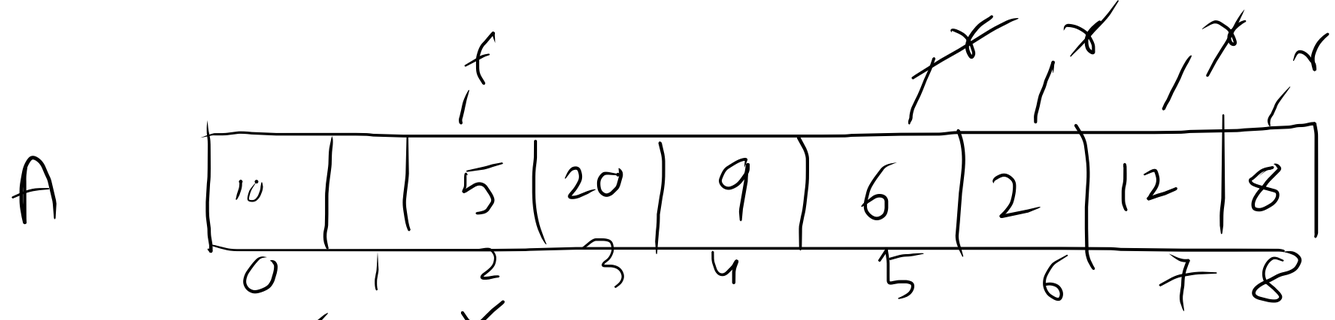


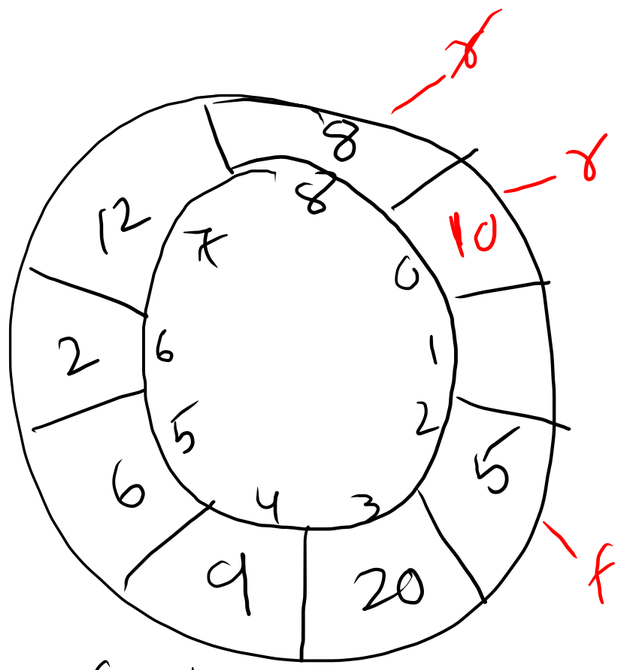
2 12 8 10

front (A)
    return front

IsFull (A)
  if front == rear
      return true
  else return false

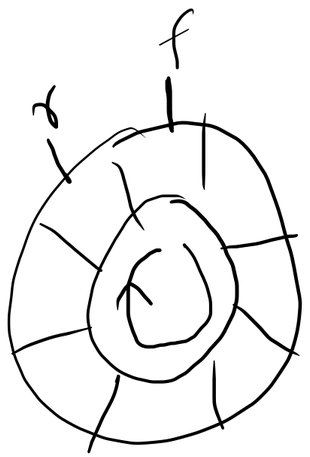
O(1)

n : length of the array.



IsFull (A)
  if rear+1 %n == front
      return true
  else return false

O(1)



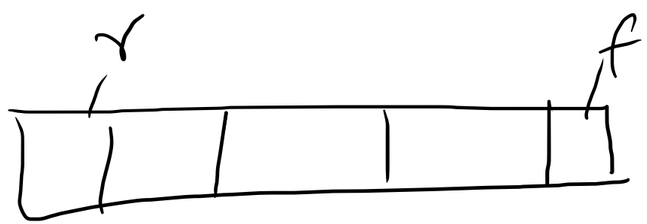
```
Isempty (A)
    if  rear == -1  and  front == -1
          return  true
    else
          return false.
```

```
Enqueue ( A, K)
 If  isfull (A)
        enqueue not possible
else
      if  isempty (A)
            rear = 0 , front = 0
            A [rear] = K
      else
            rear = (rear + 1) mod n
            A [rear] = K
```

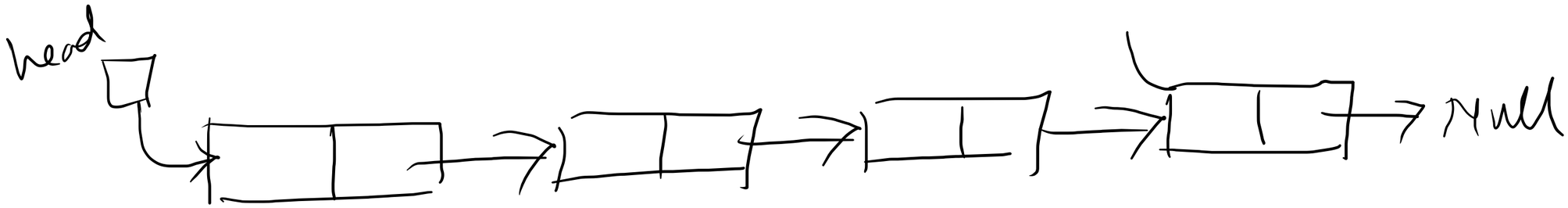
$\theta(1)$

```
Dequeue (A)
  if  isempty (A)
        dequeue not possible
  else
      if front == rear
          front = -1
          rear = -1
      else
          front = (front + 1) mod n
```

$\theta(1)$



Linked-List based implementation



Enqueue: Insert at the begining. || delete at begining

Dequeue: Delete at the end. || insert at the end.

using tail pointer: O(1)

Hash table

Dictionary ← It is an ADT

Three main operations:

It maintains (goal to maintain) a **set** of items with a key value.

- Insert(item) : add the item into the Set.
- Delete(item) : remove an item from the set.
- Search(item) : return the item with given key, if it exists otherwise report item not exist.

(optionally performed)

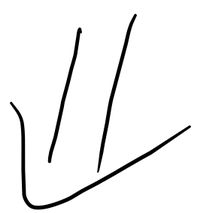
using a BST
- insert
- ~~delete~~
- search
- interact-search
  - predecessor — largest key less than the key
  - successor — smallest key greater than the key.

Height-balanced BST (AVL, Red-black)

n: total # nodes.

Dictionary operations can be performed in $O(\log n)$ time.

Objective: all Dictionary operations can be performed in $\theta(1)$ time.



Hash table.

Hash table: ← an array

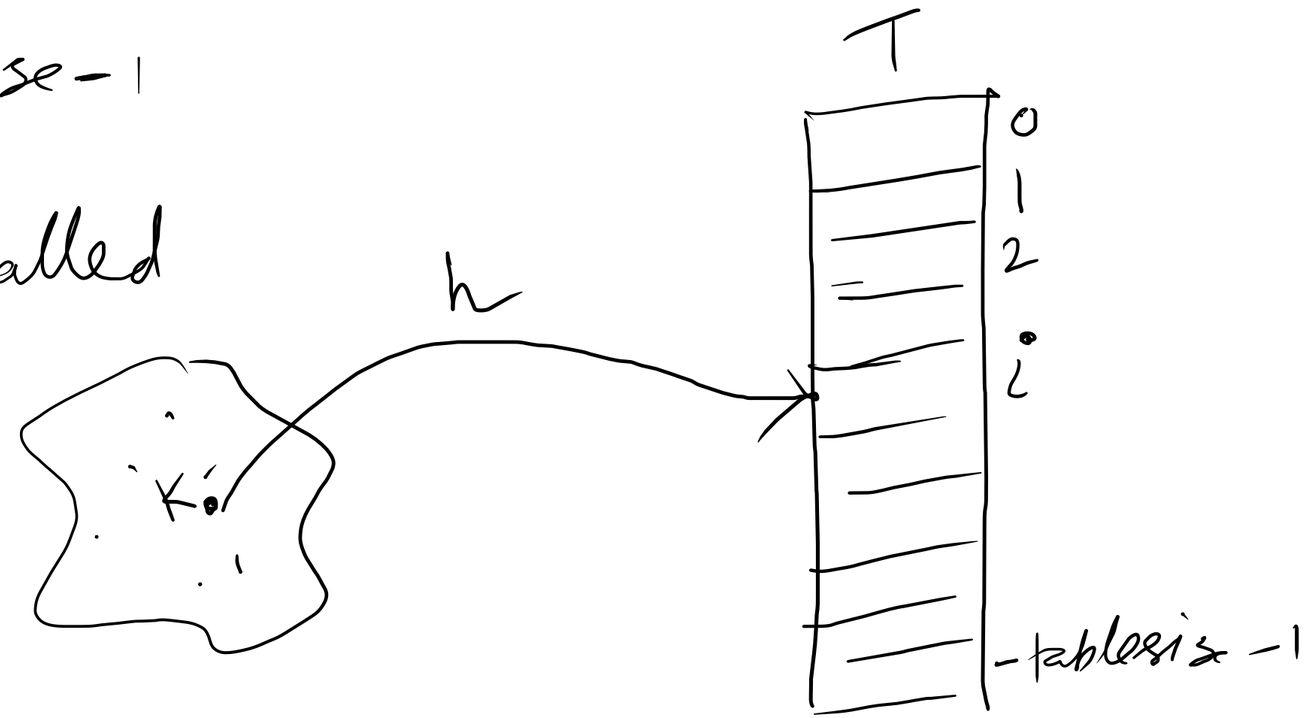
- It supports to implement
  insert, delete, search

- The implementation of hash table is called hashing.

- The hash table is an array of some fixed size and it contains the items along with the keys.
- A search is performed based on the keys.
- Each key is mapped into some position in the range 0 — tablesize-1
- This mapping is called hash function.

$$h(K) = i$$

$$h : S \longrightarrow \{0, \ldots, \text{tablesize}-1\}$$



Direct addressing: