Advanced Problem

Roman Numerals

14 March 2009

Source File	`roman.{java,c,cc}`
Input File	`roman.in`
Output File	*standard output*

For those of us used to Arabic Numerals, working with Roman Numerals can be tricky. Even adding one to a number can require a bit of thought. Your job is to take a list of Roman Numerals and to print out the next highest number. You are also to validate that the input you are given is a correctly specified number.

For those who are unfamiliar with Roman Numerals, here is a quick summary:

- Each letter used in Roman Numerals stands for a different number:

Roman Numeral	Number
I	1
V	5
X	10
L	50
C	100
D	500
M	1000

- The string of letters is the shortest possible combination of symbols, in descending order, which add up to the number. A string of letters means that their values should be added together. For example, XXX = 10 + 10 + 10 = 30, and LXI = 50 + 10 + 1 = 61. If a smaller value is placed before a larger one, we subtract instead of adding. For instance, IV = 5 - 1 = 4, XC = 100 - 10 = 90, and XIV = 10 + 5 - 1 = 14.

- Other rules:
  - Do not add more than three of the same letters together.
  - Subtract only powers of ten, such as I, X, or C. Writing VL for 45 is not allowed: write XLV instead.

- Subtract only a single letter from the last of a sequence of repeated numerals. Write VIII for 8, not IIX; 19 is XIX, not IXX; and, 189 is CXCIX, not CIXC.
- Don't subtract a letter from another letter more than ten times greater. This means that you can only subtract I from V or X, and X from L or C, so MIM is illegal.

Input

Input will come from the above captioned file. The number of lines of Roman Numerals is given as a single integer n

$$1 \leq n \leq 20000$$

on the first line.

Each of the subsequent n lines of the input file will be a string of no more than 20 characters. This string will contain only valid Roman Numeral characters ('`I`','`V`','`X`','`L`','`C`','`D`', and '`M`') and only in upper-case. All valid Roman Numerals in the input file will be in the range of I to MMMCMXCVIII.

Output

For each Roman Numeral input, you must print one line containing the next higher value. For example, for an input of `X` you would print `XI`, and for `CXCIII` you would print `CXCIV`. If an invalid Roman Numeral is given, you must print `invalid` on one line.

Output is emitted to standard output, with no leading or trailing spaces.

C, C++	`stdout`
C++	`cout`
Java	`System.out`

Example

Sample input and output are given in figures 1 and 2, respectively.

```
12
I
III
IV
V
XLVVX
MCMLXXXVIII
IIII
MCMXCIX
IC
XCIX
XM
MMMCMXCVIII
```

Figure 1: Input

```
II
IV
V
VI
invalid
MCMLXXXIX
invalid
MM
invalid
C
invalid
MMMCMXCIX
```

Figure 2: Output