CS 346U: Exploring Complexity in Science and Technology

Week 6 Assignment

Due Wednesday November 13

I. Watch videos for Unit 6 on http://complexityexplorer.org

II. Reading: Textbook, Chapters 10 and 11

III. Exercises (Ungraded and not turned in):

• All quizzes and exercises in Unit 6. Do these **before** you do the Unit 6 test.

IV. Unit 6 test (complete and submit online).

V. Assignments to turn in

1. Abstract for final project (one or two paragraphs describing what you plan to do, along with list of at least two papers you will read on the topic of your simulation).

For questions 2-3, use the following guide to simple stable Life patterns for reference:


(From http://pentadecathlon.com/lifeNews/2006/06/collisions/trivial/trivial.ltbl?bits=8&columns=6)

2. Using the **Mini-Life** NetLogo model, try the following initial pattern of five black cells, which Conway called the "R-pentomino":
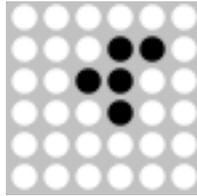
Put this pattern somewhere near the center of the lattice. Run the CA until the lattice has settled into a stable set of patterns.   Which of the above final patterns do you see, and how many copies?   (Note that you may see patterns as rotated versions of the ones in the picture above. These still count as instances of the given pattern.)

3. Using Mini-Life.nlogo, create an initial pattern like the one below, placing it near the center of the lattice. Run the CA until the lattice has settled into a stable set of patterns. Which of the above final patterns do you see, and how many copies?
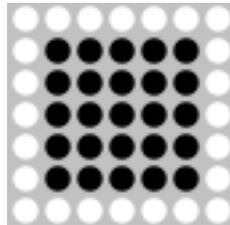
4. In the Code tab of Mini-Life, change the rules of Life to be:

- If a cell has < 4 black neighbors, then turn black, otherwise turn white.

Try this new rule out on some random initial lattices (using "randomize" with 12% black). What is the effect of this rule change on the behavior of the cellular automaton after several time steps?   Does this variant of Life still produce interesting behavior? Write a sentence or two describing your results.

5. Make another change of your own choosing to the Game of Life rule and experiment with the behavior of your rule on several random initial lattices. Describe your change and what kind of behavior it produces.

6. In the Code tab of Mini-Life.nlogo, change these two lines in the `go` procedure:

```
[ask cells [count-black-nbrs]]
[ask cells [change-color]]
```

to the following single line:

```
ask cells [count-black-nbrs change-color]
```

This is now an *asynchronous* system, where cells (in random order, once per generation) change their colors immediately upon counting their neighbors, without waiting for them to finish their own counts. Is this new system *deterministic*: does it always calculate the same resulting patterns from the same initial conditions?   How does this new system's behavior compare with that of the original Game of Life cellular automaton?   Write your answers in one or two paragraphs.

7. What is the Wolfram code number in base 10 of the elementary CA rule
 1 0 1 0 0 1 0 1 ?   What "Wolfram class" is it in?

8. What is the Wolfram code number in base 10 of the elementary CA rule
 0 0 1 0 1 1 0 0 ?   What "Wolfram class" is it in?

9. What is the Lambda value of ECA rule 90?

10. Langton's hypothesis was that an ECA with Lambda close to 1/2 should typically have more complex behavior than an ECA with a much lower Lambda value.   Is this true when you compare the typical behavior of rule 32 and rule 90?   How about when you compare rule 24 and rule 30?

11. Choose five different Elementary CAs that have Lambda = 1/2. Test each of these on several initial configurations (using ElementaryCAs.nlogo).   Which ones have "chaotic" looking behavior (Wolfram class 3)? Write a paragraph giving the Wolfram numbers of the CAs you have chosen, and the class of behavior you observe in each.

12. Give an example of an ECA with Lambda value 1/2 that does not have "complex" behavior (i.e., is in Wolfram class 1 or 2).   (If you found one in answering Question 10 above, you can give that one as an example; otherwise give a different one as an example.)

What to turn in: Complete and submit the Unit 6 test online.   Email a pdf document with your answers to Assignments 1-12 to mm@cs.pdx.edu.   You don't need to turn in any NetLogo models this week.