institute for pure & applied mathematics

Mathematics of Collective Intelligence

February 15 - 19, 2022

Scientific Overview

All known intelligent systems are collectives. Individual organisms are collectives of cells, which develop, heal, sense, and act. Groups of human and non-human animals use a range of mechanisms to coordinate their behavior across space and time, from flocks and swarms to organizations, institutions, and cultural traditions. Deep learning—the dominant approach to artificial intelligence—gains its power from combining simple units into complex architectures; many contemporary architectures (e.g., GANs) combine multiple learners, and multi-agent settings are a critical research frontier for AI, especially settings that integrate human and artificial agents. These examples imply that a scientific understanding of intelligence must fundamentally grapple with collective intelligence—in a much broader sense than typical usage of the term would suggest. A variety of mathematical and computational models have been developed to explain and design intelligent behavior in particular collectives. Several mathematical fields source the ideas used to build and understand these models, from dynamical systems, statistical mechanics, network science, and random matrix theory to information theory, optimization, Bayesian statistics, and game theory–even applied category theory, in recent years. It remains unclear, however, whether we have the right mathematical language to provide a unified, abstract account of collective intelligence–or whether such a language is even possible! This workshop will bring together leading experts who study and model collective intelligence, as well as those who seek to understand such models. Its goal is to explore the advantages and disadvantages of existing modeling frameworks; to find collective implementations of models of individual cognition; to expand the systems and settings understood as manifesting collective intelligence; and to grow the community of researchers who study the mathematical foundations of collective intelligence.

This workshop will include a poster session; a request for posters will be sent to registered participants in advance of the workshop.

Participation

Additional information about this workshop including links to register and to apply for funding, can be found on the webpage listed below. Encouraging the careers of women and minority mathematicians and scientists is an important component of IPAM's mission, and we welcome their applications.

Organizers

John Baez (UC Riverside), Pranab Das (Elon University), Jessica Flack (Santa Fe Institute), Jacob Foster (UCLA), Alison Gopnik (UC Berkeley), Max Kleiman-Weiner (Common Sense Machines), Lakshminarayanan Mahadevan (Harvard University), Josh Tenenbaum (Massachusetts Institute of Technology).

Speakers

John Baez (UC Riverside); Jessica Flack (Santa Fe Institute); Pranab Das (University of Mumbai); Jacob Foster (UC Los Angeles); Josh Tenenbaum (Massachusetts Institute of Technology); Robert Batterman (University of Pittsburgh); David Ha (Google Brain); Ali Jadbabaie (Massachusetts Institute of Technology); Natasha Jacques (Google Brain); Max Kleiman-Weiner (Common Sense Machines); Michael Levin (Tufts University); Mahadevan Lakshminarayanan (Harvard University); Melanie Mitchell (Santa Fe Institute); Elchanan Mossel (Massachusetts Institute of Technology); David Mumford (Brown University); Michael Muthukrishna (London School of Economics); Orit Peleg (University of Colorado Boulder); Patrick Shafto (Rutgers University), David Spivak (Topos Institute (Berkeley)); Lillian J. Ratliff (University of Washington); Fei Fang (Carnegie Mellon University); Lisa Lee (Google Brain);

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For more information, visit the program webpage:

www.ipam.ucla.edu/MI2022