Programming Introduction

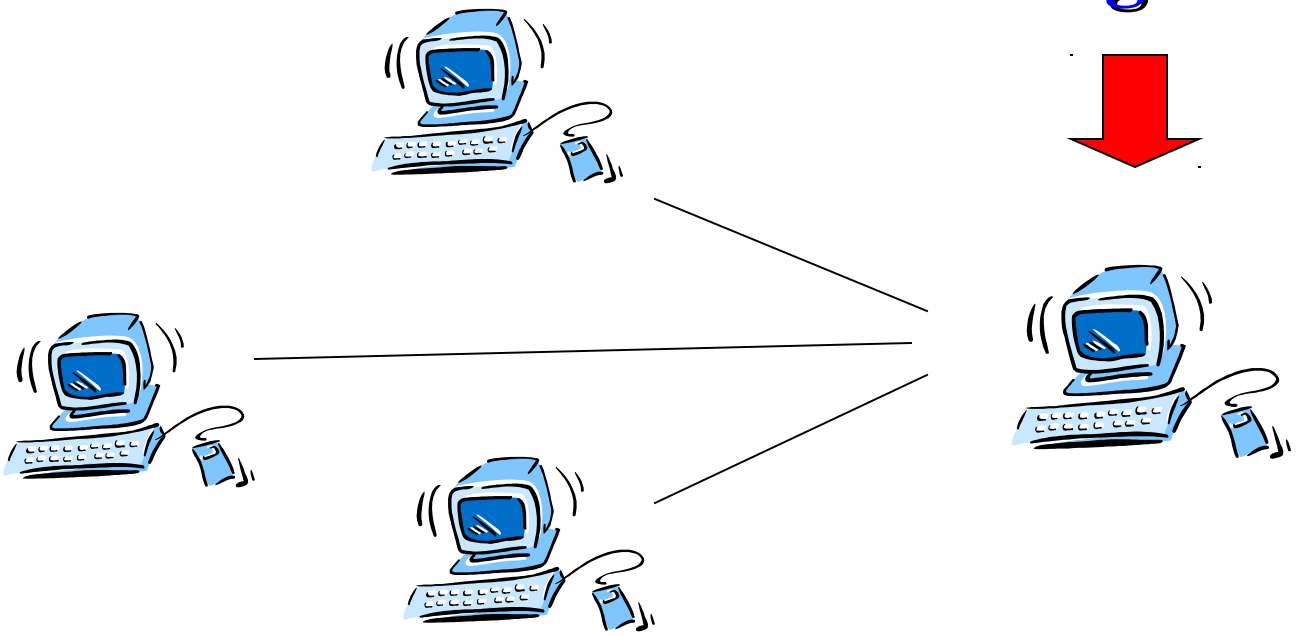
Department of Information System

SoICT, HUT

Algorithm

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

Program



What a computer can do?

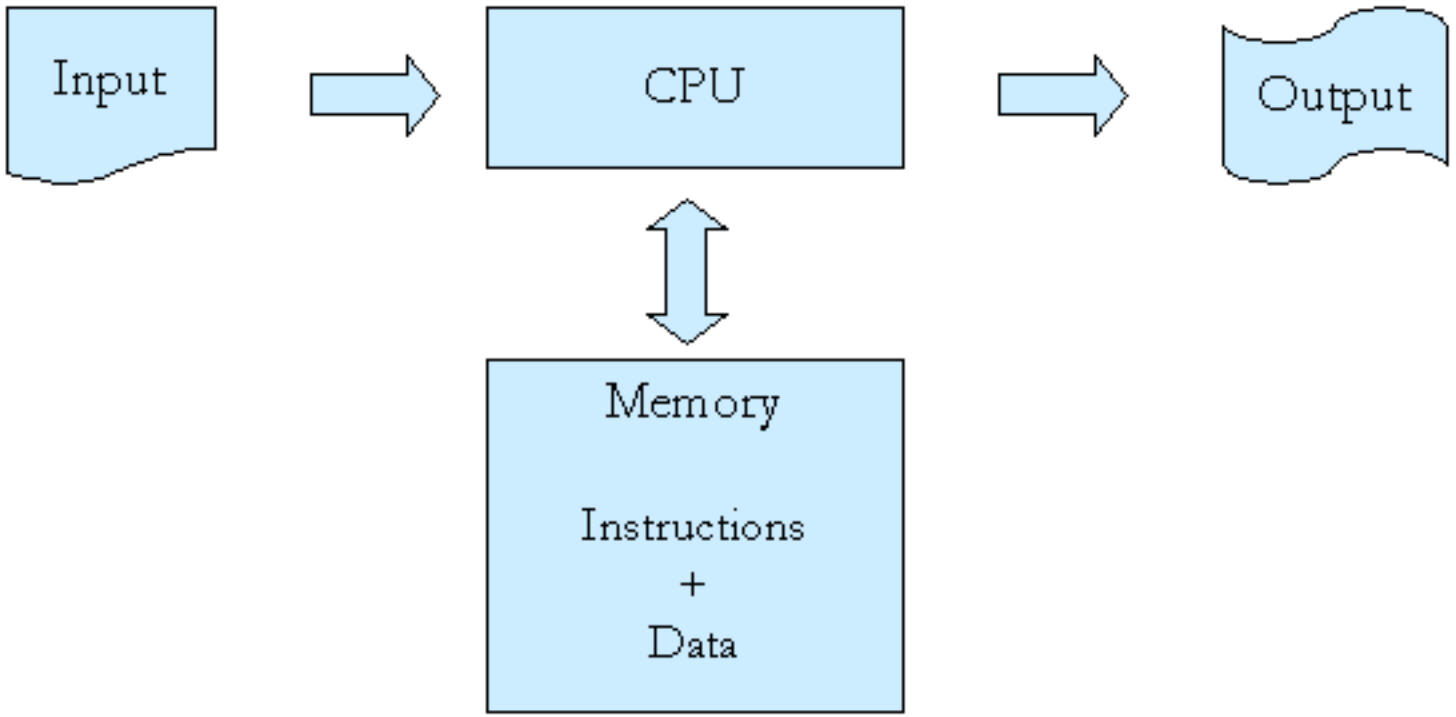
Not much… Computers understand only numbers!

- 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.

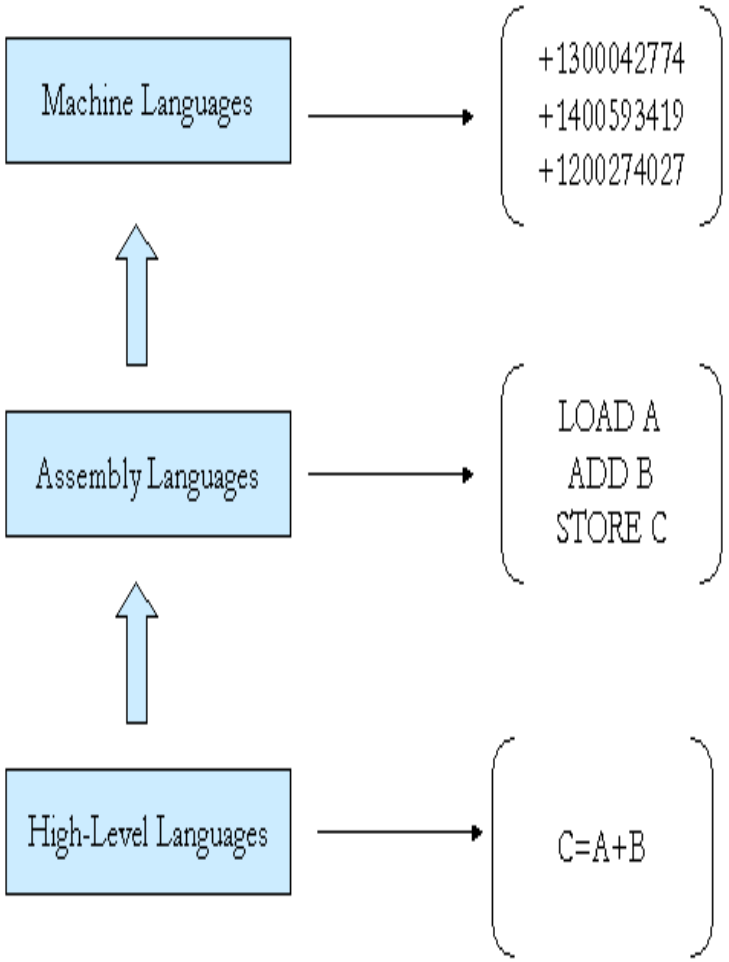
Programming languages

- **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

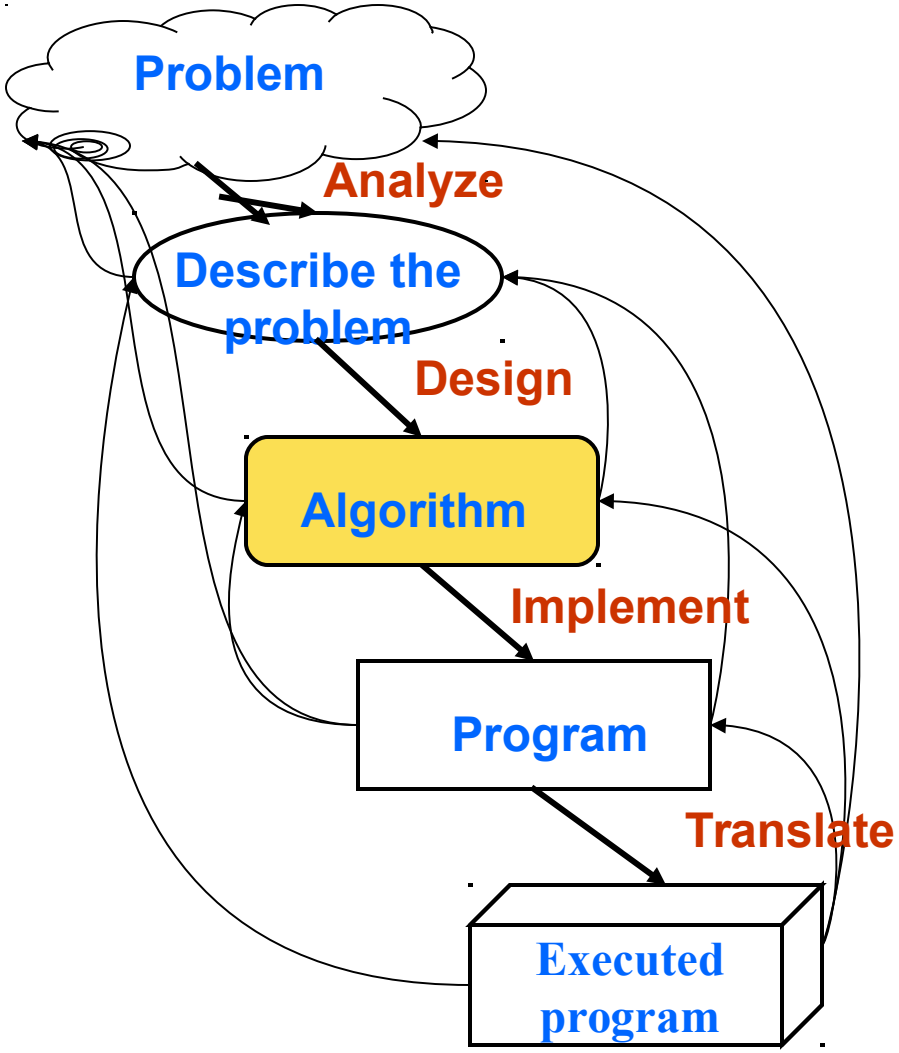
- is a language understandable by computer
- In our view, machine language is only a sequence of 0 and 1.
- There is no common machine language for computer
  - Each micro-processor has its own language
- Human cannot work directly with machine language
- However, computer cannot understand other languages

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
10101010100110010101010101001
01101001110101010101001001011 1
01001111010101011111010101000 1
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
- 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 out
- 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

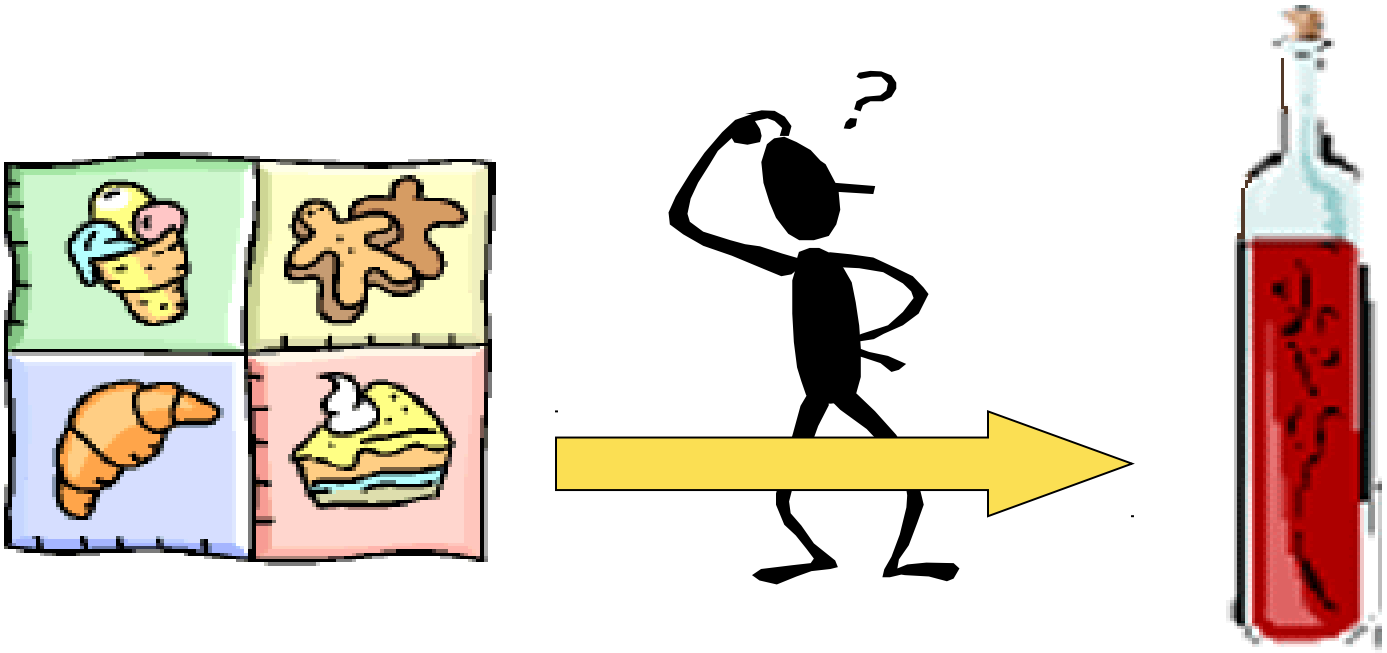
This container can be used to store

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)

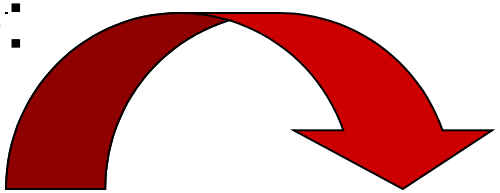


Instruction

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

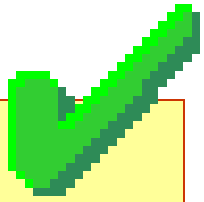
Guide about instructions

- 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

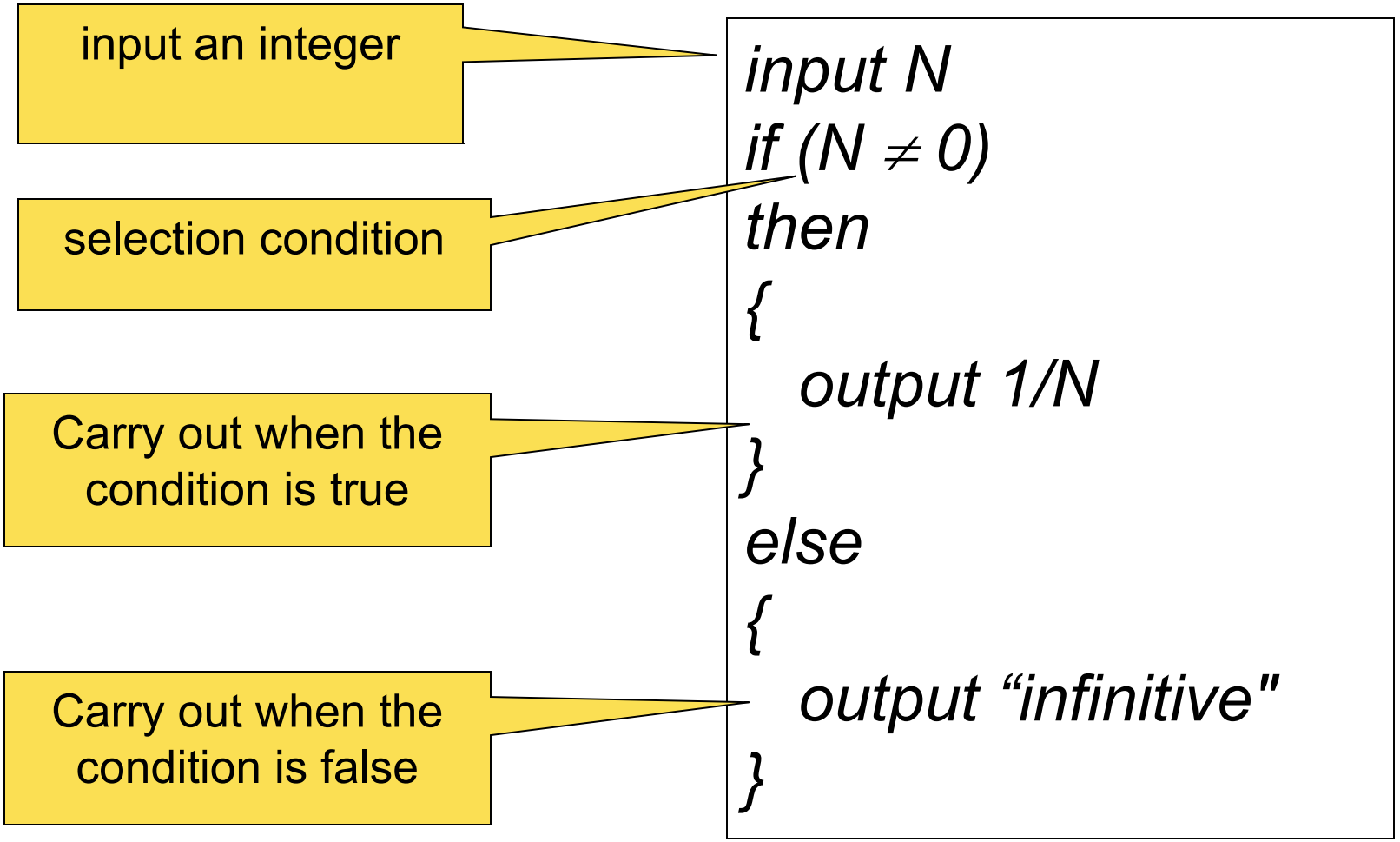
- Is an instruction that decides which of two possible sequences is executed
- It is based on a condition (true/false)

  if …

  then …

  else …

Example about rational number



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 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 <= 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*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