Abstract Submitted
for the CUWIP22 Meeting of
The American Physical Society

Learning Continuous Chaotic Attractors with a Reservoir Computer[1] LINDSAY SMITH, JASON KIM, ZHIXIN LU, DANI BASSETT, University of Pennsylvania — Neural systems are well known for their ability to learn and store information as memories. Even more impressive is their ability to abstract these memories to create complex internal representations, enabling advanced functions such as the spatial manipulation of mental representations. While recurrent neural networks (RNNs) are capable of representing complex information, the exact mechanisms of how dynamical neural systems perform abstraction are still not well-understood, thereby hindering the development of more advanced functions. Here, we train a 1000-neuron RNNa reservoir computer (RC)to abstract a continuous dynamical attractor memory from isolated examples of dynamical attractor memories. Furthermore, we explain the abstraction mechanism with a new theory. By training the RC on isolated and shifted examples of either stable limit cycles or chaotic Lorenz attractors, the RC learns a continuum of attractors as quantified by an extra Lyapunov exponent equal to zero. We propose a theoretical mechanism of this abstraction by combining ideas from differentiable generalized synchronization and feedback dynamics. Our results quantify abstraction in simple neural systems, enabling us to design artificial RNNs for abstraction and leading us toward a neural basis of abstraction.

[1]L.M.S. acknowledges support from the University Scholars Program at the University of Pennsylvania. J.Z.K. acknowledges support from the NIH (No. T32-EB020087), PD: Felix W. Wehrli, and the National Science Foundation Graduate Research Fellowship (No. DGE-1321851). D.S.B. acknowledges support from the NSF through the University of Pennsylvania Materials Research Science and Engineering Center (MRSEC) (No. DMR-1720530), as well as the Paul G. Allen Family Foundation, and a grant from the Army Research Office (No. W911NF-16-1-0474). The content is solely the responsibility of the authors and does not necessarily represent the official views of any of the funding agencies.

Lindsay Smith
University of Pennsylvania

Date submitted: 11 Jan 2022

Electronic form version 1.4