Song suggestion :: Anji (quiz winner)

Agenda

Introduction to Carry forward

Introduction to Subarray

Problem 1

Given a string s of lowercase characters, return the count of pairs (i, j) such that i < j and s[i] = 'a' and s[j] = 'g'

example

string s = "abegag"
0 1 2 3 4 5

ans = 3

explanation

(0,3) (0,5) (4,5)

Quiz 1

What is the count of a, g pair in the array.

s = acgdgag
0 1 2 3 4 5 6

explanation

(0,2) (0,4) (0,6) (5,6) — 4 pairs

Quiz 2

What is the count of a, g pair in the array.

s = "beaggaag"
0 1 2 3 4 5 6 7

explanation

(2,3) (2,4) (2,7) (5,7) (6,7) — 5 pairs

Brute force Solution

// check for every pair

```
int count pair ( string s ) {
        int result = 0;
        for (i=0; i< s.length; i++) {
                for (j= i+1; j< s.length; j++) {
                        if (s[i]=='a' && s[j]=='g'){
                                result ++;
                        }
                }
        }
        return result;
}
```

$T.C = O(n^2)$

$S.C = O(1)$

Observation

```
        0 1 2 3 4 5 6 7
s = " b e a g g a a g "
            | |       |
          1 pair    3 pairs
```

Count the 'a' to left of 'g', add the count to answer

Dry Run

string	a	c	b	a	g	k	a	g	g
count_a	1	1	1	2	2	2	3	3	3
ans	0	0	0	0	2	2	2	5	8

pseudo code

```
int    count_pair (string  s) {
       int  result  = 0;
       int   n =  s. length;
       int    count_a  = 0;
       for  ( i= 0;  i< n;  i++) {
               if  (s[i] = = 'a')
                     count_a  +=1;
               else  if  (s[i]  = = 'g')
                      result  +=  count_a;
       }
       return  (result);
}
```

T.C = O(N)

S.C = O(1)

Introduction to Subarray

A subarray can have one or more element and must be a contiguous part of array in same order

Example

arr:

4	1	2	3	-1	6	9	8	12

array	subarray?	Reason
2 3 -1 6	✓	len 4
9	✓	len 1
4 1 2 3 -1 6 9 8 12	✓	len 9
4 12	✗	non contiguous
1 2 6	✗	non contiguous
3 2 1 4	✗	incorrect order

Quiz 3

2	4	1	6	-3	7	8	4

which one below is valid sub-array?

1 6 8	✗	not contiguous
7 8 4	✓	valid
6 1 4 2	✗	incorrect order
1 4	✗	in correct order

Representation of subarray

① Mention the start & end index

② Mention start index & length

arr :

0	1	2	3	4	5	6	7	8
4	1	2	3	-1	6	9	8	12

2	3	-1	6

① Si = 2 Ei = 5 (2, 5)

② Si = 2 length = 4

Quiz 4

How many subarrays of following array start from index $\boxed{0}$

arr :

4	2	10	3	12	-2	15
0	1	2	3	4	5	6

Valid subarrays

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

Quiz 5

How many subarrays of following array start from index $\boxed{1}$

arr :

4	2	10	3	12	-2	15
0	1	2	3	4	5	6

Possible subarrays :

(1,1) (1,2) (1,3) (1,4) (1,5) (1,6)

Formula to count # subarrays

Array of size n

	Total
if subarray starts at 0th index =	n
if subarray starts at 1st index =	n-1
if subarray starts at 2nd index =	n-2
⋮	
if subarray starts at (n-1) index =	1

$$1 + 2 + 3 + \cdots + (n-1) + n = \boxed{\frac{n(n+1)}{2}}$$

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Question

Print the subarray of the array that starts from Si and ends at Ei

```
for ( i = Si ; i <= Ei ; i++ ) {
    print ( arr[i] );
}
```

T.C = O(n)

S.C = O(1)

Question

Given an array of integers, we need to print all possible subarray of the array.

example

arr =

1	2	3
0	1	2

(0,0) (0,1) (0,2)

(1,1) (1,2) (2,2)

possible subarray

$$\frac{n * (n+1)}{2} = 6$$

1 loop for si, 1 loop for Ei

pseudo code

```
for ( i=0; i<n; i++) {      // si loop
    for ( j= i; j<n; j++) {      // Ei loop
        for (k=i; k<=j; k++) {
            print (arr[k]);
        }
    }
}
```

T.c = $O(n^3)$

S.c = $O(1)$

Quiz 6

What is the length of the smallest subarray which has both max and min element of array?

max = 6

min = 1

arr :

2	2	6	4	5	1	5	2	6	4	1

Question

Given an array of N integers, return the length of smallest subarray which contains both maximum and minimum element of the array.

arr :

1	2	3	1	3	4	6	4	6	3

max_element = 6 min_element = 1

subarray length = 4

Brute Force Solution

Check all possible subarray with given constraints

T.C = O(n^3)

S.C = O(1)

Optimized Solution

Observation 1 : The answer will exactly have 1 max and 1 min element

Observation 2: Min & max will be corner element in sub array

Conclusion :

Keep track of last max & last min to calculate ans

Steps:

① Get max & min value

② Keep track of last_max and last_min to calculate least distance

Dry Run

last_min_index = -1 last_max_index = -1

min = 1 max = 6 ans = INT_MAX

arr :

2	2	6	4	5	1	5	2	6	4	1
0	1	2	3	4	5	6	7	8	9	10

i	A[i]	last_min_idx	last_max_idx	ans
0	2	-1	-1	MAX
1	2	-1	-1	MAX
2	6	-1	2	MAX
3	4	-1	2	MAX

4	5	-1	2	MAX
5	1	5	2	5-2+1 = 4
6	5	5	2	4
7	2	5	2	4
8	6	5	8	4
9	4	5	8	4
10	1	10	8	10-8+1 = 3

pseudo code

T.C = O(n)

S.C = O(1)

```
int  min max subarray (arr) {
    int n = arr. length ;
    // find min & max ele.
    int min = min (arr);
    int max = max (arr);
    // initialize last min & last max idx
    int last_min = -1, last_max = -1;
    for (i = 0; i < n; i++) {
        if (arr[i] == min) {
            last_min = i
            if (last_max != -1) {
                ans = min (ans, i - last_max + 1);
            }
        }
        if (arr [i] == max) {
            last_max = i;
            if (last_min != -1) {
                ans = min (ans, i- last_min +1);
            }
        }
    }
    return ans;
}
```

Discuss

- sliding window
- Contribution Technique