institute for pure & applied mathematics

Tensor Networks

February 5 -9, 2024

Scientific Overview

Many-body quantum mechanical systems are described by tensors. If a system has n particles, its state is an element of $H_1 \otimes \cdots \otimes H_n$, where H_j is a Hilbert space associated to the j-th particle. Due to the exponential growth of the dimension of $H_1 \otimes \cdots \otimes H_n$ with n, any naive method of representing these tensors is intractable on a computer. However, most tensors are unlikely to appear as quantum states. Tensor network states were defined to reduce the complexity of the spaces involved by restricting to a subset of tensors that is physically reasonable. States of physical interest seem to be well parameterized as tensor networks with a small number of parameters. The construction essentially consists of a decorated graph, and the structure of the graph determines which tensors can be constructed from the configuration. This leads to questions regarding the best (still tractable) structures for graphs.

Approximating a state in terms of a tensor network makes the entanglement nature of the state itself apparent, which is not visible when approximating the state in a physical coordinate system. Recently a tensor network on a classical computer apparently was more effective than Google's quantum computer. In this workshop we will compare the computational advantages of quantum computing vs tensor networks. It is important to investigate this question both practically and theoretically. Beyond tensor networks, the workshop will explore additional classes of tensors useful for many-body physics and quantum information theory and their utility in areas such as high dimensional probability.

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

Alessandra Bernardi (Università di Trento)
Joseph (J.M.) Landsberg (Texas A&M University - College Station)
Lek-Heng Lim (University of Chicago)
Jianfeng Lu (Duke University)

Speakers

Thomas Bartel (Duke University)
Gérard Ben Arous (New York University)
Fernando Brandao (Caltech)
Garnet Chan (Caltech)
Elisa Ercolessi (Università di Bologna)
Di Fang (UC Berkeley)
Alhussein Fawsi (DeepMind Technologies)
Gero Friesecke (Technische Universität München)
Runshi Geng (Texas A&M University)
David Gross (Universität zu Köln)
Karen Hallberg (Bariloche Atomic Centre)
Hang (Amy) Huang (Auburn University)
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Anthony Nouy (Université de Nantes)
Matteo Rizzi (Universität zu Köln)
Elina Robeva (University of British Columbia)
Frank Schindler (Princeton University)
Norbert Schuch (University of Vienna)
Anna Seigal (Harvard University)
Frank Verstraete (Ghent University)
Ben Villalonga (Google)
Steve White (University of California, Irvine)
Ke Ye (Chinese Academy of Sciences)
Pan Zhang (Chinese Academy of Sciences)
Jeroen Zuiddam (Courant Institute of Mathematica Sciences)

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For more information, visit the program webpage:
www.ipam.ucla.edu/TNK2024