An optimal control approach for modelling cell migration

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Abstract: Cell migration is of vital importance in many biological studies, hence robust cell tracking algorithms are needed for inference of dynamic features from (static) *in vivo* and *in vitro* experimental imaging data of cells migrating. In recent years much attention has been focused on the modelling of cell motility from physical principles and the development of state-of-the art numerical methods for the simulation of the model equations. Despite this, the vast majority of cell tracking algorithms proposed to date focus solely on the imaging data itself and do not attempt to incorporate any physical knowledge on cell migration into the tracking procedure. In this study, we present a mathematical approach for cell migration, in which we formulate the cell tracking problem as an inverse problem for fitting a mathematical model for cell motility to experimental imaging data. The novelty of this approach is that the physics underlying the model for cell migration is encoded in the tracking algorithm. To illustrate this we focus on an example of Zebrafish (*Danio rerio's larvae*) Neutrophil migration and contrast an ad-hoc approach to cell tracking based on interpolation with the model fitting approach we propose in this study.