Assignment #HW3 – Cellular Automata
CSSE490: Bio-Inspired Artificial Intelligence
Fall 2022

Prepared and submitted by:
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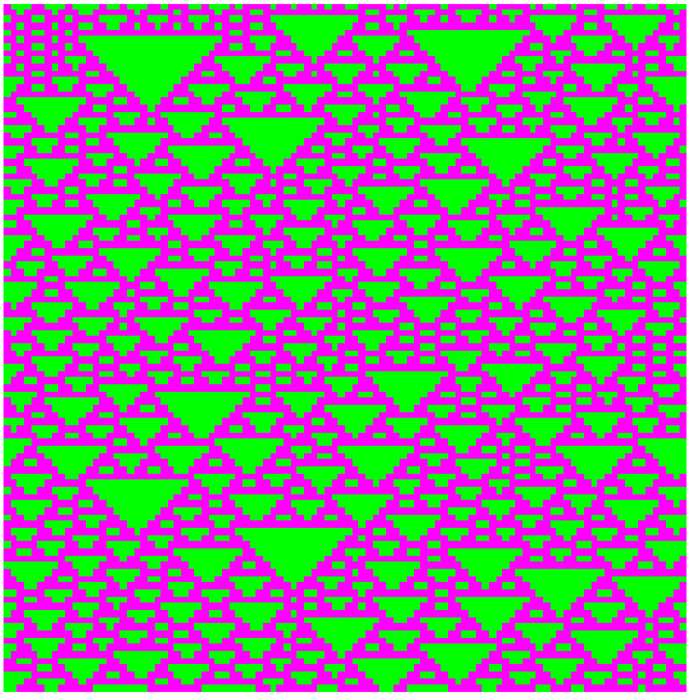
Collaboration and resources:
We worked alone

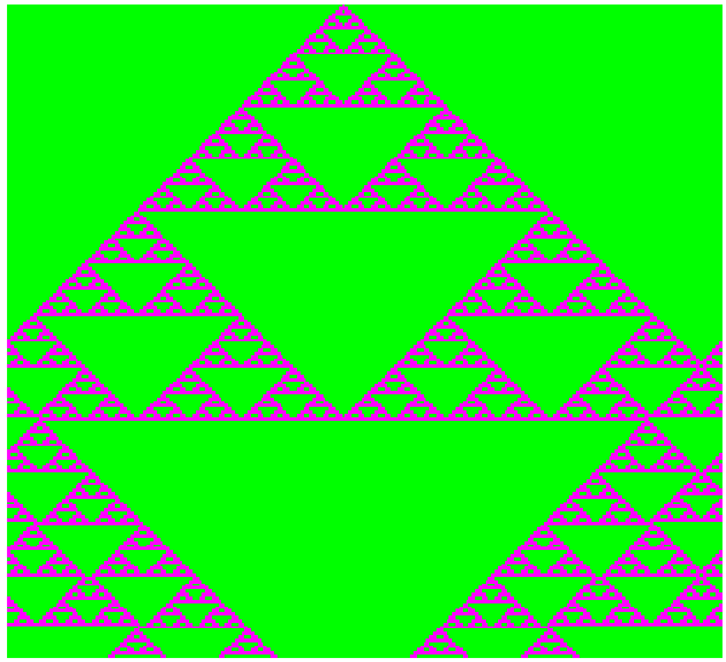
Resources I used to complete this assignment (websites, textbook, friends, etc.):
N/A

Checkpoints

For each checkpoint, simply include a screenshot of the output of your program demonstrating that the code is doing what it is supposed to.

Part 1.2 – Provide a screenshot of your simulator's presentation of rule 126:





Part 1.3 - 11 rules with the longest transient duration given the single "live" cell starting state

What are the rules that provide the 11 longest transient durations and how long do they last?

Rule	**30**	**45**	**75**	**86**	**89**	**101**	**135**	**149**	**169**	**225**	**110**
Duration	**1000+**	**1000+**	**1000+**	**1000+**	**1000+**	**1000+**	**1000+**	**1000+**	**1000+**	**1000+**	**83**

Part 1.4 - 13 rules with the longest transient duration given random starting states (average 100 runs)

(when over 1000 it defaults to 1000)

Rule	**120**	**101**	**89**	**75**	**106**	**45**	**225**	**169**	**86**	**149**	**135**	**30**	**193**
Duration	**990.2**	**983.32**	**979.17**	**966.96**	**965.26**	**961.35**	**956.62**	**928.78**	**890.92**	**878.83**	**875.11**	**853.3**	**123.57**

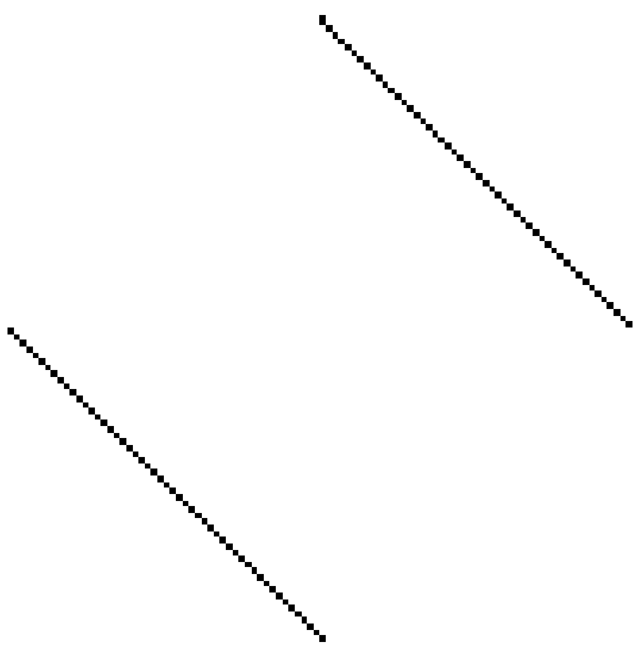
Part 1.5 - Analysis

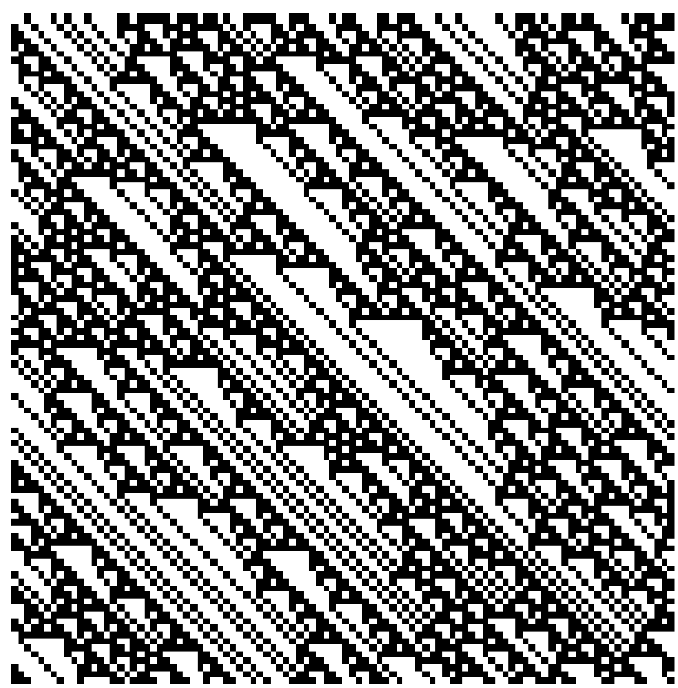
Take a look at a space-time diagram for the rules from 1.4 that did not make the top 11 in 1.3. Can you determine what causes them to last longer under the random states?

Looking at the space-time diagrams below, we see a very interesting pattern between them. For 120 and 106 it is the most obvious as they seem to be mirrors of each other. As you can see with the single alive cell in the middle as the starting state, the “movement” or “growth” across time stays in a line and is undisturbed, but with a random starting state different growth lines interact complexly creating a seemingly random pattern.

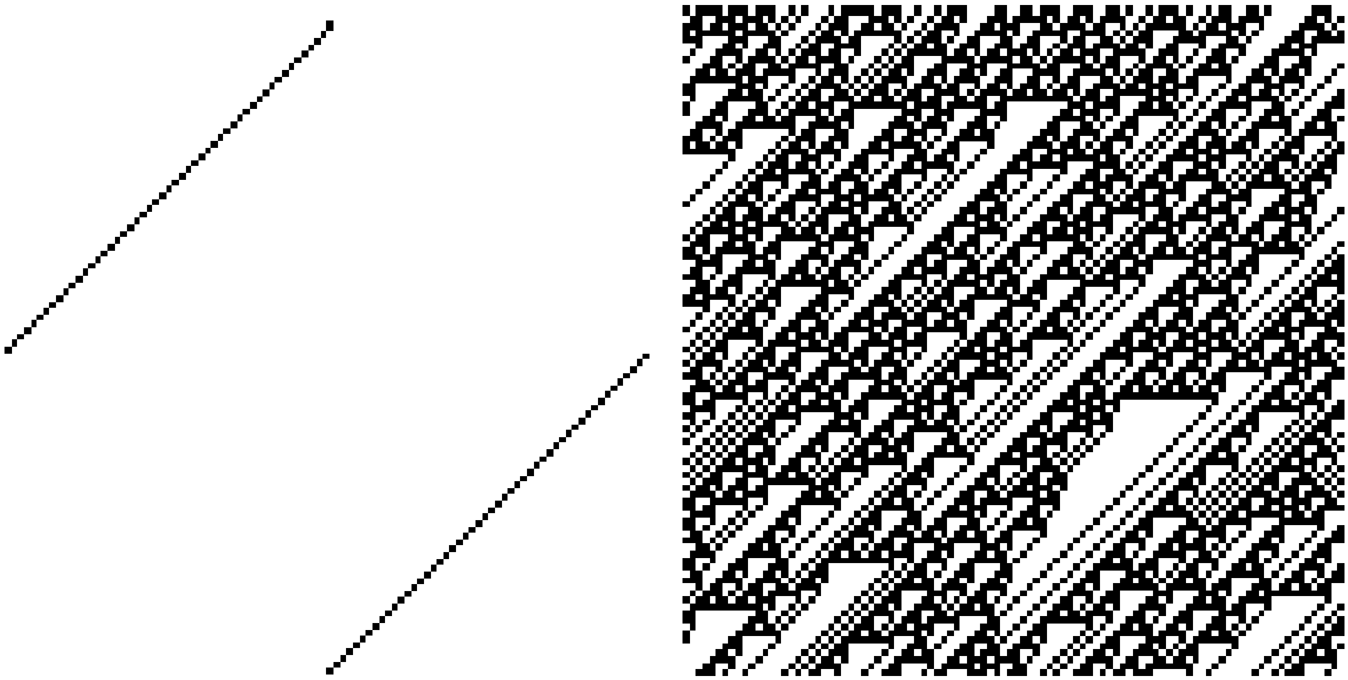
193 is more interesting as its average transient duration wasn't that long yet its pattern seems just as random as 120 and 106. It displays a similar difference between middle starting stand and random with growth lines interacting with each other earlier and more often in random starting states, but turns out to be much less random than the others.

120:

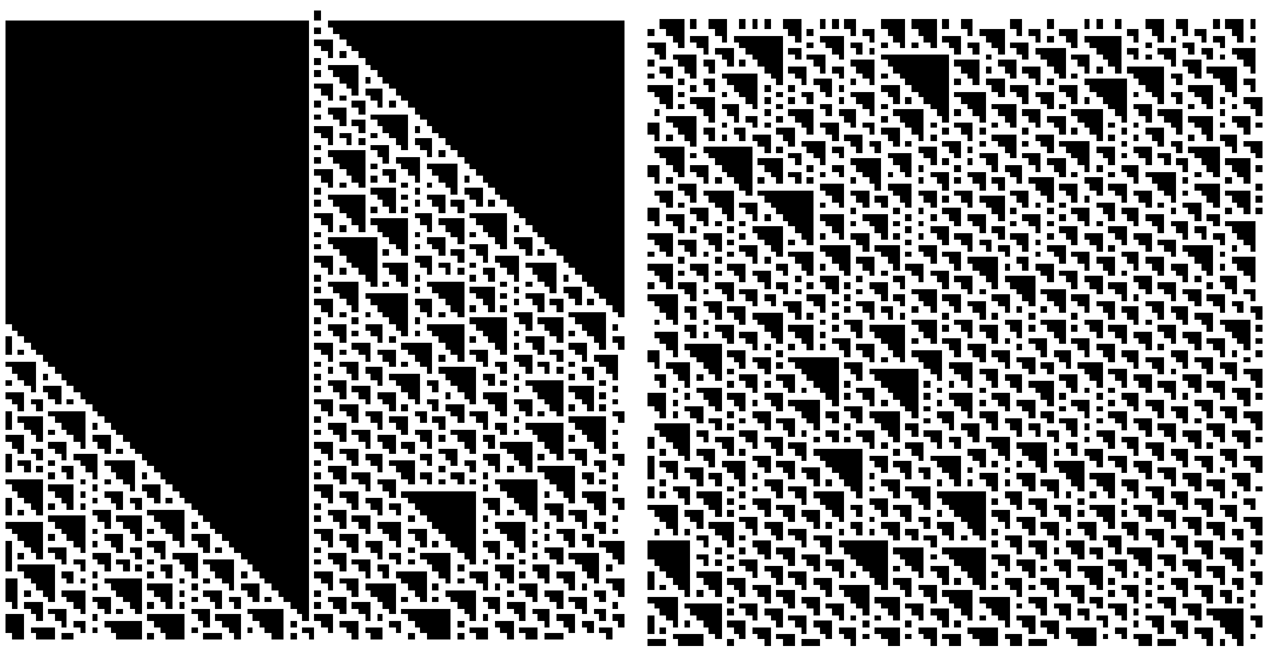




106:



193:



Part 1.6 – Edge of Chaos?

This is a very small system, but we can still test the general hypothesis regarding the dynamic activity of the CA in relation to the proportion of transition rules going to a live or dead state. What is the value of lambda for the rules with the long-lasting transient durations for 1.4 and 1.5? To calculate lambda, simply take the number of transition rules that lead to a live state divided by the total number of transition rules (8).

Rule	**120**	**101**	**89**	**75**	**106**	**45**	**225**	**169**	**86**	**149**	**135**	**30**	**193**
Lambda (0.0-1.0)	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.375**

Does this evidence support the conjecture of the paper, “Computation at the Edge of Chaos”? Why?

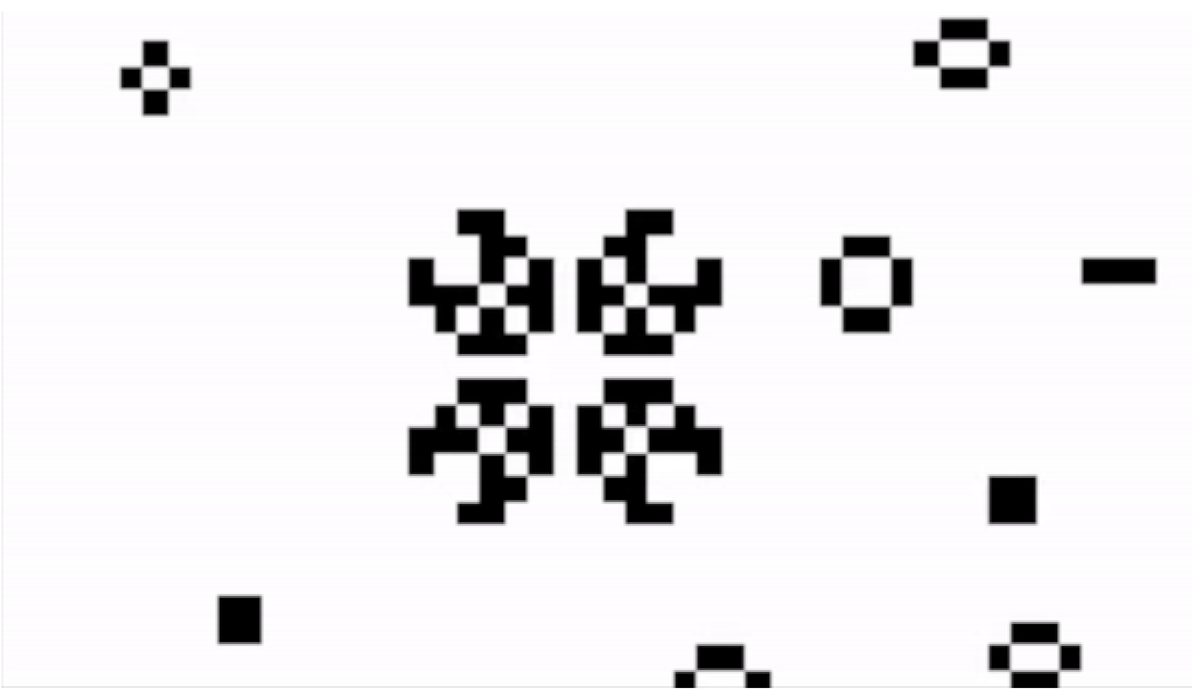
This evidence, amazingly, grealy supports the conjecture of the paper, “Computation as the Edge of Chaos.” The main conjecture of the paper is that the most interesting and complex (in some senses of the word) phenomena happen at “the edge of chaos”. The basic idea is that systems too simple and ordered (often with a lower lambda) are uninteresting, and the same goes for systems too complex and chaotic as not much can be learned from complete randomness. In Langston’s model simplicity and orderliness correlates with lower lambda and chaoticness correlates with higher lambda. In our experiment this is not exactly the case as a lambda of 1 results in complete orderliness as does a lambda of 0. But the general idea still remains true, that systems with some chaos but not complete chaos are the most interesting. For example in our trials we concluded that 193 was the most interesting as it exhibited seeming randomness to the naked eye, but according to its transient duration it is not that random. Not only this, but all the rules with high transient duration had an intermediate lambda (most with 0.5) while rule 193 strayed slightly from 0.5 and was the most interesting. I would be interested in creating a complexity curve, mapping lambda to transient duration, for all the rules to see how our curve would compare with langstons.

Part2:

Add screenshots and names of AT LEAST 5 identified patterns from this list:

https://en.wikipedia.org/wiki/Conway%27s_Game_of_Life#Examples_of_patterns

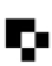
Pulsar and Blinker



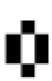
Glider

Toad

Boat



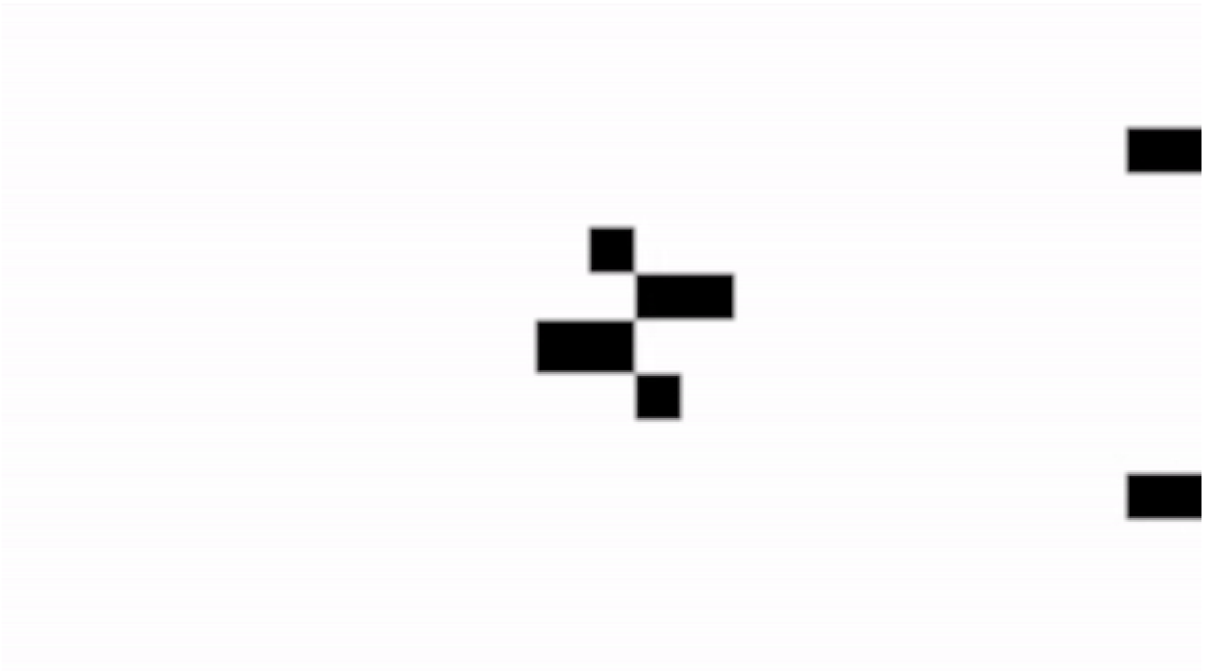
Bee-hive



If you discover something interesting, please record a video of it (Window + G, allows an easy way to record in Windows 10) and then mention it here so we know to look for it.

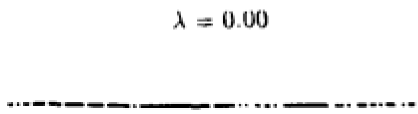
1) **There was a sibling that grows symmetrically side by side. The video is too long to make a gif.**

2) New pattern found (produced by seed 80301 with 8% of the initial cells being alive)

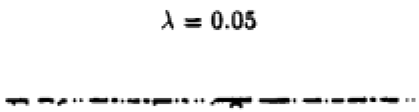


AWESOME SAUCE: Langstons CA
N = 5, K = 4

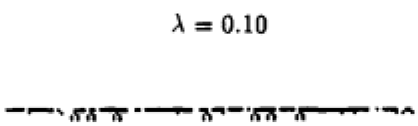
Lambda = 0
Seed = 48419



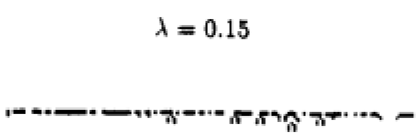
Lambda = 0.05
Seed = 12289



Lambda = 0.10
Seed = 53670

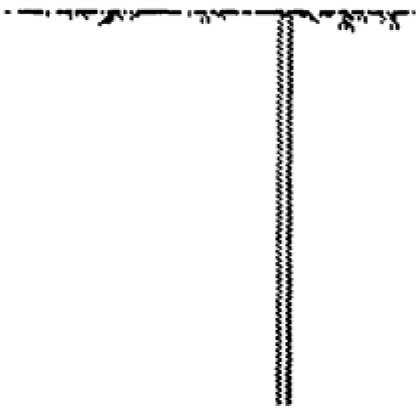


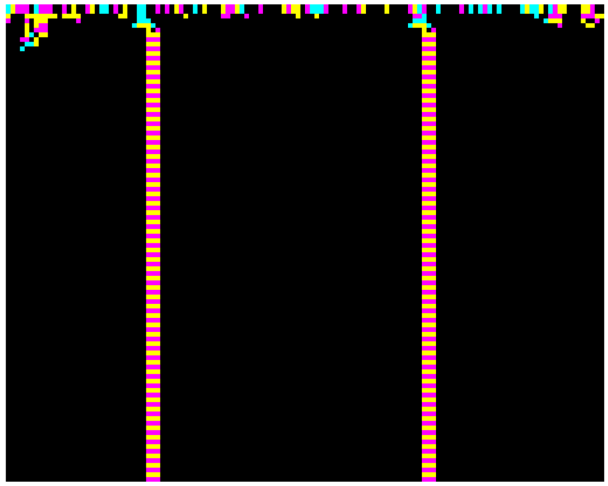
Lambda = 0.15
Seed = 21552



Lambda = 0.20
Seed = 96552 (Candy Cane!)

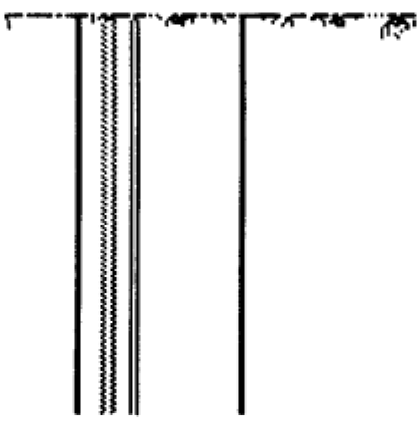
$\lambda = 0.20$

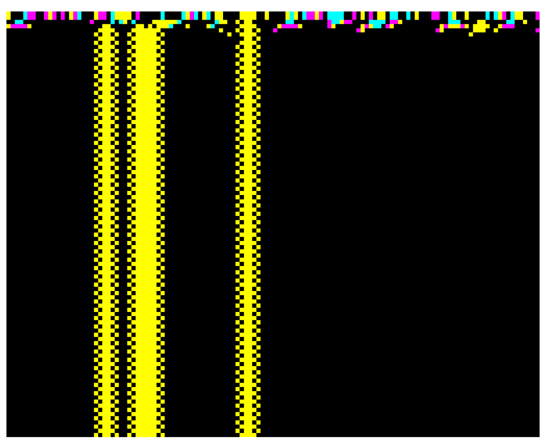




Lambda = 0.25
Seed = 29388 (Corn!)

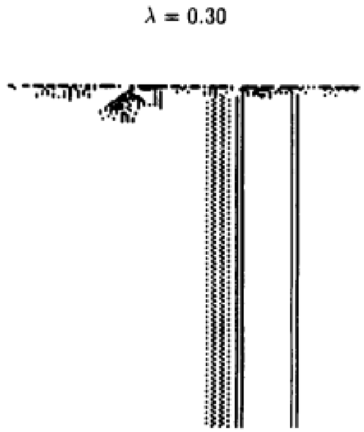
$\lambda = 0.25$

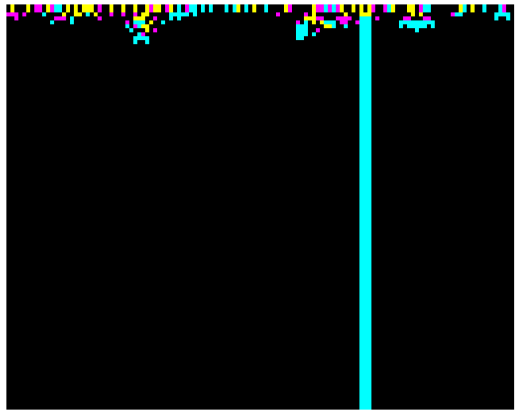




Lambda = 0.30

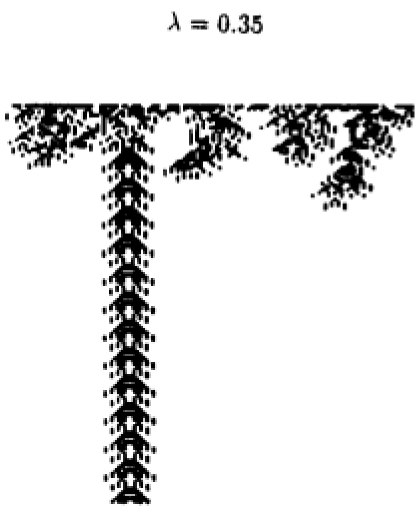
Seed= 26624

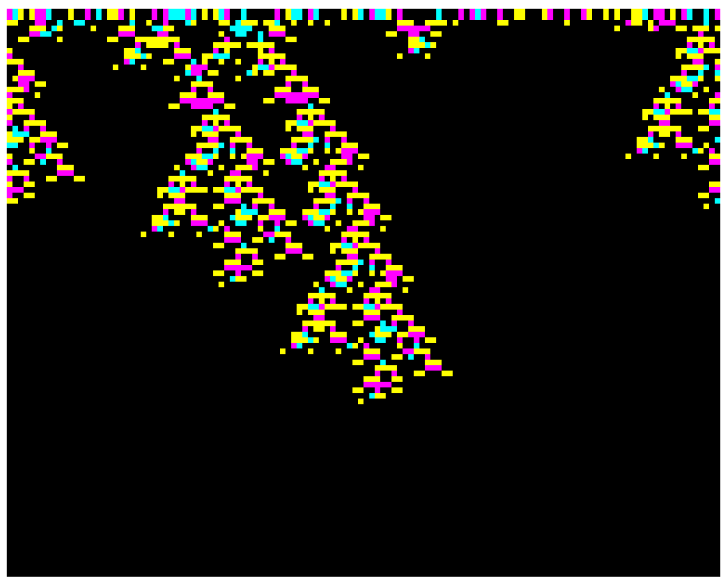




Lambda = 0.35

Seed = 32379

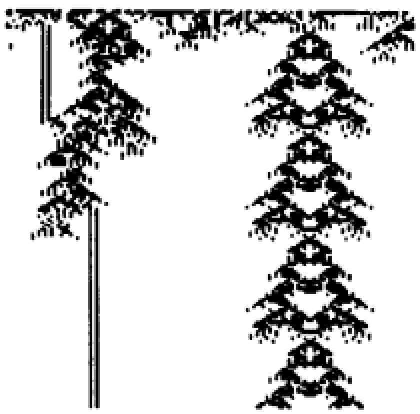




Lambda = 0.40

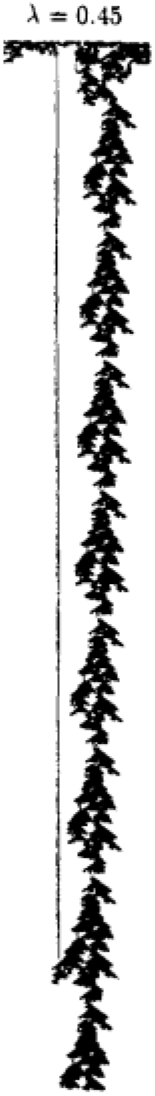
Seed = 38634

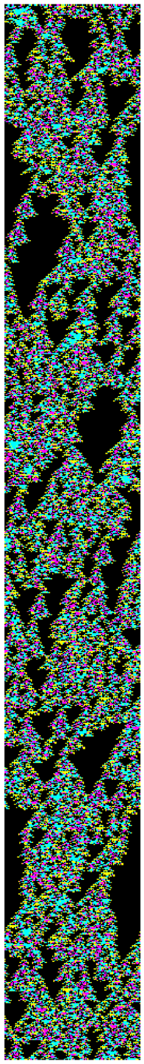
$\lambda = 0.40$



Lambda = 0.45

Seed = 20454



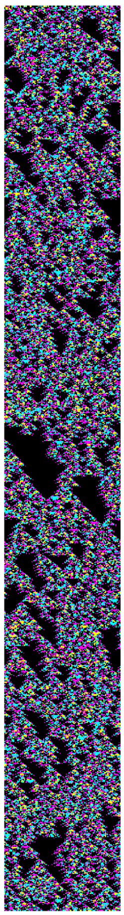


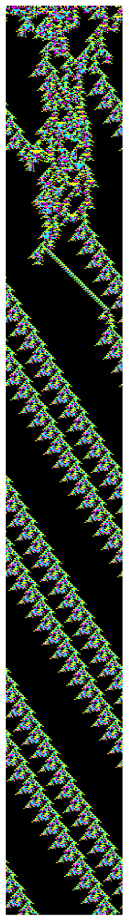
Lambda = 0.50

Seed = 37585

Seed = 298

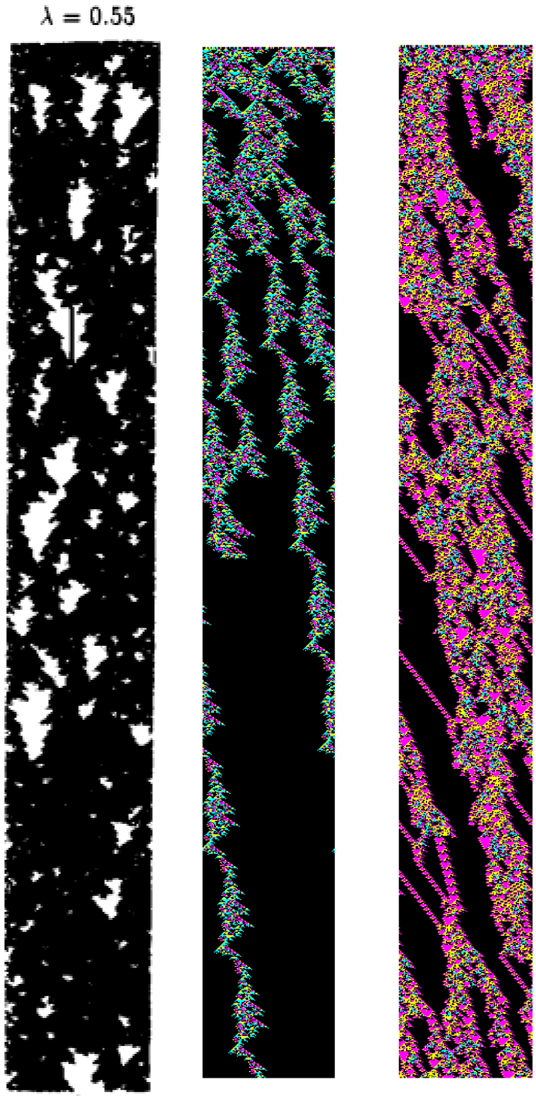
$\lambda = 0.50$





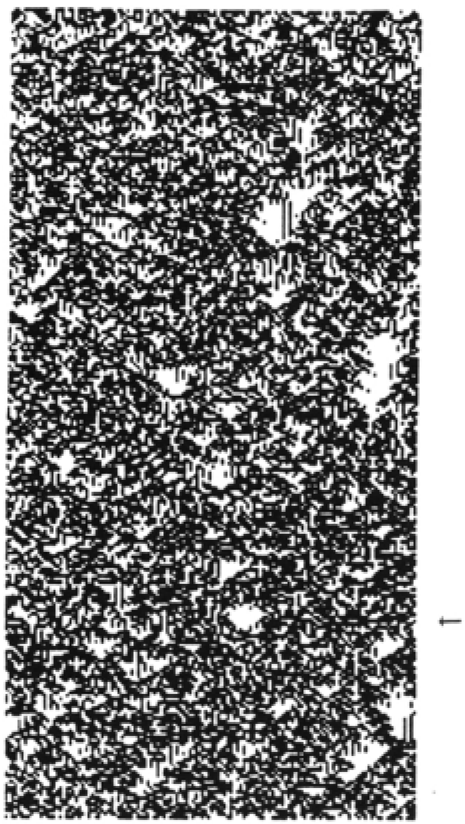
Lambda = 0.55

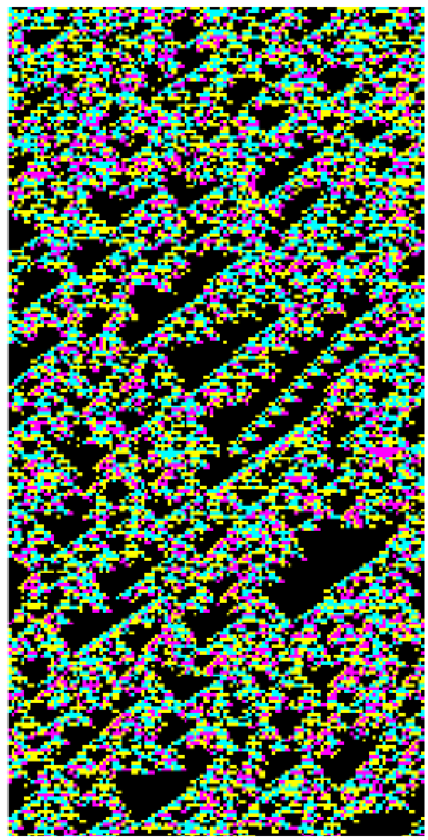
Seed = 54871



Lambda = 0.60
Seed = 37433

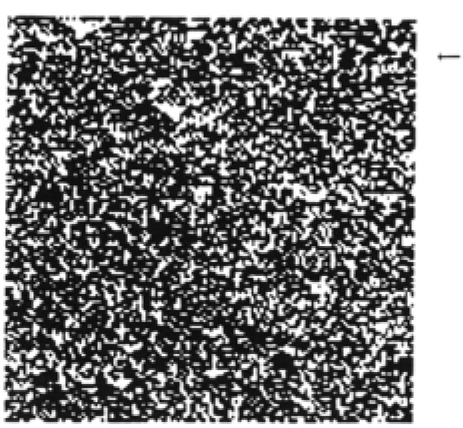
$\lambda = 0.60$

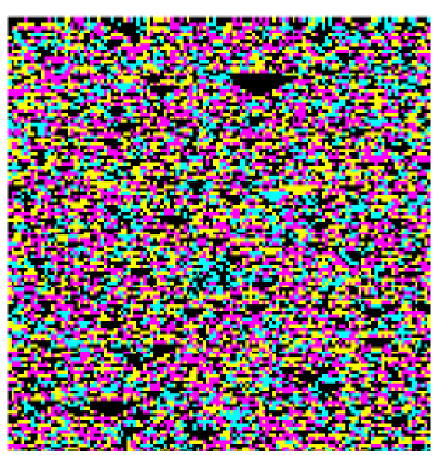




Lambda = 0.65
Seed = 97685

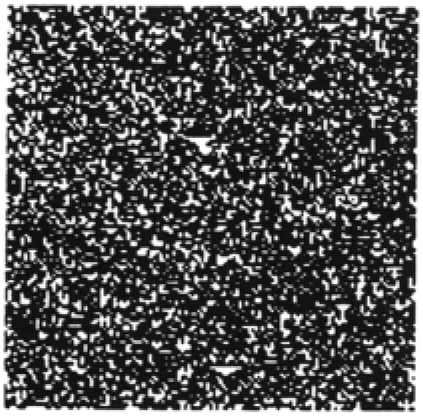
$\lambda = 0.65$

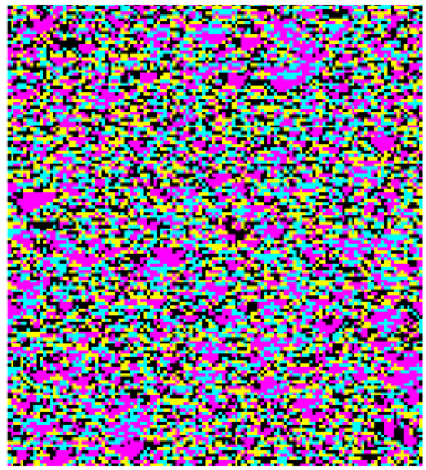




Lambda = 0.70
Seed = 33662

$\lambda = 0.70$





Lambda = 0.75
Seed = 32502

$\lambda = 0.75$