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CSC Seminar

SPEAKER

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TITLE

Physics-Informed Non-Intrusive Reduced-Order Models for Parametric Partial Differential Equations

ABSTRACT

Real-life problems are often modelled by partial differential equations (PDEs) like Burgers' equation (used in modelling fluid flow, or traffic flow) and Navier-Stokes equations (used in modelling fluid flow), to quote a few examples. Such PDEs are often parametrized by physical parameters, geometric features, boundary conditions, initial conditions, etc. For applications such as design, control, optimization, or uncertainty quantification, solutions of such PDEs are required for many values in the parameter space. High-fidelity simulations of parametric PDEs for many values of parameters can, therefore, be an expensive pursuit. This motivates the development of reduced-order models (ROM) for quick solutions. In this study, we first perform several high-fidelity simulations at several time-parameter values to create a database. Subsequently, we use Proper Orthogonal Decomposition (POD) to decompose the database into POD modes and POD coefficients. Then, a feed-forward fully connected neural network is trained to map time-parameter values to POD coefficients. The loss function that is minimized comprises of the mean-squared error of the state-space and the PDE residuals. The inclusion of the PDE residuals in the loss function informs the neural network about the dynamics. In departure from previous studies on physics-informed neural networks, we use the Galerkin expansion of the PDE terms. This allows training a neural network in the reduced space. We'll discuss several aspects of this novel implementation of physics-informed nonintrusive ROM on Burgers' equation along with a priori techniques to tune the hyperparameters and potential benefits in speeding up generation of newer simulation results.

Tuesday, September 12, 2023 at 2 pm
seminar room Prigogine