

Lab 5: Genetic Algorithms

DUE: Monday, November 15, in class at the start of class.

In this lab you will experiment with the Game of Life and with one-dimensional cellular automata.

1. In this step you will experiment with the Game of Life. In Netlogo, go to the Models Library, then to the Computer Science folder, then to the Cellular Automata folder, and open the model “Life”. This is a Netlogo implementation of the Game of Life.
 - a. Using the “setup-random” button, start Life off with a random initial pattern. Click on “go-forever”, and watch the action until the lattice has reached a fixed-point configuration (possibly with some oscillating “blinkers”). Do this a few times, for different initial densities. In your report, draw 10 different types of fixed-point or oscillating “creatures” (small patterns) that you observe.
 - b. Using the “setup-blank” button and the “add-cells” button, create several gliders going in different directions (see Figure 10.3, p. 150 in the textbook). See what happens when two gliders collide. (This is for fun – no need to include results in your report.)
 - c. Modify the Life rule in some way (by changing the Netlogo code). Repeat part (a). Describe your new rule and report on what differences you observe from the original version of Life. Now try a second modification, and report on what differences you observe.
2. In this step you will experiment with elementary one-dimensional CAs and the lambda parameter.
 - a. In class, we discussed the elementary cellular automata: one-dimensional, binary state, each cell connected to its two nearest neighbors. There are 256 such cellular automata. Explain where this number comes from.
 - b. Each elementary CA is defined by 8 bits (the values of its update states for the 8 possible neighborhoods). As described in the book, Wolfram proposed a numbering scheme in which the 8 bits are interpreted as a binary integer. Assume the following ordering of the 8 possible neighborhoods:
111 110 101 100 011 010 001 000

As an example, let the following be the output states for each corresponding neighborhood:

1 0 1 0 0 0 1 1

Interpreted as a binary integer, this is cellular automaton 163. Its lambda value (the fraction of 1s in the update states) is $4/8$ ($= 0.5$).

Note that there are only 9 possible lambda values for such CAs: $0, 1/8, 2/8, \dots, 8/8$

For each of these lambda values, except 0 and $8/8$, choose two different elementary cellular automata with that lambda value, and give its Wolfram number. For your report, create a table like the following (feel free to use different CAs from those in the table for these lambda values):

lamda	CA	Wolfram rule number	Wolfram class
1/8	00100000	32	
1/8	00001000	8	
2/8	10001000	136	
2/8	00100010	34	

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Finish this table, choosing CAs for the other lambda values. Now, use the applet at <http://www.cs.uic.edu/~wilkinson/Applets/automata.html> to view the behavior of the CAs in your table. Use the left < and right > arrow buttons under the display to scroll through the Wolfram numbers, and the top “random seed” button to run the corresponding CA starting with a random initial pattern.

For each of the CAs in your table, view its behavior starting with several random patterns, and decide which “Wolfram class” it is in, given the description of the classes on pp. 155–156 of the textbook. Fill in the class numbers in your table. In your report, give your finished table, and discuss in a paragraph or so how well lambda correlates with Wolfram class in your sample of elementary CAs.