

QuickSort

① Choose a "pivot."

In this note, our pivot-picking strategy chooses first element as pivot.

14	33	43	21	5	9	18	67	30
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② Partition: run Tony Hoare's In-place Partitioning scheme

- Partition = place all items less than or equal to the pivot to the left and all items greater than pivot to the right.
- Tony Hoare: accomplishes this in $\Theta(N)$ time and $\Theta(1)$ space.

a) Place **L** pointer at index 1.

b.) Place **G** pointer at end.

2) Move pointers towards each other until L lands on an item that is greater than pivot and when G lands on an item less than or equal to pivot.

Swap items 1 and 6 are pointing to.

d) Repeat (d) until L is on right side of G.

5) Swap pivot and item at 6.

14	33	43	21	5	9	18	67	30
P	L							G

Diagram illustrating an array structure with elements: 14, 38, 43, 21, 5, 9, 18, 67, 30. Annotations include a purple arrow pointing from index 3 to index 5, a blue arrow pointing from index 6 to index 8, and labels 'p', 'L', and '6' below the array.

Diagram illustrating the initial state of the array and pointers:

14	9	43	21	5	33	18	67	3
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Pointers: p points to 14, l points to 43, and g points to 5. A bracket above the array indicates the range from index 2 to 4.

Step f!

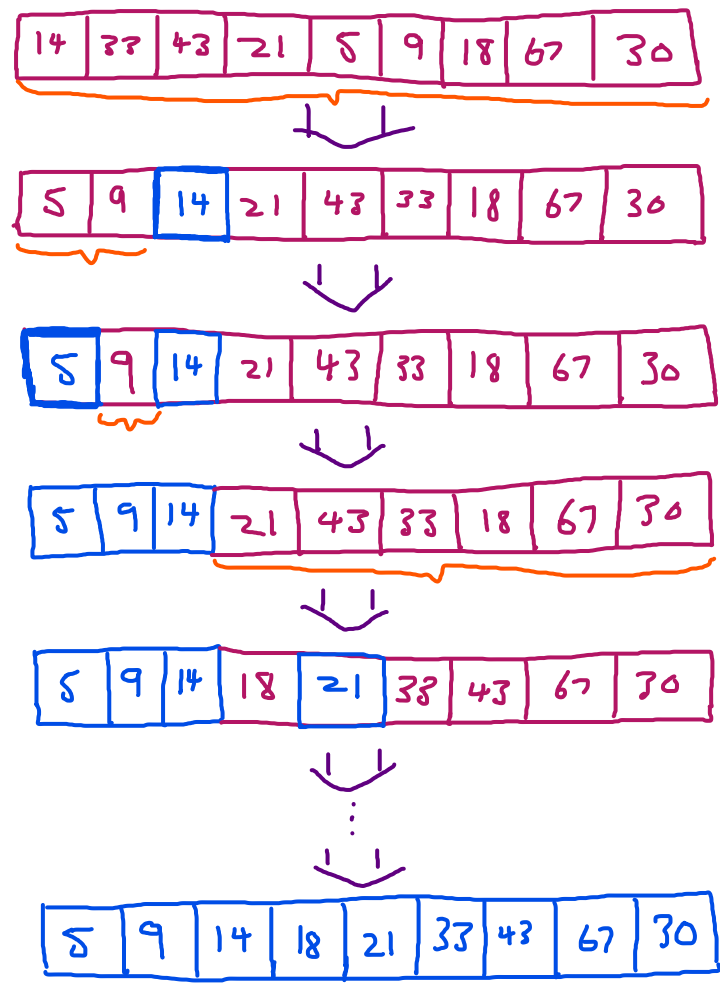
14	9	5	21	43	33	18	67	30
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p b L

Notice: the pivot is now in the correct position of the sorted array

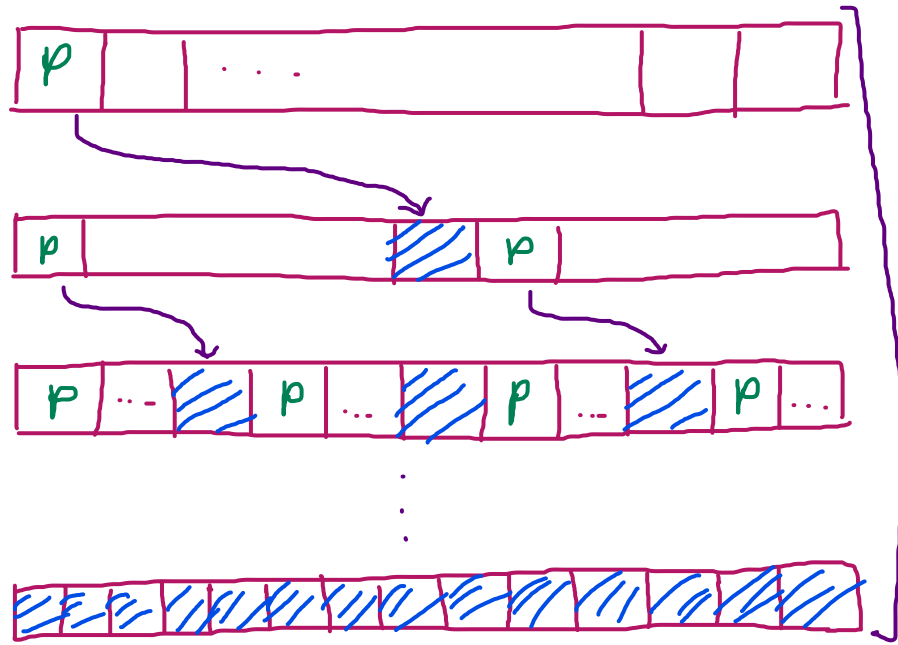
Diagram illustrating a linked list structure. The list contains nodes with values: 5, 9, 14, 21, 43, 33, 18, 67, 30. The node containing 14 is highlighted, and a pointer 'p' is shown below it. An arrow indicates the next pointer field of the node with 14 points to the node with 21.

3 Recursion: repeat steps 1 and 2 on left and right subarrays of pivot.



Runtime?

Best case: $\Theta(N \log N)$



$$\underbrace{N + N + \dots + N}_{\log N} = \Theta(N \log N)$$

Level	Work
0	N ← How many elements involved in partition
1	$\frac{N}{2} * 2 = N$
2	$\frac{N}{4} * 4 = N$
⋮	$< N$
$\log N$	$< N$

Worst case? $\Theta(N^2)$

Level

Work

0

N



1

N-1



2

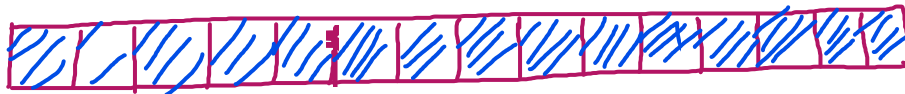
N-2



⋮

⋮

⋮



N

1

$$N + (N-1) + (N-2) + \dots + 2 + 1 = \Theta(N^2)$$