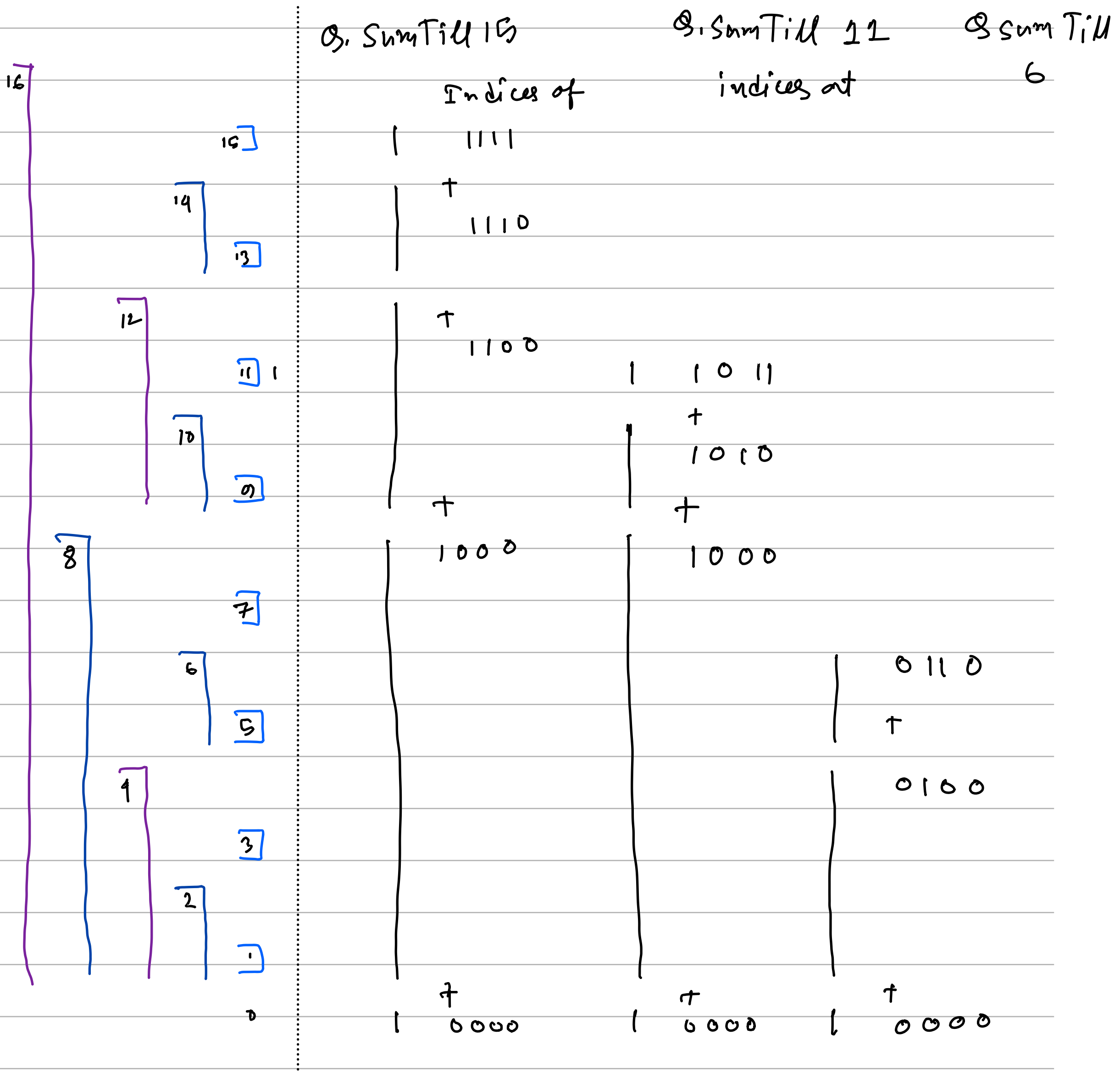
Fenwick Tree

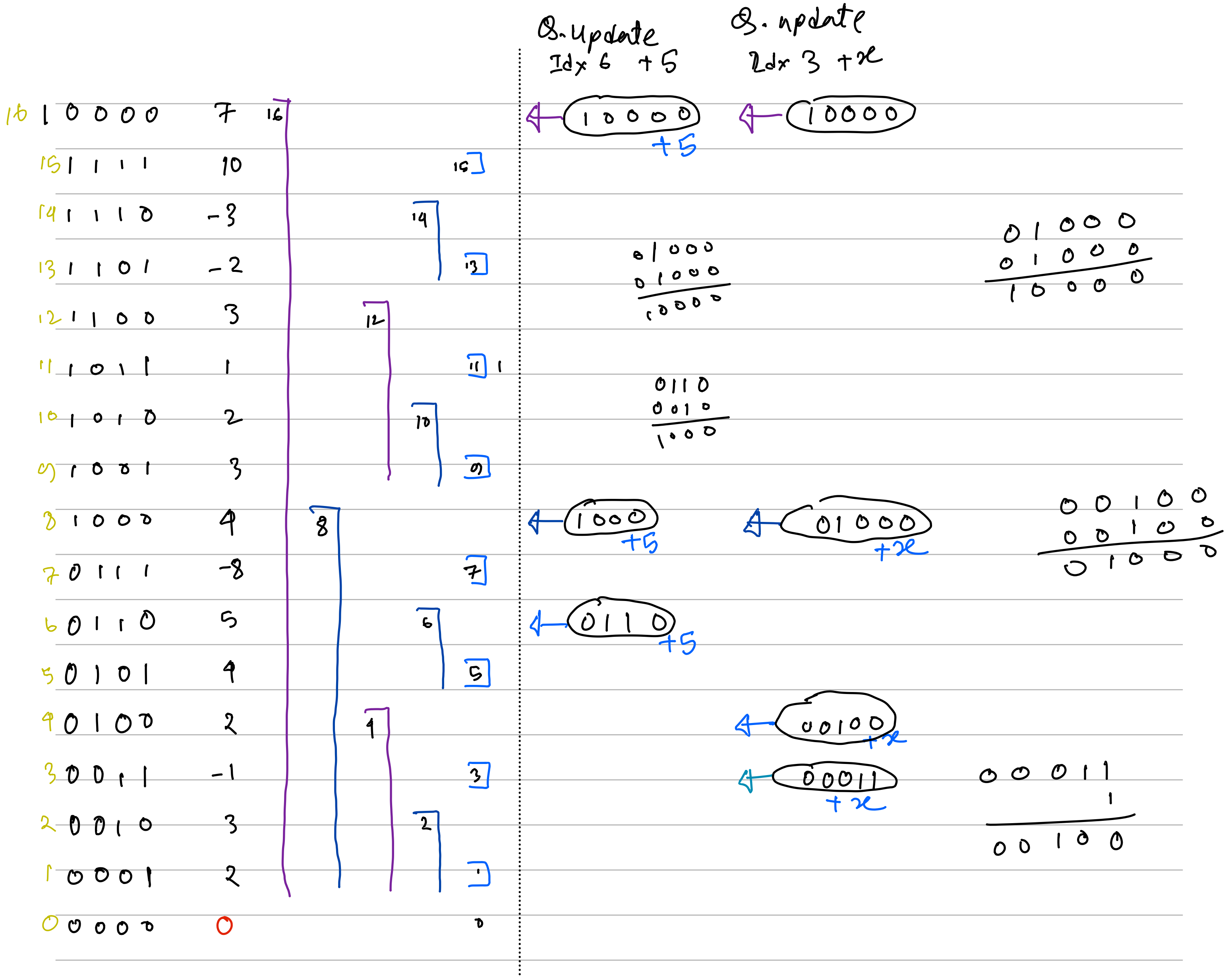
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
arr :	3	2	-1	2	4	5	-8	4	3	2	1	3	-2	-3	10	7

16	10000	7
15	1111	10
14	1110	-3
13	1101	-2
12	1100	3
11	1011	1
10	1010	2
9	1001	3
8	1000	4
7	0111	-8
6	0110	5
5	0101	4
4	0100	2
3	0011	-1
2	0010	3
1	0001	2
0	0000	0



```
int SumTill (int idx)
    int ans = 0;
    while ( idx > 0 )
            ans += fenTree[idx];
            idx -= (idx & -idx);

    return ans;
```



16	1 0 0 0 0	7
15	1 1 1 1	10
14	1 1 1 0	-3
13	1 1 0 1	-2
12	1 1 0 0	3
11	1 0 1 1	1
10	1 0 1 0	2
9	1 0 0 1	3
8	1 0 0 0	4
7	0 1 1 1	-8
6	0 1 1 0	5
5	0 1 0 1	4
4	0 1 0 0	2
3	0 0 1 1	-1
2	0 0 1 0	3
1	0 0 0 1	2
0	0 0 0 0	0

```
void   updateFrom( int idx , int val )
       while( idx < n+1)
             fenTree[idx] += val ;
             idx  +=  ( idx & -idx );
```

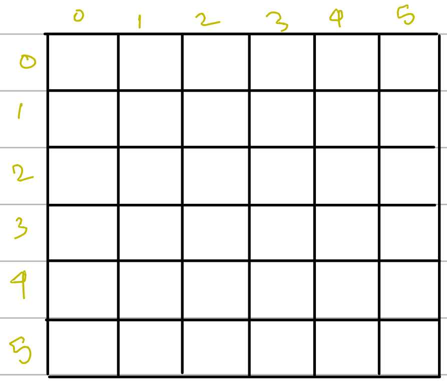
```
void  buildFenTree( nums )
    for(int i=0;  i<n; i++)
        updateFrom( i+1, nums[i])
```

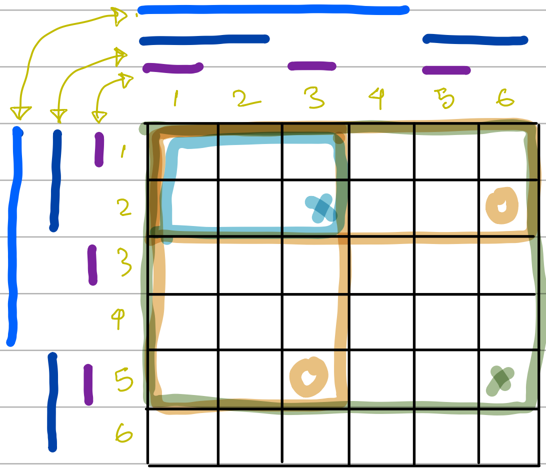
O(n log n)

```
void  buildFenTree (nums)
      prefixSum :-
      for(int  i=1 ;  i<n+1 ; i++)
          fenTree[i] =
   prefixSum[i] - prefixSum[i-(i&-i)]
```

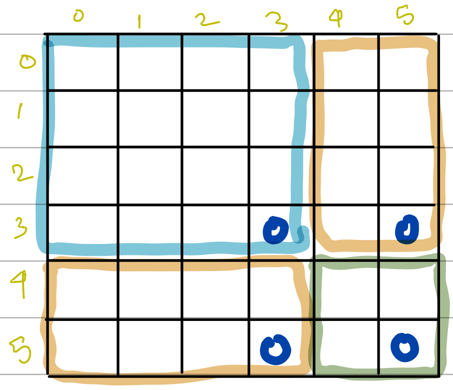
O(n)

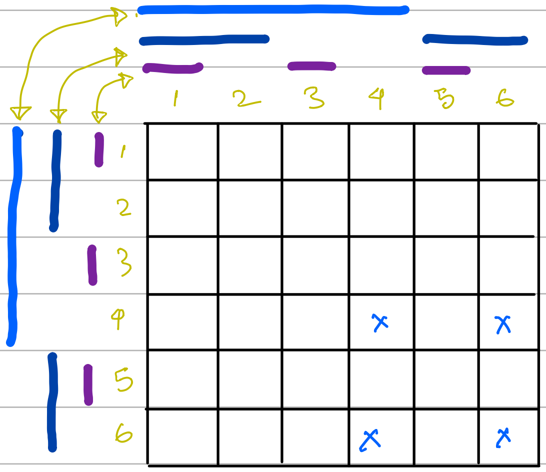
2D Fenwick Tree





RangeSum(2,3 to 5, 6) → SumTill(5,6) - SumTill(5,3)
- SumTill (2,6) + SumTill(2,3)





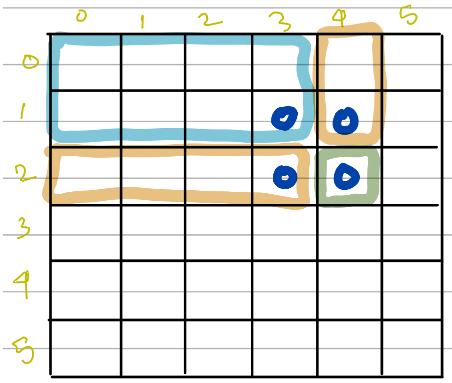
SumTill(6,6) → i = 110   j = 110   i > 0   i -= (i & -i)
j > 0   j -= (j & -j)

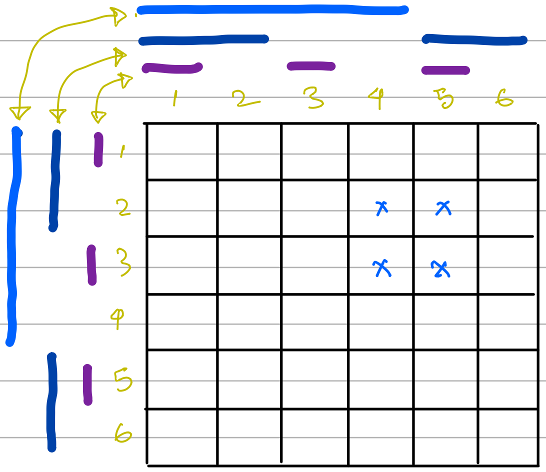
i → 110   i → 100   i → 0

j → 110, 100, 000   110, 100, 000   110, 100, 000

$\underline{000}$ 0 $\underline{000}$ 0 $\underline{000}$ 0

1 index arr; 0 row, col = 0



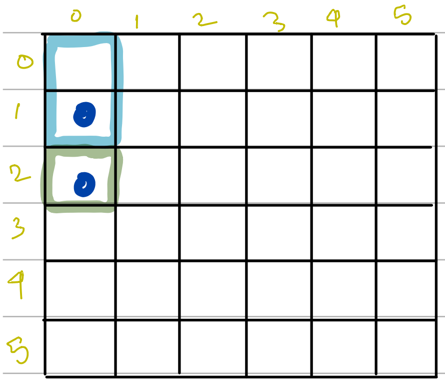


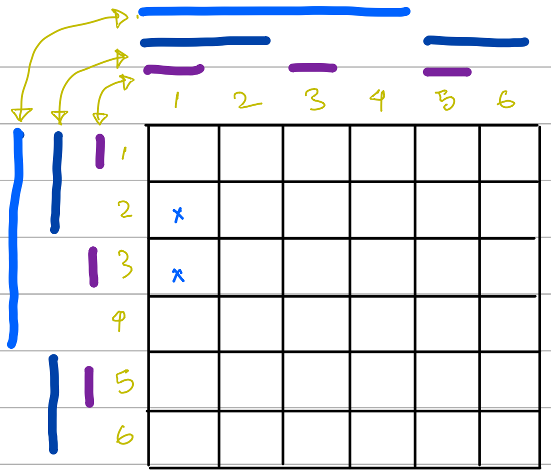
sumTill(3,5)

011 , 101

010 , 100

000 , 000

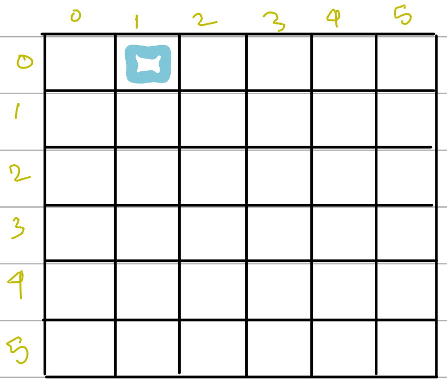


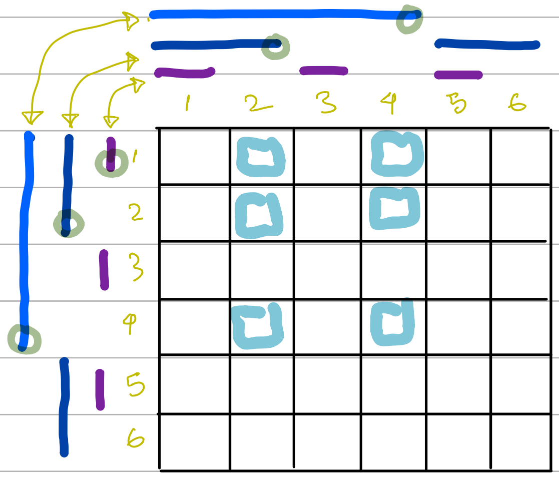


sumTill (3, 1)

011 , 001
010 , 000
000

```
int sumTill( int x, int y)
    int ans = 0
    for( ; x > 0 ; x -= (x & -x))
        for( ; y > 0 ; y -= (y & -y))
            ans += fenTree[x][y];
    return ans;
```





update (1, 2)

1 01   10 2
2 10   100 4
4 100   1000
1000

```
void updateFrom( int x, int y, int diff)
for( ; x < n+1 ; x += (x & -x))
    for( ; y < n+1 ; y += (y & -y))
        fenTree[x][y] += diff ;
```