29 Quipus (the birth of writing numbers)

15 points

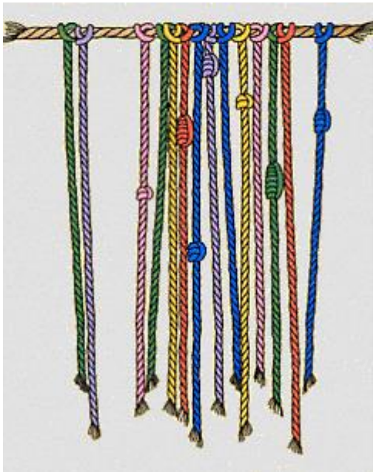
Introduction

Over the course of evolution, Homo sapiens has moved from living in small groups of hunter-gatherer, to develop large social structures, Kingdoms and Empires. But our brain has not evolved to be able to store huge quantity of numerical information, like how many chickens are needed to feed my Kingdom, or the list of who has paid their taxes, or how much I need to maintain the army that prevents the neighbor King from becoming the King of my Empire. That is why, to overcome our brain limitation, a new need appeared: the need of storing Empire-sized mathematical data.

So, more or less 5,500-5,000 years ago, in Mesopotamia, the Sumerians were the first to solve the problem: they invented a system to store information through signs pressed in clay tablets. This newfangled system was called “writing”.

Another peculiar script that survived until the Spanish conquest of South America was the system used by the Inca Empire (that ruled up to 12 million people) to record large amounts of mathematical data: the Quipus. Each quipu consists of many cords of different colors, with several knots tied in different places.

A single quipu can contain hundreds of cords and thousands of knots. By combining different knots in different cords with different colors, it is possible to record large amounts of mathematical data.



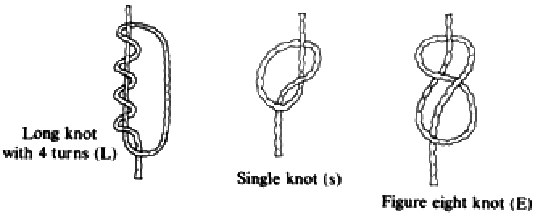
Quipu coding

Although the investigations have not clarified completely its interpretation, a simplification of a quipu consists in:

Each knot is a digit. A group of knots form a number.

There are three different types of knots:

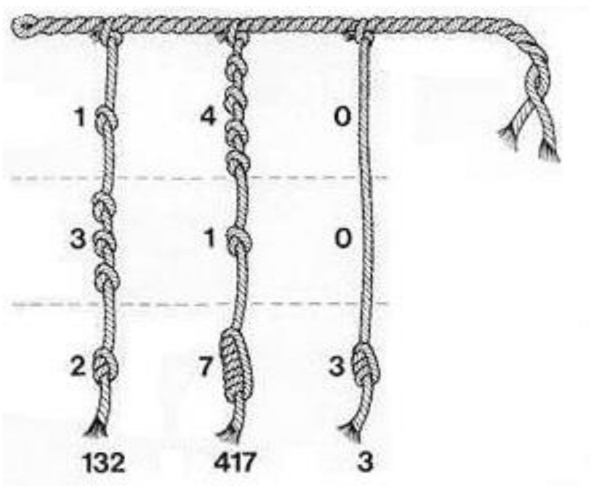
- Single: it is a single knot, represented with an `s`
- Long: it is a knot with one or more additional turns, represented with a `L`
- Eight shaped: represented with an `E`
- The absence of knot is represented with a `X`



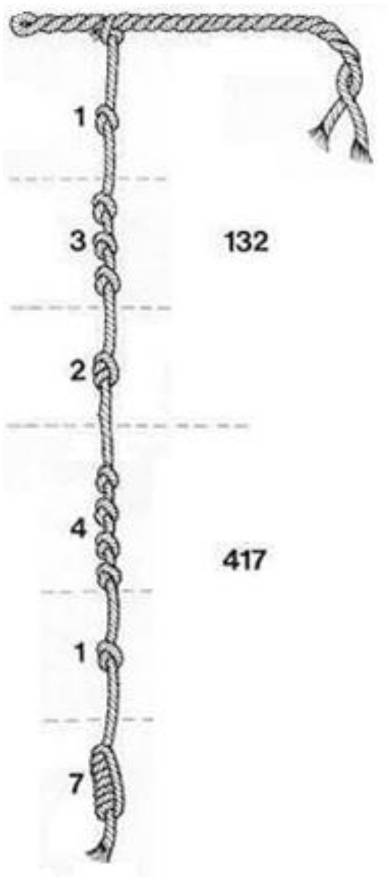
A number is represented by a sequence of knots in decimal base:

- Powers of ten are shown by position along the cord, and this position is aligned between successive cords.
- Digits in positions for 10^1 and higher powers are represented by clusters of simple knots (e.g., 40 is four simple knots in a row in the "tens" position).
- Digits in the 10^0 position are represented by long knots (e.g., 4 is a knot with four turns). Because of the way knots are tied, the digit 1 cannot be shown this way and is represented in this position by a figure-of-eight knot.
- Zero is represented by the absence of a knot in the appropriate position.
- Because the 10^0 digit is shown in a distinctive way, it is clear where a number ends. One strand on a quipu can therefore contain several numbers.

In example:
132 == 1s 3s 2L
417 == 4s 1s 7L
3 == X X 3L



In this case, there are two numbers in a single string:
132, 417 == 1s 3s 2L 4s 1s 7L



Input

Your program should read an input Quipu-matrix and help the quipucamayocs ("quipu specialists") to do some arithmetic.
It should calculate the sum of the numbers in the rows and columns, and return the Quipu-matrix with the original numbers, adding a final column with the rows' sums, and a final row with the columns' sums.
In example, for an input matrix (converted to decimal) as:

132	417	3
43	265	732

the program should calculate

```
132 + 417 +   3  =  552
 +       +       +
 43 + 265 + 732 = 1040
 ||      ||      ||
175     682     735
```

and return the matrix

132	417	3	552
43	265	732	1040
175	682	735	0

In this sample the numbers are in decimal just for clarification process, but the program must read and write the matrix in Quipu, of course, otherwise Incas will not understand it.
As the input Quipu-matrix size is unknown, it will end with the # character.

```
1s  X  X
 X  X 3s
 X 4s 2s
 E 3L  E
 #
```

Output

Corresponding to the numbers 1001, 43 , 321
...so **1001+43+321=1365** ...

```
1s  X  X  1s
 X  X 3s  3s
 X  4s  2s 6s
 E  3L  E  5L
```