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Research Highlight: Deep Learning via Dynamical Systems: An Approximation Perspective

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Arguably the most distinguishing aspect of deep learning is the approximation of functions through composition – something that is quite different from classical methods that build complicated functions using linear combinations of simple ones. In this paper, we establish some basic results on the approximation mechanism of composition, building on the dynamical systems approach to deep learning, where deep residual networks are idealized as continuous-time dynamical systems,

In particular, we establish general sufficient conditions for universal approximation using continuous-time deep residual networks, which can also be understood as approximation theories in L_p using flow maps of dynamical systems. In specific cases, rates of approximation in terms of the time horizon are also established. Overall, these results reveal that composition function approximation through flow maps presents a new paradigm in approximation theory and contributes to building a useful mathematical framework to investigate deep learning.

References:

Q. Li, T. Lin, and Z. Shen, “Deep learning via dynamical systems: An approximation perspective,” J. Eur. Math. Soc., Apr. 2022, doi: 10.4171/JEMS/1221.