C++ Program Design
-- Introduction

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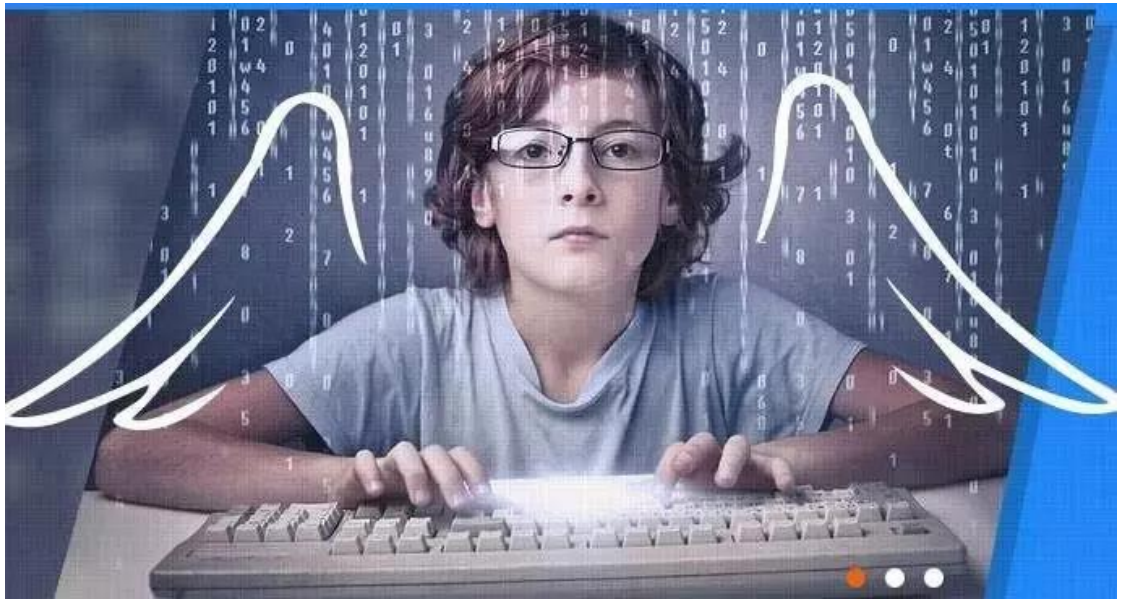
Summer 2018

http://jjcao.github.io/cPlusPlus

Coding is important



- 生活、工作在数字时代：网络+人工智能
- 许多工作岗位即将或已经正在逐步的被机器所替代的时代。
- 一切过程都需要被程序化
- 别人编程，我享用？

- **When human beings acquired language, we learned not just how to listen but how to speak. When we gained literacy, we learned not just how to read but how to write. And as we move into an increasingly digital reality, we must learn not just how to use programs but to make them.**
- **In the emerging, highly programmed landscape ahead, you will either create the software or you will be the software. It's really that simple: Program, or be programmed.**
- **Choose the former, and you gain access to the control panel of civilization. Choose the latter, and it could be the last real choice you get to make.**
- 人类学语言时，学的不仅是听还有说；学字时，学的不仅是读还有写；
- 而现在随着我们向一个越来越数字化的世界迈进，我们也不仅应该学会如何使用程序，还要学会如何开发程序。

- 在未来，面对着一个高度程序化的世界，如果你不能开发软件，那么你将变成软件。就是这么简单：要么编程，要么被编程。

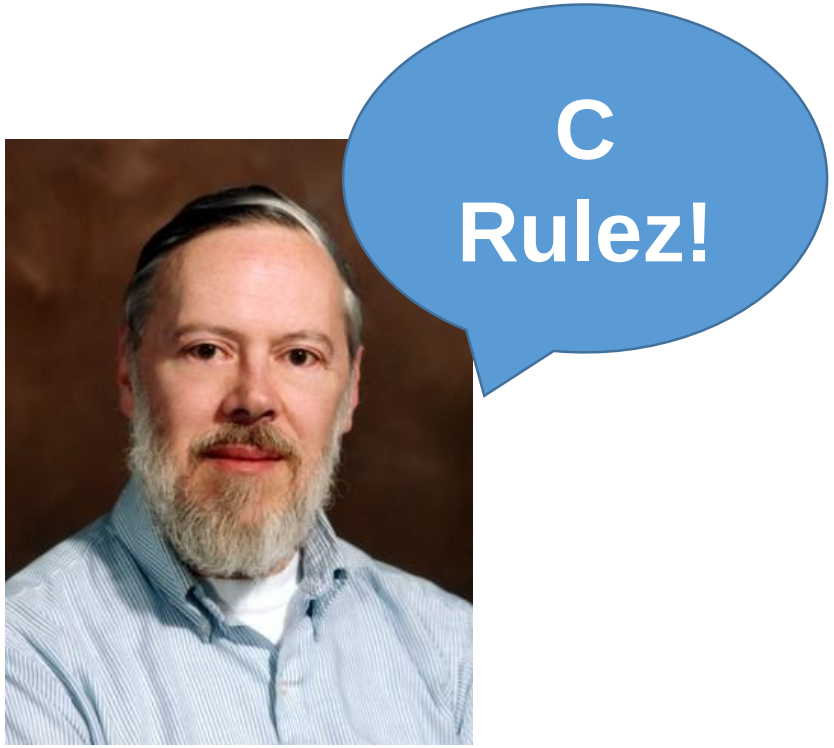
-- Douglas Rushkoff, in Program or Be Programmed: Ten Commands for a Digital Age (2010)

本学期的目标

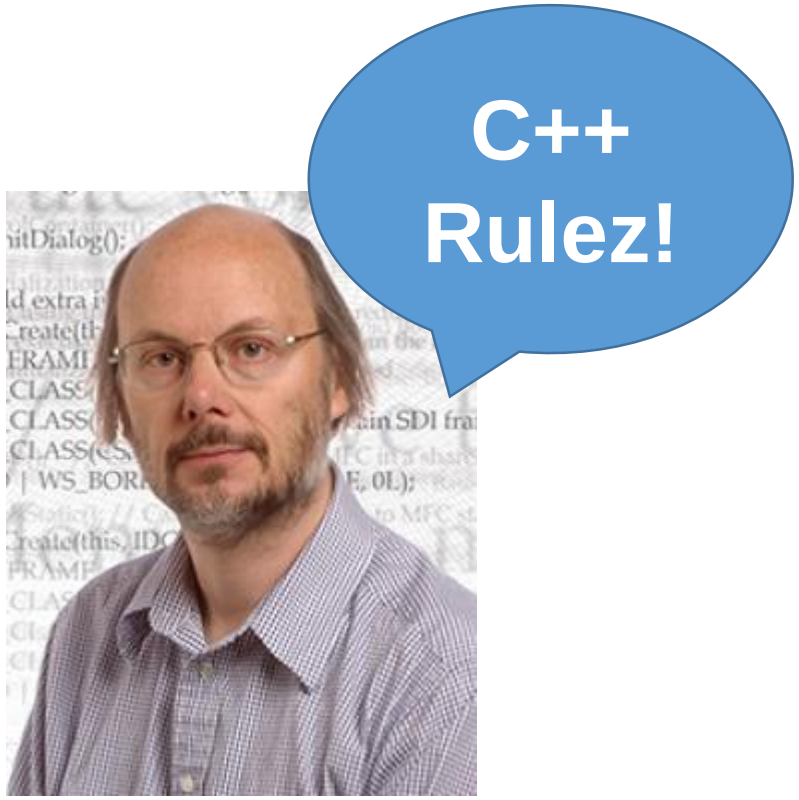
给定数据+问题描述，独立写程序解决这个问题

Is Matlab/Python the final weapon for us?

Why teaching C++

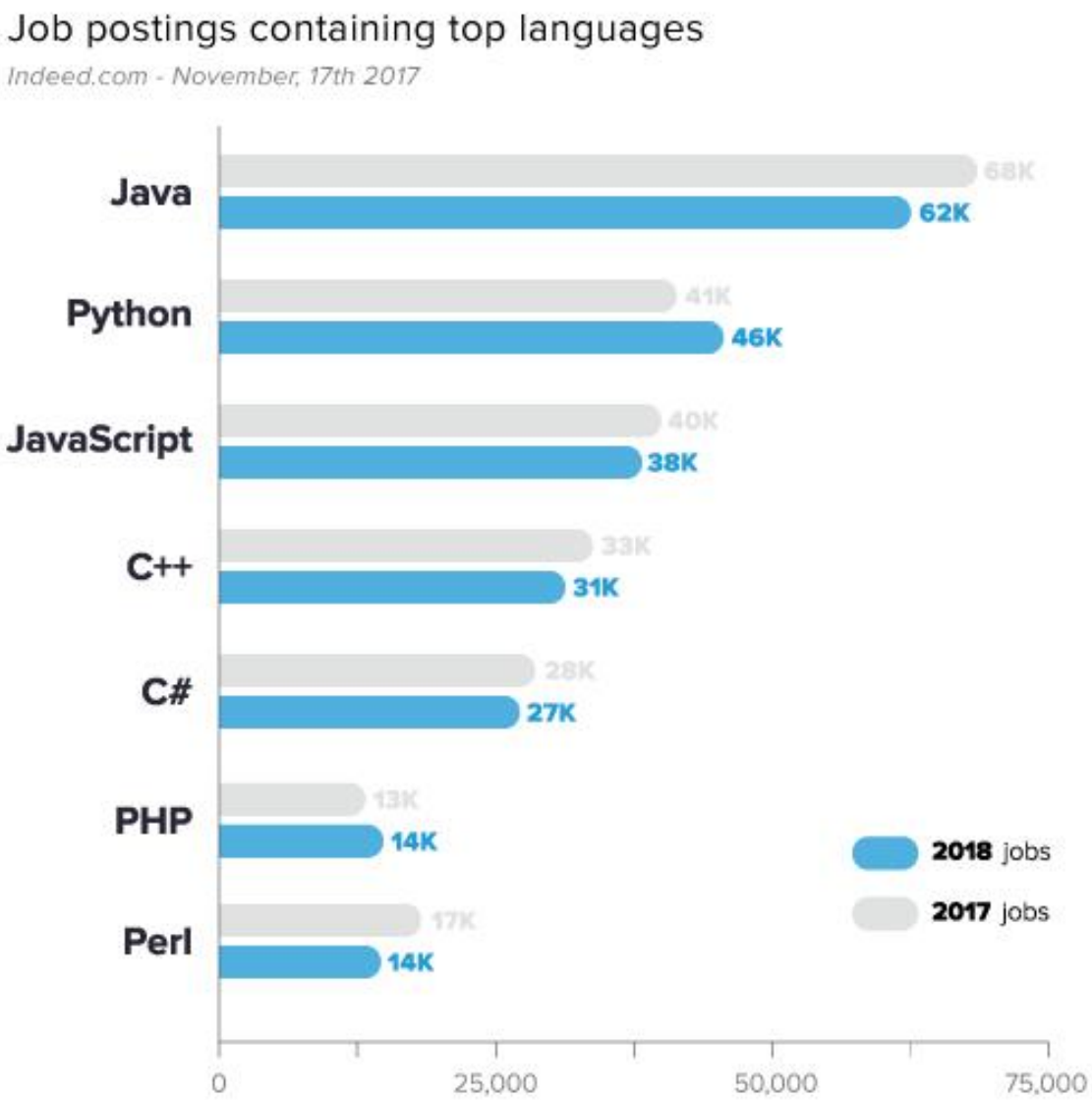


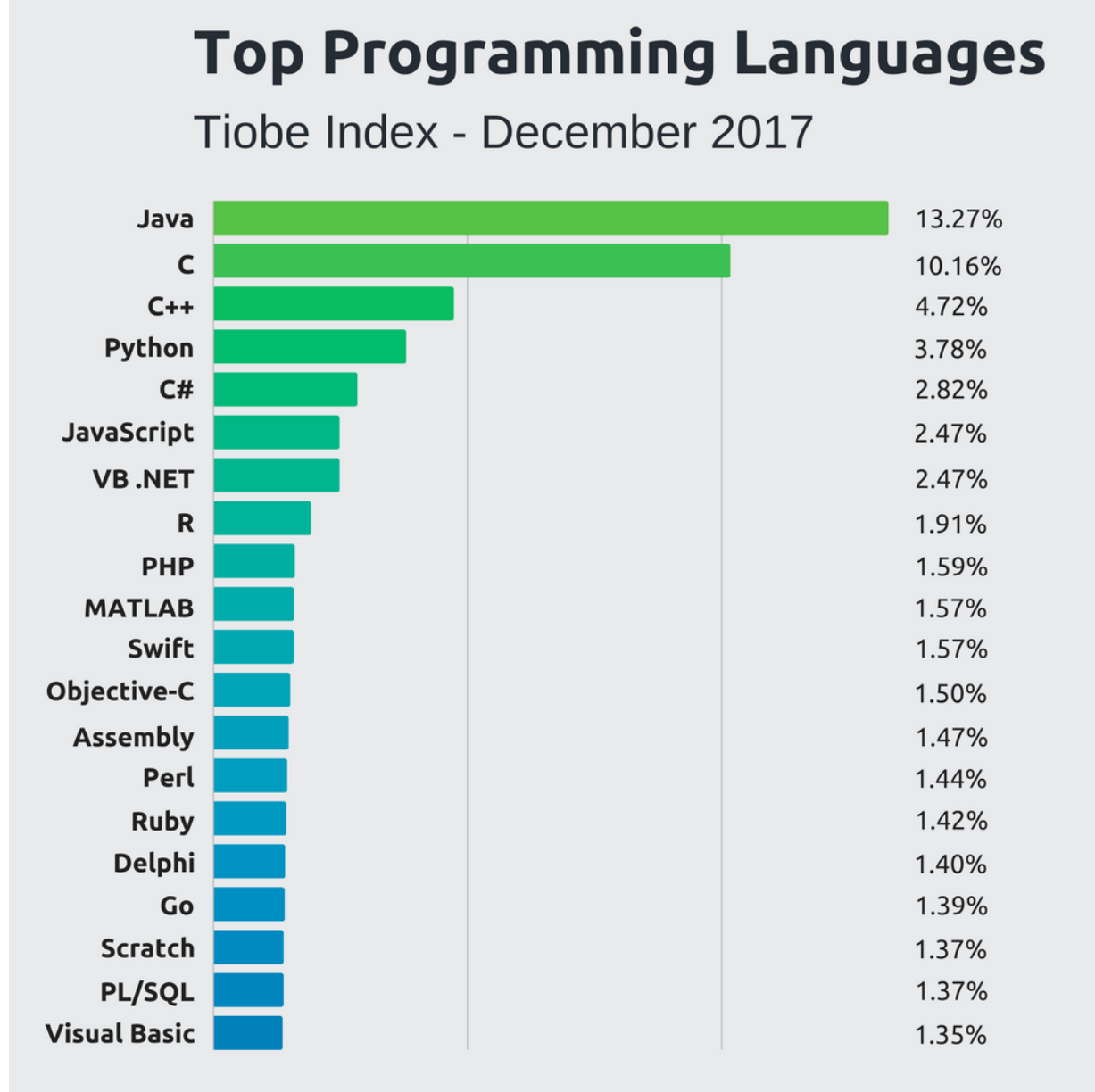
Dennis Ritchie
1969 -- 1973 at Bell Labs
C99, C11



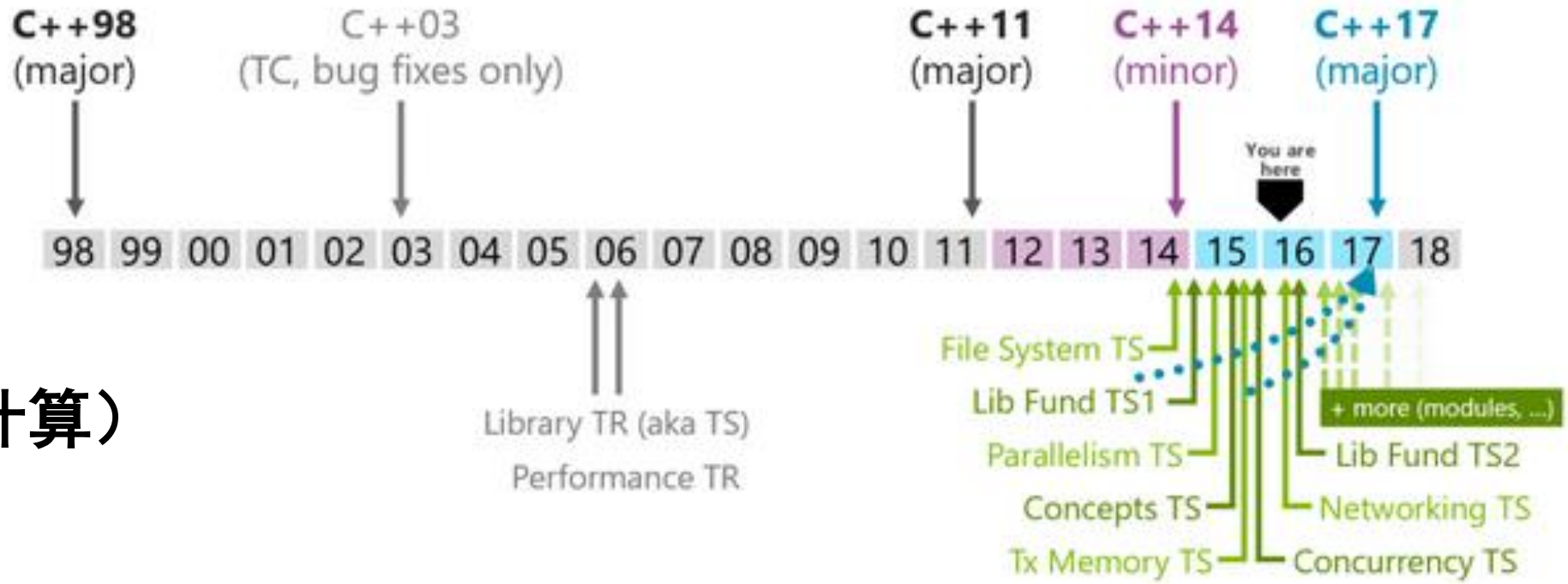
Bjarne Stroustrup
1979--1983 at Bell Labs
C++11, C++14, C++17, C++20

Bjarne Stroustrup
[bijani sdʒəusdʒup]


Job postings containing top languages
Indeed.com - November, 17th 2017
Java
68K
62K
Python
41K
46K
JavaScript
40K
38K
C++
33K
31K
C#
28K
27K
PHP
13K
14K
Perl
17K
14K
2018 jobs
2017 jobs
0
25,000
50,000
75,000


Top Programming Languages
Tiobe Index - December 2017
Java 13.27%
C 10.16%
C++ 4.72%
Python 3.78%
C# 2.82%
JavaScript 2.47%
VB .NET 2.47%
R 1.91%
PHP 1.59%
MATLAB 1.57%
Swift 1.57%
Objective-C 1.50%
Assembly 1.47%
Perl 1.44%
Ruby 1.42%
Delphi 1.40%
Go 1.39%
Scratch 1.37%
PL/SQL 1.37%
Visual Basic 1.35%

C++称霸的领域



- 游戏
- HPC（高性能计算）
  - 人工智能底层
- 编译器
- 金融财务领域：高频交易平台
- 等等

Why teaching C++

- Versatile
  - Python > C++ > Matlab
- 易于掌握
  - Python (free) > Matlab (commercial)
- 性能
  - C++。是Matlab和Pythong的必要补充。

- Java, Matlab & Python 不适合学习数据结构和算法
- The most of **libraries** for science computation are still implemented in C++.
- 其它语言不够 **hard**, C++可以用来区分great programmers and mediocre programmers.

CS231n @ stanford

- CS231n: Convolutional Neural Networks for Visual Recognition
- Spring 2018

- Prerequisites
  - **Proficiency in Python, high-level familiarity in C/C++**
    - All class assignments will be in Python, but some of the deep learning libraries we may look at later in the class are written in C++.
    - If you have a lot of programming experience but in a different language (e.g. C/C++/Matlab/Javascript) you will probably be fine.

编程语言和思想

- Assembly language
- Computation: Fortran 1954
- System programming: C 1969, **C++** 1979, C# 1999, Objective-C
- Application: Java 1995, Java script, **PHP**
- Unix shell to everything: Perl, **Python**, Ruby
- Computation: **Matlab**, Mathematics, Mapple, R
- The "concept“ of "programming languages“ are quite "similar"

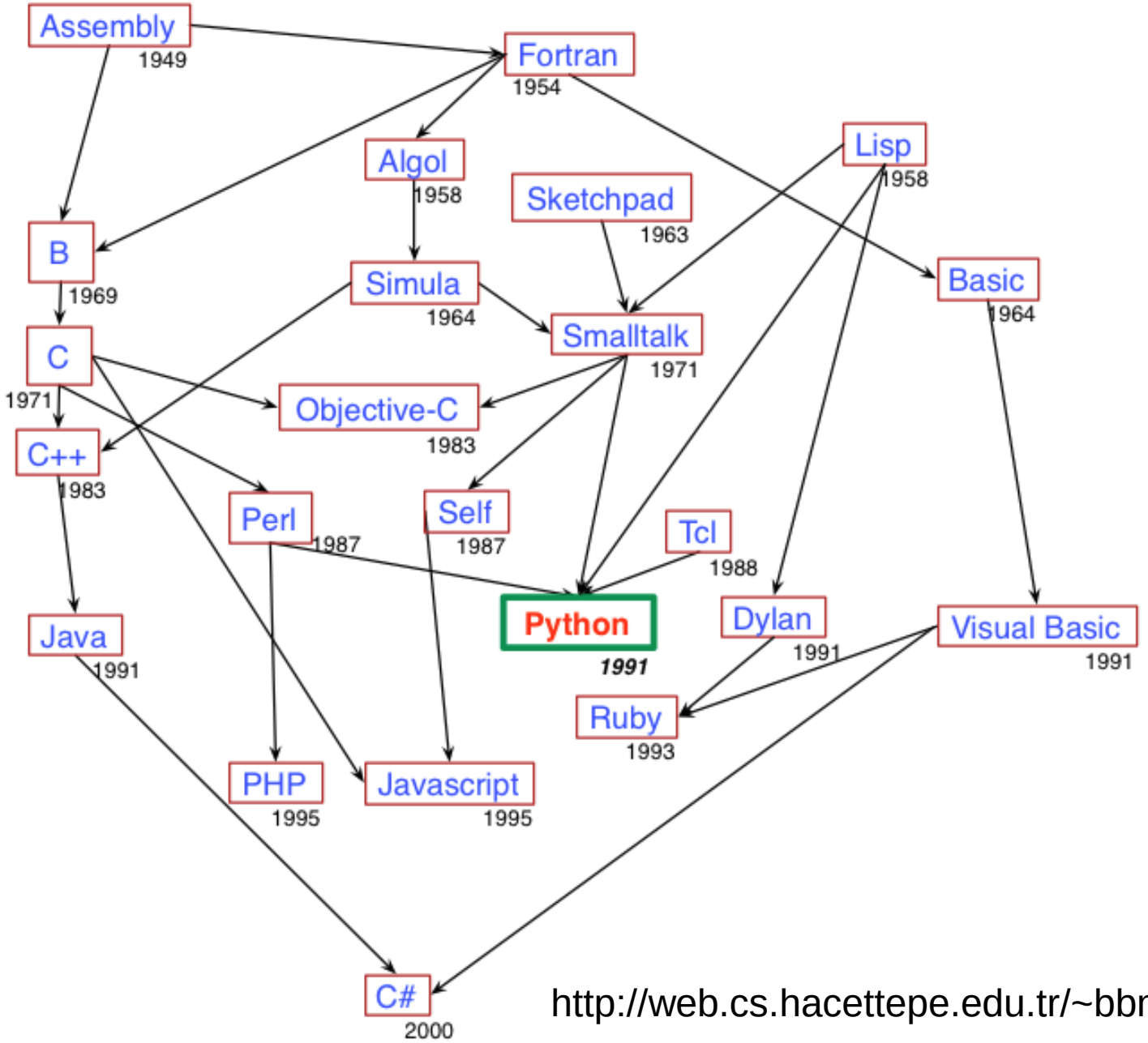
Language is the dress of thought.

~Samuel Johnson

But if thought corrupts language, language can also corrupt thought.

~George Orwell

Evolution of Programming Languages

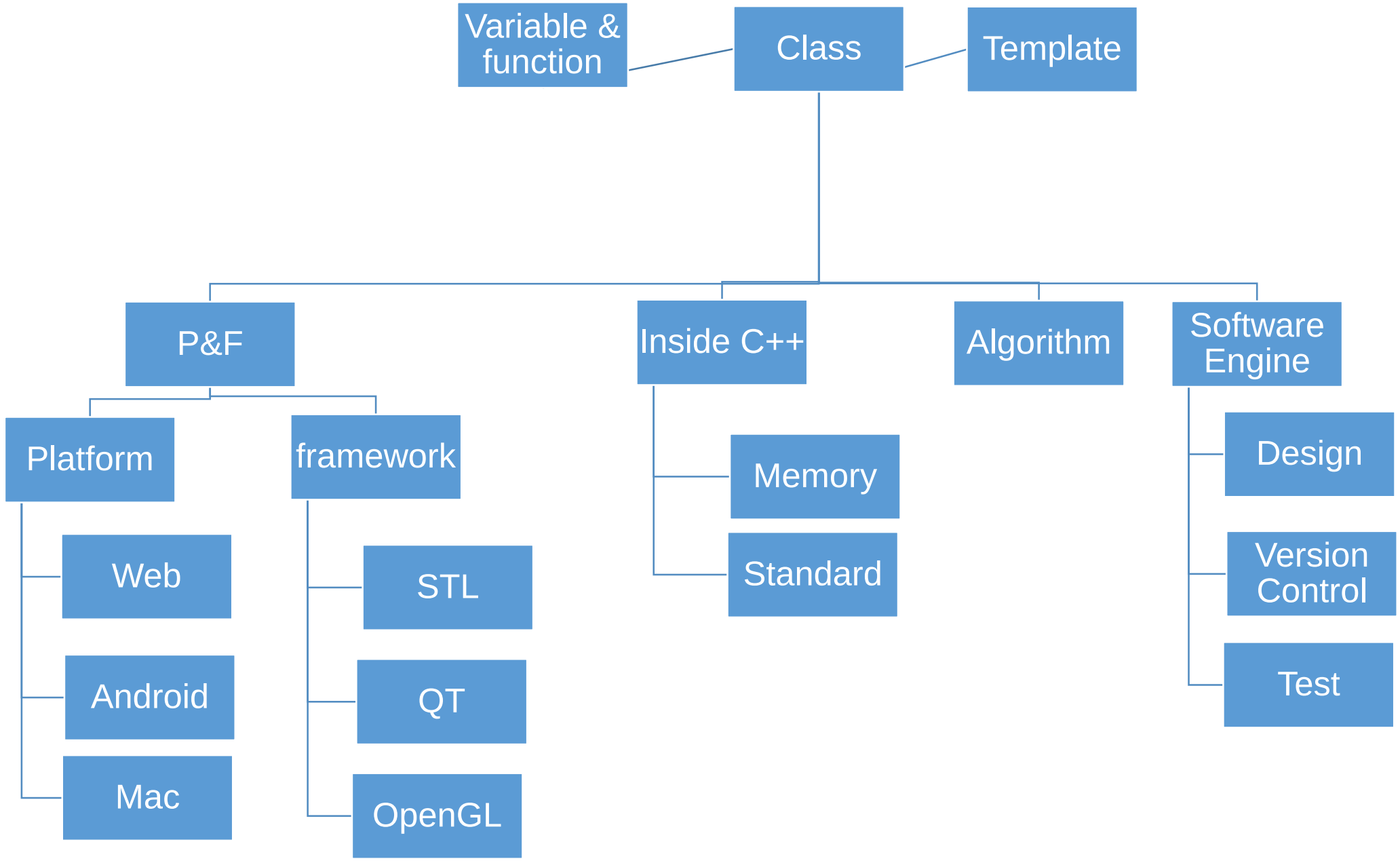


- 其实这么多年我看着各种库的起起落落，还有一种感慨是研究者**不能始终抱着一个大腿**，要与时俱进。但是时代的潮流在哪里也不是随时都能看出来的，也没法时刻保持自己在前沿，但好在**掌握了一个库之后再换另一个库并不是很费劲**。
  - --CMU LTI博士研究生 王赟

http://web.cs.hacettepe.edu.tr/~bbm101

课程相关

- 教师
  - Junjie Cao, http://jjcao.github.io
  - jjcao@dlut.edu.cn
- 主页: http://jjcao.github.io/cPlusPlus/


Variable & function
Class
Template
P&F
Inside C++
Algorithm
Software Engine
Platform
framework
Memory
Standard
Design
Version Control
Test
Web
Android
Mac
STL
QT
OpenGL

考核

item	ratio
签到、日常测试、作业	30%
Exam	70%

How to Succeed?

- 56 hours (32 talks + 24 practices) in 4 weeks
- 每个人都可以
  - Work hard
  - 精英日课2: 正确的学习方法只有一种风格
  - 多做编程练习胜过多看书
  - “少想多做”，落实到editor内；
  - 增量开发，确保每一步可运行:
    - void main() first
    - Function 1
    - Function 2
    - …
  - Debug your code
  - 英文搜索错误信息, **Google!!!**
  - **Learn by good example: follow open source projects**
  - **代码行数 约等于 编程能力**

对数学的学生而言;
进阶要求

Video

- The birth of the computer, George Dyson
- SageMath – Open source is ready to compete with Mathematica for use in the classroom, William Stein

程序员 vs 程序猿

General ideas about C++

- **Machine Language**
  - The **very limited set** of instructions that a CPU natively understands is called **machine code** (or **machine language** or an **instruction set**)
  - each instruction is composed of a number of binary digits, each of which can only be a 0 or a 1. These binary numbers are often called **bits** (short for binary digit)
    - an example x86 machine language instruction: 10110000 01100001
  - each set of binary digits is **translated** by the CPU into an **instruction** that tells it to do a very specific job
    - compare these two numbers
    - put this number in that memory location.
  - Different types of CPUs will typically have **different** instruction sets, so instructions that would run on a Pentium 4 would not run on a Macintosh PowerPC based computer.
  - Back when computers were first invented, programmers had to **write programs directly in machine language**, which was a very difficult and time consuming thing to do.
- **Assembly Language**
- **High-level Languages**

General ideas about C++

- **Machine Language**
  - an example x86 machine language instruction: 10110000 01100001
- **Assembly Language**
  - each instruction is identified by a **short name** (rather than a set of bits), and **variables** can be identified by names rather than numbers
  - must be translated into machine language by using an **assembler**.
  - Assembly languages tend to be very **fast**, and assembly is still used today when speed is critical.
  - However, the reason assembly language is so fast is because assembly language is tailored to a particular CPU. Assembly programs written for one CPU will **not run on another CPU**.
  - Furthermore, assembly languages still require a lot of instructions to do even simple tasks, and are **not very human readable**.
    - the same instruction as above in assembly language: mov al, 061h
- **High-level Languages**

General ideas about C++

- **Machine Language**
  - an example x86 machine language instruction: 10110000 01100001
- **Assembly Language**
  - the same instruction as above in assembly language: mov al, 061h
- **High-level Languages**
  - C++: **more abstract, easy**:
    - Conciseness: 1 = many
    - Maintainability: easier to modify
    - Portability: suitable for different types of processor

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

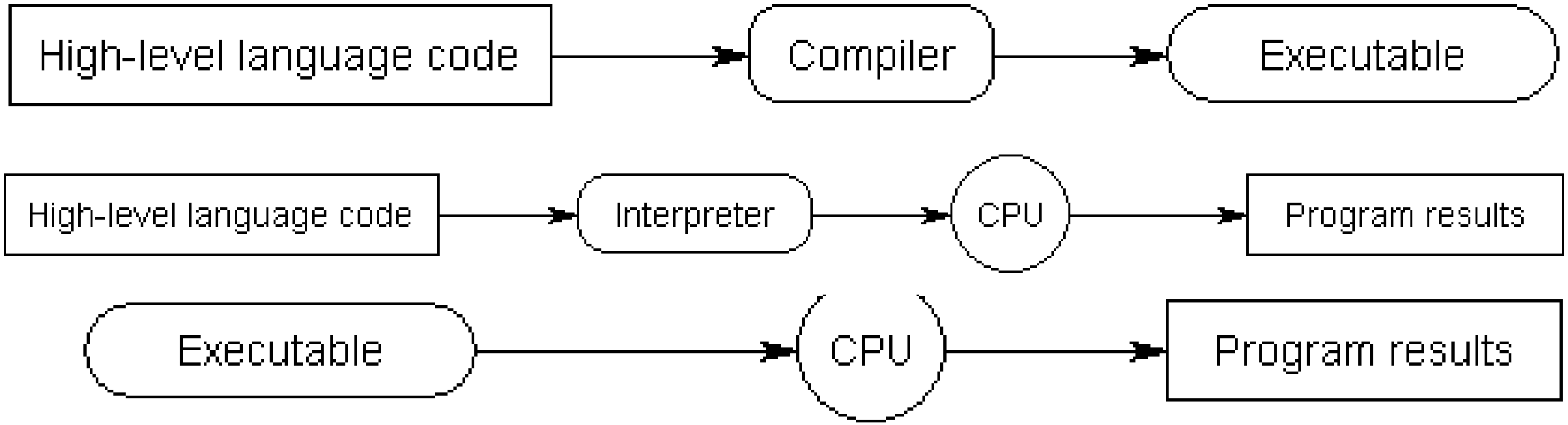
  - C++ is a **high-level** language, **compiled** language, strong **types**, **case sensitive**.

The Compilation Process

Our language v.s. binary language the computer used

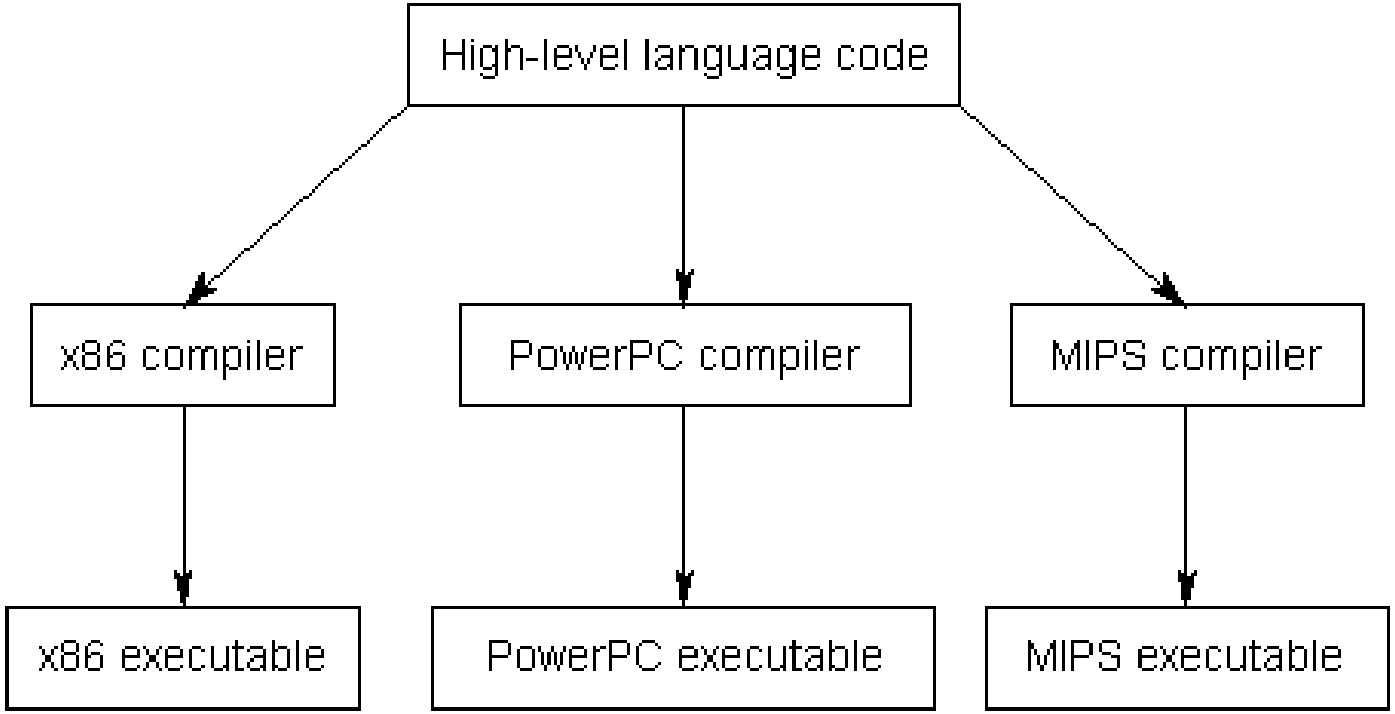
C++ is like natural language

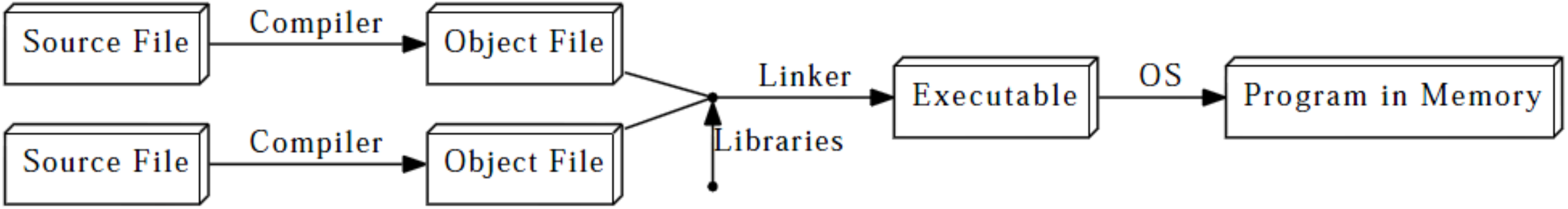
Compiler: make computer understand C++



The Compilation Process

Compiler: make computer understand C++





C and C++'s philosophy能力与责任

- Underlying design philosophy: "**trust the programmer**"
  - Wonderful
    - compiler will not stand in your way if you try to do something unorthodox that makes sense,
  - Dangerous
    - compiler will not stand in your way if you try to do something that could produce unexpected results.
    - That is one of the primary reasons why knowing **what you shouldn't do** in C/C++ is almost **as important as knowing what you should do** -- because there are quite a few pitfalls that new programmers are likely to fall into if caught unaware.

控制台程序(Console programs)

远比图形接口程序容易实现和迁移到不同的操作系统

Hello World

```
// A Hello World program
# include <iostream>
int main()
{
    std::cout << "Hello, world!\n";
    return 0;
}
```

Line-By-Line Explanation

- // 注释comment

indicates that everything following it until the end of the line is a **comment**: it is ignored by the compiler.

- /* and */
  - (e.g. x = 1 + /*sneaky comment here*/ 1;
  - multiple lines;

```
// A Hello World program
# include <iostream>
int main() {
    std::cout << "Hello, world!\n";
    return 0;
}
```

- Usages
  - Comments exist to **explain non-obvious** things going on in the code. Use them: **document** your code well!

```
// A Hello World program
# include <iostream>
int main() {
    std::cout << "Hello, world!\n";
    return 0;
}
```

- # **preprocessor commands**
  - 用#开始的行是预处理命令(preprocessor commands), which usually change what code is actually being compiled.
  - #include tells the **preprocessor** to dump in the contents of another file, here the iostream file, which defines the procedures for input/output.

```
// A Hello World program
# include <iostream>
int main() {
    std::cout << "Hello, world!\n";
    return 0;
}
```

- int main()
  - main 函数名
  - 跟随mian的()说明它是一个函数
  - main()之前的int表明该函数返回一个整数值
  - 当程序被执行（载入内存），main()是第一个被执行的函数（程序的入口）

```
// A Hello World program
# include <iostream>
int main() {
    std::cout << "Hello, world!\n";
    return 0;
}
```

- 大括号{}表明main()的函数体
  - {}把多个命令组成一组命令：multiple commands =》a block代码块
  - 每一个命令/声明（command/statement）必须分号结尾
  - More about this syntax in the next few lectures.

```
// A Hello World program
# include <iostream>
int main() {
    std::cout << "Hello, world!\n";
    return 0;
}
```

- cout <<
- This is the syntax for outputting some piece of text to the screen.

```
// A Hello World program
# include <iostream>
int main() {
    std::cout << "Hello, world!\n";
    return 0;
}
```

- std是一个名称空间Namespaces
  - 作用域解析操作符scope resolution operator ::
  - 通知编译器要调用std中的cout，而不是别处jjcao::cout

using namespace std;

- This line tells the compiler that it should look in the std namespace for any identifier we haven’t defined.
- If we do this, we can omit the std:: prefix when writing cout.

```
// A Hello World program
# include <iostream>
int main() {
    std::cout << "Hello, world!\n";
    return 0;
}
```

- 字符串String
  - *Hello, world*
  - 像这样显示指定的字符串，叫string literal.字符串字面量

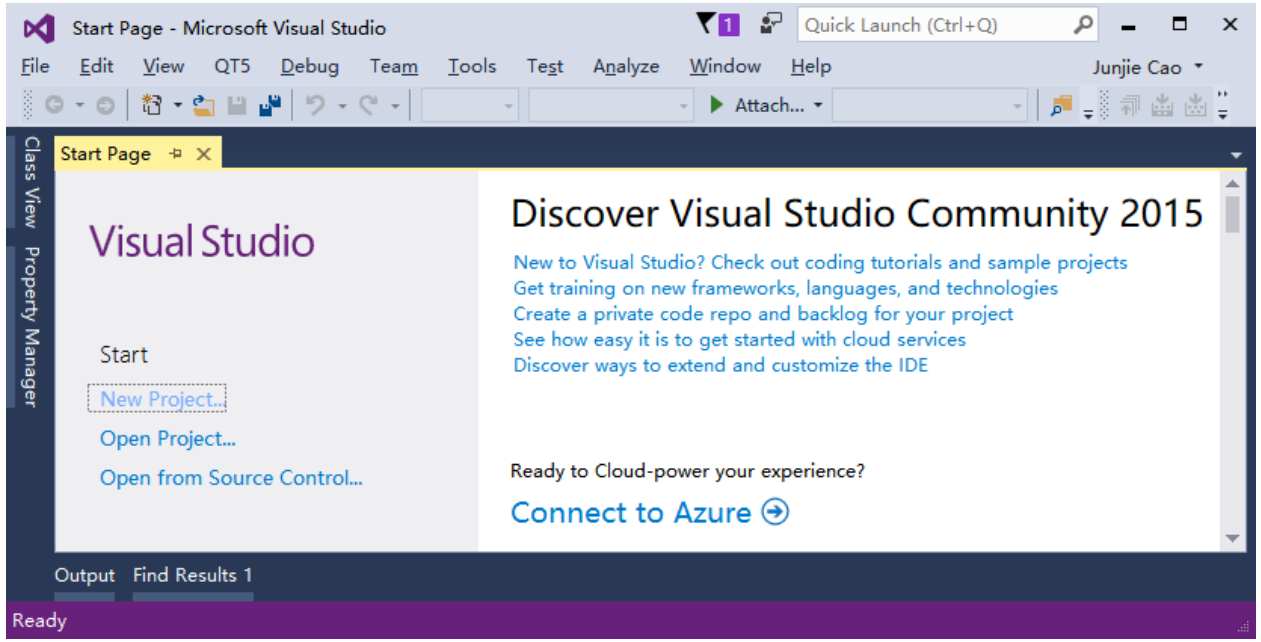
- \n
  - The \n indicates a **newline** character.
  - 转义序列（Escape sequences）: It is an example of an escape sequence – a symbol used to represent a special character in a text literal.

```
// A Hello World program
# include <iostream>
int main() {
    std::cout << "Hello, world!\n";
    return 0;
}
```

- return 0
  - 通知OS，本程序成功执行完毕。
  - 是main block的最后一行
- 注意
  - 每一个声明需要分号结束（预处理命令和{}除外（如果是定义class的时候，{}也要跟着分号））
  - 忘记分号，是新手常犯错误

Integrated Development Environment
集成开发环境IDE

- Visual C++: Windows
- Code::Blocks: Linux
- Xcode, Eclipse: Mac



- CodeChef: Web based
  - Web-based compilers are fine for dabbling and simple exercises. However, they are generally quite limited in functionality -- many won't allow you to save projects, create executables, or effectively debug your programs. You'll want to migrate to a full IDE when you can.

- [Installing an Integrated Development Environment (IDE)]

编译你的第一个程序

- lab01_IDE_VC_Win32ConsoleApplication.pptx
- LearnCpp.com

A few common C++ problems

- LearnCpp.com
- http://www.runoob.com/cplusplus

Reference Courses

- cpp for school
  - simpler and with assignments, projects, quiz and papers.
- LearnCpp.com
  - more detail explanations than cpp for school

Reference Books

1.C++ Primer

2. The C++ Programming Language. (more advance than 1)
3. The C++ Standard Library – A Tutorial and Reference
4. **Teach Yourself C++ in One Hour a Day**

5. **Code complete 2nd**
6. Clean Code A Handbook of Agile Software Craftsmanship

Useful Links

- http://www.cplusplus.com

Academic Integrity

- Honest work is required of a scientist or engineer.
- Integrity is the key for everything!!!

- Discussion is permitted.
- Everything you turn in must be your own work.
- Cite your sources, explain any unconventional action.

- If you have a question, ask.