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Interacting cell system models for cell sorting and collective motion

Biological structure and function in cell populations often result from the complex interaction of a large number of components. In particular when cells that are in direct physical contact or located close to each other are known to interact, possibly in a type-specific manner, one is interested in concluding characteristics of the global, collective behavior of the cell configurations from the individual properties of the cells and the details of the intercellular interaction. To understand the determinants of these processes and to conclude the tissue level traits, it is necessary to design and analyze appropriate mathematical models.

It is argued that the model class of interacting particle systems is well-suited for this task. For two exemplary problems, cell sorting and collective motion of oriented cells with ferromagnetic alignment, cell based lattice models are developed which describe the major details of the respective intercellular interaction. If suitably simplified, these models are analytically tractable. Several results concerning the long-time behavior and the emergence of structure are presented and interpreted in biological terms. Challenging mathematical problems that require further theoretical developments are identified.