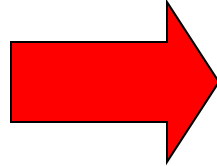




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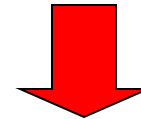
Programming Introduction

Department of Information System
SoICT, HUT

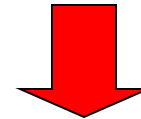


Algorithm

A set of instructions specifying the steps required to accomplish a task



Program



What a computer can do?

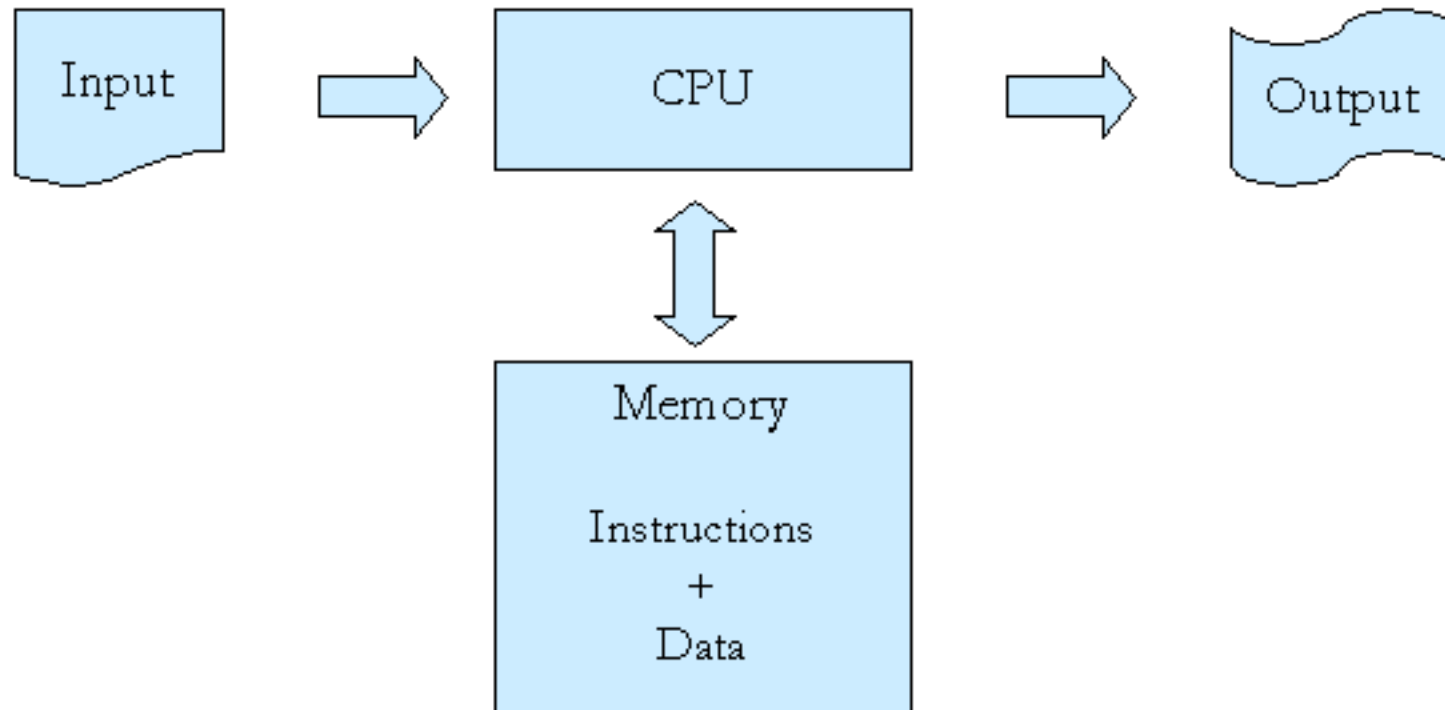
Not much... Computers understand only numbers!

- Store and retrieve numbers (fast and accurate).
- Add, subtract, multiply and divide numbers (also, fast and accurate).
- Compare numbers.
- Follow a list of instructions and jump around in the list

What else a computer can do?

- More complex calculations can be implemented from a set of simple calculations
- Communicate with peripheral devices to input/output data
 - Input: mouse, keyboards, joystick.
 - Output: graphic cards, printers
- Everything is doable with numbers

Von Neumann Architecture



Von Neumann Architecture

What is a computer program?

- A sequence of instructions aims at solving a specific task
- Instruction is carried out one after the other. No instruction is carried out when the previous instruction is not accomplished
- A program is represented by a programming language.

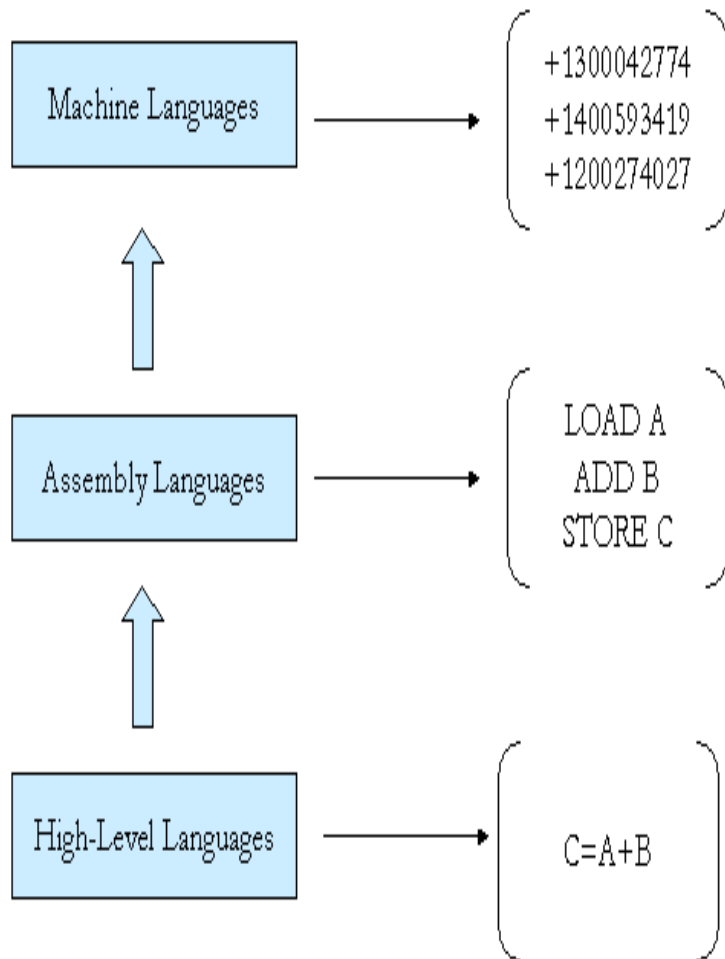
Programming languages

- **Machine language** is dependent to the computer using machine instructions. Executable programs must be in machine language
- **High level language** is independent to the computer using human algorithm instructions

Machine language

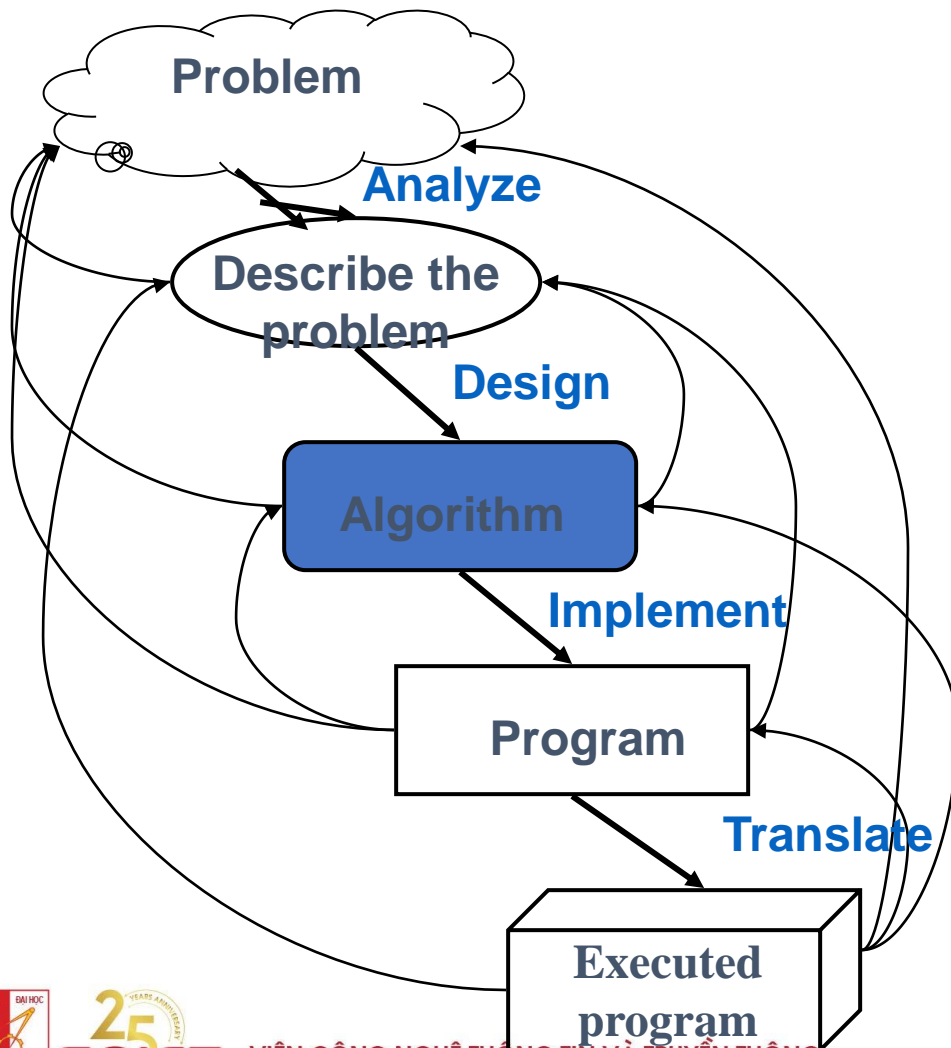
- is a language understandable by computer
- In our view, machine language is only a sequence of 0 and 1.
- There is no common machine language for computer
 - Each micro-processor has its own language
- Human cannot work directly with machine language
- However, computer cannot understand other languages

High level language



- Assembly – machine language encoded as documents (not convenient)
- Interpretation language (java, perl)
 - A program is translated into machine language during its process
- Translation language (C, pascal)
 - A program is translated into machine language once before process

The problem solving process



Rice cooking

Wash rice (0,5kg)
Pour water (1liter) to a casserole
Boil the water
Put rice into the casserole
Turn down heat
Wait 15minutes, take the casserole out

```
washrice(0,5);  
pourwater(1);  
boilwater();  
putintocasserole();  
turndownheat();  
takecasseroleout();
```

```
01001110101100101010101010010  
101010101001100101010101001  
0110100111010101010010010111  
010011110101010111110101010001  
10100001101...
```

Algorithm

- A sequence of instructions specifying the steps required to accomplish some task
- Some examples:
 - Cooking recipe
 - The rules of how to play a game
 - Directions for driving from A to B
 - A car repair manual
 - etc.

Rice cooking algorithm

- Prepare

- 0,5 kg rice, 1 liter of water

Input

- Steps:

- Wash rice (0,5 kg)
 - Pour (1 liter) water to a casserole
 - Boil the water
 - Put rice into the casserole
 - Wait until the water is shallow
 - Turn down heat
 - Wait 15minutes, take the casserole

Processing

Output

- Result:

- A casserole that contains rice for 5 people

Components of an algorithm

- Variables and values
- Instructions
 - Sequences
 - Selections
 - Iterations
 - Procedures

Values

- Represent quantities, amounts or measurements
- May be numerical or alphabetical values: eg., a people name, a people size, etc.
- Each value usually has an implicit measuring unit
- Example:
 - Value for kg of rice, value for liter of water in the rice cooking algorithm

Variables

- Containers or places to store values
- Example

Variable



This container
can be used to
store

Values

10 candies

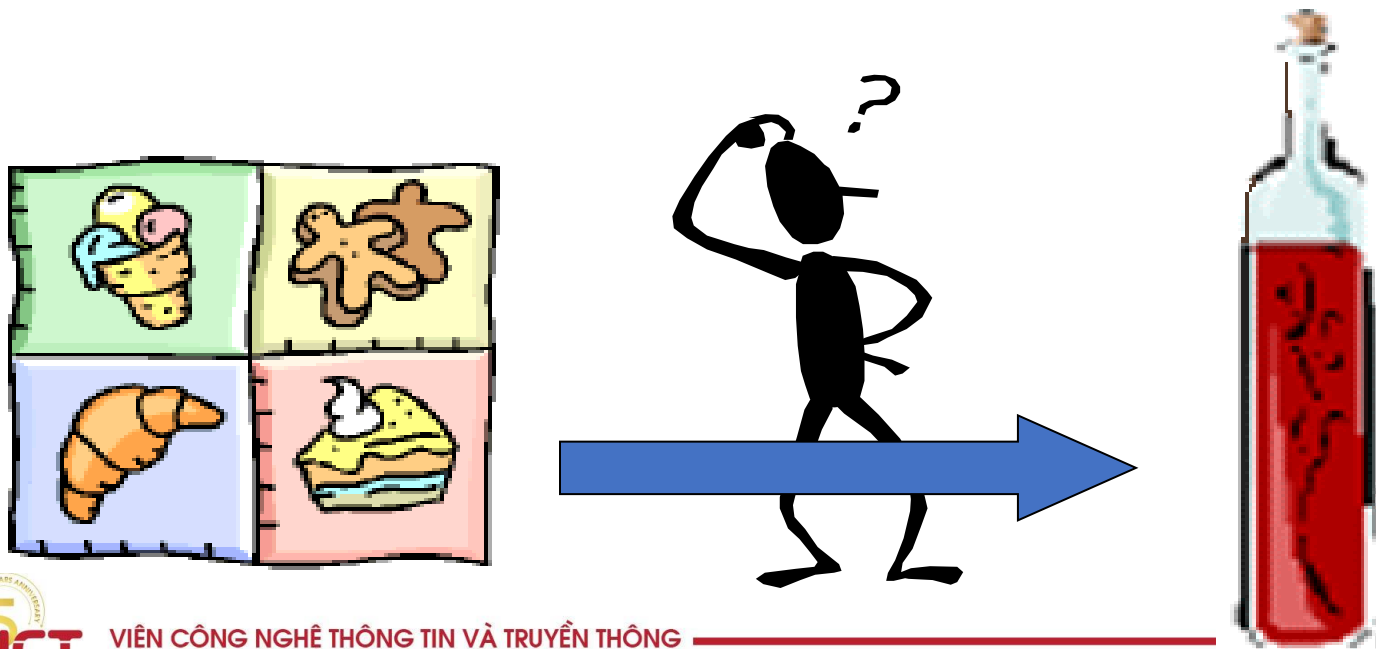
50 g sugar

3 cakes

etc.

Type of variables

- Restricted to contain a specific type of value, e.g., only integer number.
- Example : kg (rice) or liter (water)



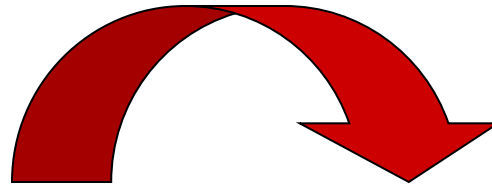
Instruction

- Instructions should be:
 - simple
 - unambiguous
 - the system knows the instruction in order to implement it

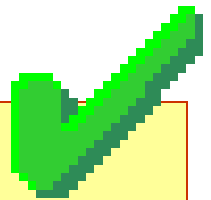
Guide about instructions

- Instructions should be simple and unambiguous
- For example:

Wash rice (0,5kg) and then pour water (1 liter) into a casserole and then boil it



- Wash rice (0,5kg).
- Pour water into a casserole (1 liter)
- Boil the water.



Sequence structure

- is series of instructions to be carried out one after the other
- Example:
 - Wash rice (0,5 kg).
 - Pour water into a casserole (1 liter)
 - Boil the water.
 - Put rice into the casserole
 - Wait until the water is shallow
 - Turn down heat
 - Wait 15 minutes, take the casserole out

Selection

- Is an instruction that decides which of two possible sequences is executed
- It is based on a condition (true/false)

if ...

then ...

else ...

Example about rational number

input an integer

input N

selection condition

if ($N \neq 0$)

then

{

output $1/N$

}

Carry out when the condition is true

else

{

output "infinitive"

Carry out when the condition is false

}

Question ?

Do these two algorithms give the same output?

Algorithm 1

```
input N
if (N  $\neq$  0)
then
{
    output 1/N
}
else
{
    output "infinitive"
}
```

Algorithm 2

```
input N
if (N  $\neq$  0)
then
{
    output 1/N
}

output "infinitive"
```

Iteration

- Repeat an instruction (or a group of instructions) while (or maybe until) some true or false condition occurs.
- Two kinds of iteration:
 - Test the condition each time before repeating the instruction
 - Test the condition each time after executing the instruction

Example

Print the odd numbers from 1 to 100

Create variable *num* with the initial value of 1

The loop is carried out while the condition *num* ≤ 100 is true

Output *num* with the current value for each loop and increase *num* by 2

```
num = 1
while (num  $\leq$  100)
do
{
    output num
    num = num + 2
}
```


Question ?

Do these two algorithms give the same output?

Algorithm 1

```
num = 1
while (num <= 100)
do
{
    output num
    num = num + 2
}
```

Algorithm 2

```
num = 1
while (num <= 100)
do
{
    num = num + 2
    output num
}
```

Algorithm 2 lists all odd numbers from 3 to 101

Example: Sum of a set of integer values

Find the differences between the two algorithms below:

Algorithm 1

```
a = 0  
sum = 0  
while (a > 0) do  
{  
    input a  
    sum = sum + a  
}  
output sum
```

Algorithm 2

```
sum = 0, a = 0  
do  
{  
    input a  
    sum = sum + a  
} while (a <> 0)  
output sum
```

Procedure

- Is a series of instructions with a name
- You can
 - refer to it (by name)
- Procedure is used in structured programming to divide a program into smaller parts with different names
 - Procedure
 - Function
 - Sub-routine

Example

Procedure RiceCooking

```
{  
    Wash rice (0,5 kg)  
    Pour (1 little) water to a  
        casserole  
    Boil the water  
    Put rice into the casserole  
    Wait until the water is shallow  
    Turn down heat  
    Wait 15minutes, take the  
        casserole out  
}
```

Procedure DinerPreparing

```
{  
    RiceCooking  
    Boiling vegetable  
    Frying meat  
    Setting the table  
}
```

Calling procedure

Declaring procedure

Exercises

1. Write an algorithm to solve the following equation:

$$a \cdot x + b = c.$$

2. Write an algorithm to:

- Input values for 3 variables a,b,c
- Print out the variable that has the highest value and the variable that has the lowest value. Print out the value for these two variables.

3. Write an algorithm to:

- Input a value for a variable $n \geq 1$
- Find all numbers $\leq n$ that satisfy the following condition
 - Divide 3 remain 2 and divide 5 remain 3

Summary

- The problem solving process
- Problem → Algorithm → Program
- Programming language
 - High level language vs. machine language
- Components of an algorithm
 - Variables and values
 - Instructions:
 - Sequences, selections, iterations, procedures



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