



# Soft Living Active and Adaptive Matter



Learning without neurons in physical systems

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## Abstract:

From electrically responsive neuronal networks to the adaptive immune response, biological systems can learn to perform complex tasks. In this seminar, we explore physical learning, a framework inspired by computational learning theory and biological systems, where networks physically adapt to applied forces to adopt desired functions. Unlike traditional engineering approaches, physical learning is facilitated by physically realizable learning rules, requiring only local responses and no explicit information about the desired functionality. Our research shows that such local learning rules can be derived for broad classes of physical networks, and that physical learning is indeed physically realizable through laboratory experiments. We further find that physical learning rules can give rise to robust and energy efficient supervised and unsupervised modes of learning. By leveraging advances of statistical learning theory and neuroscience in physical machines, we propose autonomous physical learning as a promising bridge between computational machine learning and biology, with the potential to enable the development of new classes of smart metamaterials that adapt in-situ to users' needs.

Date:  
02/12/2024

Time:  
9:00 AM-10:15 AM (PT)

## About the speaker:

Menachem Stern is a theoretical physicist exploring learning in physical systems, particularly in the contexts of mechanical systems and physically inspired learning rules. He is specifically interested in the analogies between learning in physical networks and biological/computational systems. These fundamental connections suggest the use of physical systems as learning algorithms with novel properties, as well as the understanding of learning and adaptation in nature.

Menachem is currently a postdoctoral fellow at The University of Pennsylvania, department of physics and astronomy, working with Andrea Liu and Vijay Balasubramanian. He holds a Ph.D. in physics from The University of Chicago.



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