Quicksort

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**Quicksort** (sometimes called **partition-exchange sort**) is an [efficient](https://en.wikipedia.org/wiki/Algorithm_efficiency) [sorting algorithm](https://en.wikipedia.org/wiki/Sorting_algorithm), serving as a systematic method for placing the elements of a [random access](https://en.wikipedia.org/wiki/Random_access) [file](https://en.wikipedia.org/wiki/Computer_file) or an [array](https://en.wikipedia.org/wiki/Array_data_structure) in order. Developed by British computer scientist [Tony Hoare](https://en.wikipedia.org/wiki/Tony_Hoare) in 1959[[1]](https://en.wikipedia.org/wiki/Quicksort#cite_note-1) and published in 1961,[[2]](https://en.wikipedia.org/wiki/Quicksort#cite_note-alg64-2) it is still a commonly used algorithm for sorting. When implemented well, it can be about two or three times faster than its main competitors, [merge sort](https://en.wikipedia.org/wiki/Merge_sort) and [heapsort](https://en.wikipedia.org/wiki/Heapsort).[[3]](https://en.wikipedia.org/wiki/Quicksort#cite_note-skiena-3)[[*contradictory*](https://en.wikipedia.org/wiki/Category:Articles_contradicting_other_articles)]

Quicksort is a [comparison sort](https://en.wikipedia.org/wiki/Comparison_sort), meaning that it can sort items of any type for which a "less-than" relation (formally, a [total order](https://en.wikipedia.org/wiki/Total_order)) is defined. Efficient implementations of Quicksort are not a [stable sort](https://en.wikipedia.org/wiki/Stable_sort), meaning that the relative order of equal sort items is not preserved. Quicksort can operate [in-place](https://en.wikipedia.org/wiki/In-place_algorithm) on an array, requiring small additional amounts of [memory](https://en.wikipedia.org/wiki/Main_memory) to perform the sorting. It is very similar to [selection sort](https://en.wikipedia.org/wiki/Selection_sort), except that it does not always choose worst-case partition.

[Mathematical analysis](https://en.wikipedia.org/wiki/Analysis_of_algorithms) of quicksort shows that, [on average](https://en.wikipedia.org/wiki/Best,_worst_and_average_case), the algorithm takes [O](https://en.wikipedia.org/wiki/Big_O_notation)(*n* log *n*) comparisons to sort *n* items. In the [worst case](https://en.wikipedia.org/wiki/Best,_worst_and_average_case), it makes O(*n*2) comparisons, though this behavior is rare.

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The quicksort algorithm was developed in 1959 by [Tony Hoare](https://en.wikipedia.org/wiki/Tony_Hoare) while in the [Soviet Union](https://en.wikipedia.org/wiki/Soviet_Union), as a visiting student at [Moscow State University](https://en.wikipedia.org/wiki/Moscow_State_University).

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Quicksort is a [divide and conquer algorithm](https://en.wikipedia.org/wiki/Divide_and_conquer_algorithm). Quicksort first divides a large array into two smaller sub-arrays: the low elements and the high elements. Quicksort can then recursively sort the sub-arrays. The steps are:

1. Pick an element, called a *pivot*, from the array.
2. *Partitioning*: reorder the array so that all elements with values less than the pivot come before the pivot, while all elements with values greater than the pivot come after it (equal values can go either way). After this partitioning, the pivot is in its final position. This is called the *partition* operation.
3. [Recursively](https://en.wikipedia.org/wiki/Recursion_(computer_science)) apply the above steps to the sub-array of elements with smaller values and separately to the sub-array of elements with greater values.

The base case of the recursion is arrays of size zero or one, which are in order by definition, so they never need to be sorted.

The pivot selection and partitioning steps can be done in several different ways; the choice of specific implementation schemes greatly affects the algorithm's performance.