



Scuola Superiore Sant'Anna



Informatica di base - Introduzione

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Computer Science: what is it?

- Computer science (or computing science) is the study of the theoretical foundations of information and computation and their implementation and application in computer systems (from wikipedia)
- It studies:
 - how information can be represented
 - How information can be elaborated (transformed)
- Systematic study of algorithms that transform information:
 - theory, analysis, efficient design and implementation



Computer Science

- Information processing involves:
 - Concepts, methods and tools for representing information (data structures)
 - Methods and tools for processing information (algorithms)
 - Study of the structure of modern computer systems



Algorithms, Programs, Processes

- **Algorithm:**
 - It is the logical procedure to solve a certain problem
 - Informally specified a a sequence of elementary *steps* that an “execution machine” must follow to solve the problem
 - not necessarily expressed in a formal programming language!
- **Program:**
 - It is the implementation of an algorithm in a programming language
 - Can be executed several times with different inputs
- **Process:**
 - An instance of a program that, given a set of inputs values, produces a set of outputs



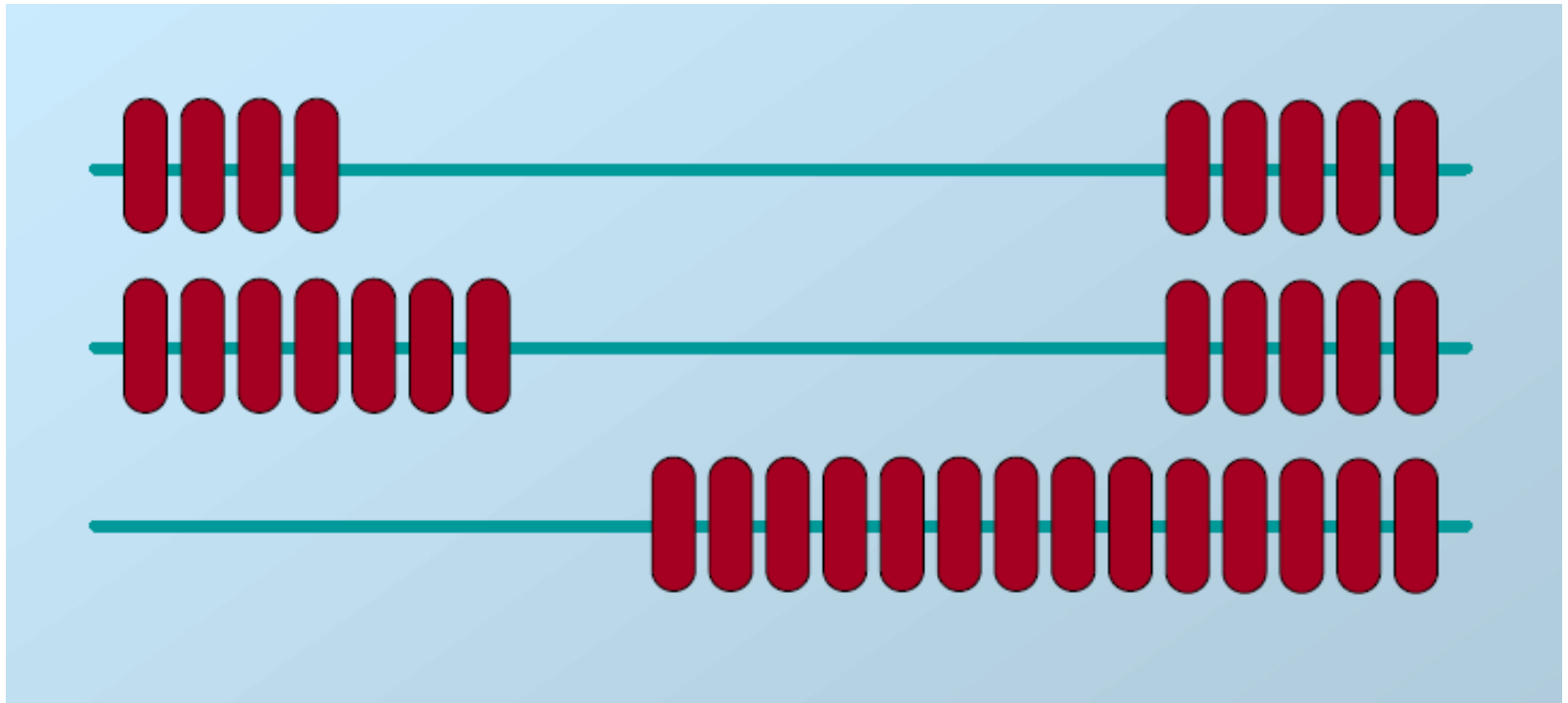
Algorithms

- Abstract level
 - the logical procedure to solve a problem
 - can be specified in any language
 - need to be precise only to a certain point



Example: sum two numbers

- Let's use the abacus





Sum two numbers: algorithm

- **Input:** two numbers a , b **Output:** one number c
- **Initialize abacus**
 - row 1, move a beads to the left, all the others to the right
 - row 2, move b beads to the left, all the others to the right
 - row 3, all beads to the right
- **Step 1:**
 - in row 1 move one bead to the right, and in row 3, move one bead to the left; repeat until no more beads to the left in row 1
- **Step 2:**
 - in row 2 move one bead to the right, and in row 3, move one bead to the left; repeat until no more beads to the left in row 2
- **Final step:** count the number of beads in the left part of row 3



Limitations

- Can you find the limitations of the previous algorithm?



Algorithms

- Ok, that was stupid
 - but useful to make an example of algorithm
- Another example
 - The Trachtenberg System
 - It was developed by the Ukrainian engineer Jakow Trachtenberg in order to keep his mind occupied while being held in a Nazi concentration camp



Algorithms for multiplication

- Fast algorithm for multiplication by 5
 - For each digit (right to left)
 - Take half of the neighbor
 - Add 5 if number is odd
- multiplication by 7
 - For each digit (right to left)
 - double it
 - Add half of its neighbor.
 - If the digit is odd, add 5.
- multiplication by 11
 - ???



Executing machine

- When describing an algorithm, we consider an abstract machine that “executes” the instructions
 - In the previous case, the human being
- A computer is a “special case” of executing machine
- We need to look at how a computer is done to understand computer science!