

# Problem 8: Put the Fries in the Bag

## 5+4+6 Points

Problem ID: fries

Rank: 2+3+4

## Introduction

Big Ben, having graduated from [UC Berkeley](#), has used his [hard-earned degree](#) to serve at the drive-thru at McAlico's. With their patented McCursion Fries™ (so good you'll keep coming back for more!), they're sure to beat out their competition: renowned fast-food diner Oski Bearger.

Now he just has to make sure he doesn't reach in too far and fall into [McWonderland!](#)



# Problem Statement

You are given a string  $S$  denoting a McBlueprint consisting of the following characters:

- Vertical bars  $|$  denoting a McFry
- Pairs of parentheses  $()$  denoting a McBag, which can contain other characters inside them
- Letter Os  $\circ$  denoting a McCursion Portal, which can be recursively expanded with the entire McBlueprint

For example, if we had the McBlueprint  $(\circ|(\mid\circ))$ , it can be expanded as follows:

1.  $(\circ|(\mid\circ))$
2.  $((\circ|(\mid\circ))|\mid(\mid\circ|(\mid\circ)))$
3.  $((((\circ|(\mid\circ))|\mid(\mid\circ|(\mid\circ))))|\mid(((\circ|(\mid\circ))|\mid(\mid\circ|(\mid\circ)))))$
4. ...

Each McFry is contained within some number of layers of McBags. For example, the McFries within 1 layer of McBag are highlighted below:

$(\circ|\mid(\mid\circ))$

The McFries within 2 layers of McBags are highlighted below:

$((\circ|\mid(\mid\circ))|\mid(\mid|\mid(\mid\circ|(\mid\circ))))$

The McFries within 3 layers of McBags are highlighted below:

$((((\circ|\mid(\mid\circ))|\mid(\mid|\mid(\mid\circ|(\mid\circ))))|\mid(\mid|\mid(\mid|\mid(\mid\circ|(\mid\circ))))))$

Note that in order to find all of the fries with a large number of layers, you may have to recursively expand the McBlueprint multiple times, as illustrated above.

Find the total number of McFries that are within at most  $N$  layers of McBags. Output the value mod  $10^9 + 7$ .

# Input Format

The first line of the input contains a single integer  $T$  denoting the number of test cases that follow.

For each test case:

- The first line contains two space-separated integers  $L$   $N$  where:
  - $L$  denotes the length of the string  $S$ .
  - $N$  denotes the maximum number of layers of McBags.
- The second line contains a string  $S$  of length  $L$  denoting the McBlueprint.

It is additionally guaranteed that  $S$  consists of a valid parenthesis sequence (no unmatched open or closed parentheses).

# Output Format

For each test case, output the total number of McFries that are within at most  $N$  layers of McBags mod  $10^9 + 7$ .

# Constraints

$$1 \leq T \leq 10$$

## Main Test Set

$$2 \leq L \leq 20$$

$$0 \leq N \leq 5$$

## Bonus Test Set

Memory Limit: **1 GB**

$$2 \leq L \leq 100$$

$$0 \leq N \leq 10^9$$

## Bonus Test Set 2

Memory Limit: **1 GB**

$$2 \leq L \leq 5000$$

$$0 \leq N \leq 10^9$$

# Sample Test Cases

## Sample Input

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```
5
7 1
(||(()))
14 2
((||(|) |) | (|))
8 5
(|((0)))
5 3
(|OO)
6 5
(O(|))
```

## Sample Output

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```
2
5
2
7
4
```

## Main Sample Explanations

For test case #1, there are 2 fries within exactly 1 McBag and 1 fry within exactly 2 McBags. Therefore, you can grab at most 2 fries within at most 1 McBag.

For test case #4, the portals can be replaced by copies of the outermost bag as follows:

```
(|OO)
(|(|OO)(|OO))
(|(|(|OO)(|OO))(|(|OO)(|OO)))
```

This representation has 1 fry within 1 McBag, 2 fries within 2 McBags, and 4 fries within 3 McBags for a total of 7 fries within at most 3 McBags.