Coding with Python & C++ -- Introduction

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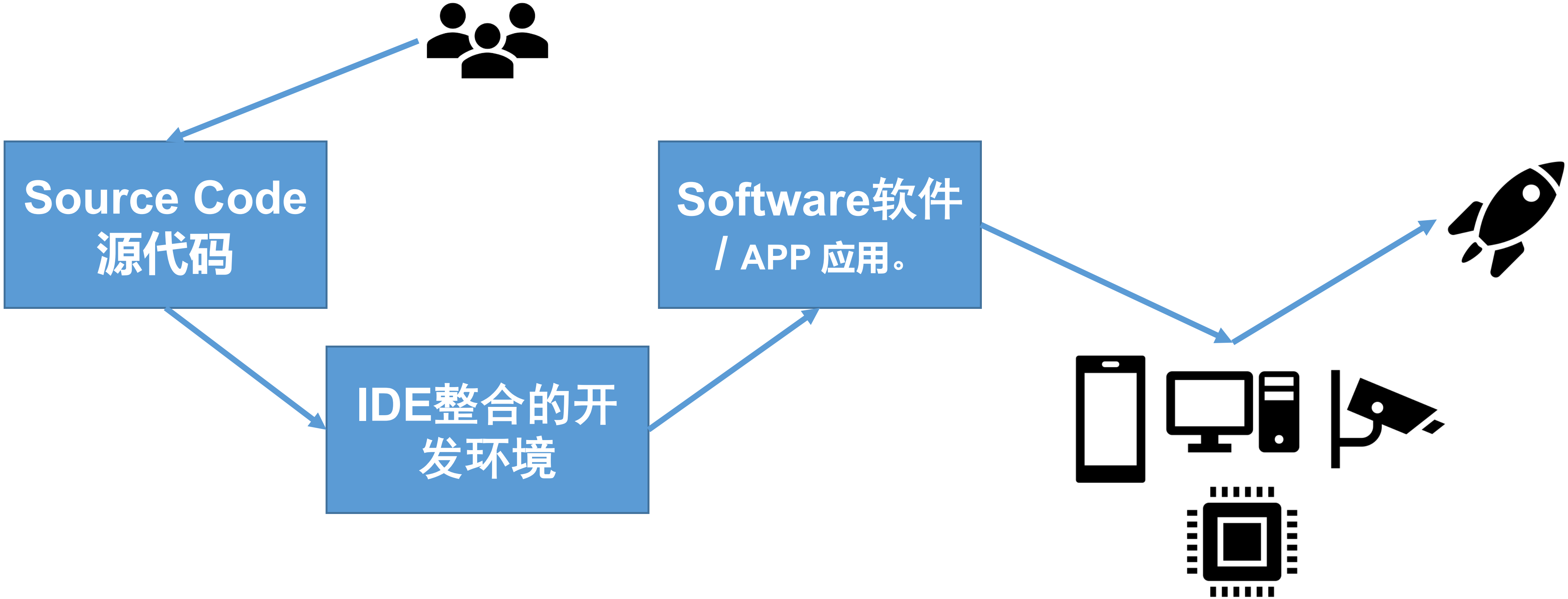
https://github.com/jjcao-school/c

0 Why coding matters?

0.0 What is computer programming?

- computer programming 计算机编程，也叫coding 编码
- 书写一些代码 code，控制计算机完成指定的任务



Source Code
源代码

IDE整合的开发环境

Software软件
/ APP 应用。

0.1 What is source code?

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

```
print("Hello, world!")
```

- 这是什么？
- 英文？
- 为什么这两段code看起来不一样？

0.1.1 The source code of a program is written in one or more languages

- Natural language 自然语言 vs. programming language 编程语言

- 自然语言?
  - 一种表达和记录人类思想的工具
  - 听说读写，思考
  - 人与人之间的交流=》协作
- 编程语言
  - 人机交流 + 人人交流
  - 可理解，明白易懂 intelligible to programmers
  - 遵守一定规则：词汇**Lexicon**，句法**Syntax**，语义**Semantics**
  - 没有自然语言灵活

0 Why coding matters?

- 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**.

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

Example 黑客

不过“黑客”这个词其实并不是起源于计算机，最早说的是麻省理工学院一个火车技术爱好者俱乐部里的人。
黑客，泛指那些善于折腾技术，能“黑进系统”的人。
日常生活中的各种事物也都可以是系统，而系统，都有两套规则。

一般人看到的是表面的规则。比如这有个应用程序，表面上的规则就是寻常的使用方法，这个按钮什么功能，那个文件怎么读取 —— 而在黑客眼中，表面之下，这个程序实际上是怎么运行的，另有一套规则。这两套规则之间有个巨大的裂口，使得黑客可以做到普通人做不到、甚至根本就不知道能做的事情。

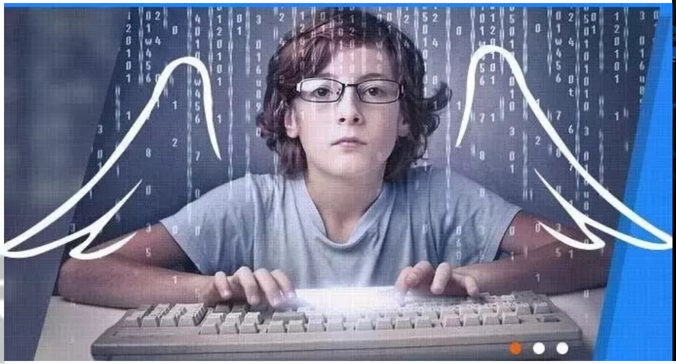
— 生活黑客

0 Why coding matters?

0.2 What is the use of coding?

1) **create websites, video games, and apps**.
2) an essential part of artificial intelligence and machine learning.
3) 构建元宇宙和现实宇宙
4) 物联网
    - 万物有眼（传感器），万物有脑（程序），万物互联

- 请举一个不同的例子



nature
THE INTERNATIONAL WEEKLY JOURNAL OF SCIENCE
At last — a computer program that can beat a champion Go player PAGE 484
ALL SYSTEMS GO
CONSERVATION
SONGBIRDS À LA CARTE
Illegal harvest of millions of Mediterranean birds
PAGE 452
RESEARCH ETHICS
SAFEGUARD TRANSPARENCY
Don't let openness backfire on individuals
PAGE 459
POPULAR SCIENCE
WHEN GENES GOT 'SELFISH'
Dawkins's calling card forty years on
PAGE 462
NATURE.COM/NATURE

Example

- **马斯克不仅成为世界上第一个发射私人火箭的人，还把火箭芯片的成本足足降低了5384倍！**
- 美国发射一次火箭的芯片组成本，约1.4亿人民币；而马斯克Space X 火箭的芯片组，仅用了**2.6万人民币！**

- 为什么可以这么便宜？编程帮了他的大忙。
- 马斯克**摒弃了NASA为火箭专门设计的复杂编程语言，直接用C++和Python，来编写火箭主芯片程序**。
- “用一台普通的电脑就可以编写！”“我正在和火箭发射用同一种编程语言！”
- 外界纷纷惊叹，整个科技圈都沸腾了。浩航星空不再这么遥不可及，用身边最“接地气”的代码，也可以触达。

0 Why coding matters?

0.3 Coding is cool

- The birth of the computer, George Dyson

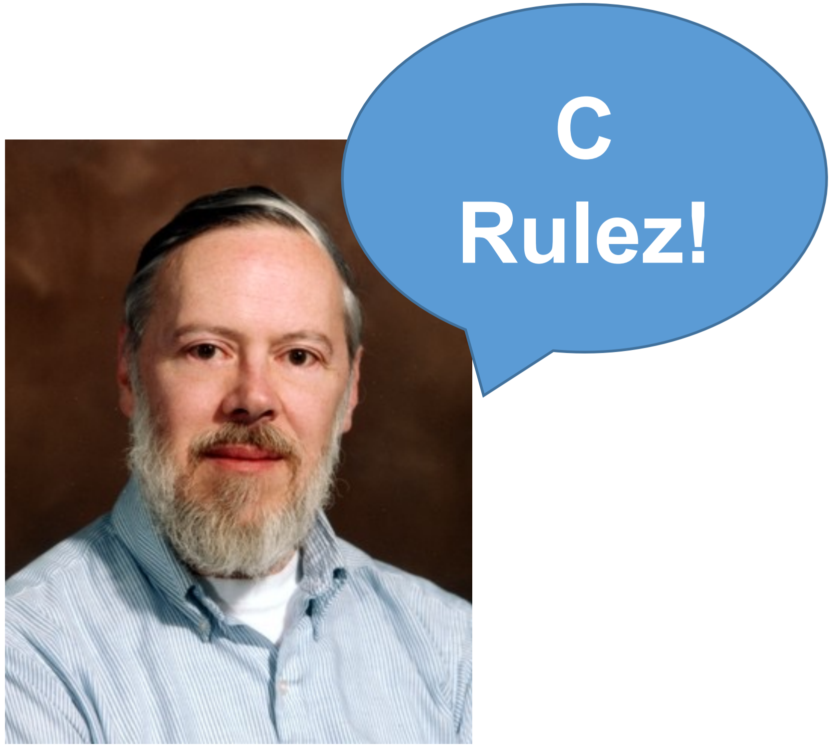
程序员 vs 程序猿

SageMath – Open source is ready to compete with Mathematica for use in the classroom, William Stein

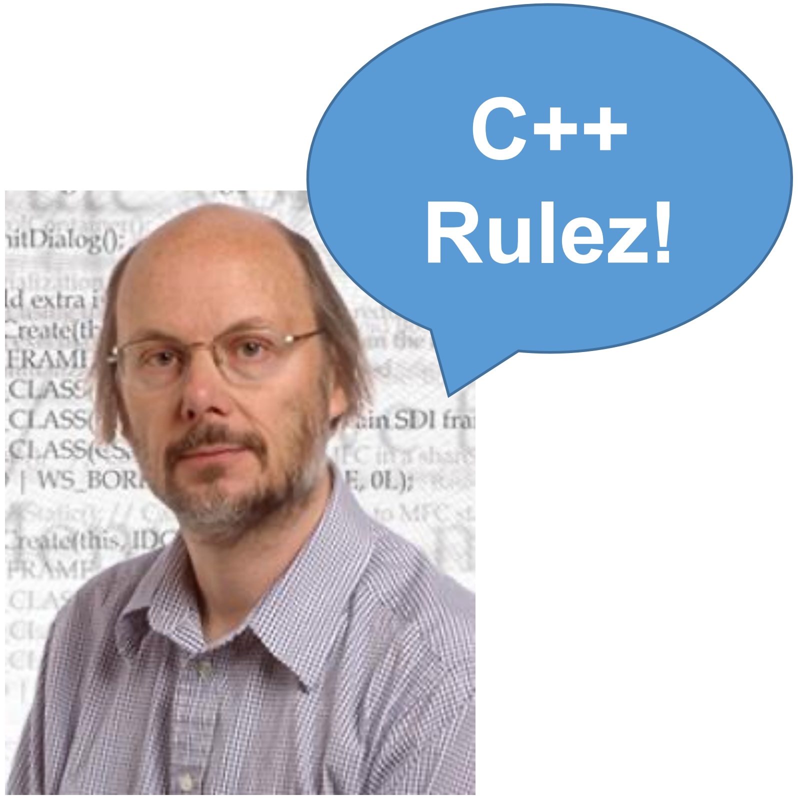
1 Why should we learn Python & C++?

Is **Matlab/Python** the final weapon?

Why teaching C++



Dennis Ritchie
1969 -- 1973 at Bell Labs
C89, …, C99, C11, C18

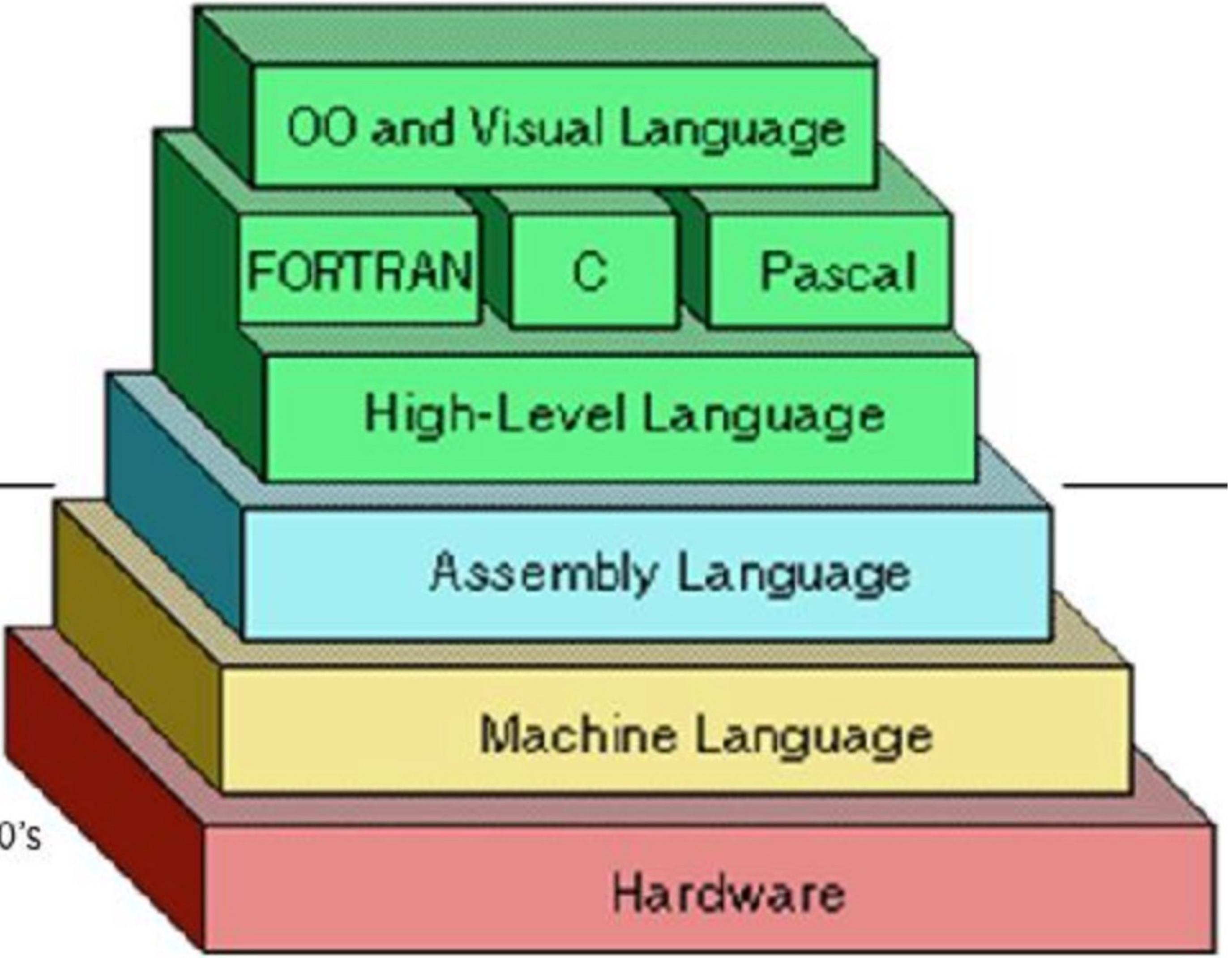


Bjarne Stroustrup: Why I Created C++ - YouTube
[bijani sdʒəusdʒup]
1979--1983 at Bell Labs
C++11, C++14, C++17, C++20

Functions, Performance && Maintainable

High Level Language

- Easy for Programmers to understand
- Contains Engilish Words



Low Level Langugae

- The computer's own Language
- Binary numbers, in 1's and 0's

Language evolution

- 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 & C++ are **high-level** languages, **compiled** languages, strong **types**, **case sensitive**.

可维护，更利于人机交流是演化的方向；同时，现实要求有足够的性能

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.

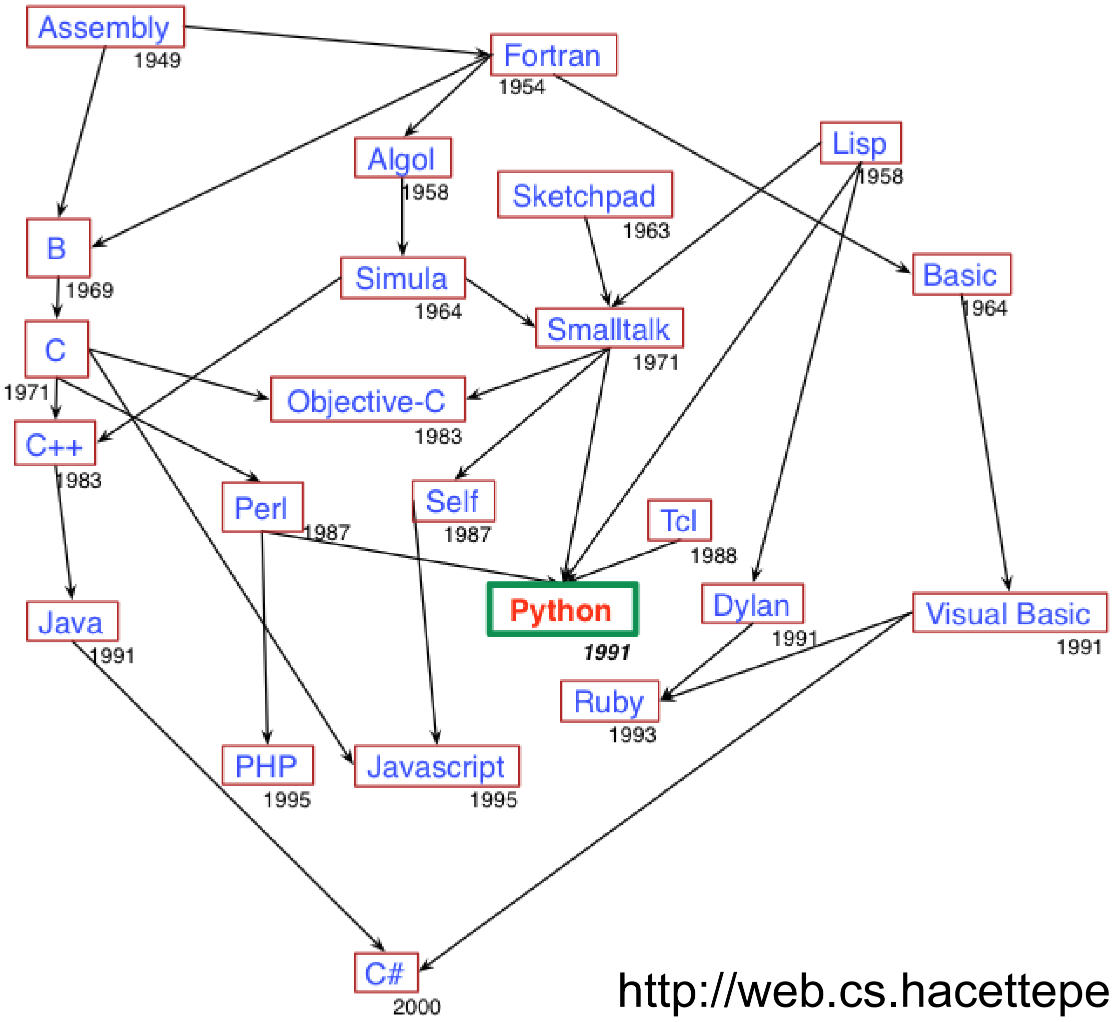
~Samuel Johnson

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

~George Orwell

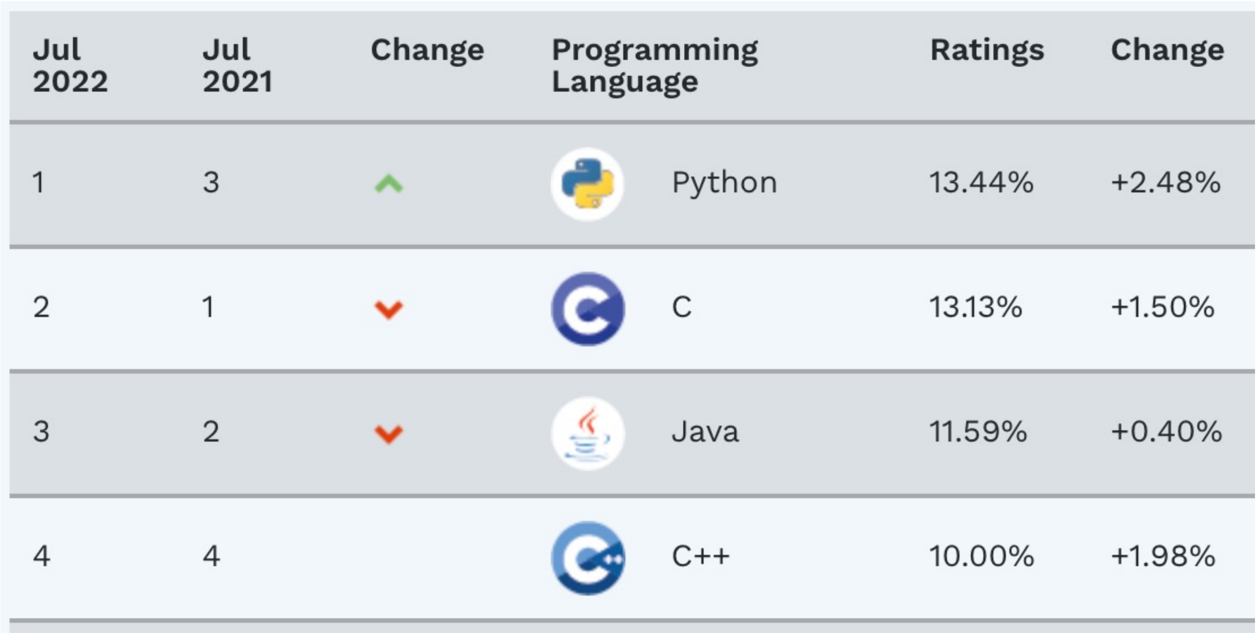
Evolution of Programming Languages

The conceptual apparatus used by the C++ language is common for all object programming languages.

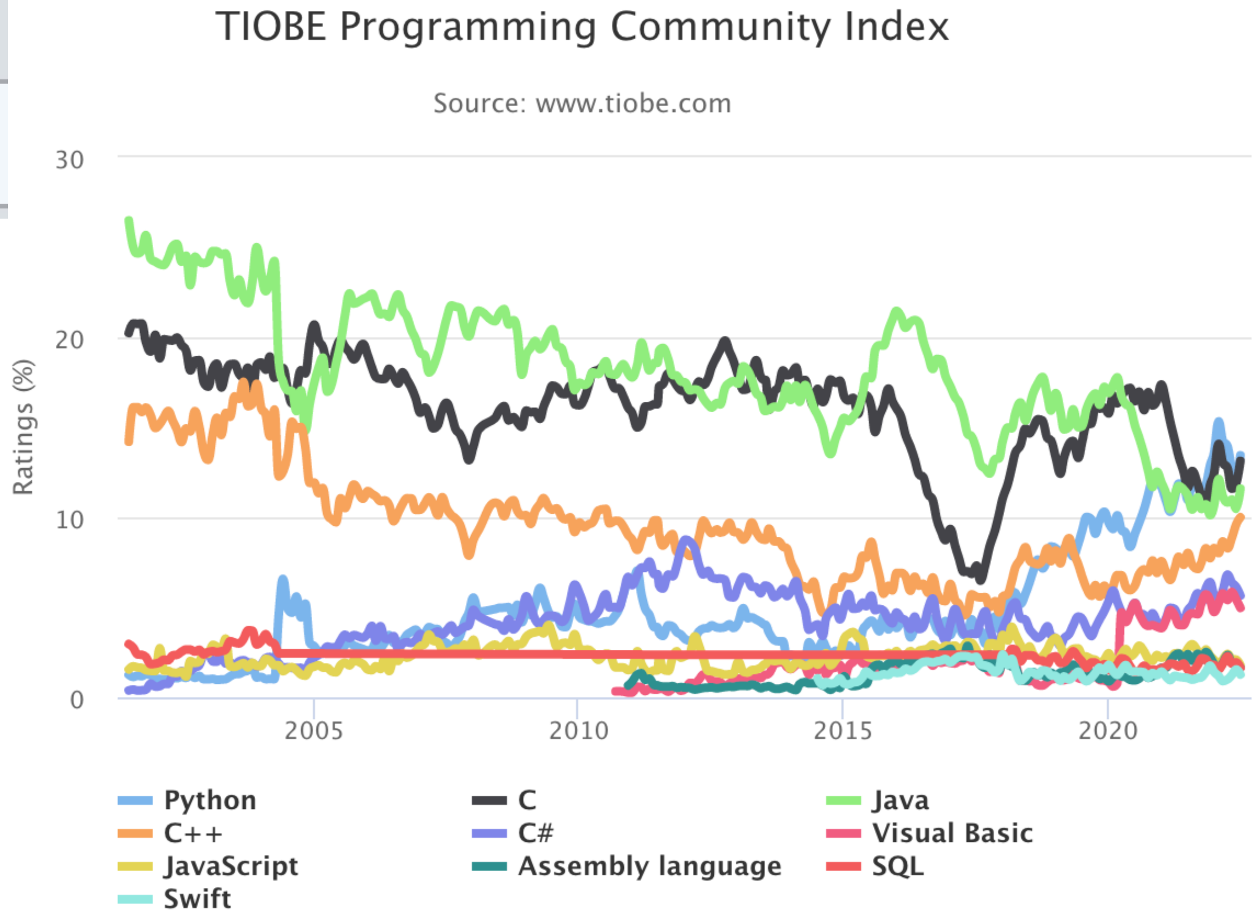


- 其实这么多年我看着各种库的起起落落，还有一种感慨是研究者**不能始终抱着一个大腿**，要与时俱进。但是时代的潮流在哪里也不是随时都能看出来的，也没法时刻保持自己在前沿，但好在**掌握了一个库之后再换另一个库并不是很费劲**。
  - --CMU LTI博士研究生 王赟

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

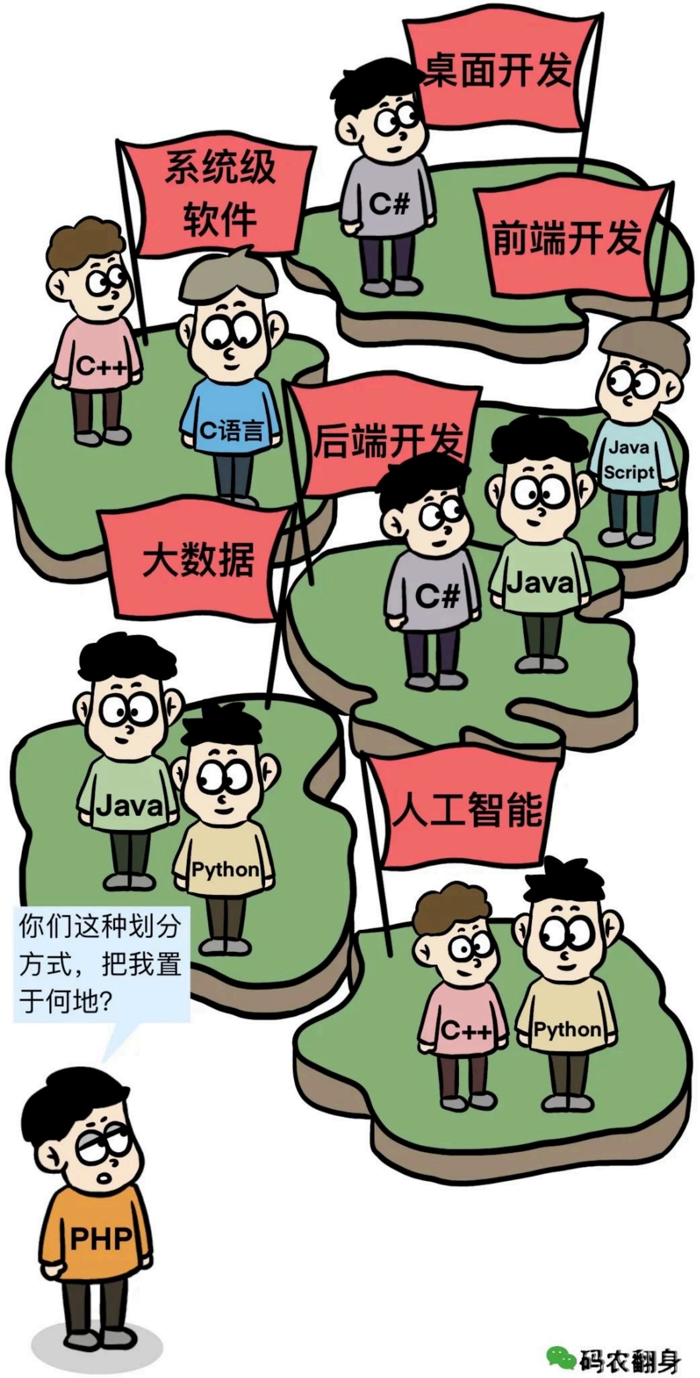


Jul 2022	Jul 2021	Change	Programming Language	Ratings	Change
1	3	▲	Python	13.44%	+2.48%
2	1	▼	C	13.13%	+1.50%
3	2	▼	Java	11.59%	+0.40%
4	4		C++	10.00%	+1.98%



TIOBE Programming Community Index

Source: www.tiobe.com


桌面开发
C#
系统级软件
C++
C语言
前端开发
JavaScript
后端开发
C#
Java
大数据
Java
Python
人工智能
C++
Python
你们这种划分方式，把我置于何地?
PHP
码农翻身

What is the most common use of C++?

- What is C++?
  - An object-oriented 面向对象 programming language
  - C++是一种混合语言，是集过程化设计、面向对象、基于对象和泛型算法等多种技术于一体的编程语言

- Its usage:
  - Large, complex applications
  - Scientific Computing
    - The most of **libraries** for science computation are still implemented in C++.
  - Performance
    - **Game：** @腾讯游戏 宣布将以游戏AI“去中心化控制 “多智能体算法助力@中科院高能所 “全变源追踪猎人星座” ，协调上百颗卫星更高效地观测宇宙。
    - **HPC（高性能计算）**
    - **AI 人工智能底层**
    - **Financial 金融:** 高频交易平台
    - **Operation System, such as windows, Linux**
    - …

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。
  - 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.

CS231n: Convolutional Neural Networks for Visual Recognition, @ Stanford, Spring 2019

Why teaching C++

- Versatile
  - Python >= C++ > Matlab
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- 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
- 其它语言不够 **hard**, C++可以用来区分great programmers and mediocre programmers.

Why learn Python & C++ together?

- **More languages — better understanding**
- Every new programming language brings something new for the understanding of how to solve the problem.
- Different tasks need different approaches and **every programming language is specified for a concrete approach**.
- Of course, one can develop a machine learning algorithm on C++ or build system monitoring utility on Python.
- But will it be comfortable? The knowledge of more instruments shows you the real nature of the problem and allows you to choose the most matching one.
- **Python and C++ are different enough** to show the pros and cons of both of them and to show the perfect matching tasks for these languages.

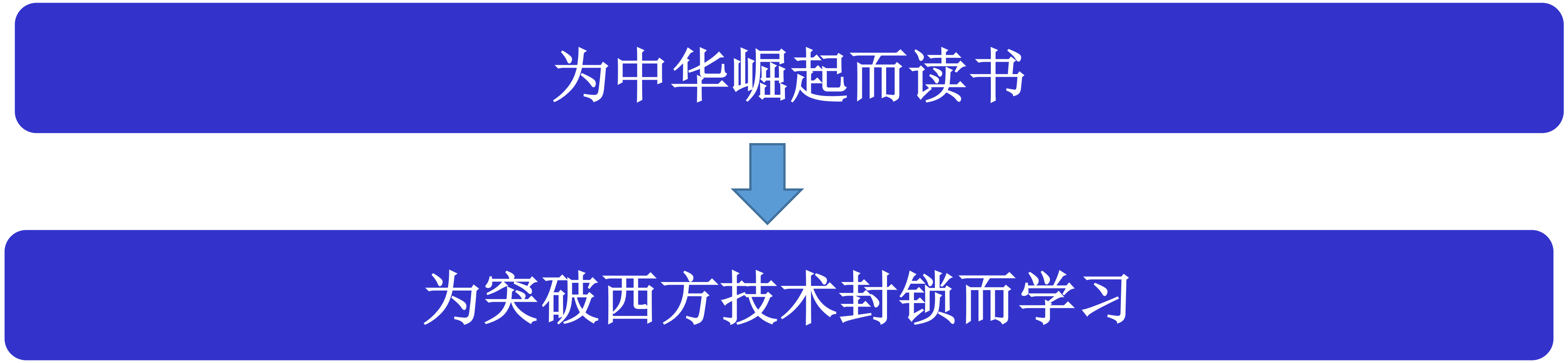
Learning Python From C++ Developer’s Point of View, Pavlo Horbonos.

2 How to learn coding?

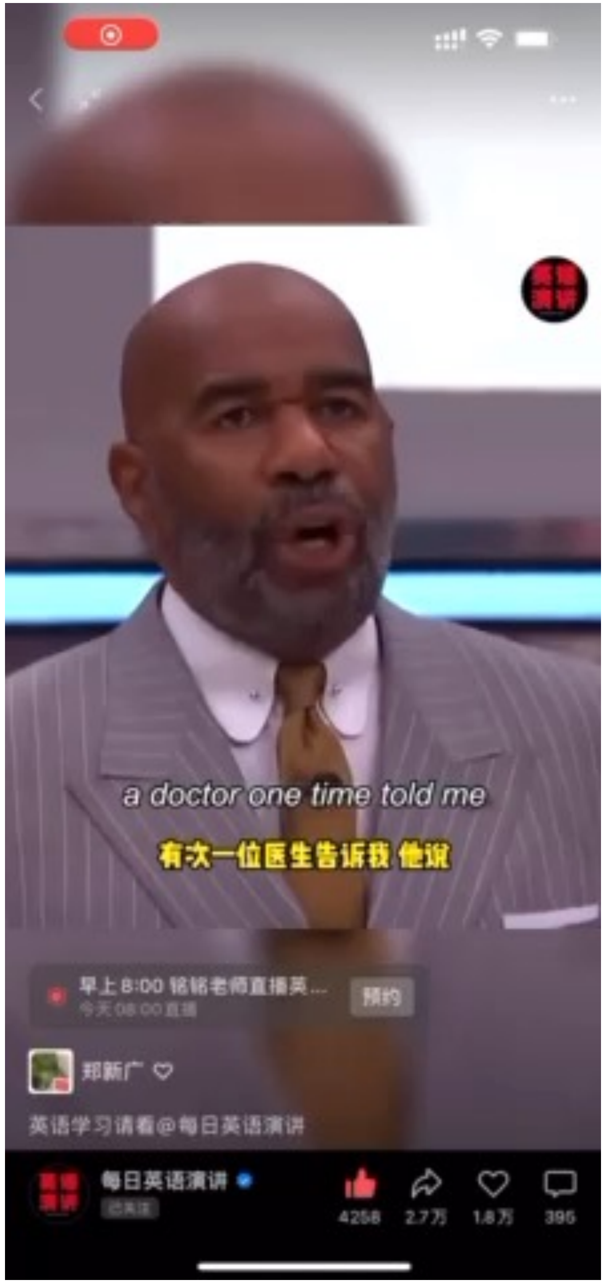
励志

- 2019年4月《科技日报》列35项卡脖子技术
  - 第13项: 核心工业软件
  - 第15项: 核心算法
  - 第20项: 航空设计软件。
- 2021年1月12日美国Adobe公司全面禁止Flash软件运行，导致大连车务段系统一夜之间全数无法访问，导致职工无法查看列车运行图，无法制定列车编组顺序表，无法编排调车计划。几乎全段的运输生产电脑全部出现同一故障。

这是软件停用的案例，非卡脖子案例。



Watch how people get up



a doctor one time told me

有次一位医生告诉我 他说

早上 8:00 铭铭老师直播英...
今天 08:00 直播

邦新广

英语学习请看@每日英语演讲

How to Succeed?

- 实践：自行车，windows，手机，…
  - 多coding胜过多读编程书籍
    - “少想少看多做”，落实到IDE内；
  - 分而治之，增量开发，确保每一步可运行:
    - void main() first
    - Function 1
    - Function 2
  - **代码行数 约等于 编程能力**
- Debug your code
  - 不怕错，不用书，因为调试之下，了无秘密
- 英文搜索错误信息, Google!!!

- Learn by good example: follow open source projects
- 精英日课2: 正确的学习方法只有一种风格

基本要求; 进阶要求

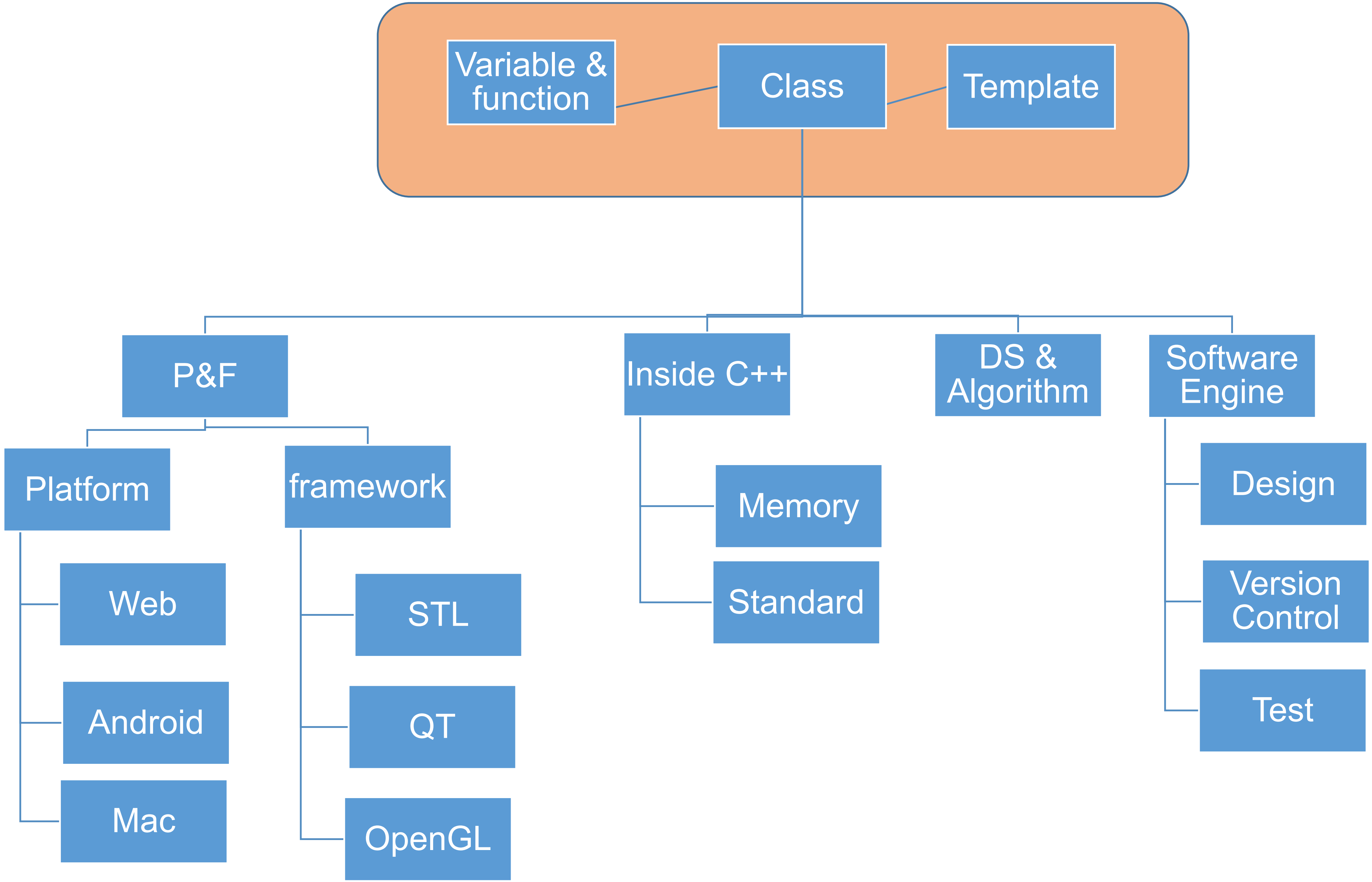
标准学习方法——六多

- 多阅读
  - 相关书籍、网上资源、源程序等
- 多练习
  - 多做有实际应用背景的题，可以自己给自己出题
- 多测试
  - 验证自己的理解，自己解答自己的疑问
- 多沟通
  - 问题：试过后还理解不了的
- 多思考
  - 思考和理解运行机制、优缺点、注意事项
- 多总结
  - 归纳和整理别人和自己的经验

目标

给定数据+问题描述，独立写程序解决这个问题

3 课程相关


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

Reference Books

1. **C++ Primer, 5th version**
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

- Python语言基础与应用 北京大学 陈斌
- 数据结构与算法Python版–北京大学–陈斌

Reference Courses

- cpp for school http://www.cppforschool.com
  - simpler and with assignments, projects, quiz and papers.
- LearnCpp.com http://www.learncpp.com
  - more detail explanations than cpp for school

- [online course & IDE]: [cpp在线中文教程](https://www.runoob.com/cplusplus/cpp-tutorial.html)，包括主流操作系统下g++和Visual C++的设置. 提供在线编译运行，可见编译错误提示，程序输出等
- [online course & IDE](https://www.dotcpp.com),大量练习题，在线提交，可以获取3种状态：编译失败，运行结果错误，成功。

Useful Links

- http://www.cplusplus.com

- [代码打包工具]: Visual C++代码打包工具, 可以自行调整.
- [总结]: C++知识体系, 总结的很好，包括一些高级内容.

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.**

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 异端的 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.