Methods for analysing patterns in solutions of reaction-diffusion equations

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We consider reaction-diffusion equations, i.e., a system of partial differential equations (PDEs) in time and two-dimensional space. The equations model the formation of patterns in animal coats and skins, for example. Stationary solutions represent a final pattern, which depends both on physical parameters and initial values. A spatial finite difference method yields a high-dimensional system of ordinary differential equations (ODEs). Stationary solutions of the ODEs are computed to approximate steady-state solutions of the PDEs.

We investigate properties of the patterns using methods from image processing. The two-dimensional stationary solutions are converted into binary images. This approach allows for the application of morphological operations on the binary image. Euler numbers and Feret diameters can be determined, for example. Moreover, we examine associated statistical quantities for sample sets of initial values in a Monte-Carlo simulation. Our aim is to analyse the dependence as well as the sensitivity of patterns on the parameters. We present results of numerical computations for different selections of those parameters.