

Sorting Speeds

● Selection Sort:

The file `SelectionSort.java` performs a selection sort.

Let $t \equiv$ time to perform sort (or number of operations)
and $n \equiv$ length of list to sort.

Note that the loop on lines 44 through 57 is executed $n - 1$ times, and that the inner loop (on lines 46 through 56) is executed, on average, $\frac{n}{2}$ times.

So, the number of operations to perform the sort is approximately

$$t \approx (n - 1) \left(\frac{n}{2} \right) \approx \frac{1}{2}(n^2 - n) \quad \text{i.e., the time required to sort}$$

is of the order $t \sim O(n^2)$

● Merge Sort:

The file MergeSort.java performs a merge sort.

```

+---+---+---+---+---+
| o |   |   |   |   |
| r |   |   |   |   |
| i |   |   |   |   |
| g | f |   |   |   |
| i | i |   |   |   |
| n | r |   |   |   |
| a | s |   |   |   |
| l | t |   |   |   |
|   |   |   |   |   |
| l | p |   |   |   |
| i | a | p | p | p |
| s | s | = | = | = |
| t | s | 0 | 1 | 2 |
+---+---+---+---+
| 5 | 4 | 0 | 0 | 0 |
| 4 | 5 | 3 | 2 | 1 |
+---+---+---+---+
| 3 | 0 | 4 | 3 | 2 |
| 0 | 3 | 5 | 4 | 3 |
+---+---+---+---+
| 8 | 8 | 2 | 5 | 4 |
| 9 | 9 | 7 | 7 | 5 |
+---+---+---+---+
| 2 | 2 | 8 | 8 | 6 |
| 7 | 7 | 9 | 9 | 7 |
+---+---+---+---+
| 1 | 1 | 1 | 1 | 8 |
| 6 | 6 | 6 | 6 | 9 |
+---+---+---+---+

```

The algorithm of the merge sort is illustrated at left. Say we want to sort the list of 10 numbers as given in the first column.

During the first pass (the loop on lines 50 through 57), the list is broken into sub-lists of length 2, each of which is sorted.

On each subsequent pass, *i.e.*, $p = 0, 1$ and 2, the size of each sub-list is doubled, with again, each sub-list being sorted (this is accomplished by the loop on lines 68 through 81).

Note that the outer loop (lines 68 through 81) is executed $\log_2 n$ times, as seen from line 61. The inner loop (lines 74 through 80) runs over the length of the list, *i.e.*, n elements.

Thus, the time to perform the sort is approximately $t \approx n \log_2 n$
i.e., the time required is of the order of $t \sim O(n \log n)$