CS 372/469
Fall 2018
Lab 3: Due 10/8, before lab

In this lab, you need to implement two of the sorting algorithms we talked about in class. For all tests, carefully save your test-results, before moving on to the next test. Please maintain 2 separate graphs – one for insertion sort with 4 tests, and 2 for quicksort with 2 tests; please label the graphs, and provide a legend.

1. Implement the insertion sort algorithm (Algorithm 1) from the handout, "sortingAlgorithms.pdf". Set $n = 1000$. Populate your input test array with random elements.

   (a) (10 points) Test its performance in the best-case where entire array is already sorted – you can do this by calling your language's sort routine on the input array, *before* calling insertion sort on it.

   (b) (10 points) Test its performance in the worst case by passing a reverse-sorted array as input.

   (c) (10 points) Manually populate your array with a fixed, same value for all elements (don't use the random number generator this time). Run insertion sort on it.

   (d) (15 points) Now, modify the code of insertion sort so that it sorts the array in *reverse* order. Test the worst-case on it – the worst-case here is triggered by passing the sorted array as input.

   In all 4 cases of insertion sort, plot the run-time on a single graph.

2. Implement the quicksort algorithm with Lomuto's pivot choice (same as Algorithm 3) from the handout, "sortingAlgorithms.pdf". Set $n = 1000$. Populate your input test array with random elements.

   (a) (22.5 points) Sort the array, and run quicksort on the sorted array (use an external routine of your language for doing the pre-sorting). Based on your results, what do you feel – is this the "best" or "worst" case ?[1] :-)

   (b) (22.5) Test quicksort's performance with the median-of-3 pivot choice, where pivot = $\mathsf{median}(A[0], A[\lfloor(n-1)/2\rfloor], A[n-1])$. (Just change line 1 in the pesudo-code in the handout). Test it with the same sorted array. Are the results better this time, i.e., does it manage to avoid the worst-case?

3. (10 points) Write a lab report that describes your work (length max. around 1.5–2 pages)

   (a) Introduction (define the background and the problem)

   (b) Results (show the numbers and figures)

   (c) Discussions (implications and issues): In particular, talk about how this compare with the asymptotic bounds we saw in class.

[1] It is the worst case, since A gets divided into partitions of size $n - 1$ and 0.

In both cases, plot the run-time on a single graph.
How to submit: Upload your **pdf** file and source code on Canvas before the due date.