Control of a Partial Differential Equation System Using Recurrent Neural Networks

TECHNISCHE UNIVERSITÄT DARMSTADT

Projektseminar (2-4 Personen)

Partial differential equations (PDE) are commonly encountered in fluid dynamics and engineering, e.g., temperature profile in a heat exchanger or concentration profile in tubular reactors (plug flow reactor). Solving nonlinear PDEs numerically, e.g., with the finite element method, can be challenging.

Recurrent neural networks (RNN) are capable of describing the dynamic evolution of nonlinear systems. RNNs use the previous information to generate a memory effect that influences future predictions. There are different structures available, e.g., Gated Recurrent Units (GRU) that include reset and update gates, while Long Short-Term Memory (LSTM) additionally include forget and output gates. LSTMs have been used to capture spatial and temporal data from PDEs in [1].

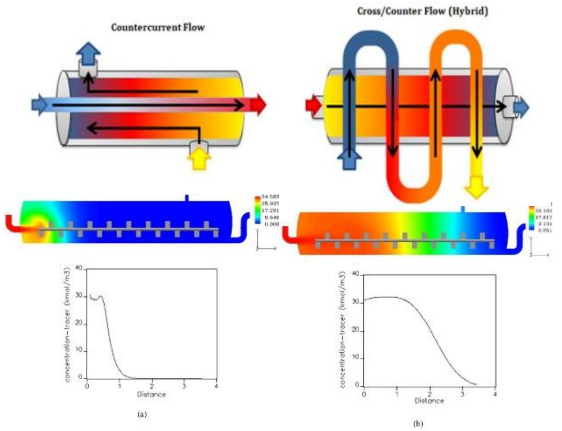
Requirements:

- Basic knowledge of modelling and RNNs, good/very good skills in Python (CasADi, PyTorch, TensorFlow), model predictive control (MPC)

Your tasks will be:

- Literature review on PDEs and RNNs
- Implement a PDE solver and a RNN framework as part of a previously released toolbox [2]
- Use a RNN to solve a PDE system and evaluate the obtained RNN model in a model-based strategy, e.g., in MPC

Language: English



[1] Hu, Y., Zhao, T., Xu, S., Xu, Z., & Lin, L. (2020). *Neural-PDE: A RNN based neural network for solving time dependent PDEs*. http://arxiv.org/abs/2009.03892

[2] Pohlodek, J., Morabito, B., Schlauch, C., Zometa, P., & Findeisen, R. (2022) *Flexible development and evaluation of machine-learning-supported optimal control and estimation methods via HILO-MPC*. https://arxiv.org/abs/2203.13671

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