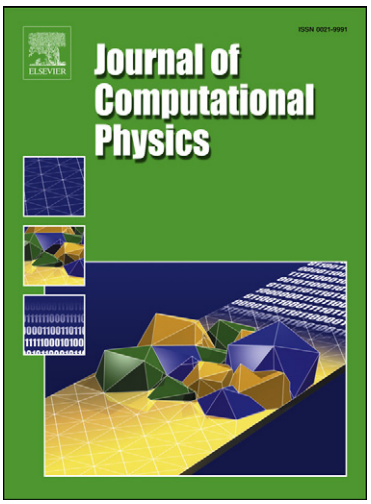

Whole cell tracking through the optimal control of geometric evolution laws

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Whole cell tracking through the optimal control of geometric evolution laws

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Abstract

Cell tracking algorithms which automate and systematise the analysis of time lapse image data sets of cells are an indispensable tool in the modelling and understanding of cellular phenomena. In this study we present a theoretical framework and an algorithm for whole cell tracking. Within this work we consider that "tracking" is equivalent to a dynamic reconstruction of the whole cell data (morphologies) from static image datasets. The novelty of our work is that the tracking algorithm is driven by a model for the motion of the cell. This model may be regarded as a simplification of a recently developed physically meaningful model for cell motility. The resulting problem is the optimal control of a geometric evolution law and we discuss the formulation and numerical approximation of the optimal control problem. The overall goal of this work is to design a framework for cell tracking within which the recovered data reflects the physics of the forward model. A number of numerical simulations are presented that illustrate the applicability of our approach.

Keywords:
Cell tracking, geometric evolution law, optimal control, phase field, finite elements.

1. Introduction

Cell migration is a fundamental process in cell biology and is tightly linked to many important physiological and pathological events such as the immune response, wound healing, tissue differentiation, metastasis, embryogenesis, inflammation and tumour invasion [1]. Experimental advances provide techniques to observe migrating cells both *in vivo* and *in vitro*. Inferring dynamic quantities from this static data is an important task that has many applications in biology and related fields. The field of cell tracking

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