BASIC PROGRAMMING

FLOWCHARTS

Le Thi Ngoc Tho, Ph.D

Faculty of Information Technology, HUTECH

ltn.tho@hutech.edu.vn

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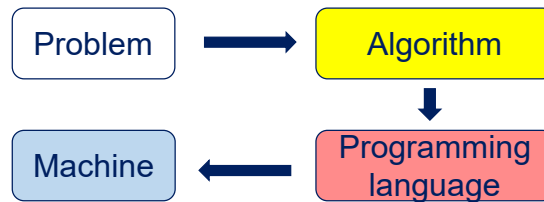
• Some Concepts

• Algorithm Representation: Flowchart

• Algorithm Structures:

  • Sequential Structure

  • Selection Structure

  • Loop Structure

• Exercises

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CONCEPTS

- How to solve a problem?

| Problem | → | Algorithm |
| Machine | ← | Programming language |

- What is algorithm?
  - Specification of how to solve a class of problems.
  - A set of rules that precisely defines a sequence of operations.

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CONCEPTS

- E.g., algorithm of boiling water

  1. Take a kettle;

  2. Pour water into the kettle;

  3. Put the kettle on a stove;

  4. Turn on heat;

  5. Wait until water in the kettle boils;

  6. Turn off the heat;

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CONCEPTS

- Characteristics of an algorithm:
  - *Precision*: the steps are precisely stated(defined).
  - *Uniqueness*: results of each step are uniquely defined and only depend on the input and the result of the preceding steps.
  - *Finiteness*: the algorithm stops after a finite number of instructions are executed.
  - *Input*: the algorithm receives input.
  - *Output*: the algorithm produces output.
  - *Generality*: the algorithm applies to a set of inputs.

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Algorithm Representation

- Using natural language: ref. water boiling example.

- Pseudocode: informal high-level description of the operating principle of a computer program or other algorithm.

- Flowchart: diagram that represents an algorithm, workflow or process, showing the steps as boxes of various kinds, and their order by connecting them with arrows.

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FLOWCHART

• Common symbols:

Name	Symbol	Usage
Start / Stop		The beginning or the end point
Process		An instruction or command
Decision		A decision, either yes or no, true or false
Input / Output		Input: Data to computer Output: Data from computer
Direction of flow		Connect the symbols, Show directions of instructions

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ALGORITHM STRUCTURES

• Sequential Structure:

  • Do Process 1,

  • Then, do Process 2,

  • ....

Process 1

Process 2
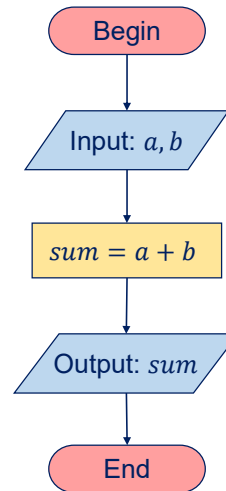
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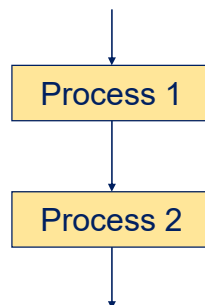
ALGORITHM STRUCTURES

- Sequential Structure:
  - E.g., Sketch flowchart:
    - Input two integers a and b,
    - Compute their sum.
    - Display the sum.

Begin

Input: a, b

$sum = a + b$

Output: sum

End

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ALGORITHM STRUCTURES

- Selection Structure:
  - If selection condition is TRUE, then do Process 1 and Process 2.

Selection condition

TRUE

Process 1

Process 2

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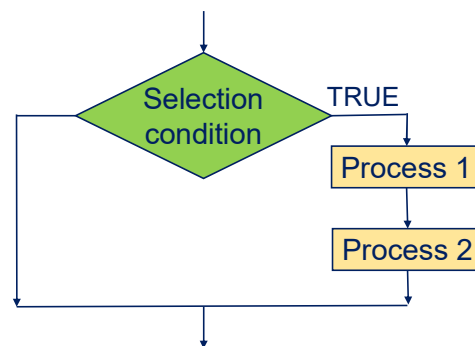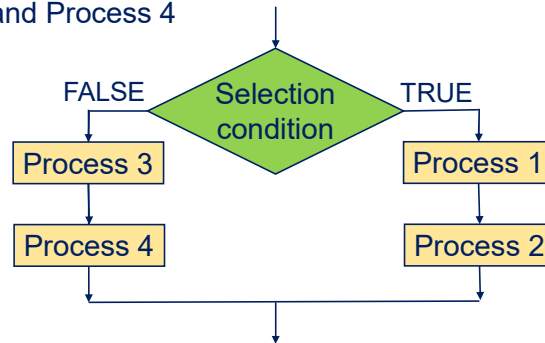
ALGORITHM STRUCTURES

- Selection Structure:
    - If selection condition is TRUE, then do Process 1 and Process 2.
    - Else, selection condition is FALSE, then do Process 3 and Process 4

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ALGORITHM STRUCTURES

- Selection Structure:
    - E.g., solve linear equation $ax + b = 0$
        - If $a = 0$, then we consider b
            - If $b = 0$, then the equation has <u>infinitely many roots</u>,
            - Else, $b \neq 0$, the equation has <u>no root</u>,
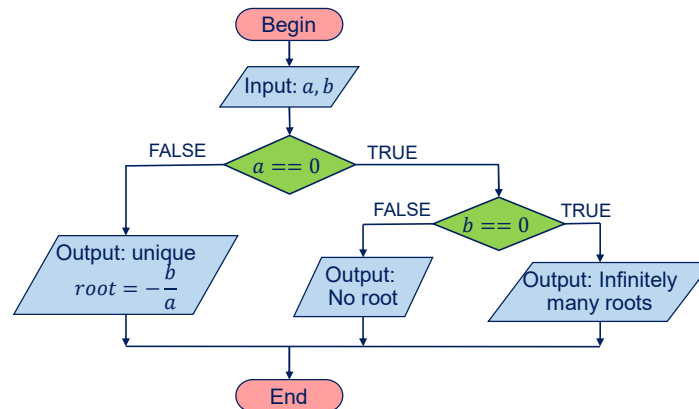   - Else, $a \neq 0$, there is a unique root $-\dfrac{b}{a}$

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ALGORITHM STRUCTURES

- Selection Structure: Solve linear equation $ax + b = 0$
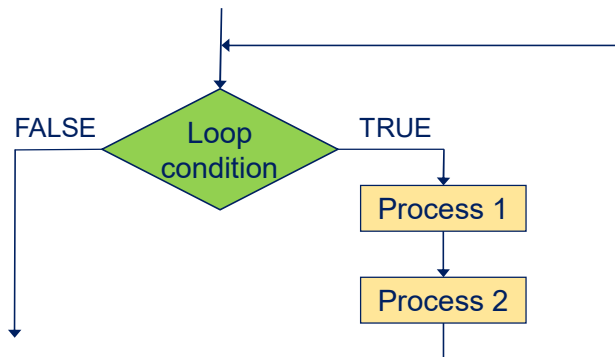

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ALGORITHM STRUCTURES

- Loop Structure:
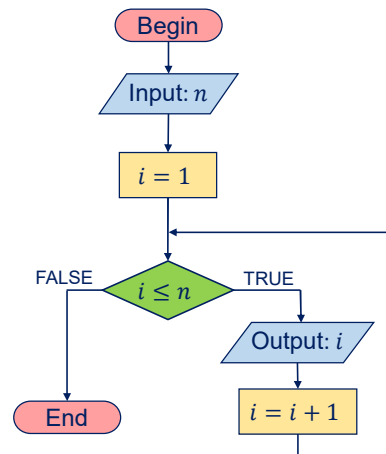 - If loop condition is TRUE, do Process 1 and Process 2

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ALGORITHM STRUCTURES

• Loop Structure: E.g.,

  • Input an integer n

  • Output the list of n integers from 1 to n

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EXERCISES (1)

• Sketch flowcharts for following problems:
  1. Given two integers a and b, find the larger number.
  2. Solve quadratic equation $y = ax^2 + bx + c$
  3. Compute the sum of N first integers $S = 1 + 2 + \cdots + N$
  4. Compute the sum of N first <u>even</u> integers $S = 2 + 4 + \cdots + 2N$
  5. Given an integer N, list all of its divisors. E.g., divisors of $N = 12$ are 1 2 3 4 6 12
  6. Given an integer N, count the number of its divisors. E.g., the number of divisors of $N = 12$ is 6

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EXERCISES (2)

- Sketch flowcharts for following problems:
    7. Given an integer N, sum up all its divisors. E.g., sum of all divisors of $N = 12$ is 28

    8. Given an integer N, e.g., $N = 128$
        - How many digits in N? E.g., 3
        - What is its last digit? E.g., 8
        - What is its first digit? E.g., 1
        - Compute the sum of all digits in N. E.g., sum $= 11$
        - Find the integer which is the reverse of N. E.g., 821

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EXERCISES (3)

- Sketch flowcharts for following problems:
    9. Check if a given integer N is a prime number.
    10. Given integer n, compute:
        a. $S = 1^2 + 2^2 + \cdots + n^2$
        b. $S = 1 + \frac{1}{2} + \cdots + \frac{1}{n}$
        c. $S = \frac{1}{2} + \frac{2}{3} + \cdots + \frac{n}{n+1}$
        d. $T = 1 \times 2 \times \cdots \times n$
        e. $S = 1! + 2! + \cdots + n!$

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Any Questions?

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