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Deep Reinforcement Learning for fluid mechanics

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In the past couple of years, the interest of the fluid mechanics community for deep reinforcement learning (DRL) techniques has increased at fast pace, leading to a growing activity on the topic. While the capabilities of DRL to solve complex decision-making problems make it a valuable tool for active flow control, recent publications also demonstrated applications to other fields, such as shape optimization or microfluidics.

This present work gauges the ability of deep reinforcement learning (DRL) techniques to assist the control of complex fluid flow [1-3]. We couple it with an in-house stabilized finite elements environment combining variational multiscale (VMS) modeling of the governing equations, immerse volume method, and multi-component anisotropic mesh adaptation to compute the numerical reward fed to the neural network. Several test cases are used as testbed for developing the methodology, in fields related to non-Newtonian fluid flow, Shape optimization and Fluid-Structure Interaction among others. Several 2D and 3D numerical examples will be presented to (1) highlight the novelty of this DRL-CFD framework, (2) to present all the steps of this framework and finally (3) to illustrate its capability for optimal flow control, much needed in the industry 4.0.

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