

An Introduction to Computer Science

Chapter 1

Topics:

The Definition of Computer Science

Algorithms

Misconceptions about Computer Science

- Computer science is the study of computers.
 - “Computer science is no more about computers than astronomy is about telescopes, biology is about microscopes, or chemistry is about beakers and test tubes. Science is not about tools. It is about how we use them, and what we find out when we do”.
(M. Fellows and I. Parberry)

Misconceptions (cont. ...)

- Computer science is the study of how to write computer programs.
 - Programming is an important part of computer science, but primarily as a tool to implement ideas and solutions.
 - A program is only a means to an end, not an end in itself.

Misconceptions (cont. ...)

- Computer science is the study of the uses and applications of computers and software.
 - Learning how to use a computer/software is no more part of computer science than driver's education is a branch of automotive engineering.

What is Computer Science then?

- The previous definitions:
 - although not necessarily (completely) wrong, are all incomplete, and thus misleading.
- *A more accurate definition:*

Computer science is the study of *algorithms*, including their properties, their hardware and linguistic realizations, and their applications.

OK, but what is an 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.
- Or, more informally:

A step-by-step method for accomplishing some task.

“Algorithms” in our Daily Life

- Algorithms are not necessarily limited to specifying mathematical tasks.
- We use “algorithms” all the time in our daily life, for example:
 - Cooking recipes.
 - Instructions for assembling things.
 - Directions how to get to places.
 - When performing routine tasks.

An Algorithm for Shampooing Your Hair

Step	Operation
1	Wet your hair
2	Lather your hair
3	Rinse your hair
4	Lather your hair
5	Rinse your hair
6	Stop, you have finished shampooing your hair

An Algorithm for Calculating your GPA

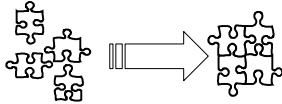
Step	Operation
1	$total_gp = 0$
2	$course_count = 0$
3	Repeat steps 4-5 for all your courses _i
4	$total_gp = total_gp + grade\ in\ course_i$
5	$course_count = course_count + 1$
6	$GPA = total_gp / course_count$
7	Print the value of GPA
8	Stop.

Aren't all "instructions" then an algorithm?

- ... a well-ordered collection ...
 - Must know in which order to perform the steps (matters whether you rinse or lather your hair first!).
- ...unambiguous and effectively computable operations ...
 - must know specifically how to perform each step.
- ... that produces a result ...
 - must be doing something well defined.
- ... and halts in a finite amount of time ...
 - must guarantee that the process stops (eventually).

Algorithms and Problem Solving

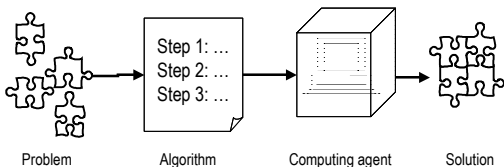
- We have a task or a problem that needs to be solved:



- We want to translate the procedure for solving the problem into an algorithm that is:
 - Correct
 - Efficient
 - Each step is computable

Why bother?

If we can specify an algorithm to solve a problem, then we can automate its solution.



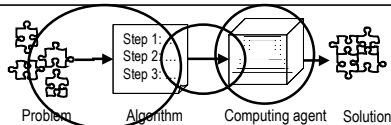
Computing Agent

- A *computing agent* is an entity capable of performing the steps described in the algorithm, that is, execute the algorithm.
- Could be a:
 - Person
 - DNA (!)
 - Computer
- In our case, typically a computer.

Definition of Computer Science

Computer science - the study of algorithms, including:

- 1) Their formal and mathematical properties
- 2) Their hardware realizations
- 3) Their linguistic realizations
- 4) Their applications



1. Formal and Mathematical Properties

- Computer Science is about:
 - How to design algorithms to solve a wide range of problems.
 - How to determine whether problems are (efficiently) computable
 - That is, can be specified as an algorithm!
 - Studying the behavior of algorithms to decide whether they are correct and how efficient they are.

2. Their Hardware Realization

- Computer Science is about:
 - Designing and building computer systems capable of executing algorithms.
 - Non-stopping technological advances:
 - Faster and faster computers, networks, ...
 - Parallel computing
 - “Quantum computing”?

3. Their linguistic realizations

- Computer Science is about:
 - Designing programming languages and translating algorithms into these languages so they can be executed by the hardware.
 - Functional programming
 - Object Oriented programming
 - Visual programming
 - ...

4. Their applications

- Computer Science is about:
 - Identifying important problems (new uses) for computers.
 - Designing software to solve these new problems.
- Old and new applications:
 - First computers were used mainly for numerical calculations and massive data storage/retrieval.
 - Then, ... business use, graphics, multimedia, games, Internet, WWW, cars, house appliances, ...
- What's to come?
