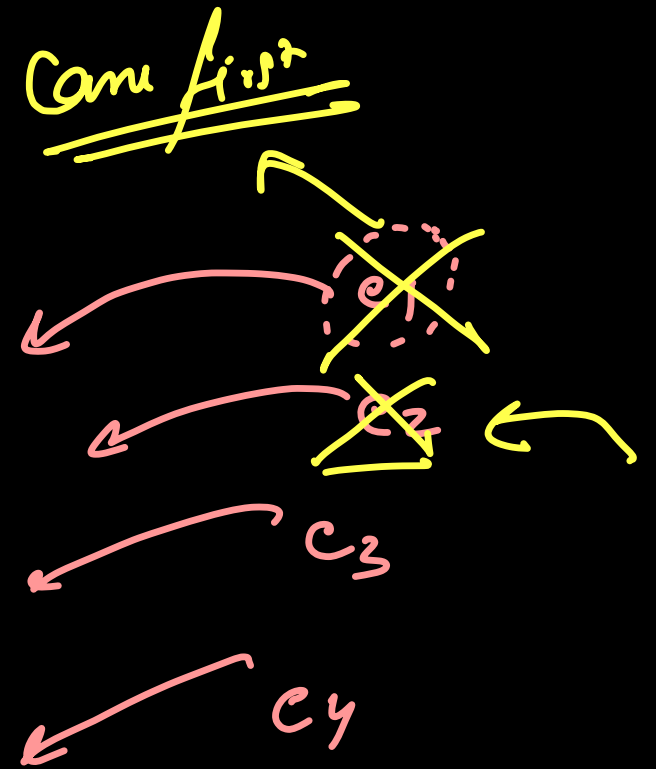
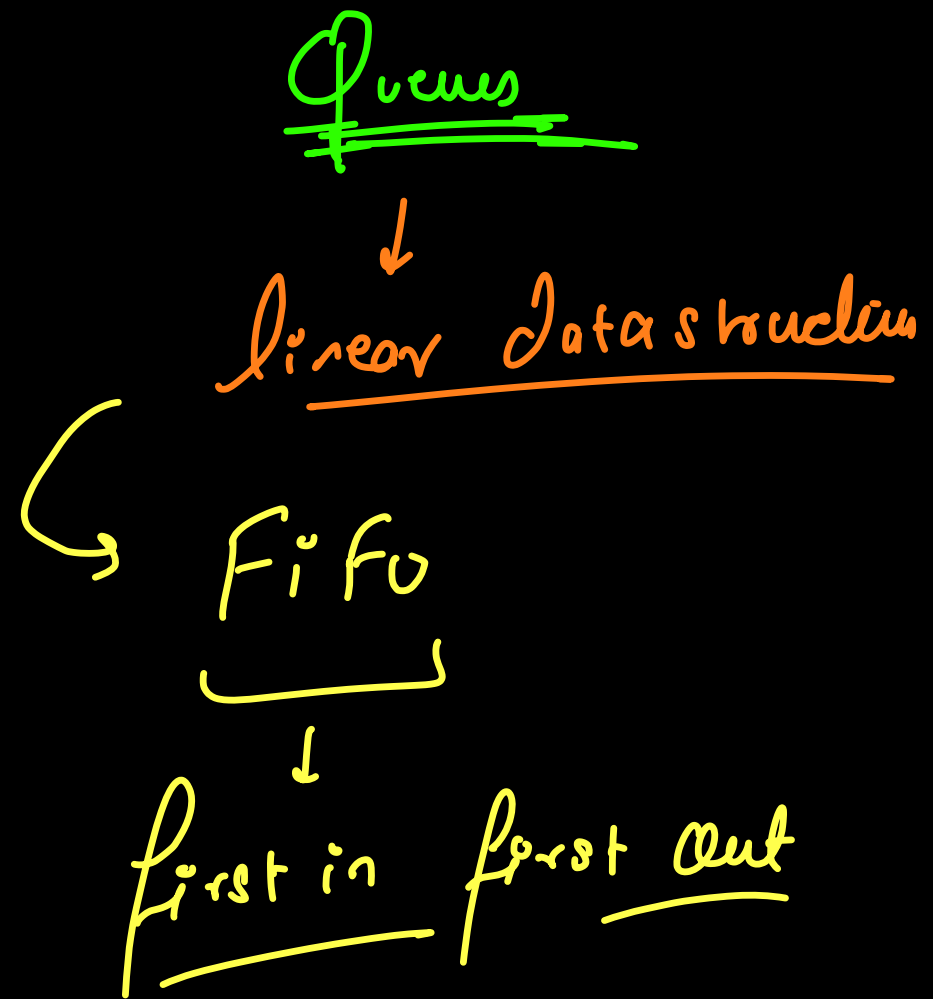


queueing a linked  
queue



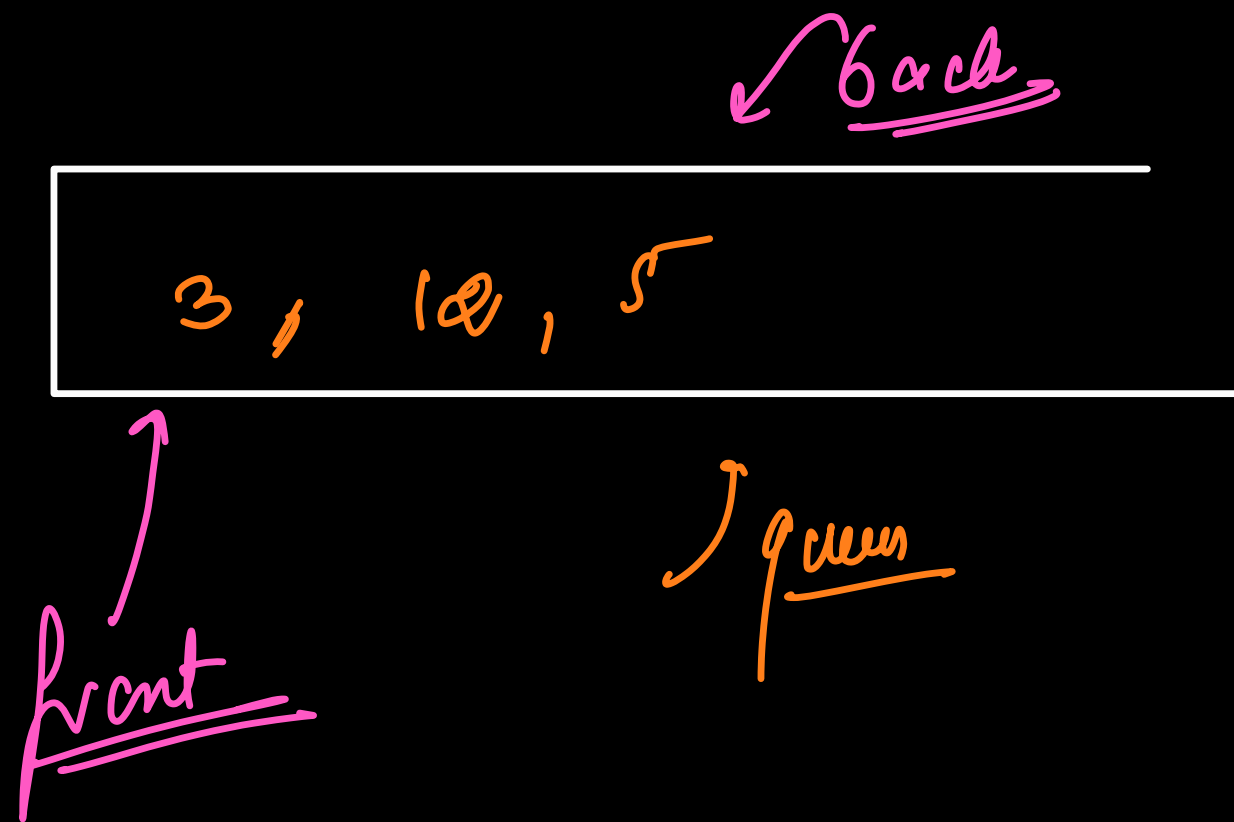
[  
↑

p<sub>1</sub> p<sub>2</sub> p<sub>3</sub>

Stack → push  
→ pop

Queue → enqueue → insertion  
→ dequeue  
→ remove

10



enqueue(10)  
enqueue(3)  
enqueue(12)  
enqueue(5)  
dequeue()

## # Application of queue in CS.

↳ Javascript like lang → microtask queue, callback queue ----

↳ queue are used in backend for message brokers.

↳ lot of OS related algo

message queue

enqueue  
↓  
done on the  
back of the  
queue

dequeue  
↓  
done on the front

front()

↓  
get the front  
elem

is Empty

front

back/rear

20		30		40		50
----	--	----	--	----	--	----

40      50

10

queue using arrays X



arr.push(-)

$\downarrow$   
 $O(1)$

remove front  $\rightarrow$  add  $A+1$

$O(n)$

1. head

mid of queue

2



3



4



6



10

tail



pop back

remove A+tail

enqueue(i)

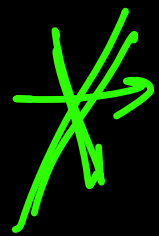
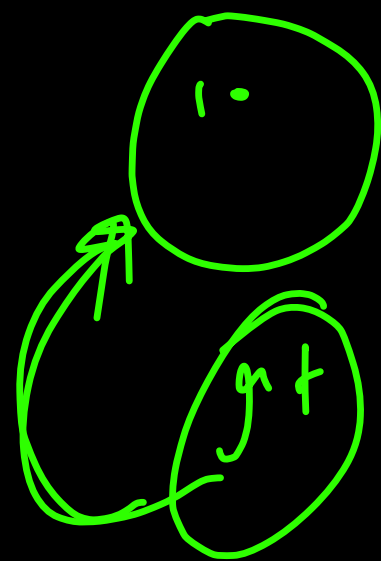
add At tail

$O(1)$

dequeue  $\rightarrow$

remove A+head

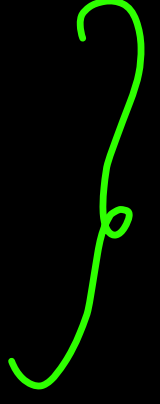
$O(1)$



2 h

null

new head = h.next  
h.next = null  
h = new head



Queue using arrays

↳ peek back →

pop back

peek front

pop front

peek Middle

pop middle

peek

pop

unshift

shift

→ splice()

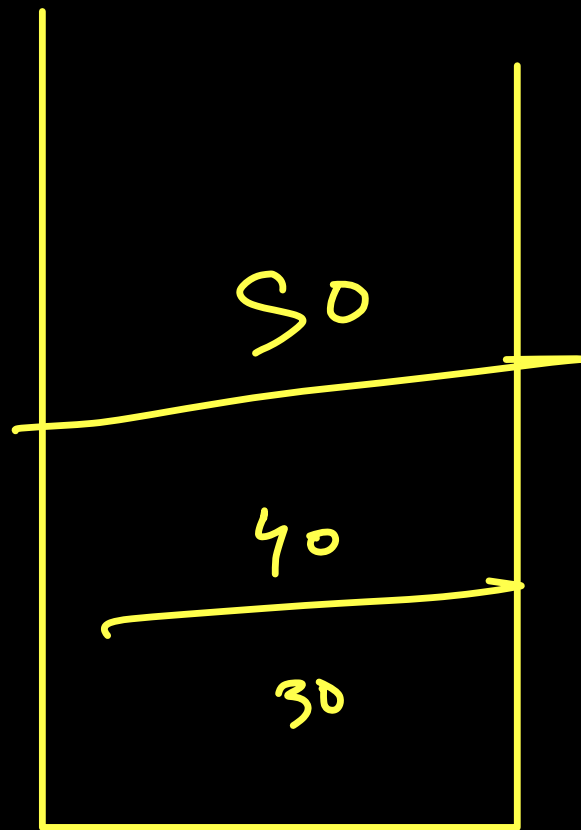
91

92

//

queue  $\rightarrow$  fifo  $\swarrow$

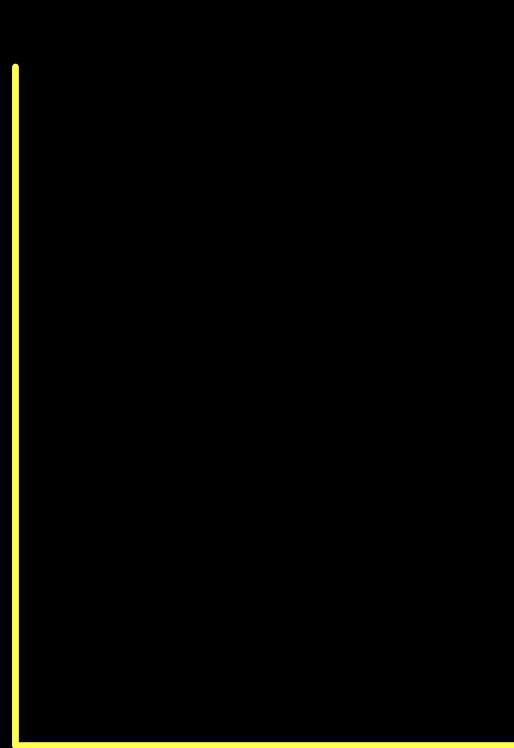
lifo



S<sub>1</sub>

primary

lifo



S<sub>2</sub>

secondary

data

enqueue(10)  $\leftarrow$  O(1)  
20  
30  
40

dequeue  $\rightarrow$

enqueue(50)

dequeue  $\rightarrow$

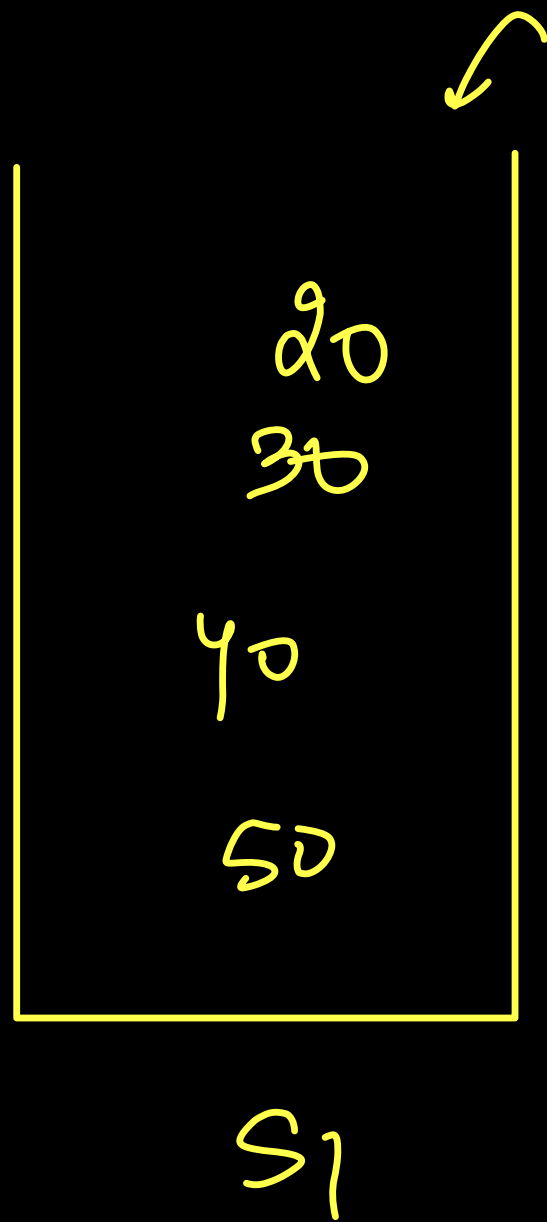
$\rightarrow$  O(n)



Queue using Stack

↓  
insert → effect  
del → in effect

del → effect  
insert → in effect



engw  $\rightarrow O(n)$   
10, 20, 30, 40  
↑ ↑ ↑

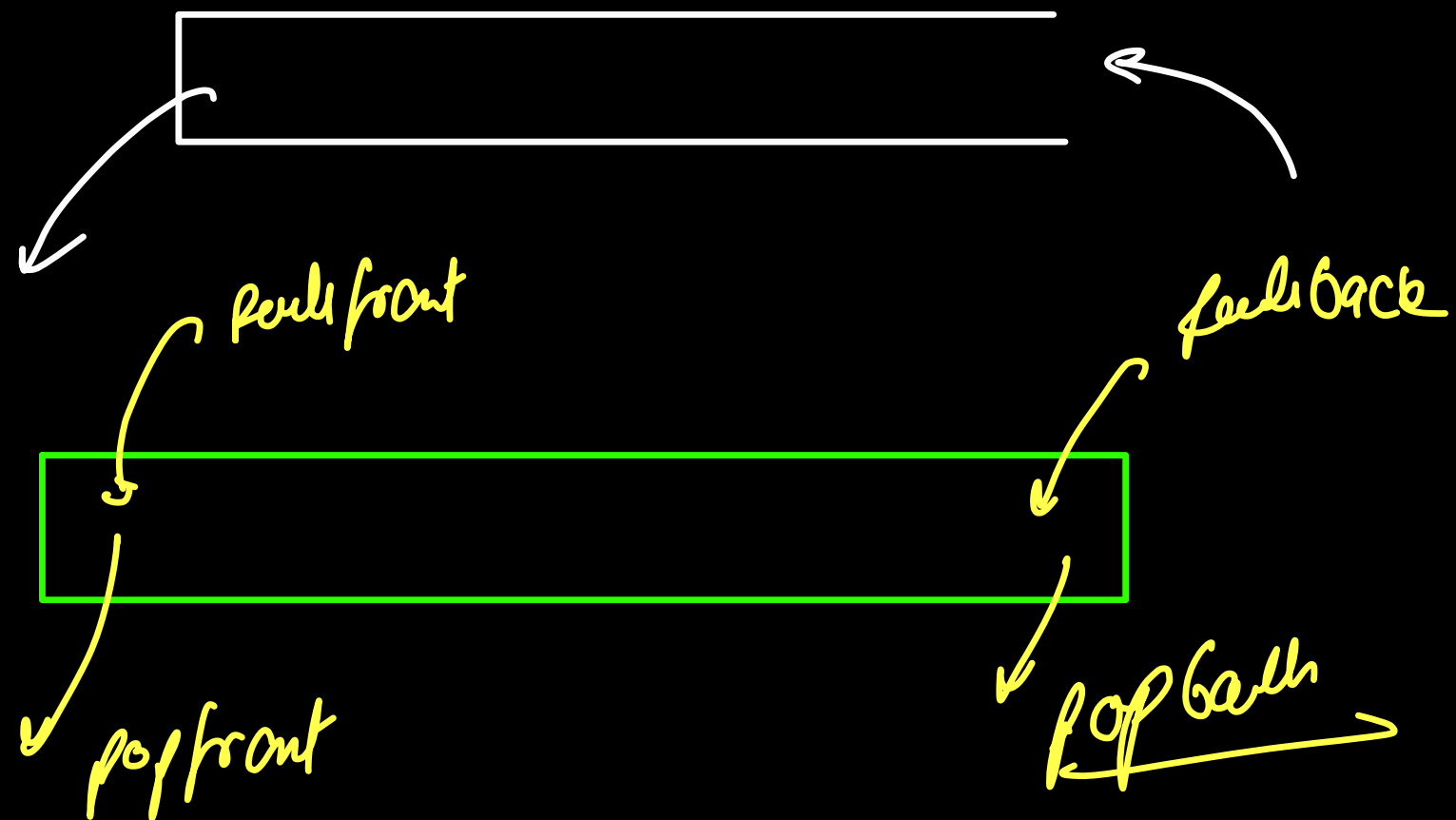
space  $\rightarrow O(1)$

→ linear queue

→ deque. → double ended queue

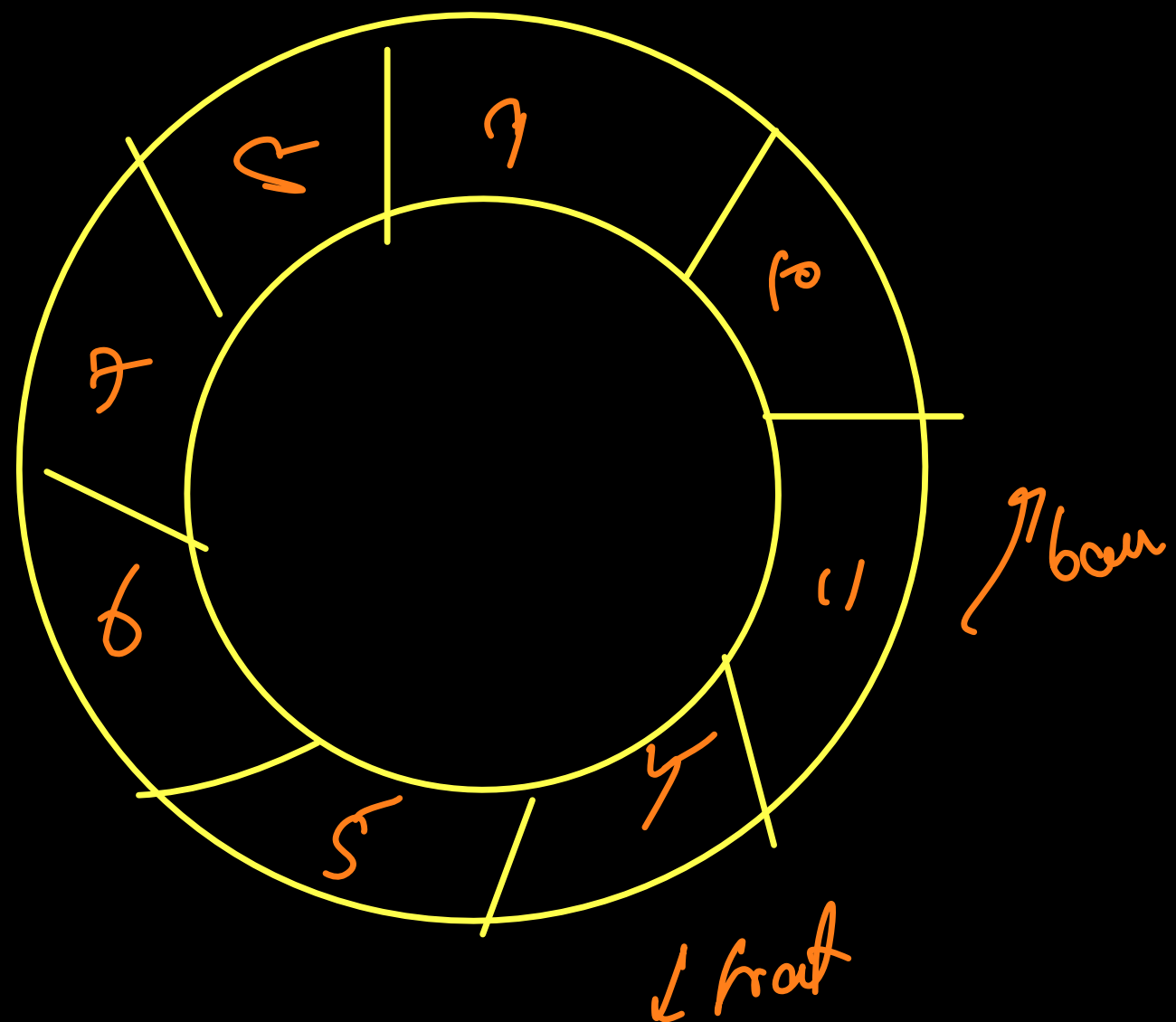
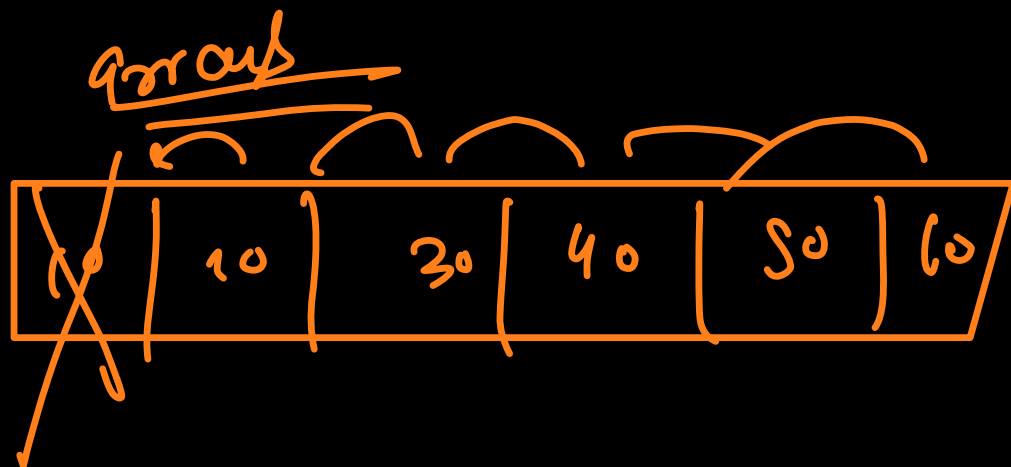
ll

push front → add At head  
pop front → remove from head  
push back → add At Tail  
pop back → remove At Tail



O(1)

# Circular queue



$$k = 7$$

$$\text{back} \rightarrow 12$$

0	1	2	3	4	5	6
12	13	7	8	9	10	11

front

back

$$\text{back} = (\text{back} + 1) \% k$$

$$\text{front} = (\text{front} + 1) \% k$$

enqueue(s)

↓  
6  
7  
8  
9

deque

dequeue

10, 11, 12, 13