



Technische
Universität
Braunschweig



Learning State-Space Models of Dynamical Systems from Data

Lecture of

Prof. Dr. Peter Benner

Dynamik Komplexer Technischer Systeme
MPI Magdeburg

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Okerhochhaus, Pockelsstraße 3,
seminar room, ground floor

Learning dynamical models from data plays a vital role in engineering design, optimization, and predictions. Building models describing the dynamics of complex processes (e.g., weather dynamics, reactive flows, brain/neural activity, etc.) using empirical knowledge or first principles is frequently onerous or infeasible. Therefore, system identification has evolved as a scientific discipline for this task since the 1960ies. Due to the obvious similarity of approximating unknown functions by artificial neural networks, system identification was an early adopter of machine learning methods. In the first part of the talk, we will review the development in this area until now.

For complex systems, identifying the full dynamics using system identification may still lead to high-dimensional models. For engineering tasks like optimization and control synthesis as well as in the context of digital twins, such learned models might still be computationally too challenging in the aforementioned multi-query scenarios. Therefore, it is desirable to identify compact approximate models from the available data. In the second part of this talk, we will therefore exploit that the dynamics of high-fidelity models often evolve in low-dimensional manifolds. We will discuss approaches learning representations of these low-dimensional manifolds using several ideas, including the lifting principle and autoencoders. In particular, we will focus on learning state-space representations that can be used in classical tools for computational engineering. Several numerical examples will illustrate the performance and limitations of the suggested approaches.