ĐẠI HỌC

BÁCH KHOA

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# ĐẠI HỌC BÁCH KHOA HÀ NỘI
# VIỆN CÔNG NGHỆ THÔNG TIN VÀ TRUYỀN THÔNG

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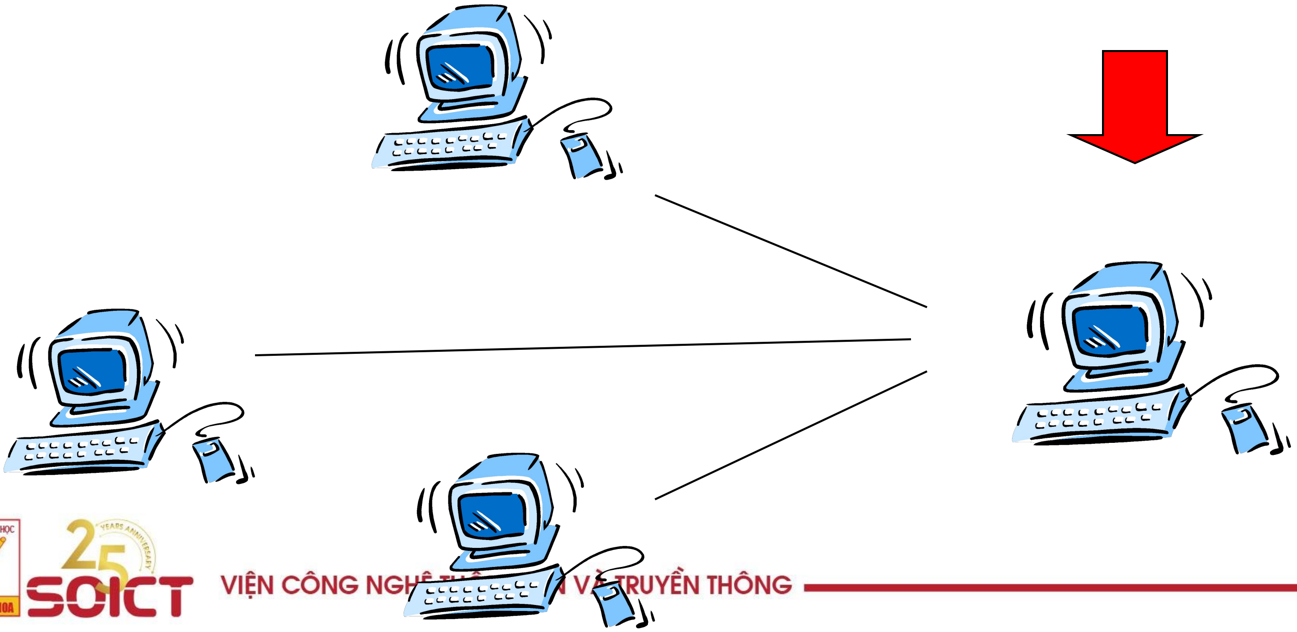
# Programming Introduction

## IT3210 - C Programming Language

## Algorithm

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

## Program



## What a computer can do?

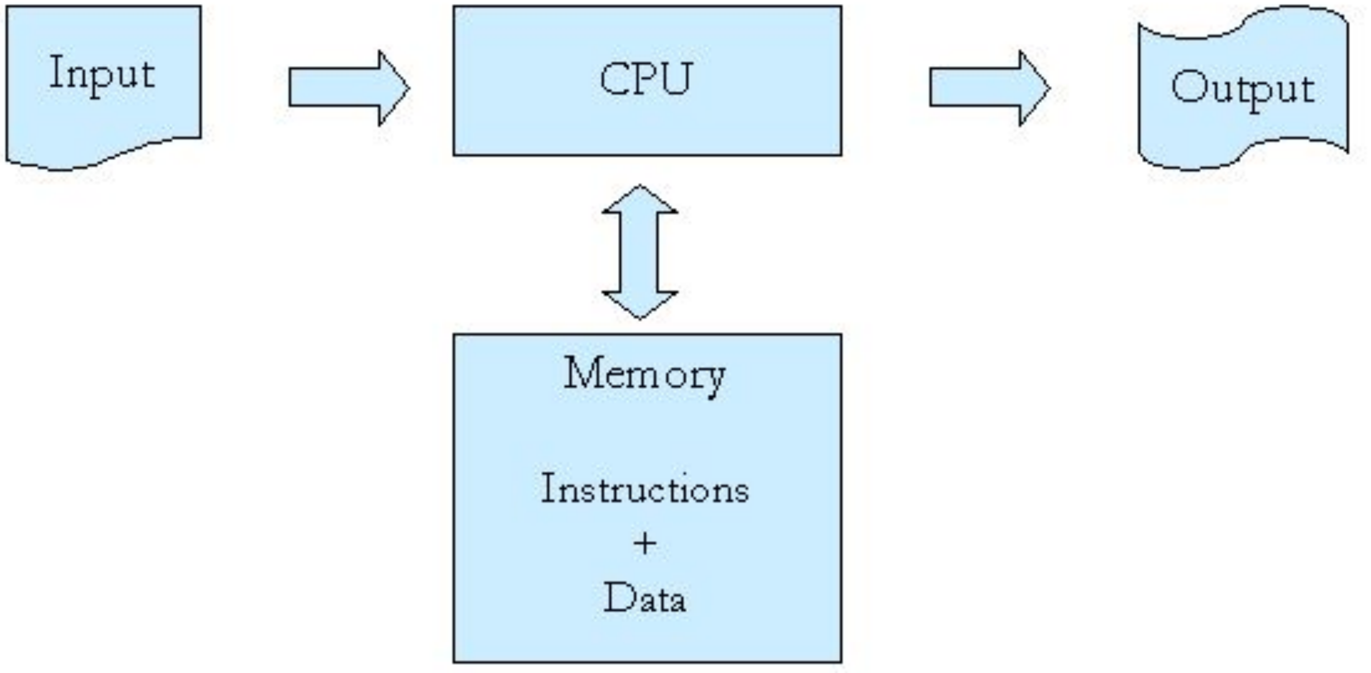
Not much… Computers understand only numbers!

- 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.

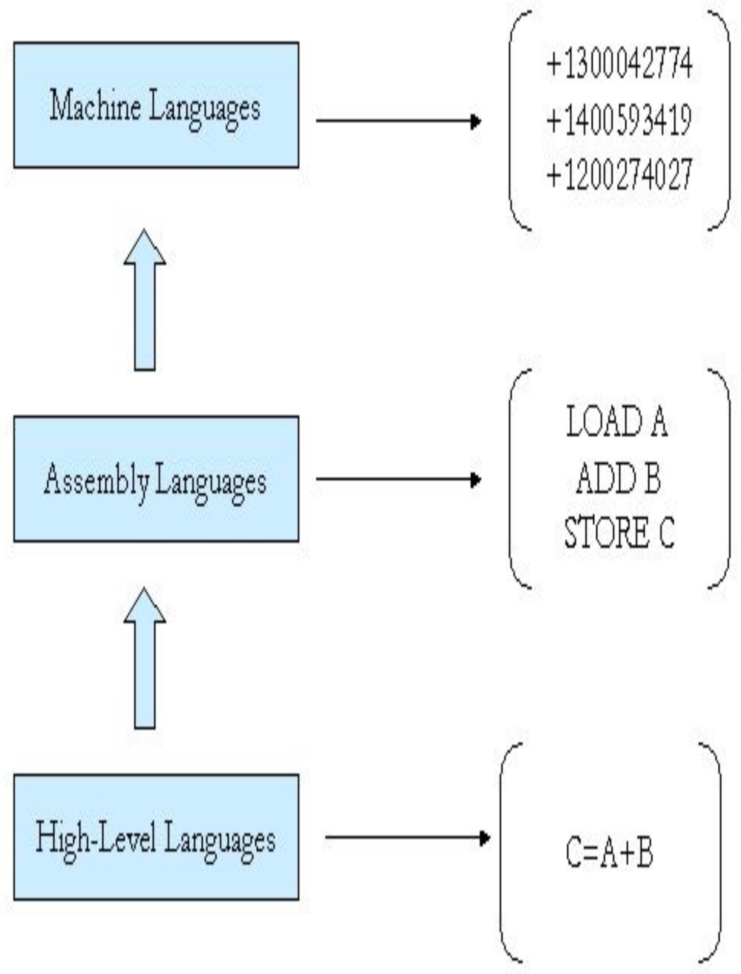
## Programming languages

- **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

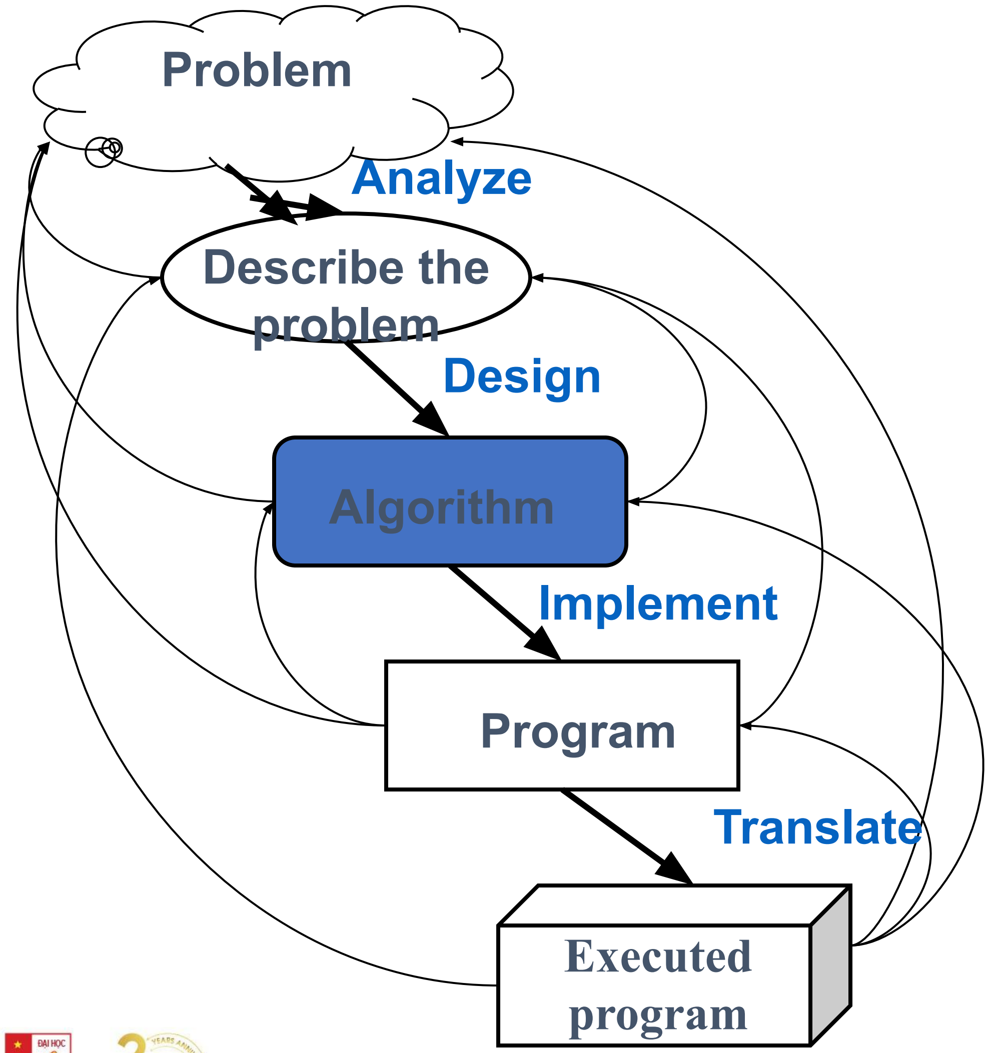
- is a language understandable by computer
- In our view, machine language is only a sequence of 0 and 1.
- There is no common machine language for computer
  - Each micro-processor has its own language
- Human cannot work directly with machine language
- However, computer cannot understand other languages

# 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
10101010100110010101010101001
01101001110101010101001001011
10100111101010101111101010100
0110100001101...
```

## 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
- 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 ca
- Result:
  - A casserole that contains rice for 5 people

Input

Processing

Output

## 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*

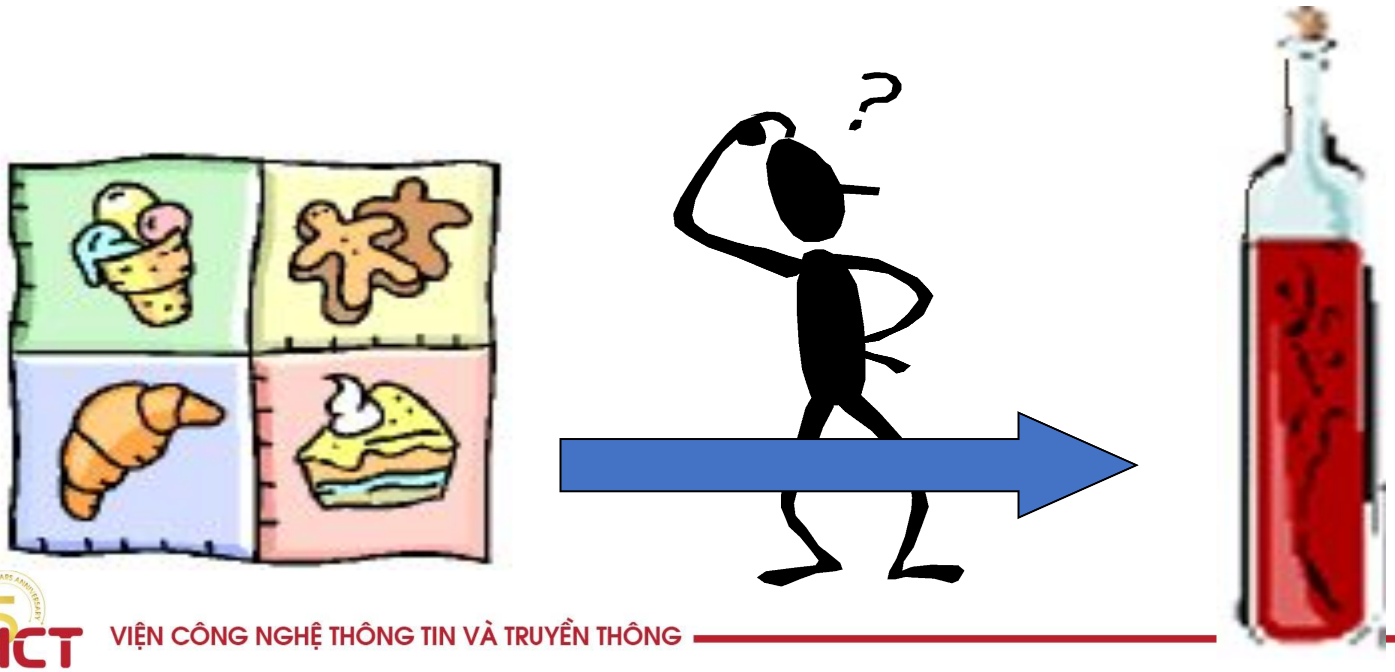
*Values*

This container can be used to store

$\left\{ \begin{array}{l} \text{10 candies} \\ \text{50 g sugar} \\ \text{3 cakes} \\ \text{etc.} \end{array} \right.$

# 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

selection condition

Carry out when the condition is true

Carry out when the condition is false

```
input N
if (N ≠ 0)
then
{
   output 1/N
}
else
{
   output “infinitive"
}
```

# Question ?

Do these two algorithms give the same output?

## Algorithm 1

```
input N
if (N ≠ 0)
then
{
        output 1/N
}
else
{
      output “infinitive"
}
```

## Algorithm 2

```
input N
if (N ≠ 0)
then
{
      output 1/N
}

output “infinitive"
```

Algorithm 2 returns both two outputs when N ≠ 0

## 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 <u>before</u> repeating the instruction
    - Test the condition each time <u>after</u> 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 <= 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 shallo
    Turn down heat
    Wait 15minutes, take the
        casserole out
}
```

```
Procedure DinerPreparing
{
    RiceCooking
    Boiling vegetabl
    Frying meat
    Setting the table
}
```

Calling procedure

Declaring procedure

## Exercises

1. Write an algorithm to solve the following equation:

   $a*x + b = c.$

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 >=1
   - Find all numbers <=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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## Thank you for your attentions!