

# Chapter 1

## 1 What is an algorithm

An algorithm is a sequence of computational steps that transforms an input into an output, generally to solve a well-defined computational problem.

## 2 What is a data structure

Data structures are a way to store and organize data in memory to facilitate efficient access and modification (e.g., to enhance the speed of an algorithm).

## 3 How to quantitatively measure algorithm efficiency

Intuitively, it takes  $c$  units of time to perform a given computational operation. Typically the number of operations required by an algorithm corresponds to the size of the input  $n$ ; therefore, algorithmic efficiency is expressed as a function of input size.

For instance, to sort  $n$  integers in increasing order, the *insertion sort* algorithm takes  $c \cdot n^2$  units time, whereas the *merge sort* takes  $c \cdot n \lg n$ . Comparably speaking then, the  $n \lg n$  algorithm will outperform the  $n^2$  algorithm for large input sizes  $n$ .

There's an entire mathematical notation for identifying and comparing these input-efficiency functions for algorithms, called *asymptotic notation*; it's discussed at length in chapter 3.

	1 second	1 minute	1 hour	1 day	1 month	1 year	1 century
$\lg n$	$2^{10^6}$	$2^{10^7}$	$2^{10^9}$	$2^{10^{10}}$	$2^{10^{12}}$	$2^{10^{13}}$	$2^{10^{15}}$
$\sqrt{n}$							
$n$							
$n \lg n$							
$n^2$							
$n^3$							
$2^n$							
$n!$							