CS 153 Machine Exercise 2 - Linear Feedback Shift Registers

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1 Description

For this exercise, you have to implement an LFSR using Python (Python3). To check the correctness of your implementation, your LFSR will be simulated using different parameters (number of flipflops, initial values, feedback coefficients). Your program must be able to read from `stdin` (for the paraemters) and write to `stdout` (for the results).

2 Input Format

Input will start with a number `T`, which is the number of test cases. Each of the next `T` lines is a test case that contains three numbers, m, s, and p, delimited by spaces. These numbers define the LFSR:

- The first number m is the degree of the LFSR. The flipflops in the LFSR are labeled $m-1, m-2, \ldots, 2, 1, 0$, where $m-1$ is the leftmost flipflop and 0 is the rightmost flipflop. The output of the LFSR will come from the rightmost flipflop and the feedback will be given to the leftmost flipflop.
- The second number s is the initial value stored in the flipflops, encoded as an integer with m bits. Each bit in s represents a value stored in one of the flipflops. That is, $s = s_{m-1}s_{m-2}s_{m-3}\ldots s_2s_1s_0$, where s_i is the value stored in flipflop i.
- The third number p is the feedback coefficients of the LFSR, encoded as an integer with m bits. Each bit in p represents the state of a feedback switch. That is, $p = p_{m-1}p_{m-2}p_{m-3}\ldots p_2p_1p_0$, where p_i is state of the feedback switch that corresponds to flipflop i. If $p_i = 1$, then the output of flipflop i is included in the feedback. If $f_i = 0$, then the output of flipflop i is not included in the feedback.

2.1 Constraints

Here are the possible values of the input. You may assume that the input will always have the proper data types and the proper values.

- $m > 1$
- $0 \leq s < 2^m$
- $0 \leq f < 2^m$

3 Output Format

For each test case output

`case t:`

where `t` is the test case number (starting from 1), followed by 2^m lines. For the next 2^m lines, output

`clock: j, value: s_j`

where j is the number of the clock cycle (starting from 0) and `s_j` is the output of the LFSR at clock cycle j. The end of each test case must be followed by a new line.

4 Sample Input and Output

4.1 Sample Input

```
2
3 4 3
4 8 15
```

4.2 Sample Output

```
case 1:
clock: 0, value: 0
clock: 1, value: 0
clock: 2, value: 1
clock: 3, value: 0
clock: 4, value: 1
clock: 5, value: 1
clock: 6, value: 1
clock: 7, value: 0

case 2:
clock: 0, value: 0
clock: 1, value: 0
clock: 2, value: 0
clock: 3, value: 1
clock: 4, value: 1
clock: 5, value: 0
clock: 6, value: 0
clock: 7, value: 0
clock: 8, value: 1
clock: 9, value: 1
clock: 10, value: 0
clock: 11, value: 0
clock: 12, value: 0
clock: 13, value: 1
clock: 14, value: 1
clock: 15, value: 0
```

4.3 Explanation

The first line of the sample input indicates that there are two test cases. The first test case is the example LFSR from the lecture. It has three registers and their initial values s_2, s_1, and s_0 are 1, 0, and 0, respectively ($4 = 100_2$). The feedback coefficients p_2, p_1, and p_0 are 0, 1, and 1, respectively ($3 = 011_2$).

The second test case is an LFSR with 4 registers with initial values $s_3 = 1$ and $s_2 = s_1 = s_0 = 0$ ($8 = 1000_2$). The feedback coefficients are all equal to 1 ($15 = 1111_2$). By simulating the LFSR using pen and paper, you should be able to get the output shown.

See the sample input and output files for more examples.

5 Submission

You can submit your solution via UVLe. Submit only one Python file with the filename <student number>.py, no hyphens (ex. 201812345.py). Only one submission is allowed.

6 Grading

Your solution will be graded on a 0-1 basis. You will get a 100% for this exercise if your solution gets all the test cases correctly. Otherwise, you will get a 0. Sample input and output files are uploaded in UVLe, along with this exercise. You can check if your program works by running it on the sample input and comparing its output with the sample output.