

Working of Merge sort Algorithm

Merge sort is the sorting technique that follows the divide and conquer approach.

It divides the given list into two equal halves, calls itself for the two halves and then merges the two sorted halves. We have to define the **merge()** function to perform the merging.

The sub-lists are divided again and again into halves until the list cannot be divided further. Then we combine the pair of one element lists into two-element lists, sorting them in the process. The sorted two-element pairs is merged into the four-element lists, and so on until we get the sorted list.

Let the elements of array are –

12	31	25	8	32	17	40	42
----	----	----	---	----	----	----	----

According to the merge sort, first divide the given array into two equal halves. Merge sort keeps dividing the list into equal parts until it cannot be further divided.

As there are eight elements in the given array, so it is divided into two arrays of size 4.

divide	12	31	25	8	32	17	40	42
--------	----	----	----	---	----	----	----	----

Now, again divide these two arrays into halves. As they are of size 4, so divide them into new arrays of size 2.

divide	12	31	25	8	32	17	40	42
--------	----	----	----	---	----	----	----	----

Now, again divide these arrays to get the atomic value that cannot be further divided.

divide	12	31	25	8	32	17	40	42
--------	----	----	----	---	----	----	----	----

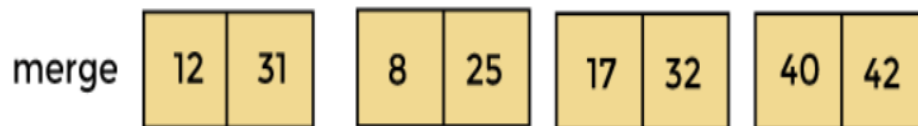
Now, combine them in the same manner they were broken.

In combining, first compare the element of each array and then combine them into another array in sorted order.

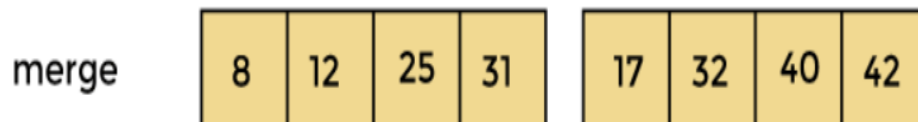
So, first compare 12 and 31, both are in sorted positions.

Then compare 25 and 8, and in the list of two values, put 8 first followed by 25.

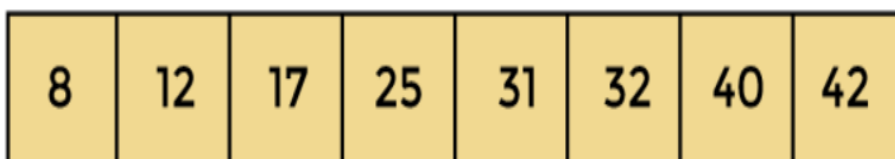
Then compare 32 and 17, sort them and put 17 first followed by 32. After that, compare 40 and 42, and place them sequentially.



In the next iteration of combining, now compare the arrays with two data values and merge them into an array of found values in sorted order.



Now, there is a final merging of the arrays. After the final merging of above arrays, the array will look like -



Now, the array is completely sorted.

Algorithm:

Merge Sort Algorithm works in the following steps-

- It divides the given unsorted array into two halves- left and right sub arrays.
- The sub arrays are divided recursively.
- This division continues until the size of each sub array becomes 1.
- After each sub array contains only a single element, each sub array is sorted trivially.
- Then, the above discussed merge procedure is called.
- The merge procedure combines these trivially sorted arrays to produce a final sorted array.

```
MergeSort(A[1 .. n]):  
    if n > 1  
        m = n/2  
        MergeSort(A[1 .. m])      // Recurse  
        MergeSort(A[m + 1 .. n]) // Recurse  
        Merge(A[1 .. n], m)
```

The pseudo code for Merge() is given below:

```
Merge(A[1 .. n], m):  
    i = 1; j = m + 1  
    for k = 1 to n  
        if j > n  
            B[k] = A[i]; i = i + 1  
        else if i > m  
            B[k] = A[j]; j = j + 1  
        else if A[i] < A[j]  
            B[k] = A[i]; i = i + 1  
        else  
            B[k] = A[j]; j = j + 1  
    for k = 1 to n  
        A[k] = B[k]
```

Example 2

