Agent-based modelling of complex systems

Assignment 1

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A simple model of forest fire may be defined as a two-dimensional cellular automaton on a grid of cells, which take one of three states: empty, occupied by a tree or burning. The automaton evolves according to the following rules, which are executed simultaneously for every cell at a given generation:

1. A burning cell turns into an empty cell.
2. A cell occupied by a tree becomes a burning cell, if any of its eight neighboring cells are burning.

Implement the model in Python on a $L \times L$ square lattice. At the beginning of the simulation, every cell of the grid should be populated by a tree with probability p. Assume that initially all trees at one of the edges are burning.

1. Find the so called percolation threshold $p^\star$, i.e. the probability that fire hits the opposite edge of the grid during the simulation. Use $L = 20, 50$ and 100 for the linear size of the lattice.
2. Plot the average size of the biggest cluster of burned threes as a function of p for $L = 100$. Use the Hoshen-Kopelman algorithm (`https://en.wikipedia.org/wiki/Hoshen-Kopelman_algorithm`) for cluster detection.
3. (Optional) Propose a method to add wind to the model. Check how the results chamge with different wind directions and strengths.