Deep Learning for Time-Series Data

The goal of this thesis is to investigate different scalable deep learning (DL) architectures for the modelling and prediction of time series with a focus on high-dimensional chaotic dynamical systems.

Recent research efforts concentrate on complementing classical approaches for dynamical system modelling and prediction [1] with scalable nonlinear machine learning based alternatives that can efficiently learn the complex spatiotemporal dynamics. Such techniques include Echo State Networks [2], Gaussian Processes and Recurrent Neural Networks [3].

However, many other deep learning architectures that experienced widespread success in sequence modelling (natural language processing, speech recognition, etc.) have yet to be investigated in the context of dynamical systems. The goal of this project is to research novel machine learning architectures, tailor them for time-series modelling, and test their efficiency in predicting complex high-dimensional dynamical systems.

The student will learn the basic theoretical concepts behind deep learning and dynamical systems and gain hands on experience in machine learning software. This project can be adapted to BSc Thesis/MSc Thesis.

PREREQUISITES
- Basic programming skills
- Ability to work independently
- Basic knowledge of ML

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[3] Data-driven forecasting of high-dimensional chaotic systems with long short-term memory networks P.R. Vlachas, 2018

In the CSE Lab, we combine computational methods, computer science tools and domain specific knowledge to solve scientific and engineering problems in areas such as Fluid Mechanics, Nanotechnology and Life Sciences. The core computational competences of our group are in particle methods and in stochastic optimization techniques. Motivated by challenges in application fields, we focus on identifying the common elements among computational techniques and on formulating common methodological, algorithmic and software structures that facilitate their further development.