Class 1 - DS

Sunday, August 22, 2021 9:26 PM

Sqrt Decomposition

#1 N - size array

Q - op

* range sum query
* point update

value	5	10	~~3~~ 9	2	1
idx	0	1	2	3	4

$\sum[1,3] \rightarrow 9$

idx=2
value=9

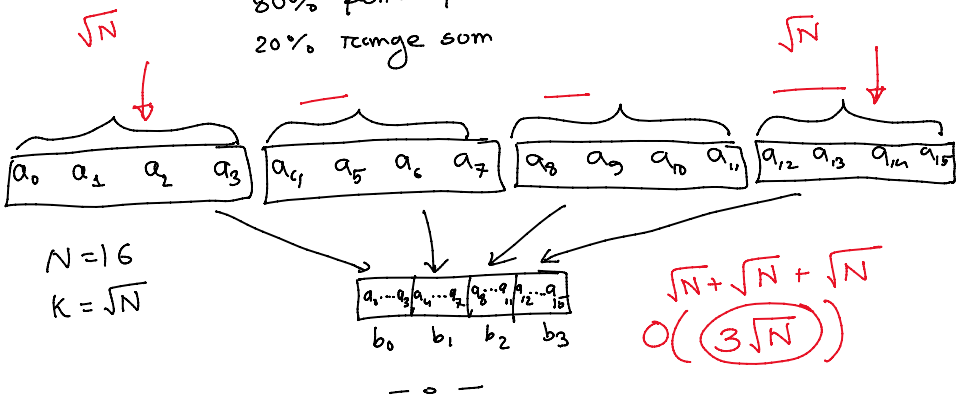
$\sum[1,3] \rightarrow 21$

$1 \le N \le 5 \times 10^4$

$1 \le Q \le 10^5$

80% point update

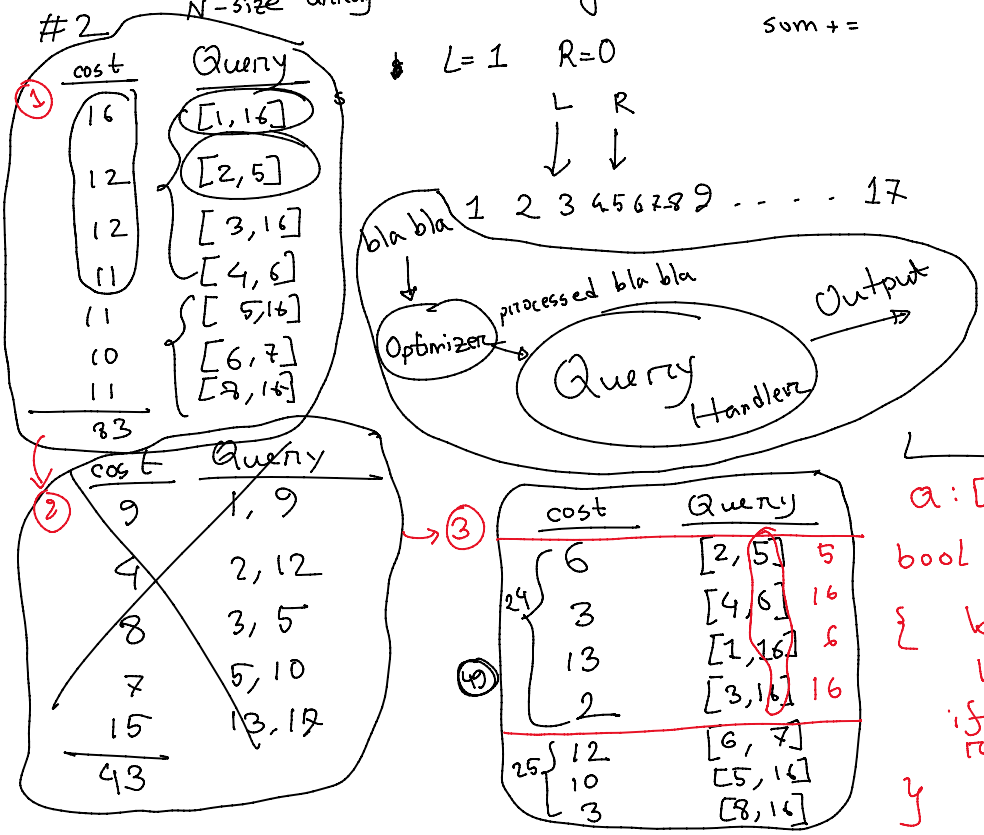
20% range sum



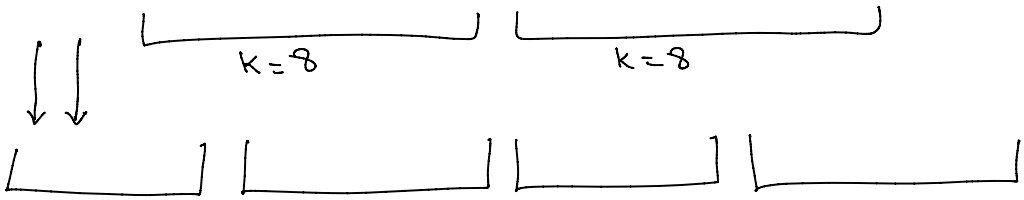
Mo's ordering

#2 N-size array → range Sum

sum +=




```
a : [L, R]
bool cmp(Q a, Q b)
{  b_a = a.L / K ;
   b_b = b.L / K ;
   if( b_a == b_b )
      return a.R < b.R ;
   return b_a < b_b
}
```



$O(\text{Left} + \text{Right})$ $\quad RM = n \times \frac{n}{k}$

$O\left(\frac{n^2}{k} + qk\right)$ $\quad LM = qk$

$O(n\sqrt{n} + q\sqrt{n})$

$= O((n+q)\sqrt{n})$

$\simeq O(n\sqrt{n})$

$\simeq O\left(\frac{n^2}{k} + nk\right)$

$\frac{n^2}{k} = nk$

$\Rightarrow n = k^2$

$\therefore k = \sqrt{n}$

$f(k) = \frac{n^2}{k} + nk$

$\Rightarrow f'(k) = -\frac{n^2}{k^2} + n$

$\Rightarrow 0 = -\frac{n^2}{k^2} + n$

$\Rightarrow \frac{n^2}{k^2} = n$

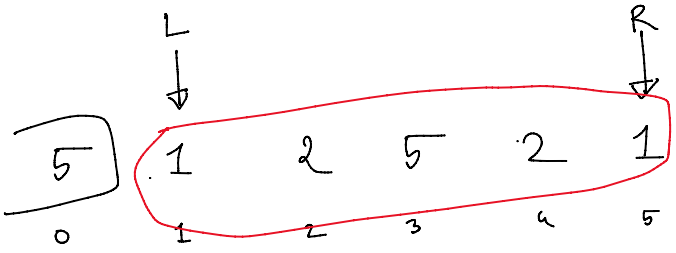
$\Rightarrow \frac{n}{k^2} = 1 \quad \Rightarrow k^2 = n$

$\therefore k = \sqrt{n}$

#3: N-size array

$[L, R] \longrightarrow$ # distinct value

$f(L,R) = f_1(R) - f_1(L-1)$



f	v
1	1
2	1
3	
4	
5	1

$f(R) - f(L-1)$

$UV = 3$

$[1, 5] \longrightarrow [0, 2]$

$[0, 2] \longrightarrow [1, 5]$