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Sorting

Sorting is a fundamental algorithm in Computer Science. A **sorting algorithm** takes a list as the input, and returns a list in an order. It is often the first step in many algorithms, and thus setting the lower bound for complexity.

Definition [\[edit\]](#)

Given a **list** **S** with **N** elements, $S' = \text{Sort}(S)$ is defined as follows:

- for $0 < i \leq N$, $S_i \leq S_{i+1}$.
- S' is a **permutation** of S .

Put in Lisp:

```
(defun is-sorted (lst)
  (cond ((< (length lst) 2) t)
        (t (and (<= (first lst) (second lst))
                  (is-sorted (cdr lst))))))
```

Sorting

Algorithms

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Problems

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Sorting Algorithms and Complexities [\[edit\]](#)

- n is the number of elements
- k is the number of distinct objects

Algorithm	Time Complexity	Space Complexity
Bubble sort	$O(n^2)$	$O(n)$ - in place, $O(1)$ extra space.
Insertion sort	$O(n^2)$	$O(n)$ - in place, $O(1)$ extra space.
Selection sort	$O(n^2)$	$O(n)$ - in place, $O(1)$ extra space.
Merge sort	$O(n \log n)$	$O(n)$ - $O(n)$ extra space.
Heap sort	$O(n \log n)$	$O(n)$ - in place, $O(1)$ extra space.
Quicksort	$O(n^2)$ - $O(n \log n)$ expected, and with high probability.	$O(1)$ inplace.
Introsort	$O(n \log n)$	$O(n)$ - $O(\log n)$ extra space.
Counting sort	$O(k + n)$	$O(k)$
Timsort 🔗	$O(n)$ Best case $O(n \log n)$ Worst Case	$O(n)$

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