Computational Many-Body Physics

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SS 2022

Exercise Sheet No. 1

- Please upload your solutions to ILIAS until **Thursday, April 21, 16:00**.
- Your solutions should include (in a single pdf-file, if possible):
  - short descriptions of the codes (including, for example, some fragments of the codes);
  - graphs of the results;
  - solutions of the analytical exercises (scanned notes are sufficient);
- Submission of the full codes is optional.

Exercise 1: Rule N (elementary cellular automata)

(9 points)

a) Write a code which calculates the first 50 generations of rule 30, starting from the configuration with all $z_i(t=0)=0$, $i=1,\ldots,120$, except for $z_{60}(t=0)=1$. The code should produce a plot showing the full time evolution of the configurations (see, for example, the wikipedia article on rule 30).
(5 points)

b) Calculate the time dependence of the number of cells with $z_i = 1$: (2 points)

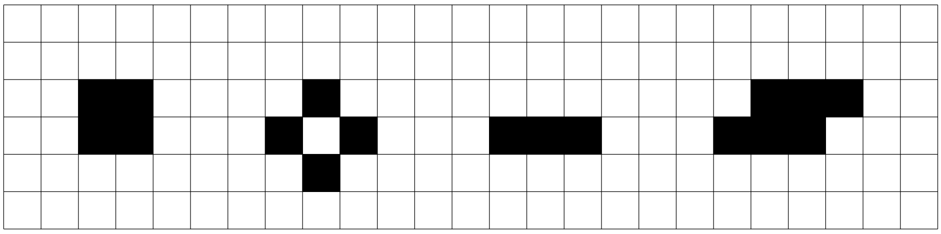
$$n(t) = \sum_i z_i(t) \ , \quad t = 1, \ldots, 50 \ .$$

c) Which of the 256 possible rules reproduces exactly any given configuration?
(2 points)

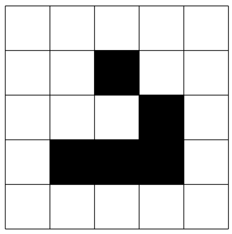
Exercise 2: Game of Life

(11 points)

a) Write a code which simulates Conway's Game of Life on a 20×20 grid with periodic boundary conditions. Check your code with a few simple configurations, such as the ones shown in the figure: (7 points)

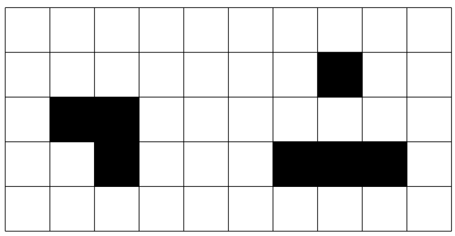


b) The following pattern ("glider") translates across the 2d grid along the diagonal.



Visualize the evolution of the glider for the same grid as in part a). (2 points)
Note: If you have difficulties with the animation of this time development, a code which calculates the configuration after a given number of time steps is sufficient.

c) The following pattern ("diehard") disappears after 130 generations.



Calculate the number of live cells, $n(t) = \sum_i z_i(t)$, for $t = 0, \dots 135$.
(2 points)