

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. When we split an odd length array in half in mergesort, assume the larger half is on the right.

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

(a) 1429, 3291, 7683, 1337, 192, 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

(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, 4392, 7683, 9001

(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

(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

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 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) 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?
- (b) Give a 5 integer array that elicits the worst case runtime for insertion sort.
- (c) (T/F) Heapsort is stable.
- (d) Give some reasons as to why someone would use mergesort over quicksort.

- (e) 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 (in-place 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.

_____ Bounded by $\Omega(N \log N)$ lower bound.

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

_____ Never compares the same two elements twice.

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

3 Bears and Beds

In this problem, we will see how we can sort “pairs” of things without sorting out each individual entry. The hot new Cal startup AirBearsnBeds has hired you to create an algorithm to help them place their bear customers in the best possible beds to improve their experience. Now, a little known fact about bears is that they are very, very picky about their bed sizes: they do not like their beds too big or too little - they like them just right. Bears are also sensitive creatures who don’t like being compared to other bears, but they are perfectly fine with trying out beds.

The Problem:

- **Inputs:**
 - A list of Bears with unique but unknown sizes
 - A list of Beds with unique but unknown sizes
 - *Note: these two lists are not necessarily in the same order*
- **Output:** a list of Bears and a list of Beds such that the *i*th Bear is the same size as the *i*th Bed
- **Constraints:**
 - Bears can only be compared to Beds and we can get feedback on if the Bed is too large, too small, or just right.
 - Beds can only be compared to Bears and we can get feedback on if the Bear is too large, too small, or just right for it.
 - Your algorithm should run in $O(N \log N)$ time on average.