An agent-based model for cell collective dynamics

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In this work, we are interested to assess by means of a mathematical model in the impact of apoptosis on the dynamics of cellular tissues, in particular on how the cell tissue flows. Indeed, cell apoptosis corresponds to the programmed cell death : when they leave the tissue, they induce local contractions but also enable cells rearrangements.

We proposed in a previous work [2] an individual-based model for collective cell motion that provides the dynamics of the positions, velocities and polarities of the cells, idealized as hard spheres. Cells interact with each other with hard repulsion, smooth attraction and polarity alignment and with boundaries with hard repulsion. The mathematical formalism and the numerical method for the hard repulsion interactions follow the strategy described in [1]. Simulations based on this model were able to successfully reproduce the main feature of several experimental dynamics in a ring-like domain. Here we propose to extend this model in order to incorporate apoptosis events and numerically study the observed fluidity in different geometrical domains and for different sets of parameters. Several possible fluidity indicators are compared.

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[1] B. Maury, J. Venel. *A discrete contact model for crowd motion.* ESAIM : Mathematical Modelling and Numerical Analysis, **45(1)**, 145–168, 2011.

[2] S. L. Vecchio, O. Pertz, M. Szopos, L. Navoret, D. Riveline. *Spontaneous rotations in epithelia as an interplay between cell polarity and boundaries.* Nature Physics, 2024.

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