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# Machine Learning for Predicting Flow Fields

*Thursday 23 March 2023 16:20 (20 minutes)*

This JLESC collaboration focuses on the prediction of flow fields using machine learning (ML) techniques. The basis for the project are jointly developed convolutional neural networks (CNNs) with an autoencoder-decoder type architecture, inspired by the work in [1]. These CNNs are used to investigate dimension-reduction techniques for a three-dimensional flow field [2]. That is, the CNNs are trained to identify the different modes of the flow, and the results are compared to conventional techniques for mode decomposition. The basic loss function considers the mean-squared error between the predicted flow field, expressed by the sum of all modes, and the flow field used as input to the CNNs. Additionally, the influence of physical loss functions that consider the dominating frequency and energy of a mode on predictions is investigated. Furthermore, time-evolution of the reduced-order space is evaluated using a reduced-order model (ROM) based on long short-term memory (LSTM) networks and gated recurrent units (GRUs). The neural networks are implemented with a performance-effective distributed parallel scheme on Fugaku.

[1] T. Murata, K. Fukami, and K. Fukagata, "Nonlinear mode decomposition with convolutional neural networks for fluid dynamics", Journal of Fluid Mechanics, vol. 882, 13, 2020, doi:10.1017/jfm.2019.822.
[2] K. Ando, K. Onishi, R. Bale, M. Tsubokura, A. Kuroda, and K. Minami, "Nonlinear mode decomposition and reduced-order modeling for three-dimensional cylinder flow by distributed learning on Fugaku", Proceedings of International Conference on High Performance Computing (ISC2021), Springer, Cham, pp.122–137, 2021, doi:10.1007/978-3-030-90539-2_8.

## JLESC topic

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