Computer System Programming

Introduction

Acknowledging : note that some lecture contents are courtesy of Prof. Ozgur Sinanoglu and Prof. Michail Maniatakos
online C++ learning open sources

Overview

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- Course aims and outline
- The Importance of computer programming
- A simple computer program “Hello, World!”

The Aims

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Teach/learn

- Fundamental programming concepts
- Key useful techniques
- Basic Standard C++ facilities

After the course, you'll be able to

- Write small C++ programs
- Read much larger programs
- Learn the basics of many other languages by yourself
- Proceed with an "advanced" C++ programming course

After the course, you will not (yet) be

- An expert programmer
- A C++ language expert
- An expert user of advanced libraries

Course Format

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- Lectures and Labs
- Three Programming assignments
- One Midterm Exam
- One Final Exam

Course Schedule

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Week	Lecture Topic	Project	Exam Schedule
1	1. Introduction to computer systems 2.Basics for computer programming • 2.1 Data Types and Variables • 2.2 Operators • 2.3 Data input and output • 2.4 Statements and flow control		
2	3.Functions • 3.1 Defining a Function • 3.2 Call a Function • 3.3 Inline Function • 3.4 Overloading Function	Project 1	
3	3.Functions • 3.4 Defining a Function • 3.5 Function templates		
4	4. Arrays, Strings and Pointers • 4.1 Arrays • 4.2 Strings • 4.3 Pointers	Project 2	Midterm
5	5. C++ Object Oriented Programming • 5.1 Classes and Objects		
6	5. C++ Object Oriented • 5.2 Inheritance • 5.3 Polymorphism	Project3	
7	6. C++ Files and Streams		Final Exam

Grading

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- Programming assignments: 30% (10% each)
- Midterm: 30% (Paper and computer based)
- Final: 40% (Paper and computer based)

Importance of programming

- Our civilization runs on software
  - Most engineering activities involve software
- Examples:
  - Ships (Monitoring, engine, hull pumps etc.)
  - Aircrafts (Signal processing, gadget control etc.)
  - Energy (Communications, visualization, etc.)
  - Social Media, Facebook, twitter and so on

Let’s get started !

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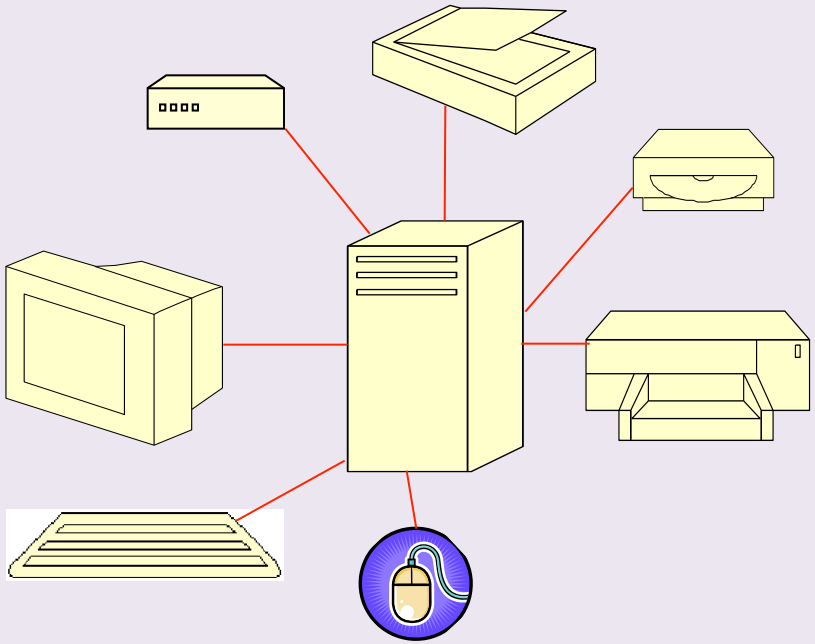
- We will first learn how a computer operates.

A computer system



- A computer system is composed of:
  - a monitor,
  - a keyboard,
  - a mouse,
  - and a case (that contains several controlling components such as processor and alike),
  - and also other peripherals like
    - CD player (might have been included in the case),
    - printer,
    - scanner,
    - modem,
    - etc.
- all connected together

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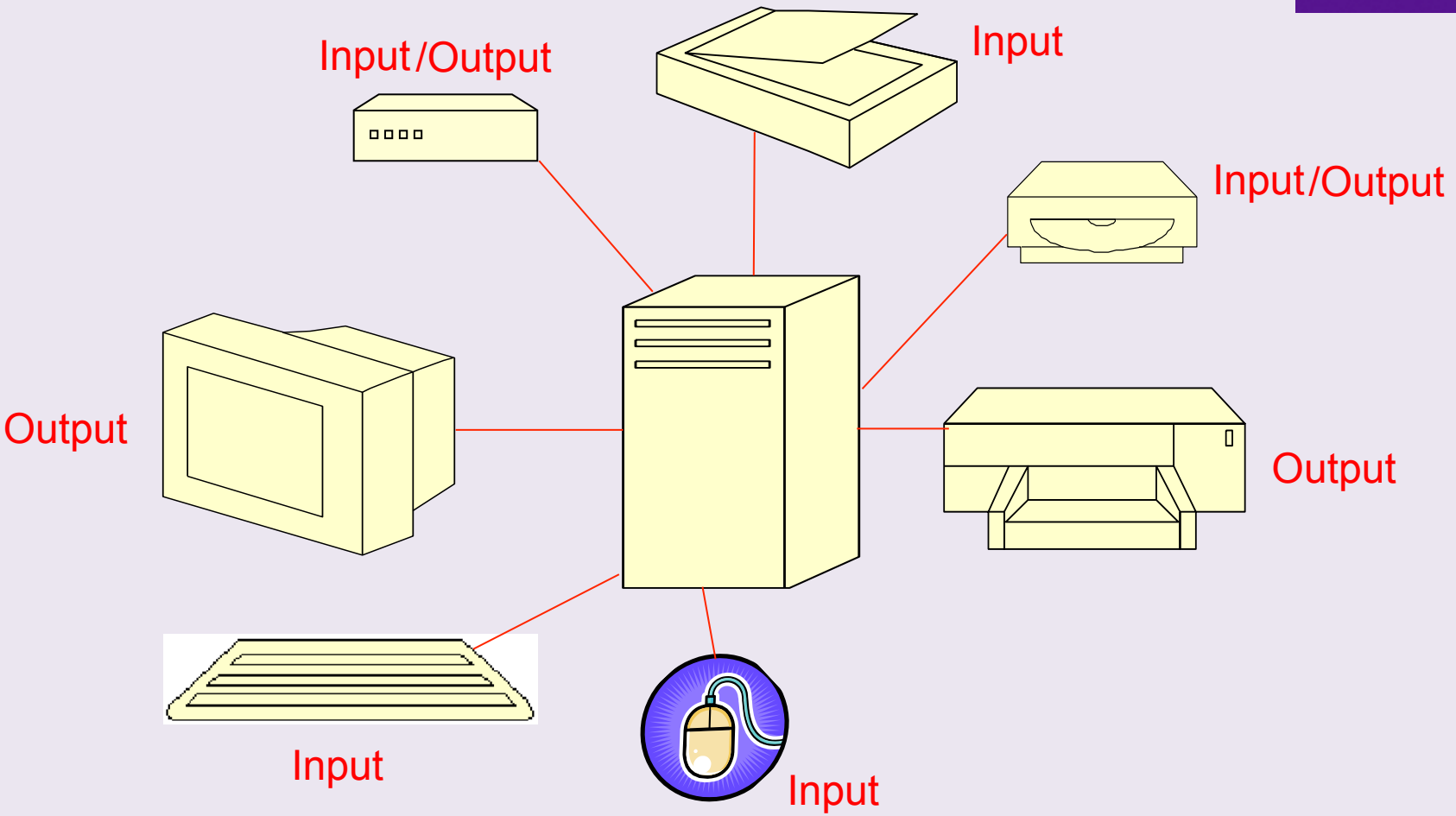
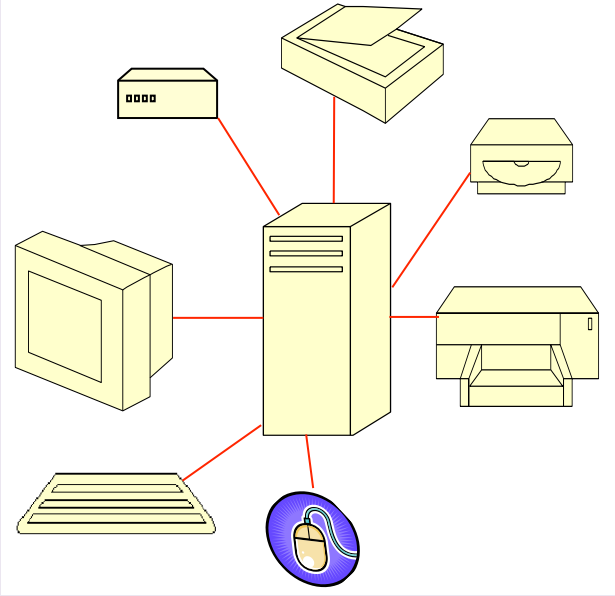
Input and output devices



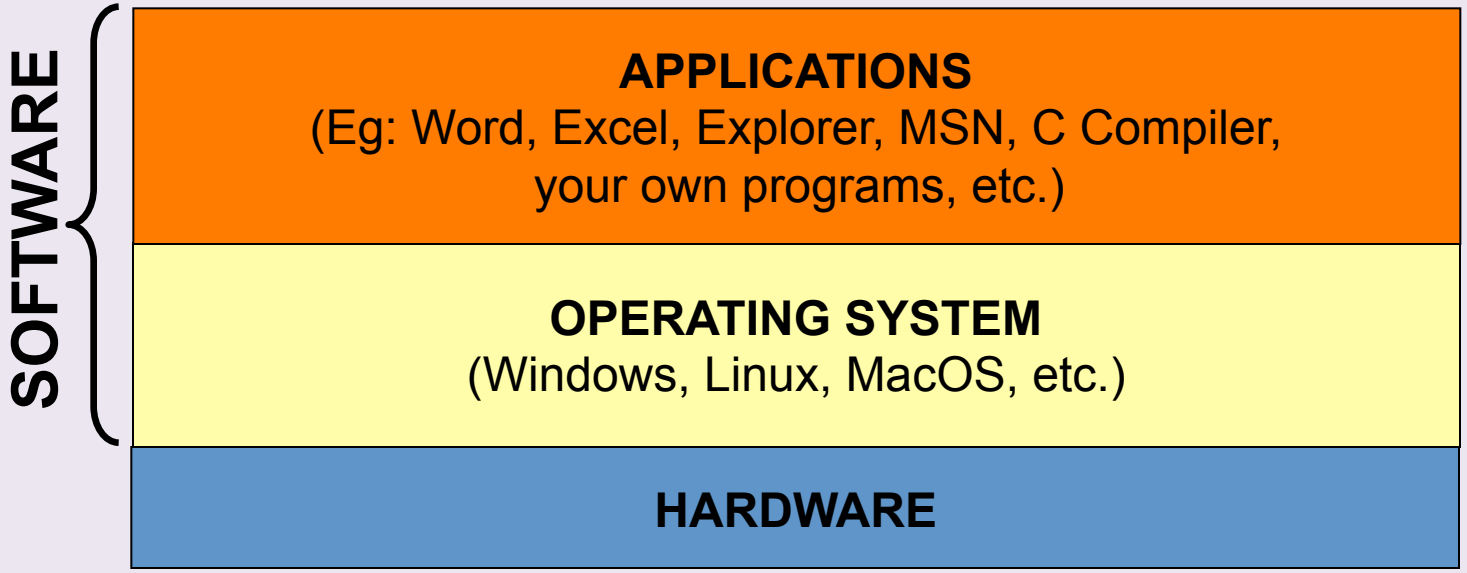
A computer system

- Note that everything could be packed in a single box, but the concepts are the same.



A computer system

- Everything we had in the previous slide is hardware.
  - i.e., physical components that implement what is requested by the software.



A computer system

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- In this course, we will learn how to develop our own software (using C++ language), but we need to understand how our programs will be executed by the hardware.

CPU: Central Processing Unit

- In terms of hardware, what is important for us is the CPU.
- It does all processing and control.
  - Everything is controlled and executed by the CPU.

CPU: Central Processing Unit

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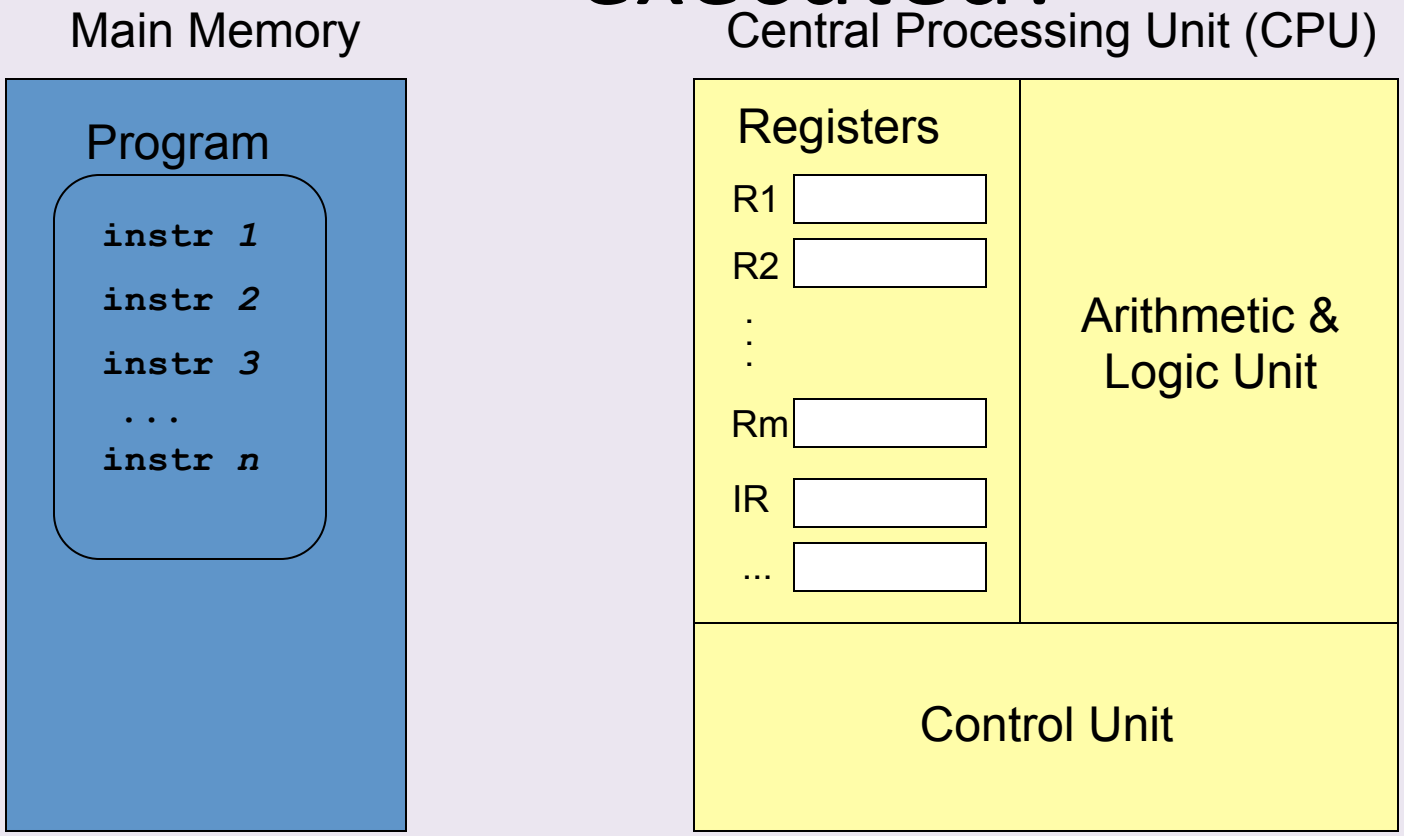
How are the instructions executed?



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How do we write programs?

We write our programs in *"C++ language"* (which is an English-like language)

```
#include <iostream>
int main()
{
    cout << "Hello world!";
    return 0;
}
```

(source code)

We use a compiler (such as GCC, Visual C++, etc.) to translate our program from "C++ language" to *"machine language"*

Compile & Link

```
11101010110010010100
01010100101000010000
10100101010100100010
10010001001010010
```

(object code)

This is the executable code in "machine language."

This is the only thing the computer can understand and run (execute).

(machine code or executable code)

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Statement vs. Instruction

- Our source code (in C++) is composed of statements.
  - Eg: a=b+c/2;
- The corresponding machine code is composed of instructions.
  - Eg: 1101001010110010 (divide c by 2)
  - 0110100100100101 (add it to b)
  - 1010110110111011 (put the result in a)
  - CPU is capable of executing instructions, not statements. Statements may be too complex.
  - Compiler implements each statement using several instructions.
    - Eg: The statement "a=b+c/2;" can be implemented as
      - » temp1 = c/2
      - » a = b + temp1

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Why have input/output?

- A program should not always produce the same output.
  - O/w, you may keep the result and delete the program after you run it for the first time.
- A program should be consistent; i.e., it should not produce random results.
- Therefore, a program should take some input, process it, and produce some output as the result of that input.

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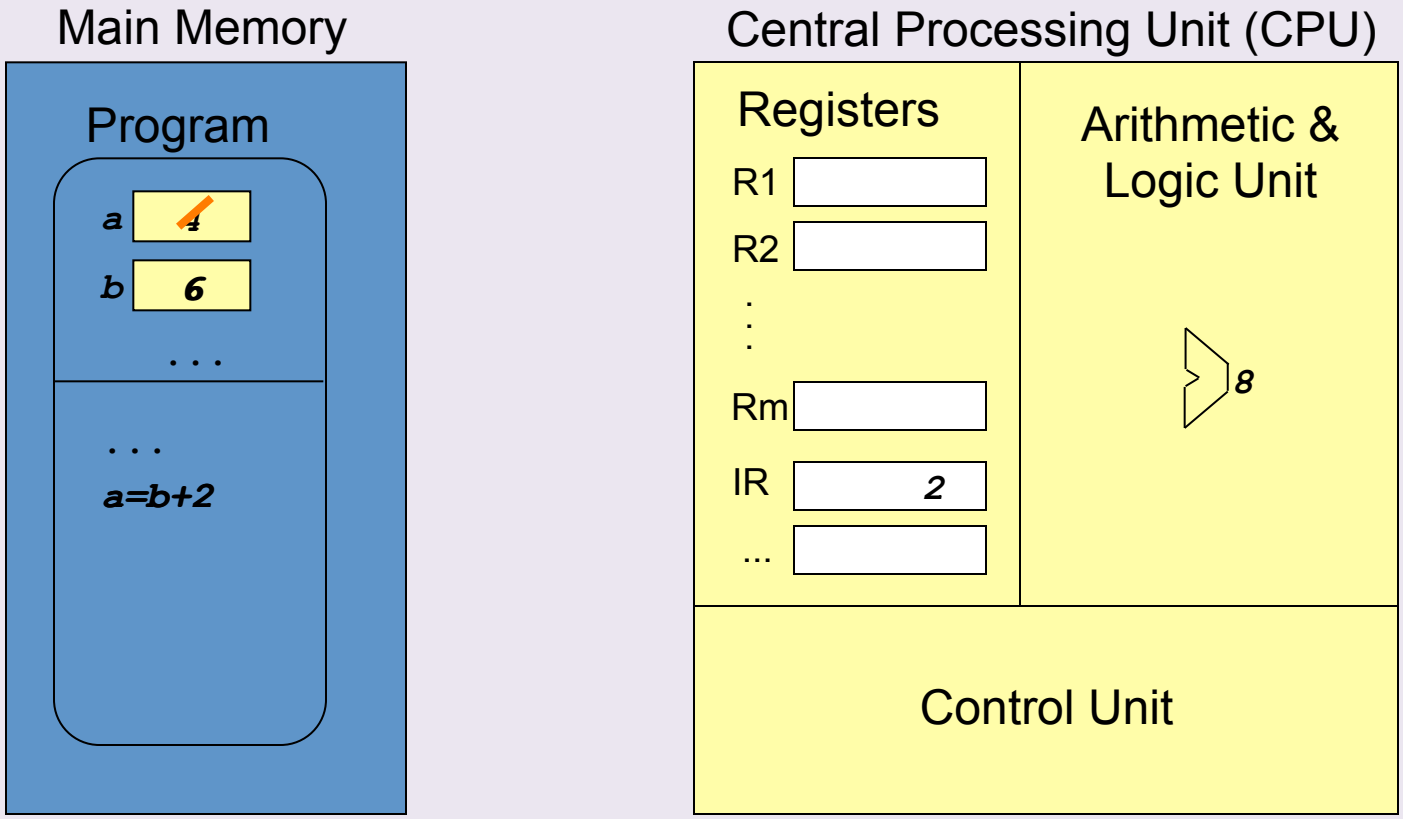
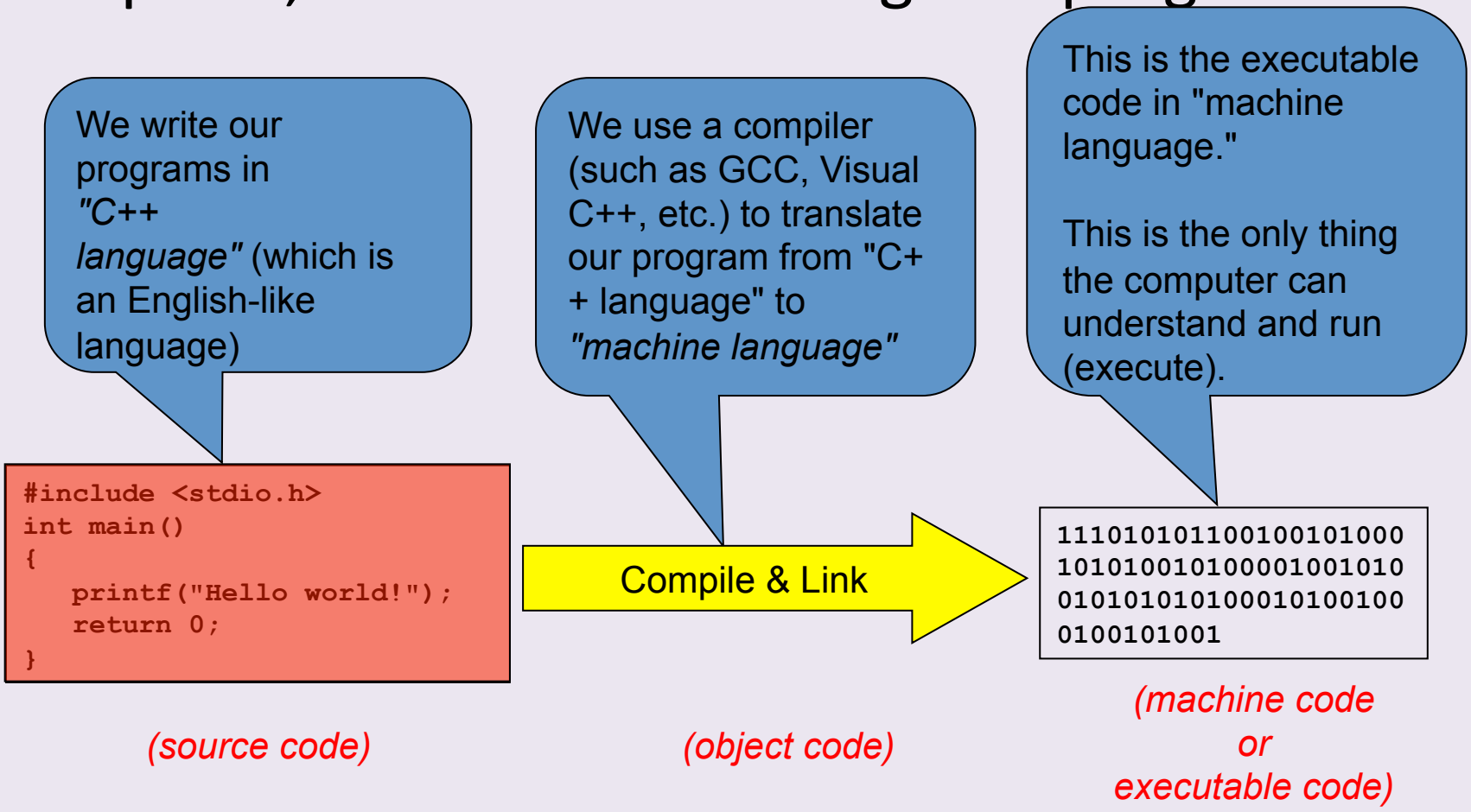
Execution of an instruction

- Let's see how an instruction like "a=b+2" is executed.
  - Assume initially a is 4 and b is 6.



Welcome to C++ Programming Language

- Now that we have an overall understanding of the computer, we can start writing C++ programs.



A first program – just the guts…

```
// …

int main()                              // main() is where a C++ program starts
{
    cout << "Hello, world!\n";          // output the 13 characters  Hello, world!
                                        // followed by a new line
    return 0;                           // return a value indicating success
}

// quotes delimit a string literal
// NOTE: "smart" quotes “   ”  will cause compiler problems.
//          so make sure your quotes are of the style  " "
// \n is a notation for a new line
```

A first program – complete

```
// a first program:

#include "../../std_lib_facilities.h" // get the library facilities needed for now

int main()                            // main() is where a C++ program starts
{
    cout << "Hello, world!\n";        // output the 13 characters  Hello, world!
                                      // followed by a new line
    return 0;                         // return a value indicating success
}

    // note the semicolons; they terminate statements
    // curly brackets { … } group statements into a block
    // main( ) is a function that takes no arguments ( )
    //      and returns an int (integer value) to indicate success or failure
```

A second program

```
// modified for Windows console mode:

#include "../../std_lib_facilities.h" // get the facilities for this course

int main()                            // main() is where a C++ program starts
{
    cout << "Hello, world\n";         // output the 13 characters  hello, world!
                                      // followed by a new line
    keep_window_open();               // wait for a keystroke
    return 0;                         // return a value indicating success
}

// without keep_window_open() the output window will be closed immediately
// before you have a chance to read the output (on Visual C++ 2010)
```

Hello, world!

- "Hello world" is a very important program
  - Its purpose is to help you get used to your tools
    - Compiler
    - Program development environment
    - Program execution environment
  - Type in the program carefully
    - After you get it to work, please make a few mistakes to see how the tools respond; for example
      - Forget the header
      - Forget to terminate the string
      - Misspell return (e.g. retrun)
      - Forget a semicolon
      - Forget { or }
      - …

Hello world

- It's almost all "boiler plate"
  - Only cout << "Hello, world!\n" directly does anything
- That's normal
  - Most of our code, and most of the systems we use simply exist to make some other code elegant and/or efficient
  - "real world" non-software analogies abound
- "Boiler plate," that is, notation, libraries, and other support is what makes our code simple, comprehensible, trustworthy, and efficient.
  - Would you rather write 1,000,000 lines of machine code?
- This implies that we should not just "get things done"; we should take great care that things are done elegantly, correctly, and in ways that ease the creation of more/other software:
  - Style Matters!

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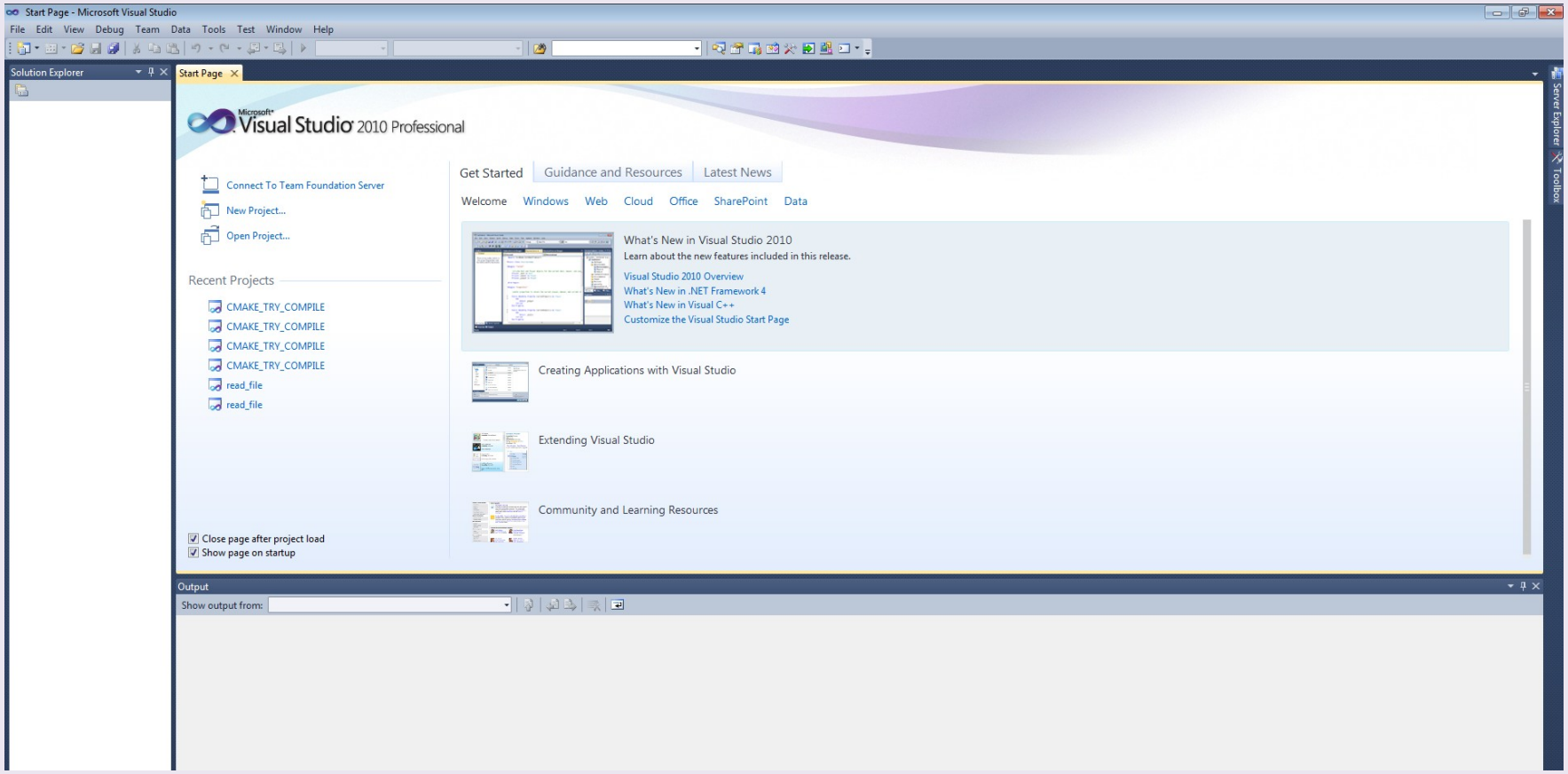
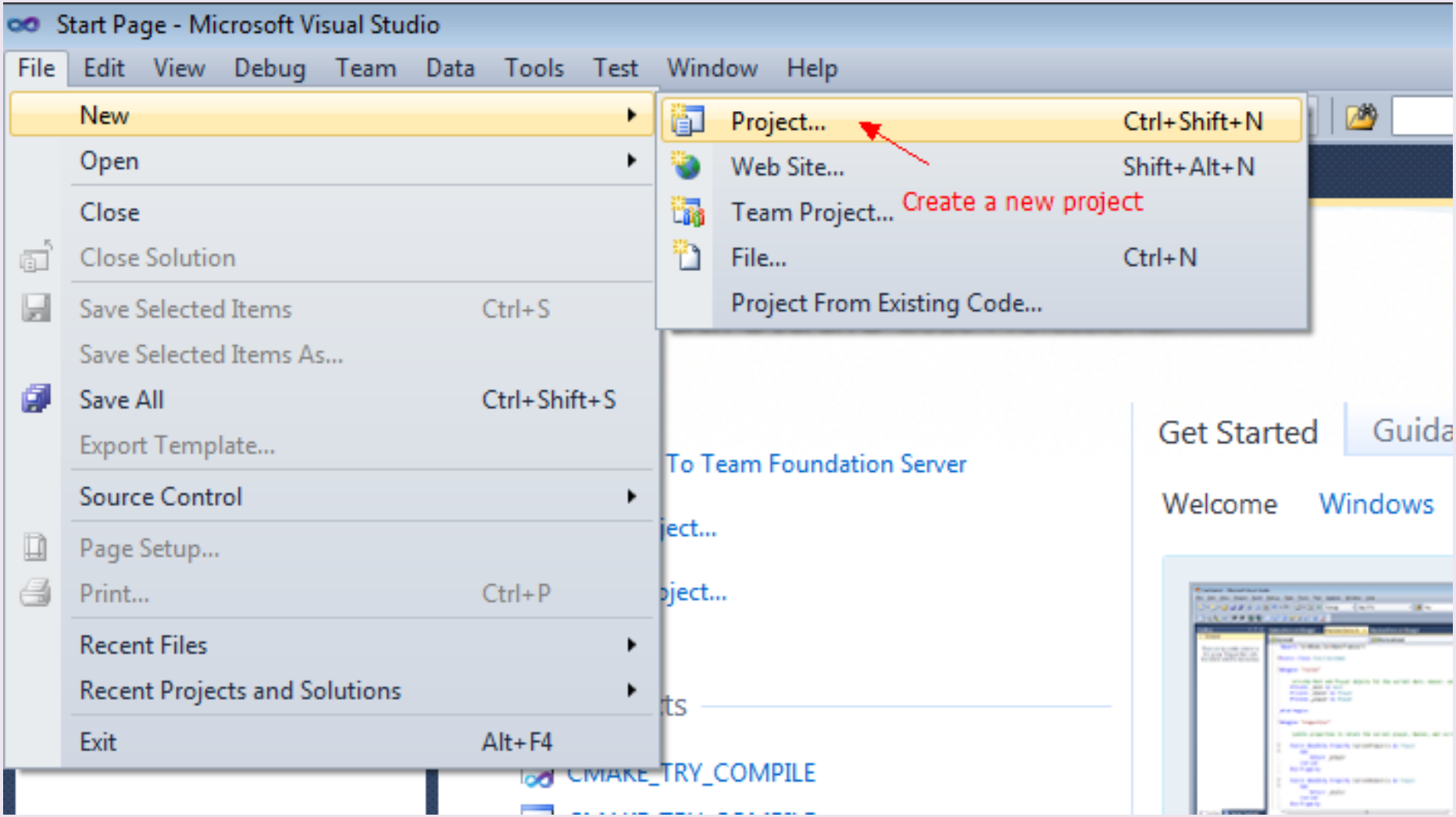
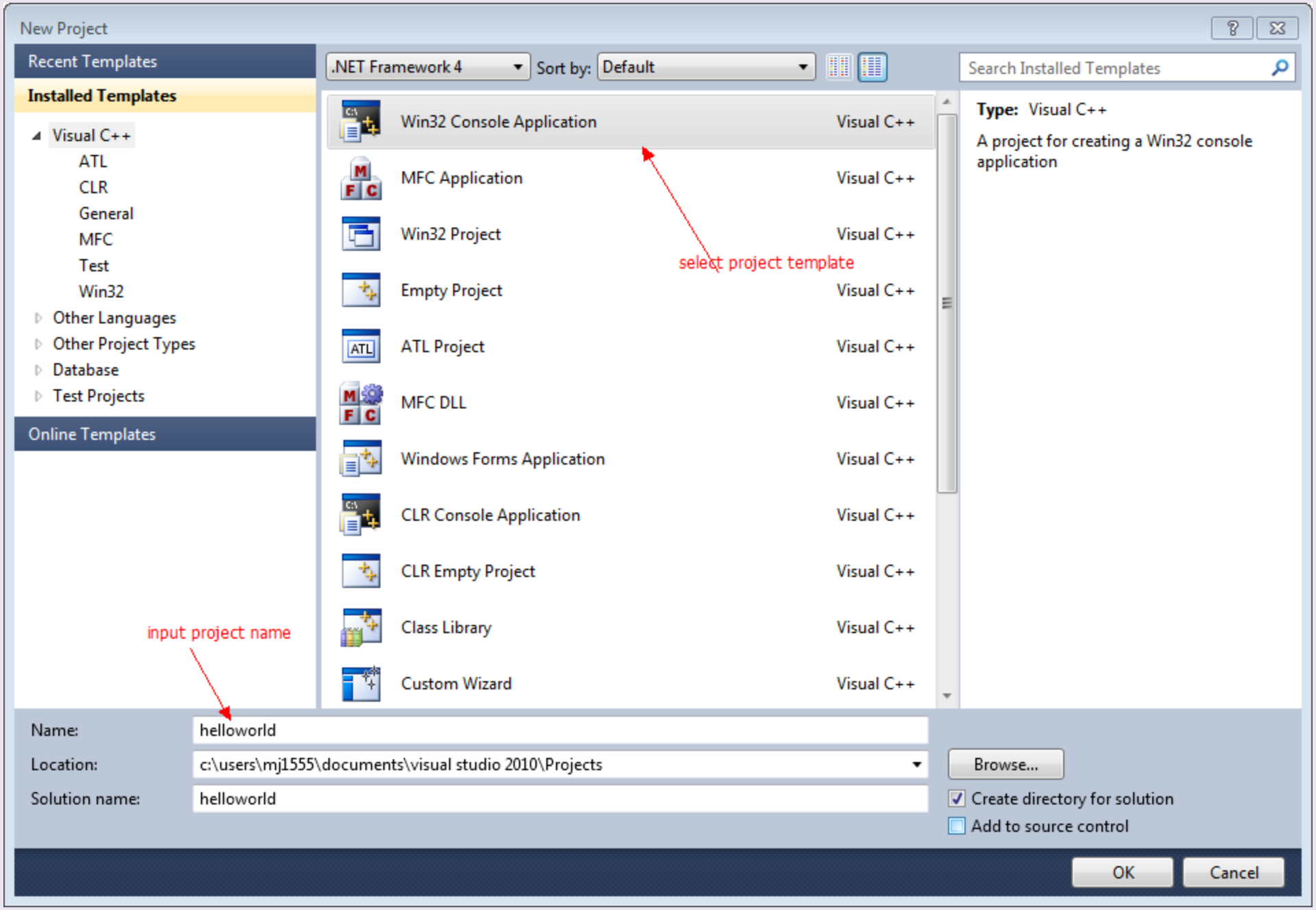
How to set up “hello world” in Visual Studio 2010

Open Visual Studio



Create a new project




New Project
Recent Templates
Installed Templates
Visual C++
ATL
CLR
General
MFC
Test
Win32
Other Languages
Other Project Types
Database
Test Projects
Online Templates
.NET Framework 4
Sort by:
Default
Search Installed Templates
Win32 Console Application
Visual C++
MFC Application
Visual C++
Win32 Project
Visual C++
Empty Project
Visual C++
ATL Project
Visual C++
MFC DLL
Visual C++
Windows Forms Application
Visual C++
CLR Console Application
Visual C++
CLR Empty Project
Visual C++
Class Library
Visual C++
Custom Wizard
Visual C++
select project template
Type: Visual C++
A project for creating a Win32 console application
input project name
Name:
helloworld
Location:
c:\users\mj1555\documents\visual studio 2010\Projects
Browse...
Solution name:
helloworld
Create directory for solution
Add to source control
OK
Cancel

Welcome to the Win32 Application Wizard

Overview

Application Settings

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.

next

< Previous | Next > | Finish | Cancel

Application Settings

Overview

Application Settings

Application type:

- Windows application
- Console application
- DLL
- Static library

Add common header files for:

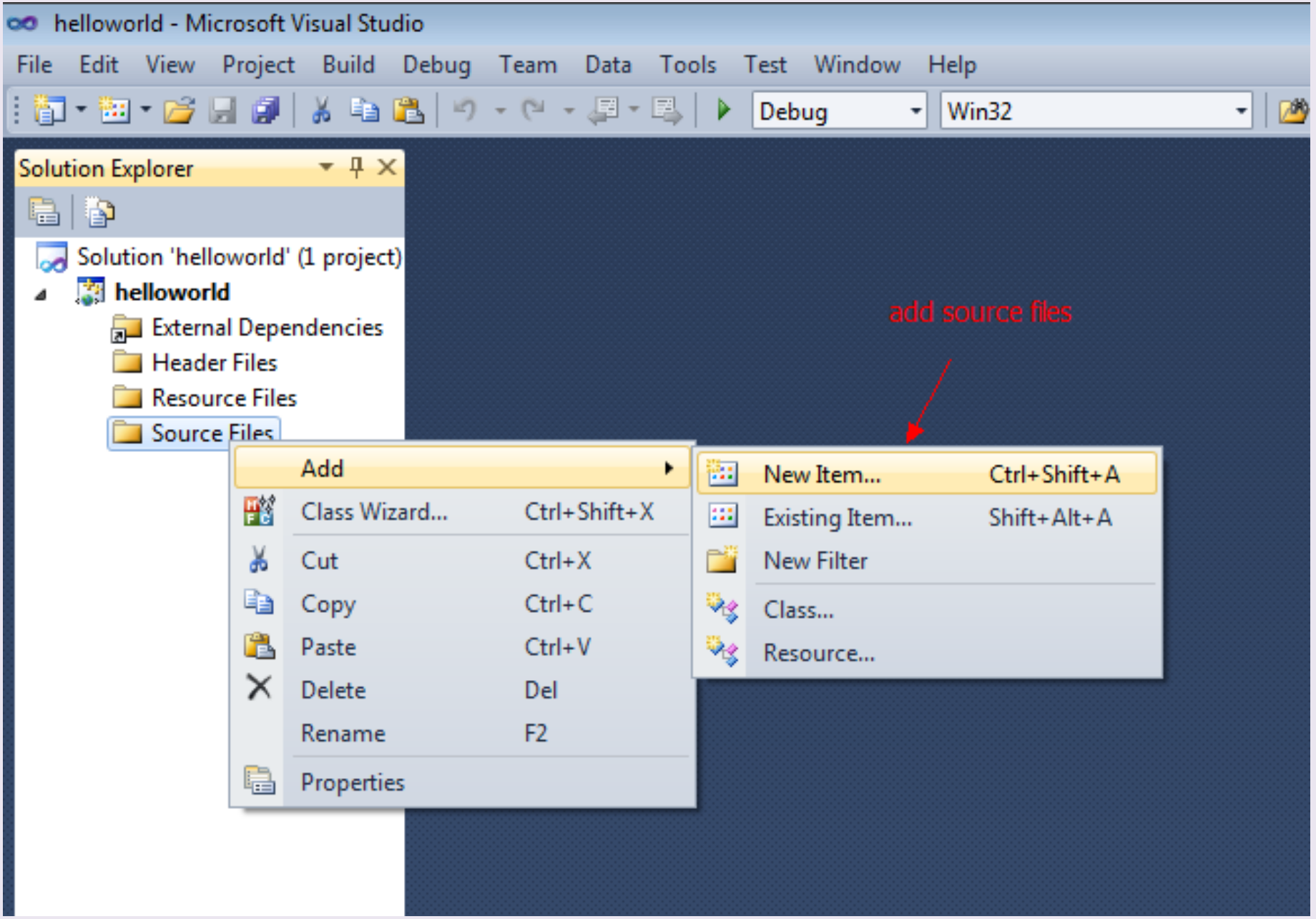
- ATL
- MFC

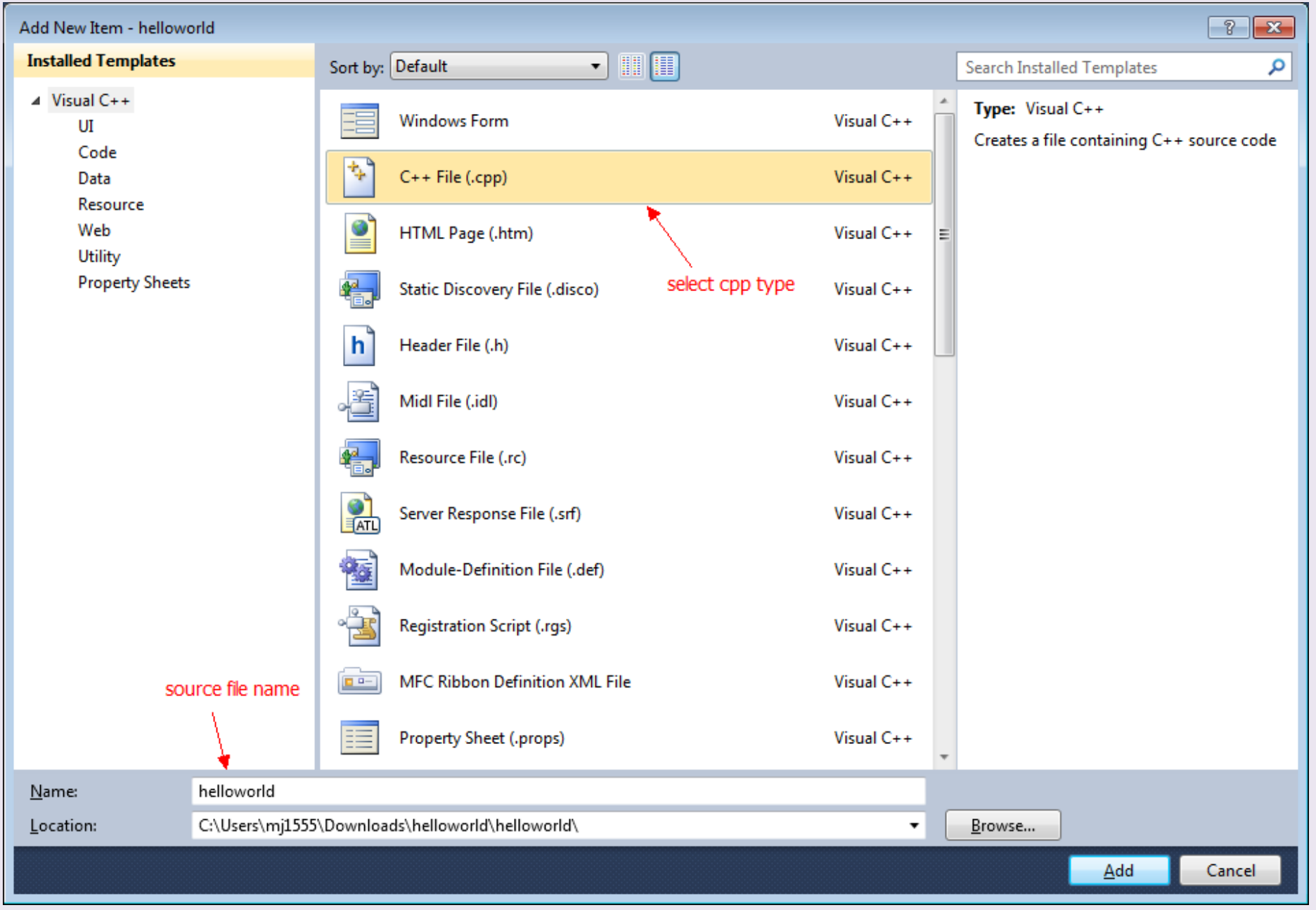
Additional options:

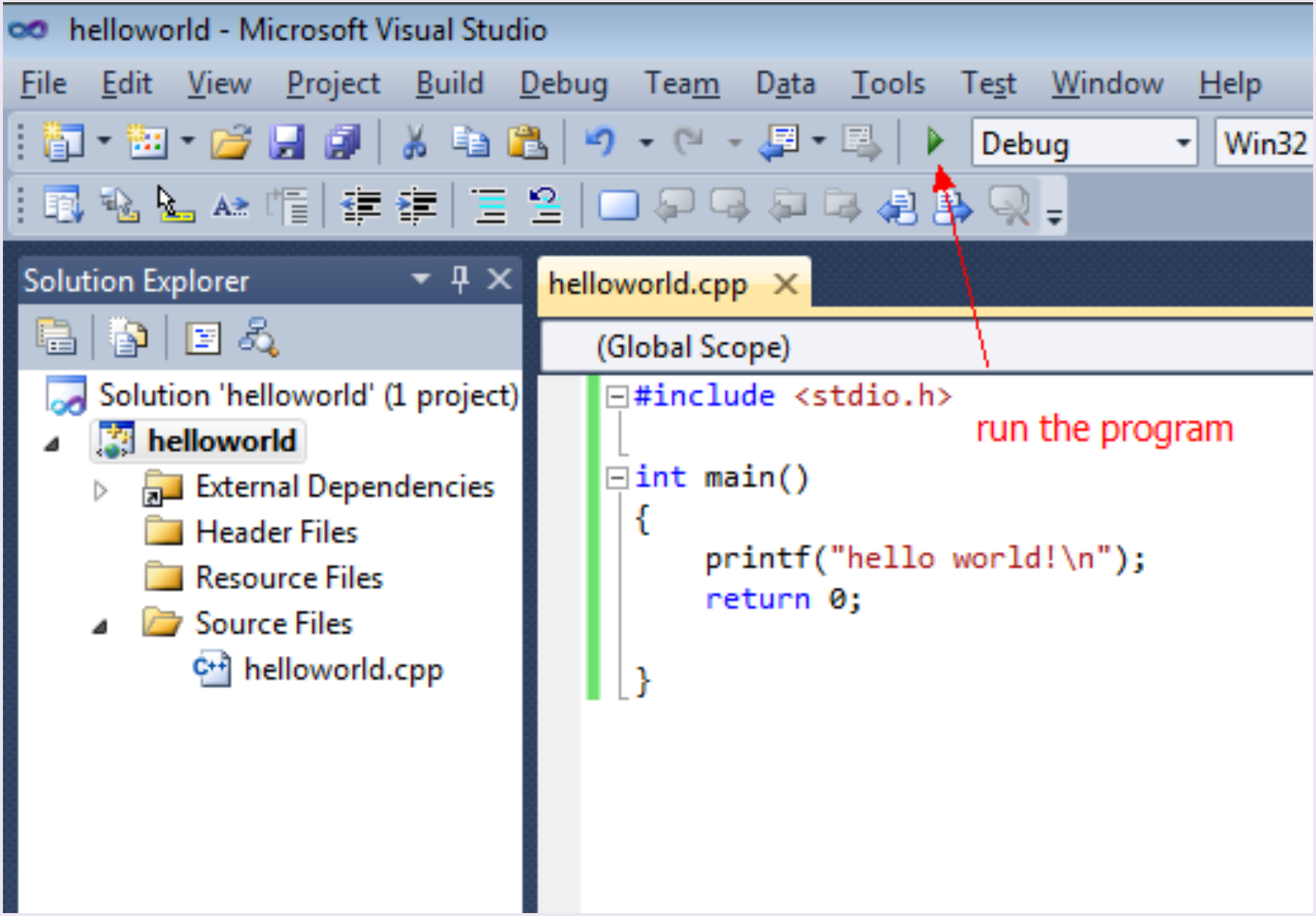
- Empty project
- Export symbols
- Precompiled header

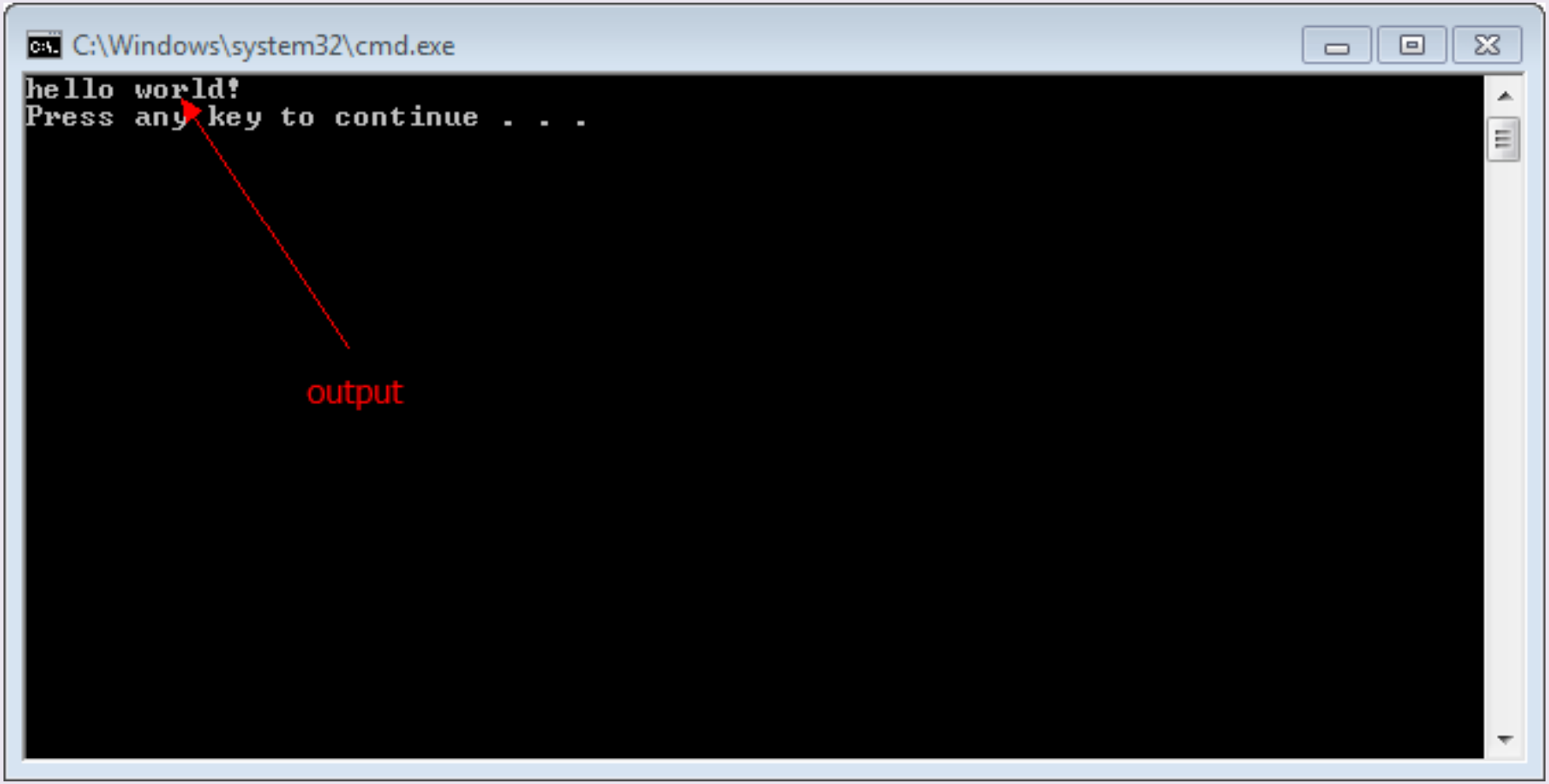
select empty project

< Previous | Next > | Finish | Cancel


helloworld - Microsoft Visual Studio
File Edit View Project Build Debug Team Data Tools Test Window Help
Debug
Win32
Solution Explorer
Solution 'helloworld' (1 project)
helloworld
External Dependencies
Header Files
Resource Files
Source Files
add source files
Add
Class Wizard... Ctrl+Shift+X
Cut Ctrl+X
Copy Ctrl+C
Paste Ctrl+V
Delete Del
Rename F2
Properties
New Item... Ctrl+Shift+A
Existing Item... Shift+Alt+A
New Filter
Class...
Resource...


Add New Item - helloworld
Installed Templates
Visual C++
UI
Code
Data
Resource
Web
Utility
Property Sheets
Sort by: Default
Search Installed Templates
Windows Form Visual C++
C++ File (.cpp) Visual C++
HTML Page (.htm) Visual C++
Static Discovery File (.disco) Visual C++
Header File (.h) Visual C++
Midl File (.idl) Visual C++
Resource File (.rc) Visual C++
Server Response File (.srf) Visual C++
Module-Definition File (.def) Visual C++
Registration Script (.rgs) Visual C++
MFC Ribbon Definition XML File Visual C++
Property Sheet (.props) Visual C++
select cpp type
Type: Visual C++
Creates a file containing C++ source code
source file name
Name: helloworld
Location: C:\Users\mj1555\Downloads\helloworld\helloworld\
Browse...
Add
Cancel


helloworld - Microsoft Visual Studio
File Edit View Project Build Debug Team Data Tools Test Window Help
Debug
Win32
Solution Explorer
Solution 'helloworld' (1 project)
helloworld
External Dependencies
Header Files
Resource Files
Source Files
helloworld.cpp
helloworld.cpp
(Global Scope)
#include <stdio.h>
int main()
{
printf("hello world!\n");
return 0;
}
run the program


C:\Windows\system32\cmd.exe
hello world!
Press any key to continue . . .
output

The next lecture

- We will take about Data Types and Variables, Operators, Data input and output