

Algorithms

Introduction

(Based on [Manber 1989])

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What They Are




- 🌐 An **algorithm** is, broadly speaking, a *step-by-step* procedure for solving a problem or accomplishing some end.
- 🌐 When it is meant for the **computer**, each step in an algorithm should be realizable by *well-defined*, limited *primitive* operations that the computer understands.
- 🌐 **Algorithm design** is an important and usually the hardest part of **programming** (which consists in finding/devising a solution and translating it into a computer program).
- 🌐 Better algorithms (designed once, used forever) save more time and money.

Development of an Algorithm

- 🌐 We typically are given a problem statement, including **input** and **output** requirements, that is an abstract yet *accurate* and *precise* account of the problem to be solved and the properties of a satisfactory solution.
- 🌐 The development of an algorithm involves the following tasks:
 1. **Design** (main subject of this course)
 2. **Verification** (or **Proof of Correctness**)
 3. **Analysis**
 4. **Implementation**(May need to iterate.)

Main Concerns

Why is algorithm design difficult?

-  Computers are different from humans; they are very fast and can handle much larger amounts of data.
-  **Counterintuitive** approaches may be needed, because of large problem scales.
-  Better solutions, if worthwhile (with greater payoffs), may be more **complicated**.

How do we approach it?

Our Approach to the Subject

- 🌐 Emphasis of the **creative** side
 - ☀️ not only memorizing solutions
 - ☀️ but also learning to create by trying to create
- 🌐 **Induction** as one central design method
 - ☀️ to explain/understand the principles behind a design
 - ☀️ to systematically guide the creation process

Design by Induction

- 🌐 Draw analogies from proving theorems by *mathematical induction*.
- 🌐 Concentrate on *extending* solutions for smaller problem instances to solutions for larger ones.
- 🌐 Induction may not solve every problem, but is helpful.