

Algorithms

INTRODUCTION

Analysis of Algorithms

Algorithm

Definition 1: A finite set of precise instructions for performing a computation or for solving a problem.

Definition 2: A specific set of instructions for carrying out a procedure or solving a problem, usually with the requirement that the procedure terminates at some point.

Definition 3: A procedure for solving a mathematical problem in a finite number of steps that frequently involves repetition of an operation.

Definition 4: A step-by-step procedure for solving a problem or accomplishing some end especially by a computer.

Algorithm

Synonym: Method, Procedure, Program, Recipe, Routine
Solution, Technique ...

Etymology: Alteration of Middle English [algorisme](#), from Old French & Medieval Latin; from Medieval Latin [algorismus](#), from Arabic [al-khuwarizmi](#), from the name of the Persian Mathematician [Al-Khowârizmi](#) who was the first to formalize the rules for the 4 basic arithmetic operations.

The Ultimate Question

Question: How do we solve problems?

- ★ Talent?
- ★ Intuition?
- ★ Luck?
- ★ Experience?
- ★ Hard work?

Answer: a combination of these 5 factors!!!

How to solve a problem? Some Heuristics

- Search for a pattern.
- Draw a figure.
- Formulate an equivalent problem.
- Modify the problem.
- Choose effective notation.
- Exploit symmetry.
- Divide into cases.
- Work backward.
- Argue by contradiction.
- Pursue parity.
- Consider extreme cases.
- Generalize.

Algorithms — Properties

- ★ **Correctness:** for all valid inputs.
- ★ **Complexity – Efficiency:** as a function of the input size.
 - Worst-case vs. average case.
- ★ **Limitations:** for the algorithm and for the problem.
- ★ **Scalability:** “similar” efficiency for any input size.
- ★ **Optimality:** optimal or near-optimal or approximately optimal solutions.