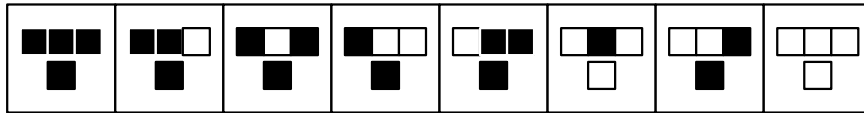


02-201 — Assignment 4 – Due Wednesday, Oct. 7 at midnight

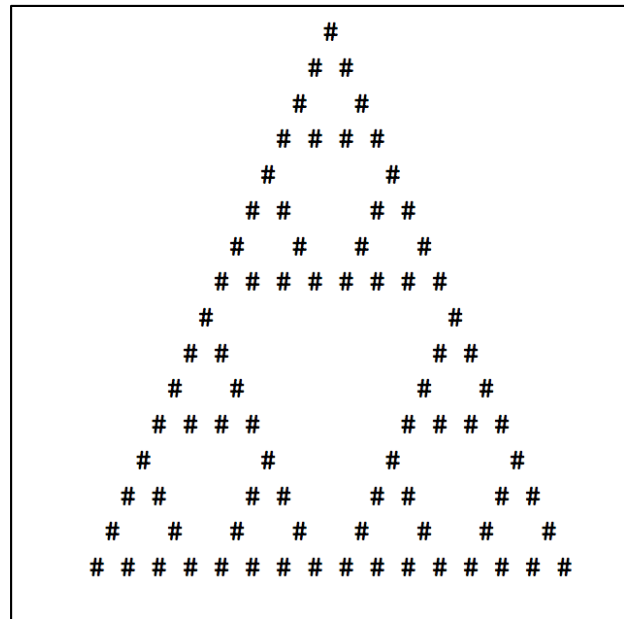
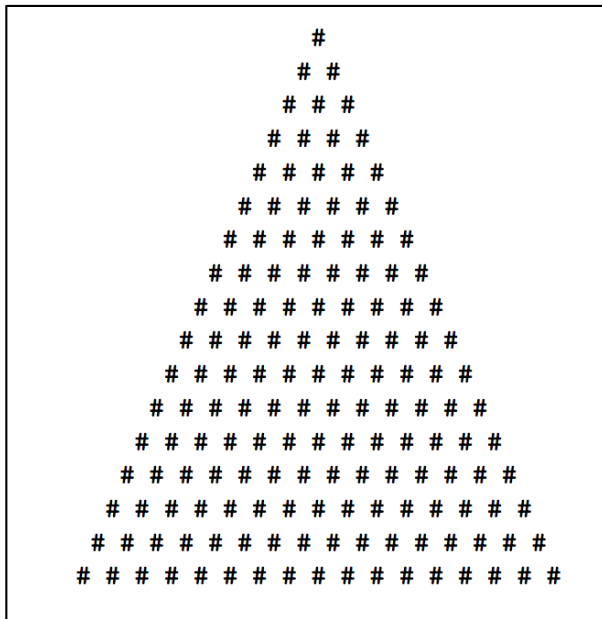
Cellular automata (CAs) are a simplified model of physics and complex systems that has been studied for many years. One-dimensional CAs are defined by the following rules:

- The “universe” is an infinitely long line of “cells.”
- Each “cell” can either be *filled* or *empty*.
- The state of a cell i at time t depends on the states of cells $i - 1$, i , and $i + 1$ at time $t - 1$. The rule for how cell i depends on these cells defines the particular CA you are studying. The rules are represented by diagrams of the following type:

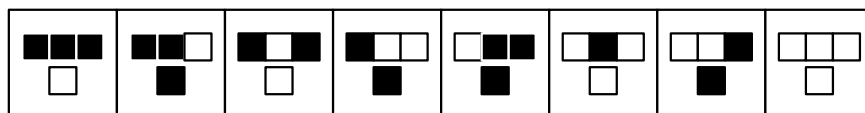


For example, the first part of the rule above means that if cell $i - 1$, i and $i + 1$ are all *filled* at time $t - 1$, then at time t , cell i will be *filled* (first box above). All the sub rules (boxes above) are applied simultaneously during a single step.

The interesting thing about CAs is that they can give surprisingly complex behavior. For example, the rule above produces the pattern on the left:



The rule



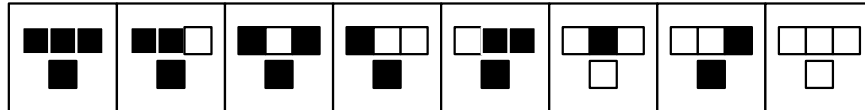
Produces the pattern on the right above, something even more complex.

The Assignment

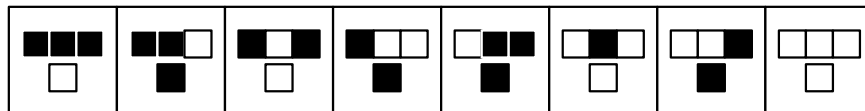
Input. You will write a program that takes in a CA rule and produces a given number of iterations of the CA. Your command should be able to be run using the following command line:

```
go run ca.go RULE WIDTH STEPS
```

Where **STEPS** is the number of steps to run the CA. Since we can't work with an infinitely long sequence of cells, we will only model **WIDTH** cells. Finally, **RULE** is a sequence of 8 '0's and '1's that give the outcome of each subrule in the order used in the examples above. For example, the rule:



would be given as “11111010” and the rule



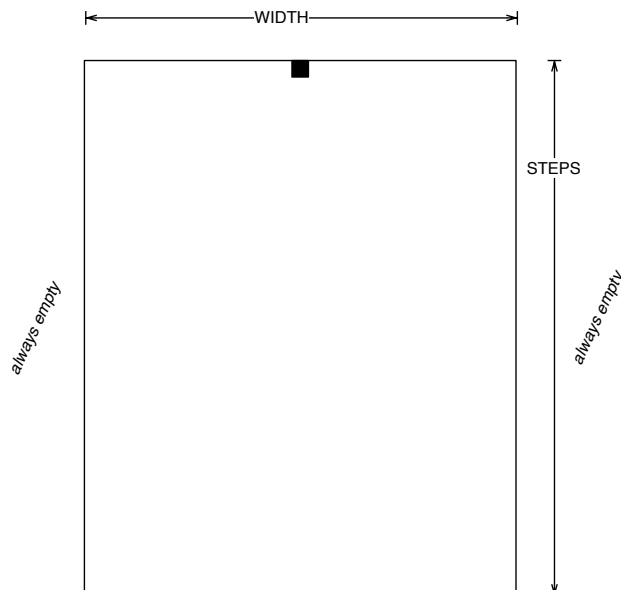
would be given as “01011010”.

Output. At each step, you should output the state of the cells. You should print an *empty* cell as a single space and a *filled* cell as a # character as in the examples above. You should output the state of the cells at the start too.

Your cells should initially all be *empty*, except for the cell at $\lfloor \text{WIDTH}/2 \rfloor$, which should be *filled*. (The $\lfloor x \rfloor$ notation means throw away the fractional part of x .)

If any of the command line parameters are not valid, you should output an error message that begins with **Error:** and stop the program.

Your program should assume that any cells outside of the **WIDTH** cells you are modeling are *empty* forever. That is you are just modifying cells $0 \dots \text{WIDTH} - 1$. The set up thus looks like this:



Learning outcomes

After completing this assignment, you should:

- be able to create lists.
- be able to walk through the items in an lists.
- be able to access characters in a string.
- have gained additional practice writing for loops, if statements, and functions.
- have practiced writing code with good “style” (formatting, modularity, comments).

Extra Credit!

Allow your program to accept *two* formats for the rule. The first format is the 0/1 string above. The second format is a number between 0 and 255 whose binary representation gives the string of 0s and 1s.