Preprocessor

Topics

- Preprocessor
- Only C from now on
- Testing Functions

The Preprocessor

- Start by reading 18, 18.1, and 18.1.1
- Preprocessing occurs before program compiles
    - Inclusion of external files
    - Definition of symbolic constants
    - Macros
    - Conditional compilation
    - Conditional execution
  - All directives begin with **#**
    - Can only have whitespace before directives
  - Directives are not C statements
    - Do not end with `;`

The #include Directive

- **`#include`** directive
  - Puts copy of file in place of directive
  - Two forms
    - **`#include <filename>`**
      - For standard library header files
      - Searches pre-designated directories
    - **`#include "filename"`**
      - Searches in current directory where exe file is
      - Normally used for programmer-defined files

#include

- Now that you know, use

```
#include <stdio.h>
```

#define – Section 18.1.3

- **`Section 18.1.3 starts with Warning!`**
- **`#define`**
  - Symbolic constants
    - Constants represented as symbols
    - When program compiled, all occurrences replaced
  - Format
    - **`#define`** ***`identifier replacement-text`***
    - **`#define PI 3.14159`**
  - Everything to right of identifier replaces text
    - **`#define PI=3.14159`**
    - Replaces **`PI`** with **`"=3.14159"`**
    - Probably an error!

#define

- Advantages
  - Takes no memory
- Disadvantages
  - Name not seen by debugger (only replacement text)
  - Do not have specific data type
- **`const`** variables preferred

Other Directives

- In the next few slides, an FYI marked slide means you can read it in passing.

Macros – Quick Read 18.1.4

- Macro
  - Operation specified in **`#define`**
  - Intended for legacy C programs
  - Macro without arguments
    - Treated like a symbolic constant
  - Macro with arguments
    - Arguments substituted for replacement text
    - Macro expanded
  - Performs a text substitution
    - No data type checking

#define : Macros – Quick Pass

- Example

```
#define CIRCLE_AREA( x ) ( PI * ( x ) * ( x ) )
area = CIRCLE_AREA( 4 );
```

   becomes

```
area = ( 3.14159 * ( 4 ) * ( 4 ) );
```

- Use parentheses
  - Without them,

```
#define CIRCLE_AREA( x )  PI * x * x
area = CIRCLE_AREA( c + 2 );
```

  becomes

```
area = 3.14159 * c + 2 * c + 2;
```

  which evaluates incorrectly

The #error and #pragma Preprocessor Directives – FYI

- **`#error`** ***`tokens section 18.1.5`***
  - Prints implementation-dependent message
  - Tokens are groups of characters separated by spaces
    - **`#error 1 - Out of range error`** has 6 tokens
  - Compilation may stop (depends on compiler)
- **`#pragma`** ***`tokens section 18.1.2`***
  - Actions depend on compiler
  - May use compiler-specific options
  - Unrecognized **`#pragma`**s are ignored

The # and ## Operators - FYI

- **#** operator
  - Replacement text token converted to string with quotes

```
#define HELLO( x ) cout << "Hello, " #x << endl;
```

  - **`HELLO( JOHN )`** becomes
    - **`cout << "Hello, " "John" << endl;`**
    - Same as **`cout << "Hello, John" << endl;`**
- **##** operator
  - Concatenates two tokens

```
#define TOKENCONCAT( x, y )  x ## y
```

  - **`TOKENCONCAT( O, K )`** becomes
    - **`OK`**

19.8 Line Numbers – FYI

- **`#line`**
  - Renumbers subsequent code lines, starting with integer
    - **`#line 100`**
  - File name can be included
  - **`#line 100 "file1.cpp"`**
    - Next source code line is numbered **`100`**
    - For error purposes, file name is **`"file1.cpp"`**
    - Can make syntax errors more meaningful
    - Line numbers do not appear in source file

Predefined Symbolic Constants

- Though for now this FYI, in later units or future courses, come back to it.
- Useful predefined symbolic constants 18.2
  - __FILE__ => The name of the current file, as a string literal
  - __LINE__ => Current line of the source file, as a numeric literal
  - __DATE__ => Current system date, as a string
  - __TIME__ => Current system time, as a string
  - __TIMESTAMP__ => Date and time (non-standard)

  - Cannot be used in **`#define`** or **`#undef`**

Assertions - FYI

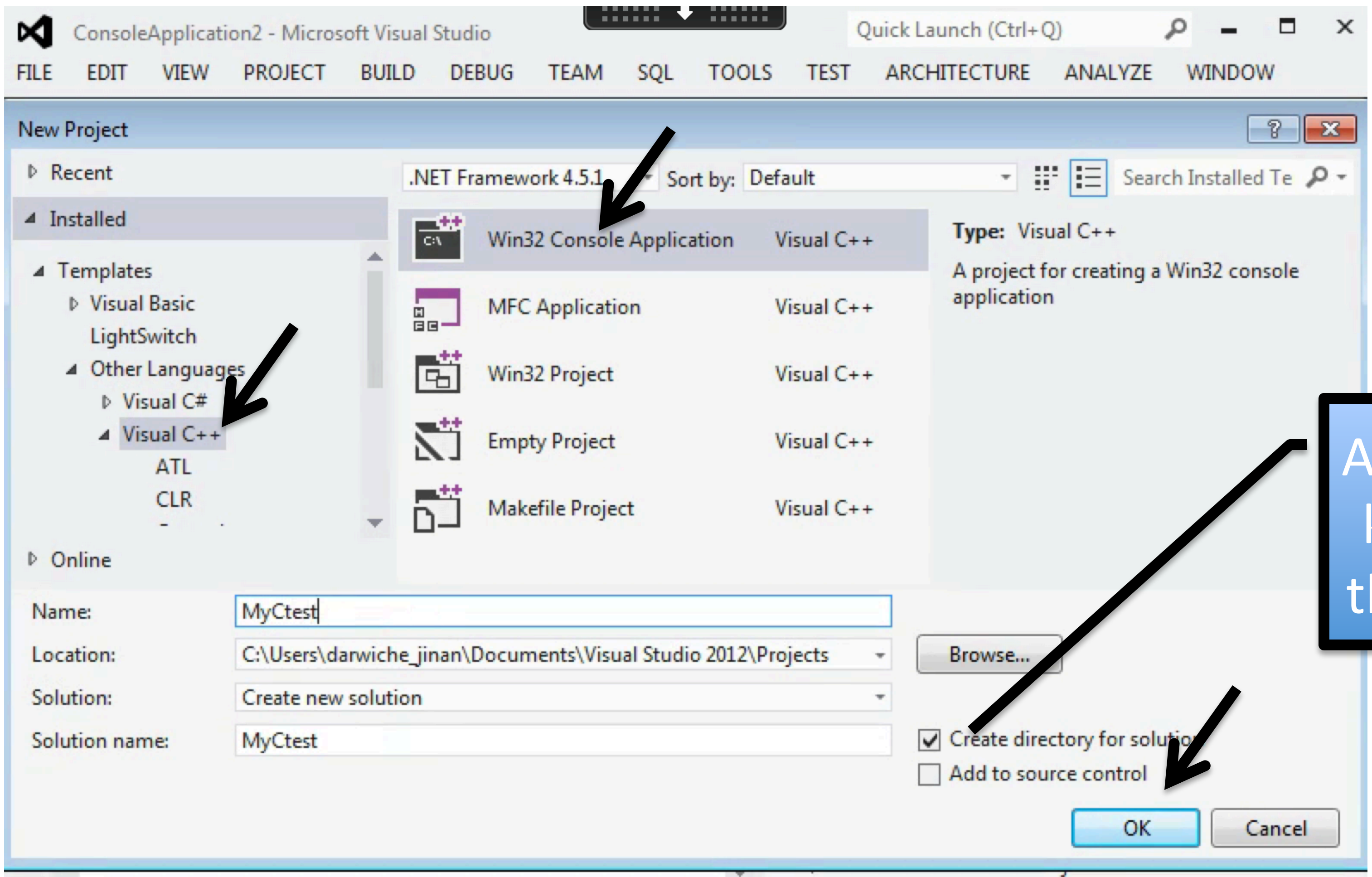
- **`assert`** is a macro
  - Header **`<cassert>`**
  - Tests value of an expression
    - If **`0`** (**`false`**) prints error message, calls **`abort`**
      - Terminates program, prints line number and file
      - Good for checking for illegal values
    - If **`1`** (**`true`**), program continues as normal
  - **`assert( x <= 10 );`**
- To remove **`assert`** statements
  - No need to delete them manually
  - **`#define NDEBUG`**
    - All subsequent **`assert`** statements ignored

This Is Important: Only C from now on

- Now that you are more comfortable with VS, and
- You know what the directives are
- Direct VS to accept only C code and not accept C++ code
- See next slide for details

From now on:
Only C

- To create new project, select Project New



ConsoleApplication2 - Microsoft Visual Studio

FILE EDIT VIEW PROJECT BUILD DEBUG TEAM SQL TOOLS TEST ARCHITECTURE ANALYZE WINDOW

New Project

.NET Framework 4.5.1 — Sort by: Default

Win32 Console Application	Visual C++
MFC Application	Visual C++
Win32 Project	Visual C++
Empty Project	Visual C++
Makefile Project	Visual C++

Type: Visual C++

A project for creating a Win32 console application

Name: MyCtest

Location: C:\Users\darwiche_jinan\Documents\Visual Studio 2012\Projects

Solution: Create new solution

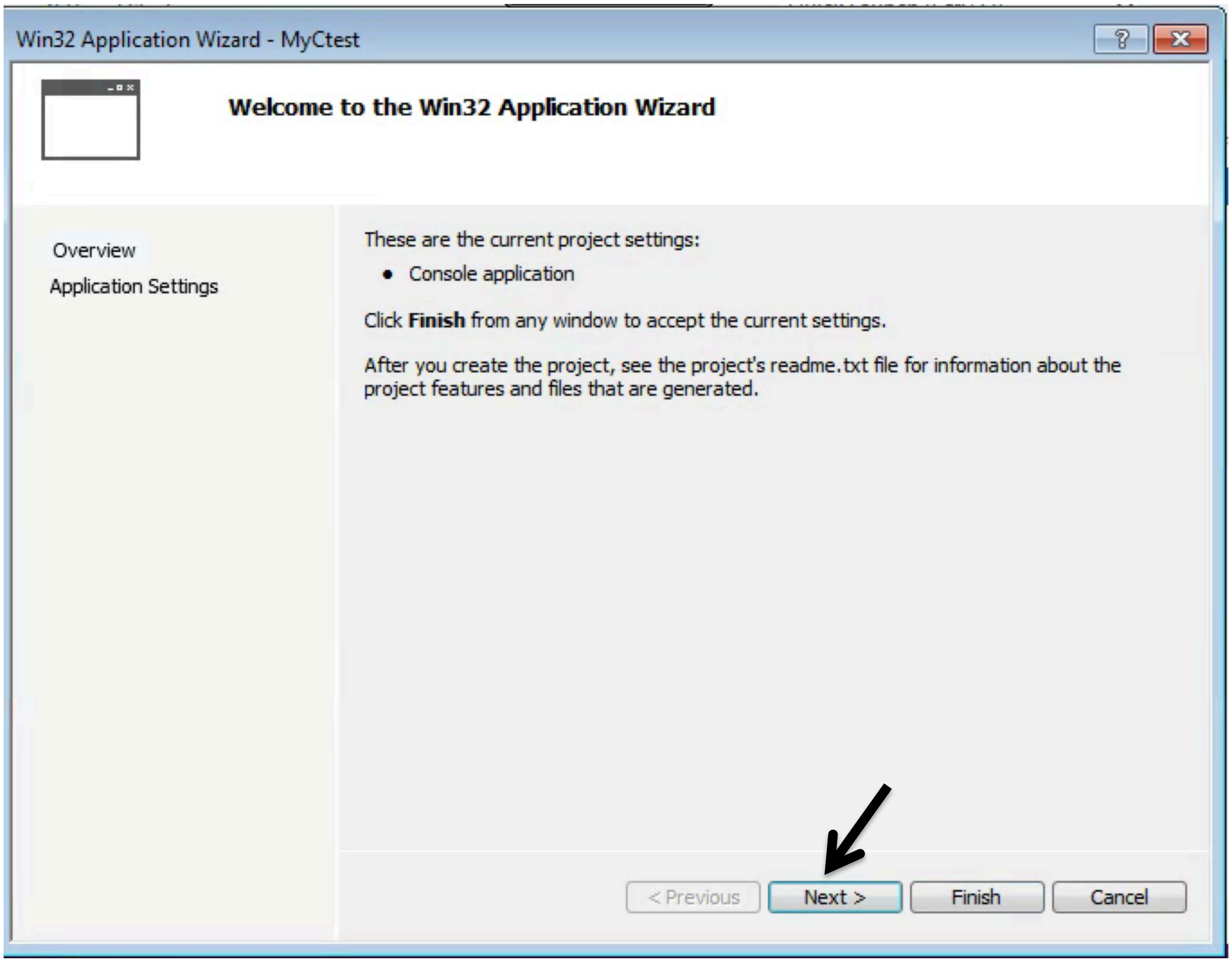
Solution name: MyCtest

☑ Create directory for solution

☐ Add to source control

Always keep this on

Next screen choose Next



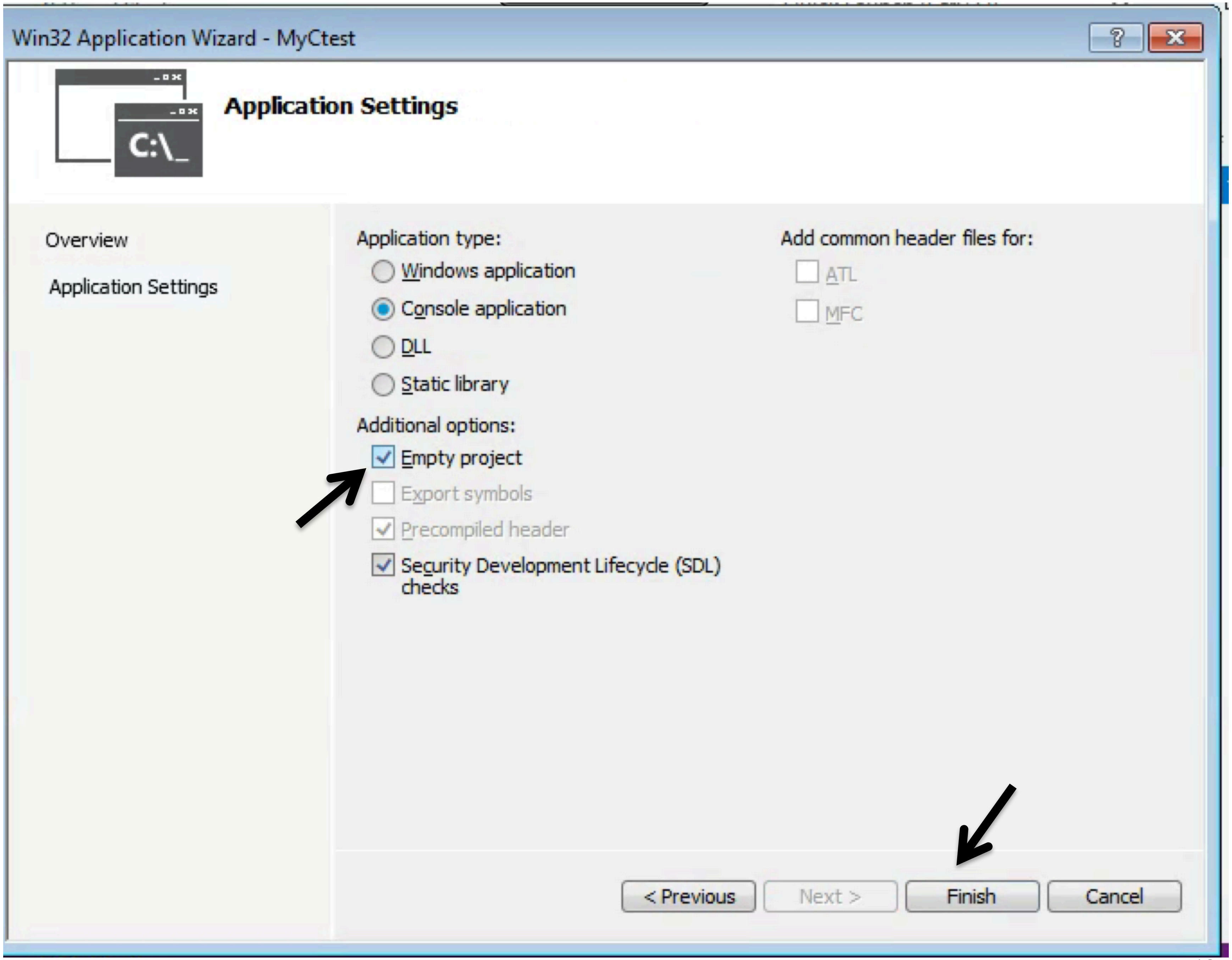
Welcome to the Win32 Application Wizard

These are the current project settings:

- Console application

Click **Finish** from any window to accept the current settings.

After you create the project, see the project's readme.txt file for information about the project features and files that are generated.



Win32 Application Wizard - MyCtest

Application Settings

Overview

Application Settings

Application type:

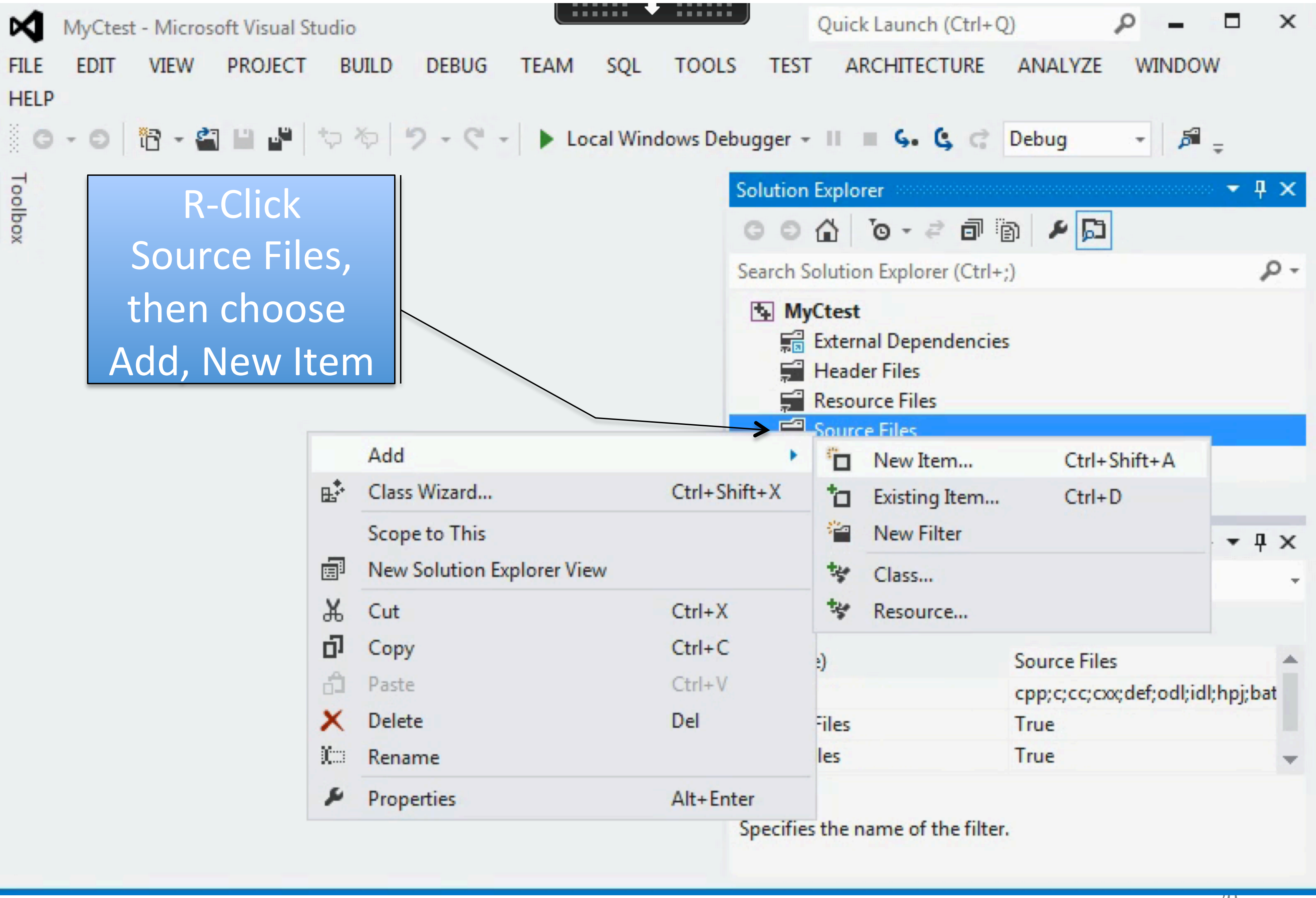
- ○ Windows application
- [✓ ● Console application]
- ○ DLL
- ○ Static library

Additional options:

- [✓] Empty project
- [ ] Export symbols
- [✓] Precompiled header
- [✓] Security Development Lifecycle (SDL) checks

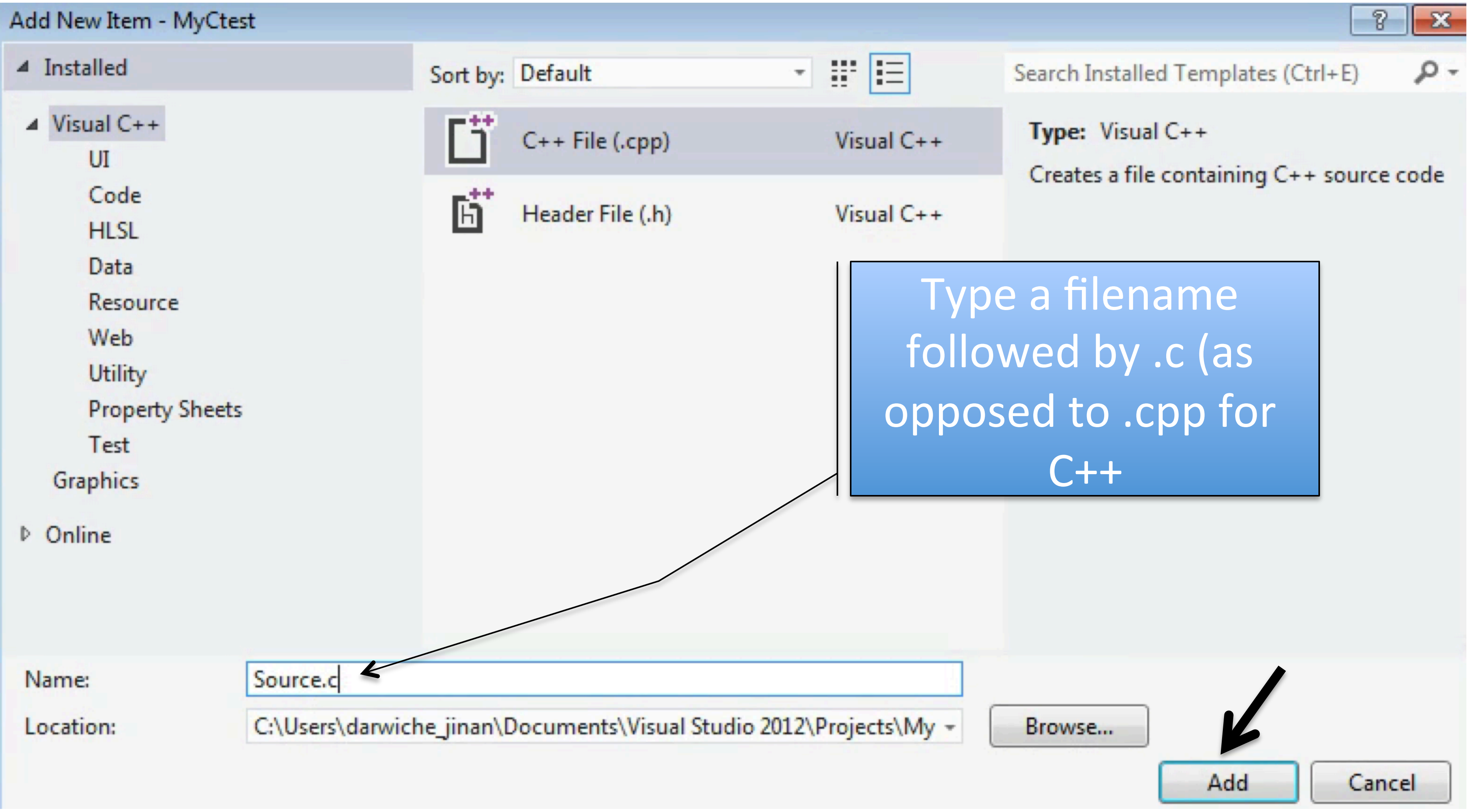
Add common header files for:

- [ ] ATL
- [ ] MFC



R-Click Source Files, then choose Add, New Item

Specifies the name of the filter.



Type: Visual C++

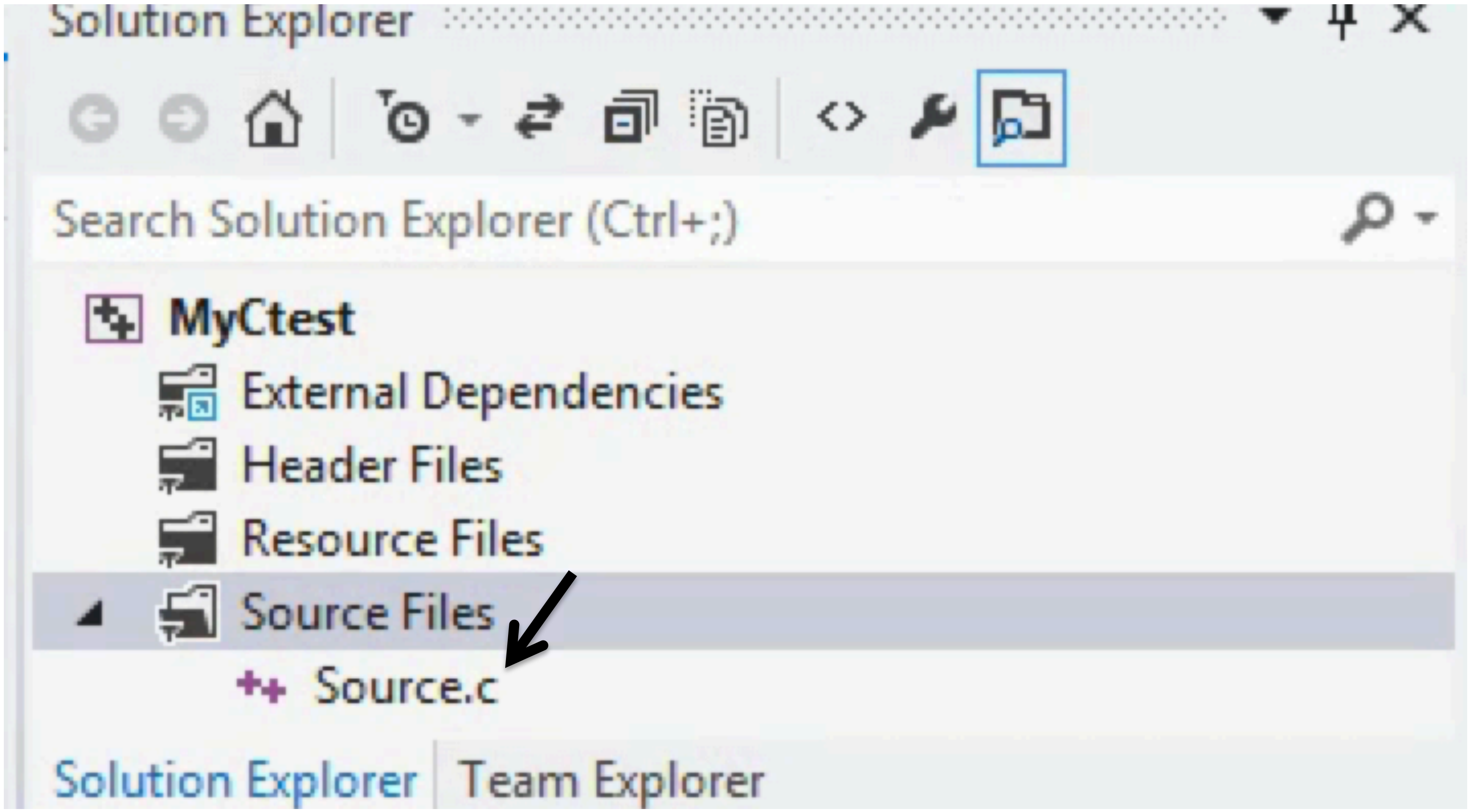
Creates a file containing C++ source code

Name: Source.c

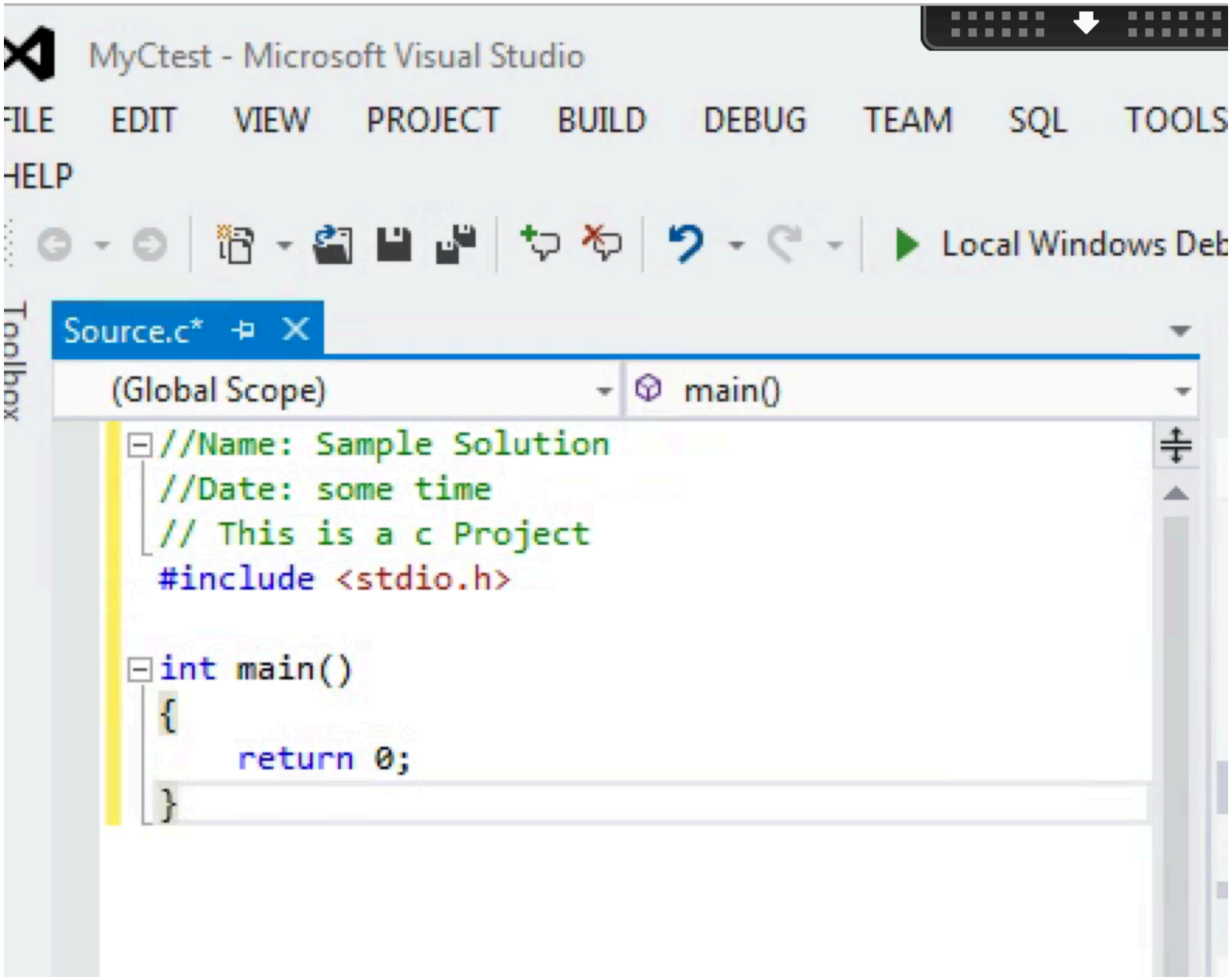
Location: C:\Users\darwiche_jinan\Documents\Visual Studio 2012\Projects\My

Type a filename followed by .c (as opposed to .cpp for C++

Note the Solution Explorer



Type C Code – Enjoy!


MyCtest - Microsoft Visual Studio
FILE EDIT VIEW PROJECT BUILD DEBUG TEAM SQL TOOLS
HELP
Local Windows Deb
Toolbox
Source.c*
(Global Scope)
main()

```c
//Name: Sample Solution
//Date: some time
// This is a c Project
#include <stdio.h>

int main()
{
    return 0;
}
```

Important:
Functions: Testing Strategy

- How do you test functions?
  - Test one function at a time
  - Display intermediate results
  - You may need to create test data to use via "driver programs"
  - If the function being tested calls other functions, create "stubs"
  - Try varying one thing at A time
    - If something goes wrong, you know what changed

Testing Strategy

- Drivers
  - allows you to test a function without the rest of a program
  - just to execute the function and show its results
  - often, provides a loop to retest the function on different arguments

Testing Strategy

- Stubs
  - simplified version of a function not written or tested yet
  - often used when testing another function
  - does not necessarily deliver correct values
  - works best when stubs are replaced by actual functions, one at a time

You Are Two

- Programmers think end users don’t know what they’re doing
- End users think programmers are disconnected from reality
- When you write code you are the programmer
- When you test code, you are the end user
- You need to please both of you; it’s not easy, but good things don’t come easy

Driver Demo!

```
/* In this scenario, we are developing a hard-working
function that determines if a certain year is a leap
year.  It returns, following the C convention, an int.
   Returning 0 will mean false.  Returning 1 will be
true.
 */
int leapYear( int year );
int main( ) {
        /*  Driver code will want to call the function
many times, with lots of different data to validate that
it is
           working correctly…  */

        printf( "leapYear( 2000 ) = %d\n", leapYear( 2000 ) );
        printf( "leapYear( 1900 ) = %d\n", leapYear( 1900 ) );
        printf( "leapYear( 1950 ) = %d\n", leapYear( 1950 ) );
        printf( "leapYear( 1999 ) = %d\n", leapYear( 1999 ) );
        printf( "leapYear( 2001 ) = %d\n", leapYear( 2001 ) );
        printf( "leapYear( 2004 ) = %d\n", leapYear( 2004 ) );
        return( 0 );
}
/*  Here is the function. You might notice some
bugs....  */
int leapYear( int year ) {
  int isTrue = 1;
  int isFalse = 0;
  int result = isFalse;

  if (year % 4 == 0) {
          result = isTrue;
  }

  return( result );
}
```

Summarizing Driver Demo!

- Drivers Are Throwaway Code Meant To Exercise Other Code
- Stubs Are Fake StandIns For Code That Will Be Fleshed Out Later
- Make sure to clean up before shipping (submitting) your assigned work

Summary

- Focus on:
  Preprocessor,
  C only,
  Testing Strategy