

Report

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Q1. What rule number would generate the following output? Explain how you figured out the rule number.

To figure out the rule number, we need to look at all possible scenarios. Analyzing the chart for examples of each possible scenario gives us the following results:

000	0
001	1
010	0
011	0
100	1
101	0
110	1
111	Undefined

Since we don't have an example of 111 in the graph, the number could be:

$$01010010 = 82 \text{ or } 11010010 = 210$$

Therefore, we I plugged both of these results into my program:

01010010

[illegible]

11010010

[illegible]

As these results show, both give the same result. Therefore rule number 82 or 210 would both generate this output.

Q2. Formulate a rule number from your student ID by taking a modulo operation with 256.

$$110373289 \% 256 = 169$$

a. A standard input of 40 cells.

```
Enter a rule number or press Q to quit.
169
How many generations?
20
Would you like to enter an array for input cells (Y/n)?
n
n
Enter input length:
40
00000000000000000000000000000000100000000000000000000
.....X.....
XXXXXXXXXXXXXXXXXX..XXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXX..X.XXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXX...XXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXX..XX.XXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXX..X.XXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXX..X.XXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXX.....XXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXX..XXX.XXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXX...XXX.XXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXX..X.X.XXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXX..X.X.XXXXXXXXXXXXXXXXXX
XXXXX.....XXXXXXXXXXXXXXXXXXXX
XXXX..XXXX.XXXXXXXXXXXXXXXXXX
XXXX..XXXX.XXXXXXXXXXXXXXXXXX
XX..X.XXX.XXXXXXXXXXXXXXXXXX
X...XXX.XXXXXXXXXXXXXXXXXX
..XX.XX.XXXXXXXXXXXXXXXXXX
```

b. A custom input formulated from your student ID by replacing odd numbers with 1's

$$110373289 \Rightarrow 110111011$$

```

Enter a rule number or presss Q to quit.
169
How many generations?
20
Would you like to enter an array for input cells (Y/n)?
y
Enter input cells array:
110111011
110111011
KX.XXX.XX
K.XXX.XXX
.XXX.XXXX
KXX.XXXX.
KX.XXXX.X
K.XXXX.XX
.XXXX.XXX
KXXX.XXX.
KXX.XXX.X
KX.XXX.XX
K.XXX.XXX
.XXX.XXXX
KXX.XXXX.
KX.XXXX.X
K.XXXX.XX
.XXXX.XXX
KXXX.XXX.
KXX.XXX.X
KX.XXX.XX
K.XXX.XXX
.XXX.XXXX

```

Q3. FST

```

000 --> 1
011 --> 1
110 --> 0
001 --> 0
100 --> 0
111 --> 1
101 --> 1
010 --> 0

```

a. I created the printTransitions function in my DFA, which gave me the following hashmap of transitions to use in my FST

b. Transition graph:

ii. Generic (Length 3)

```
//ECA
.X.
...
XXX
XXX
XXX
XXX
XXX
XXX
XXX
XXX
XXX
XXX
```

```
//FST
.X.
...
XXX
XXX
XXX
XXX
XXX
XXX
XXX
XXX
XXX
```

iii. Generic (Length 5)

```
//ECA
..X..
X...X
..X.X
...X.
XX...
X..X.
....X
.XX..
.X..X
X....
..XX.
```

```
//FST
..X..
XX...
.X..X
.X...
X...X
X..X.
X....
...XX
..X.X
....X
..XX.
```

iv. Custom (1001010)

```
//ECA
X..X.X.
....X.X
.XX..X.
.X....
...XXXX
.X.XXX.
..XXX..
X.XX..X
.XX...X
XX..X..
X.....
```

```
//FST
X..X.X.
X....X.
X..XX..
....X..
XXXX...
.XXX..X
.XXX...
X.XX..X
X.XX...
..XX..X
...X...
```

Looking at the above examples, we can deduce a few clear findings.

1. Both results always have the same number of 1s and 0s on every line - this suggests some kind of translation

For example, in output i line 1 has 3 dots and 17 X's for both models. They are just in different positions.

2. The X's are always the same distance apart when comparing every line - this suggests a translation even more strongly

For example, in iv, the second line of the first model isx.x at first this seems very different to the second line in the second model (x....x.), but translating the ECA line 1 space to the right gives this result

3. However, it doesn't seem to be a fixed translation (like move 2 units right), because sometimes the translation seems to move more than others

For example in iii, assuming the initial line is line 0: line 1 involves a translation 1 unit to the right, but line 2 needs to be translated 2 units to the right, and line 3 is translated 3 units to the right.

Based on the above, I believe the pattern to create the FST line based off of any give ECA line in this model is to translate the ECA line x units right, where x=the generation-1.

To test this, I tested the pattern with rule number 232 for 15 generations with input string 10110010010110 and achieved the following result:

```
//ECA
X.XX..X..X.XX.
.XXX.....XXXX
XXXX.....XXXX
XXXX.....XXXX
XXXX.....XXXX
XXXX.....XXXX
XXXX.....XXXX
XXXX.....XXXX
XXXX.....XXXX
XXXX.....XXXX
XXXX.....XXXX
XXXX.....XXXX
XXXX.....XXXX
XXXX.....XXXX
XXXX.....XXXX
XXXX.....XXXX
XXXX.....XXXX
```

```
//FST
X.XX..X..X.XX. (+0)
X.XXX.....XXX (+1)
XXXXXXXX.....XX (+2)
XXXXXXXXX.....X (+3)
XXXXXXXXXX..... (+4)
..XXXXXXXXXX.... (+5)
..XXXXXXXXXX.... (+6)
...XXXXXXXXXX... (+7)
....XXXXXXXXXX.. (+8)
.....XXXXXXXXXX. (+9)
.....XXXXXXXXXX (+10)
X.....XXXXXXXX (+11)
XX.....XXXXXX (+12)
XXX.....XXXXX (+13)
XXXX.....XXXX (+14)
XXXXX.....XXX (+15)
```

The pattern holds true! Each line of the FST represents the same line of the ECA+x units to the right (Where x is the line number).