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Optimal Approaches to Identifying Systems and Processes with Asymmetric Dynamics

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Abstract:

Most real dynamic systems exhibit nonlinearity. For this reason, there are different gains for different signs of the input quantity in the vicinity of the selected operating point. In some cases, this system also has different dynamics. A typical example is thermal systems that exhibit different heating and cooling rates (time constants). Although there are many black-box (inductive, experimental) and white-box (deductive, analytical) approaches and methods, and their combinations, for dynamic systems, asymmetry in their static and dynamic properties is widely neglected. The existing literature offers only a very few methods that affect this property (e.g., a relay feedback experiment based on iterative estimation of the frequency characteristic).

The goal is to propose an original (ideally online) approach to the identification of asymmetric systems and processes based on existing identification algorithms formulated in the time or frequency domains, including the formulation of an optimality criterion. The result will not be a single model, but a "multimodel". The dissertation will therefore also include the design of an algorithm to solve the optimization task, based on modern parametric optimization (e.g., metaheuristic algorithms) or a comprehensive approach to modeling and identifying dynamic systems (e.g., using RL, RNNs, etc.). Emphasis will be placed on easy implementation and the possibility of deploying the entire procedure in real time. The results will be verified through simulation and a laboratory experiment using real-world data.

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