The OpenGL Mathematics (GLM) Library

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What is GLM?

GLM is a set of C++ classes and functions to fill in the programming gaps in writing the basic vector and matrix mathematics for OpenGL applications.

GLM isn't really a *library* – it is all specified in ***.hpp** header files so that it gets compiled in with your source code.

You can find it at:

http://glm.g-truc.net/0.9.4/

You invoke GLM like this:

```
#include <glm/glm.hpp>
```

Or, you can #include only the specific GLM .hpp files you need.

If GLM is not installed in a system place, put it somewhere you can get access to. Later on, these notes will show you how to use it from there.

Why are we even talking about this?

The OpenGL overlords have “deprecated” some of the OpenGL functions we have been using to perform transformations. In the desktop world, it means that the use of such functions is ***discouraged***. In the mobile world of OpenGL-ES, it means those functions are ***gone***. You might as well become familiar with how to live without them. So, instead of saying:

```
gluLookAt( 0., 0., 3.,     0., 0., 0.,     0., 1., 0. );
glRotatef( (GLfloat)Yrot, 0., 1., 0. );
glRotatef( (GLfloat)Xrot, 1., 0., 0. );
glScalef( (GLfloat)Scale, (GLfloat)Scale, (GLfloat)Scale );
```

you would say:

```
glm::mat4 modelview;
glm::vec3 eye(0.,0.,3.);
glm::vec3 look(0.,0.,0.);
glm::vec3   up(0.,1.,0.);
modelview = glm::lookAt( eye, look, up );
modelview = glm::rotate( modelview, D2R*Yrot, glm::vec3(0.,1.,0.) );
modelview = glm::rotate( modelview, D2R*Xrot, glm::vec3(1.,0.,0.) );
modelview = glm::scale( modelview, glm::vec3(Scale,Scale,Scale) );
glMultMatrixf(   glm::value_ptr( modelview )   );
```

Exactly the same concept, but a different expression of it. Read on for details …

The Most Useful GLM Variables, Operations, and Functions

// constructor:

```
glm::mat4( );
glm::vec4( );                                   // identity matrix
glm::vec3( );
```

GLM recommends that you use the **"glm::"** syntax and not use **"using namespace"** syntax

// multiplications:

```
glm::mat4  *  glm::mat4
glm::mat4  *  glm::vec4
glm::mat4  *  glm::vec4( glm::vec3 )        // promote vec3 to a vec4
```

// emulating OpenGL transformations *with concatenation*:

glm::mat4 **glm::rotate**(glm::mat4 const & m, float angle, glm::vec3 const & axis);

glm::mat4 **glm::scale**(glm::mat4 const & m, glm::vec3 const & factors);

glm::mat4 **glm::translate**(glm::mat4 const & m, glm::vec3 const & translation);

The Most Useful GLM Variables, Operations, and Functions

// viewing volume (assign, not concatenate):

glm::mat4 **glm::ortho**(float left, float right, float bottom, float top, float near, float far);
glm::mat4 **glm::ortho**(float left, float right, float bottom, float top);

glm::mat4 **glm::frustum**(float left, float right, float bottom, float top, float near, float far);
glm::mat4 **glm::perspective**(float fovy, float aspect, float near, float far);

// viewing (assign, not concatenate):

glm::mat4 **glm::lookAt**(glm::vec3 const & eye, glm::vec3 const & look, glm::vec3 const & up);

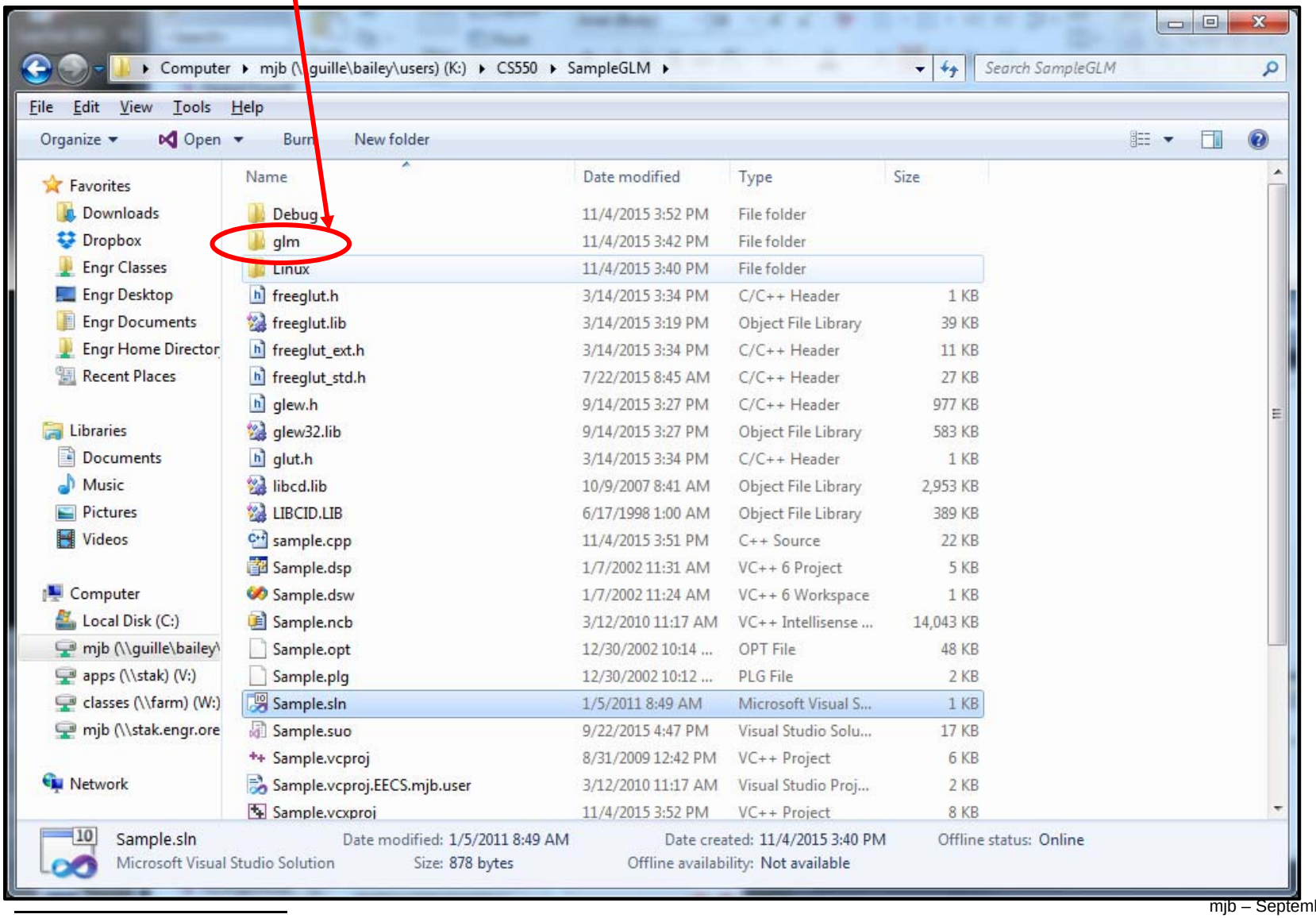
// loading matrices into opengl:

glLoadMatrix(**glm::value_ptr**(glm::mat4));

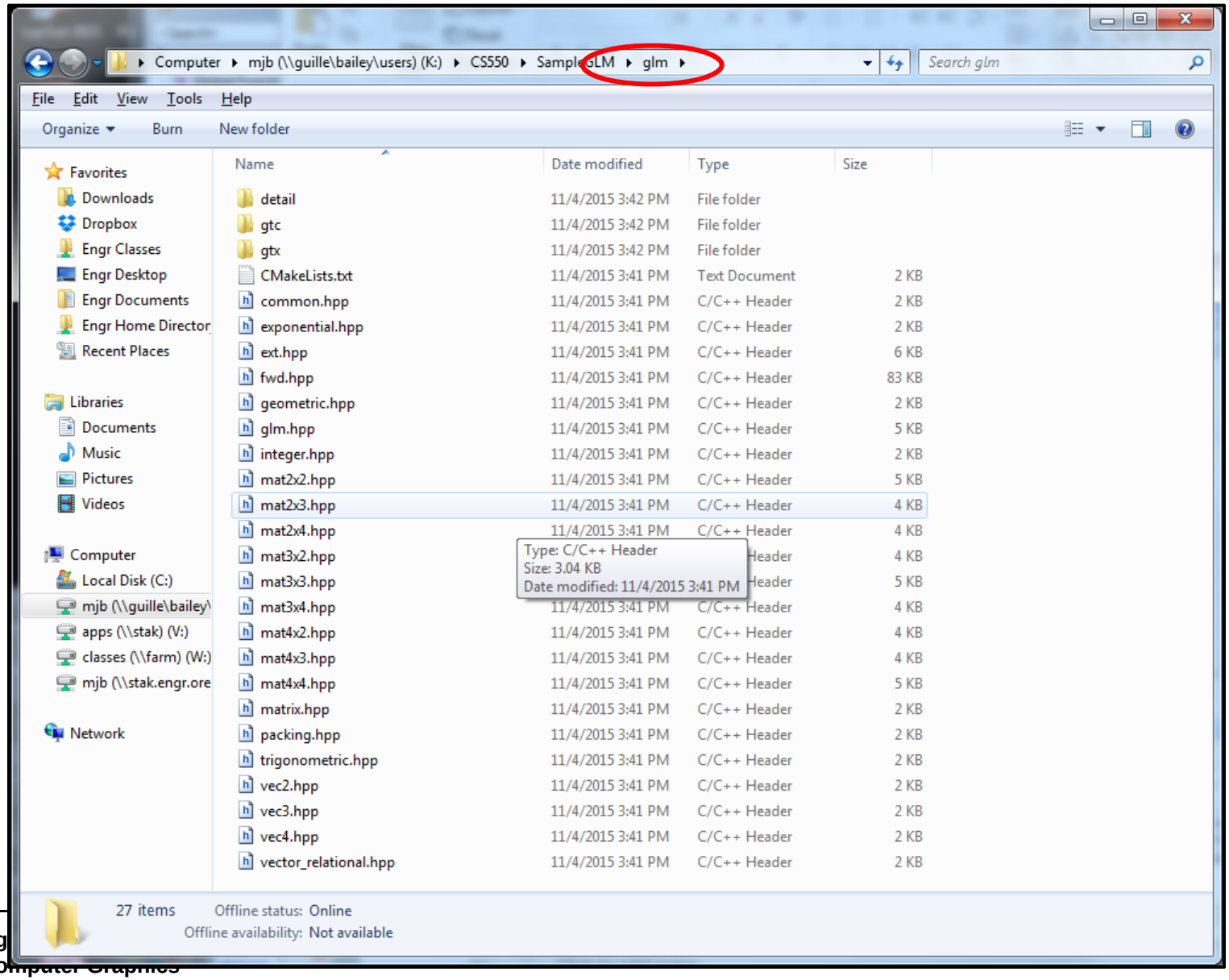
glUniformMatrix4fv(Location, 1, GL_FALSE, **glm::value_ptr**(glm::mat4));

Installing GLM into your own space

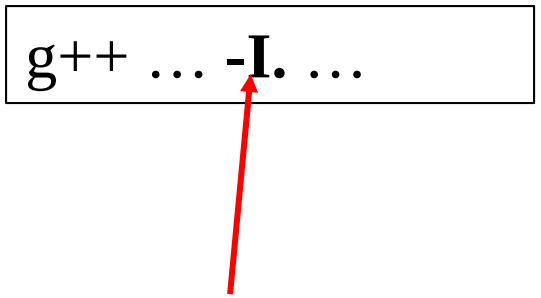
I like to just put the whole thing under my Visual Studio project folder so I can zip up a complete project and give it to someone else.



Here's what that GLM folder looks like



Telling Linux about where the GLM folder is

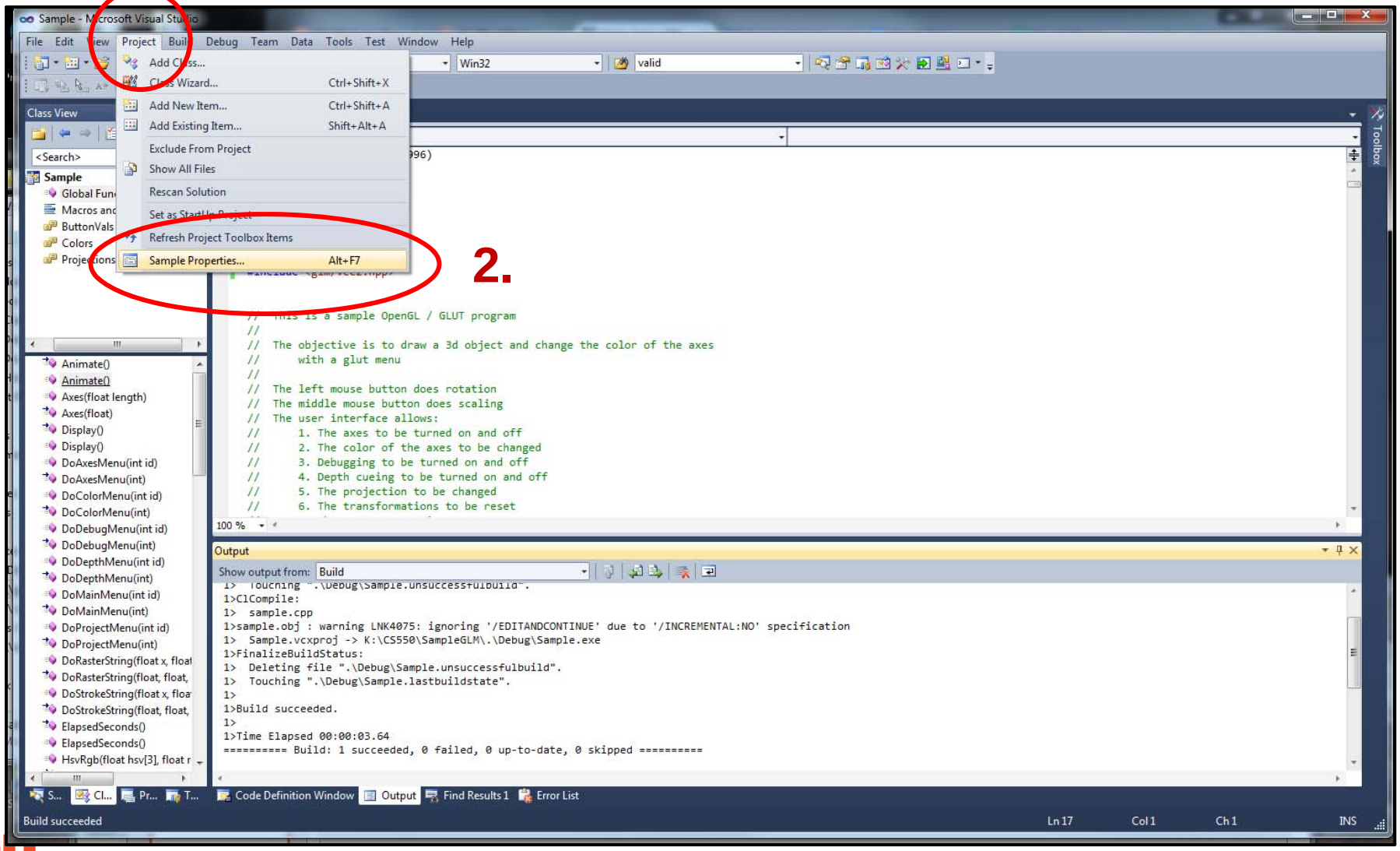


"minus-capital-eye-period" means "also look for the < > includes in this same folder"

Instead of the period, you can list a full or relative pathname.

Telling Visual Studio about where the GLM folder is

1.

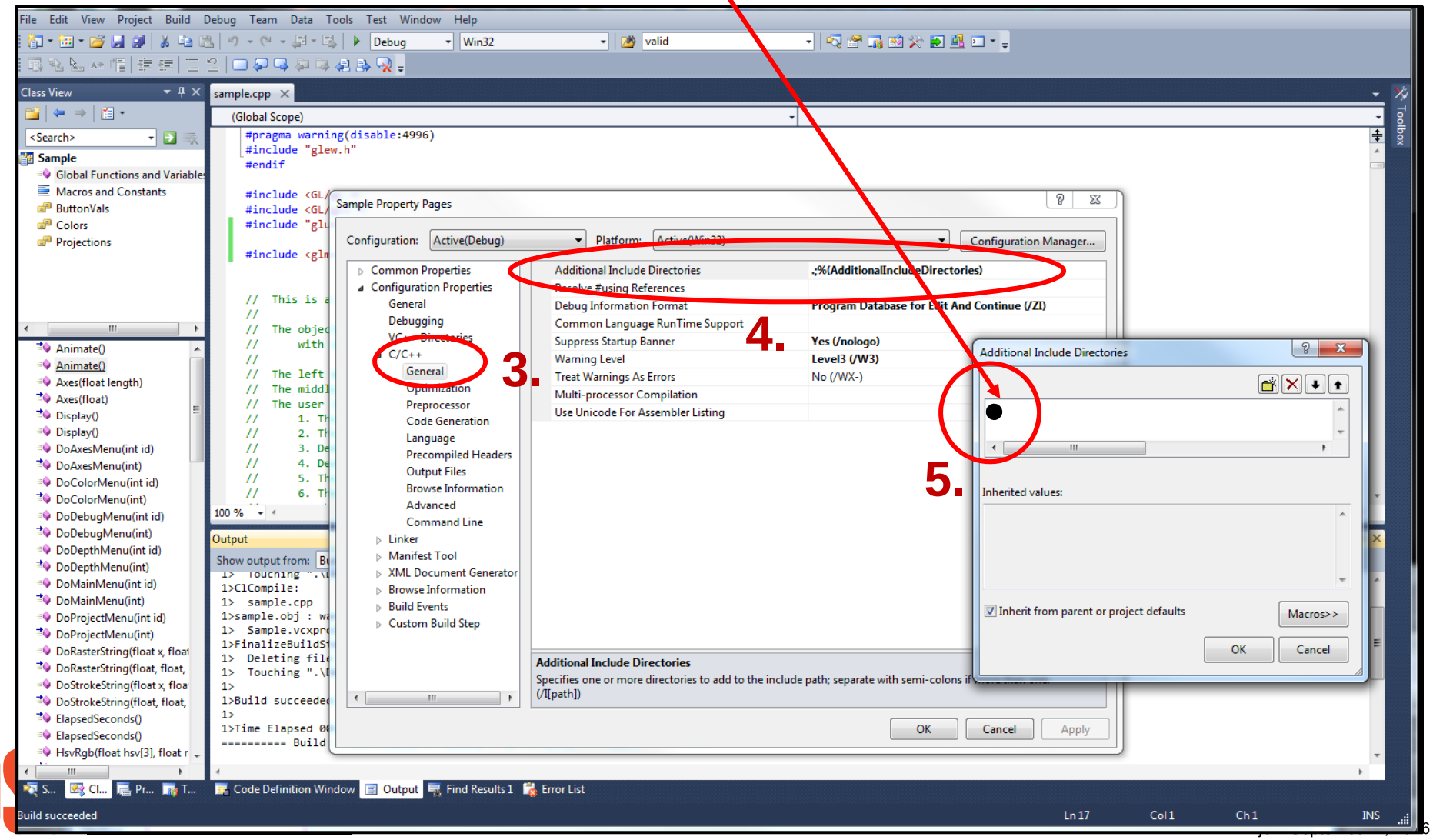


Telling Visual Studio about where the GLM folder is

A ***period***, indicating that the **project folder** should also be searched when a

#include <xxx>

is encountered. If you put it somewhere else, enter that full or relative path instead.



Using Transformations OpenGL-style


```
glMatrixMode( GL_PROJECTION );
glLoadIdentity( );
if( WhichProjection == ORTHO )
        glOrtho( -3., 3.,     -3., 3.,     0.1, 1000. );
else
        gluPerspective( 90., 1.,       0.1, 1000. );

// place the objects into the scene:
glMatrixMode( GL_MODELVIEW );
glLoadIdentity( );

// set the eye position, look-at position, and up-vector:
gluLookAt( 0., 0., 3.,     0., 0., 0.,     0., 1., 0. );

// rotate the scene:
glRotatef( (GLfloat)Yrot, 0., 1., 0. );
glRotatef( (GLfloat)Xrot, 1., 0., 0. );

// uniformly scale the scene:
if( Scale < MINSCALE )
        Scale = MINSCALE;
glScalef( (GLfloat)Scale, (GLfloat)Scale, (GLfloat)Scale );
```

Using Transformations GLM-style, I


```
#include <glm/vec3.hpp>
#include <glm/mat4x4.hpp>
#include <glm/gtc/matrix_transform.hpp>
#include <glm/gtc/type_ptr.hpp>

        . . .

// convert degrees to radians:
const float D2R = M_PI/180.f;                   // 0.01745…

        . . .

glMatrixMode( GL_PROJECTION );
glLoadIdentity( );
glm::mat4 projection;

if( WhichProjection == ORTHO )
        projection = glm::ortho( -3., 3.,     -3., 3.,     0.1, 1000. );
else
        projection = glm::perspective( 90., 1., 0.1, 1000. );

// apply the projection matrix:
glMultMatrixf(   glm::value_ptr( projection )   );
```

Using Transformations GLM-style, II


```
// place the objects into the scene:
glMatrixMode( GL_MODELVIEW );
glLoadIdentity( );
glm::mat4 modelview;

// set the eye position, look-at position, and up-vector:
glm::vec3 eye(0.,0.,3.);
glm::vec3 look(0.,0.,0.);
glm::vec3 up(0.,1.,0.);
modelview = glm::lookAt( eye, look, up );

// rotate the scene (warning -- unlike OpenGL's glRotatef,
//        GLM's rotate method takes angles in *radians*):
modelview = glm::rotate( modelview, D2R*Yrot, glm::vec3(0.,1.,0.) );
modelview = glm::rotate( modelview, D2R*Xrot, glm::vec3(1.,0.,0.) );

// uniformly scale the scene:
if( Scale < MINSCALE )
            Scale = MINSCALE;
modelview = glm::scale( modelview, glm::vec3(Scale,Scale,Scale) );



// apply the modelview matrix:
glMultMatrixf(   glm::value_ptr( modelview )   );
```