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Hybrid modelling of cell migration: coupling individual-based models with partial differential equations

Two approaches to mathematical modelling of cell migration are often used in the literature: (i) individual-based (agent-based) models, which describe the behaviour of each cell, and (ii) macroscopic partial differential equations (PDEs), which are written for cell concentrations. A widely studied example of cell migration is chemotaxis, where cells move according to extracellular chemicals that can be altered by the cells themselves. In this case, systems of coupled PDEs are used to model the concentrations of cells and external chemicals. A more detailed description is given by hybrid models that couple an individual-based model of cells with PDEs for extracellular chemicals. In this talk, we will give an overview of hybrid models used in the literature. Examples will include chemotaxis of bacteria and eukaryotic cells. We will analyse similarities and differences between hybrid models and macroscopic PDEs.