Port-Hamiltonian systems – from a general modelling wishlist to surrogate models with guarantees

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The framework of port-Hamiltonian (pH) systems is a powerful modeling paradigm in computational science and engineering. It follows a bottom-up philosophy, where each component of a complex system can be modeled separately and then, afterward, combined with the other components through well-defined interaction ports. One of the many advantages of pH systems is that properties like stability and passivity are directly encoded in the system structure. It is thus easy to maintain these properties in surrogate models whenever we are able to preserve the pH structure in the surrogate.
In this talk, I will first discuss how pH systems satisfy a broad range of modern modeling requirements, ranging from their analytical properties to structure-preserving numerical methods [2]. After this general introduction to pH systems, we discuss different aspects of surrogate modeling for pH systems. We start by pointing out the impact of the energy functional on the approximation quality [1], discuss the correct norms to compare pH systems, and explain how we can use the Hamiltonian to learn pH systems from data [3].

References

[1] T. Breiten and B. Unger. Passivity preserving model reduction via spectral factorization. *Automatica J. IFAC*, 142:110368, 2022.

[2] V. Mehrmann and B. Unger. Control of port-Hamiltonian differential-algebraic systems and applications. *ArXiv e-print 2201.06590*, 2022.

[3] R. Morandin, J. Nicodemus, and B. Unger. Port-Hamiltonian dynamic mode decomposition. *ArXiv e-print 2204.13474*, 2022.