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The ecology and evolution of spatially extended systems: cellular automata and analytical approximations

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Space is an attribute of ecological systems but often simplified away by modelers because few mathematical tools are available. Traditionally, ecologists have modeled spatial dynamics using a metapopulation approach where a population is subdivided in many discrete subpopulations. In reality, many systems are distributed over a much more continuous spatial domain, and these are difficult to analyse. Diffusion models can be used but they have some serious drawbacks, in particular when the discreteness of individuals counts and it often does in ecology. With the increasing availability of cheap processing power, researchers are using cellular automata to simulate spatial dynamics. Cellular automata have the advantage of being easy to set up, can accommodate a large variety of ecological systems. Their analysis poses some difficulties, though, limiting the generalisability of the results obtained using them. Here I will discuss mathematical techniques adapted from theoretical physics, called pair approximation models or correlation dynamics models, that can be used to obtain deeper insight in the ecology and evolution of spatially extended systems.