

## 1 Identifying Sorts

Below you will find intermediate steps in performing various sorting algorithms on the same input list. The steps do not necessarily represent consecutive steps in the algorithm (that is, many steps are missing), but they are in the correct sequence. For each of them, select the algorithm it illustrates from among the following choices: insertion sort, selection sort, mergesort, quicksort (first element of sequence as pivot), and heapsort.

**Input list:** 1429, 3291, 7683, 1337, 192, 594, 4242, 9001, 4392, 129, 1000

(a)

1429, 3291, 7683, 192, 1337 / 594, 4242, 9001, 4392, 129, 1000  
1429, 3291, 192, 1337, 7683, 594, 4242, 9001, 129, 1000, 4392  
192, 1337, 1429, 3291, 7683, 129, 594, 1000, 4242, 4392, 9001

*mergesort*

(b)

1337, 192, 594, 129, 1000, 1429, 3291, 7683, 4242, 9001, 4392  
192, 594, 129, 1000, 1337, 1429, 3291, 7683, 4242, 9001, 4392  
129, 192, 594, 1000, 1337, 1429, 3291, 4242, 9001, 4392, 7683

*quick sort*

(c)

1337, 1429, 3291, 7683, 192, 594, 4242, 9001, 4392, 129, 1000  
192, 1337, 1429, 3291, 7683, 594, 4242, 9001, 4392, 129, 1000  
192, 594, 1337, 1429, 3291, 7683, 4242, 9001, 4392, 129, 1000

*insertion sort*

(d)

1429, 3291, 7683, 9001, 1000, 594, 4242, 1337, 4392, 129, 192  
7683, 4392, 4242, 3291, 1000, 594, 192, 1337, 1429, 129, 9001  
129, 4392, 4242, 3291, 1000, 594, 192, 1337, 1429, 7683, 9001

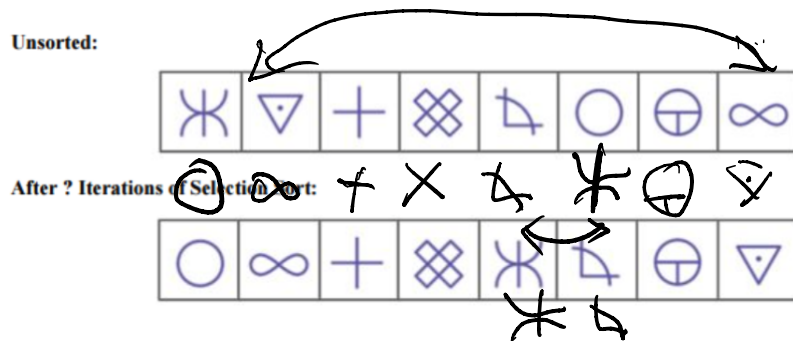
*heap sort*

In all these cases, the final step of the algorithm will be this:

129, 192, 594, 1000, 1337, 1429, 3291, 4242, 4392, 7683, 9001

## 2 Reverse Engineering

Consider the following unsorted array, and the array after an unknown number of iterations of selection sort as discussed in class (where we sort by identifying the minimum item and moving it to the front by swapping). Assume no two elements are equal



For each relation below, **write** <, >, or ? for insufficient information regarding the relation between the two objects



### 3 Conceptual Sorts

Answer the following questions regarding various sorting algorithms that we've discussed in class. If the question is T/F and the statement is true, provide an explanation. If the statement is false, provide a counterexample.

(a) (T/F) Quicksort has a worst case runtime of  $\Theta(N \log N)$ , where  $N$  is the number of elements in the list that were sorting.

F, worst  $\Theta(N^2)$

(b) We have a system running insertion sort and we find that it's completing faster than expected. What could we conclude about the input to the sorting algorithm?

①  $N$  is small

② reversals is small

(c) Give a 5 integer array such that it elicits the worst case running time for insertion sort.

5 4 3 2 1

(d) (T/F) Heapsort is stable.

F

(e) Give some reasons as to why someone would use mergesort over quicksort

① mergesort is stable

② mergesort can be highly parallelized

③ mergesort is preferred for sorting a linked list

(f) You will be given an answer bank, each item of which may be used multiple times. You may not need to use every answer, and each statement may have more than one answer.

- A. QuickSort (nonrandom, inplace using Hoare partitioning, and choose the leftmost item as the pivot)
- B. MergeSort
- C. Selection Sort
- D. Insertion Sort
- E. HeapSort
- N. (None of the above)

List all letters that apply. List them in alphabetical order, or if the answer is none of them, use N indicating none of the above. All answers refer to the entire sorting process, not a single step of the sorting process. For each of the problems below, assume that N indicates the number of elements being sorted.

ABCE  $\rightarrow$  all duplicates  
Bounded by  $\Omega(N \log N)$  lower bound.

BE Has a worst case runtime that is asymptotically better than Quicksort's worstcase runtime.

C In the worst case, performs  $\Theta(N)$  pairwise swaps of elements.

ABD Never compares the same two elements twice.

N Runs in best case  $\Theta(\log N)$  time for certain inputs

$\rightarrow 4 \ 3 \ 2 \ 1$   
 $4 \ 5 \ 3$   
 $4 \ 3 \ 5$   
 $3 \ 4 \ 5 \ 2$