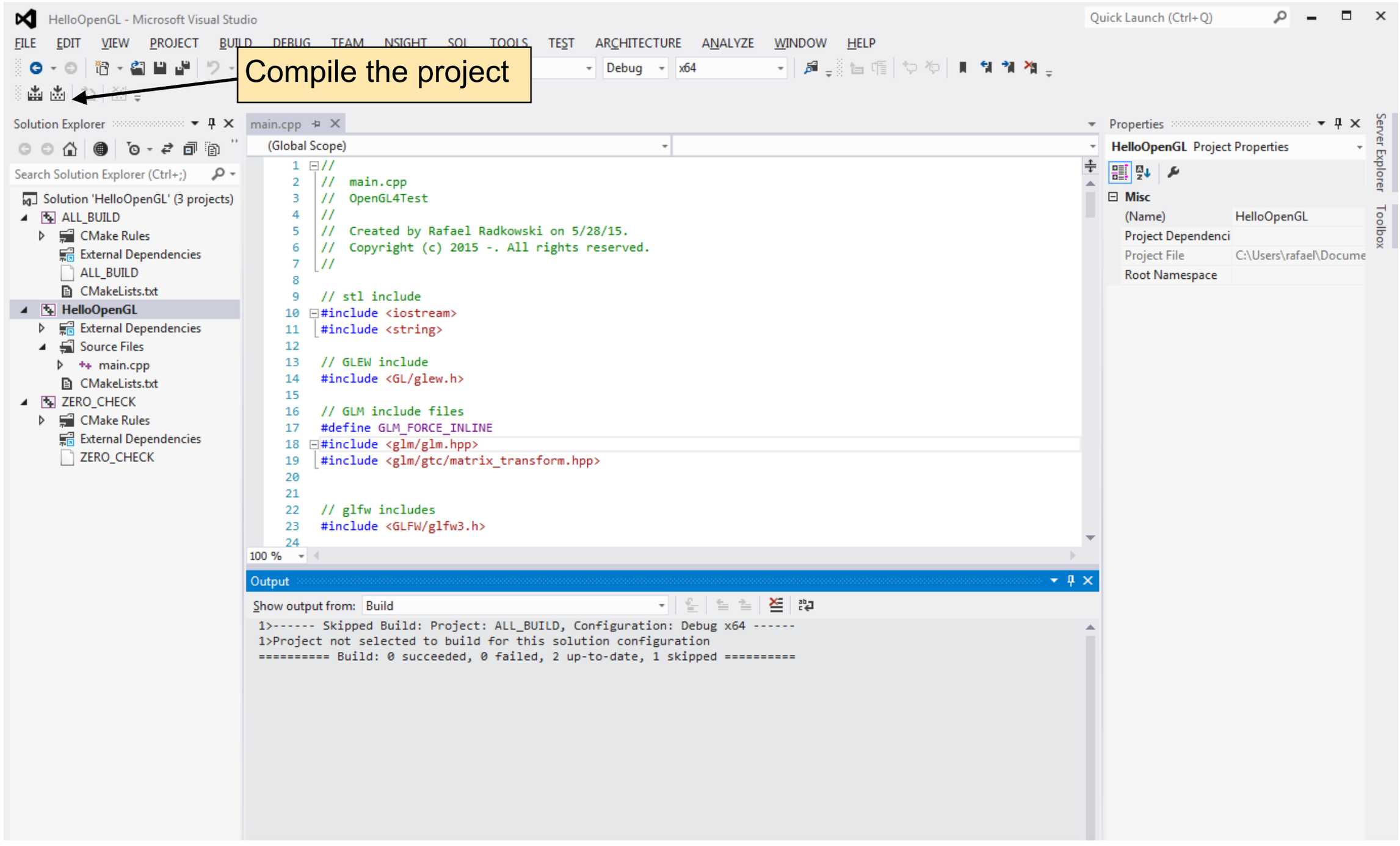
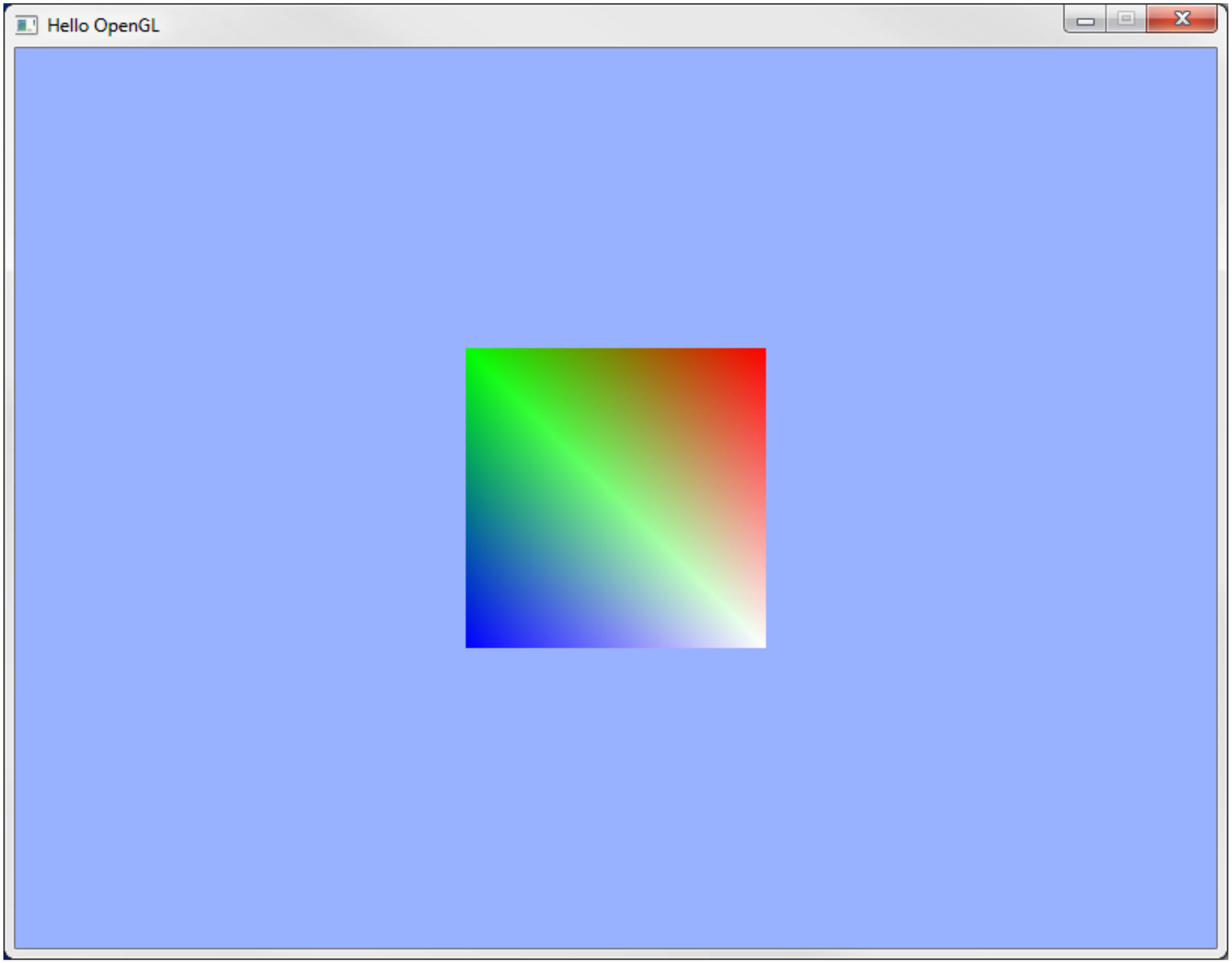
# Compile first



# Result



# Thank you!

# Questions

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