Sorting algorithm

A **sorting algorithm** is an algorithm that puts elements of a list in a certain order. The most-used orders are numerical order and lexicographical order. Efficient sorting is important for optimizing the use of other algorithms (such as search and merge algorithms) which require input data to be in sorted lists; it is also often useful for canonicalizing data and for producing human-readable output. More formally, the output must satisfy two conditions:

1. The output is in nondecreasing order (each element is no smaller than the previous element according to the desired total order);
2. The output is a permutation (reordering) of the input.

Since the dawn of computing, the sorting problem has attracted a great deal of research, perhaps due to the complexity of solving it efficiently despite its simple, familiar statement. For example, bubble sort was analyzed as early as 1956.[1] Although many consider it a solved problem, useful new sorting algorithms are still being invented (for example, library sort was first published in 2006). Sorting algorithms are prevalent in introductory computer science classes, where the abundance of algorithms for the problem provides a gentle introduction to a variety of core algorithm concepts, such as big O notation, divide and conquer algorithms, data structures, randomized algorithms, best, worst and average case analysis, time-space tradeoffs, and upper and lower bounds.

Classification

Sorting algorithms are often classified by:

- Computational complexity (worst, average and best behavior) of element comparisons in terms of the size of the list (n). For typical serial sorting algorithms good behavior is O(n log n), with parallel sort in O($\log^2 n$), and bad behavior is O(n^2). (See Big O notation.) Ideal behavior for a serial sort is O(n), but this is not possible in the average case, optimal parallel sorting is O(log n). Comparison-based sorting algorithms, which evaluate the elements of the list via an abstract key comparison operation, need at least O(n log n) comparisons for most inputs.
- Computational complexity of swaps (for "in place" algorithms).
- Memory usage (and use of other computer resources). In particular, some sorting algorithms are "in place". Strictly, an in place sort needs only O(1) memory beyond the items being sorted; sometimes O(log(n)) additional memory is considered "in place".
- Recursion. Some algorithms are either recursive or non-recursive, while others may be both (e.g., merge sort).
- Stability: stable sorting algorithms maintain the relative order of records with equal keys (i.e., values).
- Whether or not they are a comparison sort. A comparison sort examines the data only by comparing two elements with a comparison operator.
- General method: insertion, exchange, selection, merging, *etc.* Exchange sorts include bubble sort and quicksort. Selection sorts include shaker sort and heapsort. Also whether the algorithm is serial or parallel. The remainder of this discussion almost exclusively concentrates upon serial algorithms and assumes serial operation.
- Adaptability: Whether or not the presortedness of the input affects the running time. Algorithms that take this into account are known to be adaptive

Stability

Stable sorting algorithms maintain the relative order of records with equal keys. (A key is that portion of the record which is the basis for the sort; it may or may not include all of the record.) If all keys are different then this distinction is not necessary. But if there are equal keys, then a sorting algorithm is stable if whenever there are two records (let's say R and S) with the same key, and R appears before S in the original list, then R will always appear before S in the sorted list. When equal elements are indistinguishable, such as with integers, or more generally, any data where the entire element is the key, stability is not an issue. However, assume that the following pairs of numbers are to be sorted by their first component:

```
(4, 2)  (3, 7)  (3, 1)  (5, 6)
```

In this case, two different results are possible, one which maintains the relative order of records with equal keys, and one which does not:

```
(3, 7)  (3, 1)  (4, 2)  (5, 6)   (order maintained)
(3, 1)  (3, 7)  (4, 2)  (5, 6)   (order changed)
```

Unstable sorting algorithms may change the relative order of records with equal keys, but stable sorting algorithms never do so. Unstable sorting algorithms can be specially implemented to be stable. One way of doing this is to artificially extend the key comparison, so that comparisons between two objects with otherwise equal keys are decided using the order of the entries in the original data order as a tie-breaker. Remembering this order, however, often involves an additional computational cost.

Sorting based on a primary, secondary, tertiary, etc. sort key can be done by any sorting method, taking all sort keys into account in comparisons (in other words, using a single composite sort key). If a sorting method is stable, it is also possible to sort multiple times, each time with one sort key. In that case the keys need to be applied in order of increasing priority.

Example: sorting pairs of numbers as above by second, then first component:

```
(4, 2)  (3, 7)  (3, 1)  (5, 6) (original)
```

```
(3, 1)  (4, 2)  (5, 6)  (3, 7) (after sorting by second component)
(3, 1)  (3, 7)  (4, 2)  (5, 6) (after sorting by first component)
```

On the other hand:

```
(3, 7)  (3, 1)  (4, 2)  (5, 6) (after sorting by first component)
(3, 1)  (4, 2)  (5, 6)  (3, 7) (after sorting by second component,
                                order by first component is disrupted).
```

Comparison of algorithms

In this table, *n* is the number of records to be sorted. The columns "Average" and "Worst" give the time complexity in each case, under the assumption that the length of each key is constant, and that therefore all comparisons, swaps, and other needed operations can proceed in constant time. "Memory" denotes the amount of auxiliary storage needed beyond that used by the list itself, under the same assumption. These are all comparison sorts. The run time and the memory of algorithms could be measured using various notations like theta, omega, Big-O, small-o, etc. The memory and the run times below are applicable for all the 5 notations.

Comparison sorts

Name	Best	Average	Worst	Memory	Stable	Method	Other notes
Quicksort	$n \log n$	$n \log n$	n^2	$\log n$	Depends	Partitioning	Quicksort is usually done in place with O(log(*n*)) stack space. Most implementations are unstable, as stable in-place partitioning is more complex. Naïve variants use an O(*n*) space array to store the partition.
Merge sort	$n \log n$	$n \log n$	$n \log n$	Depends; worst case is n	Yes	Merging	Highly parallelizable (up to O(log(*n*)) using the Three Hungarian's Algorithm or more practically, Cole's parallel merge sort) for processing large amounts of data.
In-place Merge sort	—	—	$n \left(\log n\right)^2$	1	Yes	Merging	Implemented in Standard Template Library (STL);[2] can be implemented as a stable sort based on stable in-place merging.[3]
Heapsort	$n \log n$	$n \log n$	$n \log n$	1	No	Selection	
Insertion sort	n	n^2	n^2	1	Yes	Insertion	O(*n* + *d*), where *d* is the number of inversions
Introsort	$n \log n$	$n \log n$	$n \log n$	$\log n$	No	Partitioning & Selection	Used in several STL implementations
Selection sort	n^2	n^2	n^2	1	No	Selection	Stable with O(n) extra space, for example using lists.[4] Used to sort this table in Safari or other Webkit web browser.[5]
Timsort	n	$n \log n$	$n \log n$	n	Yes	Insertion & Merging	n comparisons when the data is already sorted or reverse sorted.
Shell sort	n	$n(\log n)^2$ or $n^{3/2}$	Depends on gap sequence; best known is $n(\log n)^2$	1	No	Insertion	Small code size, no use of call stack, reasonably fast, useful where memory is at a premium such as embedded and older mainframe applications
Bubble sort	n	n^2	n^2	1	Yes	Exchanging	Tiny code size
Binary tree sort	n	$n \log n$	$n \log n$	n	Yes	Insertion	When using a self-balancing binary search tree
Cycle sort	—	n^2	n^2	1	No	Insertion	In-place with theoretically optimal number of writes
Library sort	—	$n \log n$	n^2	n	Yes	Insertion	
Patience sorting	—	—	$n \log n$	n	No	Insertion & Selection	Finds all the longest increasing subsequences within O(*n* log *n*)
Smoothsort	n	$n \log n$	$n \log n$	1	No	Selection	An adaptive sort - n comparisons when the data is already sorted, and 0 swaps.
Strand sort	n	n^2	n^2	n	Yes	Selection	
Tournament sort	—	$n \log n$	$n \log n$	n [6]		Selection	
Cocktail sort	n	n^2	n^2	1	Yes	Exchanging	
Comb sort	n	$n \log n$	n^2	1	No	Exchanging	Small code size
Gnome sort	n	n^2	n^2	1	Yes	Exchanging	Tiny code size
Bogosort	n	$n \cdot n!$	$n \cdot n! \to \infty$	1	No	Luck	Randomly permute the array and check if sorted.

The following table describes integer sorting algorithms and other sorting algorithms that are not comparison sorts. As such, they are not limited by a $\Omega(n \log n)$ lower bound. Complexities below are in terms of *n*, the number of items to be sorted, *k*, the size of each key, and *d*, the digit size used by the implementation. Many of them are based on the assumption that the key size is large enough that all entries have unique key values, and hence that $n << 2^k$, where << means "much less than."

Non-comparison sorts

Name	Best	Average	Worst	Memory	Stable	$n << 2^k$	Notes
Pigeonhole sort	—	$n + 2^k$	$n + 2^k$	2^k	Yes	Yes	
Bucket sort (uniform keys)	—	$n + k$	$n^2 \cdot k$	$n \cdot k$	Yes	No	Assumes uniform distribution of elements from the domain in the array.[7]
Bucket sort (integer keys)	—	$n + r$	$n + r$	$n + r$	Yes	Yes	r is the range of numbers to be sorted. If r = $\mathcal{O}(n)$ then Avg RT = $\mathcal{O}(n)$[8]
Counting sort	—	$n + r$	$n + r$	$n + r$	Yes	Yes	r is the range of numbers to be sorted. If r = $\mathcal{O}(n)$ then Avg RT = $\mathcal{O}(n)$[7]
LSD Radix Sort	—	$n \cdot \frac{k}{d}$	$n \cdot \frac{k}{d}$	n	Yes	No	[7][8]
MSD Radix Sort	—	$n \cdot \frac{k}{d}$	$n \cdot \frac{k}{d}$	$n + \frac{k}{d} \cdot 2^d$	Yes	No	Stable version uses an external array of size n to hold all of the bins
MSD Radix Sort	—	$n \cdot \frac{k}{d}$	$n \cdot \frac{k}{d}$	$\frac{k}{d} \cdot 2^d$	No	No	In-Place. k / d recursion levels, 2^d for count array
Spreadsort	—	$n \cdot \frac{k}{d}$	$n \cdot \left(\frac{k}{s} + d\right)$	$\frac{k}{d} \cdot 2^d$	No	No	Asymptotics are based on the assumption that $n << 2^k$, but the algorithm does not require this.

The following table describes some sorting algorithms that are impractical for real-life use due to extremely poor performance or a requirement for specialized hardware.

Name	Best	Average	Worst	Memory	Stable	Comparison	Other notes
Bead sort	—	N/A	N/A	—	N/A	No	Requires specialized hardware
Simple pancake sort	—	n	n	$\log n$	No	Yes	Count is number of flips.
Spaghetti (Poll) sort	n	n	n	n^2	Yes	Polling	This A linear-time, analog algorithm for sorting a sequence of items, requiring O(*n*) stack space, and the sort is stable. This requires n parallel processors. Spaghetti sort#Analysis
Sorting networks	—	$\log n$	$\log n$	$n \cdot \log(n)$	Yes	No	Requires a custom circuit of size $\mathcal{O}(n \cdot \log(n))$

Additionally, theoretical computer scientists have detailed other sorting algorithms that provide better than $\mathcal{O}(n \log n)$ time complexity with additional constraints, including:

- Han's algorithm, a deterministic algorithm for sorting keys from a domain of finite size, taking $\mathcal{O}(n \log \log n)$ time and $\mathcal{O}(n)$ space.[9]
- Thorup's algorithm, a randomized algorithm for sorting keys from a domain of finite size, taking $\mathcal{O}(n \log \log n)$ time and $\mathcal{O}(n)$ space.[10]
- An integer sorting algorithm taking $\mathcal{O}\left(n\sqrt{\log \log n}\right)$ expected time and $\mathcal{O}(n)$ space.[11]

Algorithms not yet compared above include:

- Odd-even sort
- Flashsort
- Burstsort
- Postman sort
- Stooge sort
- Samplesort
- Bitonic sorter

Summaries of popular sorting algorithms

Bubble sort

Bubble sort is a simple sorting algorithm. The algorithm starts at the beginning of the data set. It compares the first two elements, and if the first is greater than the second, it swaps them. It continues doing this for each pair of adjacent elements to the end of the data set. It then starts again with the first two elements, repeating until no swaps have occurred on the last pass. This algorithm's average and worst case performance is $O(n^2)$, so it is rarely used to sort large, unordered, data sets. Bubble sort can be used to sort a small number of items (where its asymptotic inefficiency is not a high penalty). Bubble sort can also be used efficiently on a list of any length that is nearly sorted (that is, the elements are not significantly out of place). For example, if any number of elements are out of place by only one position (e.g. 0123546789 and 1032547698), bubble sort's exchange will get them in order on the first pass, the second pass will find all elements in order, so the sort will take only $2n$ time.

A bubble sort, a sorting algorithm that continuously steps through a list, swapping items until they appear in the correct order.

Selection sort

Selection sort is an in-place comparison sort. It has $O(n^2)$ complexity, making it inefficient on large lists, and generally performs worse than the similar insertion sort. Selection sort is noted for its simplicity, and also has performance advantages over more complicated algorithms in certain situations.

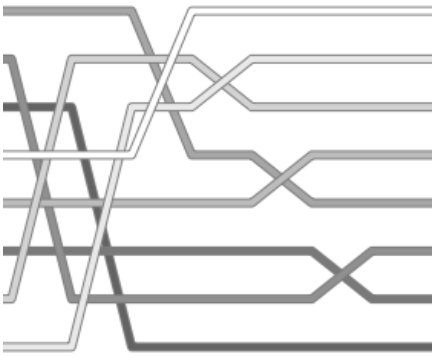
The algorithm finds the minimum value, swaps it with the value in the first position, and repeats these steps for the remainder of the list. It does no more than n swaps, and thus is useful where swapping is very expensive.

Insertion sort

Insertion sort is a simple sorting algorithm that is relatively efficient for small lists and mostly sorted lists, and often is used as part of more sophisticated algorithms. It works by taking elements from the list one by one and inserting them in their correct position into a new sorted list. In arrays, the new list and the remaining elements can share the array's space, but insertion is expensive, requiring shifting all following elements over by one. Shell sort (see below) is a variant of insertion sort that is more efficient for larger lists.

Shell sort

Shell sort was invented by Donald Shell in 1959. It improves upon bubble sort and insertion sort by moving out of order elements more than one position at a time. One implementation can be described as arranging the data sequence in a two-dimensional array and then sorting the columns of the array using insertion sort.



A Shell sort, different from bubble sort in that it moves elements to numerous swapping positions

Comb sort

Comb sort is a relatively simple sorting algorithm originally designed by Wlodzimierz Dobosiewicz in 1980.[12] Later it was rediscovered and popularized by Stephen Lacey and Richard Box with a Byte Magazine article published in April 1991. Comb sort improves on bubble sort. The basic idea is to eliminate *turtles*, or small values near the end of the list, since in a bubble sort these slow the sorting down tremendously. (*Rabbits*, large values around the beginning of the list, do not pose a problem in bubble sort)

Merge sort

Merge sort takes advantage of the ease of merging already sorted lists into a new sorted list. It starts by comparing every two elements (i.e., 1 with 2, then 3 with 4...) and swapping them if the first should come after the second. It then merges each of the resulting lists of two into lists of four, then merges those lists of four, and so on; until at last two lists are merged into the final sorted list. Of the algorithms described here, this is the first that scales well to very large lists, because its worst-case running time is O(n log n). Merge sort has seen a relatively recent surge in popularity for practical implementations, being used for the standard sort routine in the programming languages Perl,[13] Python (as timsort[14]), and Java (also uses timsort as of JDK7[15]), among others. Merge sort has been used in Java at least since 2000 in JDK1.3.[16][17]

Heapsort

Heapsort is a much more efficient version of selection sort. It also works by determining the largest (or smallest) element of the list, placing that at the end (or beginning) of the list, then continuing with the rest of the list, but accomplishes this task efficiently by using a data structure called a heap, a special type of binary tree. Once the data list has been made into a heap, the root node is guaranteed to be the largest (or smallest) element. When it is removed and placed at the end of the list, the heap is rearranged so the largest element remaining moves to the root. Using the heap, finding the next largest element takes $O(\log n)$ time, instead of $O(n)$ for a linear scan as in simple selection sort. This allows Heapsort to run in $O(n \log n)$ time, and this is also the worst case complexity.

Quicksort

Quicksort is a divide and conquer algorithm which relies on a *partition* operation: to partition an array an element called a *pivot* is selected. All elements smaller than the pivot are moved before it and all greater elements are moved after it. This can be done efficiently in linear time and in-place. The lesser and greater sublists are then recursively sorted. Efficient implementations of quicksort (with in-place partitioning) are typically unstable sorts and somewhat complex, but are among the fastest sorting algorithms in practice. Together with its modest O(log n) space usage, quicksort is one of the most popular sorting algorithms and is available in many standard programming libraries. The most complex issue in quicksort is choosing a good pivot element; consistently poor choices of pivots can result in drastically slower O(n^2) performance, if at each step the median is chosen as the pivot then the algorithm works in O(n log n). Finding the median however, is an O(n) operation on unsorted lists and therefore exacts its own penalty

with sorting.

Counting sort

Counting sort is applicable when each input is known to belong to a particular set, S, of possibilities. The algorithm runs in $O(|S| + n)$ time and $O(|S|)$ memory where n is the length of the input. It works by creating an integer array of size $|S|$ and using the ith bin to count the occurrences of the ith member of S in the input. Each input is then counted by incrementing the value of its corresponding bin. Afterward, the counting array is looped through to arrange all of the inputs in order. This sorting algorithm cannot often be used because S needs to be reasonably small for it to be efficient, but the algorithm is extremely fast and demonstrates great asymptotic behavior as n increases. It also can be modified to provide stable behavior.

Bucket sort

Bucket sort is a divide and conquer sorting algorithm that generalizes Counting sort by partitioning an array into a finite number of buckets. Each bucket is then sorted individually, either using a different sorting algorithm, or by recursively applying the bucket sorting algorithm. A variation of this method called the single buffered count sort is faster than quicksort.

Due to the fact that bucket sort must use a limited number of buckets it is best suited to be used on data sets of a limited scope. Bucket sort would be unsuitable for data that have a lot of variation, such as social security numbers.

Radix sort

Radix sort is an algorithm that sorts numbers by processing individual digits. n numbers consisting of k digits each are sorted in $O(n \cdot k)$ time. Radix sort can process digits of each number either starting from the least significant digit (LSD) or starting from the most significant digit (MSD). The LSD algorithm first sorts the list by the least significant digit while preserving their relative order using a stable sort. Then it sorts them by the next digit, and so on from the least significant to the most significant, ending up with a sorted list. While the LSD radix sort requires the use of a stable sort, the MSD radix sort algorithm does not (unless stable sorting is desired). In-place MSD radix sort is not stable. It is common for the counting sort algorithm to be used internally by the radix sort. Hybrid sorting approach, such as using insertion sort for small bins improves performance of radix sort significantly.

Distribution sort

Distribution sort refers to any sorting algorithm where data are distributed from their input to multiple intermediate structures which are then gathered and placed on the output. For example, both bucket sort and flashsort are distribution based sorting algorithms.

Timsort

Timsort finds runs in the data, creates runs with insertion sort if necessary, and then uses merge sort to create the final sorted list. It has the same complexity (O(nlogn)) in the average and worst cases, but with pre-sorted data it goes down to O(n).

Memory usage patterns and index sorting

When the size of the array to be sorted approaches or exceeds the available primary memory, so that (much slower) disk or swap space must be employed, the memory usage pattern of a sorting algorithm becomes important, and an algorithm that might have been fairly efficient when the array fit easily in RAM may become impractical. In this scenario, the total number of comparisons becomes (relatively) less important, and the number of times sections of memory must be copied or swapped to and from the disk can dominate the performance characteristics of an

algorithm. Thus, the number of passes and the localization of comparisons can be more important than the raw number of comparisons, since comparisons of nearby elements to one another happen at system bus speed (or, with caching, even at CPU speed), which, compared to disk speed, is virtually instantaneous.

For example, the popular recursive quicksort algorithm provides quite reasonable performance with adequate RAM, but due to the recursive way that it copies portions of the array it becomes much less practical when the array does not fit in RAM, because it may cause a number of slow copy or move operations to and from disk. In that scenario, another algorithm may be preferable even if it requires more total comparisons.

One way to work around this problem, which works well when complex records (such as in a relational database) are being sorted by a relatively small key field, is to create an index into the array and then sort the index, rather than the entire array. (A sorted version of the entire array can then be produced with one pass, reading from the index, but often even that is unnecessary, as having the sorted index is adequate.) Because the index is much smaller than the entire array, it may fit easily in memory where the entire array would not, effectively eliminating the disk-swapping problem. This procedure is sometimes called "tag sort".[18]

Another technique for overcoming the memory-size problem is to combine two algorithms in a way that takes advantages of the strength of each to improve overall performance. For instance, the array might be subdivided into chunks of a size that will fit easily in RAM (say, a few thousand elements), the chunks sorted using an efficient algorithm (such as quicksort or heapsort), and the results merged as per mergesort. This is less efficient than just doing mergesort in the first place, but it requires less physical RAM (to be practical) than a full quicksort on the whole array.

Techniques can also be combined. For sorting very large sets of data that vastly exceed system memory, even the index may need to be sorted using an algorithm or combination of algorithms designed to perform reasonably with virtual memory, i.e., to reduce the amount of swapping required.

Some other sorting algorithms also i.e. New friends sort algorithm, Relative split and concatenate sort etc

Inefficient/humorous sorts

Some algorithms are slow compared to those discussed above, such as the Bogosort $O(n \cdot n!)$ and the Stooge sort $O(n^{2.7})$.

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External links

- Sorting Algorithm Animations (http://www.sorting-algorithms.com/) - Graphical illustration of how different algorithms handle different kinds of data sets.
- Sequential and parallel sorting algorithms (http://www.iti.fh-flensburg.de/lang/algorithmen/sortieren/algoen.htm) - Explanations and analyses of many sorting algorithms.
- Dictionary of Algorithms, Data Structures, and Problems (http://www.nist.gov/dads/) - Dictionary of algorithms, techniques, common functions, and problems.
- Slightly Skeptical View on Sorting Algorithms (http://www.softpanorama.org/Algorithms/sorting.shtml) Discusses several classic algorithms and promotes alternatives to the quicksort algorithm.

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Sorting algorithm *Source*: http://en.wikipedia.org/w/index.php?oldid=539550083 *Contributors*: -OOPSIE-, 124Nick, 132.204.27.xxx, 2001:7C0:409:8001:2489:D468:B2A2:4BF0, A3 nm, A5b, AManWithNoPlan, Aaron Rotenberg, Abhishekupadhya, Accelerometer, Adair2324, AdamProcter, Advance512, Aeons, Aeonx, Aeriform, Agateller, Agorf, Aguydude, Ahoerstemeier, Ahshabazz, Ahy1, Alain Amiouni, Alansohn, AlexPlank, Alksub, AllyUnion, Altenmann, Alvestrand, Amirmalekzadeh, Anadverb, Andre Engels, Andy M. Wang, Ang3lboy2001, Angela, Arpi0292, Artoonie, Arvindn, Astronouth7303, AxelBoldt, BACbKA, Bachrach44, Balabiot, Baltar, Gaius, Bartoron2, Bbi5291, Beland, Ben Standeven, BenFrantzDale, BenKovitz, Bender2k14, Bento00, Bidabadi, Bkell, Bobo192, Boleyn, Booyabazooka, Bradyoung01, Brendanl79, Bryan Derksen, BryghtShadow, Bubba73, BurtAlert, C. A. Russell, C7protal, CJLL Wright, Caesura, Calculuslover, Calixte, CambridgeBayWeather, Carey Evans, Ccn, Charles Matthews, Chenopodiaceous, Chinju, Chris the speller, Ciaccona, Circular17, ClockworkSoul, Codeman38, Cole Kitchen, Compfreak7, Conversion script, Cpl Syx, Crashmatrix, Crumpuppet, Cuberoot31, Cwolfsheep, Cyan, Cybercobra, Cymbalta, Cyrius, DHN, DIY, DaVinci, Daiyuda, Damian Yerrick, Danakil, Daniel Quinlan, DarkFalls, Darkwind, DarrylNester, Darth Panda, David Eppstein, Dcirovic, Dcoetzee, Deanonwiki, Debackerl, Decrypt3, Deepakjoy, Deskana, DevastatorIIC, Dgse87, Diannaa, Dihard, Domingos, Doradus, Duck1123, Duvavic1, Dybdahl, Dysprosia, EdC, Eddideigel, Efansoftware, Eliz81, Energy Dome, Etopocketo, Fagstein, Falcon8765, Fastily, Fawcett5, Firsfron, Foobarnix, Foot, Fragglet, Fred Bauder, Fredrik, Frencheigh, Fresheneesz, Fuzzy, GanKeyu, GateKeeper, Gavia immer, Gdr, Giftlite, Glrx, Grafen, Graham87, Graue, GregorB, H3nry, HJ Mitchell, Hadal, Hagerman, Hairhorn, Hamaad.s, Hannes Hirzel, Hashar, Hede2000, Hgranqvist, Hirzel, Hobart, HolyCookie, Hpa, IMalc, Indefual, InverseHypercube, Iridescent, Itsameen-bc103112, J.delanoy, JBakaka, JLaTondre, JRSpriggs, JTN, Jachto, Jaguaraci, Jamesday, Japo, Jay Litman, Jbonneau, Jeffq, Jeffrey Mall, Jeronimo, Jesin, Jirka6, Jj137, Jll, Jmw02824, Jokes Free4Me, JonGinny, Jonadab, Jonas Kölker, Josh Kehn, Joshk, Jthemphill, Justin W Smith, Jwoodger, Kalraritz, Kevinsystrom, Kievite, Kingjames iv, KlappCK, Knutux, Kragen, KyuubiSeal, LC, Ldoron, Lee J Haywood, LilHelpa, Lowercase Sigma, Luna Santin, Lzap, Makeemlighter, Malcolm Farmer, Mandarax, Mark Renier, MarkisLandis, MartinHarper, Marvon7Newby, MarvonNewby, Mas.morozov, Materialscientist, MattGiuca, Matthew0028, Mav, Maximus Rex, Mbernard707, Mdd4696, Mdtr, Medich1985, Methecooldude, Michael Greiner, Michael Hardy, Michaelbluejay, Mike Rosoft, Mindmatrix, Mountain, Mr Elmo, Mrck@charter.net, Mrjeff, Musiphil, Myanw, NTF, Nanshu, Nayuki, Nevakee11, NewEnglandYankee, NickT988, Nicolaum, Nikai, Nish0009, Nixdorf, Nknight, Nomen4Omen, OfekRon, Olathe, Olivier, Omegatron, Ondra.pelech, OoS, Oskar Sigvardsson, Oğuz Ergin, Pablo.cl, Pajz, Pamulapati, Panarchy, Panu-Kristian Poiksalo, PatPeter, Patrick, Paul Murray, Pbassan, Pcap, Pce3@ij.net, Pelister, Perstar, Pete142, Petri Krohn, Pfalstad, Philomathoholic, PierreBoudes, Piet Delport, Populus, Pparent, PsyberS, Pyfan, Quaeler, RHaworth, RJFJR, RapidR, Rasinj, Raul654, RaulMetumtam, RazorICE, Rcbarnes, Reyk, Riana, Roadrunner, Robert L, Robin S, RobinK, Rodspade, Roman V. Odaisky, Rsathish, Rursus, Ruud Koot, Ryguasu, Scalene, Schnozzinkobenstein, Shadowjams, Shanes, Shredwheat, SimonP, SiobhanHansa, Sir Nicholas de Mimsy-Porpington, Slashme, Sligocki, Smartech, Smjg, Snickel11, Sophus Bie, Soultaco, SouthernNights, Spoon!, Ssd, StanfordProgrammer, Staplesauce, Starwiz, Staszek Lem, Stephen Howe, Stephenb, StewieK, Suanshsinghal, Summentier, Sven nestle2, Swamp Ig, Swift, T4bits, TakuyaMurata, Tamfang, Taw, Tawker, Teles, Templatetypedef, The Anome, The Thing That Should Not Be, TheKMan, TheRingess, Thefourlinestar, Thinking of England, ThomasTomMueller, Thumperward, Timwi, Titodutta, Tobias Bergemann, Tortoise 74, TowerDragon, Travuun, Trixter, Twikir, Tyler McHenry, UTSRelativity, Udirock, Ulfben, UpstateNYer, User A1, VTBassMatt, Vacation9, Valenciano, Veganfanatic, VeryVerily, Veryangrypenguin, Verycuriousboy, Vrenator, Wantnot, Wazimuko, Wei.cs, Wfunction, Wiki.ryansmith, Wikiwonky, WillNess, Wimt, Worch, Writtenonsand, Ww, Yansa, Yuval madar, Zawersh, Zipcodeman, Ztothefifth, Zundark, 900 anonymous edits

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