MOX-Report No. 58/2021

Enhancing numerical stabilization methods for advection dominated differential problems by Machine Learning algorithms

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Abstract

In this work, we propose a residual-based stabilization method for advection dominated differential problems enhanced by artificial neural networks. Specifically, we consider the Streamline Upwind Petrov-Galerkin stabilization method and we employ neural networks to compute an optimal form of the stabilization parameter on which the method relies. We train the neural network on a dataset generated by repeatedly solving an optimization problem, by minimizing the distance between the numerical solution and the exact one for different parametrizations of problem data and setting of the numerical scheme. The trained network is later used to predict the optimal stabilization for any given configuration and to be readily used "online" for any new configuration of the problem. 1D and 2D numerical tests show that our novel approach leads to more accurate solutions than the standard approaches for the problem under consideration.

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