Xoring Ninja

HackerRank

An XOR operation on a list is defined here as the *xor* ($\oplus$) of all its elements (e.g.: $XOR(\{A, B, C\}) = A \oplus B \oplus C$).

The $XorSum$ of set arr is defined here as the sum of the XORs of all non-empty subsets of arr known as arr'. The set arr' can be expressed as:

$$XorSum(arr) = \sum_{i=1}^{2^n-1} XOR(arr'_i) = XOR(arr'_1) + XOR(arr'_2) + \cdots + XOR(arr'_{2^n-2}) + XOR(arr'_{2^n-1})$$

For example: Given set $arr = \{n_1, n_2, n_3\}$

- The set of possible non-empty subsets is:
  $arr' = \{\{n_1\}, \{n_2\}, \{n_3\}, \{n_1, n_2\}, \{n_1, n_3\}, \{n_2, n_3\}, \{n_1, n_2, n_3\}\}$
- The $XorSum$ of these non-empty subsets is then calculated as follows:
  $XorSum(arr)$ = $n_1 + n_2 + n_3 + (n_1 \oplus n_2) + (n_1 \oplus n_3) + (n_2 \oplus n_3) + (n_1 \oplus n_2 \oplus n_3)$

Given a list of n space-separated integers, determine and print $XorSum \; \% \; (10^9 + 7)$.

For example, $arr = \{3, 4\}$. There are three possible subsets, $arr' = \{\{3\}, \{4\}, \{3, 4\}\}$. The XOR of $arr'[1] = 3$, of $arr'[2] = 4$ and of $arr[3] = 3 \oplus 4 = 7$. The XorSum is the sum of these: $3 + 4 + 7 = 14$ and $14 \; \% \; (10^9 + 7) = 14$.

Note: The cardinality of powerset(n) is 2^n, so the set of non-empty subsets of set arr of size n contains $2^n - 1$ subsets.

Function Description

Complete the *xoringNinja* function in the editor below. It should return an integer that represents the XorSum of the input array, modulo $(10^9 + 7)$.

xoringNinja has the following parameter(s):

- *arr*: an integer array

Input Format

The first line contains an integer T, the number of test cases.

Each test case consists of two lines:
- The first line contains an integer n, the size of the set arr.
- The second line contains n space-separated integers $arr[i]$.

Constraints

$1 \leq T \leq 5$
$1 \leq n \leq 10^5$
$0 \leq arr[i] \leq 10^9, \; 1 \leq i \leq n$

Output Format

For each test case, print its $XorSum \; \% \; (10^9 + 7)$ on a new line. The i^{th} line should contain the output for the i^{th} test case.

Sample Input 0

```
1
3
1 2 3
```

Sample Output 0

```
12
```

Explanation 0

The input set, $S = \{1, 2, 3\}$, has 7 possible non-empty subsets: $S' = \{\{1\}, \{2\}, \{3\}, \{1, 2\}, \{2, 3\}, \{1, 3\}, \{1, 2, 3\}\}$.

We then determine the XOR of each subset in S':
$XOR(\{1\}) = 1$
$XOR(\{2\}) = 2$
$XOR(\{3\}) = 3$
$XOR(\{1, 2\}) = 1 \oplus 2 = 3$
$XOR(\{2, 3\}) = 2 \oplus 3 = 1$
$XOR(\{1, 3\} = 1 \oplus 3 = 2$
$XOR(\{1, 2, 3\} = 1 \oplus 2 \oplus 3 = 0$

Then sum the results of the XOR of each individual subset in S', resulting in $XorSum = 12$ and $12 \% (10^9 + 7) = 12$.

Sample Input 1

```
2
4
1 2 4 8
5
1 2 3 5 100
```

Sample Output 1

```
120
1648
```