TEMPLE UNIVERSITY
Department of Mathematics

Applied Mathematics and Scientific Computing Seminar

Room 617 Wachman Hall

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Long-Time Simulation of Calcium Waves in a Heart Cell on Modern Multi-Core Parallel Computing Platforms

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Abstract. State-of-the-art distributed-memory computer clusters contain multi-core CPUs with 18 and more cores. These processors are ideally suited for many applications, for instance in particular for parameter studies of long-time simulations of calcium waves in a heart cell. We demonstrate the performance of the multi-core CPU Intel Skylake with 18 cores. A special-purpose code solving a system of non-linear reaction-diffusion partial differential equations with several thousands of point sources modeled mathematically by Dirac delta distributions serves as realistic test bed. The system is discretized in space by the finite volume method and advanced by fully implicit time-stepping, with a matrix-free implementation that allows the complex model to have an extremely small memory footprint. The method is implemented in C with MPI for distributed- and shared-memory parallelism. The sample application is a seven-variable model of calcium induced calcium release (CICR) that models the interplay between electrical excitation, calcium signaling, and mechanical contraction in a heart cell. The results demonstrate the scale and speed of simulations possible with CPUs that are accessible also for individual research labs.