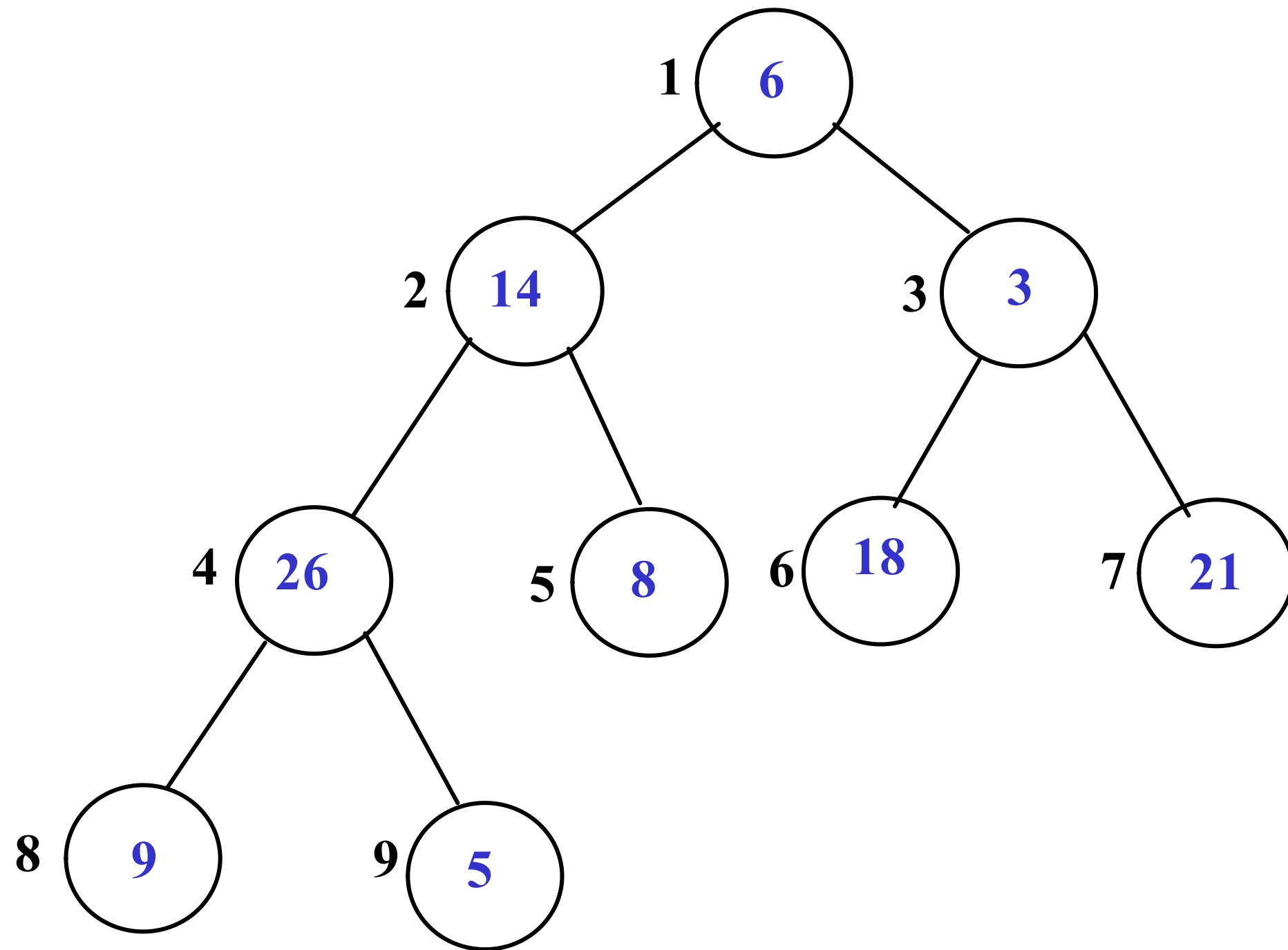


# Complete Binary Tree



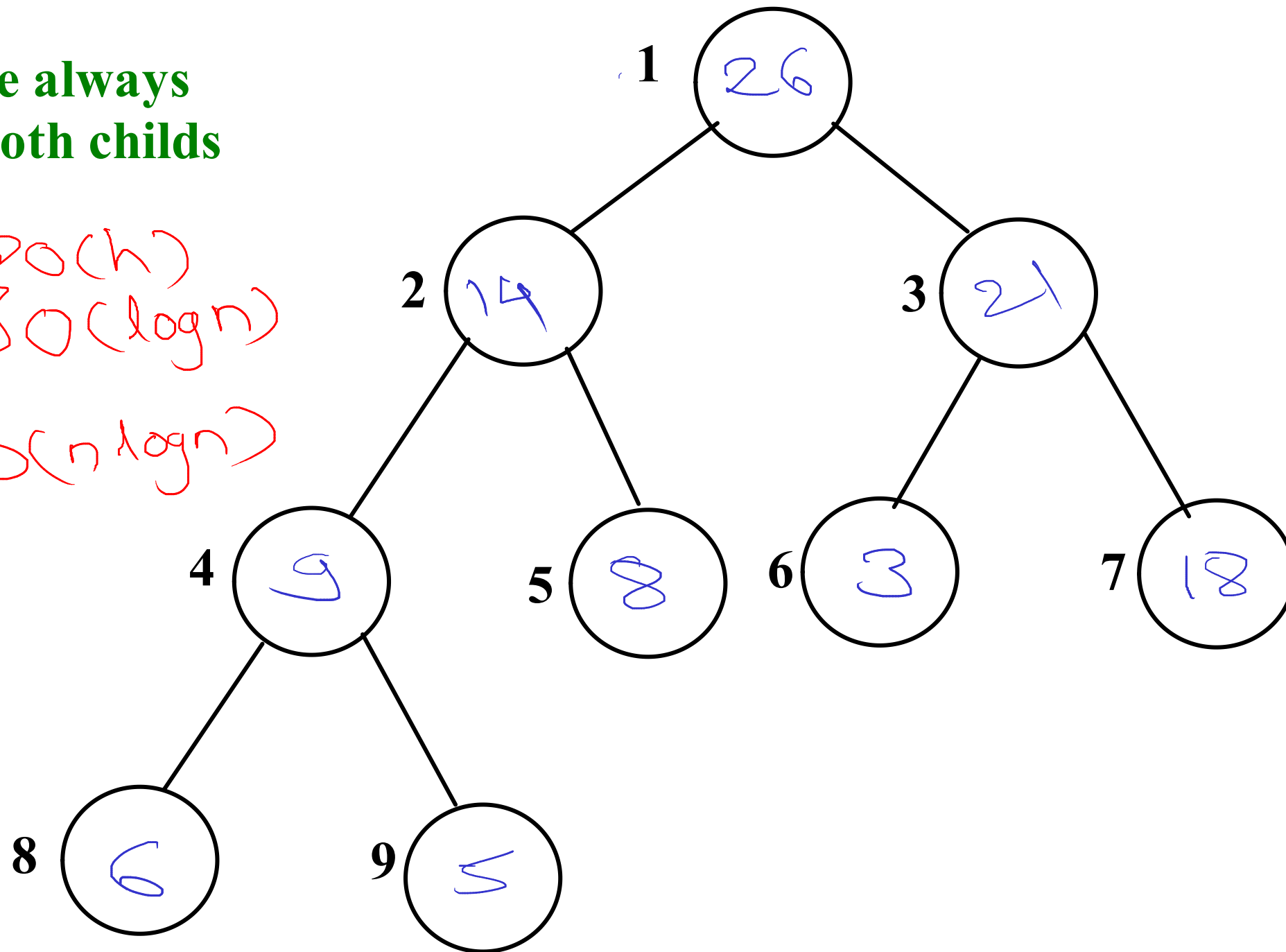
6	14	3	26	8	18	21	9	5
1	2	3	4	5	6	7	8	9

# Max Heap -add

6 14 3 26 8 18 21 9 5

- parent should be always greater than its both childs

single element  $\begin{cases} O(h) \\ O(\log n) \end{cases}$   
n elements  $\rightarrow O(n \log n)$



26	14	21	9	8	3	18	6	5
1	2	3	4	5	6	7	8	9

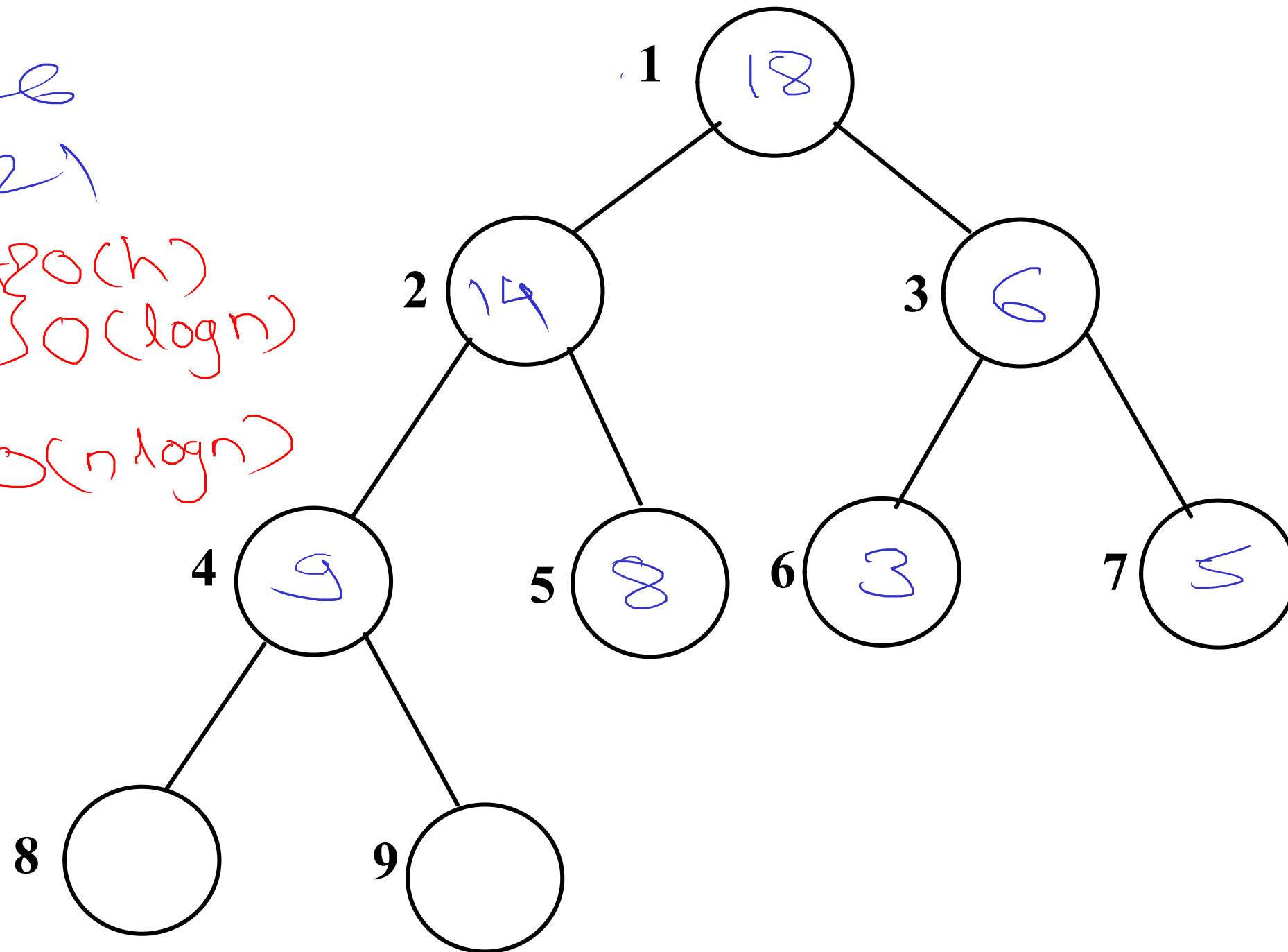
# Max Heap - Delete

max = 26

max = 21

single element  $\begin{cases} O(h) \\ O(\log n) \end{cases}$

n elements  $\rightarrow O(n \log n)$



18	14	6	9	8	3	5	21	26
1	2	3	4	5	6	7	8	9

# Merge Sort

//1. Divide array into parts

//2. Sort both partitions individually by applying same method

//3. merge both sorted partitions into temp array in such a way that temp array  
// is also sorted

//4. overwrite temp array into original array

1	3	6	7	9					
<del>1</del>	<del>3</del>	<del>6</del>	<del>7</del>	<del>9</del>					
<del>1</del>	6		3	7					
<del>6</del>	<del>1</del>	<del>9</del>	<del>3</del>	<del>7</del>	2	8	4	5	
0	1	2	3	4	5	6	7	8	

ms(arr, 0, 8) |

ms(arr, 0, 4) | [1 | 3 | 6 | 7 | 9] |

ms(arr, 0, 2) | [1 | 6 | 9] |

ms(arr, 0, 1) | [1 | 6] |

ms(arr, 0, 0) | 6 |

ms(arr, 1, 1) | 1 |

ms(arr, 2, 2) | 9 |

ms(arr, 3, 4) | [3 | 7] |

ms(arr, 3, 3) | 3 |

ms(arr, 4, 4) | 7 |

levels of  
division =  $\log n$

per level n elements  
are compared

Total comparisons =  $n \log n$

$T(n) = O(n \log n)$

# Quick Sort

//1. Select pivot (axis/referance) element from array

i. pivot = left most element

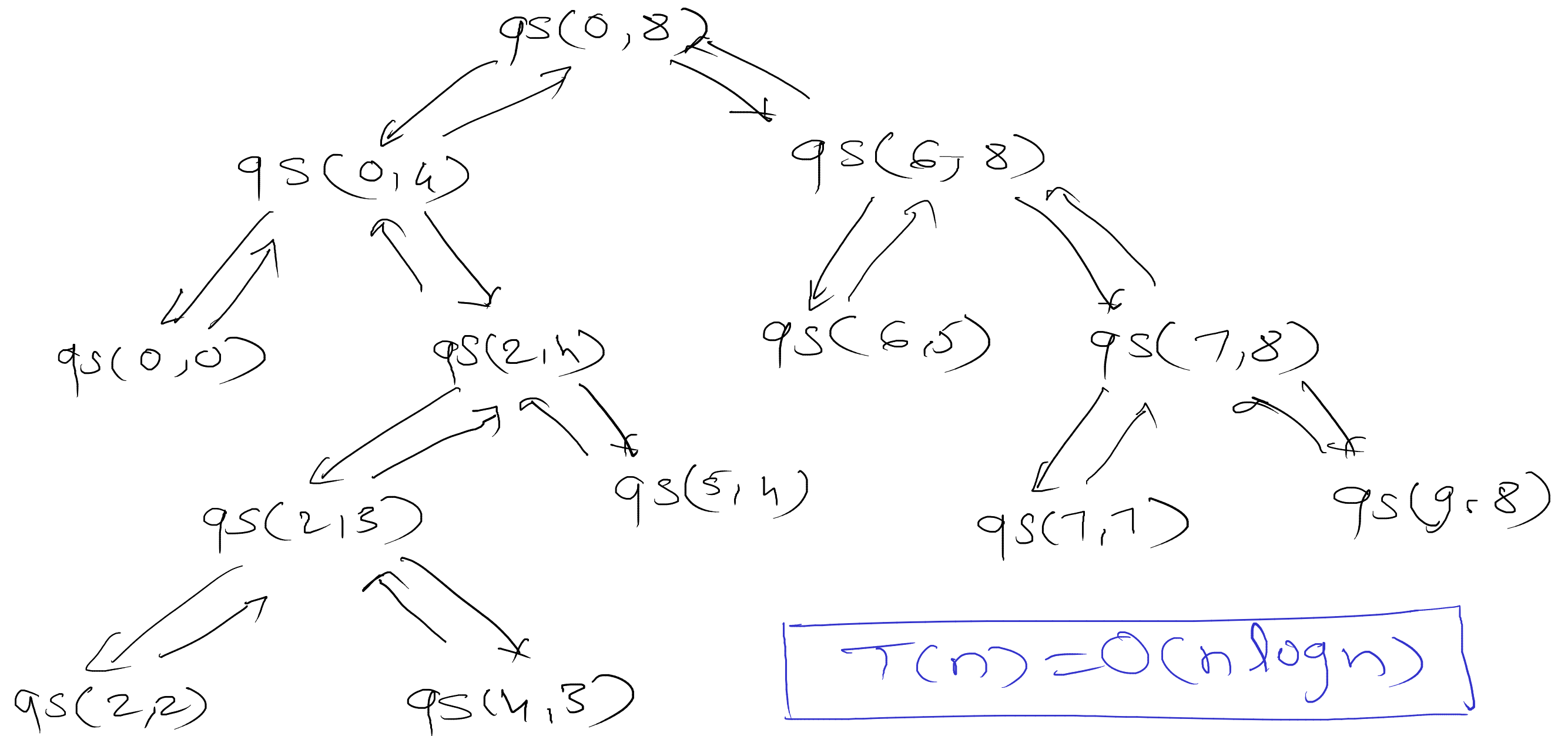
ii. pivot - right most element

iii. pivot = random element

//2. Arrange all smaller elements than pivot on left side of pivot

//3. Arrange all greater elements than pivot on right side of pivot

//4. Sort both left and right partitions of pivot individually by same method



1	2	3	4	5	6
---	---	---	---	---	---

2	3	4	5	6
---	---	---	---	---

3	4	5	6
---	---	---	---

4	5	6
---	---	---

5	6
---	---

6
---

levels = n

comp  $\propto n$

$n \times n$

$T(n) = O(n^2)$

— Time Complexity of quick sort is dependent on selection pivot.

— To keep time complexity minimum pivot is selected by applying below methods

- (i) median of 3
- (ii) Dual pivot