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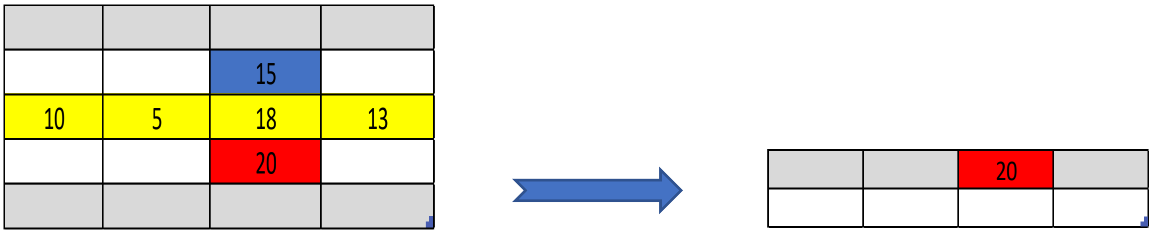
PEAK FINDER 2D

1- Find middle row/column, then pick a number in middle row/column ==> $\theta(1)$
2- Check if the number is peak number, if it is a peak number then return it ==> $\theta(1)$
3- Find max number in row/column ==> $\theta(m)\ or\ \theta(n)$
4- Check if the number is peak number, if it is a peak number then return it ==> $\theta(1)$
5- Compare max number with its neighbors ==> $\theta(1)$
   - If the max's neighbor is bigger than max, then maintain search on neighbor's part
     arr[midRow+1][max] > arr[midRow][max]
     arr[max][midCol+1] > arr[max][midCol]
   - If the max's other neighbor is bigger, then maintain search on this neighbor's part
     arr[midRow-1][max] > arr[midRow][max]
     arr[max][midCol-1] > arr[max][midCol]

n (number of rows)	m (number of columns)	rowOrCol	Time(ns)
10	100	0	13800
10	100	1	12500
10	100	2	3900
100	10	0	11800
100	10	1	15100
100	10	2	9100
50	200	0	197599
50	200	1	151499
50	200	2	85700
200	50	0	245500
200	50	1	37600
200	50	2	474699
50	1000	0	219700
50	1000	1	158200
50	1000	2	449800
1000	50	0	241600
1000	50	1	135099
1000	50	2	78700
50	10000	0	1661400
50	10000	1	126201
50	10000	2	680400
10000	50	0	230900
10000	50	1	143999
10000	50	2	1238900

Condition 1: rowOrCol = 0 ---> array is split by row



To find the peak number in an nXm-sized array;

n: number of rows

m: number of columns

$$T(n,m) = \begin{cases} m, n = 1 \\ T\left(\frac{n}{2}, m\right) + m, \quad n > 1 \end{cases}$$

$$T(n,m) = m + T\left(\frac{n}{2}, m\right)$$ 1.Equation

In 1.Equation, we write $T\left(\frac{n}{2}, m\right) = m + T\left(\frac{n}{4}, m\right)$ instead of $T\left(\frac{n}{2}, m\right)$

$$T(n,m) = 2m + T\left(\frac{n}{4}, m\right)$$ 2.Equation

$$T(n,m) = km + T\left(\frac{n}{2^k}, m\right)$$ General Formula

$$T(1,m) = m$$

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

Substitute k value in the general formula

$$T(n,m) = \log n \,.\, m + T(1,m)$$

$$T(n,m) = \log n \,.\, m + m$$

$$O(n) = n. logm$$

Condition 2: rowOrCol = 1 ---> array is split by column

		11	
		15	
10	19	18	13
		20	
		9	

10	19

To find the peak number in an nXm-sized array;

n: number of rows

m: number of columns

$$T(n,m) = \begin{Bmatrix} n\,, m = 1 \\ T\left(n, \frac{m}{2}\right) + m, \quad m > 1 \end{Bmatrix}$$

$$T(n,m) = n + T(n, \frac{m}{2})$$ 1.Equation

In 1.Equation, we write $T\left(n, \frac{m}{2}\right) = n + T(n, \frac{m}{4})$ instead of $T\left(n, \frac{m}{2}\right)$

$$T(n,m) = 2n + T(n, \frac{m}{4})$$ 2.Equation

$$T(n,m) = kn + T(n, \frac{m}{2^k})$$ General Formula

$$T(n,1) = n$$

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

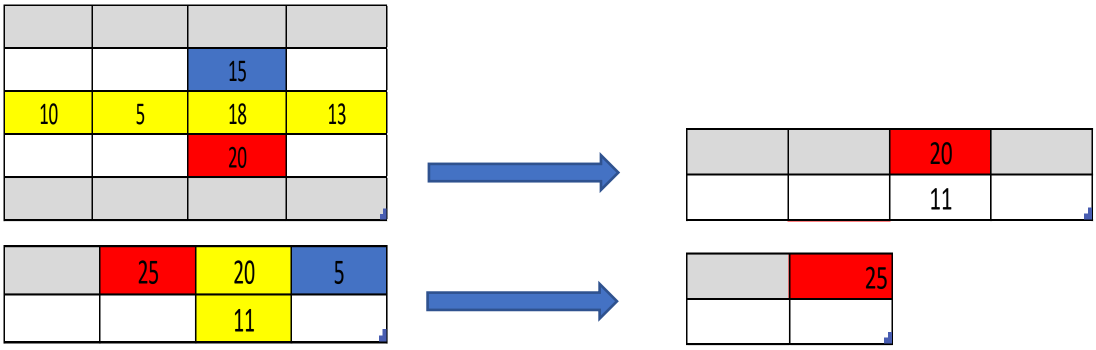
Substitute k value in the general formula

$$T(n,m) = \log n \,.\, m + T(n,1)$$

$$T(n,m) = \log n \,.\, m + n$$

$$O(n) = m.logn$$

Condition 3: rowOrCol = 2 ---> first, array is split by row then column



To find the peak number in an nXm-sized array;

n: number of rows

m: number of columns

$$T(n,m) = \begin{cases} n, m = 1 \\ m, n = 1 \\ T\left(\frac{n}{2}, m\right) + m, \quad n > 1 \\ T\left(n, \frac{m}{2}\right) + n\ , m > 1 \end{cases}$$

$$T(n,m) = m + T\left(\frac{n}{2}, m\right)$$ 1.Equation

$$T\left(\frac{n}{2}, m\right) = m + T\left(\frac{n}{2}, \frac{m}{2}\right)$$ 2. Equation

$$T\left(\frac{n}{2}, \frac{m}{2}\right) = \frac{m}{2} + T\left(\frac{n}{4}, \frac{m}{2}\right)$$ 3. Equation

$$T\left(\frac{n}{4}, \frac{m}{2}\right) = \frac{n}{4} + T\left(\frac{n}{4}, \frac{m}{4}\right)$$ 4. Equation

$$T\left(\frac{n}{4}, \frac{m}{4}\right) = \frac{m}{4} + T\left(\frac{n}{8}, \frac{m}{4}\right)$$ 5. Equation

We write the above equations, starting from the 5th equation, backwards to the 1st equation.

$$T(n,m) = m + n + \frac{m}{2} + \frac{n}{2} + \frac{m}{4} + \frac{n}{4} + T\left(\frac{n}{8}, \frac{m}{4}\right)$$

$$T(n,m) = m + n + \frac{m}{2^k} + \frac{n}{2^k} + T\left(\frac{n}{2^k}, \frac{m}{2^k}\right)$$ General Formula

$$n\sum_{k=1}^{\infty}\frac{1}{2^k} = n$$

$$m\sum_{k=1}^{\infty}\frac{1}{2^k} = m$$

$$T(n,m) = m + n + m + n = 2m + 2n$$

$$O(n,m) = m + n$$

PEAK FINDER 3D

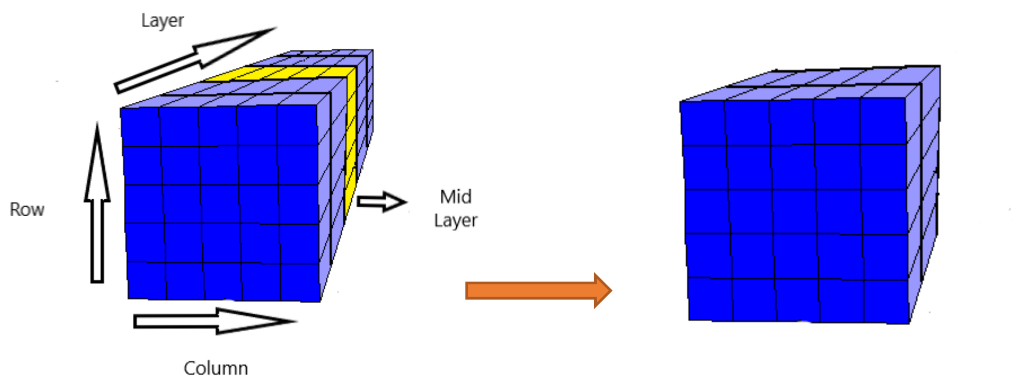
1- Find middle layer, then pick a number in midLayer => $\theta(1)$
2- Check if the number is peak number, if it is a peak number then return it => $\theta(1)$
3- Find max number in midLayer => $\theta(mn)$
4- Check if the number is peak number, if it is a peak number then return it => $\theta(1)$
5- Compare max number with its neighbors => $\theta(1)$
   - If the max's neighbor is bigger than max, then maintain search on neighbor's part => $\theta(1)$

     arr[max][max][midLayer] > arr[max][max][midLayer+1]

   - If the max's other neighbor is bigger, then maintain search on this neighbor's part => $\theta(1)$

     arr[max][max][midLayer] > arr[max][max][midLayer-1]

Split by layer



To find the peak number in an nXmXd-sized array;

n: number of rows

m: number of columns

d: number of layers

$$T(n,m,d) = \begin{Bmatrix} n.m, \quad d = 1 \\ T\left(n,m,\dfrac{d}{2}\right) + m.n, \quad d > 1 \end{Bmatrix}$$

$$T(n,m,d) = n.m + T(n,m,\tfrac{d}{2})$$ 1.Equation

In 1.Equation, we write $T\left(n,m,\frac{d}{2}\right) = n.m + T\left(n,m,\frac{d}{4}\right)$ instead of $T\left(n,m,\frac{d}{2}\right)$

$$T(n,m,d) = 2.n.m + T(n,m,\tfrac{d}{4})$$ 2.Equation

$$T(n,m,d) = k.n.m + T(n,m,\tfrac{d}{2^k})$$ General Formula

$$T(n, m, 1) = m.n, \qquad \frac{d}{2^k} = 1$$

$$k = \log d$$

Substitute k value in the general formula

$$T(n, m, d) = \log d.m.n + T(n, m, 1)$$

$$T(n, m, d) = \log d.m.n + n.m$$

$$O(n, m, d) = m.n.logd$$