Autonomous Intelligent Systems,
Institute for Computer Science VI, University of Bonn

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Exercises for Artificial Life (MA-INF 4201), SS25

Exercises sheet 2, till: Mon 21. April, 2025

14.4.2025

Remark: The assignments are designed to intensify the work with the research topics presented within the lecture, and to help you practice typical tasks of Artificial Life.
You will need more than 50% of all possible points and at least two presentations to be admitted to the exam. Please work in working groups of three of four persons.
You have to hand in the solutions by Monday before the start of the lecture, by uploading the solution as a .pdf file to eCampus.
You have to put the names of all (3 or 4) participating students in the solution explicitly.

Assignment 10 (2 Points)

How long would it take to print all Z possible rules for a 1-dimensional CA for the case $k = 4$ and $r = 1$ if you can manage to print 100 rules per second?
To answer this task set up a formula for the number $Z = Z(r, k)$ of possible rules as a function of the neighborhood radius r and the number of states k.

Assignment 11 (2 Points)

Prove or disprove the following sentence for 1-dim, $k = 2$, cellular Automata:
All totalistic rules are legal, because they are symmetric and have a silent state.

Assignment 12 (1 Point)

Find and name a simulation tool for 1-dimensional cellular automata, that is operating under Unix/Linux, or Android, or iOS, or Windows, or one that is operating from a web browser. Give the detailed web address, and write a personal comment about the simulation tool.

Assignment 13 (4 Points)

A rule of a Cellular Automaton can be visualized as a table.
Depict the tables for the (*d=1,r=1,k=2*) rules defined by the following (decimal) Wolfram Numbers, and classify for each rule if it is *legal, symmetric, totalistic, or peripheral*:
`( 0, 17, 42, 51, 110, 165, 204, 243 ).`
Your solution shall show, how the Wolfram number and the table are connected.

Assignment 14 (2 Points)

Please write down formulas that calculate the number Z of possibles rules for a 1-dimensional CA with respect to the neighborhood radius r and the number of states k for the case of:
a) all possible rules $Z =$
b) rules that are peripheral $Z_p =$
c) rules that are totalistic $Z_t =$
d) rules that have a silent state $Z_s =$.

Assignment 15 (4 Points)

Imagine you would have to explain the 4 behaviours of CAs (Wolfram's classification) to someone who has not listened to the Artificial Life lecture and no experience in cellular automata.
Name these 4 behaviours of CAs (Wolfram's classification) and describe their characteristics in your own words (maximum two sentences each).

Programming Assignment: A (5 Points, due date **Mon 28.4.2025**)

Implement a 1-dimensional cellular automaton in Python with the $k = 2$ states $\{0, 1\}$, with a neighborhood radius of $r = 1$ or $r = 2$, and 84 cells.
The boundary cells $j = 0, j = 1, j = 82, j = 83$ shall be fixed to the content $a_j = 0$. The programm shall depict in every line the complete state of all 84 cells as `text console ASCII` output.
Implement two possible starting conditions for the CA:
S: a seed (all cells are empty but cell no 42, $a_{i=42} = 1$), and
R: random starting condition, each cell is set with a probability of $p = 0.5$.
Let the user enter at runtime: the neighborhood radius r, the rule for the CA (Wolfram Notation), and the starting condition (S or R) and depict at least 20 iterations of the CA.

Dear students,
This semester we require all programming assignments to be handed in as a Jupyter Notebook (.ipynb file). Please use the python version 3.10. We are going to use the standard Google colab session to correct your code.
You can find this google product at (https://colab.research.google.com/). Obviously you do share personal data when using a google product. You can use any other program allowing to create an ipynb-file. However, we are only going to grade the Code on a Google colab basis.

Best regards,
Your tutors