State Estimation of a Wind Turbine Model using Multi-Fidelity Recurrent Neural Networks

TECHNISCHE UNIVERSITÄT DARMSTADT

Project Seminar (3-4 People)

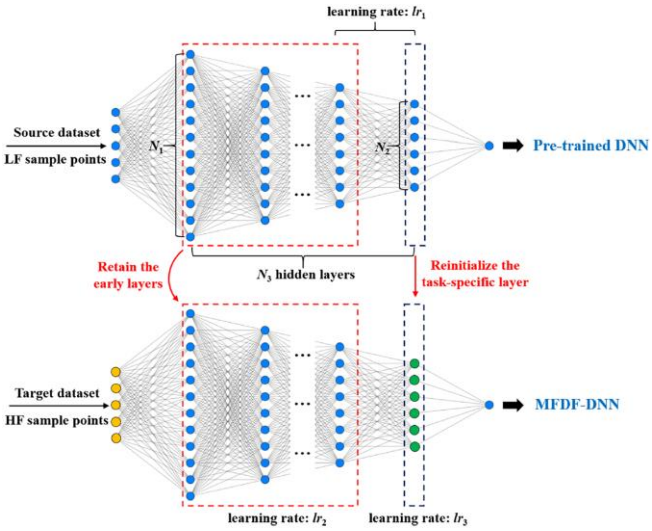
Wind turbines are highly nonlinear, dynamical systems with complex disturbances, such as varying wind speeds. In order to efficiently control such systems, modern wind turbine controllers (e.g., model predictive controllers) need precise knowledge of the wind turbine system states. Since not all states can be measured directly, state estimation techniques offer a solution.

This project explores data-driven state estimation using recurrent neural networks (RNNs), such as long short-term memory (LSTM) networks. A key challenge in training these networks is the limited availability of high-quality data. To address this, this project focuses on implementing multi-fidelity neural networks, which leverage a combination of low- and high-fidelity data sources [1, 2] to achieve accurate state estimation even when the amount of high-quality data is limited.

Your tasks will include:

- Conducting a literature review on multi-fidelity network approaches (e.g., multi-agent systems, transfer learning [3], …)
- Designing and implementing multi-fidelity RNN architectures
- Applying and testing the models using wind turbine data with varying levels of fidelity
- Performing hyperparameter tuning to optimize estimator performance

For this project, background knowledge about neural networks is required, preferably including recurrent network approaches such as LSTMs. Experience in programming in Python, Pytorch, and/or Tensorflow is beneficial. The report will be written in English. If you have any questions, feel free to contact us.



[1] https://github.com/jgeisler0303/CADynTurb
[2] https://openfast.readthedocs.io/en/main/
[3] https://doi.org/10.1016/j.aei.2022.101689

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