

# Introduction

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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

- 🌐 Two distinct features:
  - ☀️ 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
- 🌐 What is the “design by induction” method?
  - ☀️ draw analogies from proving theorems by mathematical induction
  - ☀️ concentrate on *extending* solutions of smaller problems instances to solutions of larger ones
  - ☀️ induction may not solve every problem, but is helpful