CITATION: GAVIN BROWN PRIZE 2022

On the range of lattice models in high dimensions, Mark Holmes and Edwin Perkins. Probability Theory and Related Fields 176, no. 3 (2020): 941-1009.

Super-Brownian motion is an evolutionary process involving both branching, and a Brownian motion. It was originally found as the scaling limit of discrete branching Brownian motions, uncovering a rich mathematical structure. Gradually it was recognised that this superprocess arose in many different models from probability and statistical physics, where it is now an important research topic.

A key question here is to find information about the models that is preserved in the scaling limit. The convergence here is quite delicate, as one passes from a discrete system to a continuum limit.

In the paper *On the range of lattice models in high dimensions*, Mark Holmes and Edwin Perkins provide precise conditions that ensure that the range of lattice models converges to the range of the limiting superprocess.

The behaviour of the system is quite different in high and low dimensions: in low dimensions, the scaling limit depends on the model, while in high dimensions it exhibits mean-field behaviour, with the interactions spread out over space.

The results work in a very general setting, and are carefully verified for four of the most well-known models: voter models, the contact process modelling an epidemic on a lattice, oriented percolation, and lattice trees. This unified approach also offers tools for future applications.

As a bonus, the paper also calculates the one-arm exponent in percolation — the probability that a distant point is hit by the set-valued process — which has been the object of much research.

It is a very beautiful and inspiring presentation despite the difficulty of the subject and the delicate technicalities of the convergence, with several reviewers noting the careful explanations and the way in which new concepts are related to more familiar ones.

In the words of the reviewers, this work "not only solves some long-standing open problems, but also provides new methods that should have fruitful applications in the future" ... "it is truly outstanding achievement in the area of interacting stochastic systems in high dimensions and is a landmark in our understanding of large space-time scaling".