

SORTING

Bubble Sort

[4 8 3 1 2]

4 3 8 1 2

4 3 1 8 2

4 3 1 2 8

3 1 2 4 8

1 2 3 4 8

[4 | 8 3 1 2]
4 8 3 1 2

Insertion

traverse through sorted
to find spot

Selection Sort

[4 3 8 1 2]

[1 3 8 4 2]

[1 2 8 4 3]

[1 2 3 4 8]

traverse through array
to find next smallest

$$O(1)$$

$$O(n)$$

$$O(n^2)$$

$$O(n^3)$$

$[4, 2, 8, 1]$

$[4, 2]$

$[8, 1]$

$[4]$

$[2]$

$[8]$

$[1]$

$[2, 4]$

$[1, 8]$

$[1, 2, 4, 8]$

$(n \log n)$

n work

n work

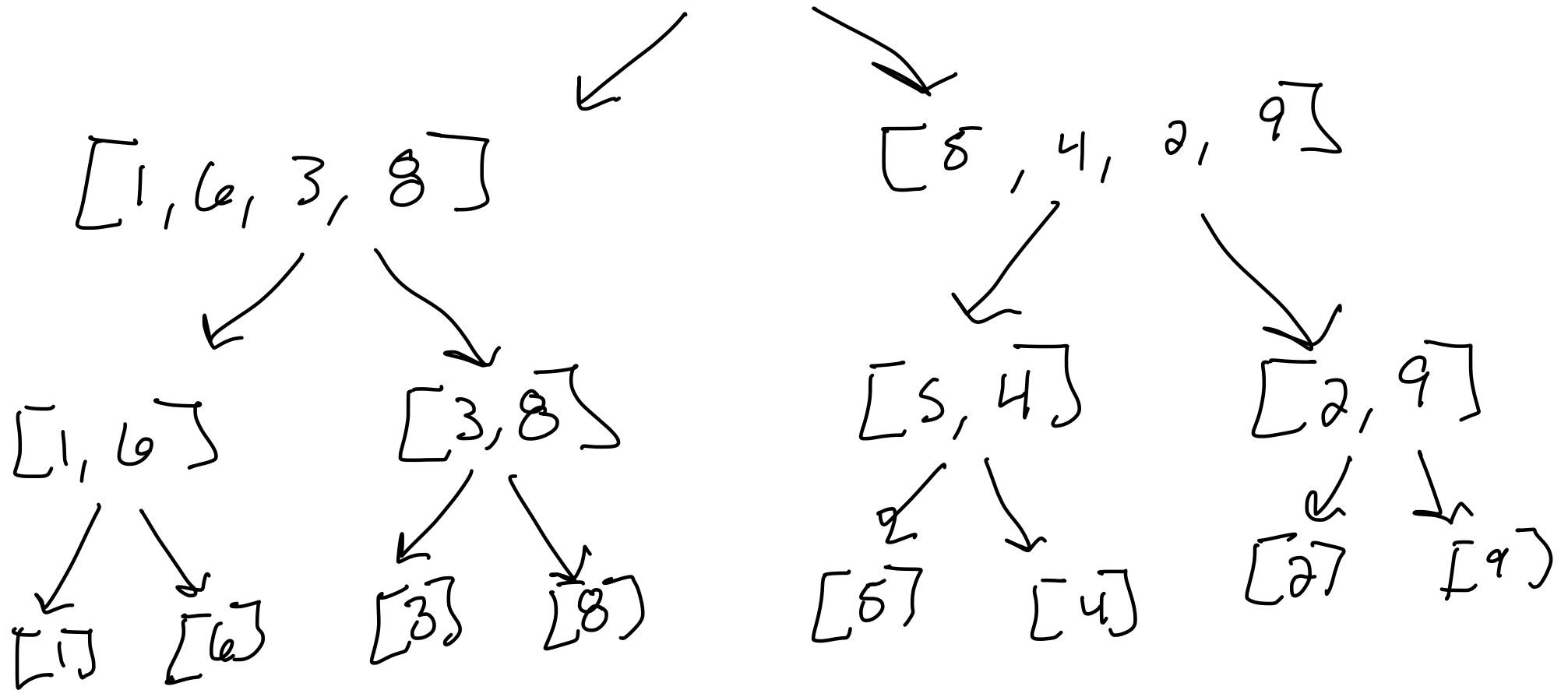
[1, 3, 6, 7]

[4, 5, 6, 9]

1	3	6	7	4	5	6	9
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1	3	4	5	6	6	7	9
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$[1, 6, 3, 8, 5, 4, 2, 9]$



MERGE SORT

- divide and conquer algorithm
- recursive
- process:
 - divide array into 2 halves
 - **recursively** sort each half (by calling mergesort on each half)
 - merge sorted halves (take 2 sorted lists and combine into one sorted list)

MERGE SORT - COMPLEXITY

$\log_2(n)$

- Tree like, recursive halving/combining
- How much work at each step of tree?

n

time
space

complexity: $O(n \log n)$
complexity: $O(n)$

QUICK SORT

- divide and conquer algorithm
- recursive
- process:
 - choose pivot (often leftmost or rightmost element)
 - place:
 - everything less than pivot to it's left
 - everything greater than pivot to it's right
 - pivot in between
 - repeat process for left chunk and right chunk (use quicksort to sort each chunk)

QUICK SORT

- How to move elements to correct side of pivot?
- Start scanning from both sides
 - Scan from left -> until find entry $>$ pivot
 - Scan from $<$ - right until find entry $<$ pivot
 - Swap entries
- Stop once scan indices cross and swap pivot element into place
 - leftmost pivot, swap pivot with rightmost in left subarray
 - rightmost pivot, swap pivot with leftmost in right subarray

QUICK SORT - COMPLEXITY

- Recursive halving of problems - how many levels?
- How much work at each level

	best	average	worst	space complexity	stable
quick sort	$n \log(n)$	$n \log(n)$	$O(n^2)$	$\log(n)$	no
merge sort	$n \log(n)$	$n \log(n)$	$n \log(n)$	n	yes
bubble sort	n	n^2	n^2	\downarrow	yes
insertion sort	n	n^2	n^2	\downarrow	yes
selection sort	n^2	n^2	n^2	\downarrow	no