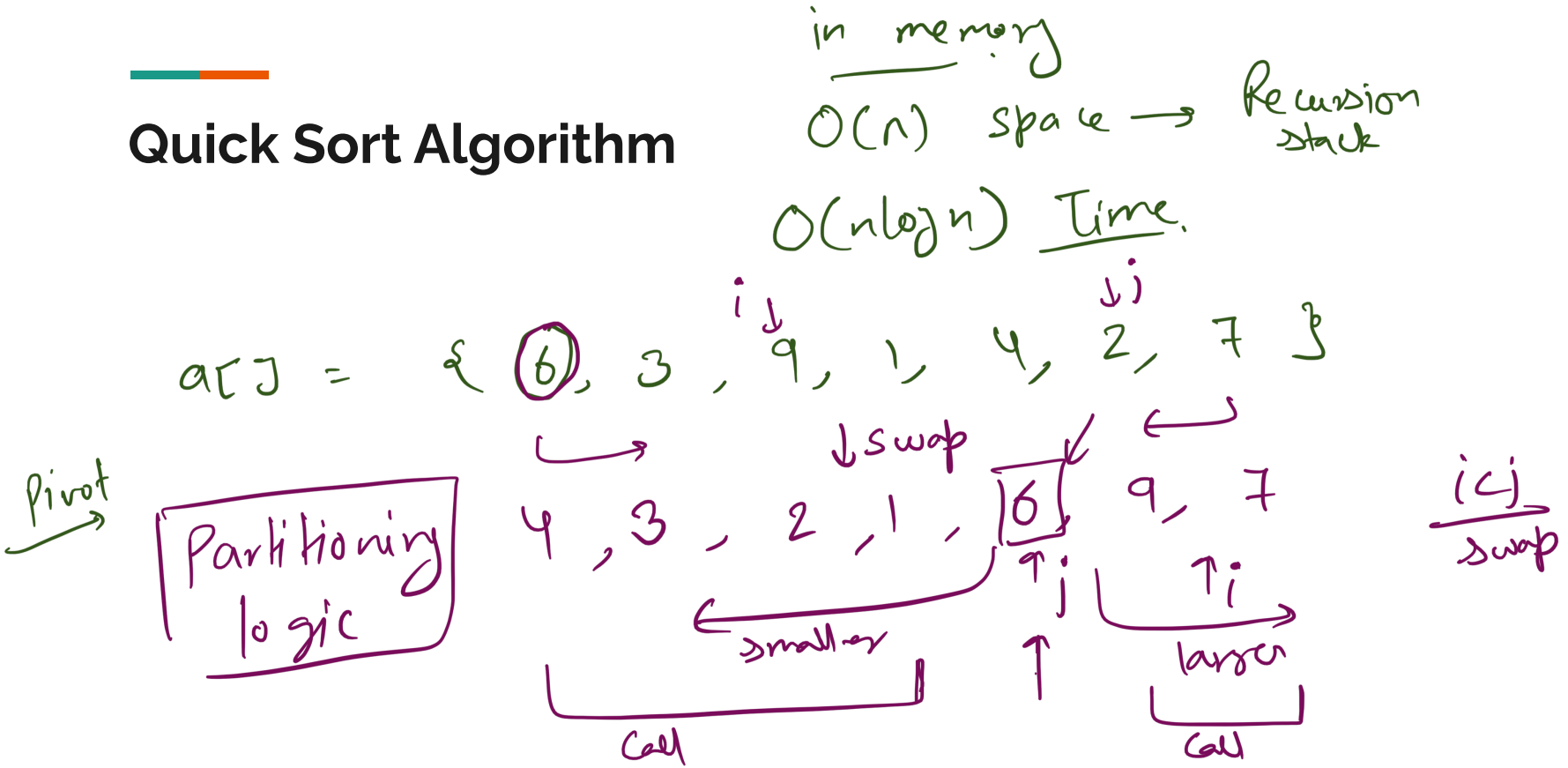
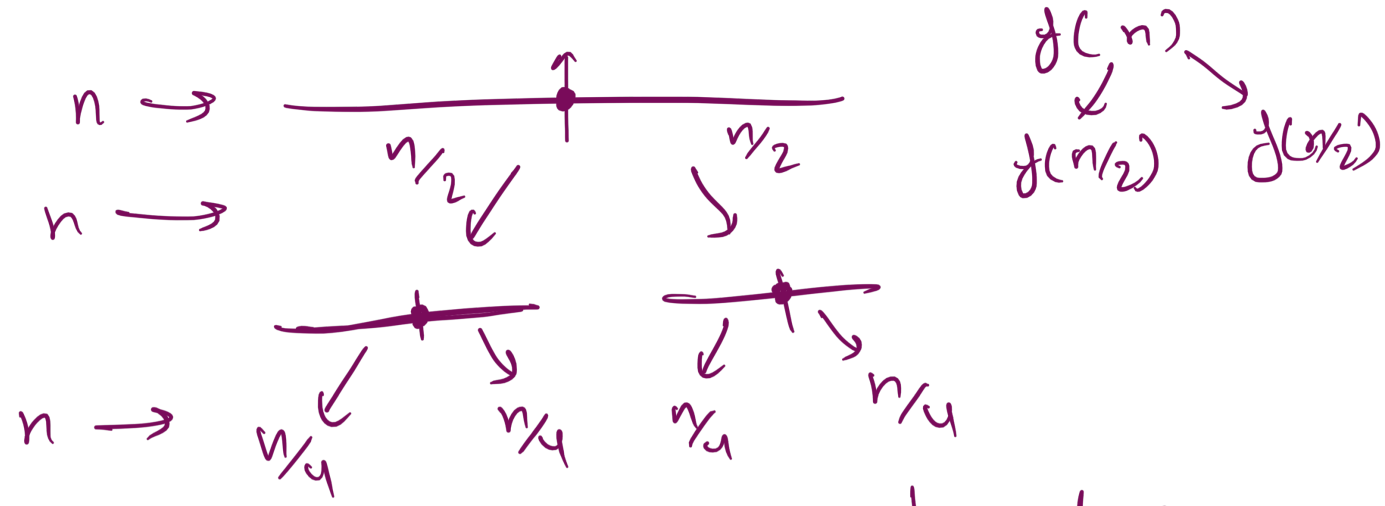
Sorting Algorithm - II

Divide & Conquer

Quick Sort Algorithm





best case

$n \to \frac{n}{2} \to \frac{n}{4} \to \dots \to 1$ (k steps)

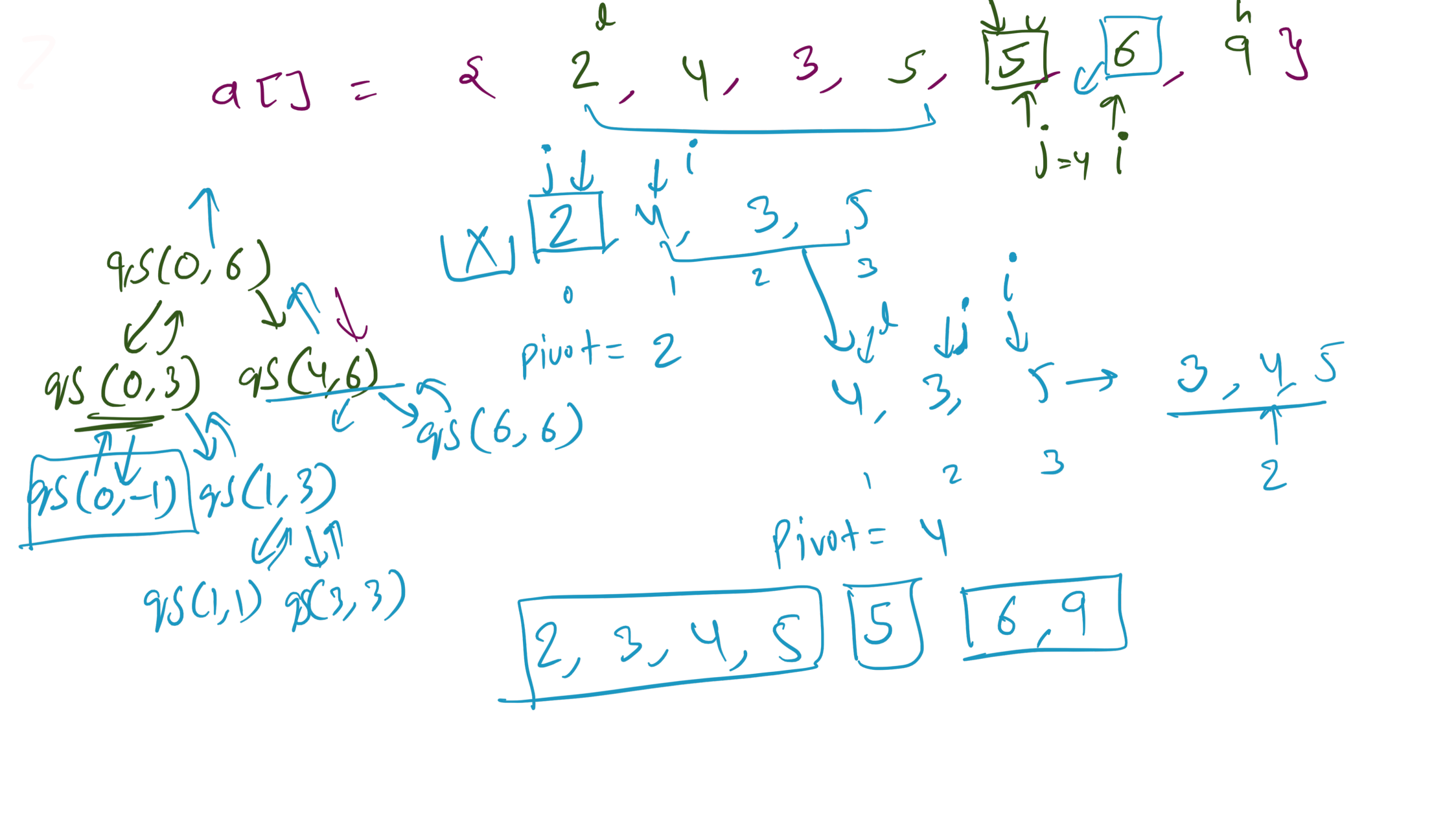
$\frac{n}{2^k} = 1 \Rightarrow k = \log_2 n$

1 element.

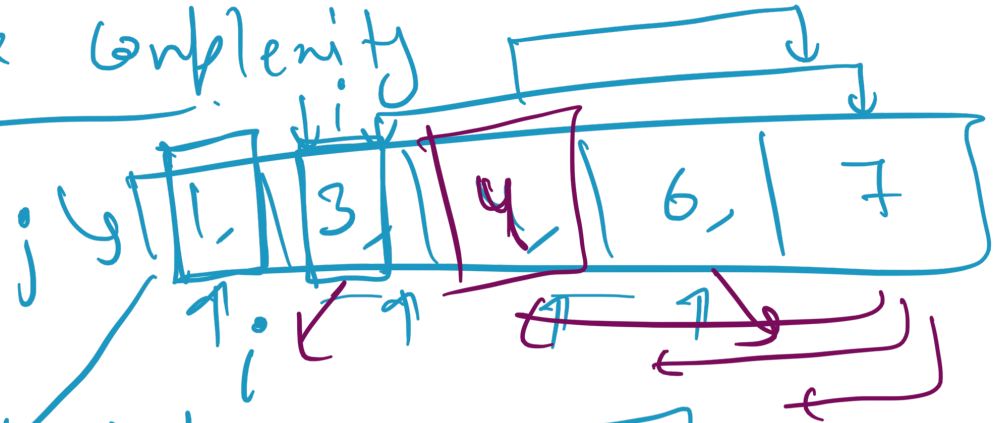
$\log n$

$O(n \log n)$

$O(n^2)$


a[] = { 2, 4, 3, 5, 5, 6, 9 }
j
i
j=4
i
qs(0,6)
qs(0,3)
qs(4,6)
qs(0,-1)
qs(1,3)
qs(6,6)
qs(1,1)
qs(3,3)
X
2
4, 3, 5
pivot = 2
0
1
2
3
4, 3, 5
pivot = 4
1
2
3
3, 4, 5
2
2, 3, 4, 5
5
6, 9

Time complexity



pivot = 1

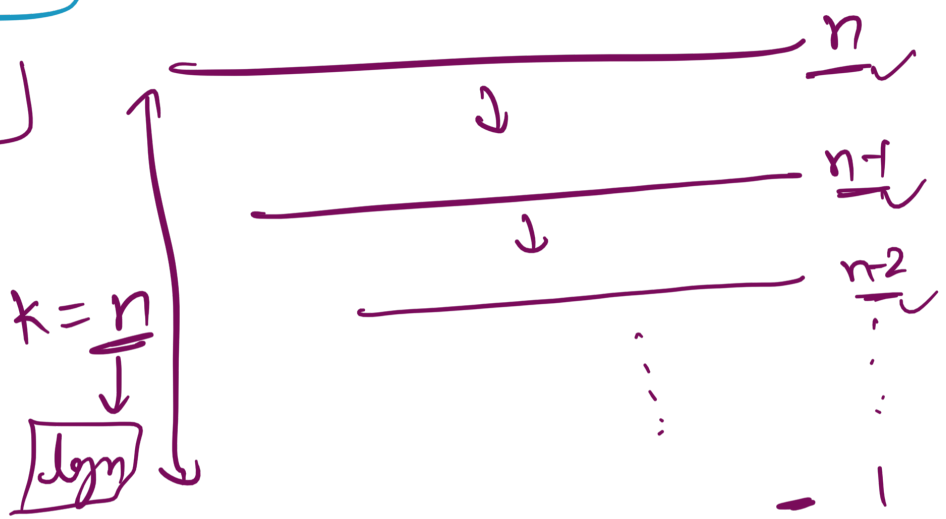
return 0

qs(a, 0, -1)

qs(a, 1, 4)

qs(a, 1, 0)

qs(a, 2, 4)



$n + (n-1) + (n-2) \cdots$

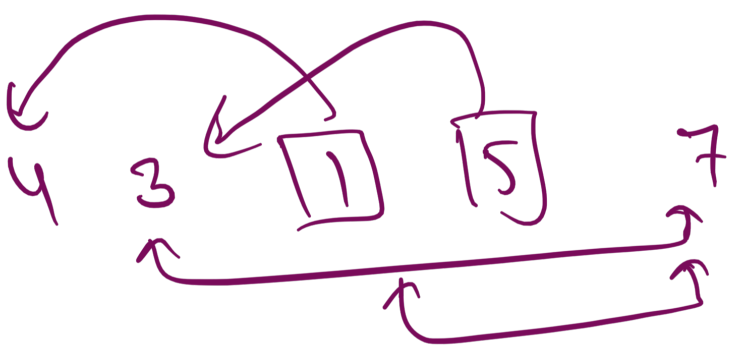
$\frac{n(n+1)}{2} \rightarrow O(n^2)$

Worst case

2 methods

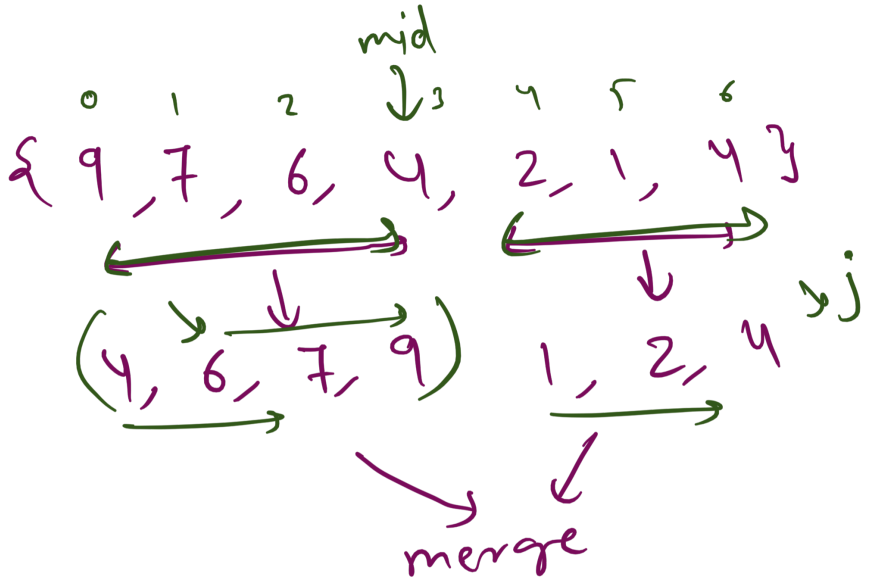
Pivot change

- (i) mid element as pivot
- (ii) random element as pivot
  - average case : $O(n \log n)$
  - worst case : $O(n^2)$

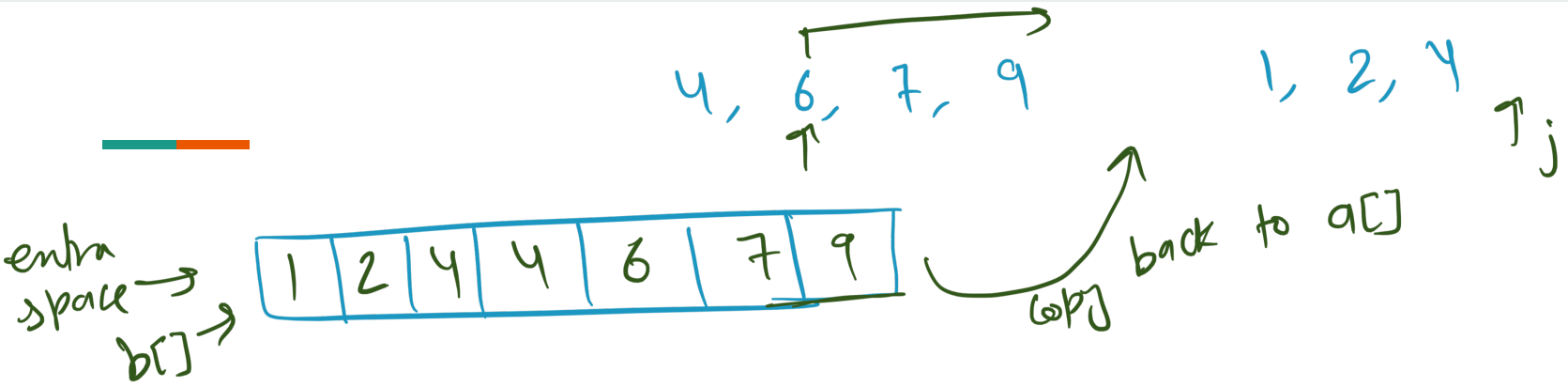


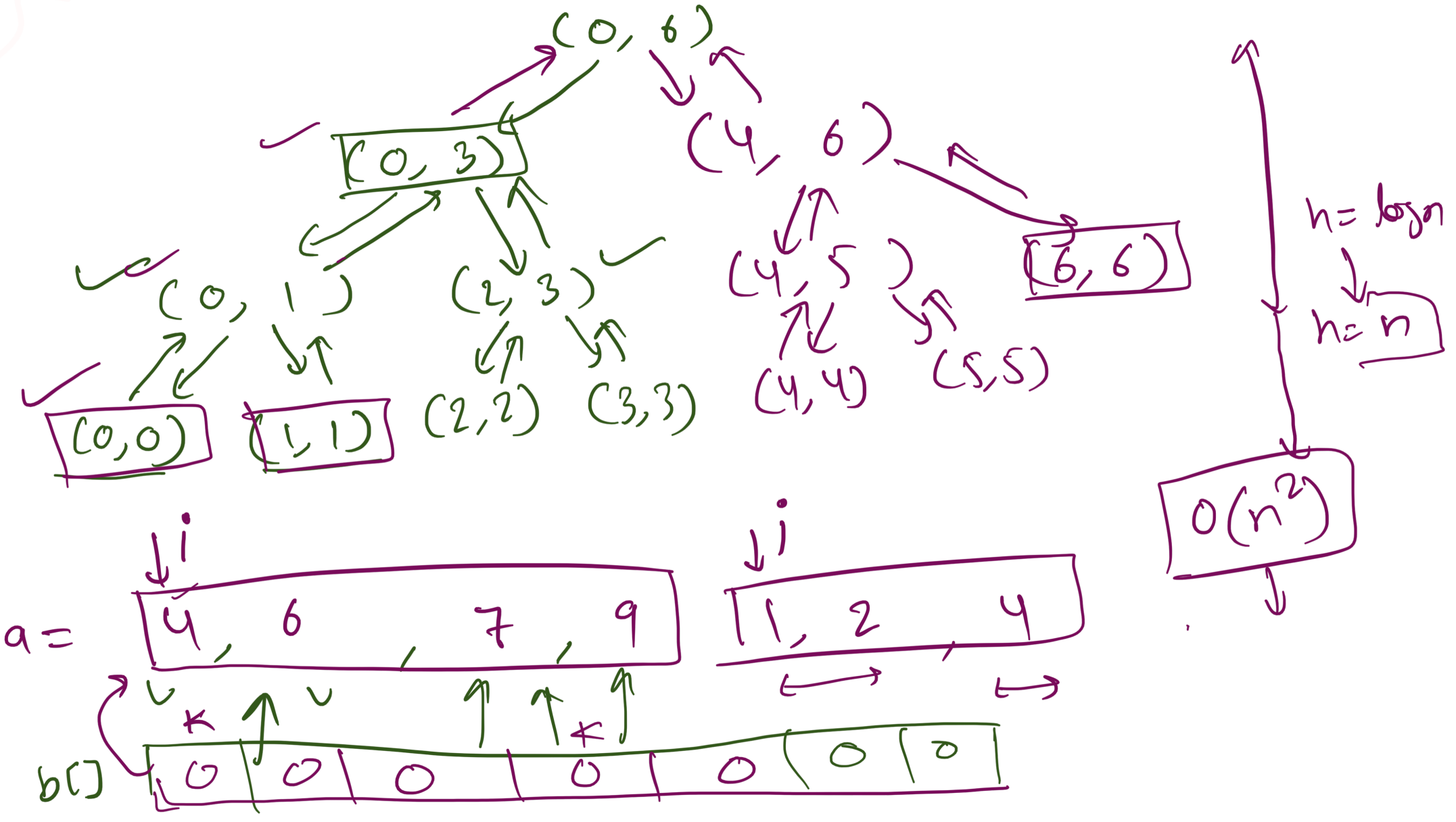
Merge Sort Algorithm

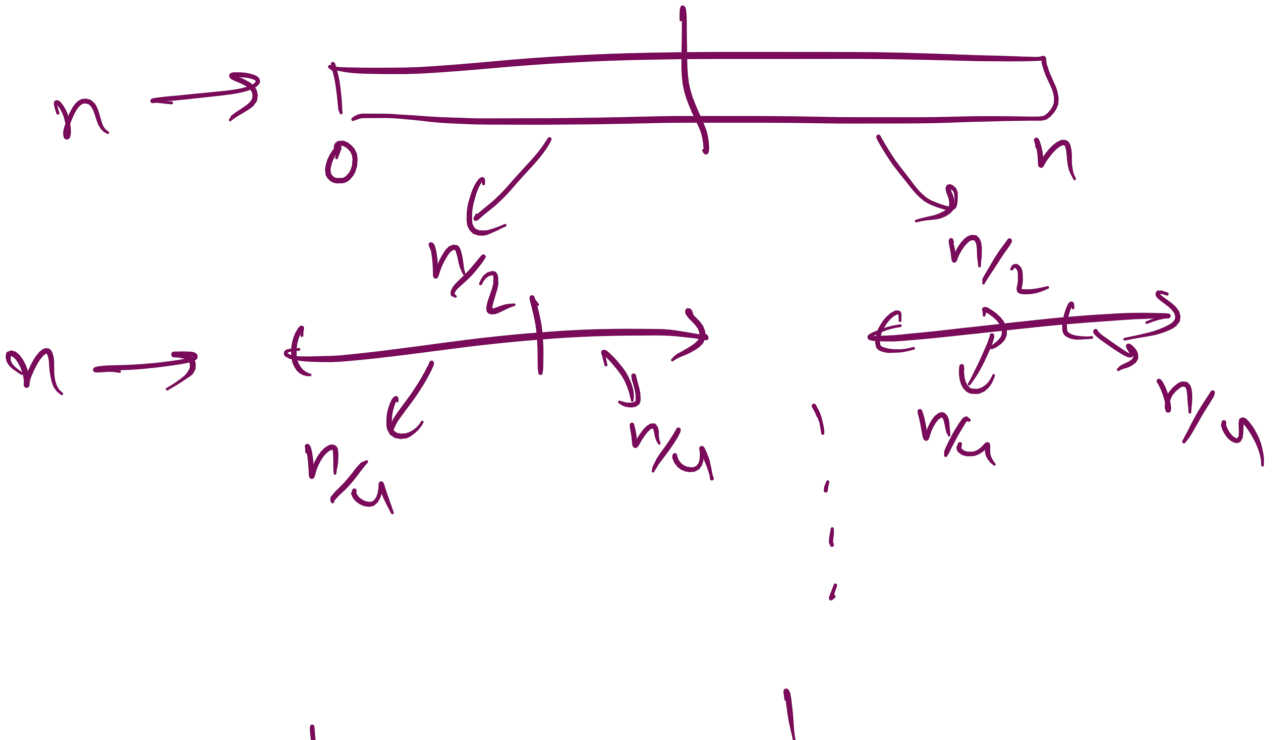
```
mergeSort (a, l, h) {
    if (l < h) {
        mid = (l+h)/2;
        mergeSort (a, l, mid);
        mergeSort (a, mid+1, h);
        merge (a, l, mid, h);
    }
}
```



[1, 2, 4, 4, 6, 7, 9]


4, 6, 7, 9
1, 2, 4
j
extra space
b[]
1 2 4 4 6 7 9
copy back to a[]


(0, 6)
(0, 3)
(4, 6)
(0, 1)
(2, 3)
(4, 5)
(6, 6)
(0,0)
(1,1)
(2,2)
(3,3)
(4,4)
(5,5)
h = log n
h = n
O(n²)
i
i
a =
4, 6, 7, 9
1, 2, 4
b[]
0 0 0 0 0 0 0

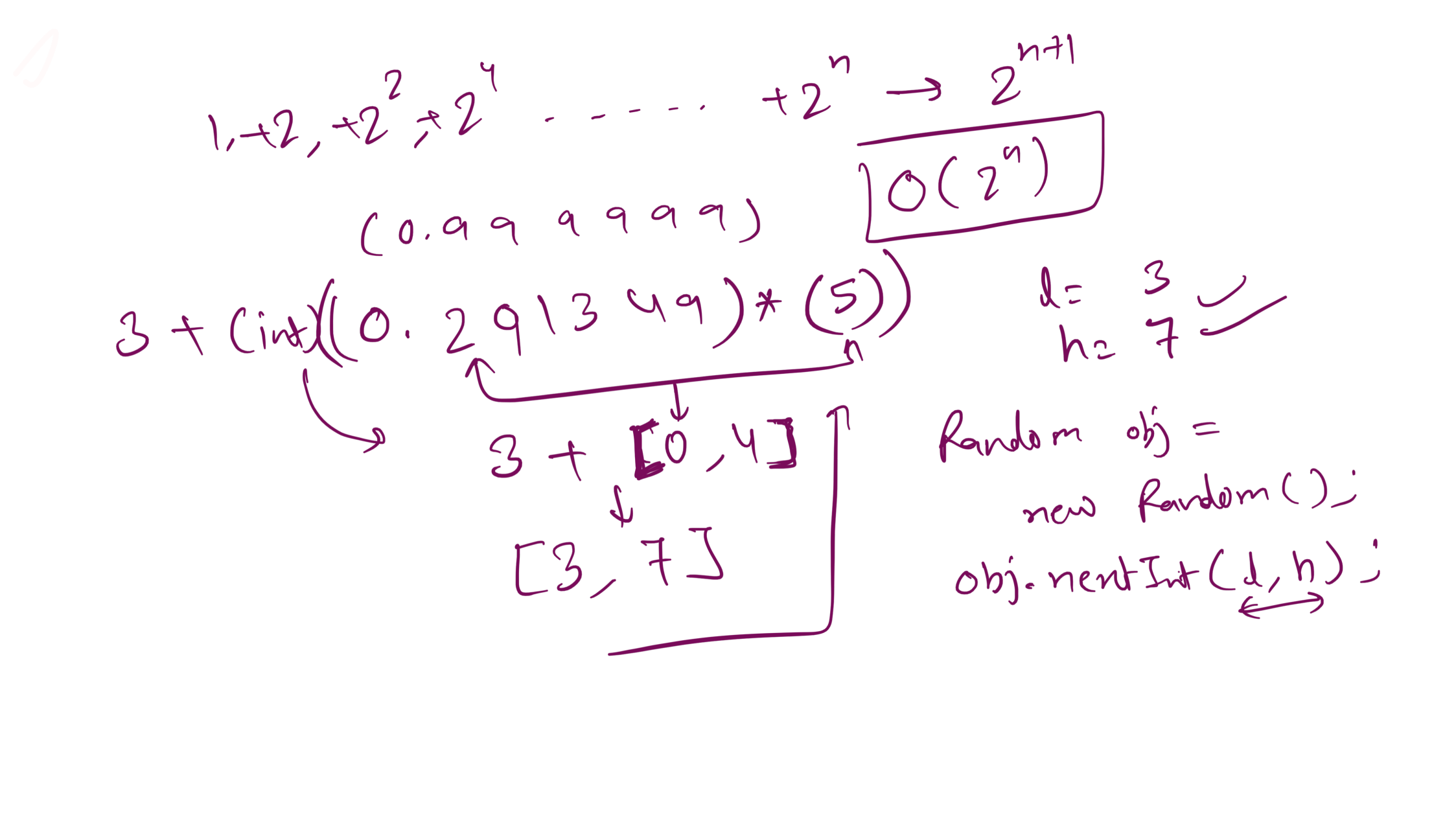


$h = \log n$

$O(n \log n)$

Practice Problems

1. Given a set of strings, find the longest common prefix using Divide and Conquer.
    a. Strings “**Apple**”, “**App**” and “**Apply**” have “**App**” in common prefix
2. Strassen’s Matrix Multiplication.
3. Find the Closest Pair of Points using Divide and Conquer algorithm.
4. Solve problems from the Standard Algorithms section: https://www.geeksforgeeks.org/divide-and-conquer/


1, +2, +2^2 ; 2^4 ..... +2^n → 2^(n+1)
O(2^n)
(0.99 9 9 9 9)
3 + (int)((0.2913 49) * (5))
d = 3
h = 7
3 + [0, 4]
[3, 7]
Random obj =
new Random();
obj.nextInt(d, h);