PostDoc Position in Deep Reinforcement Learning for CFD

Context

The recent development of machine learning methods has led to a surge of recent work considering the coupling of ML techniques with computational fluid dynamics (CFD). Combining modern powerful CFD simulation tools and deep reinforcement learning (DRL, in which a deep neural network learns to perform a task from scratch via trial and error) paves the way to an entirely new perspective on how to design flow control strategies, using the feature extraction capabilities of deep neural networks to take full advantage of actuation possibilities. This is key to the realization of improved engineering design in a variety of industrial and process applications (e.g., to reduce the environmental impact of transport emissions, increase the efficiency of renewable energy sources, or regulate process temperatures), which remains extremely cumbersome with analytical and semi-analytical methods derived from optimal control theory and model reduction.

Objective

Our objective is to improve over canonical control methods with the addition of DRL components while handling the complexity inherent to the unsteadiness, nonlinearity, and multi-scale nature of high-fidelity, large-scale flow solutions. To this end, the recruited post-doctoral research will study and implement methodological improvements needed to achieve sample-efficient DRL, as the CFD environment can represent up to 99% of the computational time. Practices to be considered in the present project include the systematic compression of observations by auto-encoders trained on-the-fly (to allow using smaller networks) and the improvement of the existing parallel learning pattern. The researcher will implement these developments in an in-house, modular DRL library, to allow for easy plug-in-plug-out development and testing of new algorithms and components specialized for fluid dynamics control and optimization applications. He will also apply the developed methodology to challenging flow control problems upscaling the complexity of the cases classically considered in the community.

Participants

This project leverages recent DRL advances in the field of computational fluid dynamics in general, and flow control in particular. The CFL Research Group at CEMEF is ideally positioned to pursue this objective, as it gathers experts in high-performance computing for complex multiphysics CFD applications, flow control and DRL, and has early contributed to DRL research applied to fluid mechanics as part of the MINDS initiative supported by the Carnot M.I.N.E.S. Institute.

Applicants

Work will take place at CEMEF. We are looking for outstanding and ambitious doctors in data science, machine learning, computational fluid mechanics and engineering physics, with the desire to develop data-driven tools to impact flow control practice. Experience in programming (preferably Python, C++) and machine learning implementations (TensorFlow), is required. Prior experience in collaborative projects using git would be appreciated.

Contacts

Prof. Elie Hachem : elie.hachem@minesparis.psl.eu

Dr. Jonathan Viquerat : jonathan.viquerat@minesparis.psl.eu