UtahStateUniversity
MATHEMATICS & STATISTICS

Applied Math Seminar

Thursday, March 22nd, 2018 @ 2:00 P.M. ANSC 112

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A High-order Meshfree Framework for Solving PDEs on Irregular Domains and Surfaces

We present meshfree methods based on Radial Basis Function (RBF) interpolation for solving partial differential equations (PDEs) on irregular domains and surfaces; such domains are of great importance in mathematical models of biological processes. First, we present a generalized high-order RBF-Finite Difference (RBF-FD) method that exploits certain approximation properties of RBF interpolants to achieve significantly improved computational complexity, both in serial and in parallel. Like all RBF-FD methods, our method requires stabilization when applied to solving PDEs. Consequently, we present a robust and automatic hyperviscosity-based stabilization technique to rectify the spectra of RBF-FD differentiation matrices. The amount of hyperviscosity is determined quasi-analytically in two stages: first, we develop a novel mathematical model of spurious solution growth, and second, we use simple 1D Von Neumann analysis to analytically cancel out these spurious growth terms. The resulting expressions for hyperviscosity are a generalization of formulas from both RBF-FD and classical spectral methods. The resulting stabilized RBF-FD method serves as a high-order meshfree framework for solving PDEs on irregular domains. Finally, we present a powerful new RBF-FD technique that allows for the solution of PDEs on surfaces using scattered nodes and Cartesian coordinate systems. In all cases, our methods achieve O(N) complexity for N nodes..

Short Bio: Varun Shankar received his PhD in 2014 in Scientific Computing from the School of Computing at Utah. He is currently an Assistant Professor (Lecturer) in the Department of Mathematics, and an Adjunct Assistant Professor in the School of Computing at the University of Utah. His research interests are in Radial Basis Functions and other meshfree methods for PDEs, machine learning, math biology, computational fluid dynamics, and high performance computing.