**Programming Concepts**

Table of Contents

[Data Structures 1](#_Toc32561376)

[Arrays 1](#_Toc32561377)

[Strings 2](#_Toc32561378)

[Linked Lists 2](#_Toc32561379)

[Stacks and Queues 2](#_Toc32561380)

[Hash Tables 2](#_Toc32561381)

[Trees 2](#_Toc32561382)

[Binary Search Tree 2](#_Toc32561383)

[Tries 2](#_Toc32561384)

[Heaps 2](#_Toc32561385)

[Graphs 2](#_Toc32561386)

[Advanced Data Structures 2](#_Toc32561387)

[Algorithms 2](#_Toc32561388)

[Recursion 2](#_Toc32561389)

[Dynamic Programming 2](#_Toc32561390)

[Backtracking 2](#_Toc32561391)

[Sorting and Searching 2](#_Toc32561392)

[Pathfinding 2](#_Toc32561393)

[Bit Manipulation 2](#_Toc32561394)

[Randomized Algorithms 2](#_Toc32561395)

[Applications 2](#_Toc32561396)

[Design 2](#_Toc32561397)

[Data Structure Design 2](#_Toc32561398)

[System Design 2](#_Toc32561399)

# Data Structures

## Arrays

In [computer science](https://en.wikipedia.org/wiki/Computer_science), an array data structure, or simply an array, is a [data structure](https://en.wikipedia.org/wiki/Data_structure) consisting of a collection of elements ([values](https://en.wikipedia.org/wiki/Value_(computer_science)) or [variables](https://en.wikipedia.org/wiki/Variable_(programming))), each identified by at least one array index or key. An array is stored such that the position of each element can be computed from its index [tuple](https://en.wikipedia.org/wiki/Tuple) by a mathematical formula.

**Associative Array**

**Bit Array**

**One-dimensional Array**

## Strings

In [computer programming](https://en.wikipedia.org/wiki/Computer_programming), a string is traditionally a [sequence](https://en.wikipedia.org/wiki/Sequence) of [characters](https://en.wikipedia.org/wiki/Character_(computing)), either as a [literal constant](https://en.wikipedia.org/wiki/Literal_(computer_programming)) or as some kind of variable. The latter may allow its elements to be mutated and the length changed, or it may be fixed (after creation). A string is generally considered as a [data type](https://en.wikipedia.org/wiki/Data_type) and is often implemented as an [array data structure](https://en.wikipedia.org/wiki/Array_data_structure) of [bytes](https://en.wikipedia.org/wiki/Byte) (or [words](https://en.wikipedia.org/wiki/Word_(computer_architecture))) that stores a sequence of elements, typically characters, using some [character encoding](https://en.wikipedia.org/wiki/Character_encoding). String may also denote more general [arrays](https://en.wikipedia.org/wiki/Array_data_type) or other sequence (or [list](https://en.wikipedia.org/wiki/List_(abstract_data_type))) data types and structures.

Depending on the programming language and precise data type used, a [variable](https://en.wikipedia.org/wiki/Variable_(programming)) declared to be a string may either cause storage in memory to be statically allocated for a predetermined maximum length or employ [dynamic allocation](https://en.wikipedia.org/wiki/Dynamic_allocation) to allow it to hold a variable number of elements.

When a string appears literally in [source code](https://en.wikipedia.org/wiki/Source_code), it is known as a [string literal](https://en.wikipedia.org/wiki/String_literal) or an anonymous string.

**String Interpolation**

In computer programming, string interpolation (or variable interpolation, variable substitution, or variable expansion) is the process of evaluating a string literal containing one or more placeholders, yielding a result in which the placeholders are replaced with their corresponding values.

## Linked Lists

In [computer science](https://en.wikipedia.org/wiki/Computer_science), a linked list is a linear collection of data elements, whose order is not given by their physical placement in memory. Instead, each element [points](https://en.wikipedia.org/wiki/Pointer_(computer_programming)) to the next. It is a [data structure](https://en.wikipedia.org/wiki/Data_structure) consisting of a collection of [nodes](https://en.wikipedia.org/wiki/Node_(computer_science)) which together represent a [sequence](https://en.wikipedia.org/wiki/Sequence). In its most basic form, each node contains: [data](https://en.wikipedia.org/wiki/Data_(computing)), and a [reference](https://en.wikipedia.org/wiki/Reference_(computer_science)) (in other words, a link) to the next node in the sequence. This structure allows for efficient insertion or removal of elements from any position in the sequence during iteration. More complex variants add additional links, allowing more efficient insertion or removal of nodes at arbitrary positions. A drawback of linked lists is that access time is linear (and difficult to [pipeline](https://en.wikipedia.org/wiki/Instruction_pipelining)). Faster access, such as random access, is not feasible. [Arrays](https://en.wikipedia.org/wiki/Array_data_structure) have better [cache locality](https://en.wikipedia.org/wiki/Locality_of_reference) compared to linked lists.

## Hash Tables

## Trees

## Binary Search Tree

## Tries

## Heaps

## Graphs

## Advanced Data Structures

# Algorithms

## Recursion

## Dynamic Programming

## Backtracking

## Sorting and Searching

## Pathfinding

## Bit Manipulation

## Randomized Algorithms

# Applications

# Design

## Data Structure Design

## System Design