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Stochastic modelling of reaction-diffusion processes in biology

Radek Erban

University of Oxford, Mathematical Institute

Many cellular and subcellular biological processes can be described in terms of diffusing and chemically reacting species (e.g. genes and proteins). Several stochastic simulation algorithms (SSAs) suitable for the modelling of such reaction-diffusion processes will be analysed. The connections between SSAs and the deterministic models (based on reaction-diffusion partial differential equations (PDEs)) will be presented. We consider chemical reactions both at a surface (e.g. a membrane with receptors) and in the bulk. We show how the "microscopic" parameters should be chosen to achieve the correct "macroscopic" reaction rate. This choice is found to depend on which SSA is used.