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Cellular automaton modelling of biological pattern formation

Abstract: Examples of biological pattern formation are life cycles of bacteria and social amoebae, embryonic tissue formation, wound healing or tumour growth. Thereby, development of a particular spatio-temporal "multi-cellular" pattern may be interpreted as cooperative phenomenon emerging from an intricate interplay of local (e.g. by adhesion) and non-local (e.g. via diffusing signals) cell interactions. What are cooperative phenomena in interacting cell systems and how can they be studied?
Mathematical models are required for the analysis of cooperative phenomena. Typical modeling attempts focus on a macroscopic perspective, i.e. the models (e.g. partial differential equations) describe the spatio-temporal dynamics of cell concentrations. More recently, cell-based models have been suggested in which the fate of each individual cell can be tracked. Cellular automata are discrete dynamical systems and may be utilized as cell-based models.
Here, we analyze spatio-temporal pattern formation in cellular automaton models of interacting discrete cells. We introduce lattice-gas cellular automata and a cellular automaton based on an extended Potts model that allows to consider cell shapes. Model applications are bacterial pattern formation and tumour growth.