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Controlling the Ising model using spatiotemporal Markov decision theory

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Dynamics that are governed by both spatial and temporal interaction structures occur in a wide range of disciplines, such as economics, ecology, logistics and healthcare. In many situations, it is of interest to control such spatiotemporal processes and to drive them towards desirable behaviours. In this talk, we introduce the spatiotemporal Markov decision process (STMDP), an extension of the classic Markov decision process that provides a framework for sequential decision making in spatiotemporal stochastic settings. We illustrate the framework by applying it to a dynamic version of the Ising model on a two-dimensional lattice. At low temperatures and under a small positive magnetic field, this model is known to transition from the all-minus configuration to the all-plus configuration through the formation of a droplet of +-spins that will eventually nucleate the entire lattice. Our aim is to speed up this nucleation process by means of external influences and find the most efficient strategy to drive the process towards the all-plus configuration. After casting this problem as an STMDP, we provide insights in the structure and performance of the optimal policy.