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Cell remodelling in 3D vertex models

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ABSTRACT

Cellular tissues undergo multiple cell remodelling events during morphogenetic movements. These include delamination, extrusion, intercalation, or proliferation. At the cell scale, these phenomena are simulated resorting to vertex models, where each cell is represented by a discretisation of its boundary [1]. The numerical modelling of these events poses different challenges related to the simultaneous solution of the mechanical equilibrium and the handling of the connectivity changes between cells.

We here present a methodology to model mechanical equilibria and cell reorganisation. The methodology is based on a description of the cell through a network of vertices, where mechanical equilibria is imposed by minimising an energy functional related to surface and volume constraints. while topological changes are simulated through a dual network of cell centres and boundary nodes, which track connectivity changes in a robust manner.

The model is employed for the simulation of extrusion and wound healing of epithelia [2]. By resorting to differential adhesion between different types of surfaces (cell-substrate, cell-cell, cell-media), different extrusion processes are also simulated.

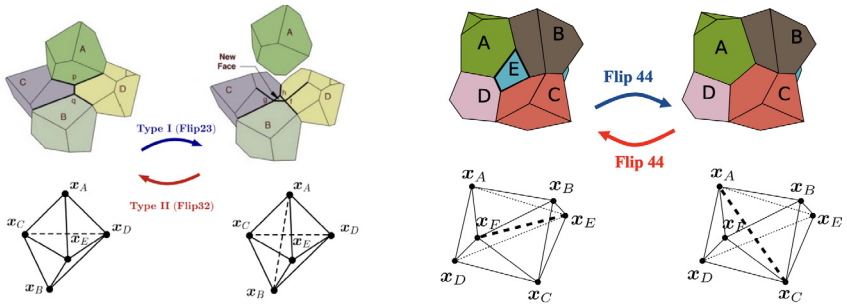

Figure 1: Scheme of flips on tetrahedral (dual) network for handling connectivity changes.

REFERENCES

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