Textbook


Six levels in the hierarchy:
- Algorithmic foundations
- Hardware world
- Virtual machine
- Software world
- Applications
- Social Issues
What is Computer Science

- Misconception 1: Computer science is the study of computers.
- Misconception 2: Computer science is the study of how to write computer programs.
- Misconception 3: Computer science is the study of the uses and applications of computers and software.
The Definition of Computer Science

Computer science is the study of algorithms, including:

1. Their formal and mathematical properties
2. Their hardware realizations
3. Their linguistic realizations
4. Their applications
Algorithm

A procedure for solving a mathematical problem in a finite number of steps that frequently involves repetition of an operation; broadly: a step-by-step method for accomplishing some task.
Three types of operations

- **Sequential operations**: carries out a single well-defined task, usually expressed as simple declarative sentences.
- **Conditional operations**: “question-asking” instructions of an algorithm.
- **Iterative operations**: “looping” instructions of an algorithm.
Examples of algorithms

- Programming the VCR (p.6 of textbook)
- Euclid’s algorithm for finding the greatest common divisor (gcd) of two positive integers. (2300-year-old!) (p.23 of textbook)
- Adding two numbers …
Given \( m \geq 1 \) and two positive numbers each containing \( m \) digits: \( a_{m-1}a_{m-2}...a_0 \) and \( b_{m-1}b_{m-2}...b_0 \)

Wanted: \( c_{m-1}c_{m-2}...c_0 \), where

\[
c_{m-1}c_{m-2}...c_0 = (a_{m-1}a_{m-2}...a_0) + (b_{m-1}b_{m-2}...b_0)
\]
Algorithm

- **Step 1:** Set the value of carry to 0
- **Step 2:** Set the value of \( i \) equal to the value 0
- **Step 3:** Repeat the instructions in steps 4 through 6 until the value of \( i \) is greater than \( m-1 \)
  - **Step 4:** Add the two digits \( a_i \) and \( b_i \) to the current value of carry to get \( c_i \)
  - **Step 5:** if \( c_i \geq 10 \), reset \( c_i \) to \((c_i-10)\) and reset the value of carry to 1; otherwise, set the new value of carry to 0
  - **Step 6:** Add 1 to \( i \), effectively moving one column to the left
- **Step 7:** set \( c_m \) to the value of carry
- **Step 8:** print out the answer
- **Step 9:** Stop
Analyzing the algorithm

- Steps 1, 2, 4, 6, 7, 8, 9: sequential
- Step 5: conditional
- Step 3: iterative
Why formalizing the steps?

- If we can specify an algorithm to solve a problem, then we can automate its solution.
- Computer science can be viewed as “the science of algorithmic problem solving”.
- Computability: is it true that every problem can be solved algorithmically?
- The answer to the above question is No.
Related issues

- Efficiency: brute force algorithm for chess playing
- There are problems that we do not yet know *how* to solve algorithmically.
Algorithm: formal definition

A well-ordered collection of unambiguous and effectively computable operations that, when executed, produces a result and halts in a finite amount of time.
Algorithm: key ideas

- Example: shampooing instructions
- Example: making a cherry pie
- Example: prime number