PH502: Scientific Programming Concepts

Irish Centre for High End Computing (ICHEC)

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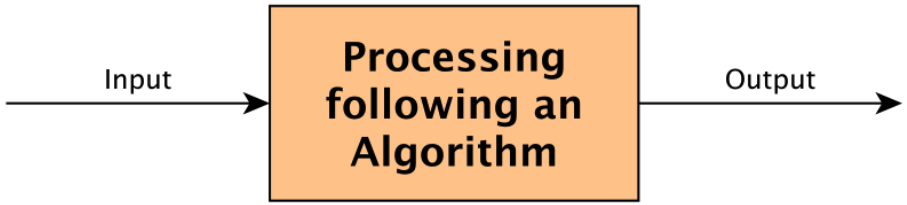
Overview

- We will discuss algorithms is a more general sense.

What is an Algorithm?

- A computational problem is a specification of input-output relation.



- A set of well-defined instructions for performing a computation to solve problems.
- The description must be precise so that it is clear how to perform the computation.
- The instructions may contain mathematical or logical operations, repetition, procession to another instruction, or a set of another instructions.

Examples

- Google's Page Rank Algorithm
- Traveling Sales Man Problem
- Linear Assigment Problems
- Stable Marriage Problem
- The Game of Life
- Sudoku Solving Algorithms

Simple White Cake

Ingredients:

- 1 cup white sugar
- 1/2 cup butter
- 2 eggs
- 2 teaspoons vanilla extract
- 1 1/2 cups all-purpose flour
- 1 3/4 teaspoons baking powder
- 1/2 cup milk

Directions:

1. Preheat oven to 175 degrees C. Grease and flour a 9x9 inch pan.
2. In a medium bowl, cream together the sugar and butter. Beat in the eggs, one at a time. Then stir in the vanilla. Combine flour and baking powder. Add to the creamed mixture and mix well. Finally stir in the milk until batter is smooth.
3. Pour or spoon batter into the prepared pan.
4. Bake for 30 to 40 minutes in the preheated oven.
5. Cake is done when it springs back to the touch.

Human vs Computer Algorithms

Human Algorithms	**Computer Algorithms**
Written in natural language	Written in programming language
Informal steps	Formal, effective steps
Leave obvious steps implicit	All steps are well defined
Regarded as well-understood	Operations are unambiguous

Euclid's Algorithm

- Euclid's Algorithm describes how to find the greatest common divisor of two numbers.
- Given two positive integers a and b, their greatest common divisor denoted by $gcd(a, b)$ is the largest positive integer that divides them both. Ex: gcd(10, 8)=2.
- One of the oldest numerical algorithms (300 BC) still in use.
- Used in various fields: integer factorisation and cryptography, important for electronic commerce,...
- Algorithm:
  1. Divide a by b and let r be the remainder.
  2. If r=0, then b is the answer. Stop.
  3. Else, Set a=b and b=r and Go back to Step 1.

Expressing Algorithms: Natural Language

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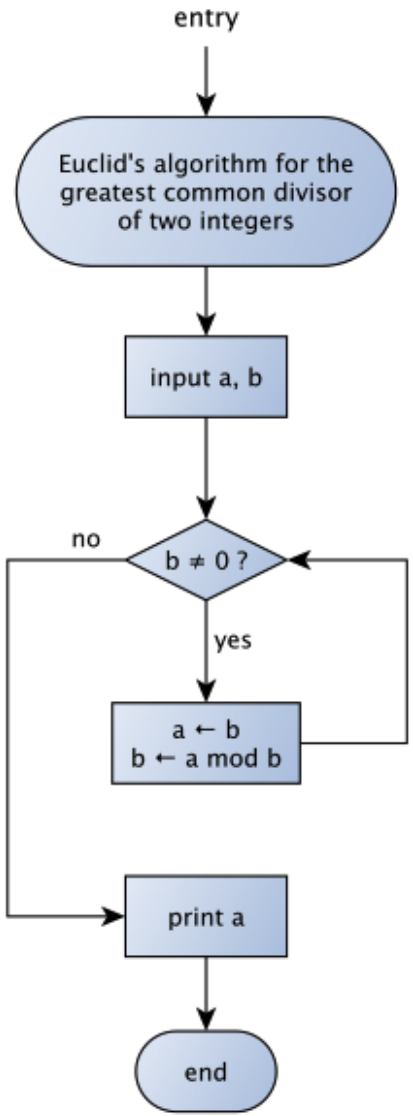
Euclid's Algorithm:

Given a and b integers, where a is larger than or equal to b, the procedure takes the remainder of a and b. If it is zero, a and b's GCD is b itself; if not, repeat this procedure for both b and the remainder of a and b.

- Ambiguous and non-structured steps
- Difficult to understand as the steps are overlapped

Expressing Algorithms: Flowchart



- Clear method for small algorithms; becomes confusing for large ones
- Still redundant and visually polluted

Expressing Algorithms: Pseudocode

- Similar to programming languages (but simplified)
- Clear and concise
- Not concerned with issues of software engineering, i.e., Data abstraction, modularity, error handling (ignored for simplicity)

GCD(a, b)
while $b \neq 0$ **do**
  temp=b
  b=a mod b
  a=temp
end while
return a