Hashing 2: Problems

Question 1

Given N elements, find the first non-repeating element.

$$a[6] = \{ 1 \quad 2 \quad 3 \quad 1 \quad 2 \quad 5 \}$$ ans = 3

$$a[8] = \{ 4 \quad 3 \quad 3 \quad 2 \quad 5 \quad 6 \quad 4 \quad 5 \}$$ ans = 2

Idea 1   (incorrect)

1. Insert all elements with frequency in Hashmap

2. Iterate over Hashmap to get first key with value = 1.

   Order of Insertion of keys is not maintained in Hashmap / Hashset. (unordered)

Idea 2

1. Insert all elements in Hashmap with freq.

2. Iterate over array & print first element with hm[a[i]] == 1

Code

```
hashmap <int, int> hm
for (i=0 to n-1) {
    if ( hm.search ( a[i]) == true) {
        hm [a[i]] ++
    }
    else {
        hm . insert ( a[i], 1)
    }
}

for (i=0 to n-1) {
    if ( hm [a[i]) == 1) {
        return a[i)
    }
}

return -1
```

TC = O(N)

SC = O(N)

Question 2

Given an array, check if there exists a pair (i, j)

s.t.

$$A(i) + A(j) = K \qquad \& \quad i \neq j$$

eg.

$$A = [\underset{0}{8} \quad \underset{1}{9} \quad \underset{2}{1} \quad \underset{3}{-2} \quad \underset{4}{5} \quad \underset{5}{4}]$$

$K = 7$

ans = true $(1, 3)$

$K = 10$

ans = true $(1, 2)$

$K = 11$

ans = false

$$A = [\underset{0}{3} \quad \underset{1}{5} \quad \underset{2}{1} \quad \underset{3}{2} \quad \underset{4}{1} \quad \underset{5}{2}]$$

$K = 7$

ans = true $(1, 3)$

$K = 10$

ans = false

Bruteforce

$a(i) + a(j) = K$

$a(j) = K - a(i)$

```
for (i=0 to n-1) {      // a(i)
    for (j= i+1 to n-1) {
        if (a(j) == K - a(i)) {   // a(i) + a(j) == K
            return true;
        }
```

3
3
return false

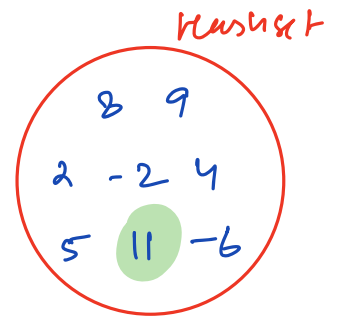$$TC = O(N^2)$$
$$SC = O(1)$$

Observation

1. Store all array elements in hashset

2. ∀i, check if K-a(i) is present

$$a[9] = \{ 3 \quad 8 \quad 9 \quad 2 \quad -2 \quad 4 \quad 5 \quad 11 \quad -6 \quad 4 \} \quad K=9$$

K-a(i)   1   0   7   11   return true

Hashset

8   9
2 -2 4
5   11 -6

A = [2   5   5]   K=10

(K-a(i))   8   5   return true

hashset

2   5
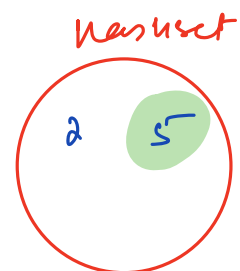
Problem :

$A = [\quad 2 \quad 5]$ $K = 10$

K-a(i) $\quad\quad 8 \quad 5$ ans=true
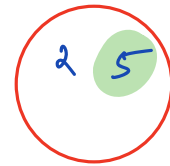

Solution : Do not insert all elements in hashset beforehand. Rather only insert from $[0, i-1]$

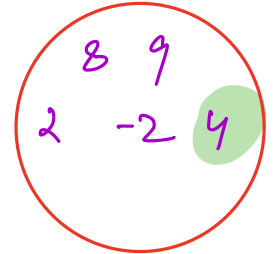$A = [\quad 8 \quad 9 \quad 2 \quad -2 \quad 4 \quad 5 \quad 11 \quad -6 \quad 4]$ $K = 9$

K-a(i) $\quad 1 \quad 0 \quad 7 \quad 11 \quad 5 \quad 4$ return true

hashset

$A = [\quad 2 \quad 5 \quad 5]$ $K = 10$

K-a(i) $\quad\quad 8 \quad 5 \quad 5$ return true
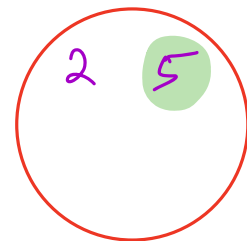

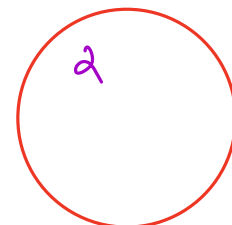$A = [2 \quad 5]$ $K = 10$

K-a(i) $\quad 8 \quad 5$ return false

Code

```
hashset < int > hs

for ( i=0 to n-1) {
    if ( hs. contains ( K - a[i]) {
        return true
    }
    hs. insert (a[i])
}
return false
```

TC = O(N)

SC = O(N)

Question3

Given an array, count the no. of pairs (i,j)

s.t. $A[i] + A[j] = K$ & $i != j$

$$A = [\underset{0}{3} \quad \underset{1}{5} \quad \underset{2}{1} \quad \underset{3}{2} \quad \underset{4}{1} \quad \underset{5}{2}]$$ K = 3

(2,3)   (3,4)

(2,5)   (4,5)

ans = 4

```
hashset < int > hs

for ( i=0 to n-1) {
    if ( hs. contains ( K-a[i]) {          ← check if K-a[i) is present
        return true
    }                                        count # times (K-a[i]) is present
    hs. insert (a[i])
}                                            hashset      →   hashmap
return false                                 < A[i]>          < A[i), freq. of A[i]>
```

Code

```
Hashmap < int, int >   hm

int  am = 0

for ( i=0 to n-1) {

    if ( hm. contains ( K-a[i])) {

        am += hm [ K-a[i]]

    }

    // insert a[i] in hashmap

    if ( hm. contains (a[i]) ) {

        hm[a[i]] ++

    }
    else {

        hm . insert ( a[i], 1)

    }
}
```

$TC = O(N)$
$SC = O(N)$

xtum ans

	0	1	2	3	4	5	6	7
A = [	2	5	2	5	8	5	2	8)	K=10

K-a(i)   8   5   8   5   2   5   8   2

count   0   0   0   +1   +2   +2   +1   +3

ans= 9

hashmap
⟨2,3⟩ ⟨5,3⟩
⟨8,2⟩

Question 4

Given an array, check if there exists a subarray
with sum = 0.

A[10] = [2   2   1   -3   4   3   1   -2   -3   2]

ans = true

Brute force   : $O(N^3)$

Prefix Sum / Carry forward   : $O(N^2)$

Observation

$$A[10] = \begin{matrix} 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 \\ [2 & 2 & 1 & -3 & 4 & 3 & 1 & -2 & -3 & 2] \end{matrix}$$

$$pf[] = [2 \quad 4 \quad 5 \quad 2 \quad 6 \quad 9 \quad 10 \quad 8 \quad 5 \quad 7]$$

$$sum(i \text{ to } j) = pf[j] - pf[i-1] = 0$$

$$sum(0 \text{ to } j) = pf[j] = 0$$

$$check \quad pf[j] == pf[i-1] \quad OR$$

$$pf[j] = 0$$

Approach :

1. Calculate prefix sum array

2. Iterate over prefix array

   - If any element = 0, then return true

   - Else insert it in hashset

3. If hashset size < N, return true

4. Else return false

Code

```
HashSet <int>  hs

int pf[n]    // calculate pf array

for (i=0  to  n-1) {

    if (pf[i] == 0)  return true

    hs.insert ( pf[i] )

}

if ( hs.size() < n )

    return true

return false
```
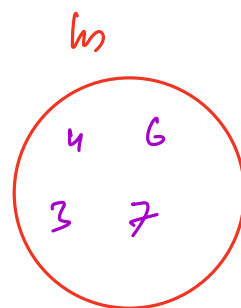
TC = O(N)

SC = O(N)

A = [4   2   -3   1   3]

pf[] = [4   6   3   4   7]

hs.size() = 4   n = 5

4 < 5   =>   true

hs

4   6

3   7

Question 5

Given an array, check if there exists a subarray with sum = K.

$$A = [\;\underset{0}{2}\quad\underset{1}{3}\quad\underset{2}{9}\quad\underset{3}{-4}\quad\underset{4}{1}\quad\underset{5}{5}\quad\underset{6}{6}\quad\underset{7}{2}\quad\underset{8}{5}\;]$$

| K=11 | [5,6] | true |

| K=10 | (0,3) | true |

$$A = [\;5\quad 10\quad 20\quad 100\quad 105\;] \qquad K=110$$

ans = false

Observation

$$sum\;(i\;to\;j) \;=\; pf(j) - pf(i-1) \;=\; K$$

$$sum\;(0\;to\;j) \;=\; pf(j) \;=\; K$$

check $\quad pf(j) == pf(i-1) + K \qquad OR$

$$pf(j) = K$$

$$A[9] = [\quad 2 \quad 3 \quad 9 \quad -4 \quad 2 \quad 4 \quad 6 \quad 2 \quad 5\;] \qquad k=11$$

indices: 0 1 2 3 4 5 6 7 8

$$pf[] = [\quad 2 \quad 5 \quad 14 \quad 10 \quad 12 \quad 16 \quad 22 \quad 24 \quad 29\;]$$

pf[j]

pf[j]-K   -9   -6   3   -1   0   5

am → true

hashset

2 5

14 10 12
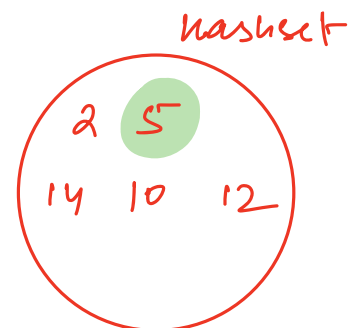
search pf[j]-K

code

hashset <int> hs

int pf[n]   // calculate pf array

for (i=0 to n-1) {

   if (pf[i] == -k) return true

   if (hs. contains (pf[i] - K))   return true

   hs. insert (pf[i])

}

return false

$$TC = O(N)$$
$$SC = O(N)$$

HashSet < int >   hs

sum = 0

for (i=0 to n-1) {

    sum += a(i)

    if (sum == K)   return true

    if (hs. contains (sum - K))   return true

    hs. insert (sum)

}

return false

$TC = O(N)$

$SC = O(N)$

Doubt

$A \% M = B \% M$ find largest M

    if A == B   then $M = \infty$

      A != B

      2   3 $2 \% 1 = 0$ $3 \% 1 = 0$

       $4 \% 2$ $6 \% 2$
       0 1 2 3   0 1 2 3 4 5