Doctoral Landscape Award (DLA) project

Professor Serafim Kalliadasis

October 2027 start

Data-driven modelling and prediction of complex systems

The overarching objective is to utilise existing state-of-the-art data-driven methodologies, and, building on recent efforts in the group, develop new ones as needed, to efficiently simulate and accurately predict complex systems. Of particular interest are families of continuous deep architectures, which have recently re-emerged as “neural ordinary-differential equations (NODEs)” and physics-informed neural networks (PINNs). Specifically, NODEs will be utilised in the first instance to analyse the dynamics of a set of ODEs [which for a sufficiently large number of ODEs yield a partial-differential equation (PDE)], followed by stochastic-differential equations (SDEs) and ultimately SPDEs. This work will be complemented by the use of PINNs where NNs will be trained to act as the numerical solution of ODEs/PDEs/SDEs/SPDEs. | New line | A number of prototypical systems will be considered in order of increased complexity. These include the Lorenz system, a set of three ODEs obtained from the Rayleigh-Benard convection between two parallel plates (which in turn can viewed as a model of the atmosphere) via dimension reduction. The Lorenz system exhibits non-trivial behaviour including transition to chaos. Particular emphasis will be given to a systematic sensitivity analysis to assess the predictability of NODEs for the prototypical systems we will consider.