

Joint Aerospace/Applied Mathematics Seminar



Jan Hesthaven

**Dean, School of Basic Sciences and Professor of Mathematics,
Ecole Polytechnique Fédérale de Lausanne (EPFL)**

Controlling oscillations in high-order accurate methods through neural networks

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Abstract: While discontinuous Galerkin methods have proven themselves to be powerful computational methods, capable of accurately solving a variety of PDE's, the combination of high-order accuracy and discontinuous solutions remain a significant challenge. Traditional methods such as TVB limiting or artificial viscosity methods have several disadvantages, e.g., a need to specify one or several parameters or the complexity of the methods to avoid overdissipation.

In this talk we discuss recent developments in which an artificial neural network is used as a troubled cell indicator in limiter based methods or to estimate the nonlinear viscosity in artificial viscosity methods. The neural network is trained independently and is therefore not problem dependent.

Extensive computational results in one- and two-dimensions shall demonstrate the efficiency of such techniques which, as we shall likewise demonstrate, are often both superior and faster than traditional techniques.

This work is done in collaboration with D. Ray (EPFL, CH), N. Discacciati (EPFL, CH) and J. Yu (Beihang, PRC).

Bio: After receiving his PhD in 1995 from the Technical University of Denmark, Professor Hesthaven joined Brown University, where he became Professor of Applied Mathematics in 2005. In 2013 he joined Ecole Polytechnique Fédérale de Lausanne (EPFL) in Switzerland, where he is the Dean of the School of Basic Sciences and Professor of Mathematics. His research interests are in the development, analysis, and application of high-order accurate methods for the solution of complex time-dependent problems, often requiring high-performance computing. A particular focus of his research has been the development of computational methods for problems of electromagnetics, including high-order methods for scattering, reduced basis methods and uncertainty quantification for EM problems. He has received awards for both research and teaching, and since 2014 has been a fellow of the Society for Industrial and Applied Mathematics.