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FC-based shock-dynamics solver with neural-network localized artificial-viscosity assignment

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This presentation introduces a new spectral scheme for the numerical solution of shock-wave problems in general non-periodic domains, under arbitrary boundary conditions [1]. The approach utilizes the Fourier Continuation (FC) method for spectral representation of non-periodic functions in general domains in conjunction with smooth localized artificial viscosity assignments produced by means of a Shock-Detecting Neural Network (SDNN). The minimally invasive neural net-induced viscous term eliminates Gibbs ringing while enabling spectral dispersionless flows, and, unlike most other approaches, it does not suffer from unphysical spurious oscillations over smooth flow regions. The FC-SDNN algorithm, which relies on a Mach number proxy for neural-network analysis of the solution's regularity, generally provides accurate resolution of discontinuities, as well as significantly smoother profiles away from jump discontinuities than those produced by other methods, including ENO/WENO solvers, Godunov schemes and other finite volume and artificial viscosity approaches. The character of the method will be demonstrated by means of applications to a number of important test cases, including a Mach 3 wind-tunnel step problem, a Double Mach ramp reflection of a shock, and a shock-vortex interaction, among others.

REFERENCES

[1] O. P. Bruno, J. S. Hesthaven, and D. V. Leibovici. FC-based shock-dynamics solver with neural-network localized artificial-viscosity assignment. *arXiv preprint arXiv:2111.01315*, 2021.