Precision Convergence Webinar Series

Clustering and generalization of abstract structures in reinforcement learning and musicality

By Michael J. Frank

Brown University

With High-Level Panel of Leaders in Science, Technology, On-the-Ground Action, and Policy

Wednesday, November 9, 2022 | 11 AM to 1 PM EST (2 hours in duration)

For Remote Participation, please register HERE

ABSTRACT: Humans are remarkably adept at generalizing knowledge between experiences in a way that can be difficult for computers. Previous computational models and data suggest that rather than learning about each individual context, humans build latent abstract structures and learn to link these structures to arbitrary contexts, facilitating generalization, but with a cost in efficiency of initial learning. In these models, task structures that are more popular across contexts are likely to be reused in new contexts. Neural signatures of such structure learning are predictive across individuals of the ability to transfer knowledge to new situations. However, these models predict that structures are either re-used as a whole or created from scratch, prohibiting the ability to generalize constituent parts of learned structures. This contrasts with ecological settings, where task structures can be decomposed into constituent parts and reused in a compositional fashion. Moreover in many situations people can transfer structures that they have learned to entirely new situations, by analogy, even when surface aspects of the transition and reward functions change. I will present novel computational models across levels (from neural networks to bayesian formulations) that address how agents and humans can learn and generalize such abstract and compositional structure. Throughout, I will give examples of how such computations can allow a musician to learn to compositionally transfer musical scales and rhythms within and across instruments. Discussion with panelists will follow on the similarity/dissimilarity between human and machine in such abstraction

PRESENTER: Michael J. Frank is Edgar L Marston Professor of Cognitive, Linguistic & Psychological Sciences at Brown University. He directs the Center for Computational Brain Science within the Carney Institute for Brain Science. He received his PhD in Neuroscience and Psychology in 2004 at the University of Colorado, following undergraduate and master's degrees in electrical engineering. Frank's work focuses primarily on theoretical models of frontostriatal circuits and their modulation by dopamine, especially their cognitive functions and implications for neurological and psychiatric disorders. The models are tested and refined with experiments across species, neural recording methods, and neuromodulation. Honors include the Troland Research Award from the National Academy of Sciences (2021), Kavli Fellow (2016), the Cognitive Neuroscience Society Young Investigator Award (2011), and the Janet T Spence Award for early career transformative contributions (Association for Psychological Science, 2010). Dr Frank is a senior editor for eLife.

About the series: The precision convergence series is launched to catalyze unique synergy between, on the one hand, novel partnerships across sciences, sectors and jurisdictions around targeted domains of real-world solutions, and on the other hand, a next generation convergence of AI with advanced research computing and other data and digital architectures such as PSC's Bridges-2, and supporting data sharing frameworks such as HuBMAP, informing in a real time as possible the design, deployment and monitoring of solutions for adaptive real-world behavior and context.

The McGill Centre for the Convergence of Health and Economics (MCCHE) is a virtual world network of scientist, action and policy leaders promoting the weaving of digital-powered interdisciplinary science into person-centered domain-specific solutions at scale to global challenges faced by traditional and modern economy and society worldwide. The MCCHE stimulates lasting collaborations that bridge the many divides in the market, economy, and society that are at the root of these most pressing modern challenges through collaborative of modular convergence innovation platforms.

The Pittsburgh Supercomputing Center is a joint computational research center between Carnegie Mellon University and the University of Pittsburgh. Established in 1986, PSC is supported by several federal agencies, the Commonwealth of Pennsylvania and private industry. PSC provides university, government, and industrial researchers with access to several of the most powerful systems for high-performance computing, communications, and data-handling available to scientists and engineers nationwide for unclassified research. PSC advances the state-of-the-art in high-performance computing, communications and informatics and offers a flexible environment for solving the largest and most challenging problems in computational science.