CS50 for MBAs

Algorithms

Last Time

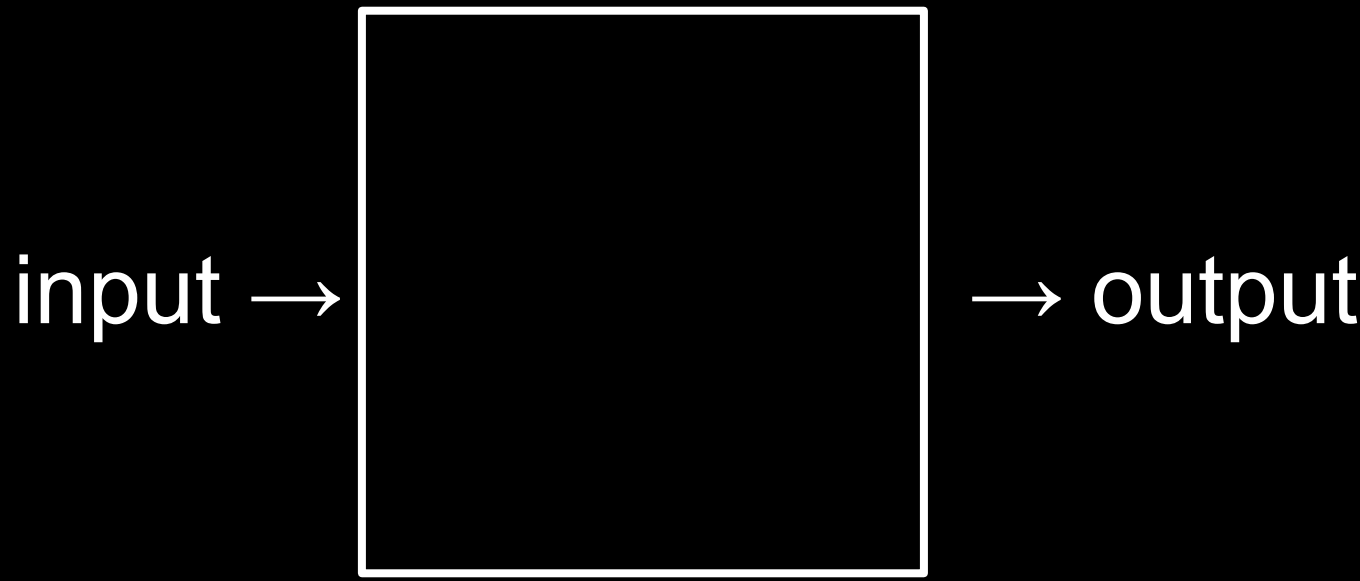
- representation
- algorithms, pseudocode
- functions, variables, conditions, loops

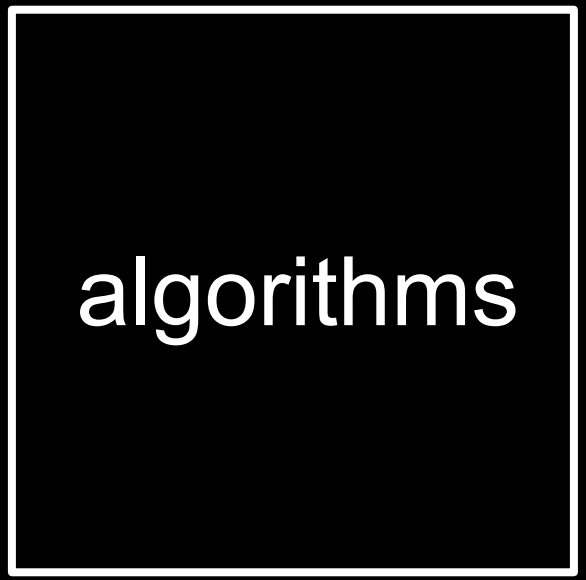
This Time

- abstraction
- correctness, efficiency
- searching, sorting

shorts

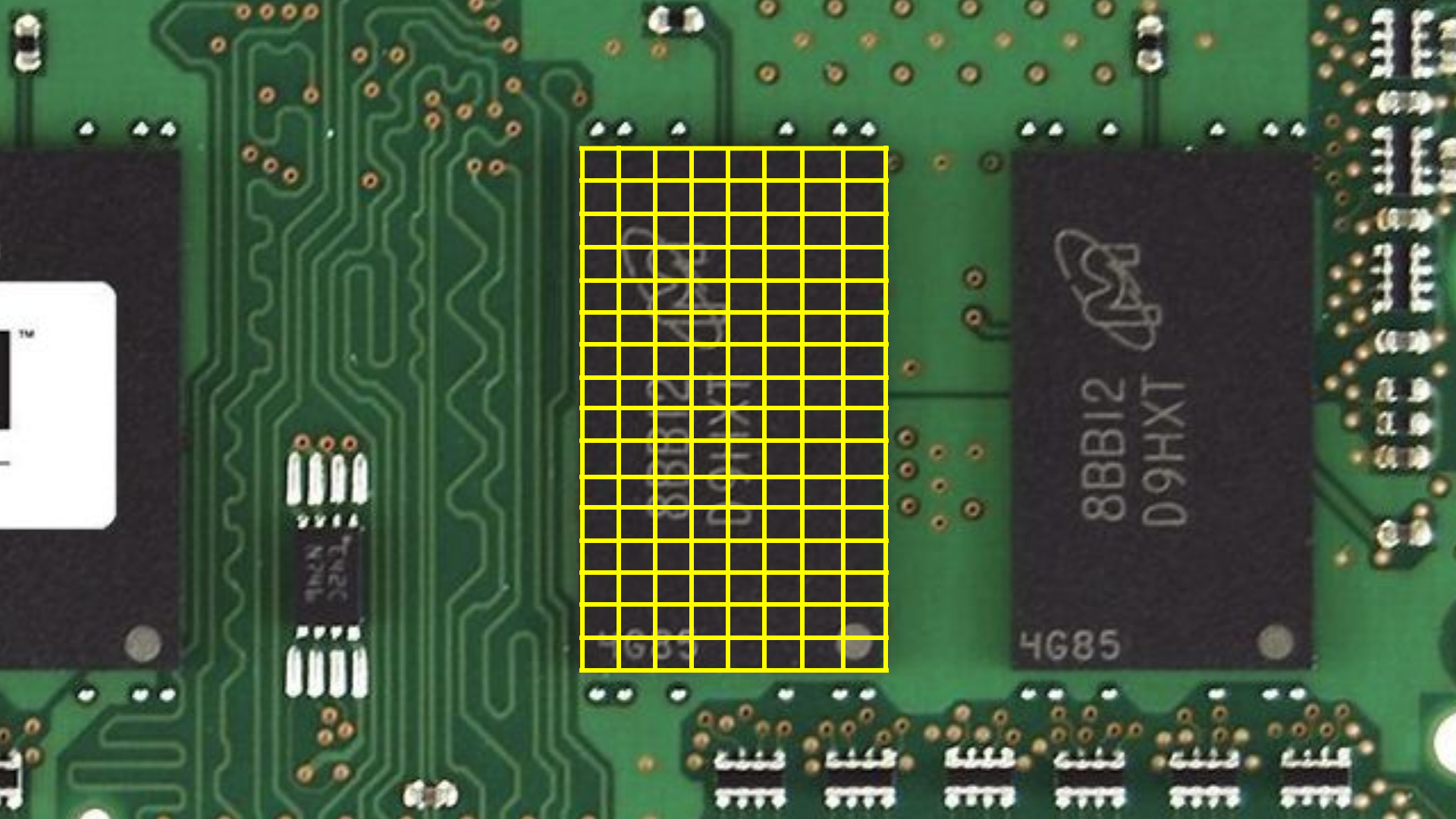
abstraction

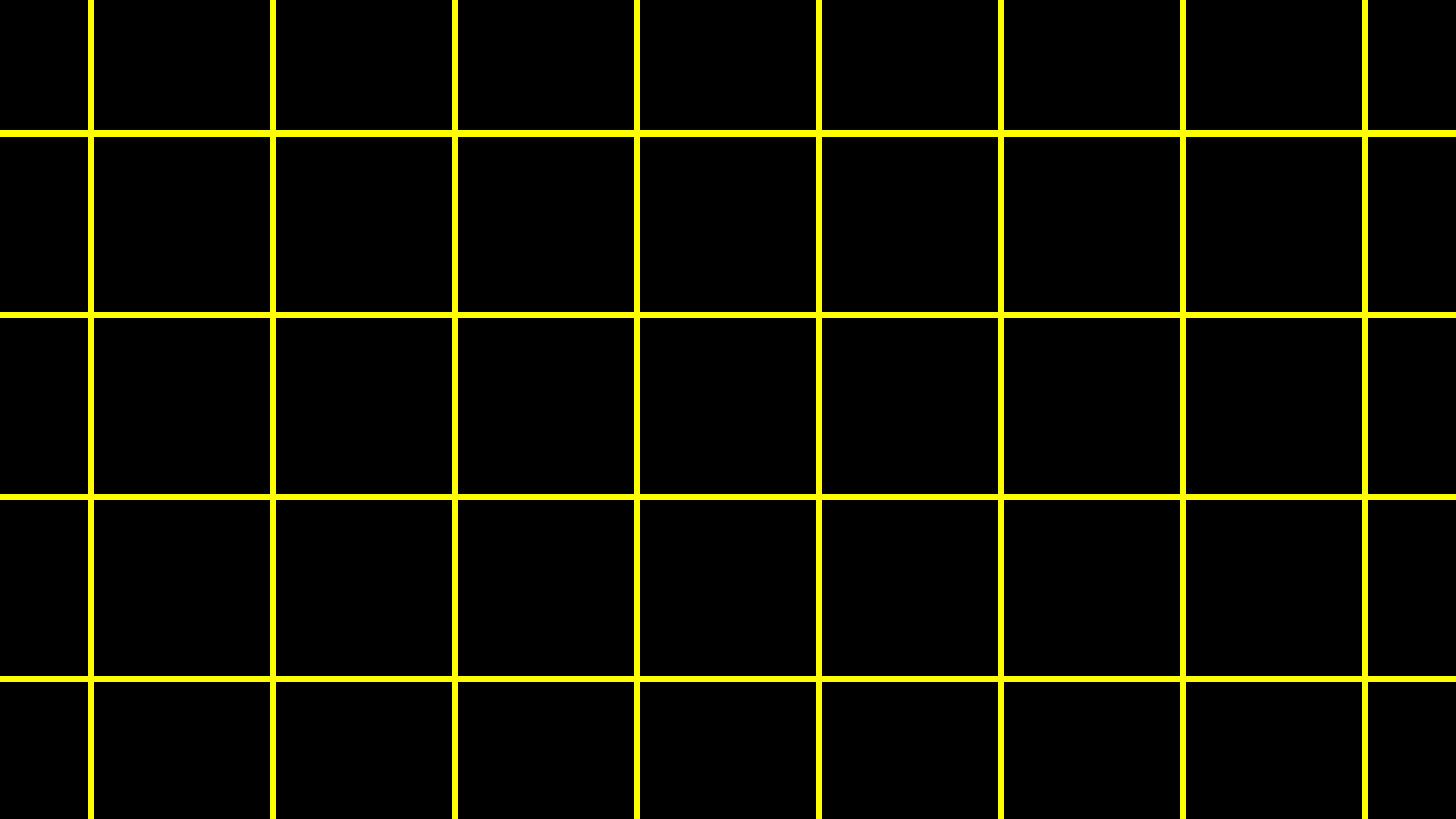

input →
→ output

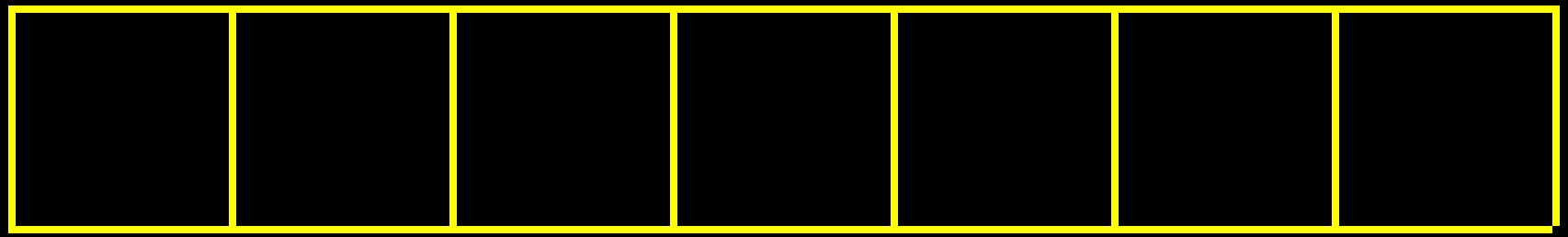

algorithms

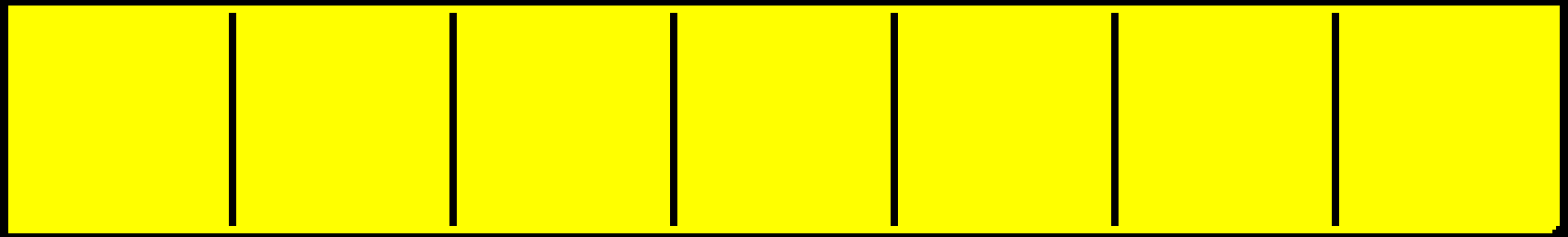

crucial
by Micron
8BBI2
D9HXT
8BBI2
D9HXT
4G85
4G85
4G85
47J6


8BBI2
D9HXT
4G85
8BBI2
D9HXT
4G85


8BBI2
D9HXT
4G85







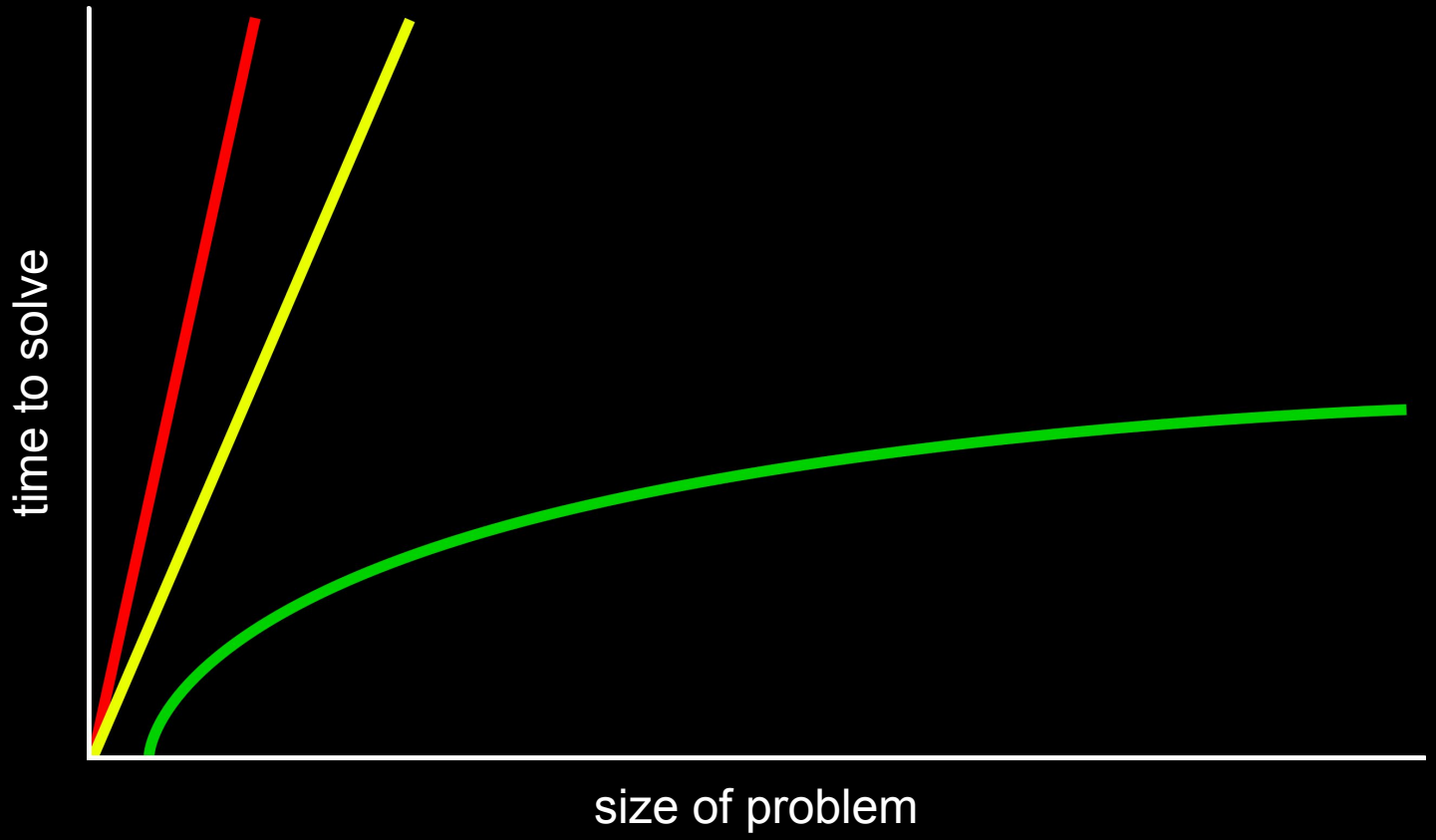
linear search

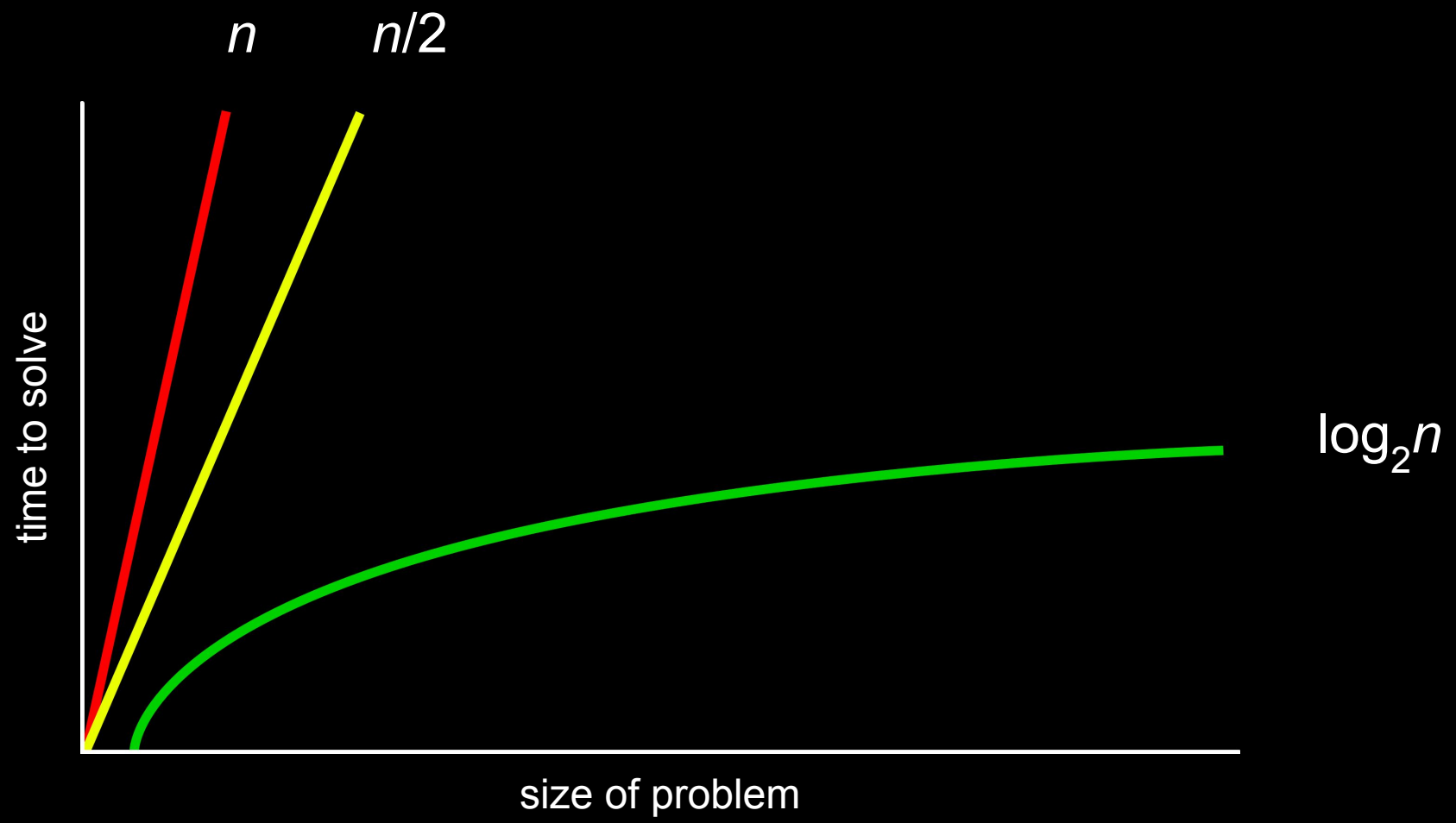
```
For i from 0 to n-1
    If i'th element is 50
        Return true
Return false
```

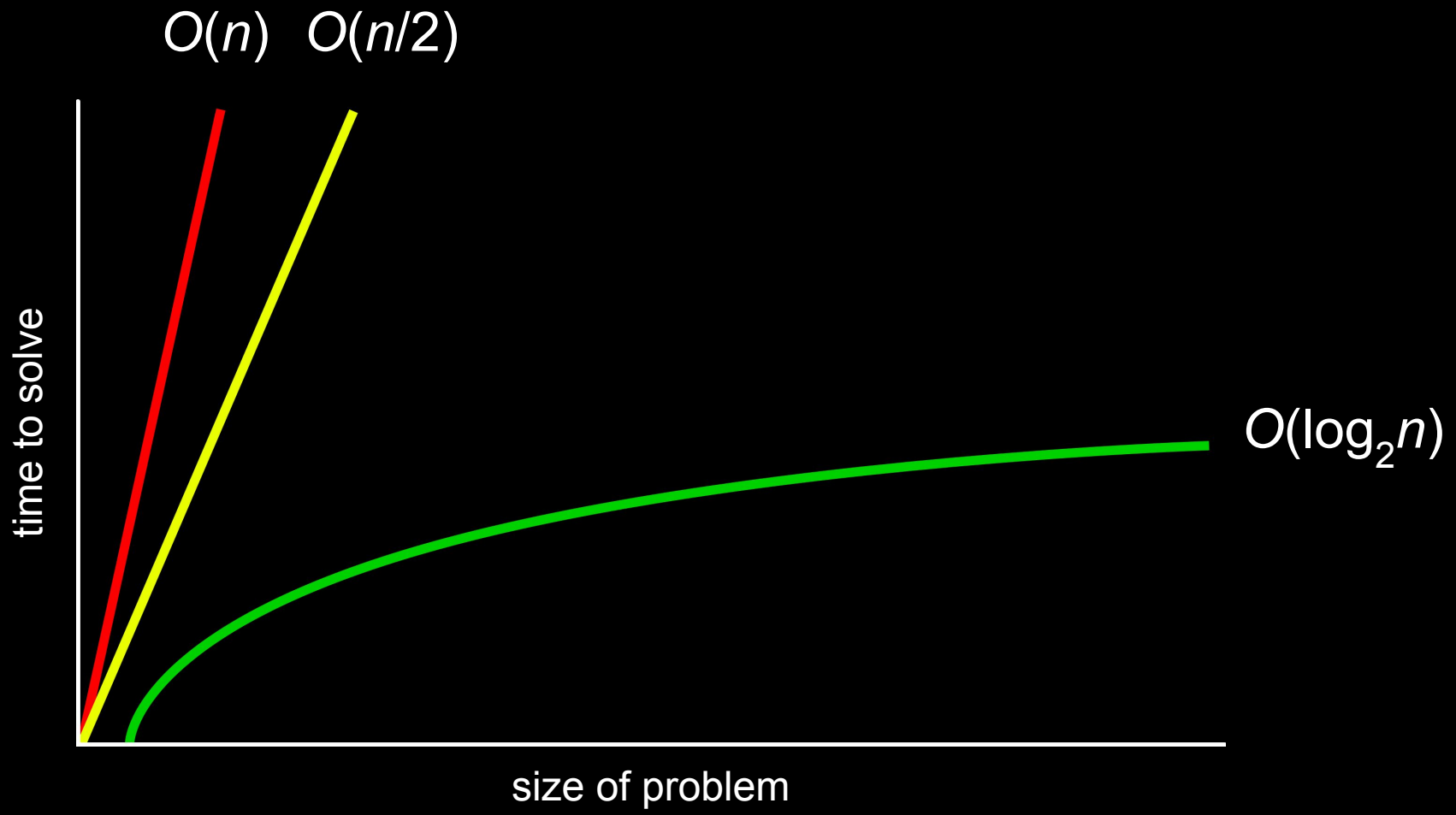
binary search

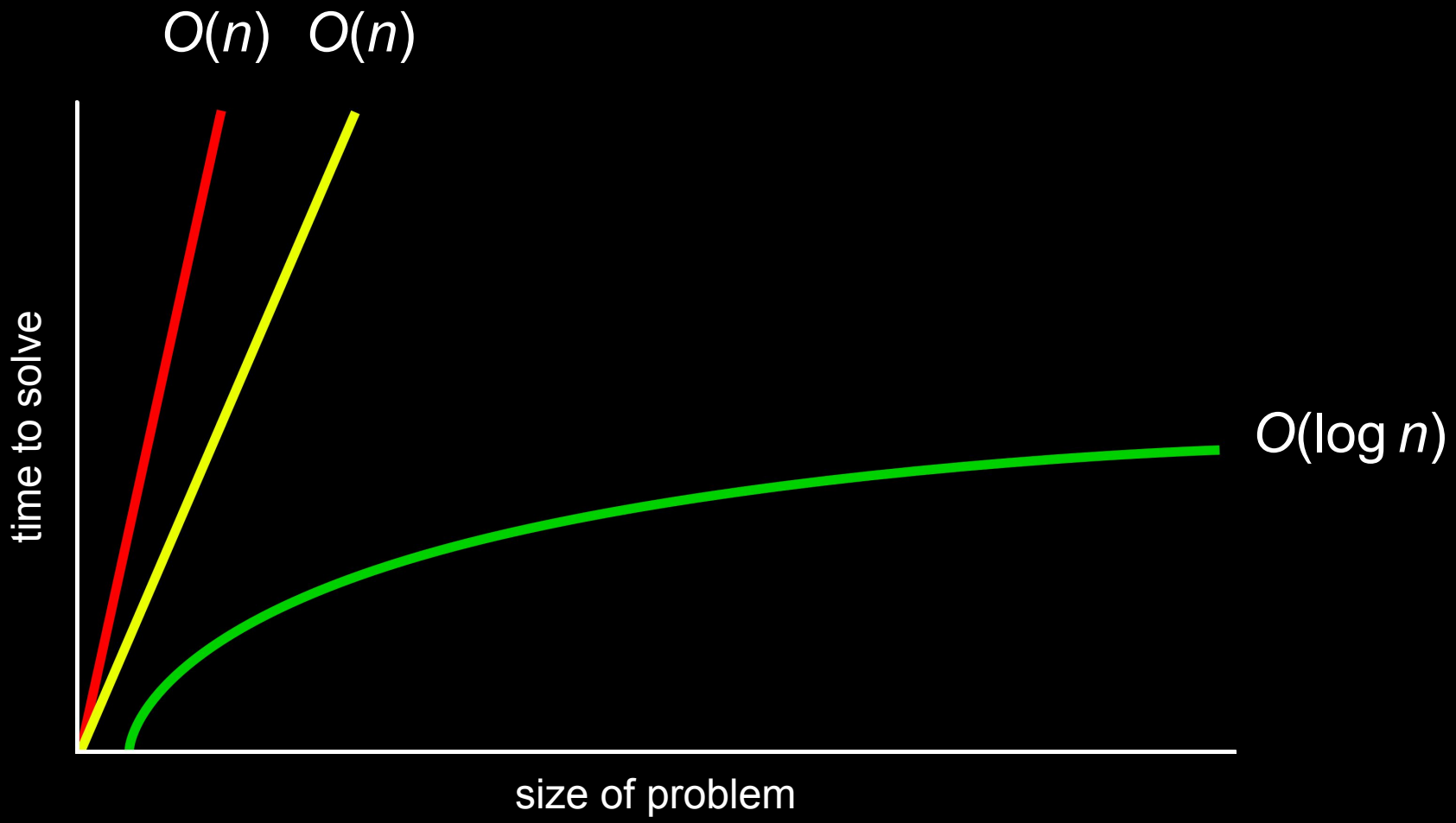
```
If middle item is 50
    Return true
Else if 50 < middle item
    Search left half
Else if 50 > middle item
    Search right half
```

```
If no items
    Return false
If middle item is 50
    Return true
Else if 50 < middle item
    Search left half
Else if 50 > middle item
    Search right half
```


time to solve
size of problem


n
n/2
time to solve
log2n
size of problem


O(n)
O(n/2)
O(log2n)
time to solve
size of problem


O(n)
O(n)
O(log n)
time to solve
size of problem

$O(n^2)$

$O(n \log n)$

$O(n)$

$O(\log n)$

$O(1)$

$O(n^2)$

$O(n \log n)$

$O(n)$ linear search

$O(\log n)$ binary search

$O(1)$

$\Omega(n^2)$

$\Omega(n \log n)$

$\Omega(n)$

$\Omega(\log n)$

$\Omega(1)$

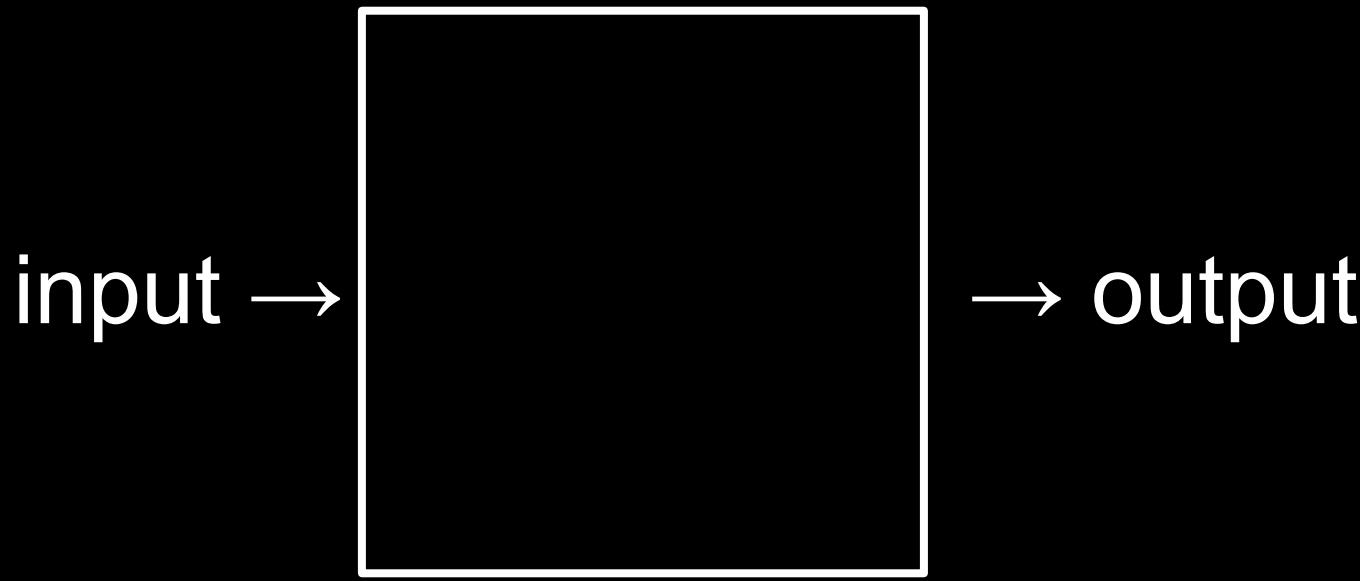
$\Omega(n^2)$

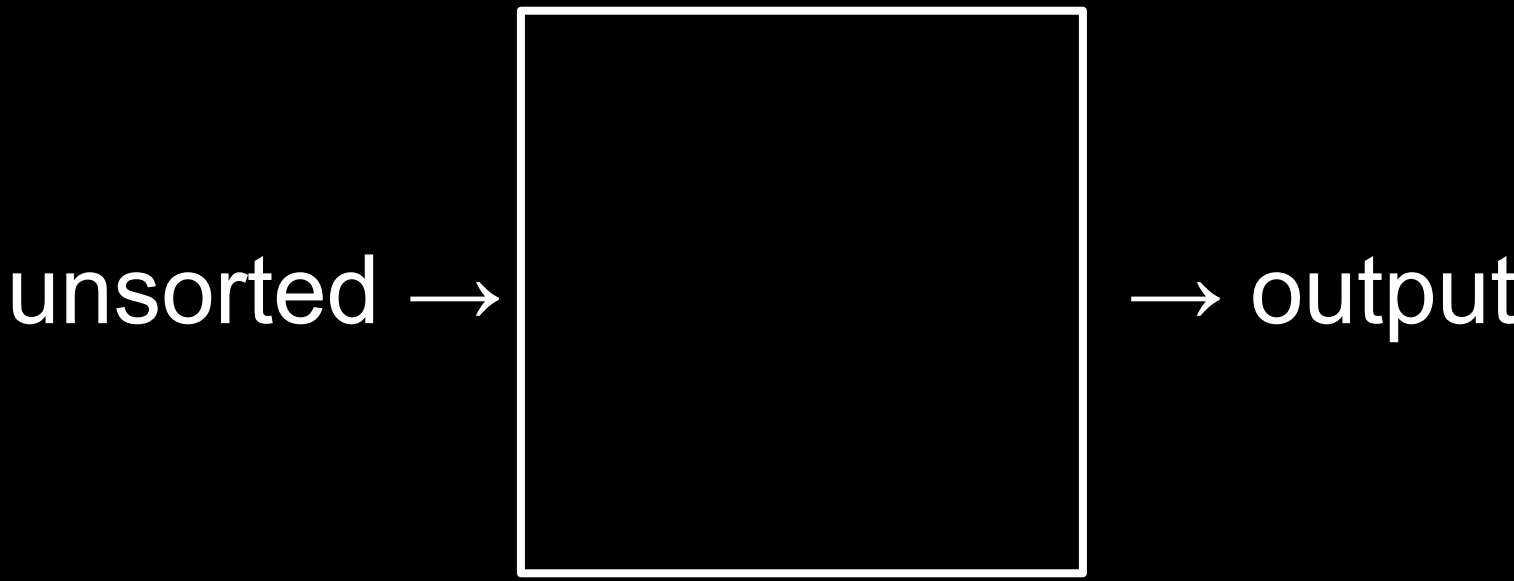
$\Omega(n \log n)$

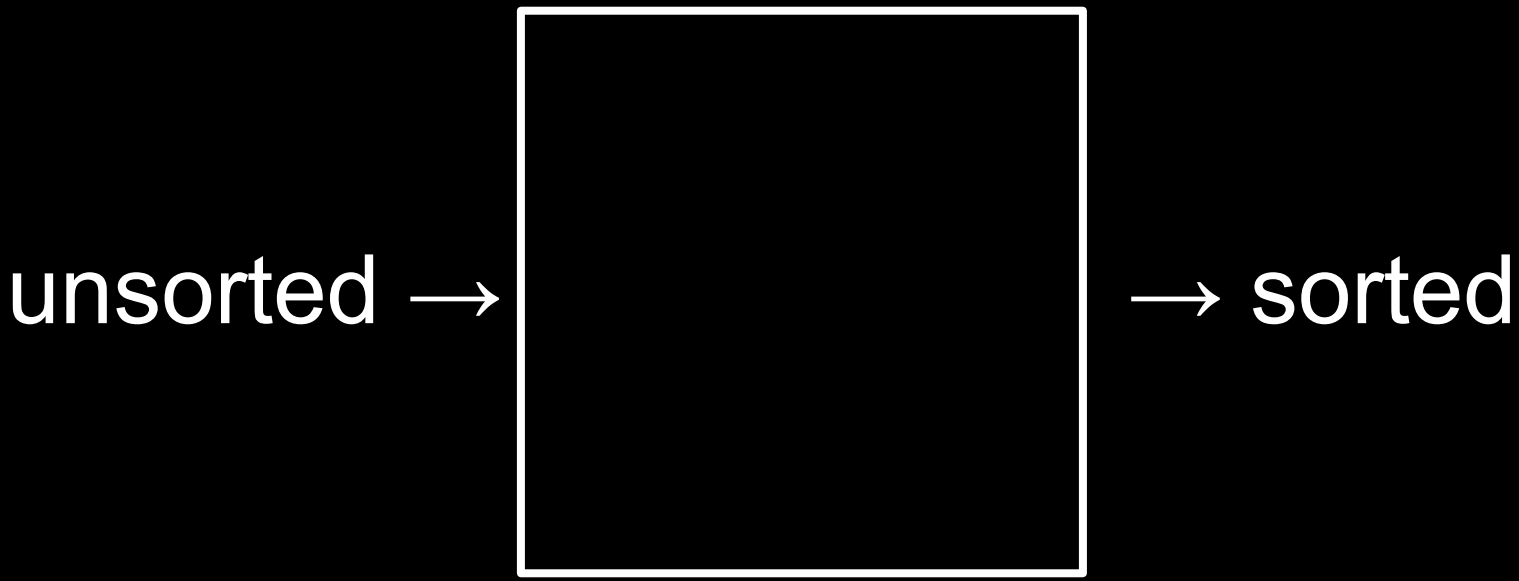
$\Omega(n)$

$\Omega(\log n)$

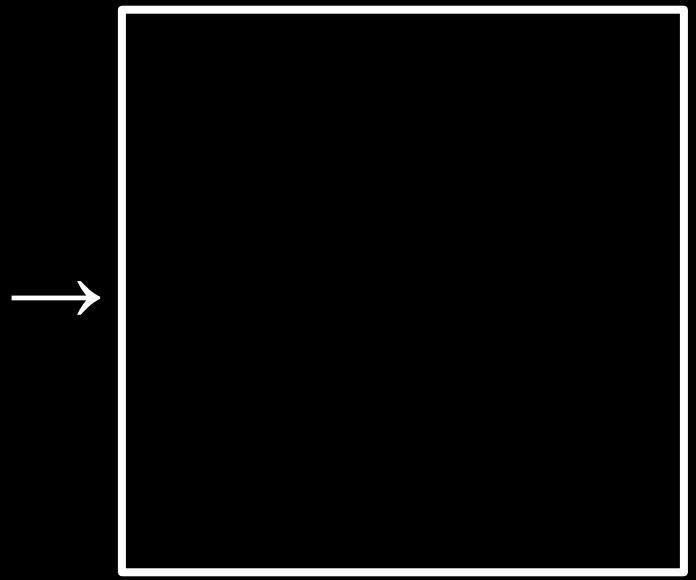
$\Omega(1)$ linear search, binary search


input →
→ output


unsorted →
→ output

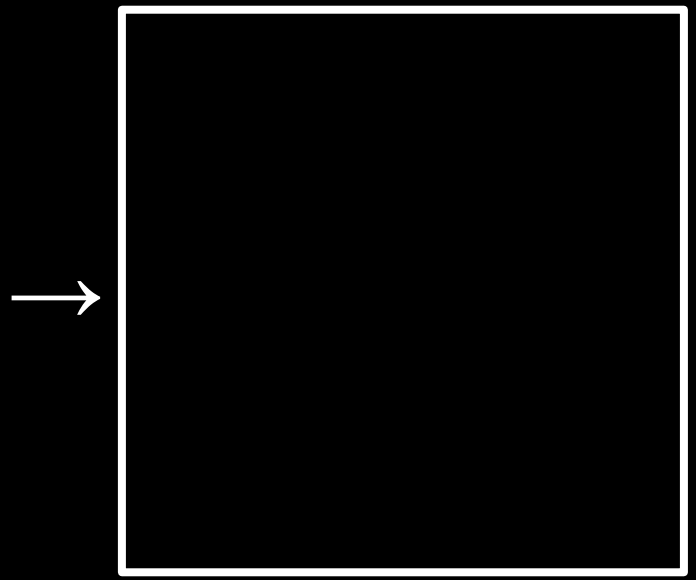

unsorted →
→ sorted

15 23 16 8 42 50 4



sorted

15 23 16 8 42 50 4



4 8 15 16 23 42 50

6 3 8 5 2 7 4 1

bubble sort

```
Repeat n-1 times
    For i from 0 to n-2
        If i'th and i+1'th elements out of order
            Swap them
```

$(n - 1) \times (n - 1)$

$(n - 1) \times (n - 1)$

$n^2 - 1n - 1n + 1$

$(n - 1) \times (n - 1)$

$n^2 - 1n - 1n + 1$

$n^2 - 2n + 1$

$(n - 1) \times (n - 1)$

$n^2 - 1n - 1n + 1$

$n^2 - 2n + 1$

$O(n^2)$

$O(n^2)$ bubble sort

$O(n \log n)$

$O(n)$

$O(\log n)$

$O(1)$

$\Omega(n^2)$ bubble sort

$\Omega(n \log n)$

$\Omega(n)$

$\Omega(\log n)$

$\Omega(1)$

selection sort

```
For i from 0 to n-1
    Find smallest item between i'th item and last item
    Swap smallest item with i'th item
```

n

$n + (n - 1)$

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

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

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

$n(n + 1)/2$

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

$n(n + 1)/2$

$(n^2 + n)/2$

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

$n(n + 1)/2$

$(n^2 + n)/2$

$n^2/2 + n/2$

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

$n(n + 1)/2$

$(n^2 + n)/2$

$n^2/2 + n/2$

$O(n^2)$

$O(n^2)$ selection sort

$O(n \log n)$

$O(n)$

$O(\log n)$

$O(1)$

$\Omega(n^2)$ selection sort

$\Omega(n \log n)$

$\Omega(n)$

$\Omega(\log n)$

$\Omega(1)$

bubble sort

```
Repeat n-1 times
    For i from 0 to n-2
        If i'th and i+1'th elements out of order
            Swap them
```

```
Repeat until no swaps
    For i from 0 to n-2
        If i'th and i+1'th elements out of order
            Swap them
```

$\Omega(n^2)$ selection sort, bubble sort

$\Omega(n \log n)$

$\Omega(n)$

$\Omega(\log n)$

$\Omega(1)$ linear search, binary search

$\Omega(n^2)$	selection sort
$\Omega(n \log n)$	
$\Omega(n)$	bubble sort
$\Omega(\log n)$	
$\Omega(1)$	linear search, binary search


Google

recursion

```
1   Pick up phone book
2   Open to middle of phone book
3   Look at page
4   If person is on page
5       Call person
6   Else if person is earlier in book
7       Open to middle of left half of book
8       Go back to line 3
9   Else if person is later in book
10      Open to middle of right half of book
11      Go back to line 3
12  Else
13      Quit
```

```
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```

```
1   Pick up phone book
2   Open to middle of phone book
3   Look at page
4   If person is on page
5       Call person
6   Else if person is earlier in book
7       Search left half of book
8
9   Else if person is later in book
10      Search right half of book
11
12  Else
13      Quit
```

```
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10  Else
11      Quit
```
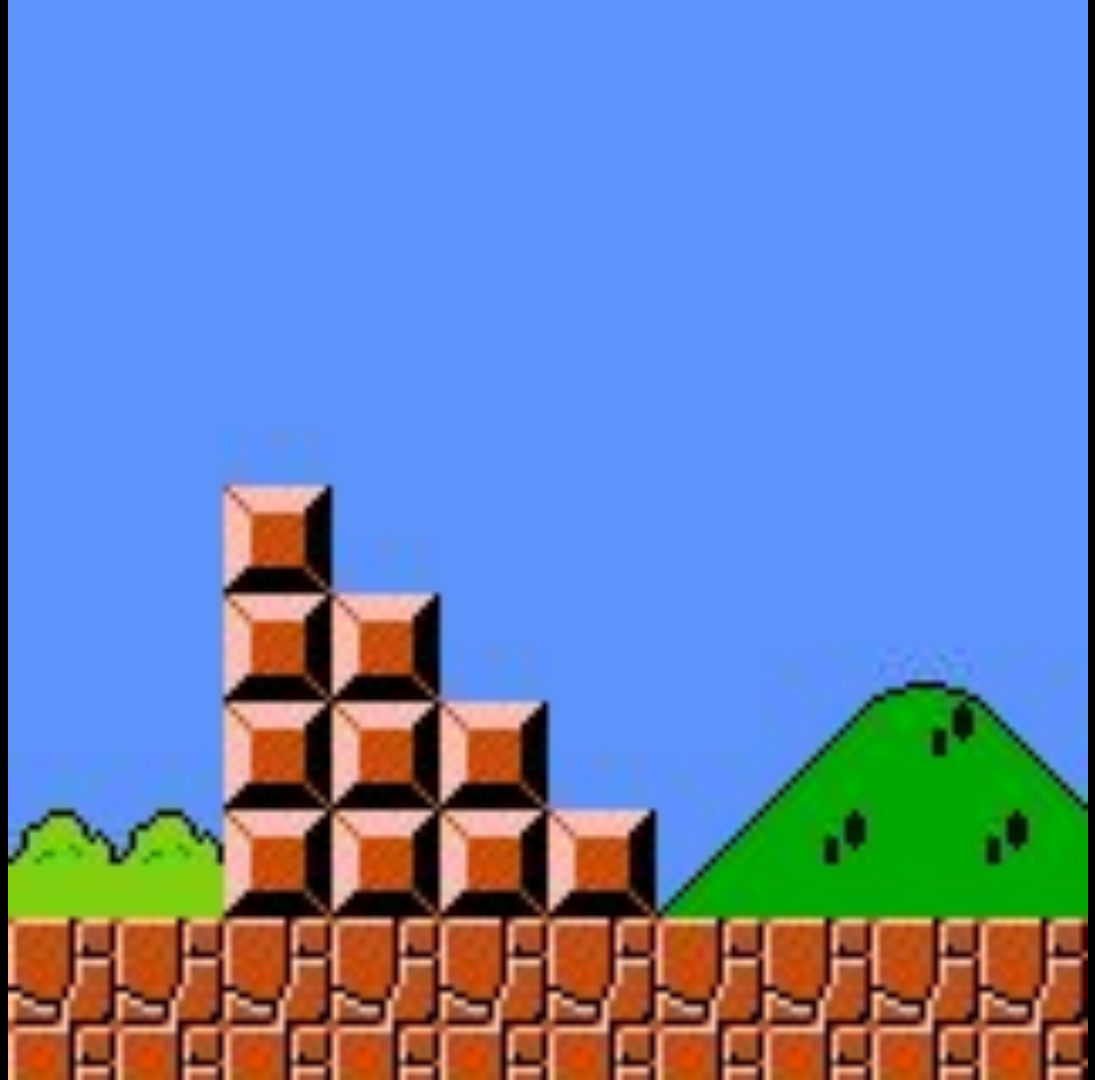



merge sort

```
If only one item
    Return
Else
    Sort left half of items
    Sort right half of items
    Merge sorted halves
```

```
If only one item
    Return
Else
    Sort left half of items
    Sort right half of items
    Merge sorted halves
```

7 4 5 2 6 3 8 1

7 4 5 2 6 3 8 1

7 4 5 2 6 3 8 1

7 4 5 2 6 3 8 1

7 4 5 2 6 3 8 1


7 4 5 2 6 3 8 1

7

5 2 6 3 8 1

4

5 2 6 3 8 1

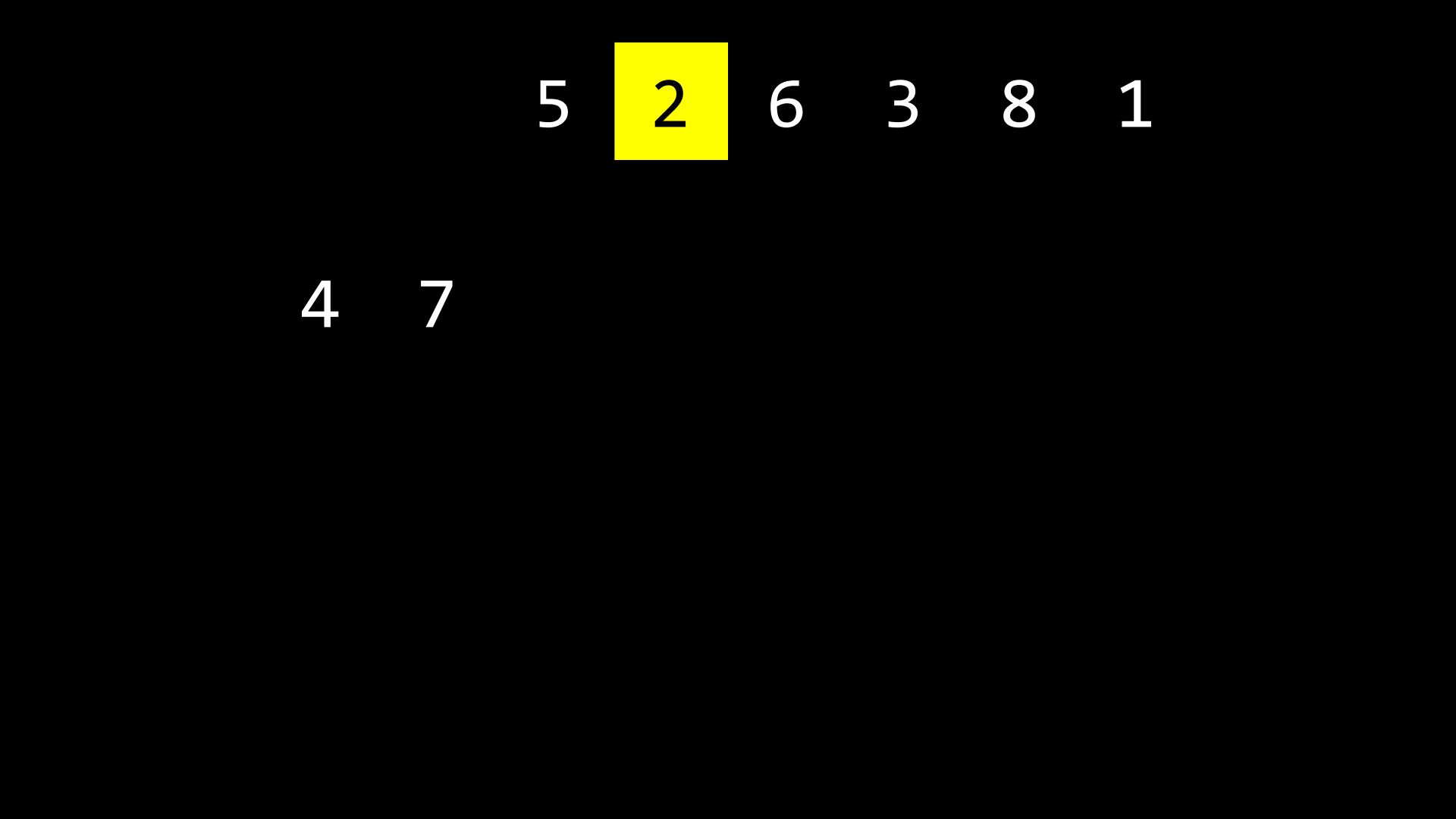
4 7

5 2 6 3 8 1

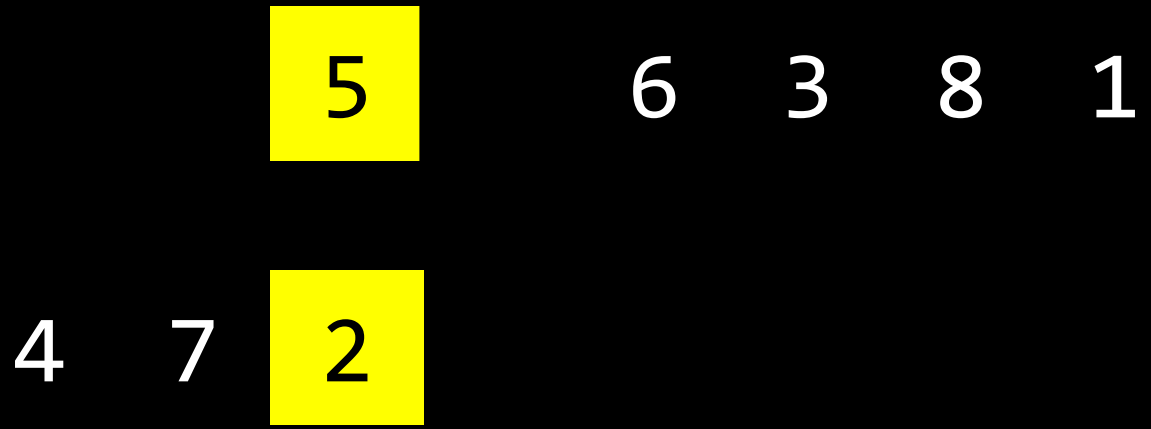
4 7

5 2 6 3 8 1

4 7


5 2 6 3 8 1
4 7

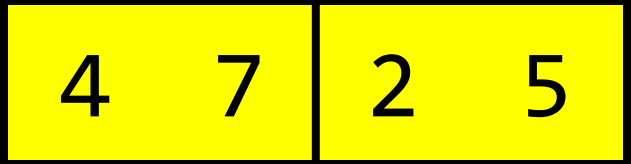
4 7


5
6 3 8 1
4 7 2

6 3 8 1

4 7 2 5

6 3 8 1



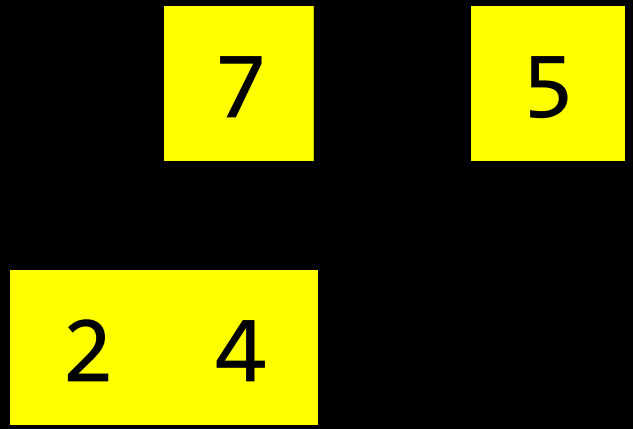
6 3 8 1

4 7

5

2

6 3 8 1



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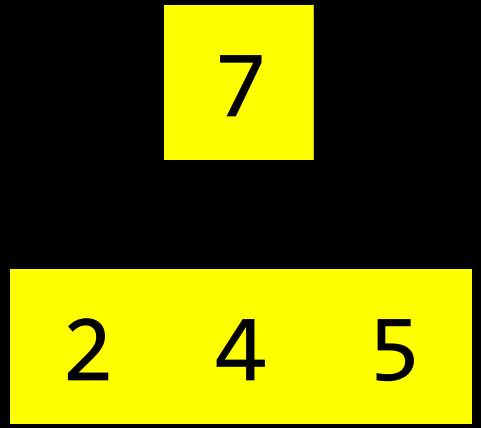


6 3 8 1

2 4 5 7

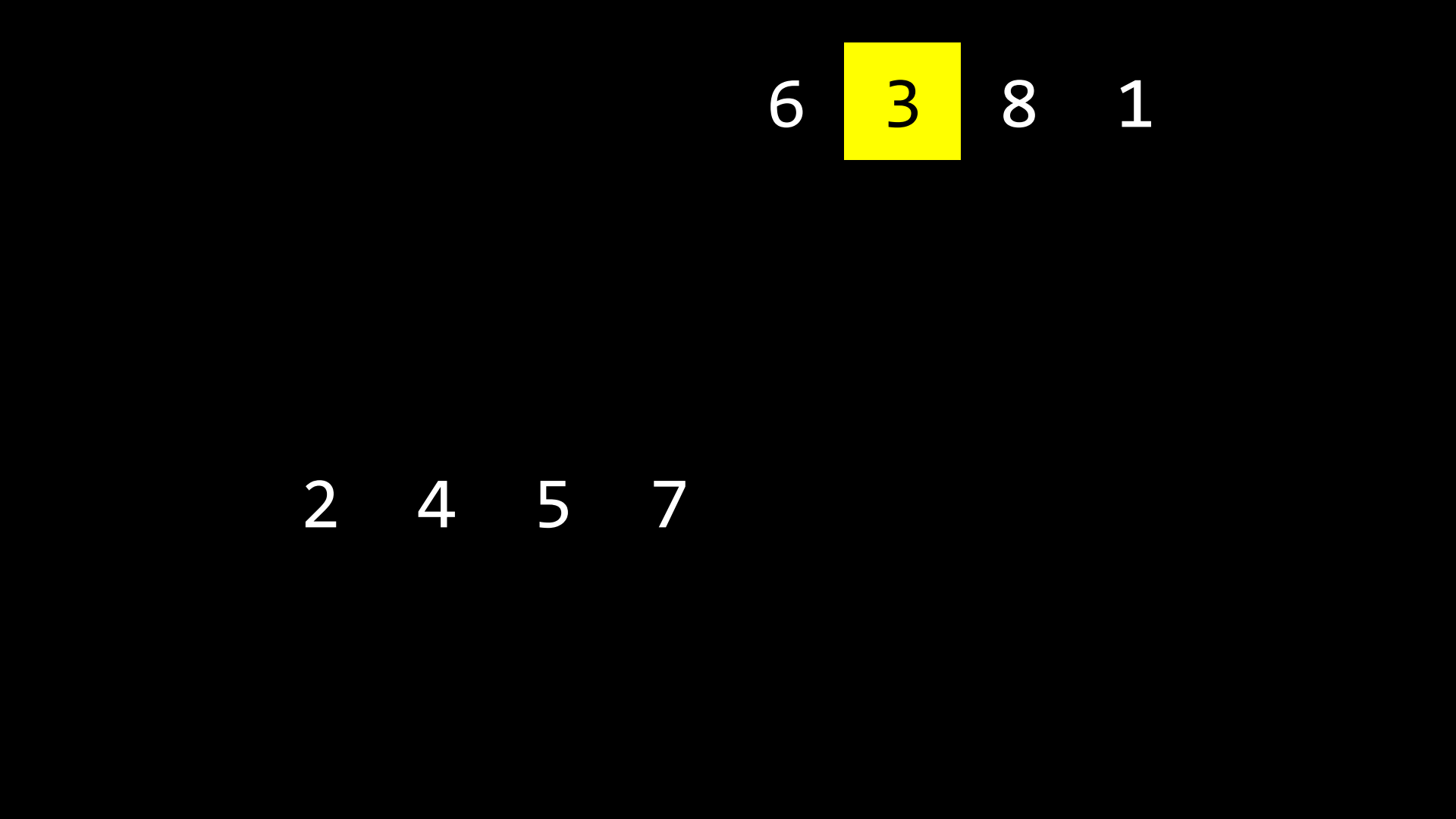
6 3 8 1

2 4 5 7

6 3 8 1

2 4 5 7

2 4 5 7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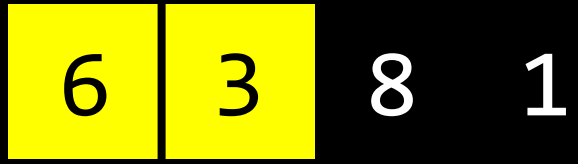
2 4 5 7



2 4 5 7

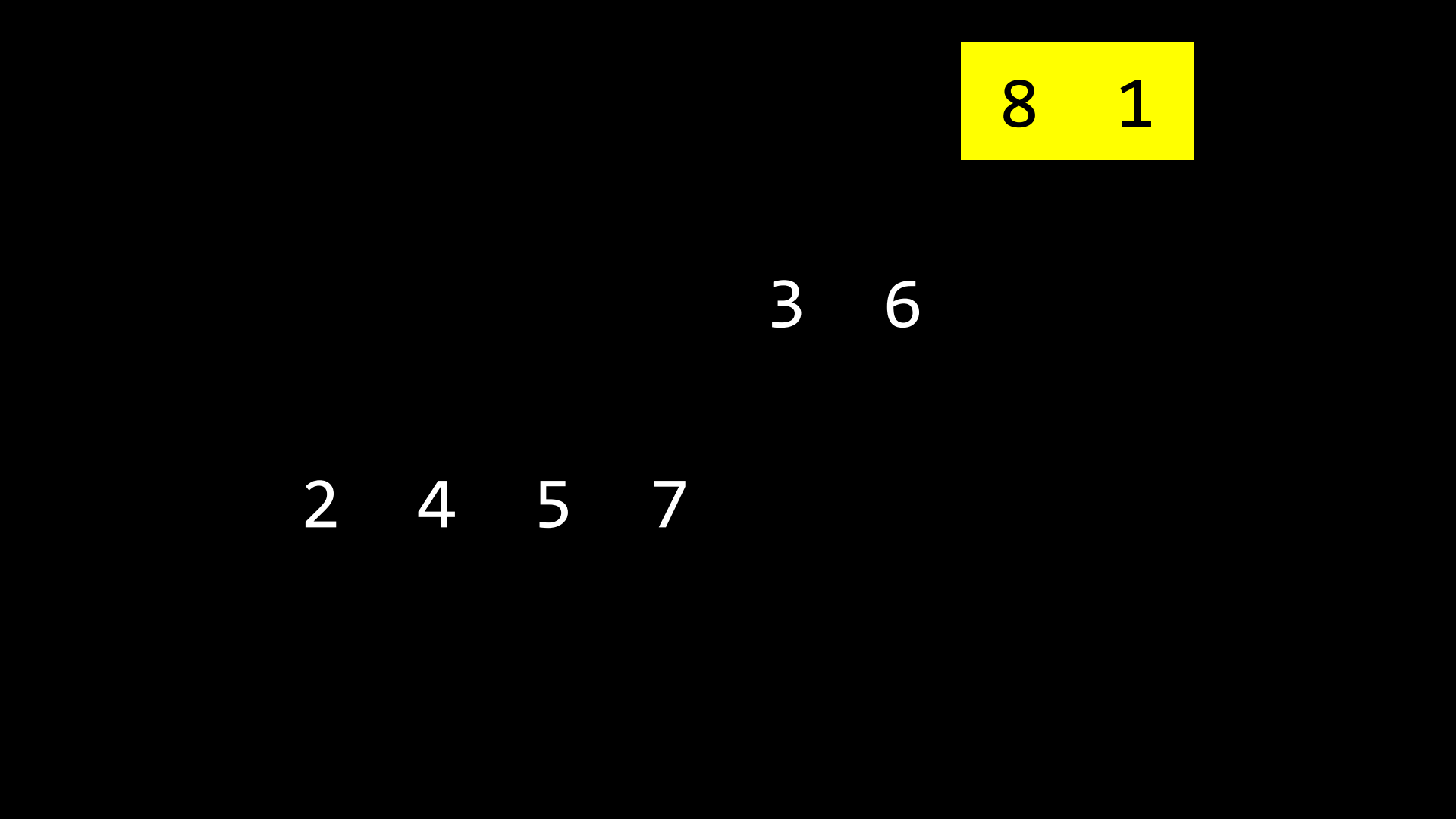
8 1

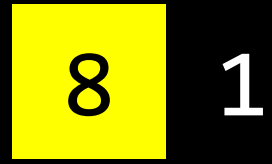
2 4 5 7

8 1

3 6

2 4 5 7

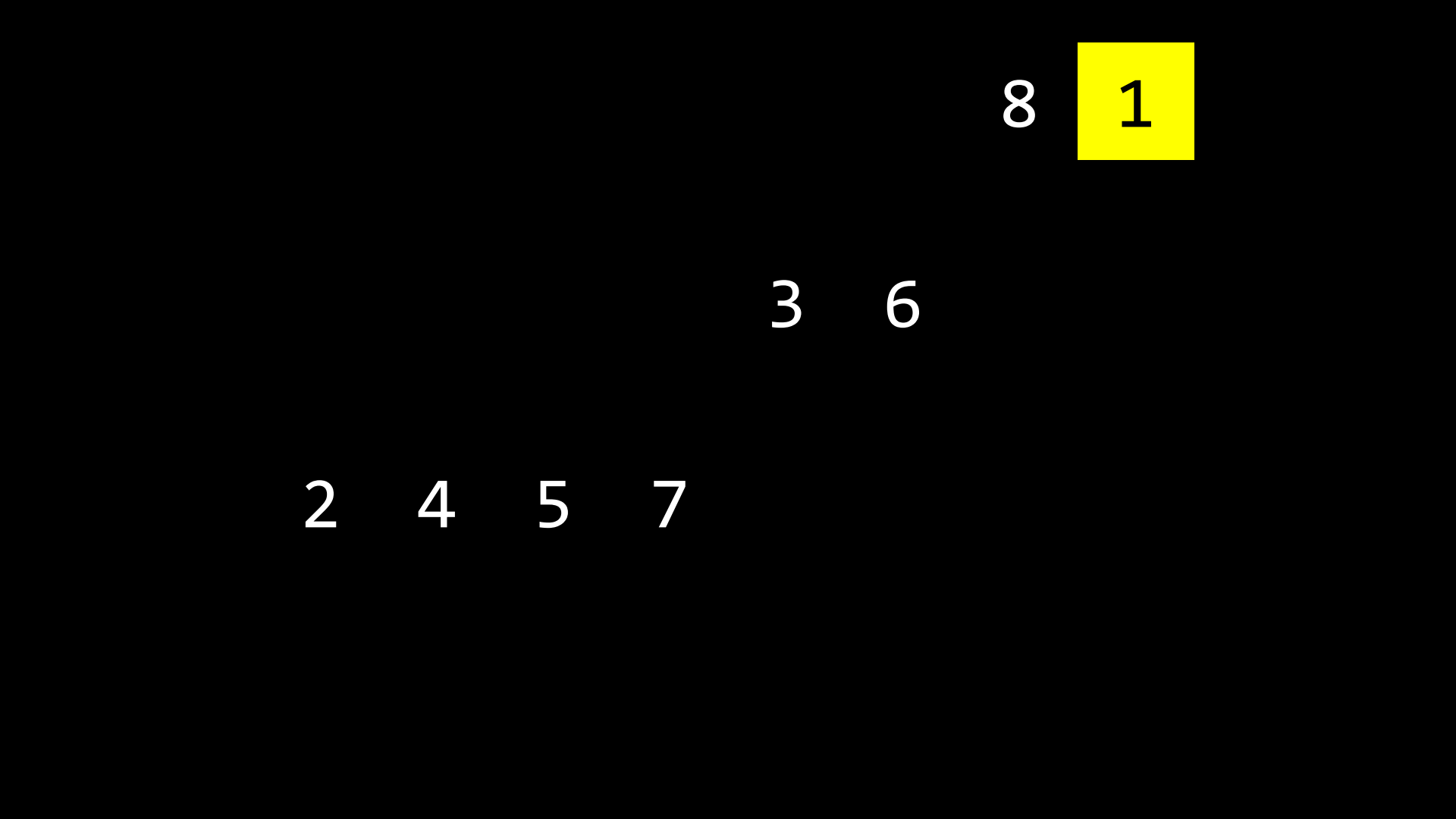

8 1
3 6
2 4 5 7



1

3 6

2 4 5 7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1
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6
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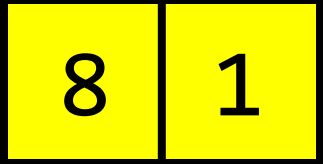

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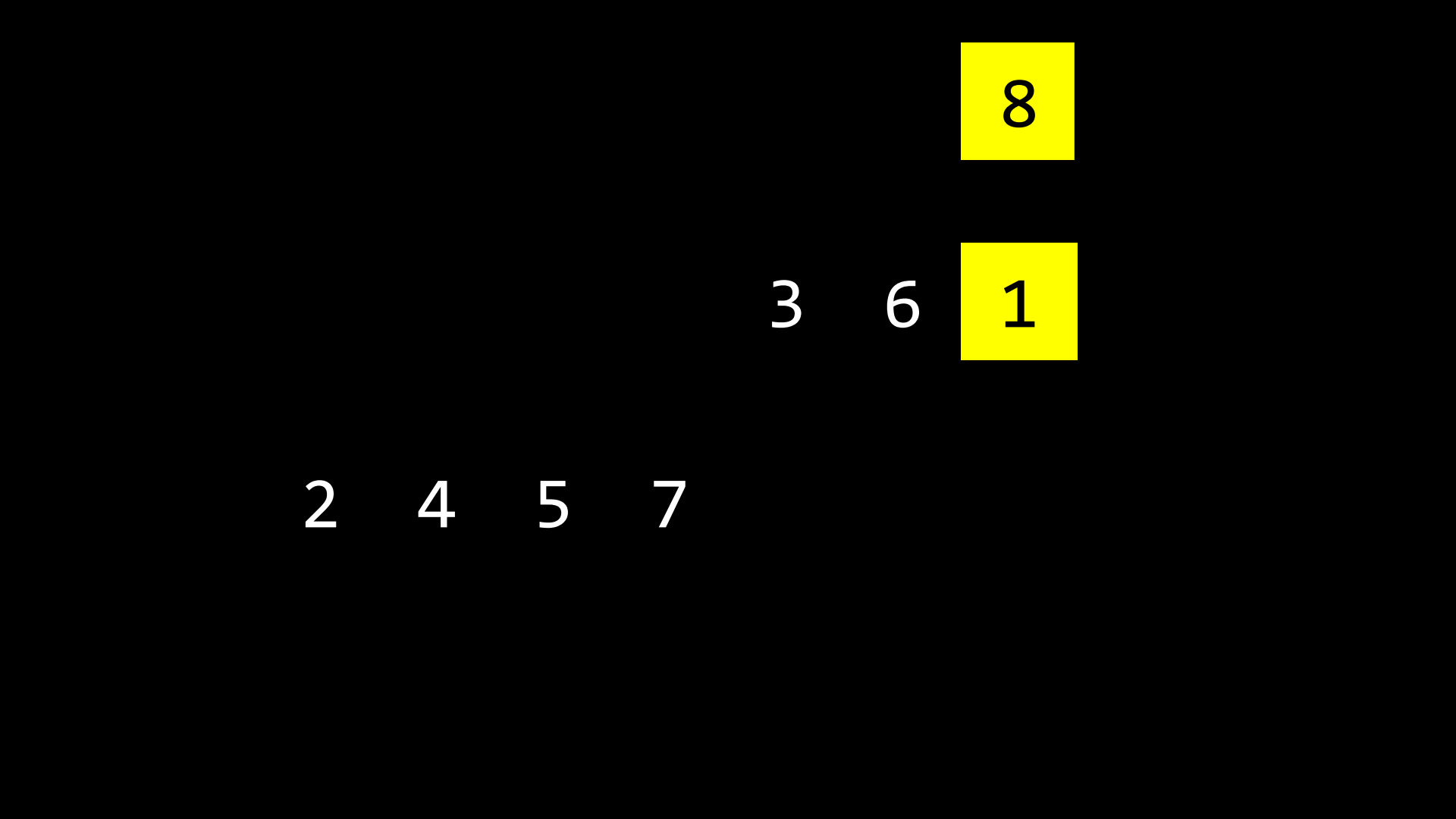
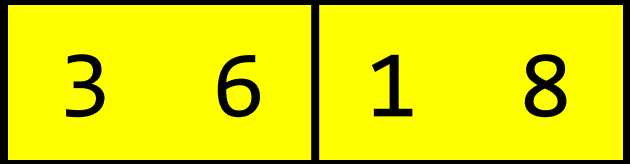
2 4 5 7


8
3 6 1
2 4 5 7

3 6 1 8

2 4 5 7



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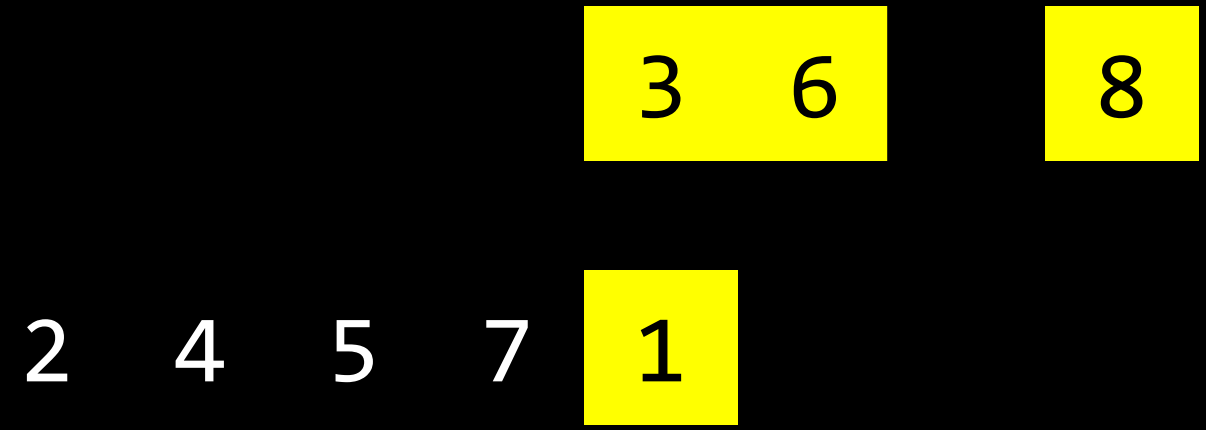
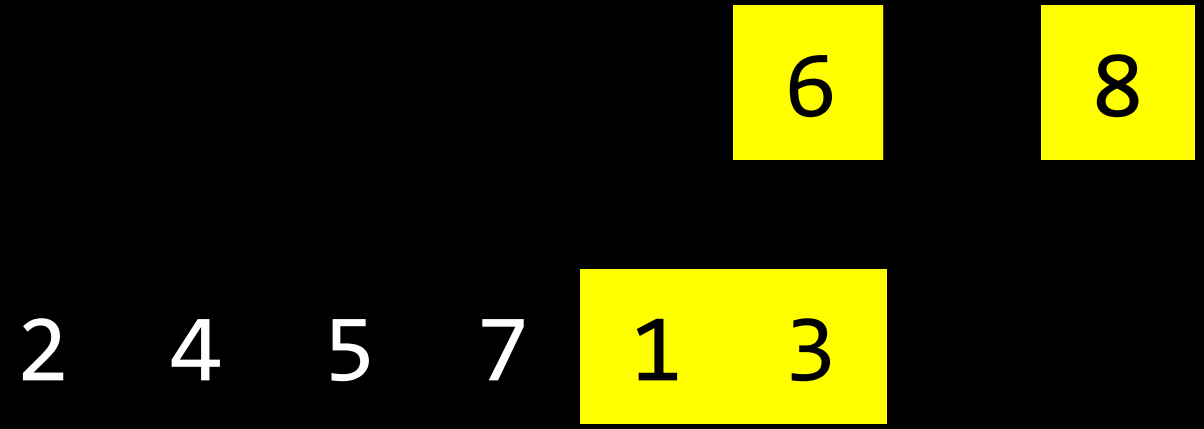
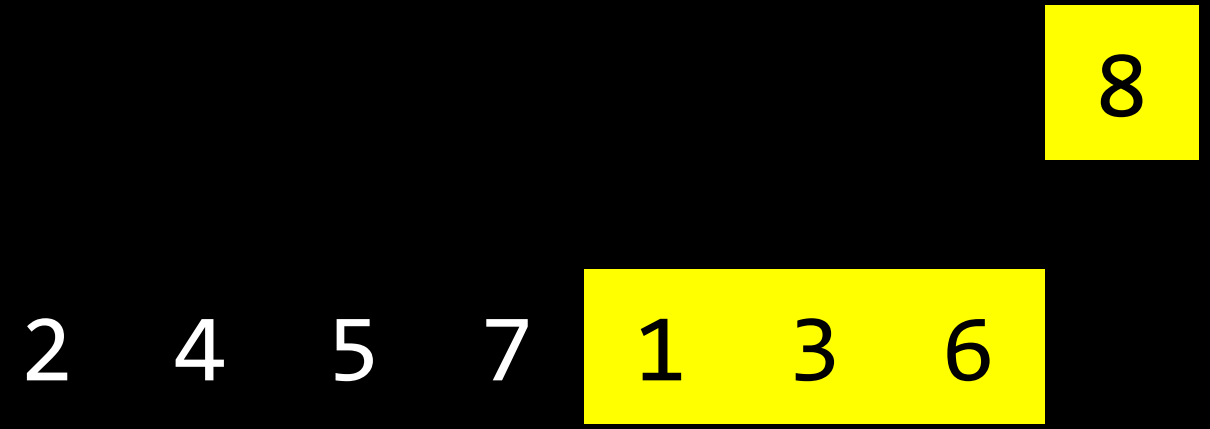
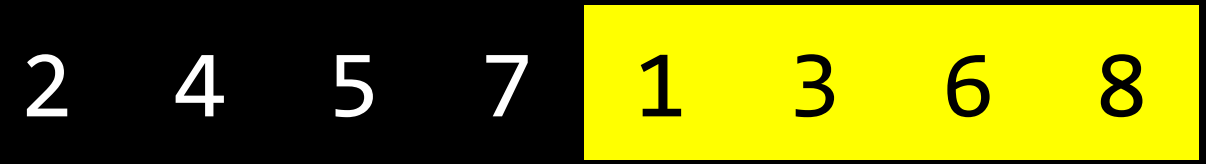
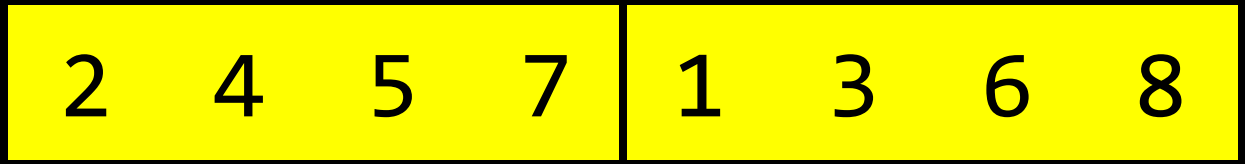

3 6
8
2 4 5 7
1


6
8
2
4
5
7
1
3


8
2 4 5 7 1 3 6


2 4 5 7 1 3 6 8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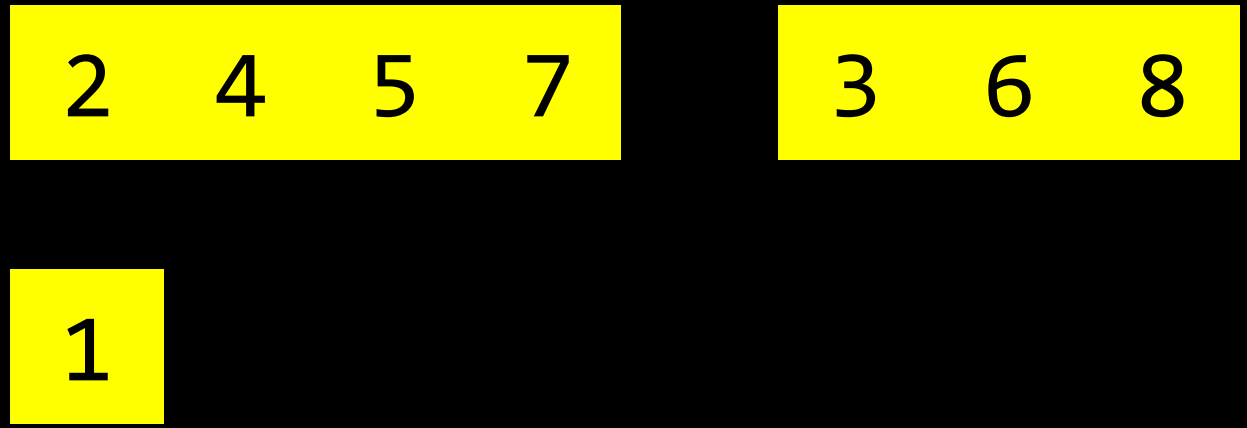
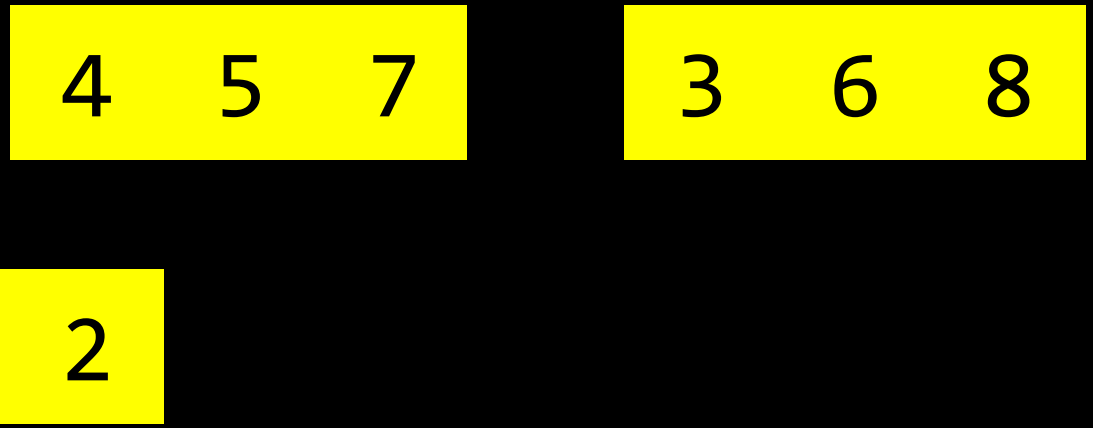
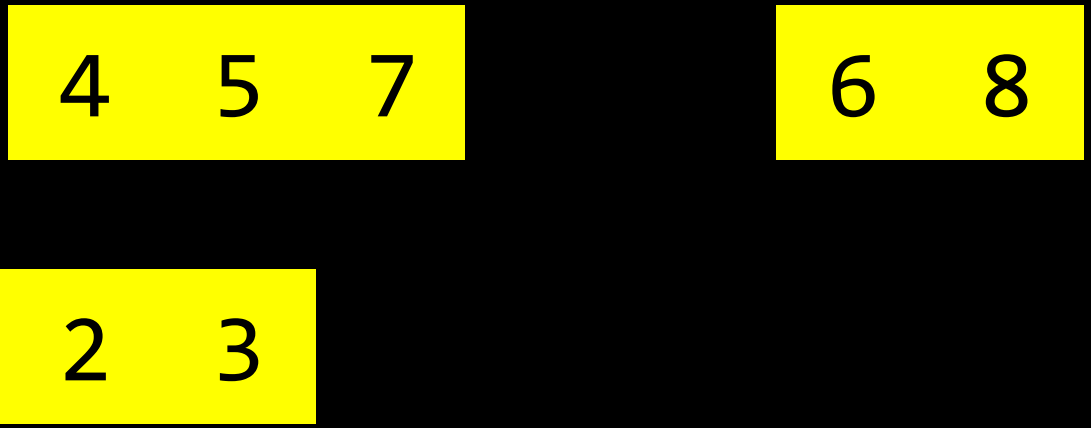
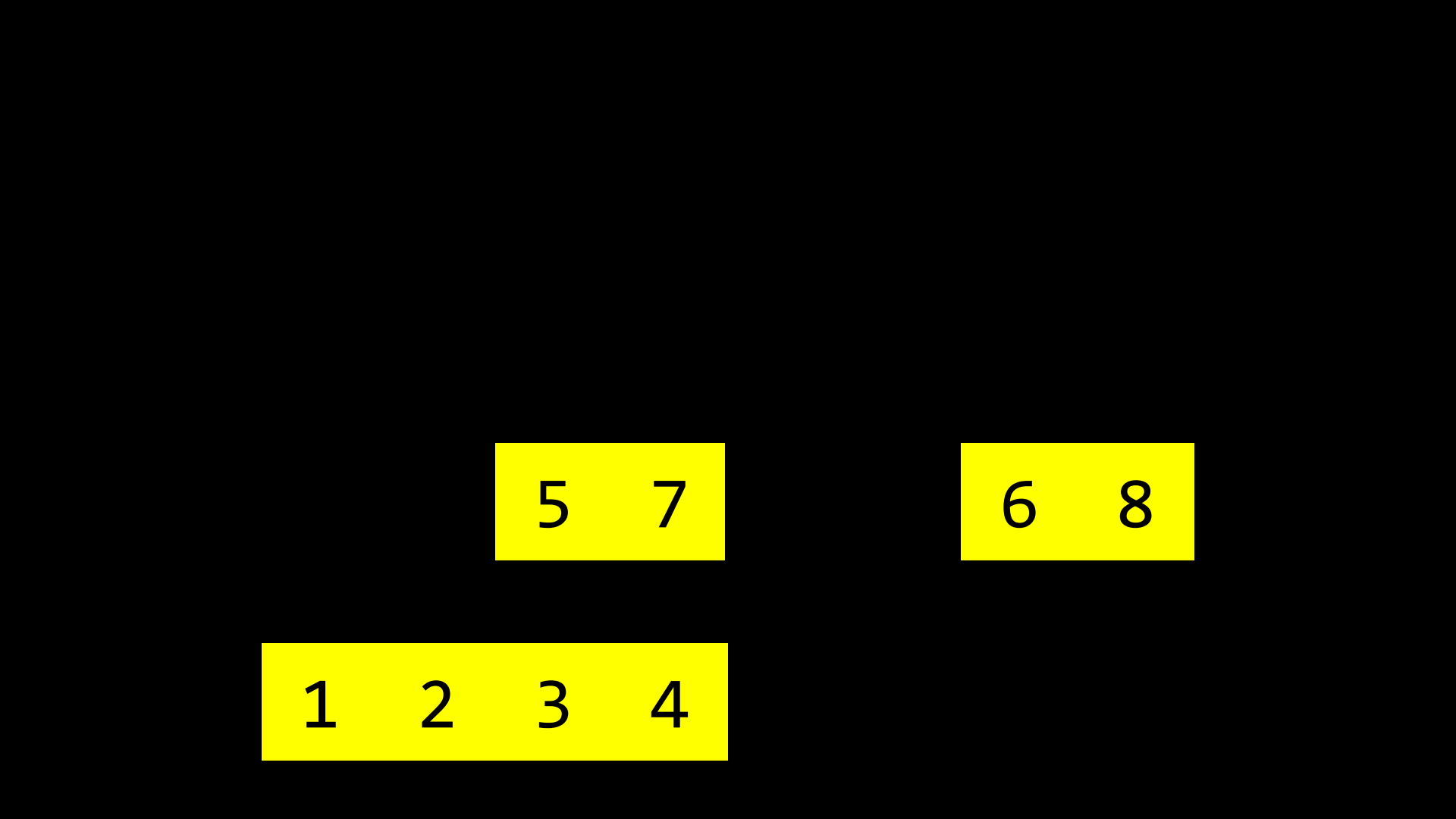
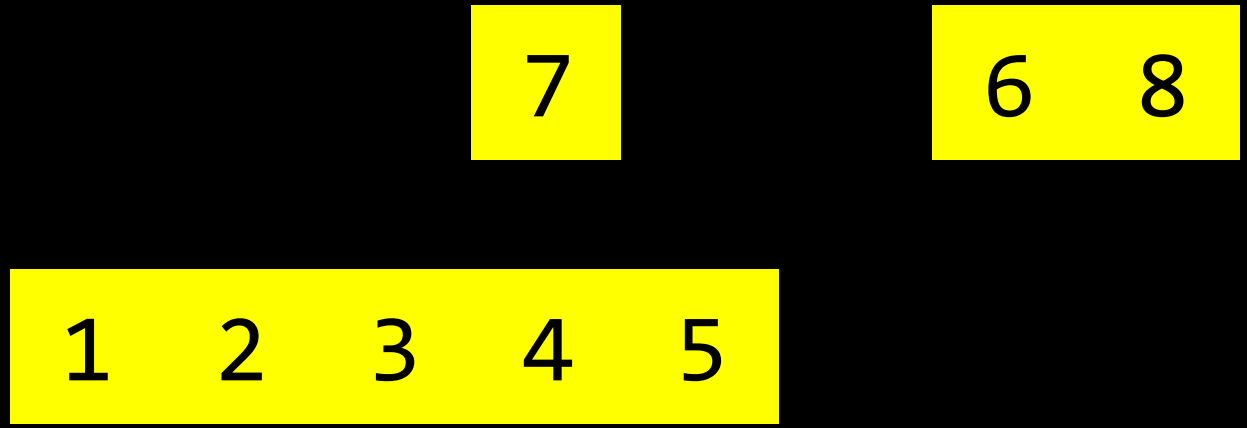
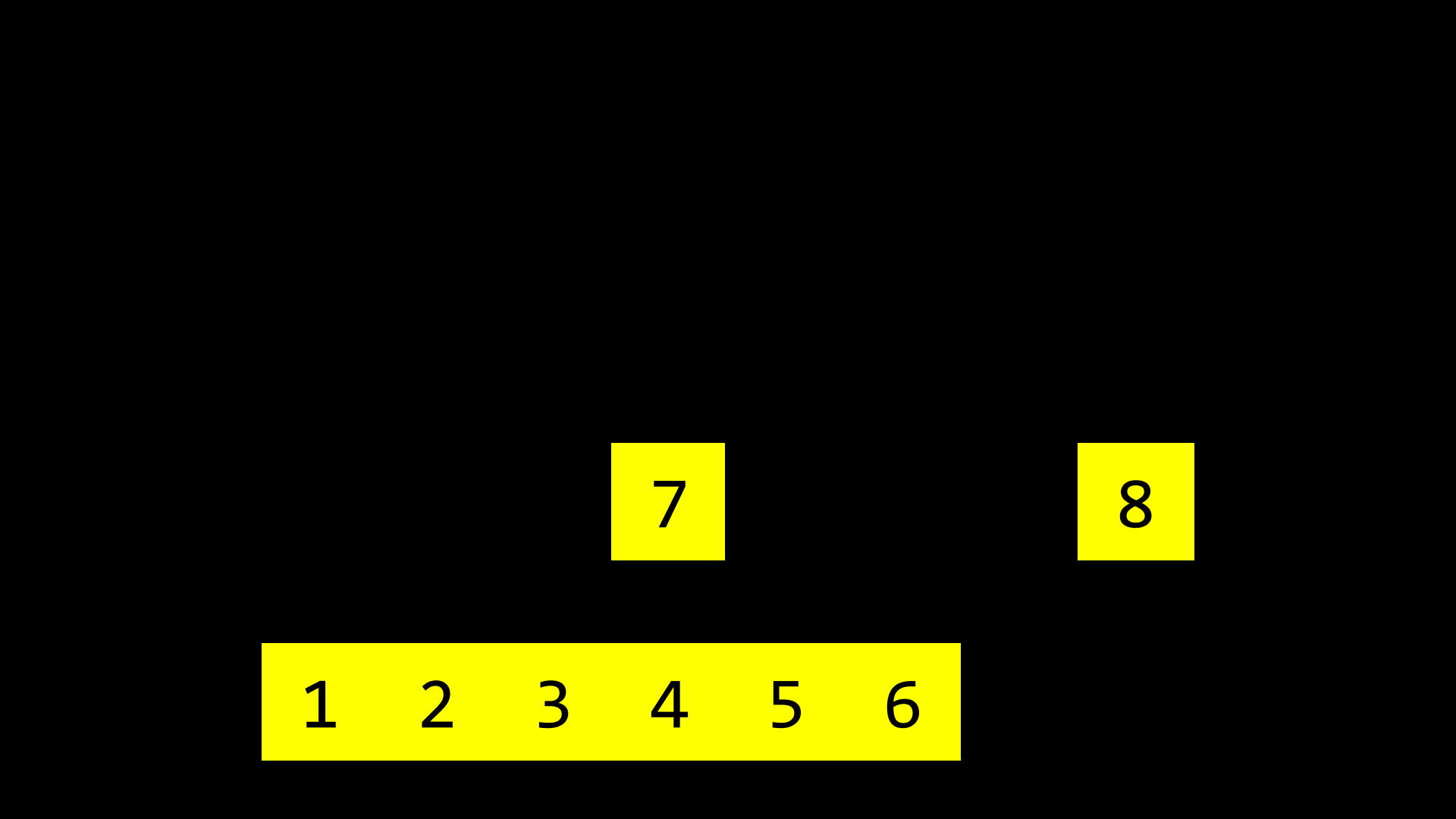

2 4 5 7
3 6 8
1


4 5 7
3 6 8
1 2


4 5 7
6 8
1 2 3


5 7
6 8
1 2 3 4

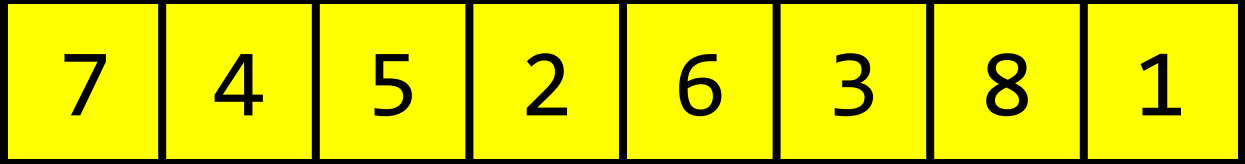

7
6 8
1 2 3 4 5

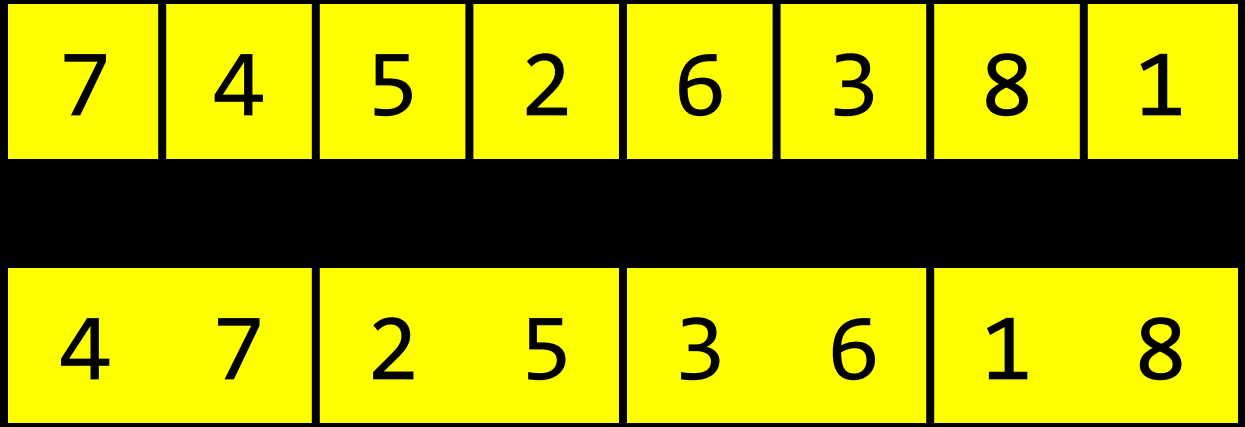

7
8
1 2 3 4 5 6

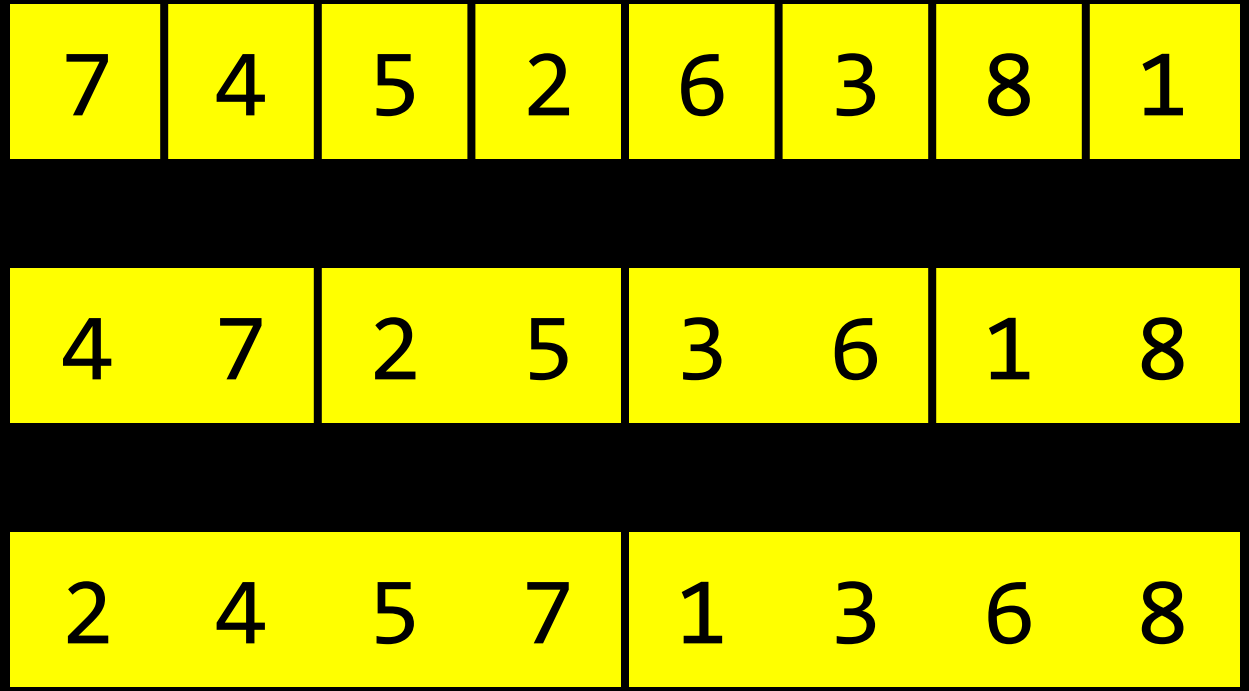
8

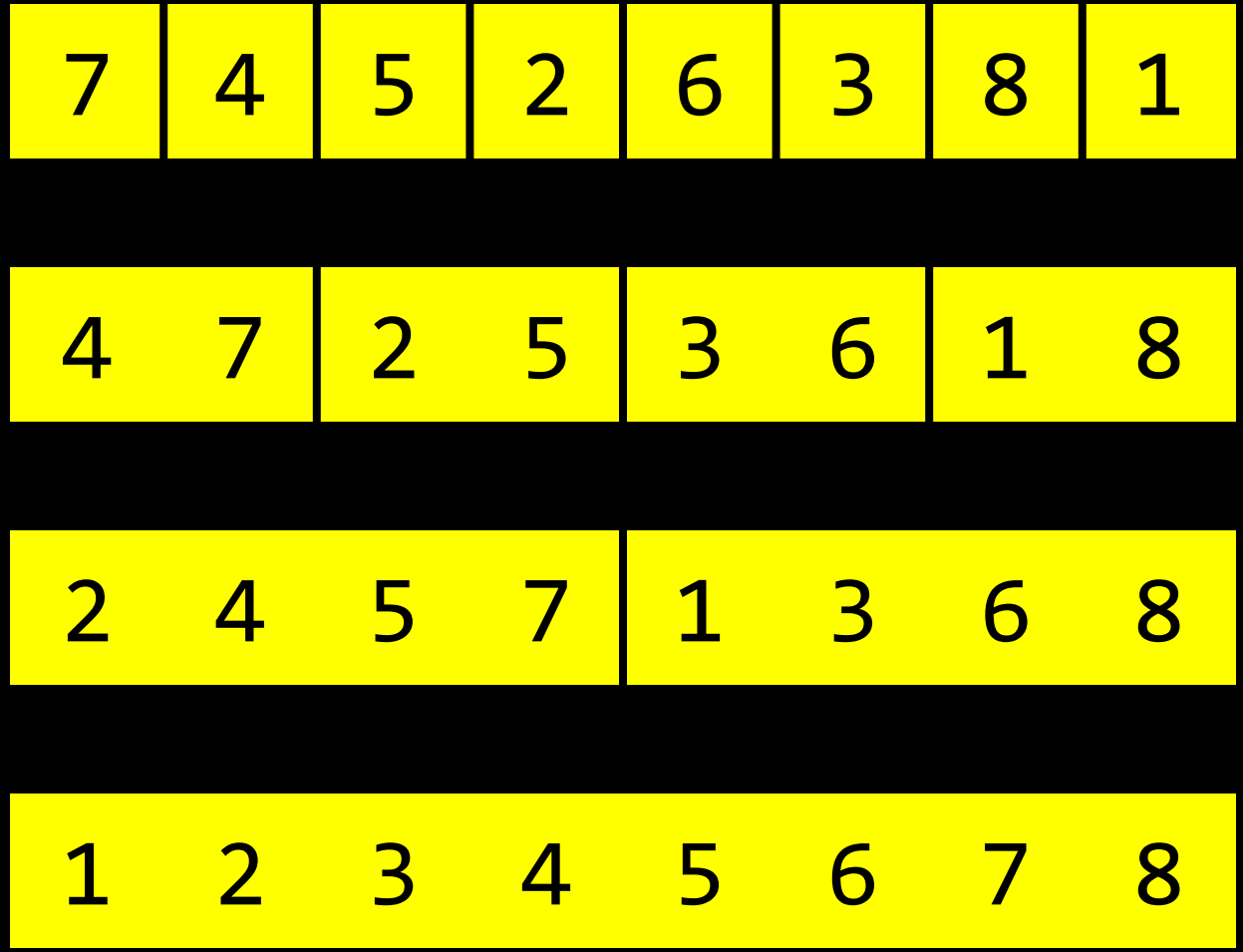
1 2 3 4 5 6 7

1 2 3 4 5 6 7 8


7
4
5
2
6
3
8
1


7 4 5 2 6 3 8 1
4 7 2 5 3 6 1 8


7 4 5 2 6 3 8 1
4 7 2 5 3 6 1 8
2 4 5 7 1 3 6 8


7 4 5 2 6 3 8 1
4 7 2 5 3 6 1 8
2 4 5 7 1 3 6 8
1 2 3 4 5 6 7 8

$O(n^2)$

$O(n \log n)$ merge sort

$O(n)$

$O(\log n)$

$O(1)$

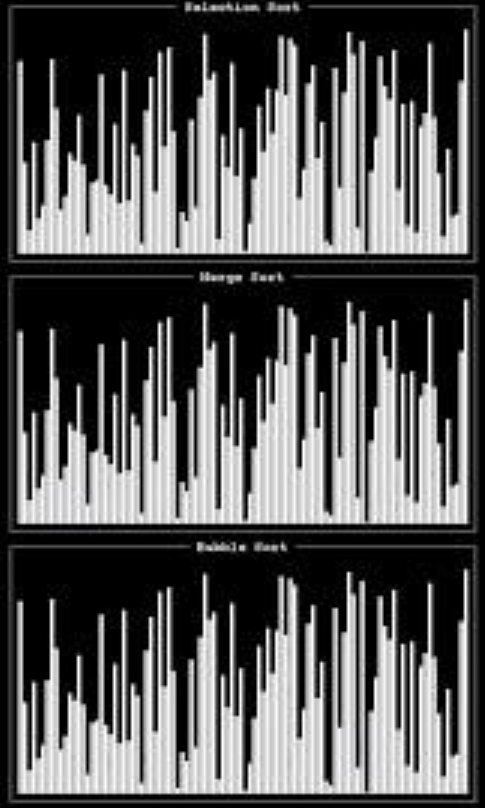
$\Omega(n^2)$

$\Omega(n \log n)$ merge sort

$\Omega(n)$

$\Omega(\log n)$

$\Omega(1)$



Assignment 1

Office Hours

CS50 for MBAs

Algorithms