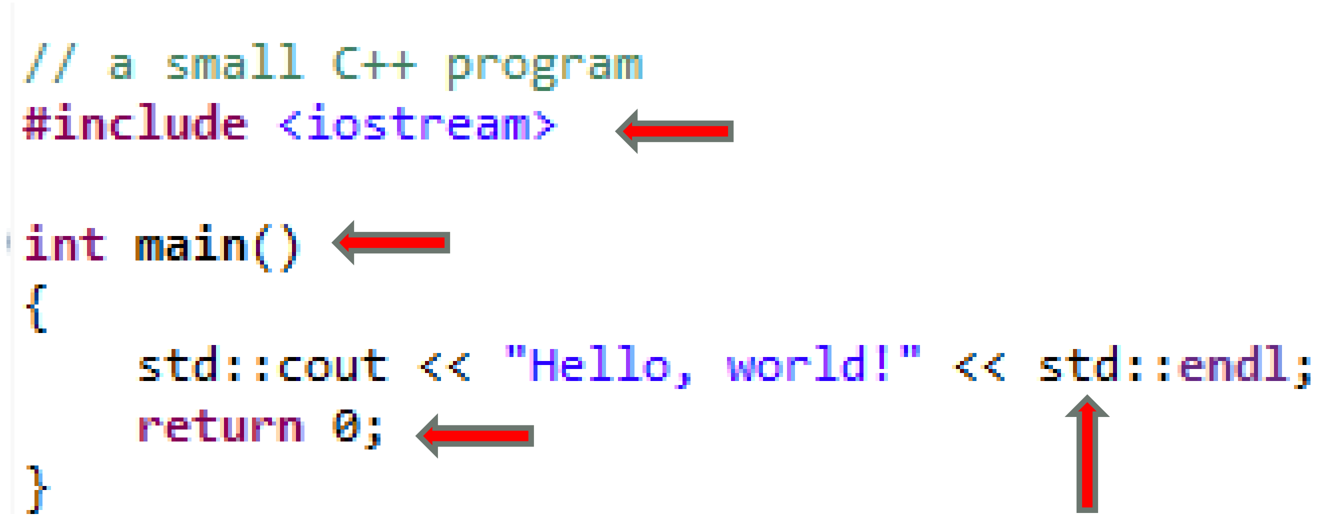
C++: A simple program

Outline

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

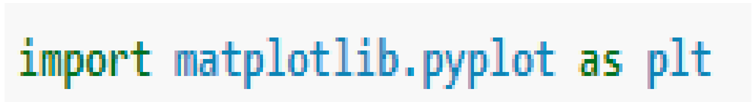
Source Code – hello.cpp



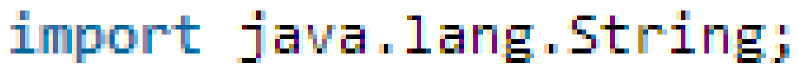
```cpp
// a small C++ program
#include <iostream>

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

Something Different– header files

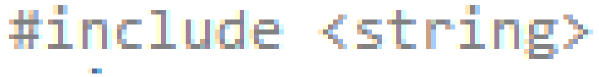
- Python and Java
  - classes are all in 1 file
  - import statements used to include references to classes from libraries
- C++
  - classes are in 2 files (.cpp and .h)
  - Include files reference a library (or object file)- linker includes it in executable
- C++ is more difficult to use in this respect



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



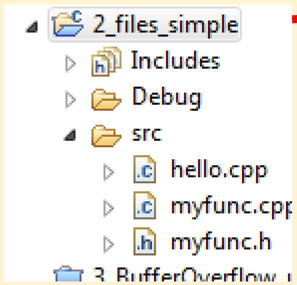
```
import java.lang.String;
```



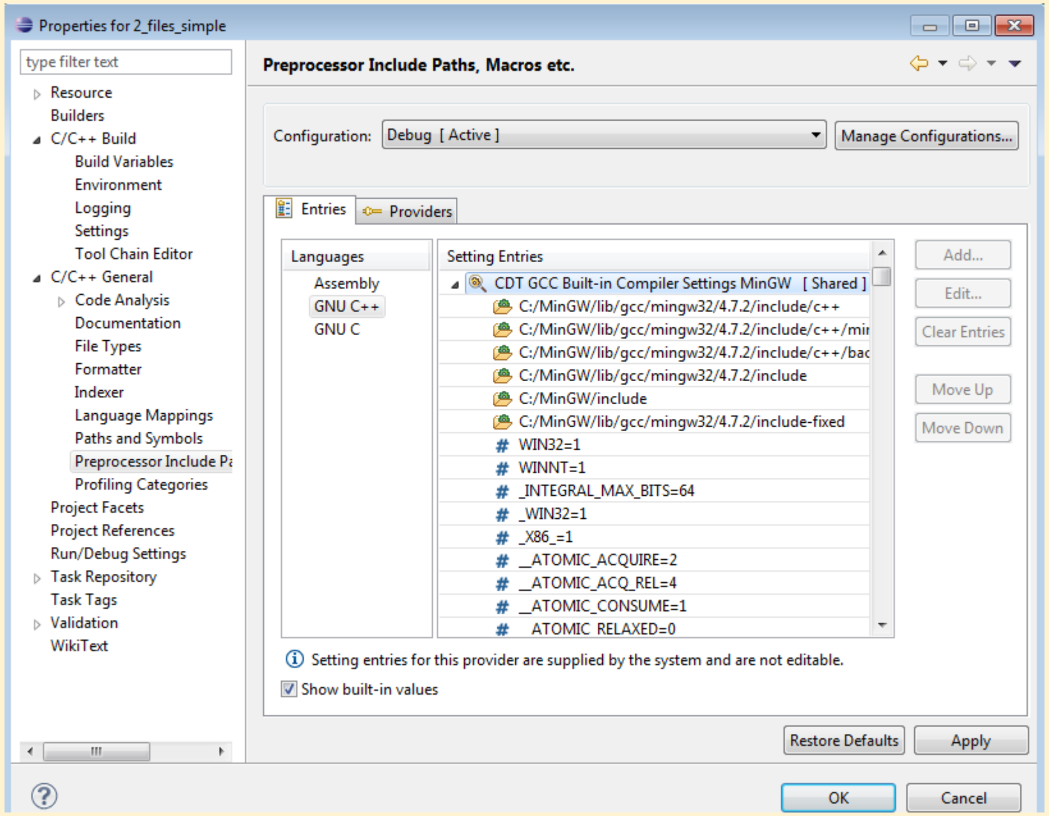
```
#include <string>
```

Eclipse Help
Where Preprocessor finds <> include files

Right click on Project
Select Properties



2_files_simple
- Includes
- Debug
- src
  - hello.cpp
  - myfunc.cpp
  - myfunc.h



Properties for 2_files_simple

type filter text

- Resource
- Builders
- C/C++ Build
  - Build Variables
  - Environment
  - Logging
  - Settings
  - Tool Chain Editor
- C/C++ General
  - Code Analysis
  - Documentation
  - File Types
  - Formatter
  - Indexer
  - Language Mappings
  - Paths and Symbols
  - Preprocessor Include Pa
  - Profiling Categories
- Project Facets
- Project References
- Run/Debug Settings
- Task Repository
- Task Tags
- Validation
- WikiText

Preprocessor Include Paths, Macros etc.

Configuration: Debug [Active]   Manage Configurations...

Entries | Providers

Languages	Setting Entries
Assembly	CDT GCC Built-in Compiler Settings MinGW [Shared]
GNU C++	C:/MinGW/lib/gcc/mingw32/4.7.2/include/c++
GNU C	C:/MinGW/lib/gcc/mingw32/4.7.2/include/c++/mir
	C:/MinGW/lib/gcc/mingw32/4.7.2/include/c++/bac
	C:/MinGW/lib/gcc/mingw32/4.7.2/include
	C:/MinGW/include
	C:/MinGW/lib/gcc/mingw32/4.7.2/include-fixed
	# WIN32=1
	# WINNT=1
	# _INTEGRAL_MAX_BITS=64
	# _WIN32=1
	# _X86_=1
	# __ATOMIC_ACQUIRE=2
	# __ATOMIC_ACQ_REL=4
	# __ATOMIC_CONSUME=1
	# __ATOMIC_RELAXED=0

Add... Edit... Clear Entries Move Up Move Down

Setting entries for this provider are supplied by the system and are not editable.

[✓] Show built-in values

Restore Defaults   Apply

OK   Cancel

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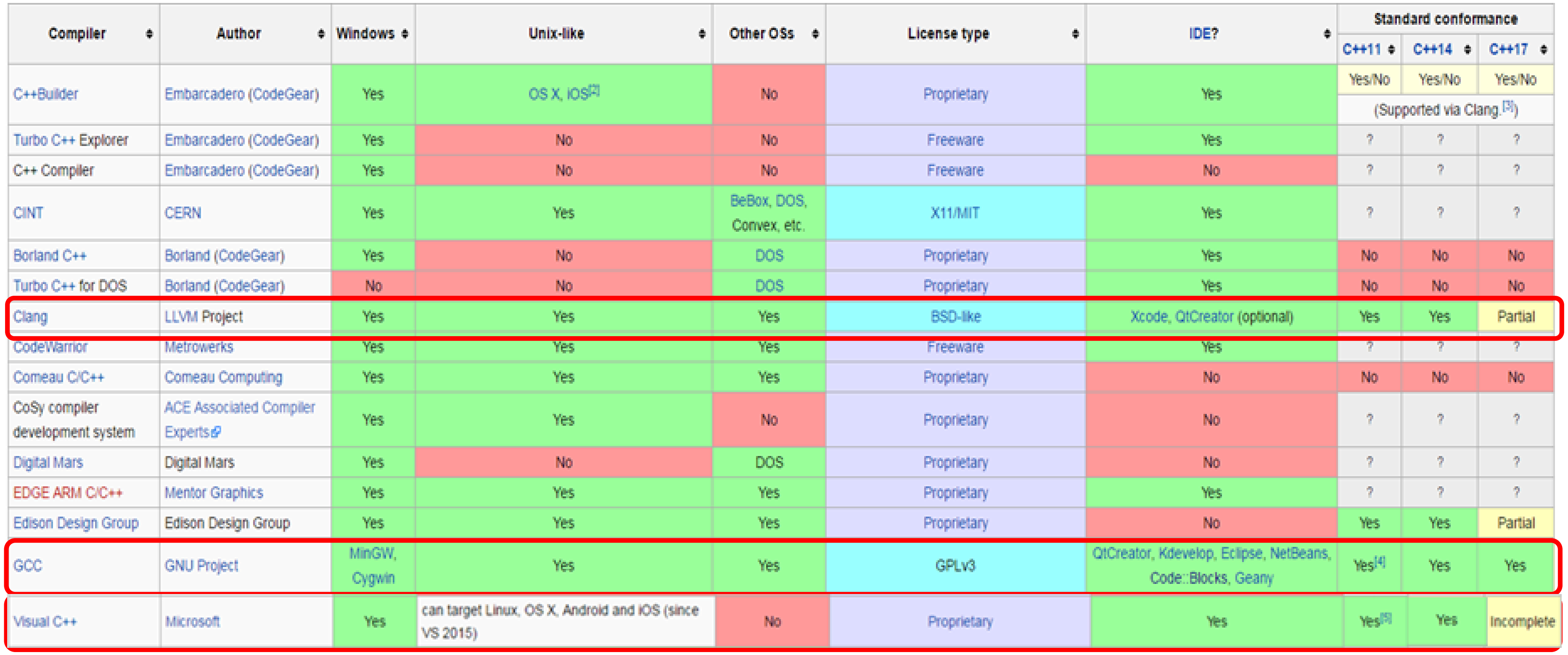
Compilers

- 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

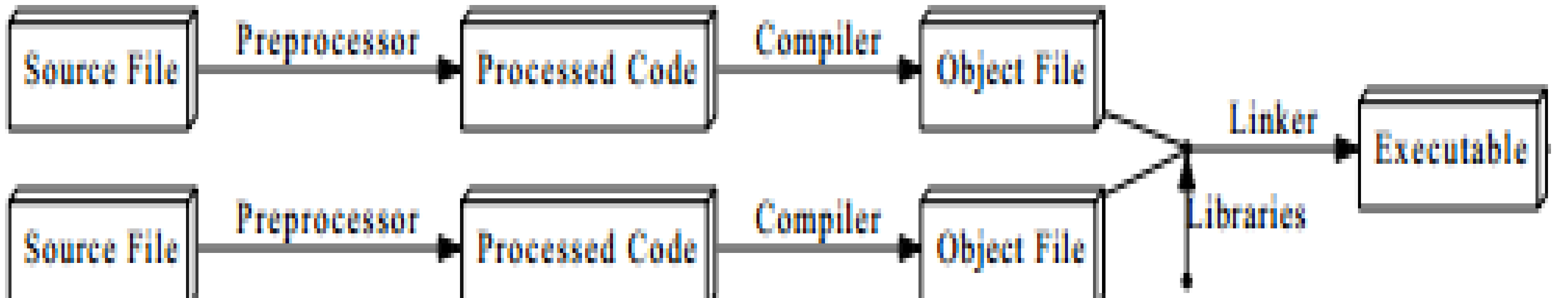
- GCC – depends on OS
  - Linux install build essentials to get GCC

```
$ 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/

  - BTW You need to learn how to use Unix based OSs!

Compiling/Linking - overview



Source File – .cpp .hpp .h files files

Preprocessor – program that performs text substitution

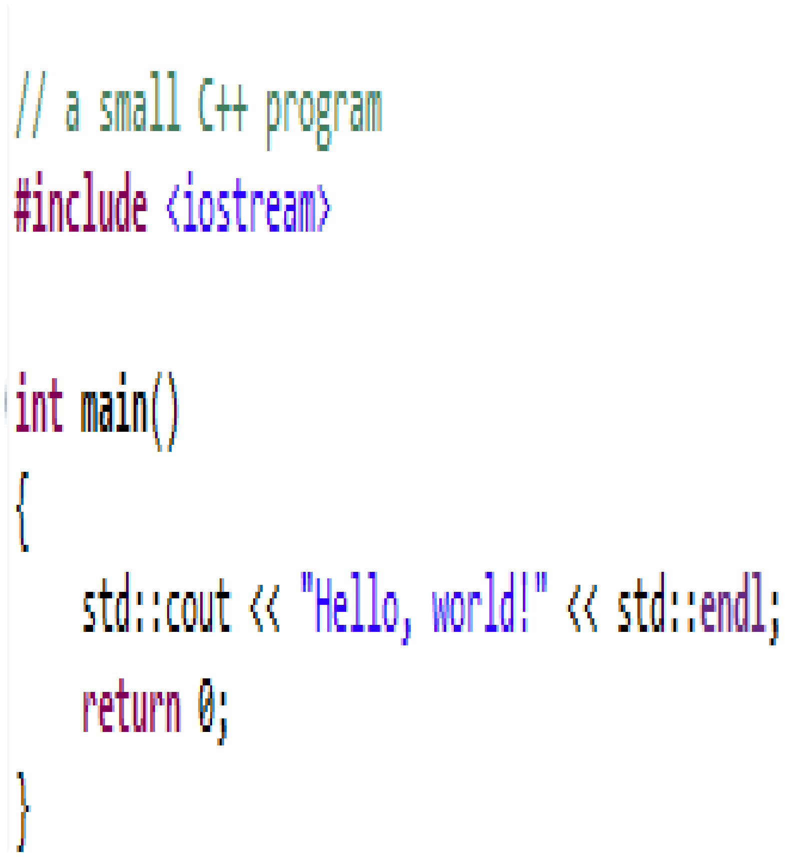
Compiler- converts preprocessed source code to object code for a particular processor

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

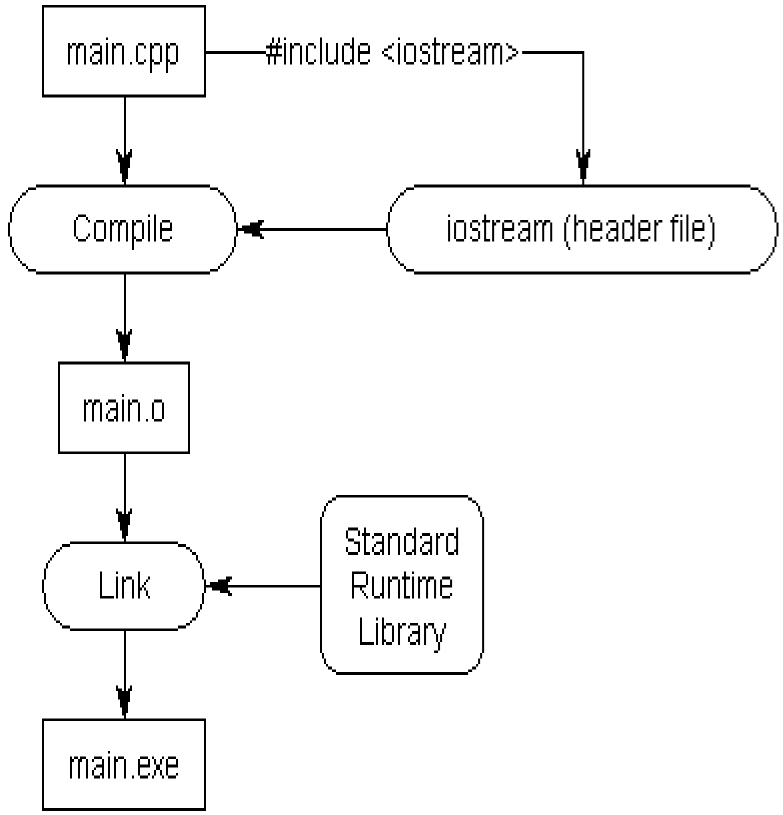
Will always link the Cruntime and StandardLibrary

See http://www.ntu.edu.sg/home/ehchua/programming/cpp/gcc_make.html for more information

Compiling/Linking



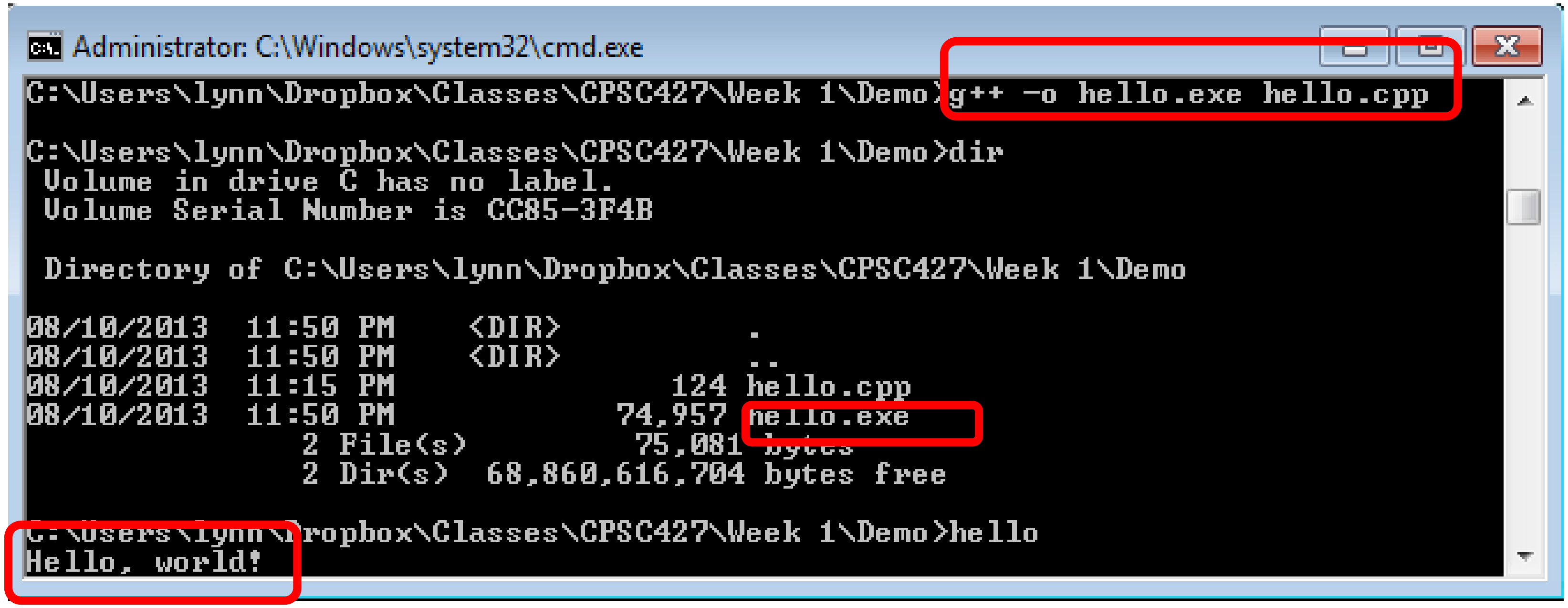
```
// a small C++ program
#include <iostream>

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



See http://www.ntu.edu.sg/home/ehchua/programming/cpp/gcc_make.html for more information
Diagram from http://www.learncpp.com/cpp-tutorial/19-header-files/

Compiling/Linking – Example 1

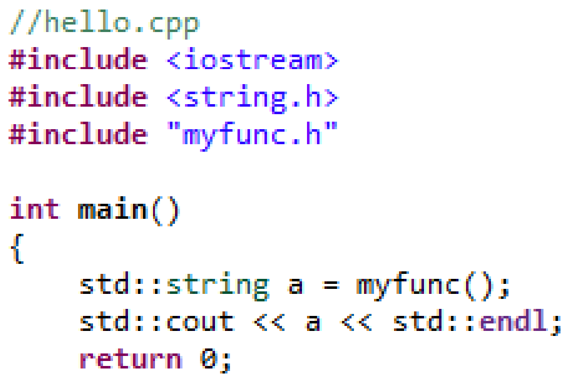
- As simple as g++ -o hello.exe hello.cpp
- Can become very complex
- Commands reside in make file



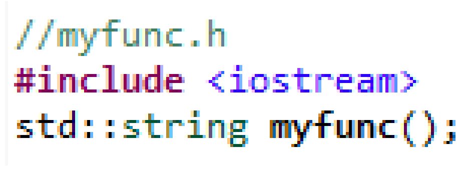
```
C:\Users\lynn\Dropbox\Classes\CPSC427\Week 1\Demo>g++ -o hello.exe hello.cpp

C:\Users\lynn\Dropbox\Classes\CPSC427\Week 1\Demo>dir
 Volume in drive C has no label.
 Volume Serial Number is CC85-3F4B

 Directory of C:\Users\lynn\Dropbox\Classes\CPSC427\Week 1\Demo

08/10/2013  11:50 PM    <DIR>          .
08/10/2013  11:50 PM    <DIR>          ..
08/10/2013  11:15 PM               124 hello.cpp
08/10/2013  11:50 PM            74,957 hello.exe
               2 File(s)         75,081 bytes
               2 Dir(s)  68,860,616,704 bytes free

C:\Users\lynn\Dropbox\Classes\CPSC427\Week 1\Demo>hello
Hello, world!
```

Compiling/Linking – Example 2

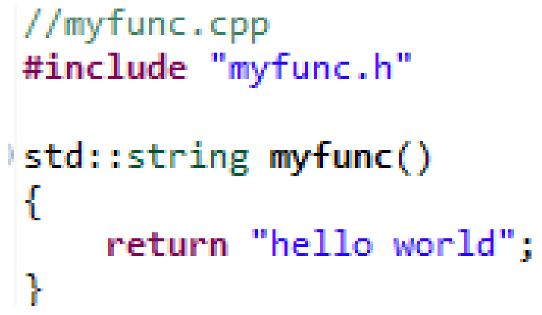
- 2 source files; hello.cpp, myfunc.cpp
- 1 user defined header file myfunc.h
- See Project -> 2_files_simple



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

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

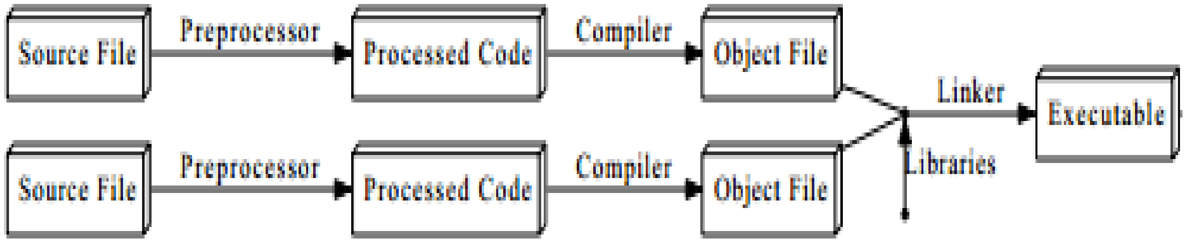


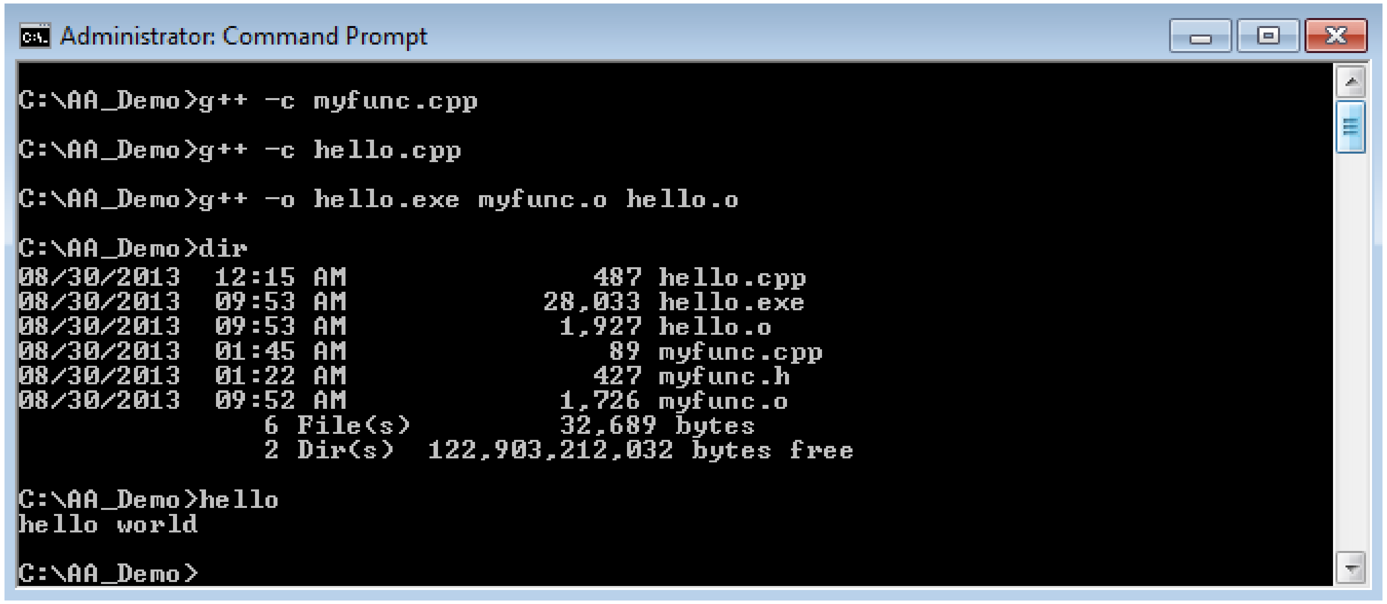
```
//myfunc.h
#include <iostream>
std::string myfunc();
```



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

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

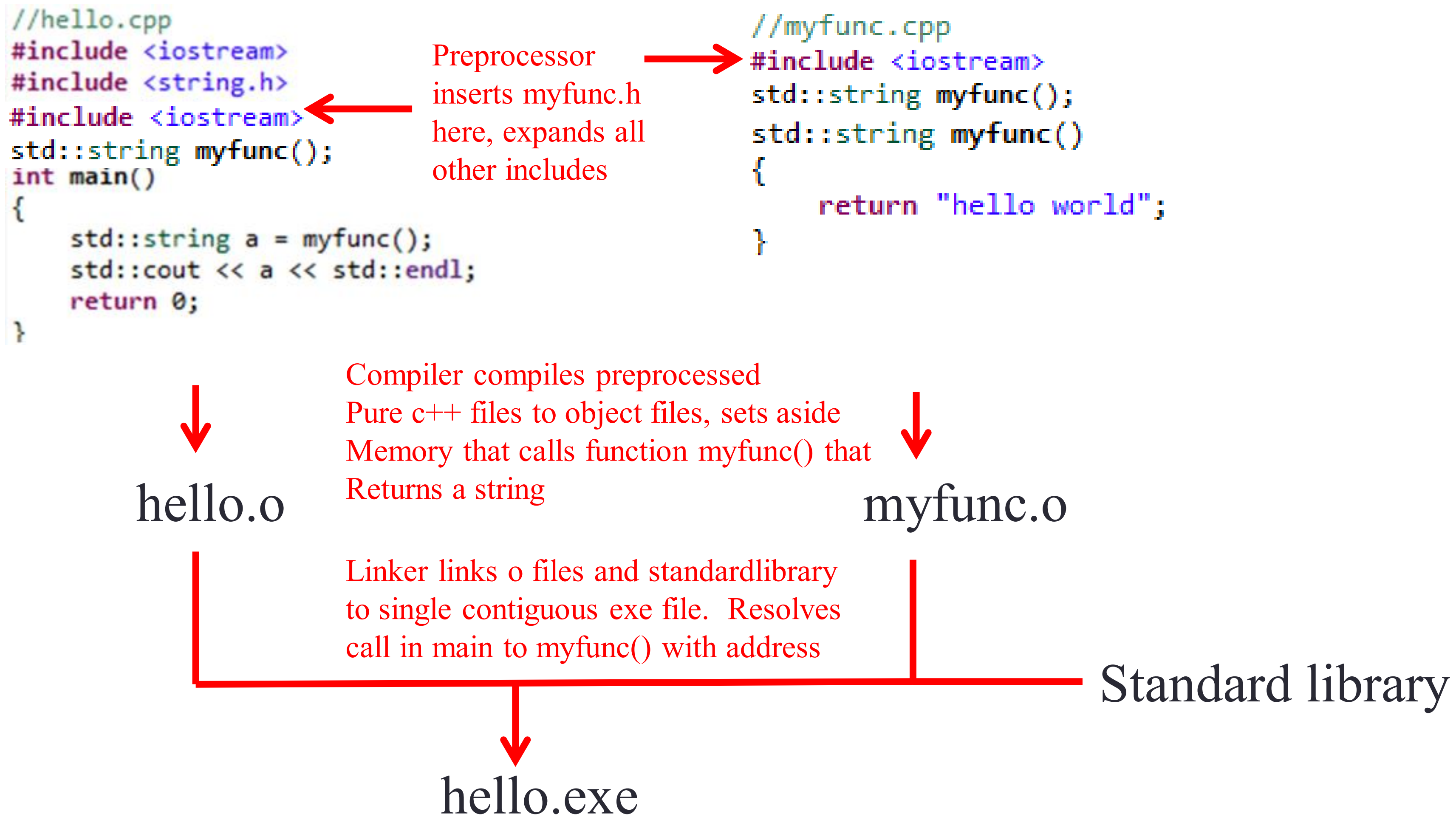
Compiling/Linking – Example 2





```
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



```
//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

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

Compiler compiles preprocessed Pure c++ files to object files, sets aside Memory that calls function myfunc() that Returns a string

Linker links o files and standardlibrary to single contiguous exe file. Resolves call in main to myfunc() with address

Compiling/Linking – Example 2

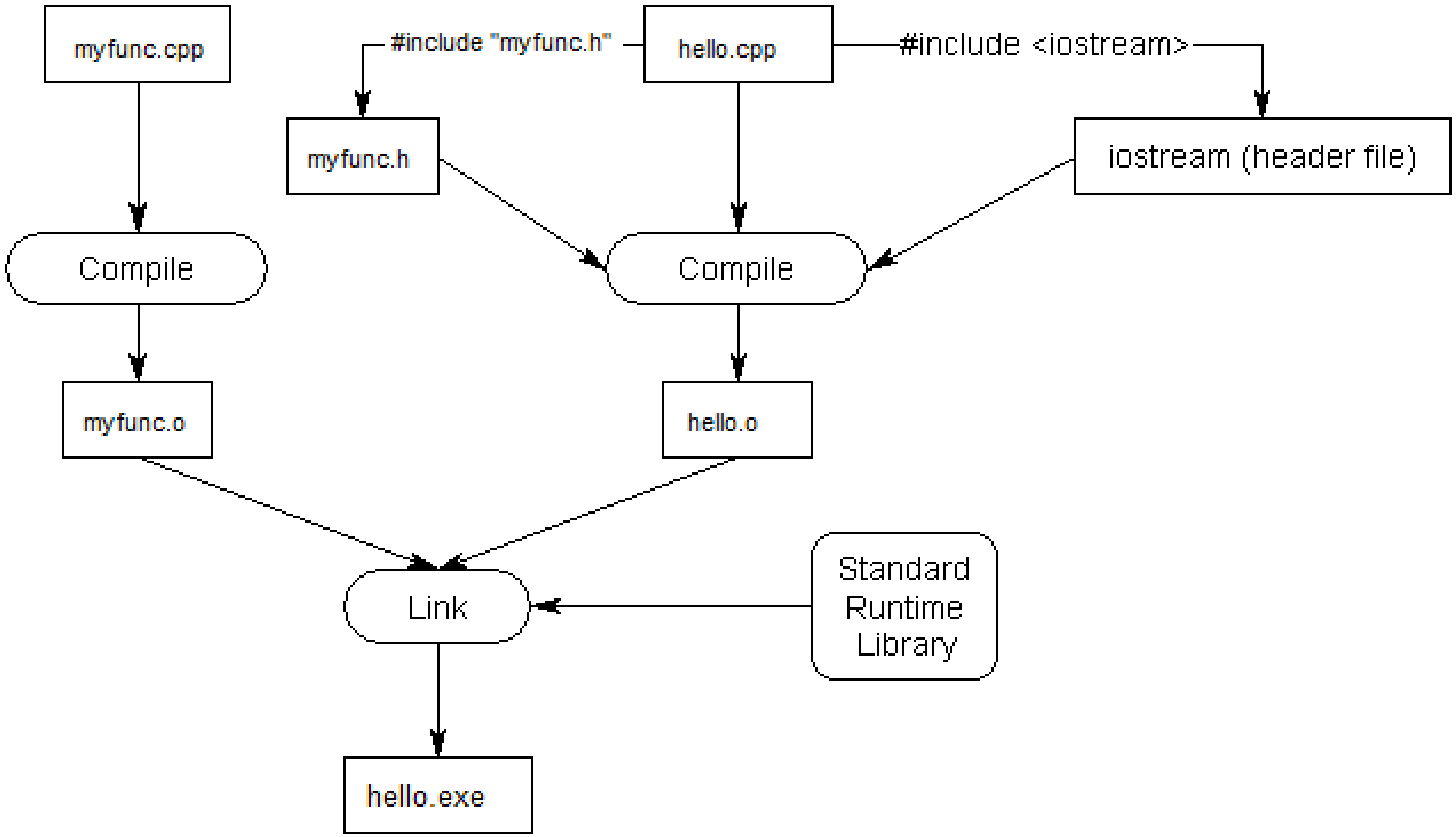
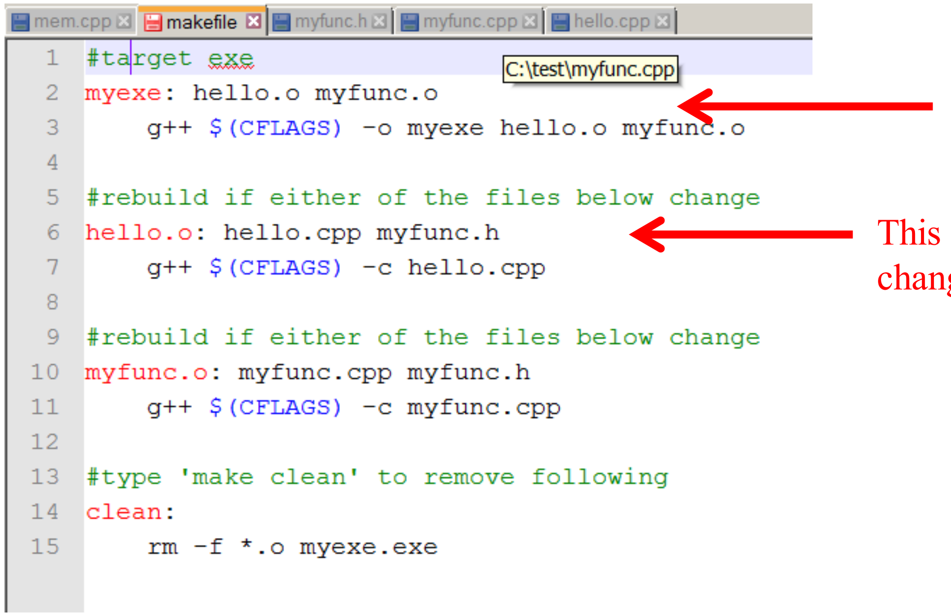


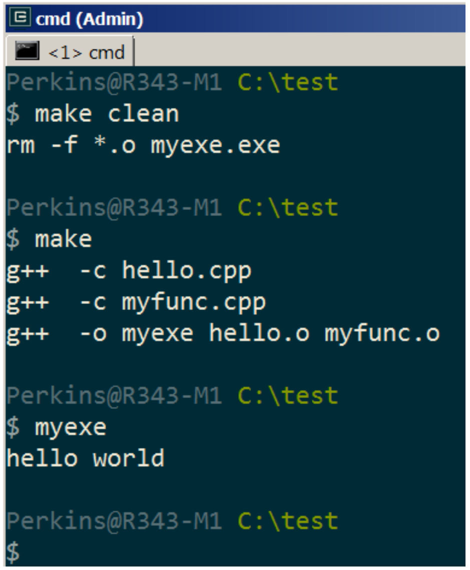
Diagram from http://www.learncpp.com/cpp-tutorial/19-header-files/

Makefiles – a way to automate things



```
#target exe
myexe: 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
```

This object file depends on these two source files, if eithe change rebuild the object file



```
Perkins@R343-M1 C:\test
$ make clean
rm -f *.o myexe.exe

Perkins@R343-M1 C:\test
$ make
g++  -c hello.cpp
g++  -c myfunc.cpp
g++  -o myexe hello.o myfunc.o

Perkins@R343-M1 C:\test
$ myexe
hello world

Perkins@R343-M1 C:\test
$
```

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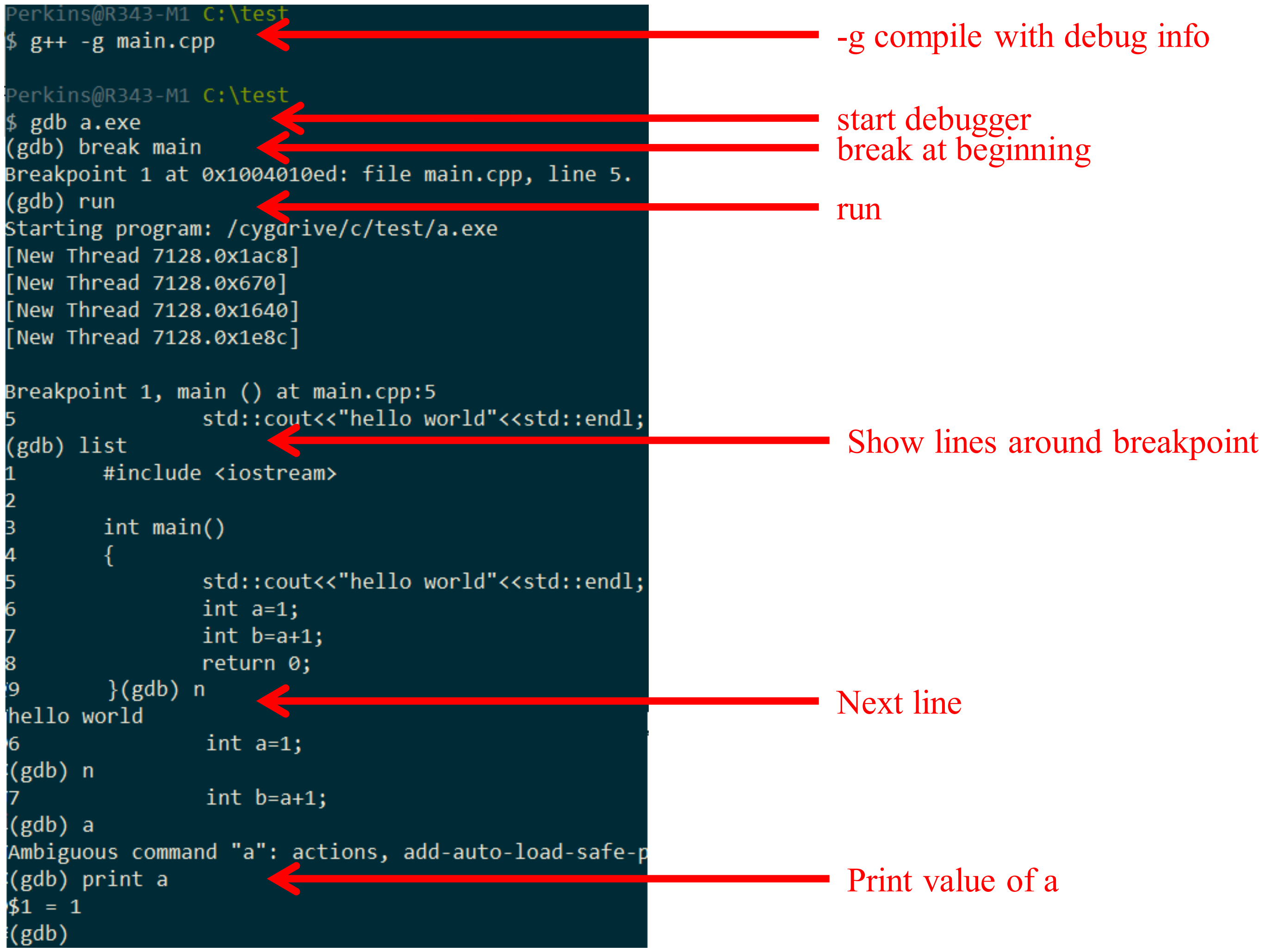
Debugging



```
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)
```

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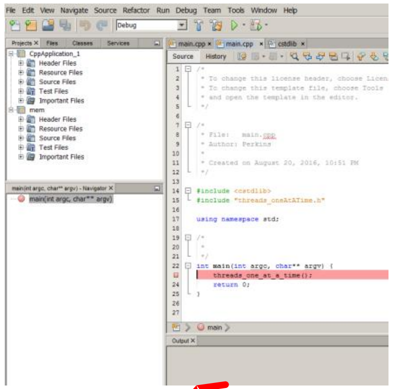
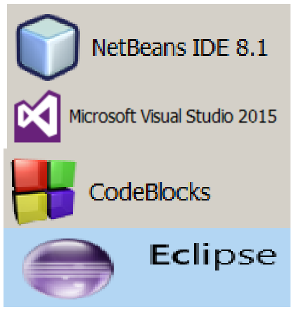
IDE and compiler interaction

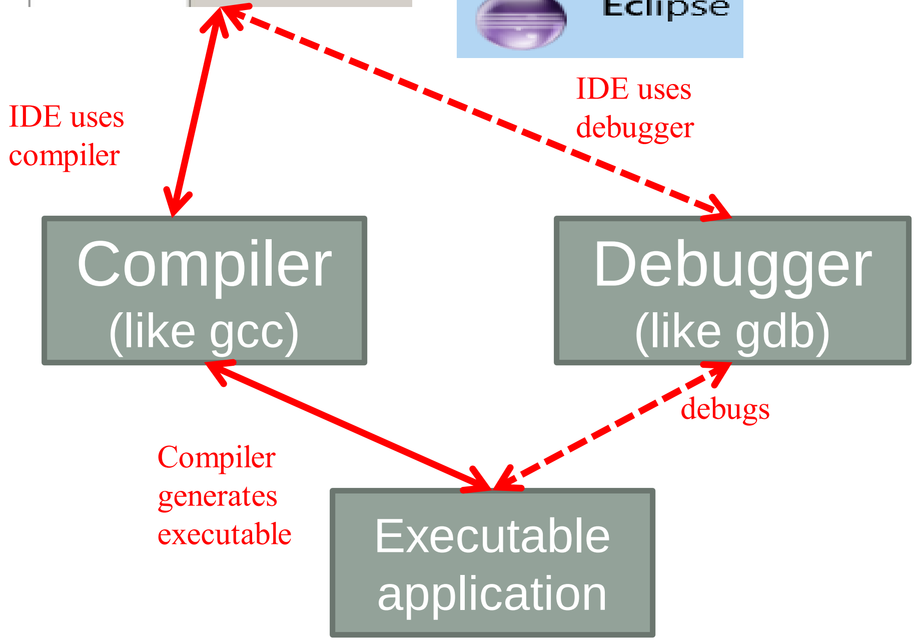


```
/*
 * To change this license header, choose Licen
 * To change this template file, choose Tools
 * and open the template in the editor.
 */

/*
 * File:   main.cpp
 * Author: Perkins
 *
 * Created on August 20, 2016, 10:51 PM
 */

#include <cstdlib>
#include "threads_oneAtATime.h"

using namespace std;

/*
 *
 */
int main(int argc, char** argv) {
    threads_one_at_a_time();
    return 0;
}
```

Integrated Development environment (IDE)
Such as…



But an IDE makes it easier
Especially on large projects



You only need these

To generate this

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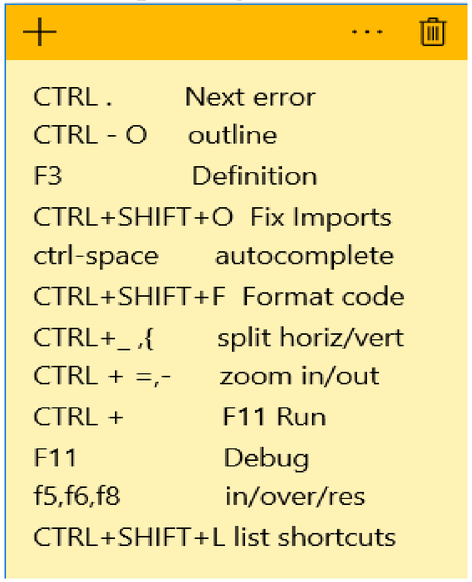
Compiling/Linking – Using an IDE

- **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

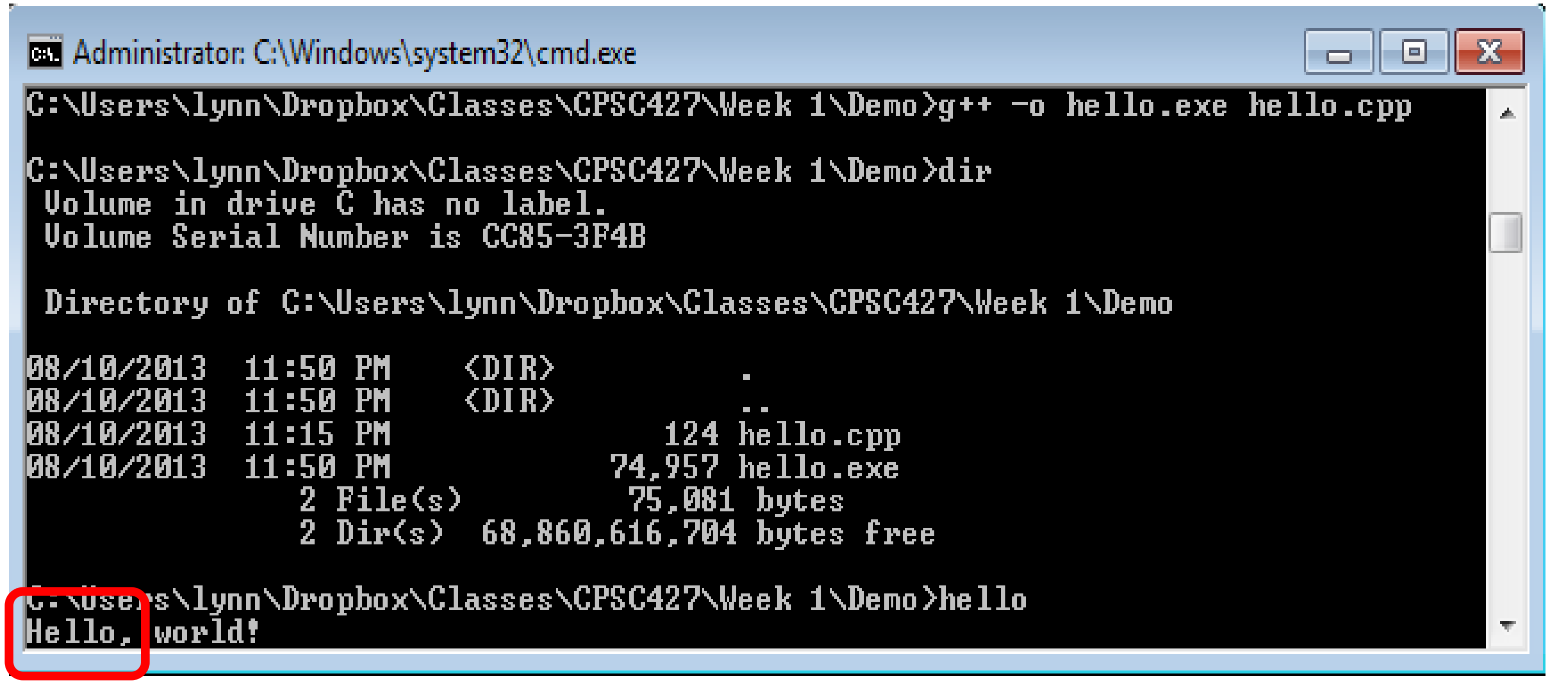


CTRL .	Next error
CTRL - O	outline
F3	Definition
CTRL+SHIFT+O	Fix Imports
ctrl-space	autocomplete
CTRL+SHIFT+F	Format code
CTRL+_ ,{	split horiz/vert
CTRL + =,-	zoom in/out
CTRL +	F11 Run
F11	Debug
f5,f6,f8	in/over/res
CTRL+SHIFT+L	list shortcuts

Key bindings I use

Running

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



```
C:\Users\lynn\Dropbox\Classes\CPSC427\Week 1\Demo>g++ -o hello.exe hello.cpp

C:\Users\lynn\Dropbox\Classes\CPSC427\Week 1\Demo>dir
 Volume in drive C has no label.
 Volume Serial Number is CC85-3F4B

 Directory of C:\Users\lynn\Dropbox\Classes\CPSC427\Week 1\Demo

08/10/2013  11:50 PM    <DIR>          .
08/10/2013  11:50 PM    <DIR>          ..
08/10/2013  11:15 PM               124 hello.cpp
08/10/2013  11:50 PM            74,957 hello.exe
               2 File(s)         75,081 bytes
               2 Dir(s)  68,860,616,704 bytes free

C:\Users\lynn\Dropbox\Classes\CPSC427\Week 1\Demo>hello
Hello, world!
```

What have we learned

- C++ has lots of similarities to Java (more as we go)
- 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