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Operator Learning and Inverse Problems

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Approximating, in particular, learning operators acting between function spaces, plays a central role in Scientific Machine Learning. Its main motivation is to facilitate an efficient evaluation of the mapping that takes a given class of "problem data" such as source terms, boundary data, or uncertain coefficient fields into the corresponding solution of a system of corresponding partial differential equations (PDEs). I On the one hand, a learned operator surrogate is to facilitate the exploration of corresponding solution manifolds via such efficient forward simulations. On the other hand, such operator surrogates are to help solving inverse problems such as recovering, from a finite number of observational data or measurements, a particular state in the solution manifold, or even the unknown problem data behind that state. In this talk we highlight some essential obstructions, namely the intrinsic high dimensionality of such recovery tasks as well as their ill-posedness to discuss then - in a possibly non-technical manner- concepts that can overcome or mitigate these obstructions. This concerns the interplay between high dimensional sparsity notions, statistical estimation, and ways how to best link physics information, represented by the PDE model, with data information through the use of proper model compliant metrics.

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