

Design and Analysis of Algorithm Lab2

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Merge sort:

Code:

```
class MergeSort
{
    void merge(int arr[], int l, int m, int r)
    {
        int n1 = m - l + 1;
        int n2 = r - m;
        int L[] = new int [n1];
        int R[] = new int [n2];

        for (int i=0; i<n1; ++i)
            L[i] = arr[l + i];
        for (int j=0; j<n2; ++j)
            R[j] = arr[m + 1+ j];

        int i = 0, j = 0;
        int k = l;
        while (i < n1 && j < n2)
        {
            if (L[i] <= R[j])
```

```
{
    arr[k] = L[i];
    i++;
}
else
{
    arr[k] = R[j];
    j++;
}
k++;
}
while (i < n1)
{
    arr[k] = L[i];
    i++;
    k++;
}
while (j < n2)
{
    arr[k] = R[j];
    j++;
    k++;
}
}
```

```

void sort(int arr[], int l, int r)
{
    if (l < r)
    {
        int m = (l+r)/2;
        sort(arr, l, m);
        sort(arr , m+1, r);
        merge(arr, l, m, r);
    }
}

static void printArray(int arr[])
{
    int n = arr.length;
    for (int i=0; i<n; ++i)
        System.out.print(arr[i] + " ");
    System.out.println();
}

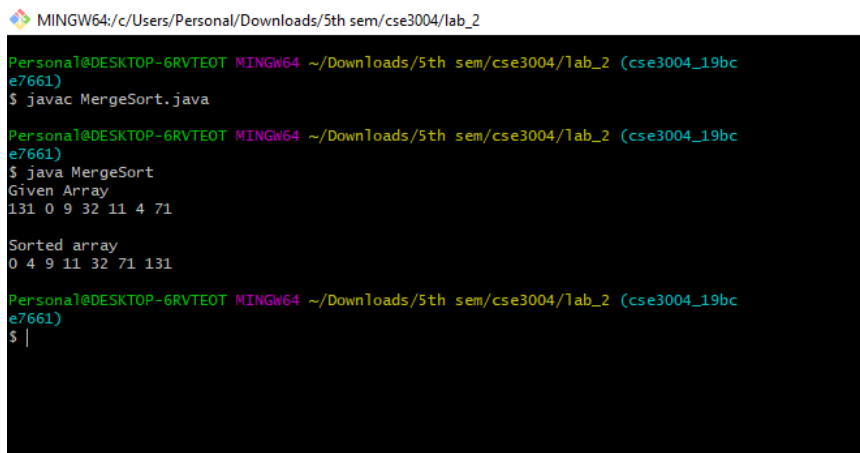
public static void main(String args[])
{
    int arr[] = {131,0,9,32,11,4,71};

    System.out.println("Given Array");
    printArray(arr);
}

```

```
MergeSort ob = new MergeSort();  
ob.sort(arr, 0, arr.length-1);  
  
System.out.println("\nSorted array");  
printArray(arr);  
  
}  
}
```

Output:



```
MINGW64/c/Users/Personal/Downloads/5th sem/cse3004/lab_2  
Personal@DESKTOP-6RVTEOT MINGW64 ~/Downloads/5th sem/cse3004/lab_2 (cse3004_19bc  
e7661)  
$ javac MergeSort.java  
  
Personal@DESKTOP-6RVTEOT MINGW64 ~/Downloads/5th sem/cse3004/lab_2 (cse3004_19bc  
e7661)  
$ java MergeSort  
Given Array  
131 0 9 32 11 4 71  
  
Sorted array  
0 4 9 11 32 71 131  
  
Personal@DESKTOP-6RVTEOT MINGW64 ~/Downloads/5th sem/cse3004/lab_2 (cse3004_19bc  
e7661)  
$ |
```

Asymptotic Analysis:

Merge sort:

Alg MS(l, h)

{ if (l < h)

mid = $\lceil \frac{l+h}{2} \rceil$

MS(l, mid)

MS(mid+1, h)

merge(l, mid, h)

}

MS(l, mid) executes $T(n/2)$

$$T(n) = T(n/2) + T(n/2) + cn$$

$$= 2T(n/2) + cn$$

$$T(n/2) = 2T(n/4) + \frac{cn}{2}$$

$$T(n) = 2 \left[2T\left(\frac{n}{4}\right) + \frac{cn}{2} \right] + cn$$

$$= 2^2 T\left(\frac{n}{4}\right) + 2cn$$

$$= 2^3 T\left(\frac{n}{8}\right) + 3cn$$

⋮

$$T(n) = 2^K T\left(\frac{n}{2^K}\right) + K \cdot c \cdot n$$

$$K = \log_2 n$$

$$T(1) = 0$$

$$= 2^K T(1) + \log_2 n \left[c \cdot n \right] = \text{sum}$$

$$= 0 + \log_2 n \cdot c \cdot n$$

$$= O(n \log_2 n)$$

$$T(n) + (c/n)T + (c/n)T = (n)T$$

$$T(n) + (c/n)T =$$

$$\frac{T(n)}{n} + \left(\frac{c}{n}\right)T = (c/n)T$$

$$T(n) + \left[\frac{T(n)}{n} + \left(\frac{c}{n}\right)T \right] \cdot n = (n)T$$