

Cyber Valley Evening Colloquium on Autonomous Systems

On the Rational Bounds of Human Cognition

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Online on Webex. For the event link please click [here](#)

Abstract

The human brain is one of the most complex autonomous systems on earth, with billions of neurons operating in parallel, giving rise to mental faculties such as reasoning, problem solving and the use of symbolic language. Despite the enormous capacity that the brain holds for parallel processing, humans are remarkably limited in the number of tasks they can execute simultaneously. Limitations in our ability to multitask are not only apparent in daily life. They are also universal assumptions of most general theories of human cognition. Yet, a rationale for why the human brain is subject to these constraints remains elusive. In this talk, I will draw on insights from neuroscience, psychology and machine learning to suggest that limitations in the brain's ability to multitask result from a fundamental computational dilemma in neural architectures. Using a combination of graph-theoretic analysis, neural network simulation and behavioral experimentation, I will demonstrate that neural systems can face a tradeoff between learning efficacy, that is promoted through the shared use of neural representations across tasks, and multitasking capability, that is achieved through the separation of neural representations between tasks. This work suggests that it can be optimal for a neural system to sacrifice multitasking capability, to learn single tasks more quickly by sharing rather than separating representations between tasks. I will conclude by demonstrating that this tradeoff can explain a variety of behavioral and neural phenomena related to human multitasking and that it can inform the design of autonomous artificial agents tasked to navigate this tradeoff.

Biographical Information

Sebastian Musslick is a Fellow of the Cognitive Science Program at Princeton University where he is about to receive his PhD degree in Quantitative and Computational Neuroscience. His research program involves the study of fundamental computational dilemmas in neural systems, to explain limitations of human and artificial cognition.

Sebastian received his diploma in Psychology at the Technische Universität Dresden in 2014, as well as a Master's degree in Neuroscience at Princeton University. During his diploma studies, he joined the University of Colorado in Boulder as a short-term research scholar from 2012 to 2013 where he developed biologically inspired models of human task switching performance. Sebastian amassed a strong record of publishing and collaborating with partners from academia and industry across disciplines, including psychology, neuroscience, mathematics, physics and computer science. In an effort to facilitate interdisciplinary exchange about the study of human and artificial cognition, he co-organized several international workshops and conferences, including the annual Conference on the Mathematical Theory of Deep Neural Networks and the annual Workshop on Mental Effort.