COP2334

Introduction to Object Oriented Programming with C++

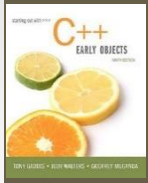
D. Singletary

Module 13

Special Topics:

C++ Lambda Expressions (Text Ch. 11)

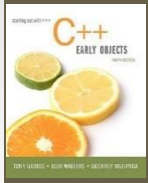
Debugging with Code::Blocks



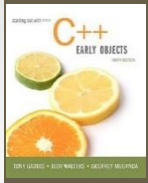
Special Topic: C++ Lambda Expressions

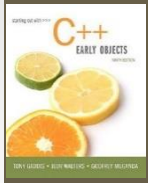
- Start by declaring a class which contains a function named sum that adds two numbers:

```
class SumFunction
{
public:
	int sum(int x, int y)
	{
		return (x + y);
	}
};
```



```
#include <iostream>
using namespace std;

class SumFunction
{
public:
	int sum(int x, int y)
	{
		return (x + y);
	}
};

int main()
{
	SumFunction sf;

	cout << sf.sum(5, 3) << endl;
	return 0;
}
```

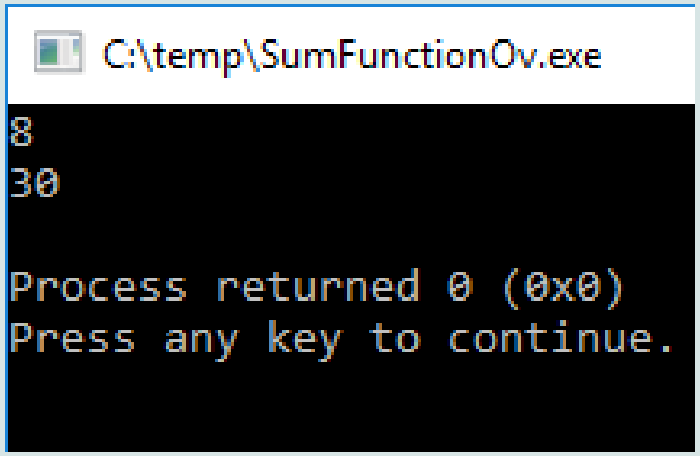




- Replace the sum function with a function operator overload
  - The C++ function operator is **()** (two parentheses)
- This is known as a function object

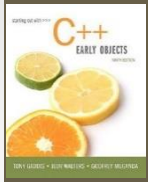
```
class SumFunctionOv
{
public:
        int operator()(int x, int y)
        {
                return (x + y);
        }
};
```

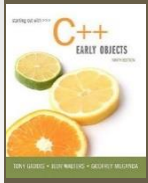
```
#include <iostream>
using namespace std;

class SumFunctionOv
{
public:
	int operator()(int x, int y)
	{
		return (x + y);
	}
};

int main()
{
	SumFunctionOv sf1;
	SumFunctionOv sf2;

	cout << sf1(5, 3) << endl;
	cout << sf2(10, 20) << endl;
	return 0;
}
```



- We don't have to create variables for our SumFunction objects
  - we can create the objects anonymously

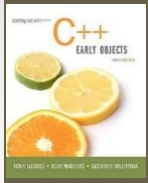
```
int main()
{
        SumFunctionOv sf1;
        SumFunctionOv sf2;

        cout << sf1(5, 3) << endl;
        cout << sf2(10, 20) << endl;

        cout << SumFunctionOv()(5, 3) << endl;
        cout << SumFunctionOv()(10, 20) << endl;
        return 0;
}
```



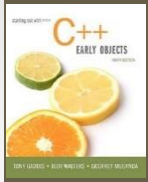


- A lambda expression also known as a *closure*) is an efficient way of creating an anonymous function object using a class *whose only member is the function call operator*
  - (this type of class is known as a closure type)
- The lambda operator is **[]** (two square brackets)
- The operator replaces the name and return type of the function (the compiler deduces the return type)

```
[](int a, int b)  { return a + b; }
```



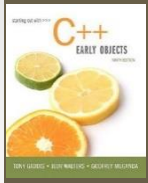

```
#include <iostream>
using namespace std;

int main()
{
	int x = 5;
	int y = 3;
	cout << [](int a, int b)  { return a + b; }(x, y) << endl;
	return 0;
}
```



- We can assign the lambda expression to a variable
  - NOTE: compiler insists on declare type as auto

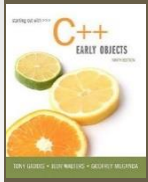
```
auto sum = [](int a, int b)  { return a + b; };
```

```
#include <iostream>
using namespace std;

int main()
{
    // lambda expression
    auto sum = [](int a, int b)  { return a + b; };

    int x = 5;
    int y = 3;

    cout << sum(x, y) << endl;
    return 0;
}
```



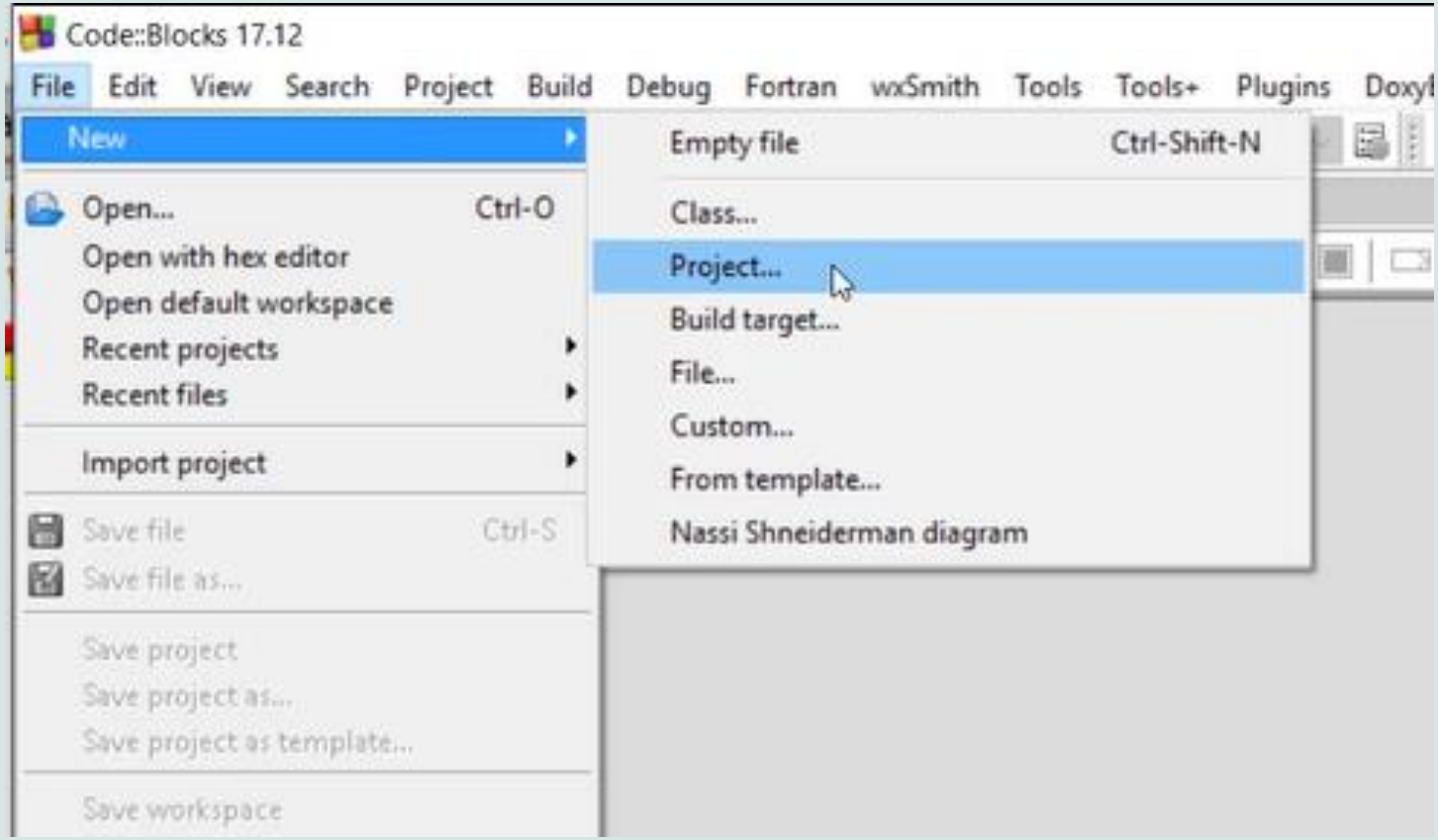
Key Benefits to Lambdas

- Conciseness
- Reduction in code bloat
- Readability
- Elimination of shadow variables
- Encouragement of functional programming
- Code reuse
- Enhanced iterative syntax
- Simplified variable scope
- Less boilerplate code
- Parallel processing opportunities

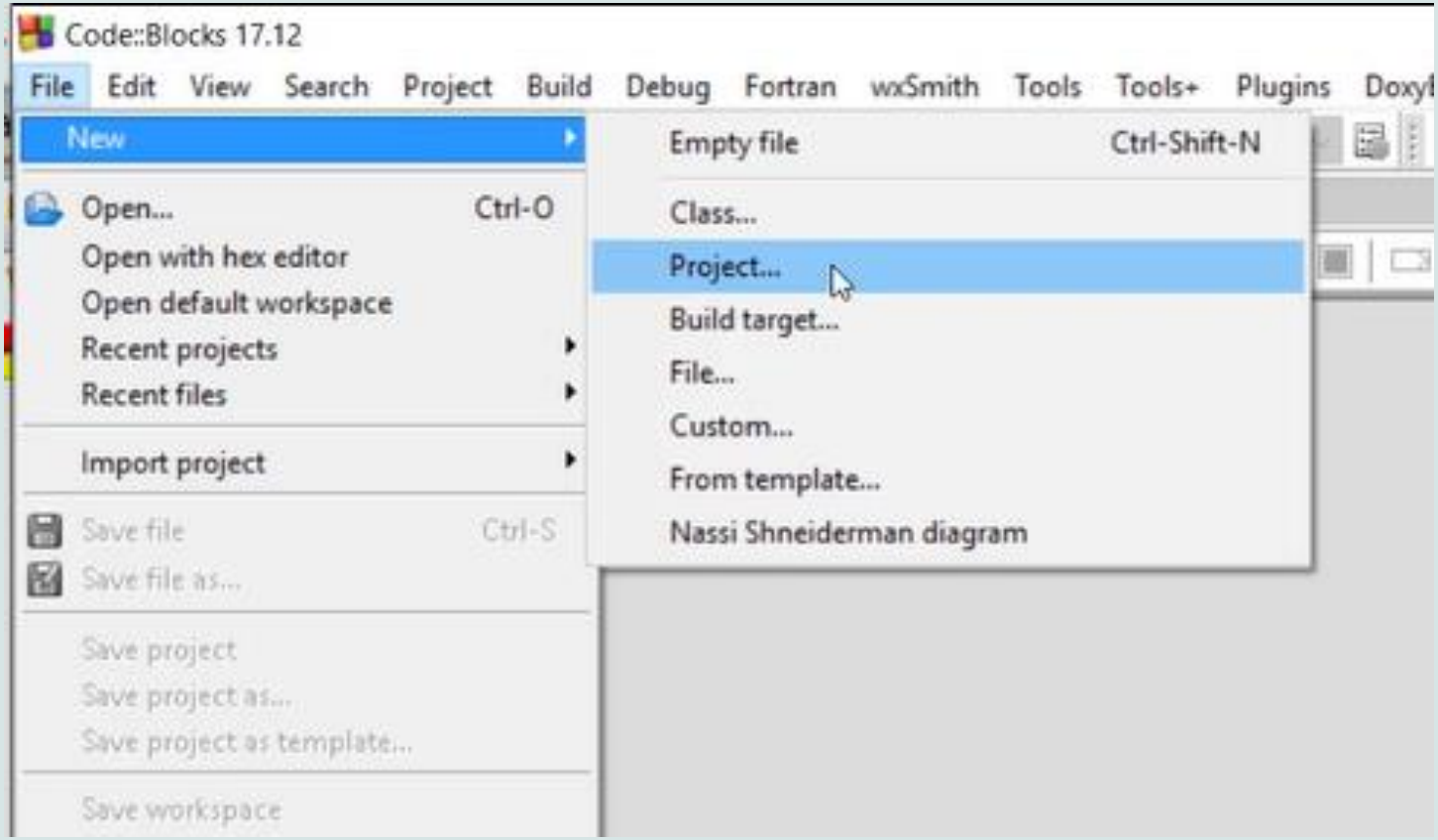


Special Topic: Debugging with Code::Blocks

- Create a Project

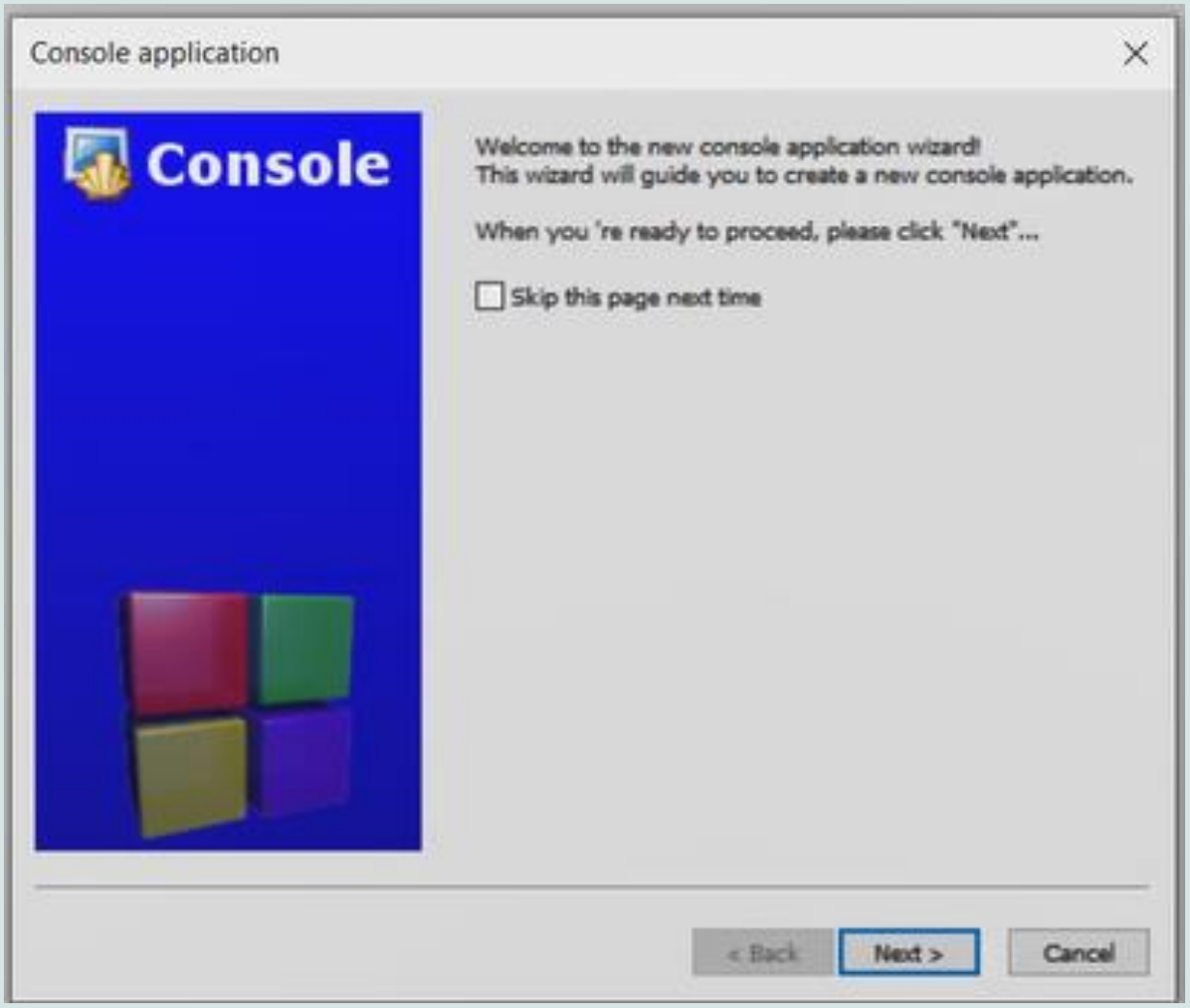


- Create a Project

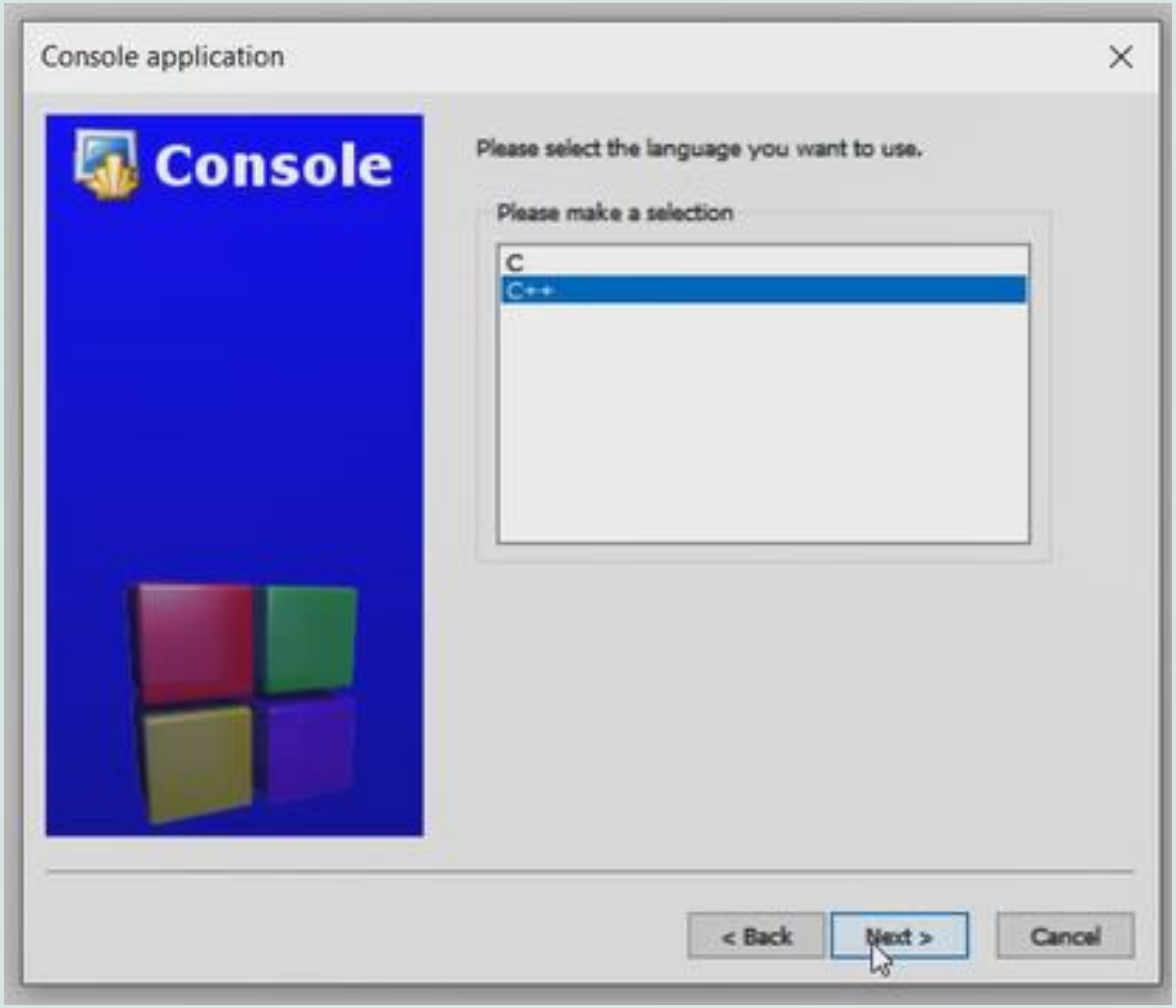


- Create a Project (Console application)

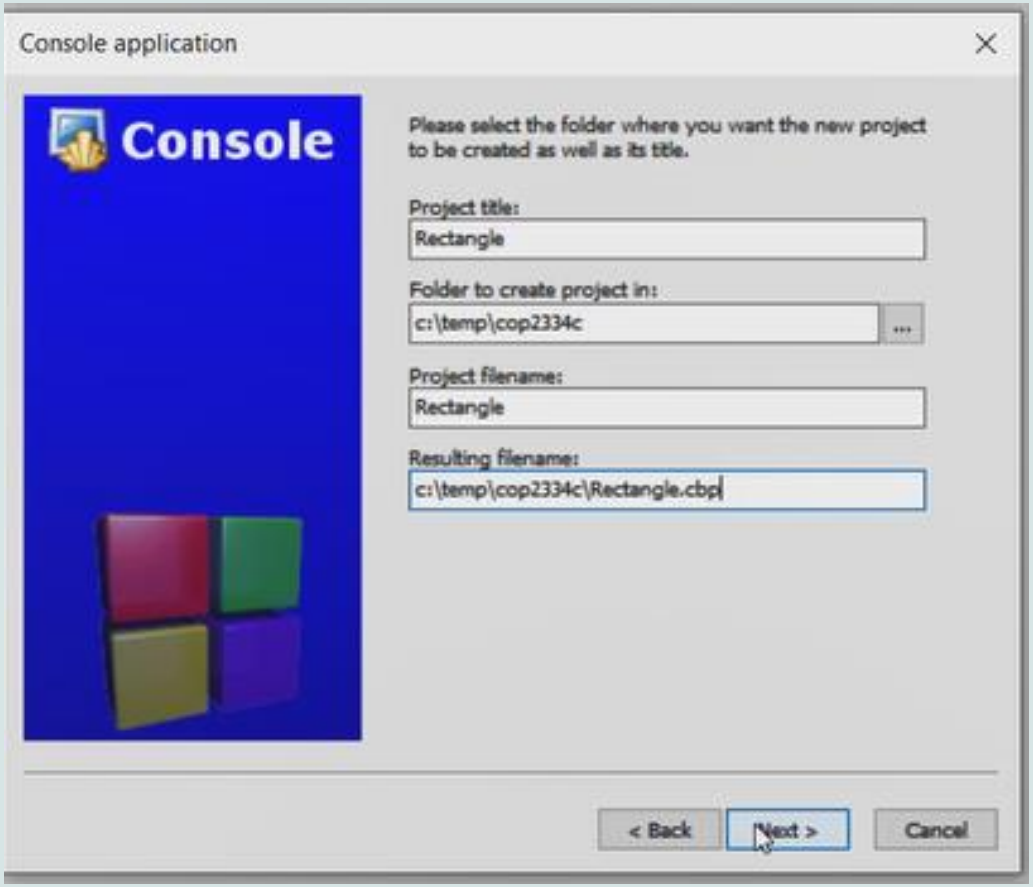
- Click Next


Console application
Console
Welcome to the new console application wizard!
This wizard will guide you to create a new console application.
When you 're ready to proceed, please click "Next"...
Skip this page next time
< Back
Next >
Cancel

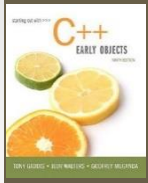
- Create a Project (C++, not C)



- Enter title and folder
- Code::Blocks will want to create a subfolder for the project, I usually remove this from the path

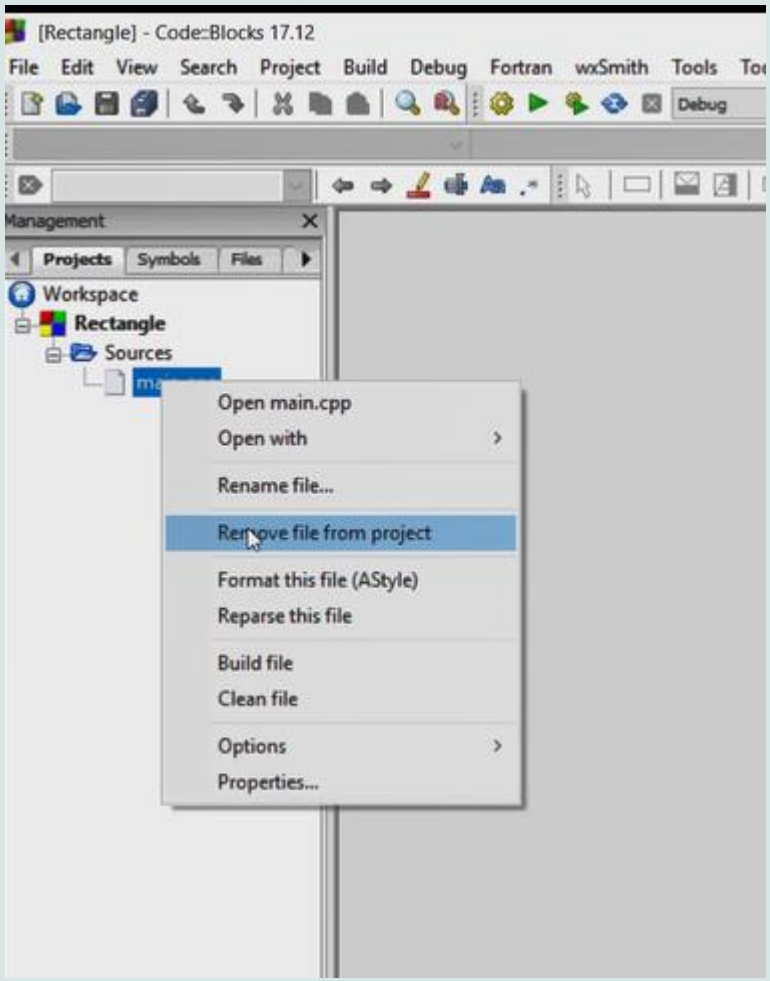


- Build Debug and Release configurations
  - Default is to build both debug and release configurations

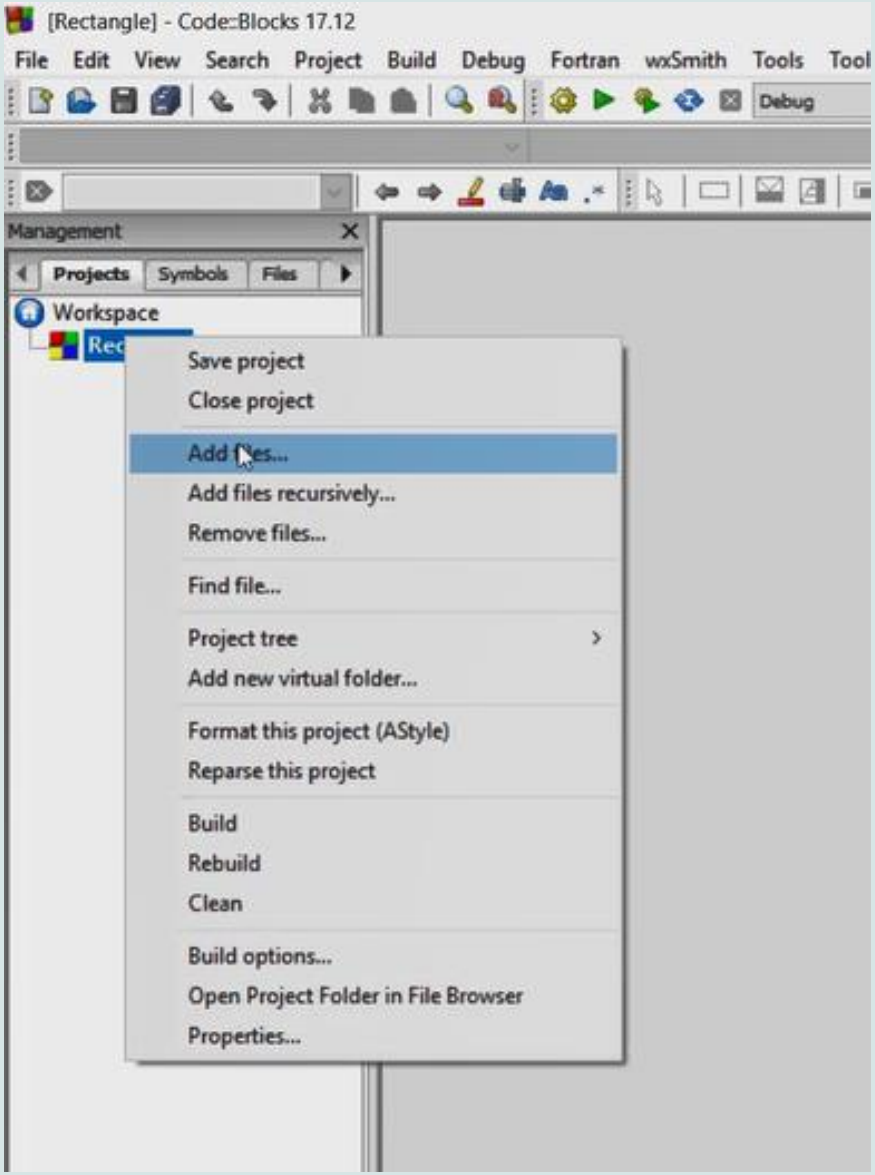


- A debug configuration contains extra information in the object files and subsequent executable image
  - The executable is bigger but allows visualization/manipulation of symbols (e.g. variables) in the debugger
  - A release configuration does not provide useful debugging information
- Never provide a debugging image to a customer unless you are working on a specific issue and have the customer's permission
  - Debugging images should only be executed under strictly controlled conditions for security and performance reasons

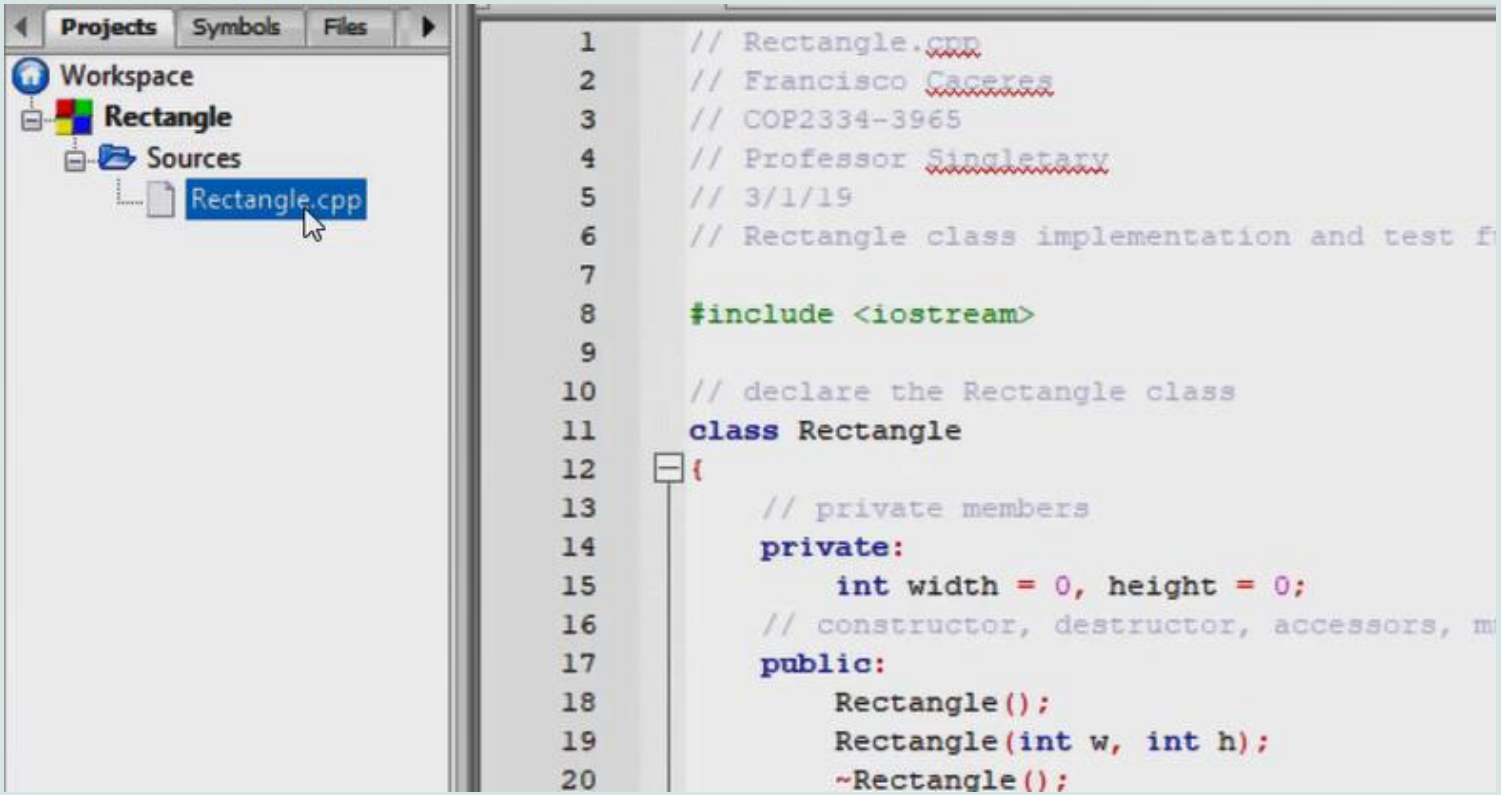
- Code::Blocks will create a new main.cpp file containing a basic main function.
  - Use it if creating a project from scratch
  - If you are using existing sources you can remove it from the project



- Add existing files to the project as necessary

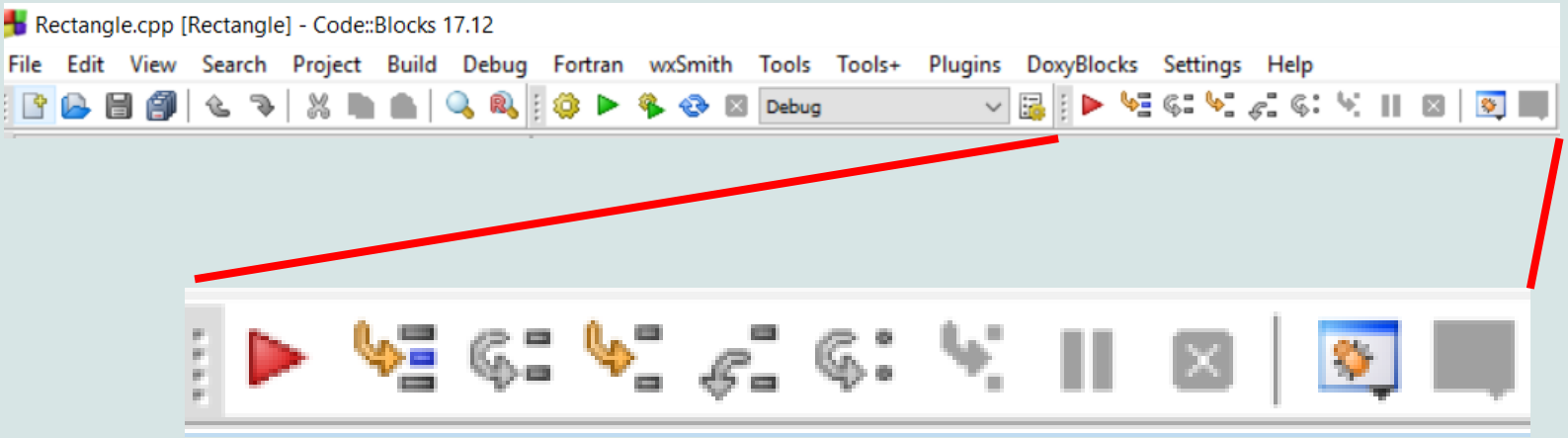


- Using existing Rectangle.cpp file

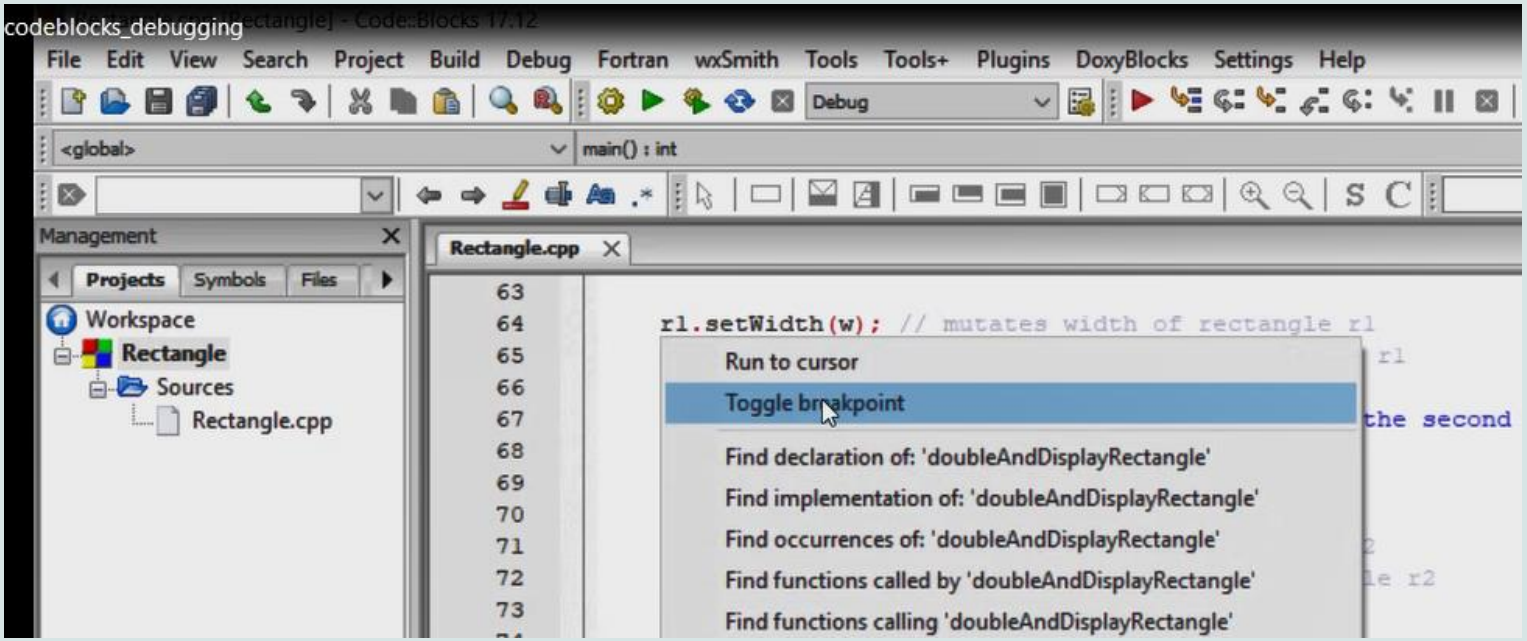



```
1   // Rectangle.cpp
2   // Francisco Caceres
3   // COP2334-3965
4   // Professor Singletary
5   // 3/1/19
6   // Rectangle class implementation and test f
7
8   #include <iostream>
9
10  // declare the Rectangle class
11  class Rectangle
12  {
13      // private members
14      private:
15          int width = 0, height = 0;
16      // constructor, destructor, accessors, m
17      public:
18          Rectangle();
19          Rectangle(int w, int h);
20          ~Rectangle();
```

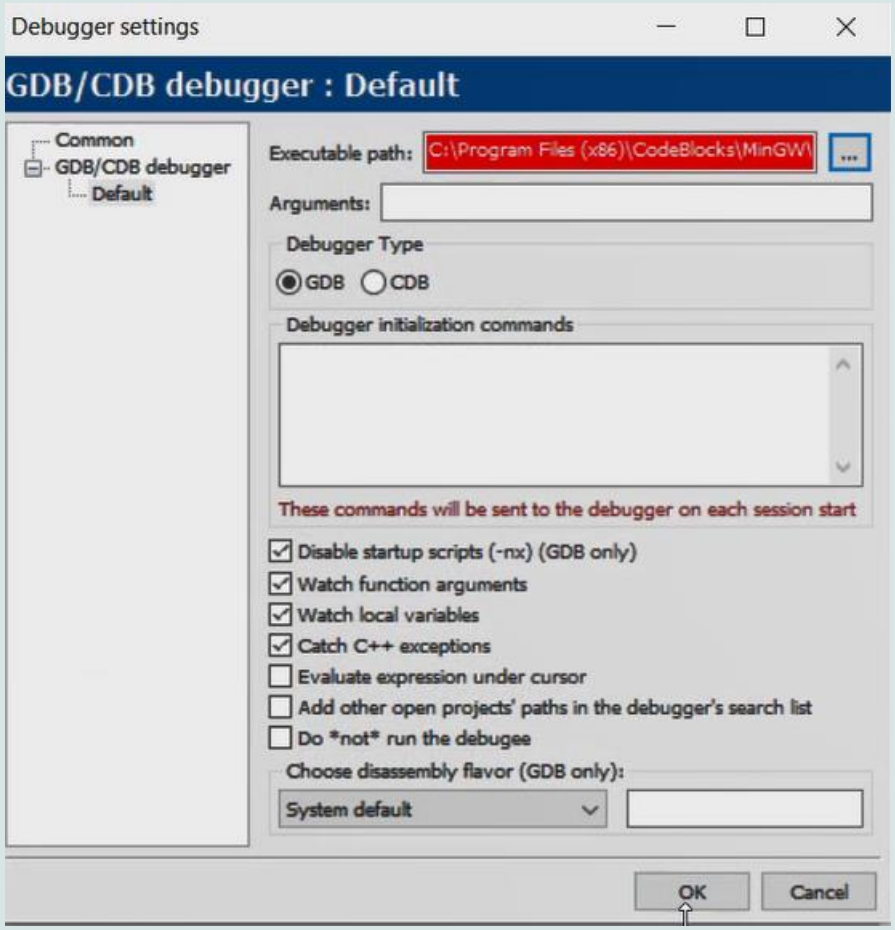
Debugging Tools



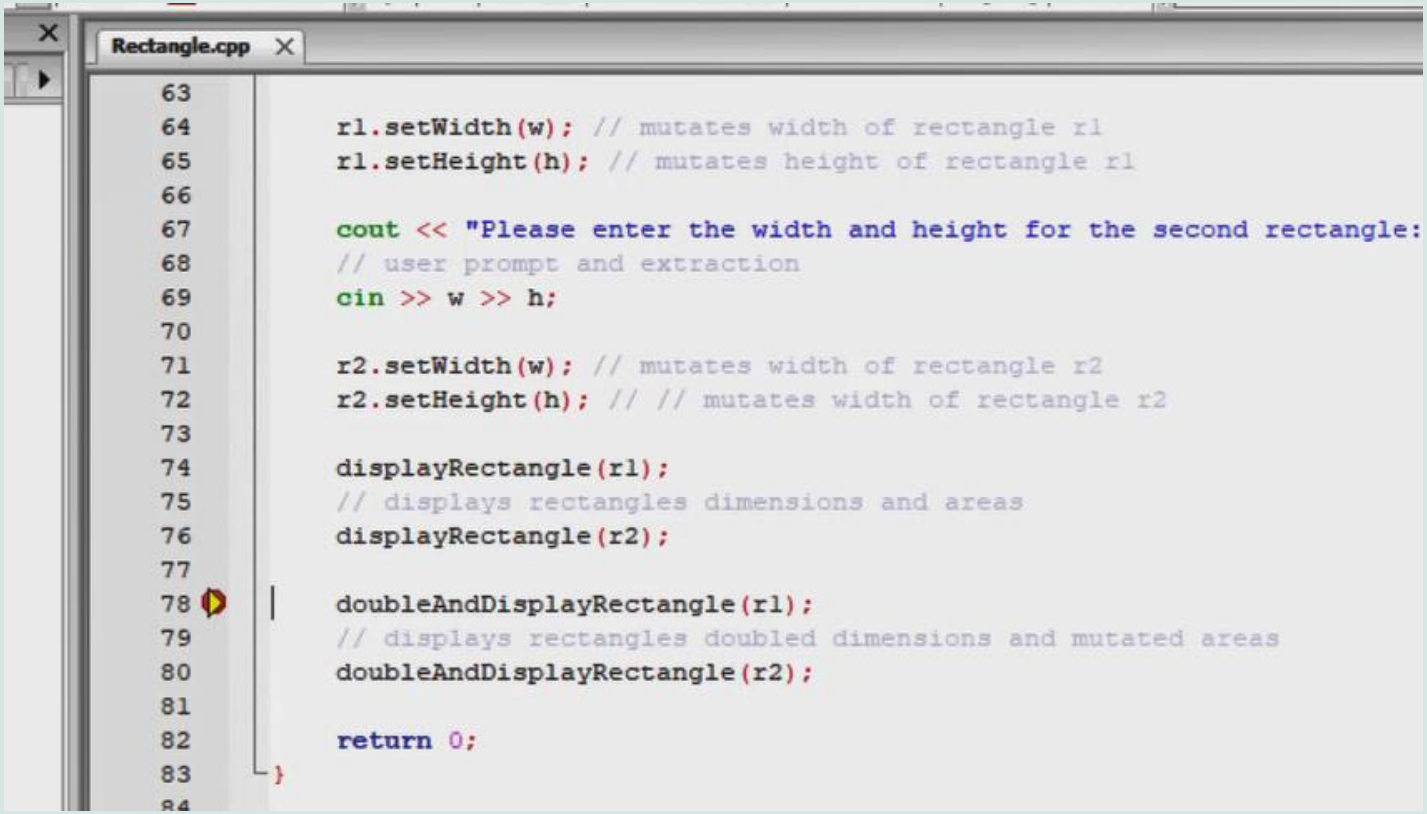
- Setting Breakpoints
  - Breakpoints will "break" execution of a program at a specific point so the call stack and variables can be examined
  - Position your cursor on the beginning of the line where the breakpoint is desired
  - Right-click and select "Toggle breakpoint"
  - Select "Debug/Continue" (red arrow)



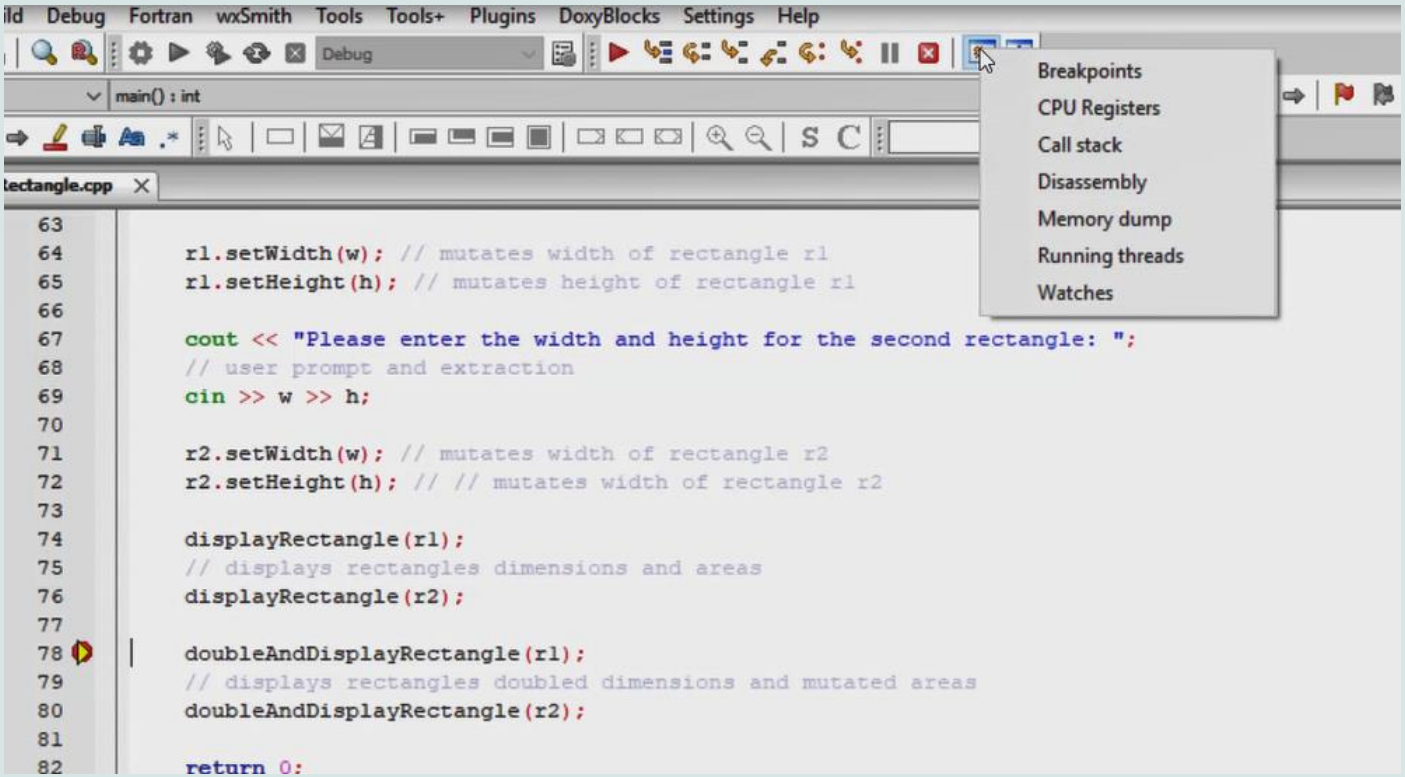
- Configuring the debugger
  - You may need to browse for your installed debugger
  - Settings/Debugger
  - Example: under the CodeBlocks install folder, MinGW\bin\gdb32.exe



- When a breakpoint is hit
  - The yellow arrow inside the red breakpoint ("stop sign") indicates the program has broken at that statement

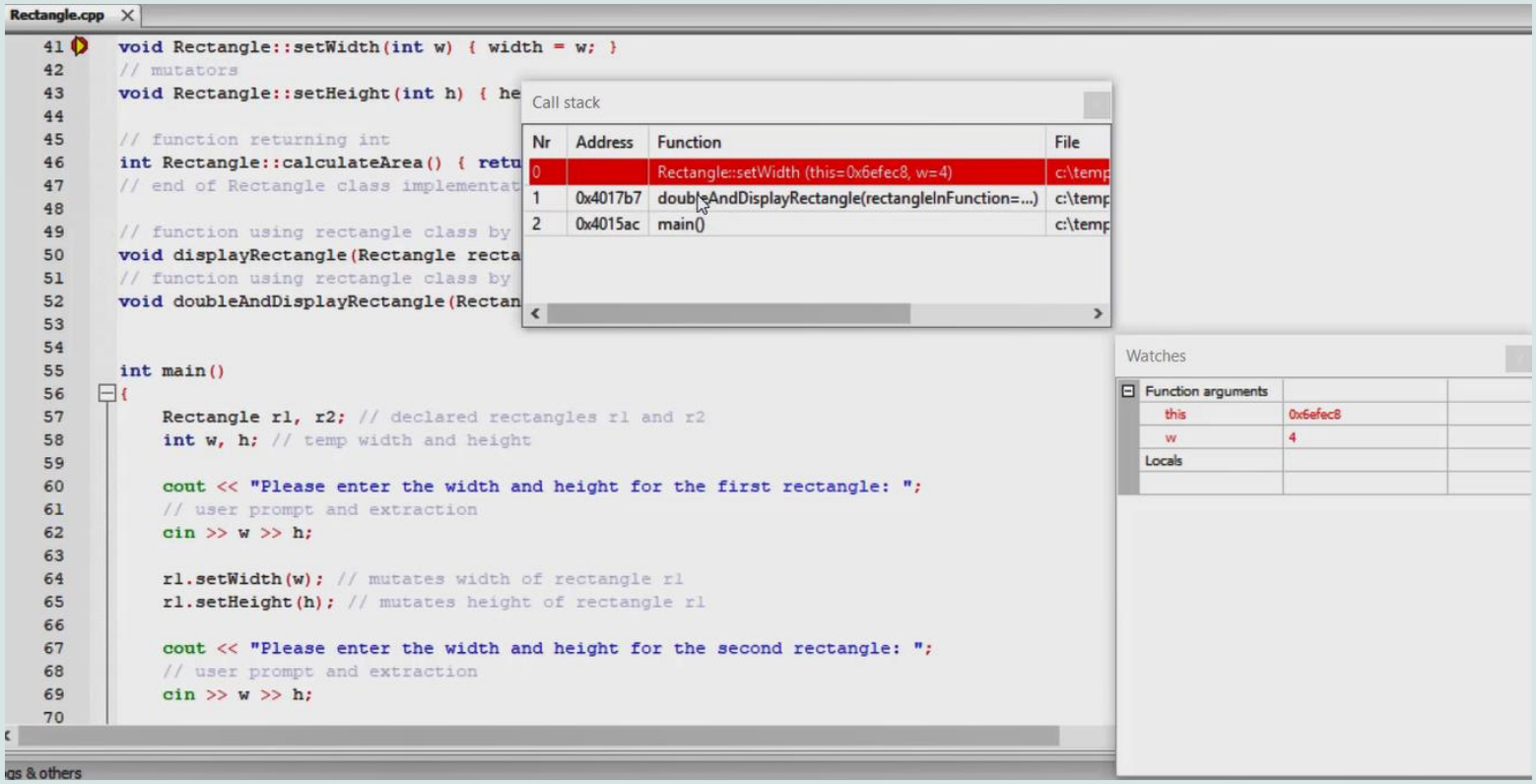


- Viewing the debug windows
  - Call stack: stack frames at the current execution point
  - Watches: variable values



Breakpoint set at Rectangle class mutator

- When breakpoint is hit from the call inside the doubleAndDisplayRectangle function, we see a 3-deep stack trace in the Call stack window and values for the w parameter and "this" in the Watches window
- Double click on a stack frame to activate in Watches



Adding variables to Watches

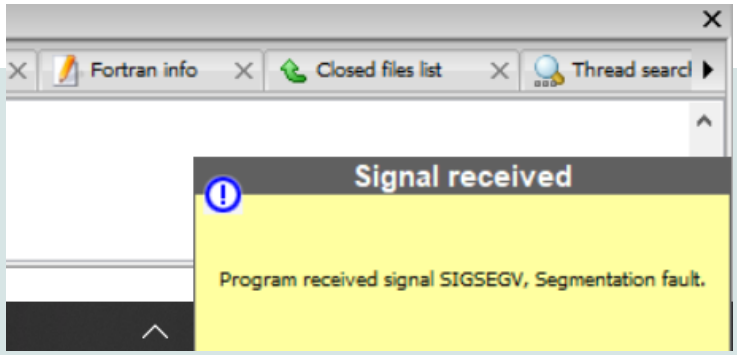
- Add a global variable and set it at various points
- Toggle a breakpoint and step through the code using "Next line" tool to watch its values
- "Step into" will enter a function, "Next line" will just execute it and step over it

```
8     #include <iostream>
9
10    int globalVar = 100;
11
```


```
void doubleAndDisplayRectangle(Rectangle& rectangleInFunction)
{
    const string DOUBLE_MESSAGE = "Doubling the rectangle dimensions!";

    globalVar = 200;
    cout << DOUBLE_MESSAGE << endl; // outputs message
    rectangleInFunction.setWidth(rectangleInFunction.getWidth() * 2);
    //mutates dimensions
    rectangleInFunction.setHeight(rectangleInFunction.getHeight() * 2);

    globalVar = 300;
```

- Program crashes when running a debug configuration will activate debugger
  - Add a pointer variable, initialize to null, then attempt to dereference
  - Execute program from debugger with no breakpoints

```
int * ptr = nullptr;

globalVar = 200;
cout << DOUBLE_MESSAGE << endl; // outputs message
rectangleInFunction.setWidth(rectangleInFunction.getWidth() * 2);
//mutates dimensions
rectangleInFunction.setHeight(rectangleInFunction.getHeight() * 2);

globalVar = 300;

cout << *ptr << endl;
```



- Notice null pointer value in Watches window
  - Program is broken at line 110 (no breakpoint)