Deep Learning for Turbulent Flows and Physics-Informed-Neural-Networks (PINNs) Applications

Dr. Ricardo Vinuesa & Hamidreza Eivazi, KTH Royal Institute of Technology

The advent of new powerful deep neural networks (DNNs) has fostered their application in a wide range of research areas, including more recently in fluid mechanics. In this presentation, we will cover some of the fundamentals of deep learning applied to computational fluid dynamics (CFD). Furthermore, we explore the capabilities of DNNs to perform various predictions in turbulent flows: we will use convolutional neural networks (CNNs) for non-intrusive sensing, i.e. to predict the flow in a turbulent open channel based on quantities measured at the wall. We show that it is possible to obtain very good flow predictions, outperforming traditional linear models, and we showcase the potential of transfer learning between friction Reynolds numbers of 180 and 550. These non-intrusive sensing models will play an important role in applications related to closed-loop control of wall-bounded turbulence. We also discuss in detail the applicaiton of physics-informed neural networks (PINNs) in the context of RANS simulations.