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Young Plenary Lecture

Automatic discovery of low-dimensional dynamics underpinning time-dependent PDEs by means of Neural Networks

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Abstract

In this talk, we present a novel Machine Learning technique able to learn differential equations that surrogate the solution of time-dependent PDEs. Our method exploits a finite number of latent variables, which provide a compact representation of the state of the system. These variables allow for the reconstruction of the spatial outputs at each temporal instant through a mesh-less decoder based on Artificial Neural Networks (ANN). We propose an algorithm able to learn in a simultaneous way the latent variables, their dynamics and the mesh-less decoder. Remarkably, our method allows building, in a fully non-intrusive manner, surrogate models for evolutionary equations, accounting for the dependence on parameters and time-dependent inputs. Numerical tests for both parabolic and hyperbolic PDEs show that very accurate numerical results are obtained, even for a reduced size of the ANNs, in a computationally efficient manner.