STMC HKOI Training

Lesson 0: Fundemental ideas about programming

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What is a computer program?

- A **computer program** is a collection of instructions that can be executed by a computer to perform a specific task [2].
- Similar to recipe for cooking
- Teaches computer what to do and how to response to input and produce outputs
- Basically, doing anything on a computer involves a program of some sort

Examples of computer programs

- Web browser
- Computer games
- Mobile applications
- Operation system (e.g. Windows, Linux, Unix, etc.)
- Productivity software (e.g. Word, PowerPoint, Excel, etc.)

What is programming?

- **Programming** is process of designing and building an executable computer program to accomplish a specific computing result or to perform a specific task [3].
- By doing programming, you ”teaches” the computer to do some specific tasks

Why learning programming?

- Programming is *everywhere*!
- Science:
  - Computer simulations
  - Automatic data collection for experiments
  - Analysis of huge amount of data (Fig. 1)
  - Develop more efficient algorithms
  - Develop state-of-the-art AI

Figure 1: The first image of black hole is obtained by analysing over 4.5 petabyte of data [1]. An impossible task without programming (Source: NASA).

Why learn programming?

- Engineering
  - Run code to calculate forces and stresses when designing building or aircrafts
  - Engineering fluid simulation
  - Game development
  - Mobile app development

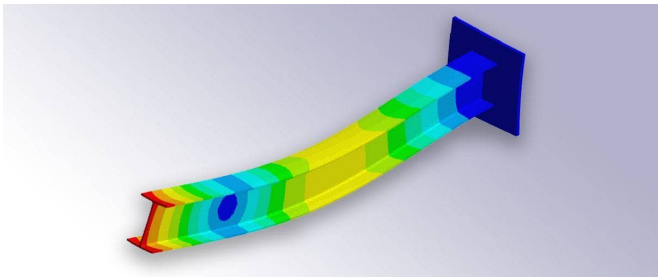

Figure 2: Simulation of beam oscillating freely in one end (Source: FEATool)

Cool, but what is INSIDE a computer program?

- Computer programs consist of **machine code** that are made up of 0s and 1s
- It's groups of 0s and 1s that represent instructions directly executable by computer
- Machine code is the language computer "speaks"
- Difficult to code in machine code

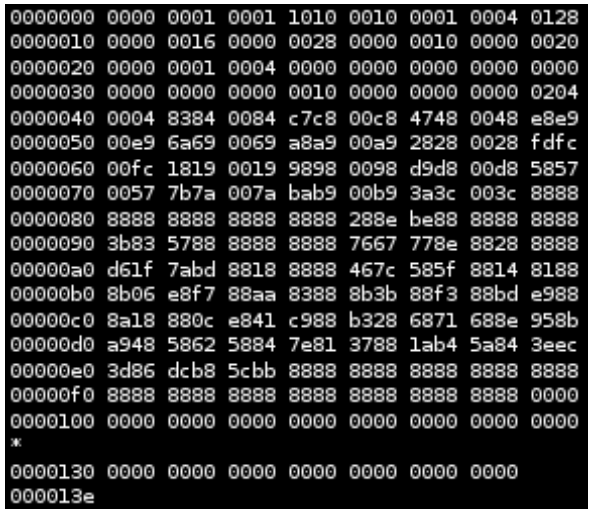

Figure 3: Machine code (Source: https://bit.ly/3sQendj)

Yikes! Does it mean we need to code THAT?

- Short answers: No
- Programmers have invented **high level language** that are closer to human language but still do the job
- Examples: C/C++, Java, Python, Ruby, R, PHP, etc.
- Code written in high level language are usually called **source code**

```python
class Deck:

    def __init__(self,deck=[],color_first=Card.RED):
        self.deck = deck
        self.set_color_first(color_first)

    def sort_cards(self):
        color = lambda x: (x.get_color() + self.color_offset) % len(Card.COLORS)
        number = lambda x: x.get_number()
        self.deck.sort(key=lambda x: 10*color(x)+number(x)) # First by color then by number

    def add_card(self,card):
        self.deck.append(card)

    def remove_card(self,color,number):
        rm_idc = -1
        for idc, card in enumerate(self.deck):
            if card.get_color() == color and card.get_number() == number:
                rm_idc = idc
                break
        if rm_idc != -1:
            return self.deck.pop(rm_idc)
        return None
```

Figure 4: Source code in python (Source: me)

Compiler: Translate source code to machine code

- Since source code are no more than a text file, computer cannot understand them
- We need a device that converts source code to machine comprehensible machine code
- That device is called a **compiler**
- The compiled result is called an **executable**, which has the file extension of `.exe` in Windows

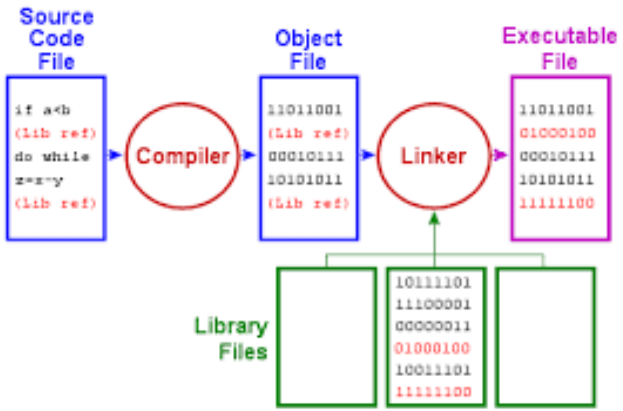

Figure 5: Compiling source code to executables (Source: https://bit.ly/3sQendj)

Interpreter: Line-by-line translation

- For some programming language (like Python), the high level instructions are compiled line-by-line during runtime
- The software that do that is called an **interpreter** instead of a compiler

Let’s move on to write our first program …

Reference I

[1] *A peek behind the black Hole IMAGE'S petabytes of data — Data Makes Possible*. [Online; accessed 27-August-2021]. Dec. 2019. URL: https://bit.ly/3jnBTvg.

[2] Wikipedia contributors. *Computer program — Wikipedia, The Free Encyclopedia*. [Online; accessed 27-August-2021]. 2021. URL: https://en.wikipedia.org/w/index.php?title=Computer_program&oldid=1040444998.

[3] Wikipedia contributors. *Computer programming — Wikipedia, The Free Encyclopedia*. [Online; accessed 27-August-2021]. 2021. URL: https://en.wikipedia.org/w/index.php?title=Computer_programming&oldid=1040498552.