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Neural networks investigation of bifurcating phenomena in fluid-dynamics

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Bifurcating phenomena, i.e. sudden changes in the qualitative behaviour of the system linked to the non-uniqueness of the solution naturally arise in several fields. Since the reconstruction of bifurcation diagrams requires a many-query context, which is usually unaffordable by means of high fidelity simulations, we propose a combination of Reduced Order Models and Machine Learning techniques to reduce the computational burden associated to the investigation of such complex phenomena. The aim of this work is to show the applicability of the Reduced Basis (RB) model reduction and Artificial Neural Network (ANN), by means of the POD-NN approach and its physics-informed variant [1, 2], to analyze multi-parameter bifurcating applications in fluid-dynamics. We considered the Navier-Stokes equations for a viscous, steady and incompressible flow: (i) in a planar straight channel with a narrow inlet of varying width and (ii) in a triangular parametrized lid driven cavity. We will also present a new empirical strategy in order to employ the RB and ANN coefficients for a non-intrusive detection of the critical points [3].

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