C++: A simple program

Outline

- Source Code
- Compiling and Running (no IDE)
- Debugging (no IDE)
- IDE and compiler interaction
- Compiling, Running and Debugging with IDE

Source Code – hello.cpp

```
// a small C++ program
#include <iostream>

int main()
{
    std::cout << "Hello, world!" << std::endl;
    return 0;
}
```

Something Different– header files

- Python and Java
  - classes are all in 1 file
  - import statements used to include references to classes from libraries
- C++
  - classes are in 2 files (.cpp and .h)
  - Include files reference a library (or object file)- linker includes it in executable
- C++ is more difficult to use in this respect

```
import matplotlib.pyplot as plt
```

```
import java.lang.String;
```

```
#include <string>
```

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Compilers

- see https://en.wikipedia.org/wiki/List_of_compilers#C.2B.2B_compilers

Compiler	Author	Windows	Unix-like	Other OSs	License type	IDE?	Standard conformance		
							C++11	C++14	C++17
C++Builder	Embarcadero (CodeGear)	Yes	OS X, iOS[2]	No	Proprietary	Yes	Yes/No (Supported via Clang.[3])	Yes/No	Yes/No
Turbo C++ Explorer	Embarcadero (CodeGear)	Yes	No	No	Freeware	Yes	?	?	?
C++ Compiler	Embarcadero (CodeGear)	Yes	No	No	Freeware	No	?	?	?
CINT	CERN	Yes	Yes	BeBox, DOS, Convex, etc.	X11/MIT	Yes	?	?	?
Borland C++	Borland (CodeGear)	Yes	No	DOS	Proprietary	Yes	No	No	No
Turbo C++ for DOS	Borland (CodeGear)	No	No	DOS	Proprietary	Yes	No	No	No
Clang	LLVM Project	Yes	Yes	Yes	BSD-like	Xcode, QtCreator (optional)	Yes	Yes	Partial
CodeWarrior	Metrowerks	Yes	Yes	Yes	Freeware	Yes	?	?	?
Comeau C/C++	Comeau Computing	Yes	Yes	Yes	Proprietary	No	No	No	No
CoSy compiler development system	ACE Associated Compiler Experts	Yes	Yes	No	Proprietary	No	?	?	?
Digital Mars	Digital Mars	Yes	No	DOS	Proprietary	No	?	?	?
EDGE ARM C/C++	Mentor Graphics	Yes	Yes	Yes	Proprietary	Yes	?	?	?
Edison Design Group	Edison Design Group	Yes	Yes	Yes	Proprietary	No	Yes	Yes	Partial
GCC	GNU Project	MinGW, Cygwin	Yes	Yes	GPLv3	QtCreator, Kdevelop, Eclipse, NetBeans, Code::Blocks, Geany	Yes[4]	Yes	Yes
Visual C++	Microsoft	Yes	can target Linux, OS X, Android and iOS (since VS 2015)	No	Proprietary	Yes	Yes[5]	Yes	Incomplete

Getting a compiler

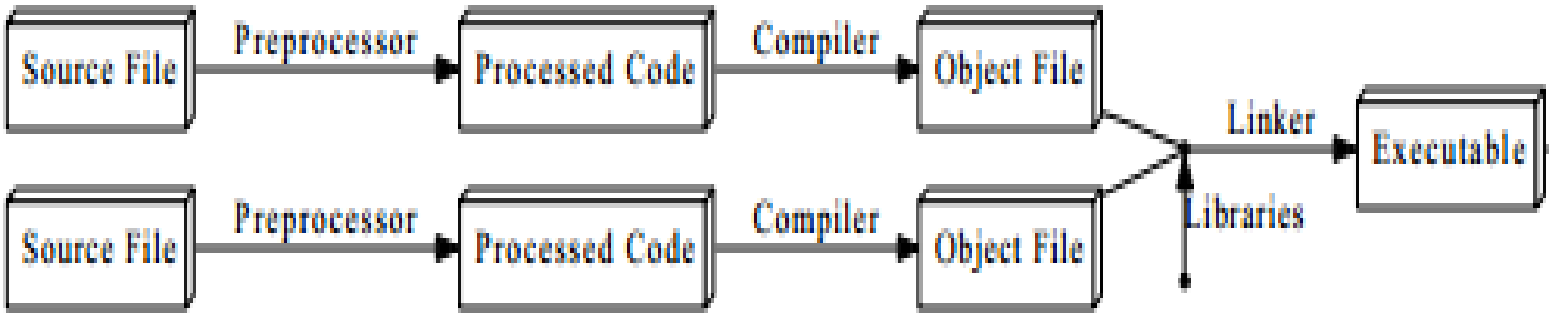
- Visual C++ - comes with MS compiler

- GCC – depends on OS
  - Linux install build essentials to get GCC

```
$ sudo apt-get update
$ sudo apt-get upgrade
$ sudo apt-get install build-essential
$ gcc -v
$ make -v
```

  - Windows – minGW or Cygwin for GCC
    - http://www.mingw.org/wiki/HOWTO_Install_the_MinGW_GCC_Compiler_Suite
    - https://www.cygwin.com/

Compiling/Linking - overview



Source File – .cpp .hpp .h files

Preprocessor – program that performs text substitution

Compiler- converts preprocessed source code to object code for a particular processor

Linker – Links object files and external libraries to form exe (or library)

Will always link the Cruntime and StandardLibrary

Compiling/Linking

```
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#include <iostream>

int main()
{
    std::cout << "Hello, world!" << std::endl;
    return 0;
}
```
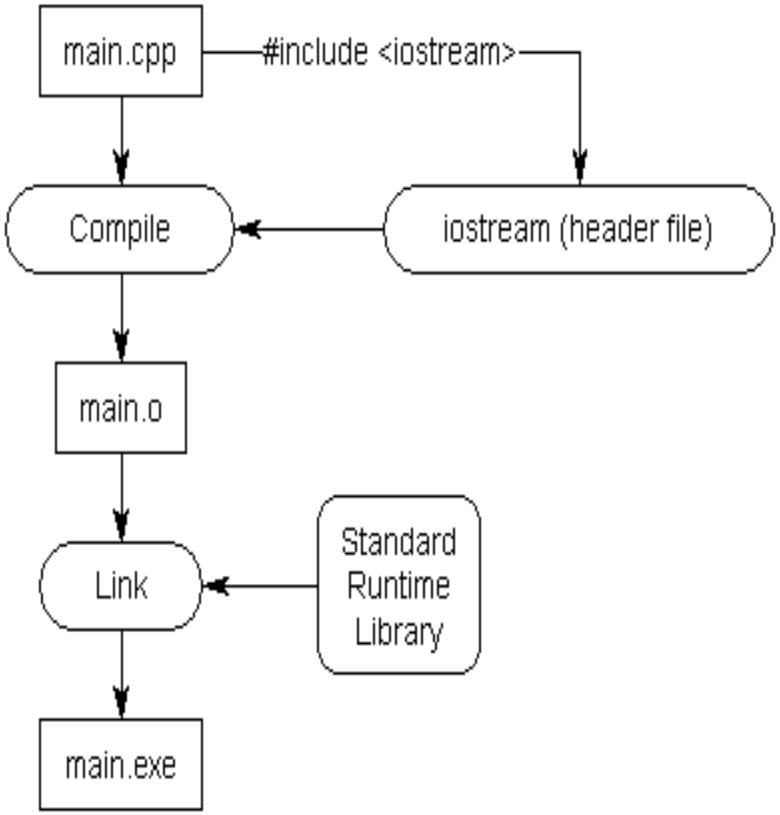
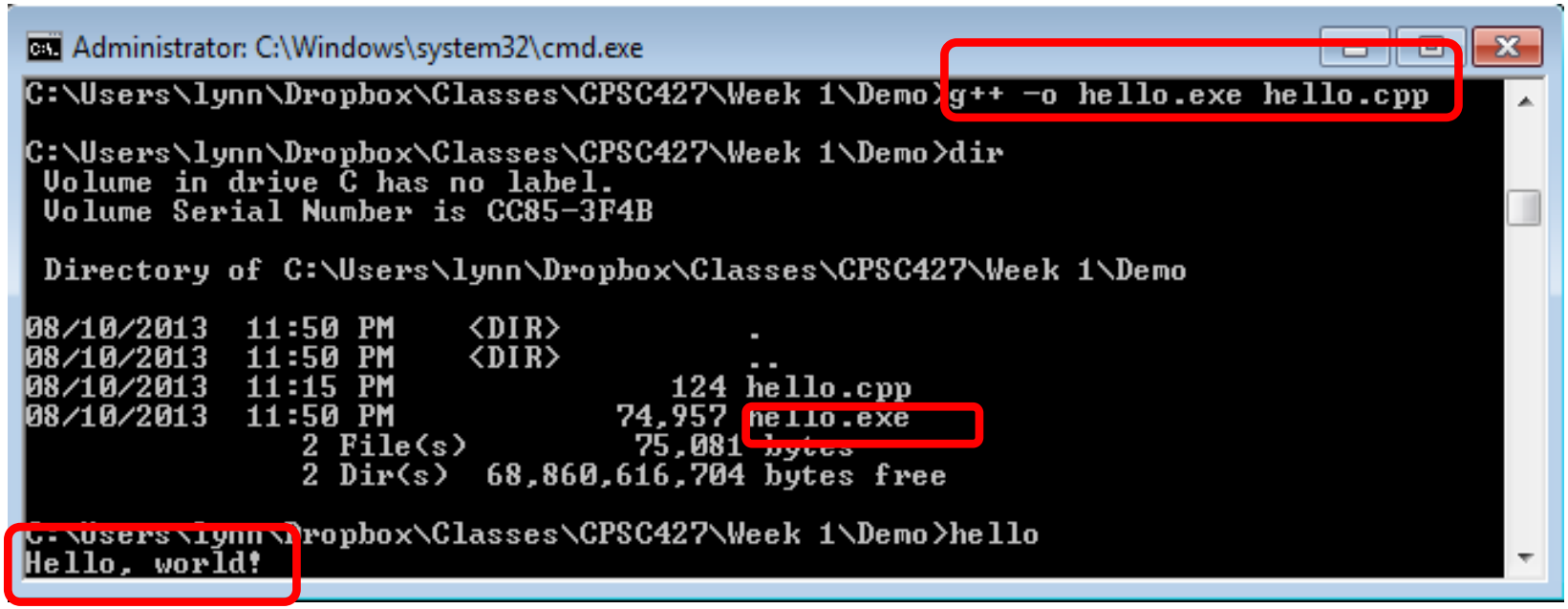



Diagram from http://www.learncpp.com/cpp-tutorial/19-header-files/

Compiling/Linking – Example 1

- As simple as g++ -o hello.exe hello.cpp
- Can become very complex
- Commands reside in make file



Compiling/Linking – Example 2

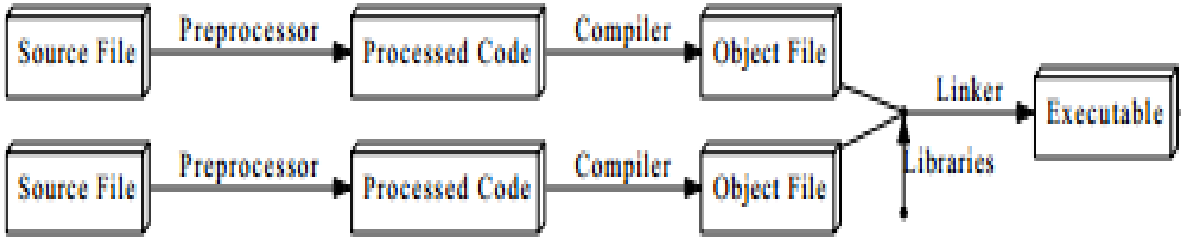
- 2 source files; hello.cpp, myfunc.cpp
- 1 user defined header file myfunc.h. This file provides declarations (return type, function name, parameters) of functions in myfunc.cpp.

```cpp
//myfunc.h
#include <iostream>
std::string myfunc();
```

```cpp
//hello.cpp
#include <iostream>
#include <string.h>
#include "myfunc.h"

int main()
{
    std::string a = myfunc();
    std::cout << a << std::endl;
    return 0;
```

```cpp
//myfunc.cpp
#include "myfunc.h"

std::string myfunc()
{
    return "hello world";
}
```

Compiling/Linking – Example 2



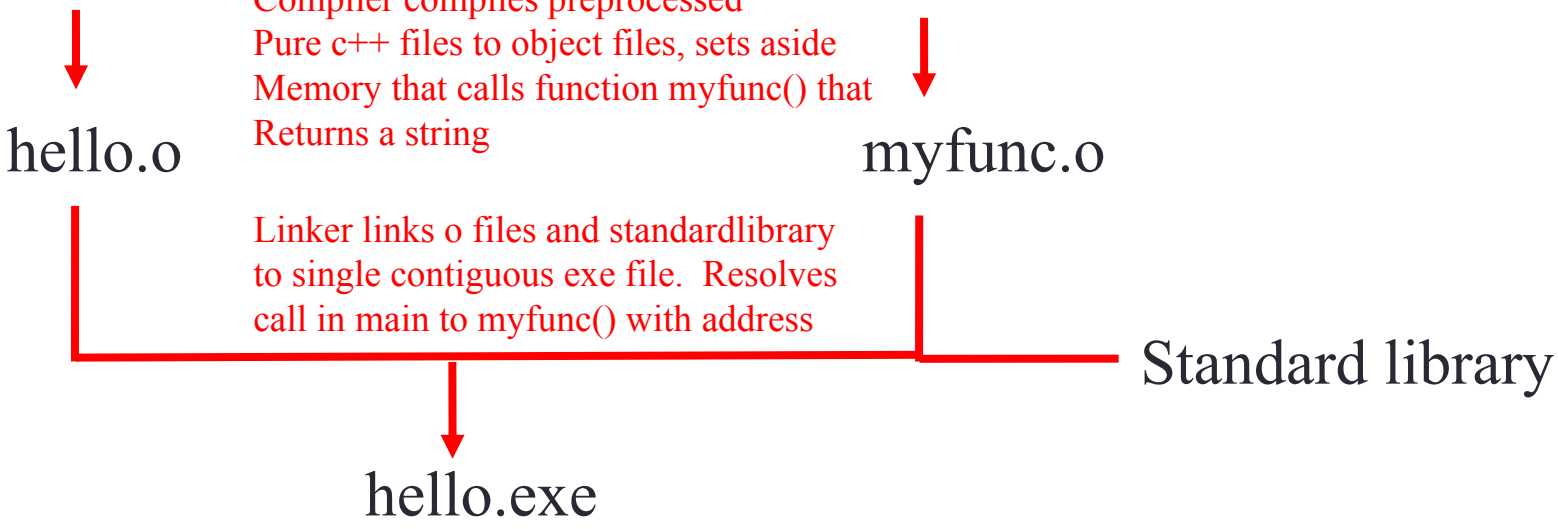

```
Administrator: Command Prompt

C:\AA_Demo>g++ -c myfunc.cpp

C:\AA_Demo>g++ -c hello.cpp

C:\AA_Demo>g++ -o hello.exe myfunc.o hello.o

C:\AA_Demo>dir
08/30/2013  12:15 AM               487 hello.cpp
08/30/2013  09:53 AM            28,033 hello.exe
08/30/2013  09:53 AM             1,927 hello.o
08/30/2013  01:45 AM                89 myfunc.cpp
08/30/2013  01:22 AM               427 myfunc.h
08/30/2013  09:52 AM             1,726 myfunc.o
               6 File(s)         32,689 bytes
               2 Dir(s)  122,903,212,032 bytes free

C:\AA_Demo>hello
hello world

C:\AA_Demo>
```

Compiling/Linking – Example 2

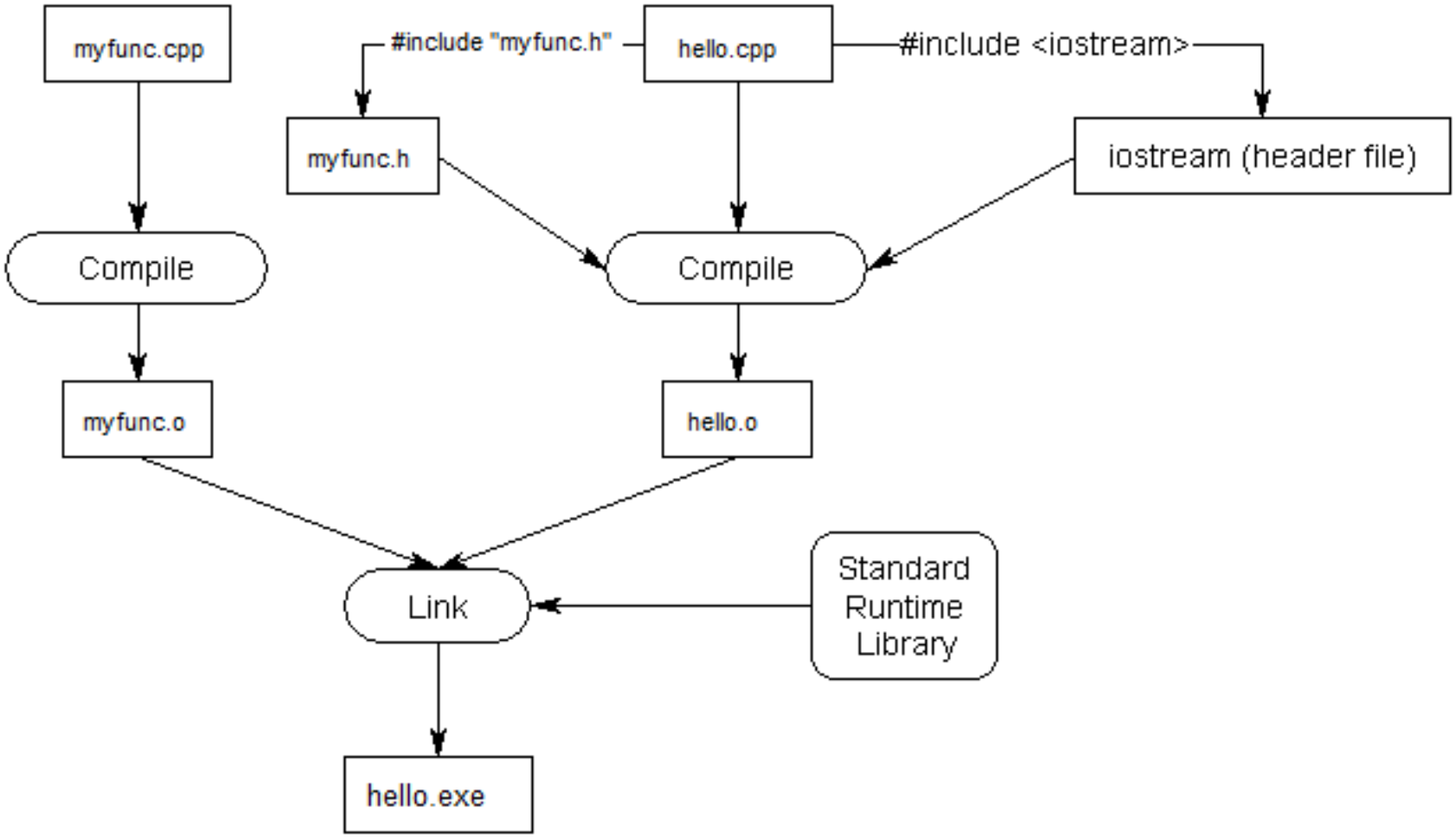
```cpp
//hello.cpp
#include <iostream>
#include <string.h>
#include <iostream>
std::string myfunc();
int main()
{
    std::string a = myfunc();
    std::cout << a << std::endl;
    return 0;
}
```

Preprocessor inserts myfunc.h here, expands all other includes

```cpp
//myfunc.cpp
#include <iostream>
std::string myfunc();
std::string myfunc()
{
    return "hello world";
}
```



Compiling/Linking – Example 2



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Compiling/Linking – Makefiles

- Typing all these commands is error prone
- Instead use ‘make’. A framework for building simple to very complex programs.
- Example: makefile from 1_gcc_demo

```
CFLAGS = -Wall
#target exe
all: hello.o myfunc.o
        g++ $(CFLAGS) -o myexe hello.o myfunc.o

#rebuild if either of the files below change
hello.o: hello.cpp myfunc.h
        g++ $(CFLAGS) -c hello.cpp

#rebuild if either of the files below change
myfunc.o: myfunc.cpp myfunc.h
        g++ $(CFLAGS) -c myfunc.cpp

#type 'make clean' to remove following
clean:
        rm -f *.o myexe.exe
```

- See online makefile tutorial

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Debugging

```
Perkins@R343-M1 C:\test
$ g++ -g main.cpp

Perkins@R343-M1 C:\test
$ gdb a.exe
(gdb) break main
Breakpoint 1 at 0x1004010ed: file main.cpp, line 5.
(gdb) run
Starting program: /cygdrive/c/test/a.exe
[New Thread 7128.0x1ac8]
[New Thread 7128.0x670]
[New Thread 7128.0x1640]
[New Thread 7128.0x1e8c]

Breakpoint 1, main () at main.cpp:5
5               std::cout<<"hello world"<<std::endl;
(gdb) list
1       #include <iostream>
2
3       int main()
4       {
5               std::cout<<"hello world"<<std::endl;
6               int a=1;
7               int b=a+1;
8               return 0;
9       }(gdb) n
hello world
6               int a=1;
(gdb) n
7               int b=a+1;
(gdb) a
Ambiguous command "a": actions, add-auto-load-safe-p
(gdb) print a
$1 = 1
(gdb)
```

-g compile with debug info

start debugger

break at beginning

run

Show lines around breakpoint

Next line

Print value of a

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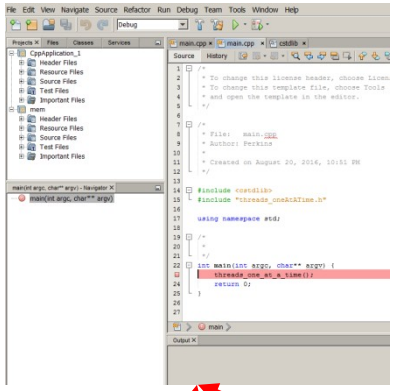
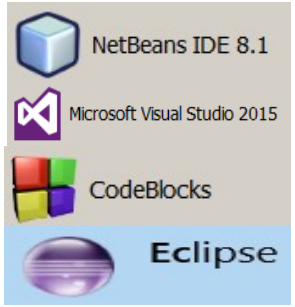
IDE and compiler interaction



Integrated Development environment (IDE)
Such as…



But an IDE makes it easier
Especially on large projects

IDE uses compiler

IDE uses debugger

Compiler (like gcc)

Debugger (like gdb)

You only need these

Compiler generates executable

Executable application

debugs

To generate this

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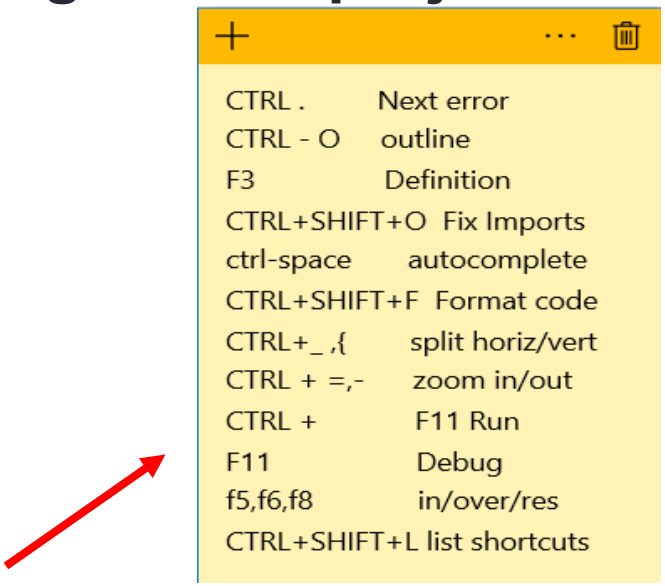
Compiling/Linking – Using an IDE

- **Let Integrated Development Environment (IDE) handle all details**
- **(build settings still there just using default project settings)**

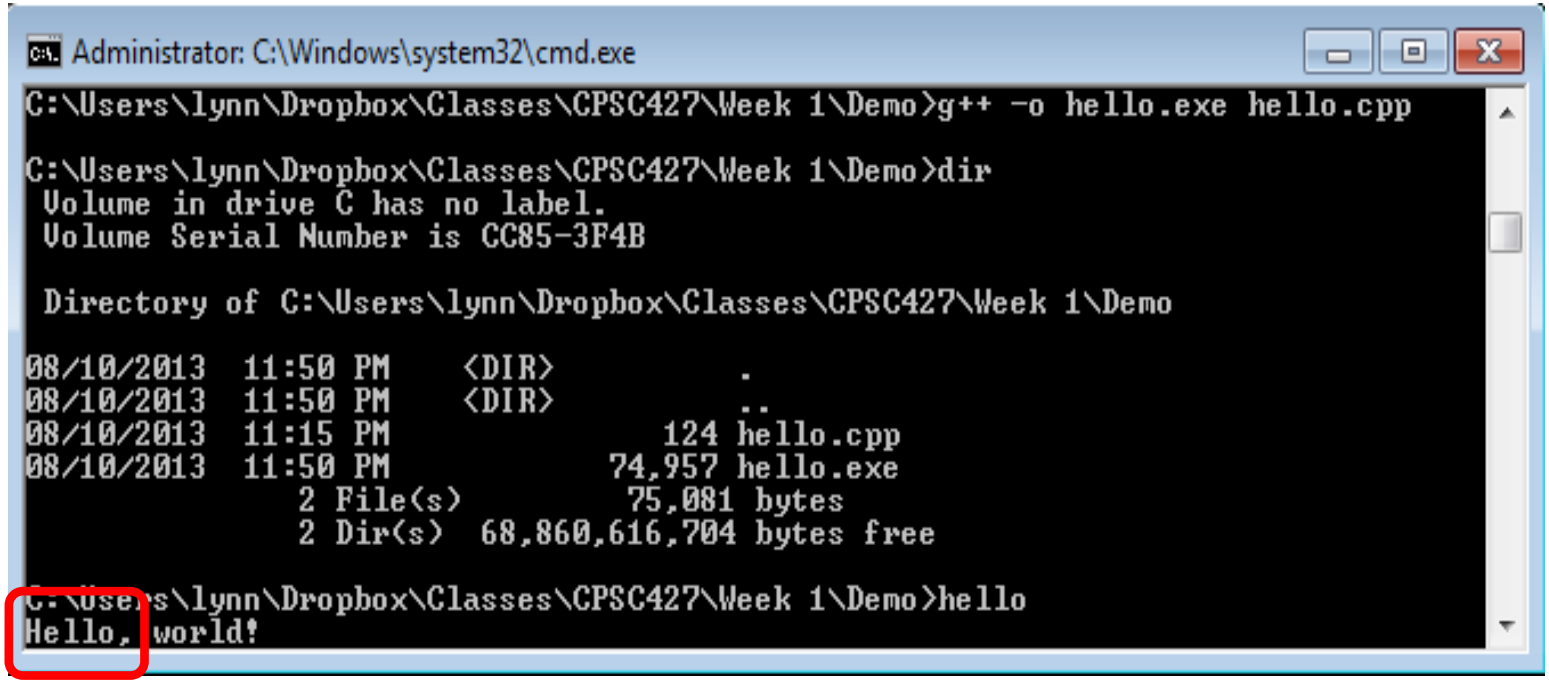
- Create C++ project
- Copy 3 files from example 2 to it
- Build it
- Here are some key shortcuts



Key bindings I use

Running

- Its an Executable! (no virtual machine)
- Can run from command line or IDE
- Fast Demo Various bits of IDE



What have we learned

C++ has lots of similarities to Java (more as we go) and some with Python

How to write a simple C++ program

How to compile using command line

How to use an IDE to create a program

For this class and most likely professionally, let the IDE manage your builds.

Basic IDE usage (Debug/release build, variables, breakpoints etc)

How to run a program

PRACTICE PLEASE