Autonomous Intelligent Systems,
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Exercises for Artificial Life (MA-INF 4201), SS11

Exercises sheet 3, due: Mon 9.05.2011

2.5.2011

Group	Name	19	20	21	22	23	Σ

Assignment 19 (4 Points)

The idea has come up to use Cellular Automata to work on *non-grid* structures.
Develop and describe a way to operate a Cellular Automaton to work with the following three topologies:
an undirected graph, a tree, a binary tree.
Please describe how the topology is influencing the structure and the definition of the rules, the neighborhood, the number of possible rules and propose a way to calculate a numerical value for describing the rule (following the concept of Wolfram Numbers).

Assignment 20 (3 Points)

Describe the below listed CA application in your own words (max 1/2 page of text), and answer the following questions within your text:
What is the application trying to do? How is the CA used to do this? What are the major result within this application?

Joachim Wahle, Michael Schreckenberg:
A Multi-Agent System for On-Line Simulations based on Real-World Traffic Data, Proc. of the 34th Hawaii International Conference on System Science 2001, p. 3037.
http://www.ais.uni-bonn.de/SS11/4201/wahle_schreckenberg_2001.pdf

Assignment 21 (3 Points)

Imagine Langton's Ant starting in a white square of an (infinite) chess-board.
Depict the first 8 steps.

Assignment 22 (3 Points)

Describe the different phases of the behaviour that Langton's Ant shows on a uniform white plane in your own words.

Assignment 23 (2 Points)

Compare the patterns that Langton's Ant created after N steps for the case **A** when started on a uniform white plane, with case **B** when started on a uniform black plane.

Artificial Life – Exercise 3

Jaana Takis, Benedikt Waldvogel

Assignment 19

Proposed idea on how to use CA on non-grid structures:

Cellular automata could in theory be used in order to represent the edges of the graph. We assume that all vertices are labelled as integers and all relations between nodes can be represented by values from a predefined set (k).

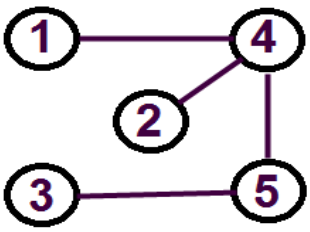
Undirected graph

CA could be used in the representation of each vertices symmetrical relation type to others. Eg. given the vertices 1, 2, 3, 4, 5 representing rooms in the house and the following rules for each vertice of the graph:

Vertices	**1**	**2**	**3**	**4**	**5**
1	0	0	0	1	0
2	0	0	0	1	0
3	0	0	0	0	1
4	1	1	0	0	1
5	0	0	1	1	0

where k = {0 – no relation, 1 – symmetrical relation “is connected to”}

We could then determine that the graph looks like this:



In this way each node's connection types could be represented by a Wolfram number, eg.

1: 1000b = 8D
2: 1000b = 8D
3: 10000b = 16D
4: 10011b = 19D
5: 01100b = 12D

The neighbourhood of the rule is the number of nodes in the graph. The number of possible rules being $v*k^{v-1}$ (where v stands for the number of vertices in the graph, k – no. of states).

Tree/binary tree

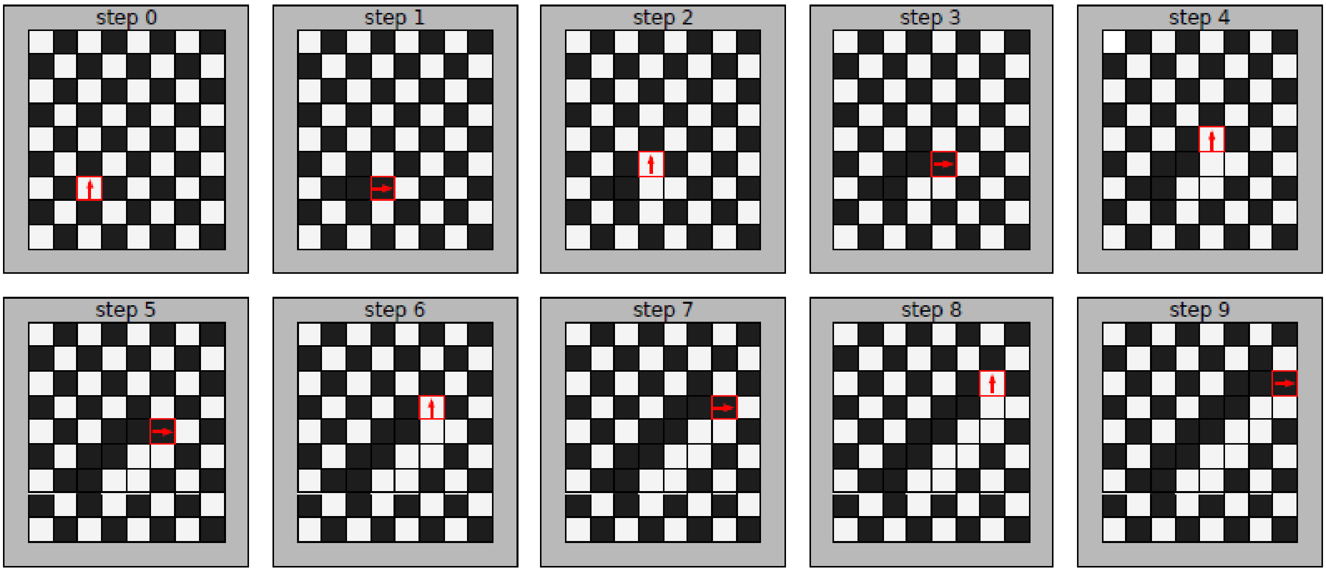
We could not deduce a way to represent this in CA.

Assignment 20

It is often impossible to extend the road network in order to cope with the increased mobility on the roads, hence traffic simulation has an increasingly bigger role in the effort to forestall possible congestions and improve route planning.

The current application looks at real-time and historic traffic data in order to simulate and predict the traffic state of a complete network on-line. Cellular automata is used on the simulation of the traffic flow on the microscopic level, ie. it tries to simulate the short-term decisions of a driver via Nagel-Schreckenberg CA model. This has the ability to reproduce basic features of real traffic via 4 rules: simulation of acceleration, deceleration, randomness and movement of a vehicle. It allows for high-speed micro-simulations of large-scale road networks due to its efficiency.
Major results of this application are that it is very fast, allows to extrapolate data into areas which are not equipped with sensors, ability to model anticipatory traffic forecast, and can also be used to simulate two very different types of traffic: urban and freeway.

Assignment 21



Assignment 22

Phase 1: Symmetric Growth
In the first 400 steps, Langton’s Ant moves over the field and flips the cell colors. One can spot an area around the ant that is roughly 50 % black. This area is growing from step to step, almost equally in all directions. There’s not yet the impression of uncontrolled chaos.

Phase 2: Chaos
The symmetric growth changes after 400 steps. The area is still growing but one can’t predict in which direction or by which pattern.

Phase 3: Highway
After more than 10 thousand steps, suddenly a roughly 10 cells wide arm is starts to grow in an 45 degree angle, depending on the initial direction of the ant. This so called “highway” is growing infinitely in its direction. If the highway hits the boundary and is wrapped around, it hits the area from phase 1 and 2 at some point. Then the next chaos phase begins until the next highway is growing after a few hundred or thousand steps.

Assignment 23

A and B depict both the same patterns. The difference is that all cell states are inverted and the pattern is mirrored vertically (see Figure 1).

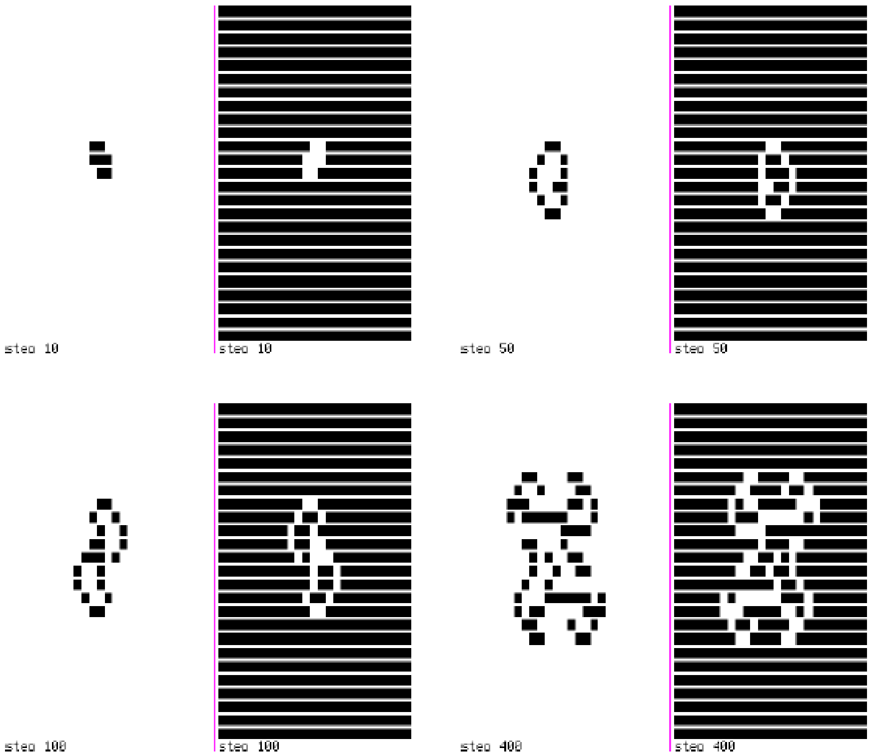


Figure 1: Langton’s Ant after 10, 50, 100 and 400 steps. (left: case A, right: case B)