Towards the efficient simulation of spatially non-local PDE models on time-dependent spatial domains

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The spatially non-local modelling of attractive and repulsive behaviour of cellular populations has gained considerable popularity and lead to the development of many integro-PDE models. Efficient numerical techniques in one, two, or three space dimensions are available allowing for the simulation of and also the parameter estimation in these models. However, when modelling processes in embryology, these often take place on a time scale in which the embryo is growing considerably as well. This leads to a current interest in integro-PDE models on time-dependent (growing) spatial domains.
Here we are concerned with adapting an existing finite-volume spatial discretization to the case of a time-dependent spatial domain. We focus on a spatially one-dimensional situation as this is sufficient for our initial application in mathematical biology. In this case but also in general the non-local term requires particular attention. In the case of a fixed spatial domain pre-computation and FFT-techniques can be applied in its evaluation, in the case of spatially uniform domain change, pre-computation becomes difficult due to a new time-dependence but FFT can still be applied, and in the case of spatially non-uniform domain change also the use of FFT is essentially ruled out. As a consequence, efficient simulations on spatially uniformly and non-uniformly changing domains are currently possible for integro-PDEs in one space dimension and on spatially uniformly changing domains for integro-PDEs in two space dimensions.

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