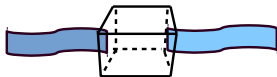


C Programming

Lecture 1: An Introduction and Overview on C



Lecturer: *Dr. Wan-Lei Zhao*
Spring Semester 2022

- 1 Syllabus
- 2 All about Computer
- 3 Programming
- 4 Basics about C Programming

Syllabus

- ① Primitive Data Types and Operations
- ② Sequential Control
- ③ Selection Control clause: `if-else` and `switch`
- ④ Loops Control clause: `while`, `do-while` and `for`
- ⑤ Functions: declaration, definition and calling
- ⑥ Pre-compilation Command/Macros: `#ifdef`
- ⑦ Array: declaration, definition and calling
- ⑧ Structures: `struct` and `union`
- ⑨ Pointers
- ⑩ File Operations: read and write
- ⑪ Bitwise Operations
- ⑫ `make`, `MakeFile`, `cmake`, and `CMakeLists.txt`
 - Performance Evaluation
 - $\text{Final score} = 10\% \times \text{Exerc.} + 30\% \times \text{Quiz.} + 10\% \times \text{Att.} + 50\% \times \text{Exam}$

Arrangement of this course

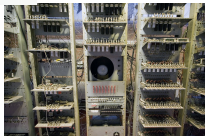
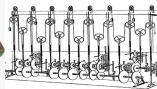
- 16 weeks \times 2 hours classes
- 8 weeks \times 2 hours labs
 - TA and I will be in the lab
- Middle-term exam
- Doing final exam, both are held in the lab
 - Multiple choices
 - Correct codes
 - 3-4 coding problems
- No cheating and no bargaining!
- If you attend all my classes
- I ensure that you can learn a lot:)

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- 1 Syllabus
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About Computer (1)

- What is computer?
 - Machine for computation
 - Essentially, no big difference from abacus
 - In our history, we have several kinds of machines used for computing
 - Abacus
 - Difference engine
 - Tide-predicting machine



About Computer (2): the model

- What is computing
 - Input data and needed operations
 - Output the answer
 - This is actually the model proposed by **Alan Turing**
 - Share the story about Alan Turing ...



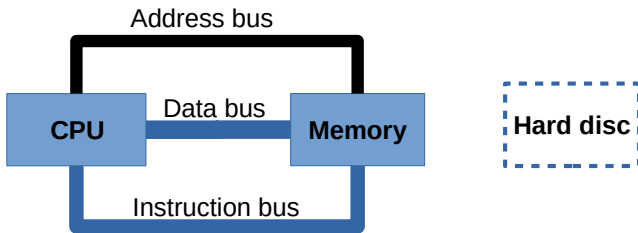
(a) Alan Turing



(b) John Von Neumann

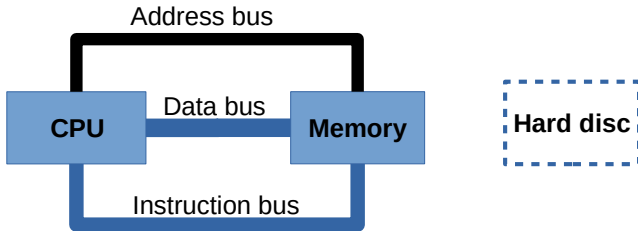
About Computer (3): the framework

- Think aloud about the major components of a computer
 - CPU: central processing unit
 - Memory
 - Hard disc
 - Keyboard
 - graphics card+Monitor/screen
 - Music card+microphone+speaker
 - Mouse
- Share the story about John Von Neumann ...



About Computer (4): the framework

- Think aloud about the major components of a computer
 - **CPU: central processing unit**
 - **Memory**
 - Hard disc
 - Keyboard
 - graphics card+Monitor/screen
 - Music card+microphone+speaker
 - Mouse

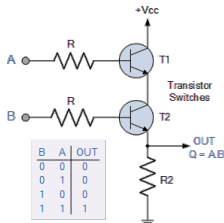


About Computer (5): who is who

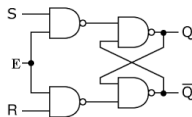


- How many of them you can finger out?

About Computer (6): basic elements in Computer Chips



AND Gate



S-R Latch

- Despite the high complexity of VLSIC (very large scale integrated circuits)
- Only two basic elements are there
- One is gate, responsible for operations, main components for CPU
- Another is latch, in charge of memory, main components for memory

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Why programming? (1)



(c) Charles Babbage



(d) Ada Lovelace

- Ada is the first programmer
- A language is named after her to memorize her contribution
- Share the story about Charles Babbage and Ada Lovelace ...

Why programming? (2)

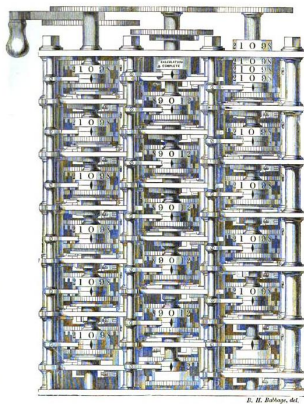
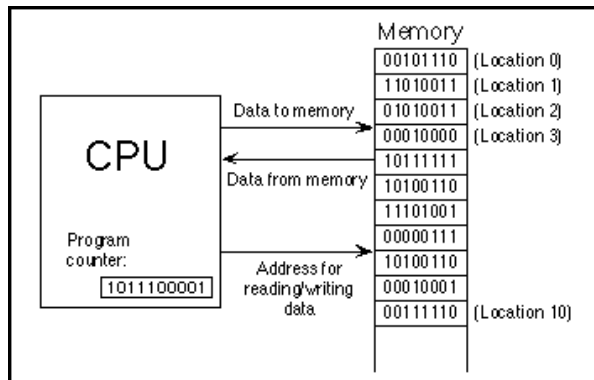


Figure: The difference machine

- Ada wrote the programs for the difference machine

Why programming? (3)



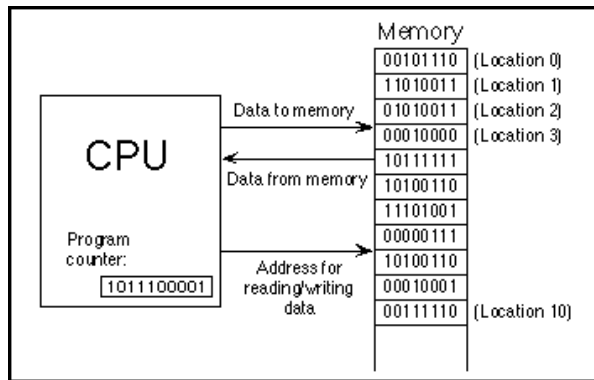
- Instructions and data fetch from memory to CPU for processing
- The results are returned back to memory

Why High Level Programming Language? (1)



- Natural language is the media that we communicate with each other
- Computer language is the media that we communicate with computer
- We should use the language that computer could understand
- At least, we need an **interpreter/translator**

Why High Level Programming Language? (2)



- Instructions are binary codes
- Machine only accepts/understands binary codes

Why Programming Language? (3)

- ① 010101 0000 0011
- ② 010101 0001 0101
- ③ 101010 0000 0001
- ④ 010101 0000 1011

Why Programming Language? (4)

① 010101 0000 0011

② 010101 0001 0101

③ 101010 0000 0001

④ 010101 0000 1011

① MOV D1 0011

② MOV D2 0101

③ ADD D1 D2

④ MOV D1 A1

- For the convenience of operation, binary instructions are denoted with readable symbols

Why Programming Language? (5)

- Machine code

- ① 010101 0000 0011
- ② 010101 0001 0101
- ③ 101010 0000 0001
- ④ 010101 0000 1011

- Assembly

- ① MOV D1 0011
- ② MOV D2 0101
- ③ ADD D1 D2
- ④ MOV D1 A1

- High level language

- ① $a=3+5;$

Why Programming Language? (6)

Codes in high level language

```
a = 3+5;  
b = a*2;  
printf("a = %d, b = %d", a, b);
```



Translator

Compiler

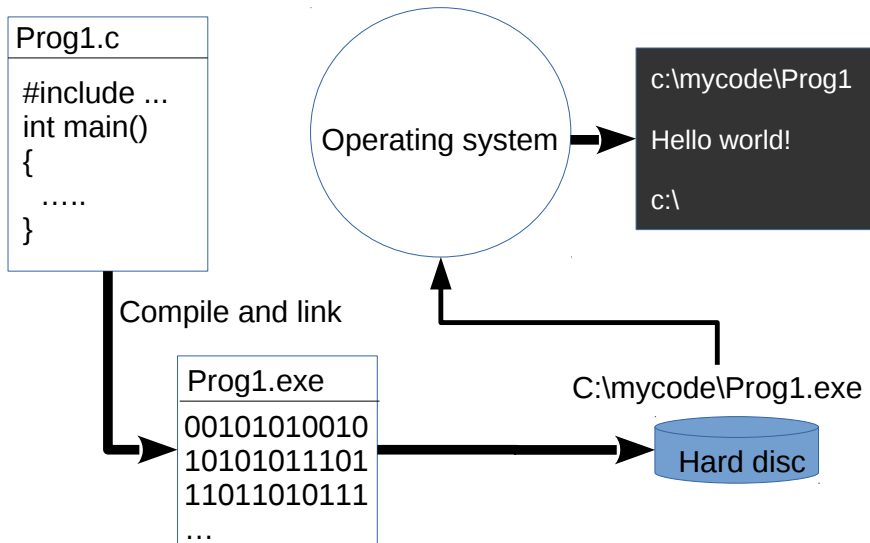


Machine codes (binary codes)

010101 0000 0011	110111 0000 0001
010101 0001 0101	010101 0000 1101
101010 0000 0001	
010101 0000 1011	
010101 0000 0010	
010101 0001 1011	

- We write a **text** file in specified format (grammar)
- These are instructions that we basically understand
- The **translator** converts the text instructions into machine codes
- Machine then runs these binary codes one by one
- Different **translators** lead to different programming languages
- Which also regulate different grammars
- C is such kind of high level language

The life-time of a computer program



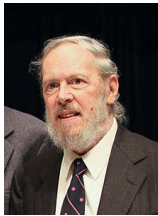
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Brief History about C



Ken Thompson
(1943 -)



Dennis M. Ritchie
(1941 - 2011)

- C is born in AT&T Bell Labs along with UNIX
- The developer Dennis Ritchie and Ken Thompson were awarded with Turing Award
- C is simple:), versatile and highly efficient (70% of assembly language efficiency)
- UNIX is one of the most stable operating systems so far developed
- [Share the story about Unix ...](#)

Your first program in C (1)

```
1 #include <stdio.h>
2 int main()
3 { /*start of a block*/
4     printf("Hello -world!\n"); /*call function 'printf'*/
5     return 0;                  /*return '0' back*/
6 } /*end of a block*/
```

- “`#include <stdio.h>`” states that we want to use **function** defined in “`stdio.h`”
- Our code is encapsulated in a function called “**`main()`**”
- In the main body of the function
- We output “Hello world!” to the screen
- “**`printf()`**” is a function **defined** in “`stdio.h`”
- **`include`**, **`int`** and **`return`** are reserved keywords

Your first program in C (2)

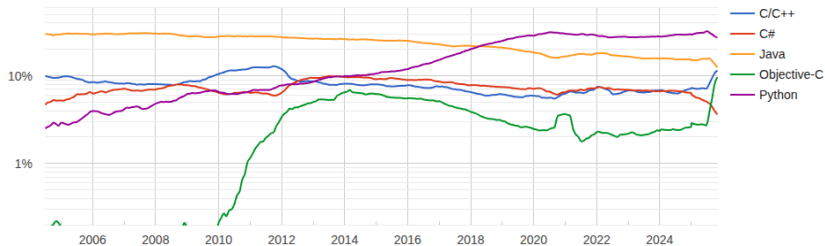
```
1 #include <stdio.h>
2 int main()
3 {
4     printf(" Hello-world-1!\n" );
5     printf(" Hello-world-2!\n" );
6     printf(" Hello-world-3!\n" );
7     return 0;
8 }
```

[Output]

```
1 Hello world 1!
2 Hello world 2!
3 Hello world 3!
```

- Codes are executed **from top to bottom**

Popularity of C in recent decades



- The popularity of C/C++ is relatively stable
- Python becomes more and more popular

The evolution diagram of programming languages

