UNIVERSITY of HOUSTON

Department of Mathematics

Scientific Computing Seminar

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Element learning: a systematic approach of accelerating finite element-type methods via machine learning, with applications to radiative transfer

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1 PM- 2 PM
Room 646 PGH

Abstract: In the past decade, (artificial) neural networks and machine learning tools have surfaced as game changing technologies across numerous fields, resolving an array of challenging problems. Even for the numerical solution of partial differential equations (PDEs) or other scientific computing problems, results have shown that machine learning can speed up some computations. However, many machine learning approaches tend to lose some of the advantageous features of traditional numerical PDE methods, such as interpretability and applicability to general domains with complex geometry.

In this talk, we introduce a systematic approach (which we call element learning) with the goal of accelerating finite element-type methods via machine learning, while also retaining the desirable features of finite element methods. The derivation of this new approach is closely related to hybridizable discontinuous Galerkin (HDG) methods in the sense that the local solvers of HDG are replaced by machine learning approaches. Numerical tests are presented for an example PDE, the radiative transfer equation, in a variety of scenarios with idealized or realistic cloud fields, with smooth or sharp gradient in the cloud boundary transition. Comparisons are set up with either a fixed number of degrees of freedom or a fixed accuracy level of 10^{-3} in the relative L^2 error, and we observe a significant speed-up with element learning compared to a classical finite element-type method.

This seminar is easily accessible to persons with disabilities. For more information or for assistance, please contact the Mathematics Department at 743-3500.