Complex Systems — Problems for lab

Fall 2024/2025

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6 Lattice simulations – till 23.01.2025

1. Implement a square lattice $L \times L$ – the most convenient is to represent it just by an array $A[i, j], i, j = 1, \ldots, L$. Fill up an array: '1' (dog) with probability p or '0' (empty) with probability $1 - p$. Save it to file and then draw - denote dog by the gray color and empty cell by the white color.

2. Use the array from the previous task and now set a flea on the very left dog in the first row on the lattice – you can set '2' for a cell visited by the flea. Flea starts to jump randomly from dog to dog but it is able to jump only a distance of 1, so to one of four adjacent cells occupied with dogs. Each cell visited by the flea is marked with '2' and stays '2' for ever. Introduce parameter t denoting time – one unit time denotes one jump. After time t save it to file and then draw - denote dog by the gray color, empty cell by the white color and flea by the black color.

   (a) Plot size of an "epidemic", i.e. fraction of nodes that will be infected by fleas in time.

   (b) Introduce "immunization" parameter pi and study epidemic spreading for several p below and above percolation threshold.

3. Implement one-dimensional Wolfram Cellular Automata. Use periodic boundary conditions and single block input. Compare rules 18, 26 and 181. Show result for rule 61.

4. (extra 1) Compare behavior of rule 30 for different boundary conditions (reflective, constant, random and null) and random input.

5. (extra 2) Implement two-dimensional Game of Life. What happens when a spaceship hits a block?