B.Sc. / M.Sc. Thesis

Variational Autoencoder for Turbulence Generation

Variational autoencoders (VAE) are a class of generative models based on Bayesian inference methods. They are very successful in a range of machine learning applications like image creation, fault detection and are generally useful in semi-supervised learning scenarios. As opposed to standard autoencoders, VAEs approximate a latent state distribution from the training process, from which samples can be drawn in the inference phase, leading to new but statistically equivalent data points.

In this thesis, the capabilities of (variational) autoencoders for the generation of turbulence will be explored. High quality turbulent data is generally only available from computationally expensive direct numerical simulations on large scale computers, so a potentially cheaper method is attractive. As a starting point, the candidate will review the relevant literature on the subject of inferential statistics, generative models and VAEs. In a next step, the candidate will develop a framework for the design and training of VAEs within the Tensorflow framework for both fully connected and convolutional layers and apply it to the classical test cases. After successful validation, the VAE will be trained on an existing database of DNS and LES data. This thesis is suitable for candidates with a strong interest in mathematics, statistics and a basic knowledge of data analytics and / or machine learning. Knowledge about turbulence is not essential, but a plus. The work program is intended for a M.Sc. thesis, however, it can be adapted for a B.Sc. thesis as well.

Work Packages:

- Literature study: Inferential statistics, generative models, autoencoders, variational autoencoders

- Development of a framework for the design, training and application of autoencoders in Tensorflow

- Extension to variational autoencoders

- Application to the existing turbulence database for DNS and LES

- Critical appraisal of results and documentation of the work

Prerequisites:

- Basic knowledge in Linux and Python or ability to pick it up quickly

- Self-reliant and highly motivated student

Advisors: Dr. Andrea Beck, Anna Schwarz, M.Sc.

Starting Date: as soon as possible

Auf das "Merkblatt für die Anfertigung von Bachelor- und Masterarbeiten" wird hingewiesen.