

Efficient High-order RBF-FD Methods for Advection-Diffusion-Reaction Equations on Irregular Domains

Varun Shankar, University of Utah

We present an efficient RBF-FD formulation for the solution of advection-diffusion-reaction PDEs with nonlinear reaction terms and low to moderate Peclet numbers. Such PDEs are ubiquitous in biological and engineering applications. To stabilize our methods, we present a simple artificial hyperviscosity formulation for semi-implicit time-stepping schemes that scales with order refinement. In order to tackle arbitrary local boundary conditions arising from biological applications, we also present a novel fictitious/ghost point technique tailored for semi-implicit time-stepping schemes. Finally, we present a simple modification to the RBF-FD method to ameliorate the costs involved in forming differentiation matrices for high-order methods. This new technique, called the Overlapped RBF-FD method, results in dramatic speedups on both CPUs and GPUs. We verify convergence rates on test cases, and demonstrate the application of our methods to biological problems on irregular 2D and 3D domains.