EXERCISE

One of the popular, and efficient, sorting algorithms is “merge sort”. Merge sort, first makes each element in a sequence of numbers as one piece of the numbers (as shown below) and recursively merge the numbers in a sorted order. For example, suppose we have a sequence of eight unsorted numbers (i.e., \( N = 8 \)):

6, 5, 3, 1, 8, 7, 2, 4

Merge sort first creates eight groups, each of which consists of one number (STEP 1). Then (STEP 2), merge sort merges adjacent two number to one group in a sorted order (in the ascending order in this example) – this is shown as “Round 1” in the figure below. Then, merge sort merges two groups, each of which contains two numbers, in a sorted order. Merging two groups, each of which consists of more than one element is performed by using two pointers, one for each group. For example, merging two groups of two numbers (5, 6) and (1, 3) is performed as follows. The pointer in the first group points to its first number, which is ‘5’, while the one for the second group points to ‘1’. Then, ‘5’ and ‘1’ are compared. Since ‘1’ is smaller (than ‘5’), it is moved to the top of a new group of four numbers and the pointer for the second group is now moved to ‘3’, comparing ‘5’ and ‘3’ for the next comparison. The rest of the algorithm works by merging two groups of two (“Round 2”) and four (“Round 3”) as shown in the figure below.

**Question:** Using a SIMD computer with as many processing units as you would need, is it possible to improve the execution time of the merge sort for the worst cases? If yes,
fist say “YES” in your solution explain how (and show how the execution time can be improved for the worst case using an example – it is also required for you to show “what in the example improves the execution time”). If not, first say “NO” in your solution, then explain why the execution time can not be improved for the worst case using an example.

**Note 1:** for this question either how you explain how the execution time is improved or why the execution time can not be improved using an appropriate example is important. Even though you provide the correct YES or NO, if you did not explain your idea(s) well, you will not earn much credit.

**Note 2:** the example you use in your solutions should the one for the worst case.