Lab 3

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October 18, 2020

Abstract

This report have some developments of some of the coding for the cellular automata. According to Stephen Wolfram, cellular automata are mathematical models to study systems that follow rules of self - organization. We were able to employ three different methods: The first one using a spreadsheet, the second one using a lookup table, the third one using a direct formula.

1 Introduction

Cellular automata are idealizations where space and time are discrete, and in the case of the paper of Wolfram [1], the values are 0 or 1. A cellular automaton has two possible states (0 or 1) and the state of a particular cell in the next generation dependent on the values of the two immediate preceding neighbors. In this lab, I present three different methods to obtain cellular automata: a excel spreadsheet, a lookup table and direct formula. The last two are coded in Python.

2 Spreadsheet

Each cell will have the following formula that allow a computation of the two preceding cell =MOD(INT($A1/(2^(Y2*4+Z2*2+AA2))),2)$

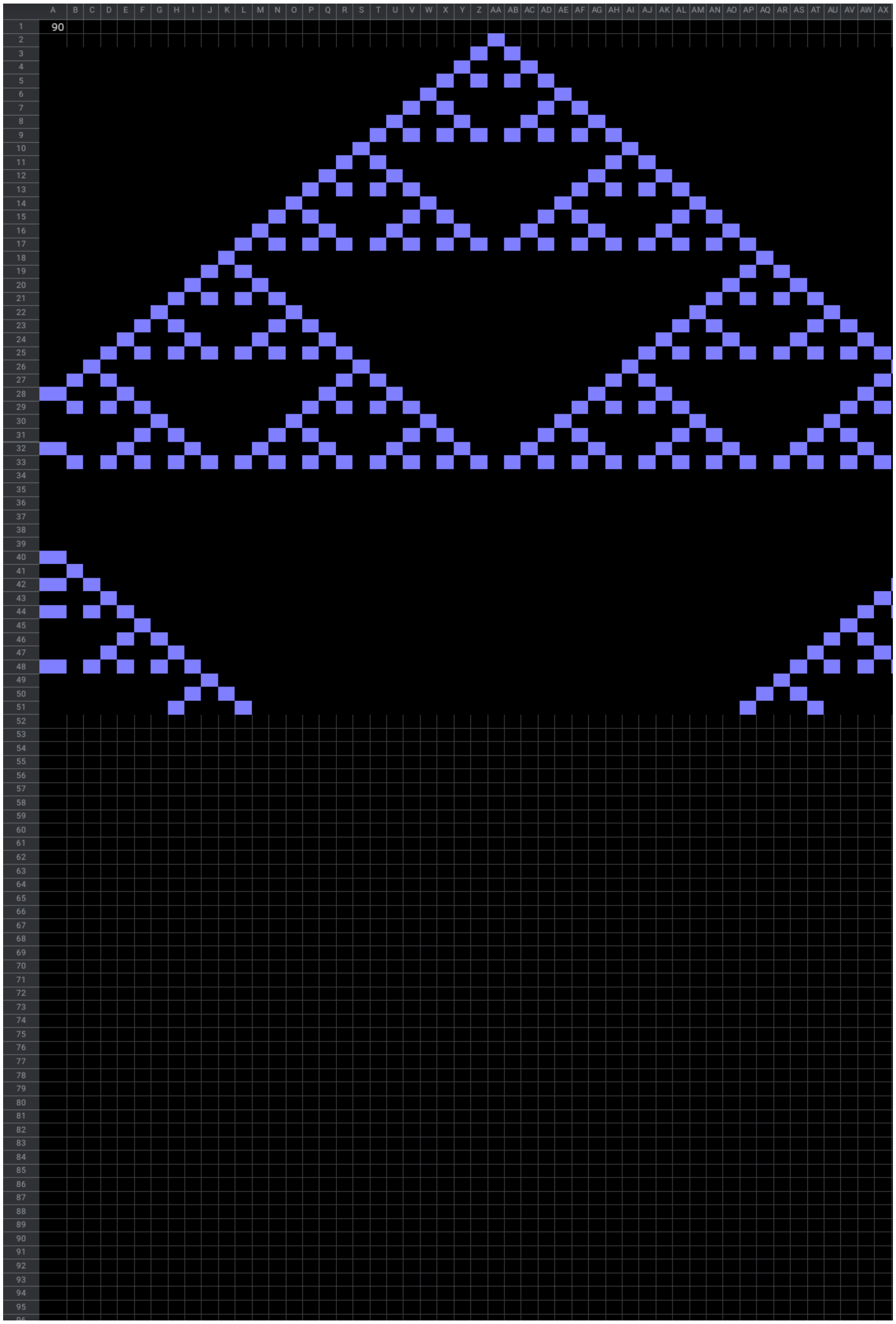

Figure 1. Representation of rule 90 in the spreadsheet

3 Lookup table

The second method to obtain the cellular automata exposed by Wolfram in his paper of 1983 is using a table in which each of the rules is converted to the binary system. The coding takes into account these conversions:

```
import numpy as np
import matplotlib.pyplot as plt
C = np.zeros((100,100)).astype(int)
def plot(x):
    fig, ax = plt.subplots()
    im = ax.imshow(x, cmap = 'gray')
    ax.axis('off')
    fig.set_size_inches(10, 10)
    plt.show()

plot(C)
C[0,50] = 1
plot(C)
bin(90)
rule = np.zeros((2,2,2))
rule[0,0,0] = 0
rule[0,0,1] = 1
rule[0,1,0] = 0
rule[0,1,1] = 1
rule[1,0,0] = 1
rule[1,0,1] = 0
rule[1,1,0] = 1
rule[1,1,1] = 0


def CA(X):

    for i in range(1,X.shape[0]-1): #row
        for j in range(1,X.shape[1]-1): #col

            N  = X[i-1,j]
            NW = X[i-1,j-1]
            NE = X[i-1,j+1]

            X[i,j] = rule[NW,N,NE]

    return X

plot(CA(C))
```

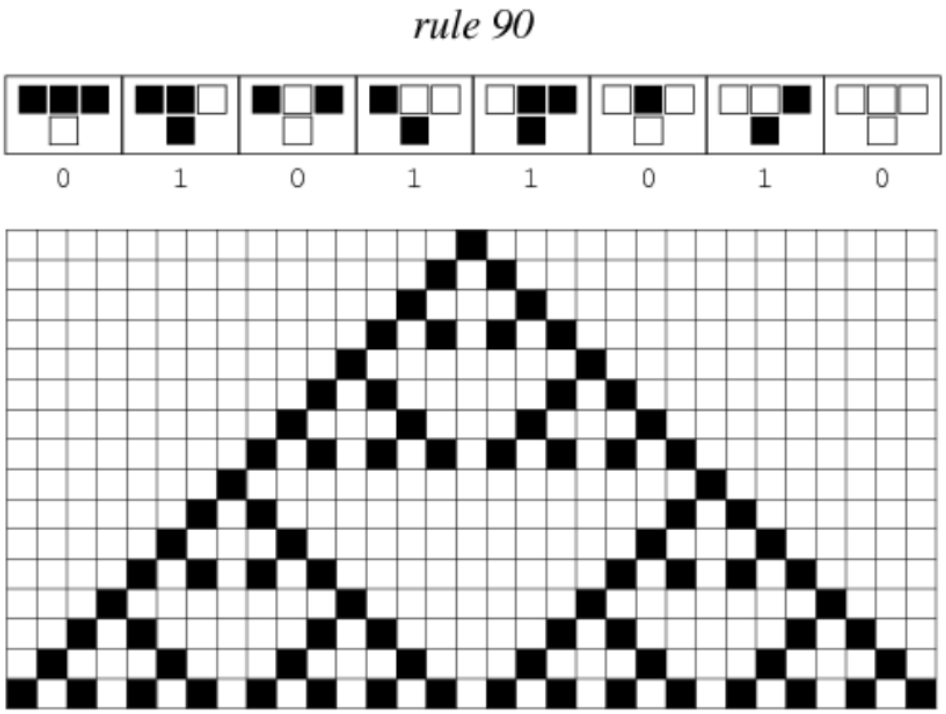

Figure 2. Representation of rule 90 in the lookup table

4 Direct formula

The third method have the coding in python for the direct formula. It indicat

```
[ ] rule = 90
```

```
[ ] plot(CA(C))
```

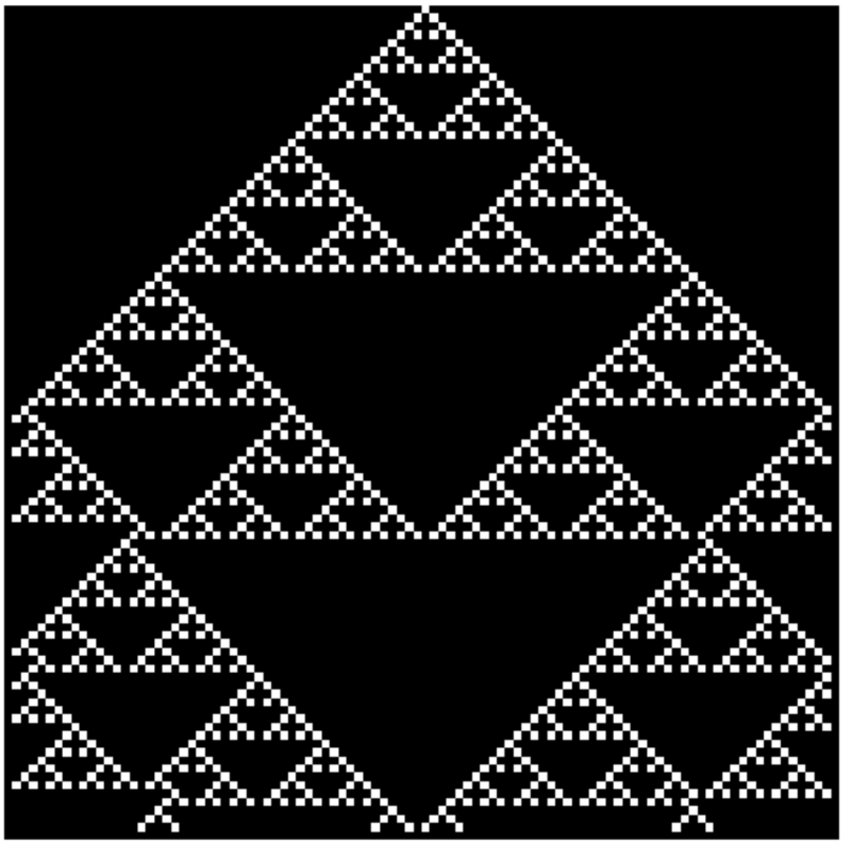

Figure 3. Representation of rule 90 in the direct formula

References

[1] S. Wolfram, *Statistical mechanics of cellular automata*, Rev Mod Phys **55**, 601 (1983).