* DGIM Algorithm :

- This is used to find out the no. of one's (1) from streaming datasets
- The algo. uses $O(\log^2 N)$ bits to represent a window of N bits.
- It allows to estimate the number of 1's in the window with an error of no more then 50%.

- COMPONENTS OF DGIM
  - Timestamp
  - Bucket

- Each bit that arrives has a timestamp for the position at which it arrives.
- If the first bit has timestamp 1, the second bit has timestamp 2 and so on. Here the positions are recognised with window size 'N' (which are usually taken as multiple of 2)
- Window are divided into buckets which consists of number of 1's and 0's.

RULES FOR FORMING A BUCKET.

1. Right side of the bucket should always start with '1' (if its start with a '0' then must be neglected or ignored).
   Eg. 1 0 0 10 1 1
   A bucket of size 4 having 4 ones four 1's and starting with a 1 from its right side end.

2. Every bucket should have atleast one '1' else no bucket can be formed.
3. All buckets should be in power of 2.
4. Bucket cannot decrease in size as we move to

the left (more increasing order towards left).

Eg.
Stream:
1 0 1 0 1 1 0 0 0 1 0 1 1 1 0 1 1 0 0 1 0 1 0

N = 24 → size of window

[1 0 1 0 1 1] 0 0 0 [1 0 1 1 1] 0 [1 1] 0 0 [1 0 1] [1] 0 ignored
2^2 2^2 2^1 2^1 2^0

Eg.
Stream: 1 0 1 0 1 1 0 0 1 0 1 1 0 1 1 1 1 0 1 0 1 1 1 0
N = 24.

~~1111 0 101111~~
~~1 0 1 0 1 1 1~~

[1 0 1 0 1 1] 0 0 [1 0 1 1 0 1] [1 1 1 0 1] 0 [1 1] [1] 0 → ignored.
2^2 00 2^2 2^2 2^1 2^0

[11 0 1] [101]
~~1~~0101 [11 01] 2^2 2^1
2^2

* Q. (10M) How many 1's in last 20 bits of given stream after appending new bits as 011 by using DGIM Algorithm.
Stream → 101011000101110110010110
: Timestamp
87 92 95 98 100
[101011] 000 [10111] 0 [11] 00 [101] [1] 0 ← neglect.

Stream : 1010110001011101100010110 : 0 1 1 (101 102 103)

New bit → 0 1 1 (101 102 103)

'0' enters [101011] 000 [10111] 0 [11] 00 [101] [1] 0 0

'1' enters [101011] 000 [10111] 0 [11] 00 [101] [1] 0 0 1

'1' enters [101011] 000 [10111] 0 [11] 00 [101] [1] 0 0 1 1

→ [1010110001 0111] 0 [1100101] [1001] [1]

2^3 — 8 → 20th bit; 2^2 — 4; 2^1 — 2; 2^0 — 1

∴ There are 11 1's in the last 20 bits.

Q. How many 1's in last 15th bits of given stream after appending new bits as 111 by using DGIM algo.
Stream : 1101110110001101010011011 1

:

Stream : 110111011000110101001101 11 : 1 1 1

Enter '1' 110111011000110101001101 11 1

Enter '1' 1101110110001101010011011111

Enter '1' 11011101100011010100110111 1 1

→ 0[11011000 1] [10101001] [10111] [11] [1]

[1101110110001]

↓ 15th bit

There are 10 1's in given stream in last 15 bits.