On the positivity in nonlocal PDE models of cell adhesion

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This talk is about a nonlocal PDE model of cell adhesion. Cell adhesion is a fundamental process in many developmental processes and has also been implicated in tumour progression and metastasis. It can be shown that solutions of this model, representing cell density, are nonnegative for nonnegative initial data and suitable boundary conditions. This qualitative property, termed positivity, of the solution should be preserved by the numerical scheme employed for the model simulation.
We consider a method of lines approach with a finite volumes spatial discretisation for the numerical solution of the model equations. Positivity is essential in the following aspects of the overall scheme

- nonnegative reconstruction of the solution from nonnegative finite volume cell averages;
- sign-preserving quadrature formulas;
- positivity preserving spatial discretisation;
- positivity preserving temporal discretisation.

We will describe options in each of these areas, discuss their relations and also the impact on an efficient numerical solution.
Related to positivity is the issue of boundedness of the solution, which we will touch upon briefly.