UCF Local Contest — September 5, 2009

KenKen Solver

filename: kenken

KenKen is a popular game similar to Sudoku, but more mathematical by nature. The name, loosely translated, means "cleverness squared." Like in Sudoku, you start with an NxN grid, with the rule that each row and column must contain the numbers 1 through N. Furthermore, the grid is split into groups of adjacent cells which contain a number and a mathematical operator (shown by bold lines separating groups). Using the operator, you must place numbers in each group such that when using the operator you get the given number. For example, on a 4x4 grid, given the number 5 and the mathematical operator +, and a group of size 2, you could sum to 5 with the numbers 1 and 4, or with 2 and 3. If the group size was 3, the possible values would be {1,1,3} or {1,2,2}. Note that the order of numbers in the group is not important.

The initial puzzle will not contain any filled cells, and each group will be defined with its number and operator (groups of size 1 contain no operator – these are freebies). The operators used for groups of size greater than 1 are addition (+), subtraction (-), multiplication (*), and division (/). Here is an example of a solved puzzle:

80× 5	4	3 3	5− 1	6	2÷ 2
4	11+ 6	5	1− 2	3	1
9× 3	2 2	3− 1	4	30× 5	6
1	3	11+ 6	5	2÷ 2	4
6 6	8× 1	2	13+ 3	4	8+ 5
10× 2	5	4	6	1 1	3

Note that a group may contain the same number more than once, as long as no row or column contains a repeated number.

Groups using subtraction or division will always be of size 2, and no group will contain more than 10 cells.

The Problem:

Given the description of a KenKen board, solve the puzzle. Each puzzle is guaranteed to be solvable and have a unique solution.

The Input:

You will solve several puzzles. Each puzzle will begin with two positive integers $N \leq 9$ (the size of the board) and $G \leq 52$ (the number of groups in the puzzle). This will be followed by N rows, each containing exactly N letters (starting in column 1), describing the groups on the board.

Each group will be assigned an upper or lower case letter ('a-z' or 'A-Z'), and no two groups will have the same letter identifier (but note that 'a' ≠ 'A'). Each group will be defined by an adjacent set of cells of the same letter, where two cells are adjacent if they share a border to the north, east, south, or west (with no wrap-around top-to-bottom or left-to-right). Following this will be G lines (G is the number of groups in the puzzle). Each line will contain the letter of a group, the number of that group, and the operator of that group, each separated by a space. Each

of the G input lines will describe a unique group. The group identifiers will be the first G lowercase letters; if $G > 26$, the uppercase letters (starting with A and going in order) will also be used. Each mathematical operator will be '+', '-', '*', '/', or '.' (quotes for clarity), where '.' is used to denote a group which has no operator (for groups of size 1). End of input will be denoted by a puzzle with $N = 0$, and should not be processed.

The Output:

For each puzzle, begin with the line "`KenKen Puzzle #`*X*`:`", with X starting at 1. This should be followed by N lines, each containing exactly N digits, giving the solution to this puzzle. Follow each puzzle with a blank line.

(Sample Input/Output on the next page)

Sample Input:

```
2 4
ab
cd
a 1 .
b 2 .
c 2 .
d 1 .
6 18
aabccd
aeeffd
ghiijj
ggkkll
mnnoop
qqnorp
a 80 *
b 3 .
c 5 -
d 2 /
e 11 +
f 1 -
g 9 *
h 2 .
i 3 -
j 30 *
k 11 +
l 2 /
m 6 .
n 8 *
o 13 +
p 8 +
q 10 *
r 1 .
0
```

Sample Output:

```
KenKen Puzzle #1:
12
21

KenKen Puzzle #2:
543162
465231
321456
136524
612345
254613
```