An Artificial Neural Network for Detecting Discontinuities

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Abstract: High-order methods for solving conservation laws need to be corrected near discontinuities to avoid Gibbs oscillations. For discontinuous Galerkin (DG) methods, a common approach is to limit the solution by i) identifying $troubled\text{-}cells$ which contain discontinuities, and ii) using a suitable limiting technique to fix the solution in these cells to suppress spurious oscillations. The classical $minmod\text{-}type$ TVB limiter is capable of correctly identifying troubled cells, provided its tunable parameter M is chosen appropriately. In general, however, it is difficult to estimate M accurately. If M is too small, more cells than necessary are flagged as troubled-cells, leading to a higher computational cost. On the other hand, if M is too large, the method may fail to identify all troubled-cells, leading to the appearance of oscillations in the solution.

In this talk, we introduce a new approach which uses $artificial\ neural\ network$ (ANNs) to identify these troubled-cells. In particular, we use a $multilayer\ perceptron$ trained extensively (offline) on a well-represented training set. The advantage of the proposed ANN method is that it is parameter-free, non-intrusive and can easily be integrated into existing code frameworks. We show that our method performs at par with the fine-tuned TVB limiter. We also demonstrate the robustness of this approach in solving scalar conservation laws when coupled with a Runge-Kutta DG scheme.

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