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When do World Models Successfully Learn Dynamic Systems?

Monday, March 2, 2026 3:15 PM (45 minutes)

In this work, we explore the use of compact latent representations with learned time dynamics ('World Models') to simulate physical systems. Drawing on concepts from control theory, we propose a theoretical framework that explains why projecting time slices into a low-dimensional space and then concatenating to form a history ('Tokenization') is so effective at learning physics datasets, and characterise when exactly the underlying dynamics admit a reconstruction mapping from the history of previous tokenized frames to the next. To validate these claims, we develop a sequence of models with increasing complexity, starting with least-squares regression and progressing through simple linear layers, shallow adversarial learners, and ultimately full-scale generative adversarial networks (GANs). We evaluate these models on a variety of datasets, including modified forms of the heat and wave equations, the chaotic regime 2D Kuramoto-Sivashinsky equation, and a challenging computational fluid dynamics (CFD) dataset of a 2D Kármán vortex street around a fixed cylinder, where our model is successfully able to recreate the flow.

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