MIT Industrial Liaison Program Faculty Knowledgebase Report

Frontiers of AI/ML: MIT's Quest for Intelligence

May 25, 2021 - May 27, 2021

Day 1: Tuesday, May 25

11:00 AM - 12:00 PM

The MIT Quest for Intelligence: a bold bet to advance our understanding of intelligence
James DiCarlo
Director, MIT Quest
Peter de Florez Professor of Neuroscience
Head, Brain and Cognitive Sciences

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James DiCarlo is the Peter de Florez Professor of Neuroscience at MIT and director of the MIT Quest. He also heads the Department of Brain and Cognitive Science and is a principal investigator at the McGovern Institute for Brain Research. His research focuses on using computational methods to understand the brain's visual system, and with this knowledge, developing brain-machine interfaces to restore or augment lost senses. DiCarlo has received an Alfred P. Sloan fellowship, a Pew Scholar Award, and a McKnight Scholar Award. He earned a PhD in biomedical engineering, and an MD, from Johns Hopkins University.

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The MIT Quest for Intelligence is focused on a central challenge in human history – understanding intelligence. We believe this quest to understand intelligence – how brains produce it and how it can be replicated in artificial systems – requires the organized, collaborative efforts of science, engineering, the humanities, and beyond.

While artificial intelligence (AI) and machine learning (ML) technologies are now ubiquitous in society, current approaches have significant limitations and issues. The Quest aims to accelerate and amplify past success by organizing around long-term collaborative projects centered in a domain of natural intelligence with multiple real-world applications. In these domains we will bring science and engineering teams together to create integrated systems from theories of natural intelligence. This will create a tight-knit, virtuous cycle – intelligence-related science research will guide engineers to build and replicate engineered systems of intelligence derived from that science, leading to simultaneous breakthroughs in natural intelligence and artificial intelligence, and producing practical advances in machine intelligence and major benefits in human health, education, and well-being.

12:00 PM - 1:00 PM

Energy-Efficient Hardware and Intelligent Materials for Brain-inspired Computing: Artificial Synapses Based on Proton and Oxygen Motion--Video time stamp starts at: 54.55
Bilge Yildiz
Professor, Nuclear Science and Engineering
Professor, Materials Science and Engineering

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Bilge Yildiz is a professor in the Nuclear Science and Engineering and the Materials Science and Engineering Departments at Massachusetts Institute of Technology (MIT), where she leads the Laboratory for Electrochemical Interfaces. She received her PhD at MIT in 2003 and her BSc from Hacettepe University in 1999. After working at Argonne National Laboratory as a research scientist, she returned to MIT as an assistant professor in 2007. Yildiz's research focuses on laying the scientific groundwork to enable next generation electrochemical devices for energy conversion and information processing. The scientific insights derived from her research guide the design of novel materials and interfaces for efficient and durable solid oxide fuel cells, electrolytic water splitting, brain-inspired computing, and solid state batteries. Her laboratory has made significant contributions in advancing the molecular-level understanding of oxygen reduction, water splitting, ion diffusion, and charge transfer on mixed ionic-electronic conducting oxides. Her research has uncovered the effects of surface chemistry, elastic strain, dislocations, and strong electric fields on the reactivity, efficiency, and degradation in these applications. Her approach combines computational and experimental analyses of electronic structure, defect mobility and composition, using in situ scanning tunneling and X-ray spectroscopy together with first-principles calculations and novel atomistic simulations. Her teaching and research efforts have been recognized by the Argonne Pace Setter (2016), ANS Outstanding Teaching (2008), NSF CAREER (2011), IU-MRS Somiya (2012), the ECS Charles Tobias Young Investigator (2012), the ACerS Ross Coffin Purdy (2018), and the LG Chem Global Innovation Contest (2020) awards.

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Day 2: Thursday, May 27

11:00 AM - 12:00 PM

Doing for our robots what nature did for us
Leslie Kaelbling
Scientific Advisor, MIT Quest
Panasonic Professor of Computer Science and Engineering, Department of Electrical Engineering and Computer Science

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Leslie Kaelbling is a Professor at MIT. She has an undergraduate degree in Philosophy and a PhD in Computer Science from Stanford, and was previously on the faculty at Brown University. She was the founding editor-in-chief of the Journal of Machine Learning Research. Her research agenda is to make intelligent robots using methods including estimation, learning, planning, and reasoning. She is not a robot.

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12:00 PM - 1:00 PM

Scaling AI the Human Way: Building AI That Grows Into Intelligence the Way a Person Does - Video time stamp starts at: 60:48
Joshua Tenenbaum
Scientific Advisor, MIT Quest
Professor of Computational Cognitive Science
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Josh Tenenbaum and his colleagues in the Computational Cognitive Science group study one of the most basic and distinctively human aspects of cognition: the ability to learn so much about the world, rapidly and flexibly. Given just a few relevant experiences, even young children can infer the meaning of a new word, the hidden properties of an object or substance, or the existence of a new causal relation or social rule. These inferences go far beyond the data given: after seeing three or four examples of "horses", a two-year-old will confidently judge whether any new entity is a horse or not, and she will be mostly correct, except for the occasional donkey or camel.

We want to understand these everyday inductive leaps in computational terms. What is the underlying logic that supports reliable generalization from so little data? What are its cognitive and neural mechanisms, and how can we build more powerful learning machines based on the same principles?

These questions demand a multidisciplinary approach. Our group's research combines computational models (drawing chiefly on Bayesian statistics, probabilistic generative models, and probabilistic programming) with behavioral experiments in adults and children. Our models make strong quantitative predictions about behavior, but more importantly, they attempt to explain why cognition works, by viewing it as an approximation to ideal statistical inference given the structure of natural tasks and environments.

While core interests are in human learning and reasoning, we also work actively in machine learning and artificial intelligence. These two programs are inseparable: bringing machine-learning algorithms closer to the capacities of human learning should lead to more powerful AI systems as well as more powerful theoretical paradigms for understanding human cognition.

Current research in our group explores the computational basis of many aspects of human cognition: learning concepts, judging similarity, inferring causal connections, forming perceptual representations, learning word meanings and syntactic principles in natural language, noticing coincidences and predicting the future, inferring the mental states of other people, and constructing intuitive theories of core domains, such as intuitive physics, psychology, biology, or social structure.

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