LEARN2SOLVE: A MODEL-CONSTRAINED TANGENT APPROACH FOR SUPERSONIC FLOWS

Hai V. Nguyen[1], Thomas Apiatan[1], and Tan Bui-Thanh[1]

[1]The University of Texas at Austin

ABSTRACT

Real-time accurate solutions of large-scale complex dynamical systems are in critical need for control, optimization, uncertainty quantification, and decision-making in practical engineering and science applications, especially digital twin applications. This paper contributes in this direction a model-constrained tangent slope learning (mcTangent) approach. At the heart of mcTangent is the synergy of several desirable strategies: i) a tangent slope learning to take advantage of the neural network speed and the time-accurate nature of the method of lines; ii) a model-constrained approach to encode the neural network tangent slope with the underlying governing equations; iii) sequential learning strategies to promote long-time stability and accuracy; and iv) data randomization approach to implicitly enforce the smoothness of the neural network tangent slope and its likeliness to the truth tangent slope up second order derivatives in order to further enhance the stability and accuracy of mcTangent solutions. In this talk, we extend the mcTangent approach to high-speed flows. Various examples with transonic and supersonic flows will be presented to demonstrate our proposed approaches against discontinuous Galerkin methods.