

Programming with C++

COMP2011: Introduction

Cecia Chan
Cindy Li
Brian Mak

Department of Computer Science & Engineering
The Hong Kong University of Science and Technology
Hong Kong SAR, China

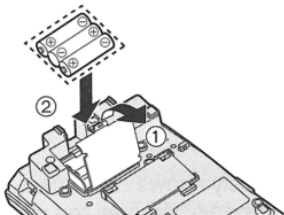


Course Objectives

- To learn how to **solve problems** by writing **computer programs**.
- To learn how to **design** a computer program.
- To learn how to program in **C++**.
- To learn how to **debug** a computer program.
- To learn **object-oriented programming**.
- To prepare you for COMP2012 (OOP & Data Structures), etc.

Question: *computer science = programming?*

Installing the Batteries

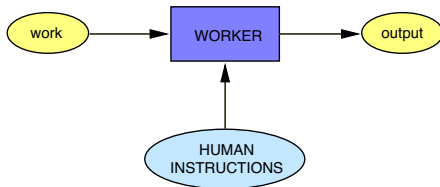


- 1 Press down in the direction of the arrow and open the cover (①).
- 2 Install the batteries in the proper order as shown (②), matching the correct polarity.
- 3 Close the battery cover.

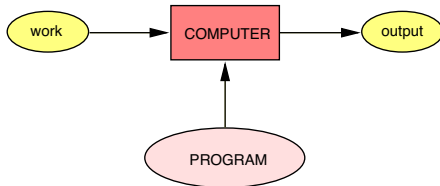
- Batteries are not included in the unit.
- Install three high quality “AA” size Alkaline (LR6) or Manganese (R6, UM-3) batteries. We recommend to use Alkaline batteries.
Battery life is: —about six months in use of Alkaline batteries.
 —about three months in use of Manganese batteries.
Battery life may depend on usage conditions and ambient temperature.

What's a Computer Program? ..

Human work model

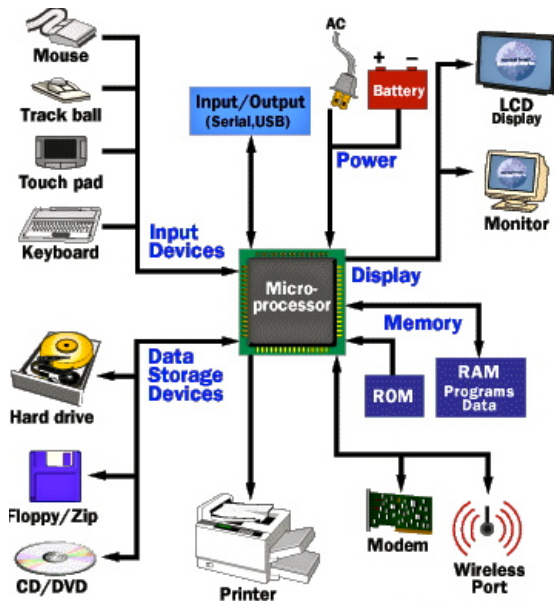


Computer work model

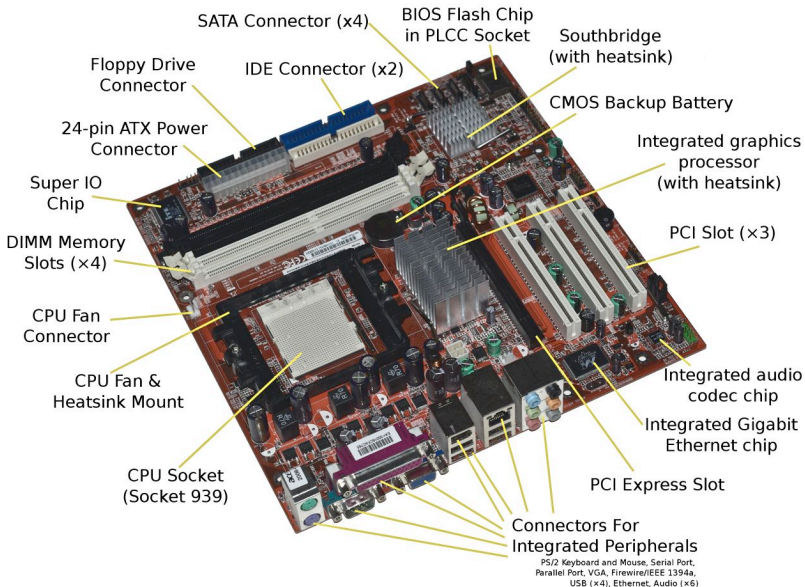


- A **computer program** is a set of **machine-readable instructions** that tells a computer how to perform a specific task. (During the execution of the program, it may interact with the users and its environment.)

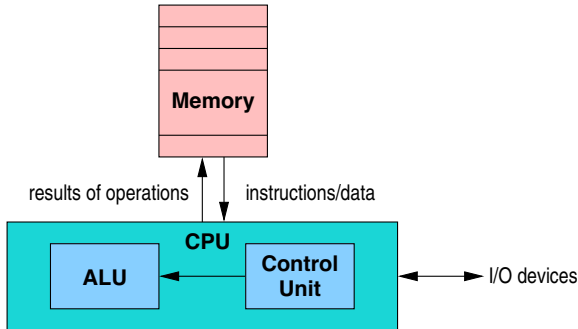
Schematic Diagram of a Personal Computer



A Typical Motherboard



von Neumann Computer Architecture



- Designed by **John von Neumann**, a mathematician, in 1945.
- It is still today's dominant computer architecture.
- **CPU** = Central Processing Unit
- **ALU** = Arithmetic Logic Unit.
- For **efficiency**, many programming languages, including C++, are designed to take advantage of the architecture.
- More on this in COMP2611 (Computer Organization).

Can You Understand This?

0000100100101110011001100110100101101100011001010000100100100010011011000110010101100011011101000111
010101110010011001010011000100101110011000110010001000001010011001110110001101100011001100100101111
0110001101101111011011010111000001101001011011000110010101100100001011100011101000001010001011100111
001101100101011000110111010001101001011011110110111000001001001000100010111001110100011001010111000
01110100001000100000101000001001001011100110000101101000110100101100111011011100010000000101000000
1010000010010010111001101110110001101110110001001100000101101000100000011011010110000101101001
011011100000101000001001001011100111010001110010111000001100101000010010010000001101101011000010110
100101101110001011000010001101100110011101010110111001100011011101000110100101101110110111000001010
0000100100101110011100000111001001101111011000110000100100110000001101000000101001101101011000010110
100101101110001110100000101000001001001000010010001101010000101001001001111010011000100111101000111
0101010101000101001000110010000000110000000010100000100101110011011000010111011001100101001000000010
0101011100110111000000101100001011010011000100110010001110000010110000100101011100110111000000001010
00001010000010010010000100100011010100000101001001001111010011000100111101000111010101010001010010
001100100000001100010000101000001001011011010110111011101100110001000000011000100101100001001010110111
001100000000101000001001011100110111010000100000001001010110111001100000010110001011011001001010110
0110011100000010110011001000110000010111010000101000010010110110111011011100010000000110010
0010110000100101011011100110000000010100000100101100110111010000100000001001010110111001100000010
1100010110110010010101100110011100000010110100110010001101000010110100001010000010010110110001100100
001000000101101100100101011001100111000000101101001100100011000001011101001011000010010101110011
00000000101000001001011011000110010000100000010110110010010101100110000001011010011001000110100
01011101001011000010010101110011000100001010000010010110000110000011000001000000001001010110
111100110000001011000010010101110011000100010110000100101011011100110000000010100000100101110011
011101000010000000100101011011100110000001011000101101100100101011001100111000000101101001100100011
1000010111010000101000001001011011010110111101110110001000000011000000101100001001010110100100110000
000010100000100101100010001000000010111001001100010011000011000100001010000010010110111001101110111
00000000101000101110010011000100110000110001001110100000101000001001011100100110010000001010
00001001011100100110010101110100101110100010111011001001100101000010100001011001001100010011000110
01100110010100110001001110100000101000001001001110011100101101000101110100110010100000100100000
01101101011000010110100101101110001011000010111001001100010011000110011001100101001100010010110110
1101011000010110100101101110000010100000100100101110011010010110010001100101011011100111010000001001
0010001001000111010000110100001100111010001000000010100001000111010011100101010100101001001000000011
0010001011100011100000101110001100010010001000001010

How About This?

main:

```
!#PROLOGUE# 0  
save %sp,-128,%sp
```

```
!#PROLOGUE# 1  
mov 1,%o0  
st %o0,[%fp-20]  
mov 2,%o0  
st %o0,[%fp-24]  
ld [%fp-20],%o0  
ld [%fp-24],%o1  
add %o0,%o1,%o0  
st %o0,[%fp-28]  
mov 0,%i0  
nop
```

Is This Better Now?

```
int main( )  
{  
    int x, y, z;  
  
    x = 1;  
    y = 2;  
    z = x+y;  
  
    return 0;  
}
```

Example: Write a Program to Sum 2 Numbers

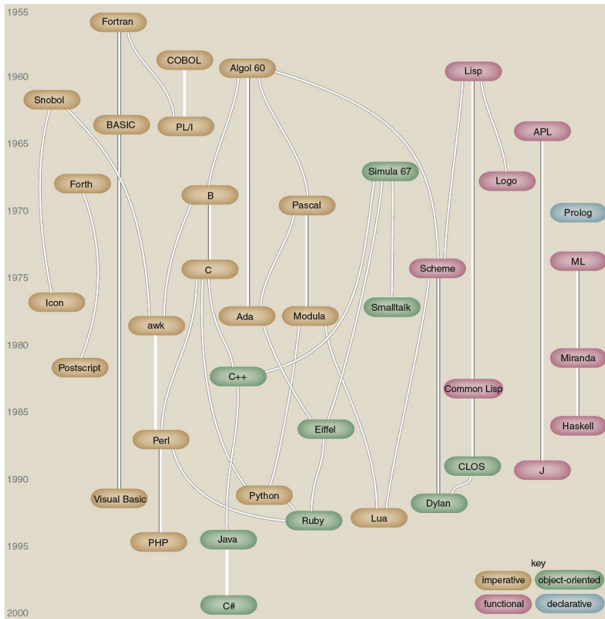
- There are 3 integer-value-holding objects: x, y, and z.
- x and y have the value of 1 and 2 respectively.
- z's value is the sum of x's and y's.

```
int main( )  
{  
    int x, y, z;  
  
    x = 1;  
    y = 2;  
    z = x+y;  
  
    return 0;  
}
```

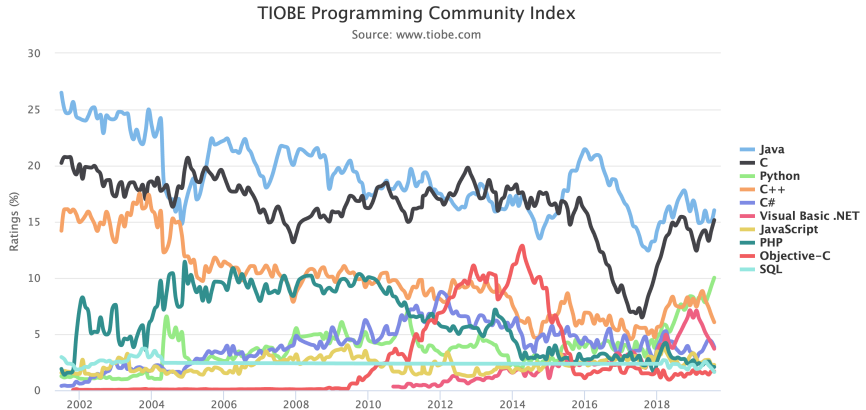
Levels of Programming Languages

- machine (binary) language is unintelligible
- assembly language is low level
 - mnemonic names for machine operations
 - explicit manipulation of memory addresses/contents
 - machine-dependent
- high level language
 - readable
 - instructions are easy to remember
 - faster coding
 - less error-prone (fewer bugs?)
 - easier to maintain
 - no mention of memory locations
 - machine-independent = portable

Chronology of Some Programming Languages



TIOBE Index: Most Popular Programming Languages



It is based on the number of skilled engineers world-wide, courses and third party vendors. Popular search engines such as Google, Bing, Baidu, etc. are used to calculate the ratings.

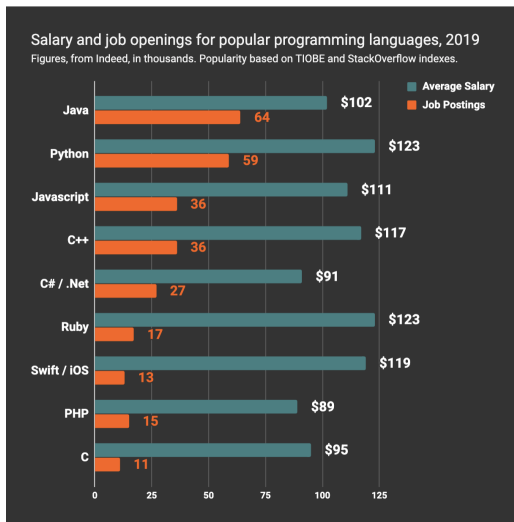
PYPL PopularitY: Most Popular Programming Languages

Worldwide, Aug 2019 compared to a year ago:

Rank	Change	Language	Share	Trend
1		Python	28.73 %	+4.5 %
2		Java	20.0 %	-2.1 %
3		Javascript	8.35 %	-0.1 %
4		C#	7.43 %	-0.5 %
5		PHP	6.83 %	-1.0 %
6		C/C++	5.87 %	-0.3 %
7		R	3.92 %	-0.2 %
8		Objective-C	2.7 %	-0.6 %
9		Swift	2.41 %	-0.3 %
10		Matlab	1.87 %	-0.3 %

It is based on the number of Google searches on the languages' tutorials.

Salary/Job Openings for Popular Programming Languages

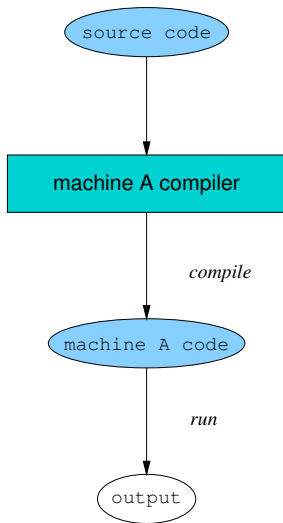


It is based on the number of job openings for the languages collected by indeed.com.

Mostly Used Programming Languages in Github

# Ranking	Programming Language	Percentage (Change)	Trend
1	JavaScript	20.109% (-2.893%)	
2	Python	17.891% (+1.726%)	
3	Java	10.401% (+0.417%)	
4	Go	8.027% (+0.774%)	
5	C++	7.383% (+0.945%)	^
6	Ruby	6.469% (-0.279%)	v
7	PHP	5.585% (-0.524%)	
8	TypeScript	5.247% (+0.428%)	
9	C#	3.693% (+0.311%)	
10	C	3.384% (+0.487%)	

Compilation: From Source to Runnable Program



A **compiler** translates **source programs** into **machine codes** that run directly on the target computer.

For example,
`a.cpp` \longrightarrow `a.out` (or `a.exe`).

Some C++ compilers:
`gcc/g++`, `VC++`.

- static codes
- compile once, run many
- optimized codes
 \Rightarrow more efficient
- examples: FORTRAN, Pascal, C++

Programming as Problem Solving

- **Understand** and **define** the problem clearly.
 - What are the input(s) and output(s)?
 - Any constraints?
 - Which information is essential?
- **Develop** a solution.
 - Construct an algorithm.
- **Translate** the algorithm into a C++ program.
- **Compile** the program.
- **Test** the program.
- **Debug** the program.
- **Document** the program as you write the program.
- **Maintain** the program
 - modify the codes when conditions change.
 - enhance the codes to improve the solution.

- Why C++?

Read the FAQ from the designer of C++, Bjarne Stroustrup.

- Which C++?

- The language has been **evolving**:

C++ 1983 \Rightarrow C++ 1998 \Rightarrow C++ 2003 \Rightarrow C++ 2011 $\Rightarrow \dots$

- We will learn C++11 (but not all the new features).

- Which compiler?

GNU gcc/g++. It is free.

(The compiler you will use in CSE lab is C++11-compliant.)

- Which IDE (integrated development environment) for writing programs?

Eclipse. It is free and supported by many operating systems such as Windows, Mac OS, and Linux.