Parallel implementation of IIF solver for stiff Advection-Reaction-Diffusion equations

Nikhil Hegde, Amlan K. Barua, Amar Gaonkar

April 25, 2022

In this project we wish to explore the parallel implementation of integration factor method for stiff advection reaction diffusion (ARD) equations which occur frequently in biological systems. The main numerical challenge for ARD based problems emerges from high resolution of spatial domains which is needed to capture sharp gradients while maintaining the stability. This makes the problem computationally challenging. The implicit integration factor (IIF) method is designed specifically to tackle the issue. While the serial implementation of IIF is quite well-known, the problem of scalability remains unexplored. The main job of the intern would be to

1. Understand the IIF method for advection reaction diffusion problems
2. Implement the serial code
3. Implement shared memory and/or distributed memory version
4. Explore the possible usage of GPUs
5. Demonstrate the efficiency of the implementation on various problems of interest, i.e., case studies

Skills needed: Basic understanding of numerical solutions of time-dependent partial differential equations, experience of using the MPI/OpenMP. Some knowledge of GPU coding would be an added advantage but is not mandatory.