Structured Autoencoders for Operator-theoretic decomposition and Model reduction of Spatio-temporal dynamics

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We explore the design of autoencoders for operator-theoretic decomposition and reduced order modeling of complex spatio-temporal dynamics. Convolutional autoencoders are used to extract the lower-dimensional manifold of the latent variables. This autoencoder is parameterized to yield provably stable predictions and is constrained by the governing equations of the full order dynamics that we aim to represent. Further, the latent space is explicitly endowed with a specific structure to promote interpretability and to extract Koopman modes. Variational inference is used in a hierarchical Bayesian setting to quantify uncertainties in the characterization and prediction of the spatio-temporal dynamics. The framework is evaluated on a range of problems involving strong gradients, wave propagation, and coherent structures. The final part of the talk will explore intrusive and non-intrusive model reduction methods on the above non-linear manifolds.