

COP 4516 3/3/2026

1) Final Team Contest

8 Problems

	1st	2nd	3rd	4th	5th	6th	7th	8th	
Score	0	10	20	40	50	60	80	90	100

2) ⑥ MCSS

① \neq Cumulative Freq, Binary Index tree / ~~Fenwick~~
Fenwick tree

Operations

add (value, index)

query (lowIdx, highIdx) = sum of values in array in btw index lowIdx and index highIdx, inclusive.

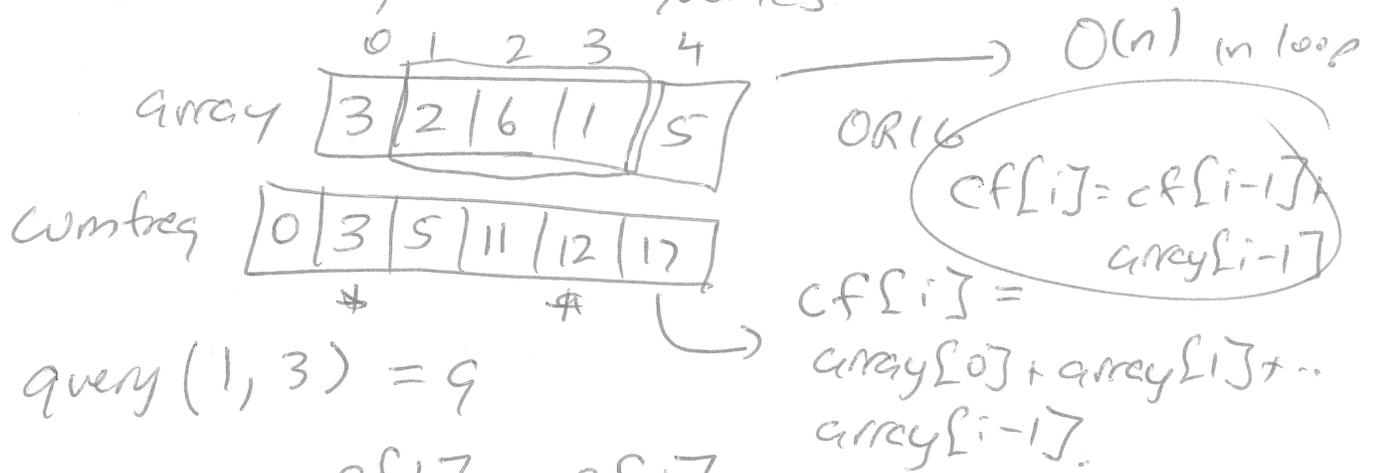
Method #1 (neg array)

	3	4	12		
	0	0	0	0	0
	1	2	3	4	5

add (12, 4) $\rightarrow O(1)$
add (3, 1) $\rightarrow O(n)$
query (2, 5) $\rightarrow 12$
add (4, 2)
query (2, 5) $\rightarrow 16$
query (1, 3) $\rightarrow 7$

Method #2 (cumulative freq / prefix sum array)

Usually better if all adds are in the beginning followed by all queries.



query(1, 3) = 9

= $cf[4] - cf[1]$

= 12 - 3 $\rightarrow O(1)$

= 9

Updates $O(n)$

	Update	Query
array	$O(1)$	$O(n)$
cf	$O(n)$	$O(1)$
BIT	$O(\log n)$	$O(\log n)$

Any update should Δ a limited # of sums.

Any query should also be based on a limited # of sums

BIT (Binary Index Tree / Fenwick Tree)

1	→	sum(1)	11
2	→	sum(1,2)	+1
3	→	sum(3)	<u>100</u>
4	→	sum(1,2,3,4)	<u>1000</u>
5	→	sum(5)	
6	→	sum(5,6)	
7	→	sum(7)	
8	→	sum(1,2,3,4,5,6,7,8)	
9	→	sum(9)	
10	→	sum(9,10)	
11	→	sum(11)	
12	→	sum(9,10,11,12)	
13	→	sum(13)	
14	→	sum(13,14)	
15	→	sum(15)	
16	→	sum(1...16)	

1-based
always
power of 2

query(1, 12)

query(1, 7)

add(6 to
index 3)

$$\begin{array}{r}
 1101 - 1 = 1100 \\
 \quad \quad \quad \uparrow \\
 \quad \quad \quad - 100 \\
 \hline
 \quad \quad \quad 1000
 \end{array}$$

More challenging BIT problem

on Kattis:

megainversions

juggler