Image based modelling using geometric surface partial differential equations (GS-PDEs)

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In this lecture, I will focus on formulating a dynamical geometric surface partial differential equation for modelling static images during the process of single or collective cell migration. In the absence of detailed experimental molecular and mechanical observations, a question asked by experimentalists is: Given a sequence of images following single or collective cell migration, is there an optimal dynamic mathematical that evolves static images at one time point into static images at a later time point? I will employ both sharp- and diffuse-interface formulations based on phase-fields for geometric surface partial differential equations to derive a dynamical spatiotemporal model for the migration of cells in 2- and 3-D. The model is solved efficiently using novel high performance computing techniques based on finite differences, and multi-grid methods. Such an approach allows us to solve in realistic times, 2- and 3-D computations which are otherwise unfeasible without such innovative numerical analysis computing strategies. To demonstrate the applicability of the computational algorithm, cell migration forces such as polarisation will be exhibited. A by-product of the computational algorithm is its ability to quantify automatically cell proliferation rates which are generally obtained through cumbersome and error-prone manual counting.

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