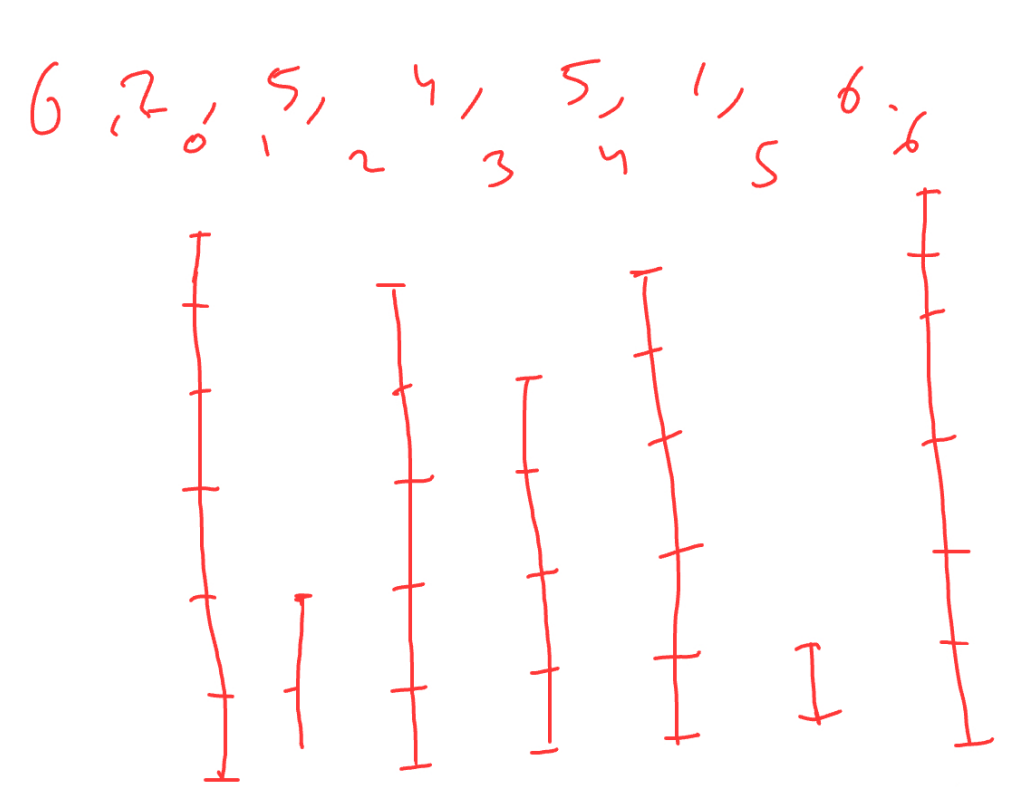
6, 2, 5, 4, 5, 1, 6
0 1 2 3 4 5 6

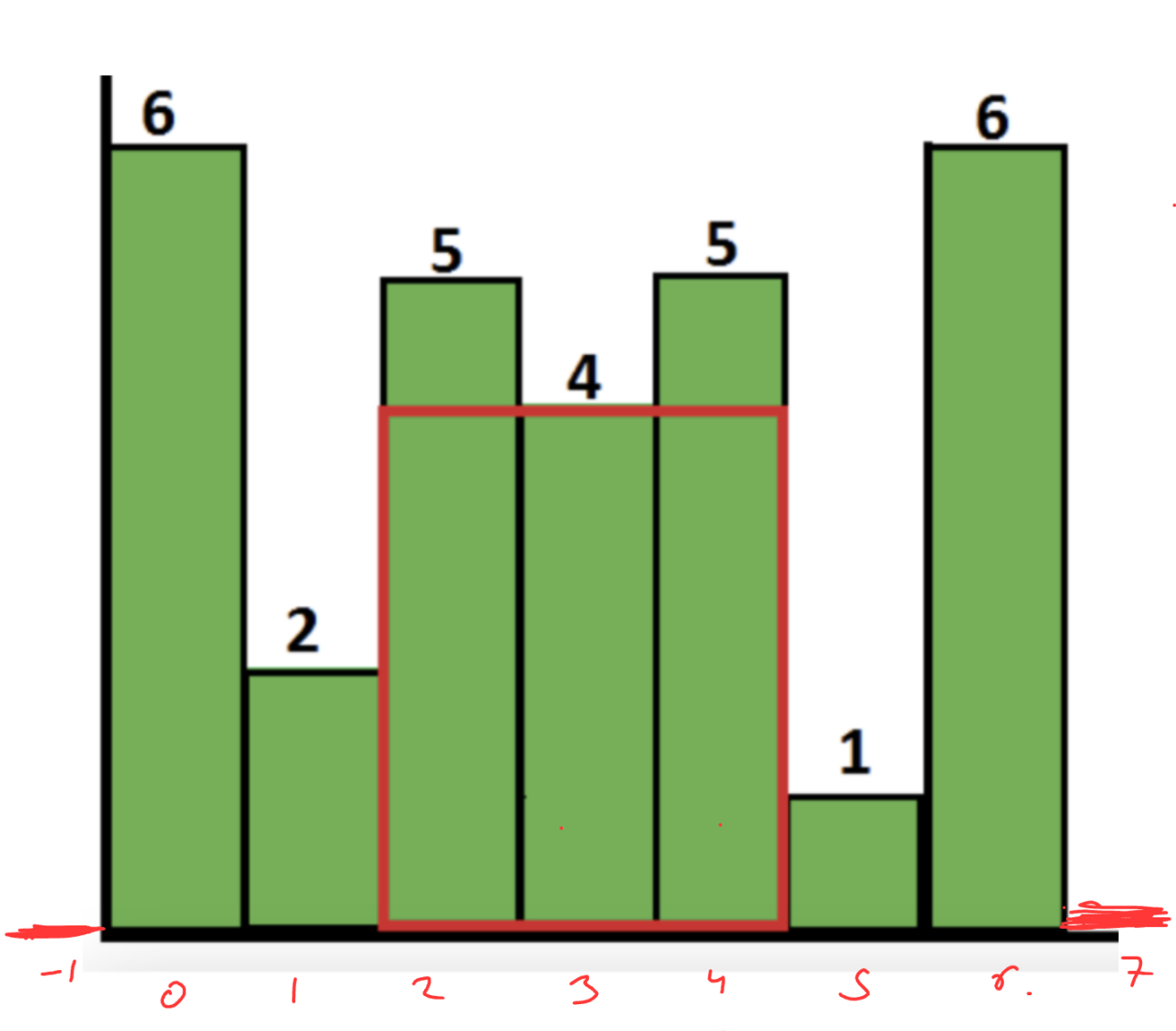


6 2 5 4 5 1 6
(1×6) (5×2) (1×5) (3×4) (1×5) (7×1) (1×6)
= 6 10 5 $\boxed{12}$ 5 7 6

[i: 0 → n−1
[j: i−1 → 0
j: i+1 → n−1

TC: $O(n^2)$ ⇐
AS: $O(1)$.

PSE.
NSE
~~NGE~~.



→ PSE: −1 −1 1 1 3 −1 5
NSE: 1 5 3 5 5 7 7

width = (5−1) −1 = 3
Ht = arr[1] = 4.
area = 3×4 = 12.

TC: $O(n)$
AS: $O(n)$

Queue

FIFO: First In First Out

→ | 1 | 2 | 3 | 4 | →

class Queue {
priv:
→ stack<int> s1, s2;
public:
push, ~~pop~~ pop, front, size, isEmpty ...
}

push(1) -
push(2)
push(3)
pop()
front() → 2
push(4)
pop()
front()
pop()
front()

s1: ~~2~~ ~~3~~ 2 3 ~~2~~ ~~1~~
s2: ~~2~~ ~~3~~ ~~4~~ ~~1~~ ~~3~~

push(): $O(1)$
pop(): $O(n)$
front(): $O(n)$.

s1: 1 2 3 ~~1~~ ~~2~~
s2: ~~2~~ ~~1~~

push(): $O(n)$.
pop(): $O(1)$
front(): $O(1)$

3
2
1
~~2~~ ~~3~~ ~~1~~ | 1 2 3

1, 2, 3.

head. tail.
size = ~~3~~ ~~4~~ 5
1 → 2 → 3 → NULL.

front
0 1 2 3 4
| 1 | 2 | 3 | 10 | 11 |

push(10) ←
push(11).
pop()
pop()
front() → 3

arr[size] ⟹ arr[size % 1000].

front
0 1 999
| 51 | 52 | | | 50 |

push(51).
push(52).

1001 % 1000
= 1

---

front
→
| ~~1~~, ~~2~~, ~~3~~, ~~4~~ | ⟹ front | 4, 3, 2, 1 |

~~4~~ ~~3~~ ~~2~~ ~~1~~ → front | 4, 3, 2, 1 |

TC: $O(n)$
AS: $O(n)$.

[ ] a = 4 | 4 | a = 3 | 4, 3 | a = 2 | 4, 3, 2 | a = 1 | 4, 3, 2, 1 |
[4] [3, 4] [2, 3, 4] [1, 2, 3, 1]

TC: $O(n)$
AS: $O(n)$.

~~0 – 0 0 0 0~~
1 – 1
2 – 1 0
→ 3 – 1 1
4 – 1 0 0
5 – 1 0 1
6 – 1 1 0
7 – 1 1 1
8 – 1 0 0 0
9 – 1 0 0 1
10 – 1 0 1 0
11 – 1 0 1 1
12 – 1 1 0 0
13 – 1 1 0 1
14 – 1 1 1 0
15 – 1 1 1 1

1, 10, 11, 100, 101, 110, 111....
⇓
Queue.

n = ~~10~~ 7

→ queue: ~~1~~, ~~10~~, ~~11~~, ~~100~~, ~~101~~, ~~110~~, ~~111~~, ~~1000~~, 1001, 1010, 1011, 1100, 1101, 1110, 1111, 10000, 10001

→ res: 1, 10, 11, 100, 101, 110, 111, 1000

TC: $O(n)$
AS:

front
res: 1, 10, 11, 100, 101, 110, 111

---

aabc

→ "a" : a
→ "aa" : #
→ "aab" : b
→ "aabc" : b

⟹ a#bb

bcbdcd

b → b
bc → b
bcb → c
bcbd → c
bcbdc → d
bcbdcd → #

⟹ bbccd#

freq.
a → 0
b → ~~1~~ 2
c → ~~0~~ ~~1~~ 2
d → ~~0~~ ~~1~~ 2

first Occ
a → −1
b → 0
c → 1
d → ~~3~~ 3

0 1 2 3 4 5
b c b d c d
b b c c d #

TC: $O(n)$
AS: $O(1)$

b c b d c ~~b~~d
b b c c d #

TC: $O(n^2)$
AS: $O(1)$

freq
a → 0
b → ~~1~~ ~~2~~ 2
c → ~~0~~ ~~1~~ 2
d → ~~0~~ ~~1~~ 2

s: b c b d c d
b b c c d #

freq:
a → 0
b → 2
c → ~~1~~ 2
d → ~~0~~ ~~1~~ 2

Queue.
~~b~~, ~~c~~, ~~d~~

TC: $O(n)$
AS: ~~$O(n)$~~.
$O(1)$.

abcde

---

0 1 2 3 4 5 6 7 8
[1, 2, 3, 1, 4, 5, 2, 3, 6]
K = 3, n = 9

[3, 3, 4, 5, 5, 5, 6]

[i: 0 → n−K]
[j: i → i+K−1]

TC: $O(n \cdot K)$
AS: $O(1)$.

≤ i − K

0 1 2 3 4 5 6 7 8
[1, 2, 3, 1, 4, 5, 2, 3, 1]
K = 3.

[3, 3, 4, 5, 5, 5, 3].

~~1~~ ~~2~~ ~~3~~, ~~1~~ ~~4~~ ~~5~~, ~~2~~ 3, 1

– Instead of values, store indices the data structure

Deque

Push / Pop → | | | | | ← Push / Pop.

push end
front
pop back
→ pop front