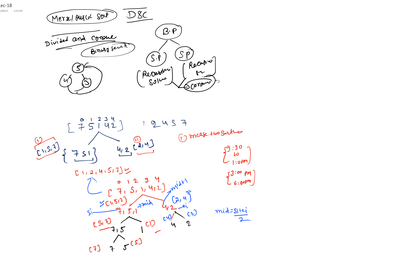
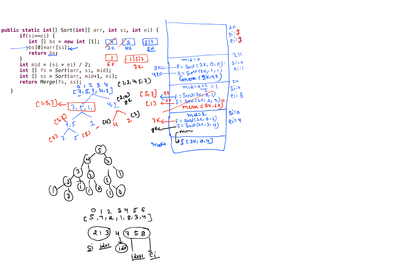
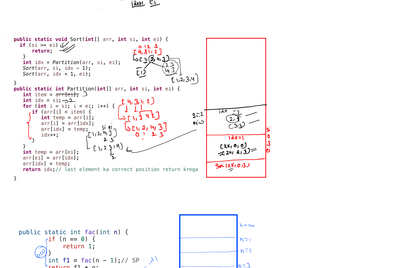


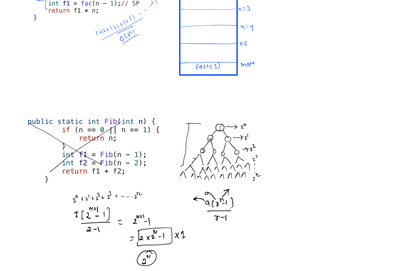

```
public static int[] Sort(int[] arr, int si, int ei) {
    if(si==ei) {
        int [] bs = new int [1];
        bs[0]=arr[si];
        return bs;
    }
    int mid = (si + ei) / 2;
    int [] fs = Sort(arr, si, mid);
    int [] ss = Sort(arr, mid+1, ei);
    return Merge(fs, ss);
}
```



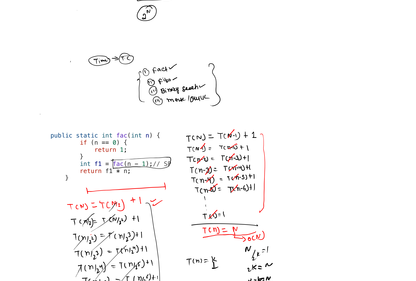

```
public static void Sort(int[] arr, int si, int ei) {
    if (si >= ei)
        return;
    int idx = Partition(arr, si, ei);
    Sort(arr, si, idx - 1);
    Sort(arr, idx + 1, ei);
}
public static int Partition(int[] arr, int si, int ei) {
    int item = arr[ei];
    int idx = si;
    for (int i = si; i < ei; i++) {
        if (arr[i] <= item) {
            int temp = arr[i];
            arr[i] = arr[idx];
            arr[idx] = temp;
            idx++;
        }
    }
    int temp = arr[ei];
    arr[ei] = arr[idx];
    arr[idx] = temp;
    return idx;// last element ka correct position return krega
}
```




```
public static int fac(int n) {
    if (n == 0) {
        return 1;
    }
    int f1 = fac(n - 1);// SP
    return f1 * n;
}
```




```
public static int Fib(int n) {
    if (n == 0 || n == 1) {
        return n;
    }
    int f1 = Fib(n - 1);
    int f2 = Fib(n - 2);
    return f1 + f2;
}
```



$2^0+2^1+2^2+2^3+\cdots 2^n$

$\frac{2^{n+1}-1}{2-1} = 2^{n+1}-1 \approx 2^{n+1}-1 \approx 2^n$

$T(n) \to T.C$

(1) Fact
(2) Fibo
(3) Binary Search
(4) Merge Sort

```
public static int fac(int n) {
    if (n == 0) {
        return 1;
    }
    int f1 = fac(n - 1);// SP
    return f1 * n;
}
```

$T(n) = T(n-1) + 1$

$T(n) = T(n-1) + 1$
$T(n) = T(n-2) + 1$
$T(n) = T(n-3) + 1$
$T(n) = T(n-4) + 1$
$T(n) = T(n-5) + 1$
$\vdots$
$T(0) = 1$

$T(n) = N$
$\to O(N)$

$T(n) = \begin{cases} 1 & N=0 \\ N & N>0 \end{cases}$

```
public static int Fib(int n) {
    if (n == 0 || n == 1) {
        return n;
    }
    int f1 = Fib(n - 1);
    int f2 = Fib(n - 2);
    return f1 + f2;
}
```

$T(n) = T(n-1) + T(n-2) + 1$

$T(n) = T(n-1) + 1$
$T(n-1) = T(n-2) + 1$
$T(n-2) = T(n-3) + 1$
$T(n-3) = T(n-4) + 1$
$\vdots$
$T(n-1) = T(n-2) + 1$
$T(n-2) = T(n-3) + 1$
$T(n-3) = T(n-4) + 1$
$\vdots$
$T(n-2) = T(n-3) + 1$
$T(n-3) = T(n-4) + 1$
$\vdots$
$T(n-3) = T(n-4) + 1$
$\vdots$
$T(n-4) = 1$

$T(n) = T(n-1) + 1$
$T(n) = 2T(n-2) + 1$
$2T(n-1) = 2T(n-2) + 2$
$2^2T(n-2) = 2^2T(n-3) + 2^2$
$2^3T(n-3) = 2^3T(n-4) + 2^3$
$\vdots$
$2^{n-1}T(1) = 2^{n-1}$

$T(n) = 1 + 2 + 2^2 + \cdots + 2^{n-1}$
$T(n) = 2^n$

$f(n) \le c\,g(n)$
$\to O(g(n))$

$T(n-1) + T(n-2) + 1 \le T(n) \to O(g(n))$

$f(n)$

$T(n) = T(n-1) + T(n-2) + 1$

$T(n) = 2T(n/2) + n$
$2T(n/2) = 4T(n/4) + n$
$4T(n/4) = 8T(n/8) + n$
$8T(n/8) = 16T(n/16) + n$
$\vdots$
$2^kT(n/2^k) = 2^{k+1}T(n/2^{k+1}) + n$

$2^k = n$
$k = \log_2 n$

$T(n/2^k) = 1$

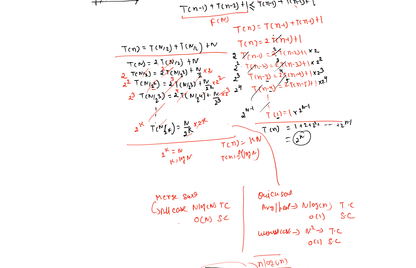
$T(n) = 1 + 2 + 2^2 + \cdots + 2^{k-1}$
$T(n) = 2^k$

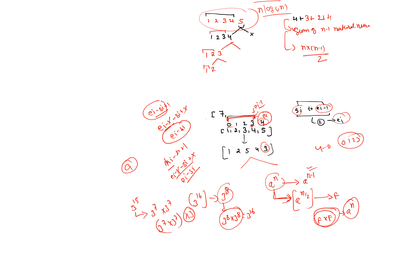
$2^k = n$
$k = \log_2 n$

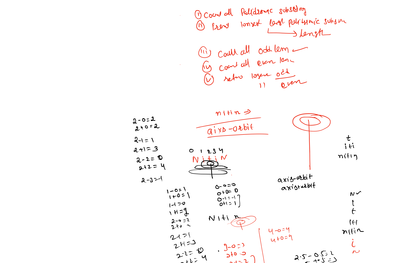
$T(n/2^k) = 1$

merge sort
Dell code
$N\log(N)$ TC
$O(N)$ SC

Quick sort
Avg $N\log(N)$ TC
$O(1)$ SC
worst case N^2 TC
$O(1)$ SC






n/2
n/2+n/4
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n/2+n/4+n/8+n/16+n/32+n/64
n/2+n/4+n/8+n/16+n/32+n/64+n/128
n/2+n/4+n/8+n/16+n/32+n/64+n/128+n/256
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