The role of artificial neural networks in quantum many-body physics

Stef Czischek

June 20, 2023

uOttawa

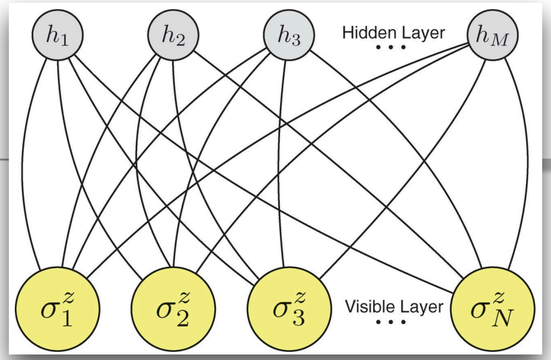
APRIQuOt

2016/2017: Neural network quantum states

Solving the quantum many-body problem with artificial neural networks

GIUSEPPE CARLEO AND MATTHIAS TROYER Authors Info & Affiliations

SCIENCE • 10 Feb 2017 • Vol 355, Issue 6325 • pp. 602-606



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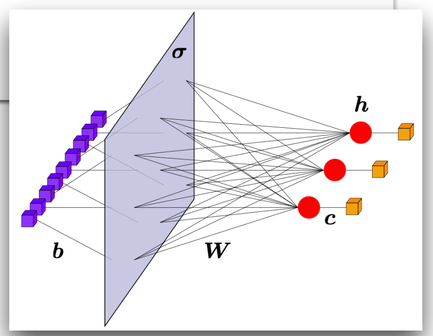

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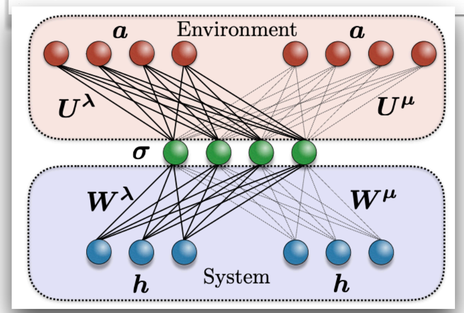

Neural-network quantum state tomography

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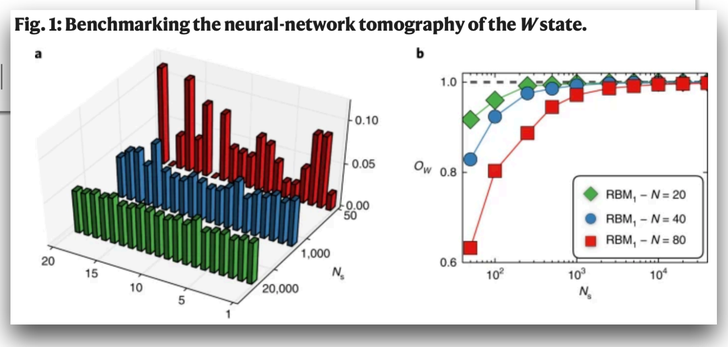
Nature Physics **14**, 447–450 (2018)



- Artificial neural networks to
  - Find ground states
  - Simulate dynamics
  - Reconstruct states from data

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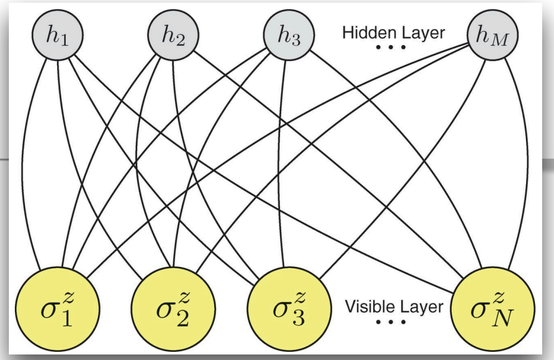

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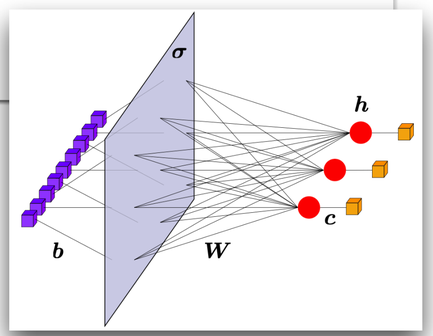

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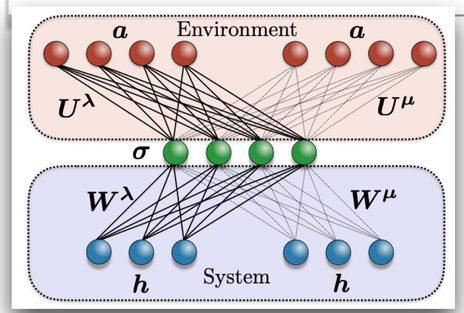

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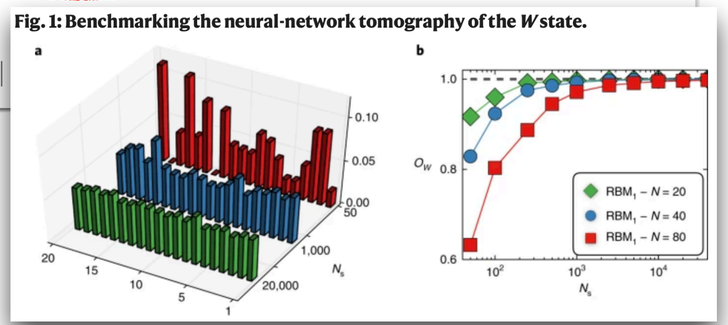

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Start of a rapidly growing field

- Various network architectures are explored
  - Beyond state-of-the-art numerical studies
- Many further applications of artificial neural networks

Reviews

Machine learning for quantum matter

Juan Carrasquilla

Article: 1797528 | Received 18 Mar 2020, Accepted 04 Jul 2020, Published online: 04 Aug 2020

Download citation https://doi.org/10.1080/23746149.2020.1797528 Check for updates

Modern applications of machine learning in quantum sciences arXiv:2204.04198v2 [quant-ph]

Anna Dawid, Julian Arnold, Borja Requena, Alexander Gresch, Marcin Płodzień, Kaelan Donatella, Kim A. Nicoli, Paolo Stornati, Rouven Koch, Miriam Büttner, Robert Okuła, Gorka Muñoz-Gil, Rodrigo A. Vargas-Hernández, Alba Cervera-Lierta, Juan Carrasquilla, Vedran Dunjko, Marylou Gabrié, Patrick Huembeli, Evert van Nieuwenburg, Filippo Vicentini, Lei Wang, Sebastian J. Wetzel, Giuseppe Carleo, Eliška Greplová, Roman Krems, Florian Marquardt, Michał Tomza, Maciej Lewenstein, Alexandre Dauphin

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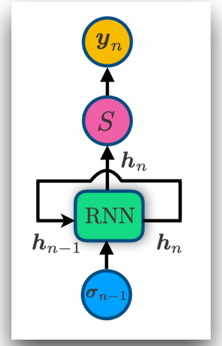

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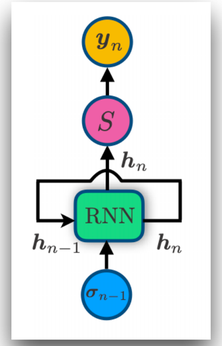

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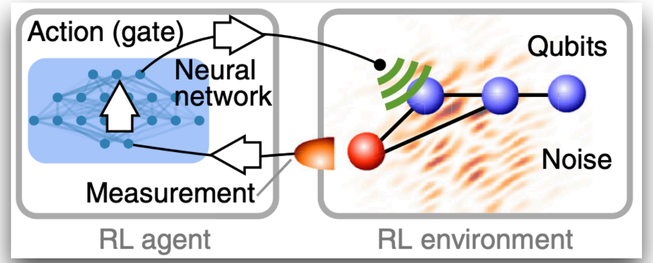

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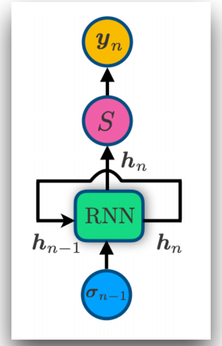

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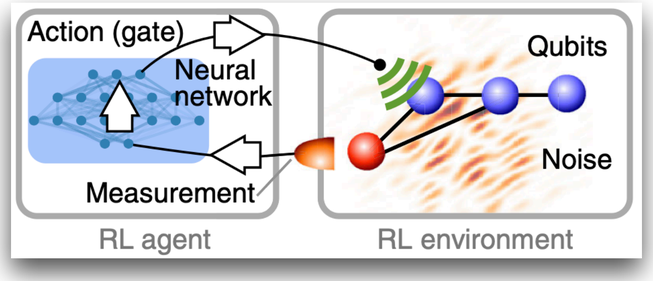

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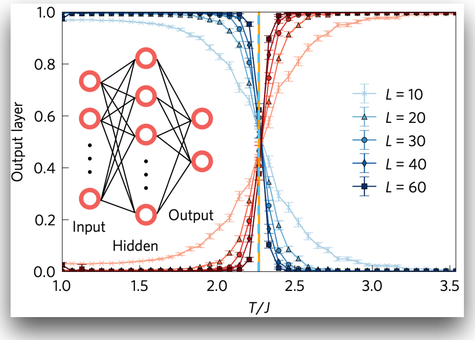

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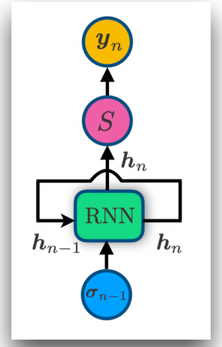

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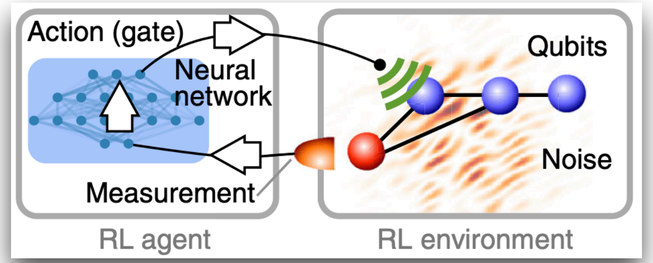

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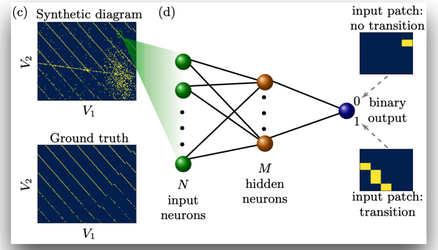

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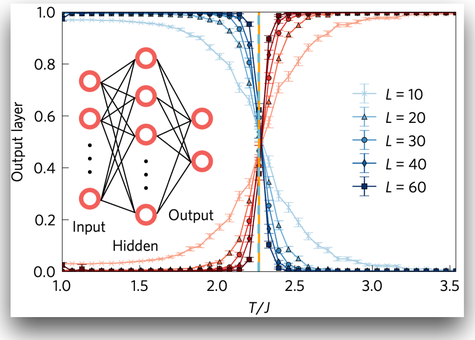

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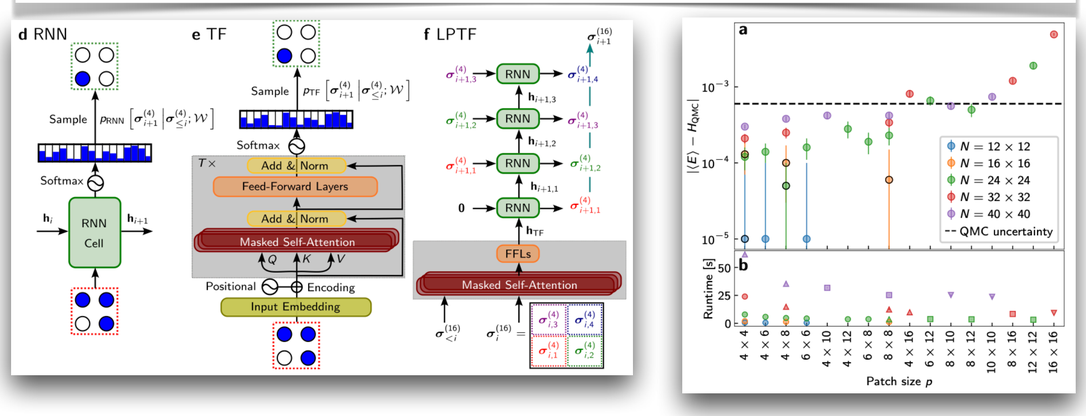
Large language models in quantum science

- Large language models give improved understanding of quantum many-body systems
  - Accuracies and computational efficiency beyond existing methods
  - Advance the development of quantum computation and quantum simulation

Variational Monte Carlo with Large Patched Transformers

Kyle Sprague, Stefanie Czischek arXiv:2306.03921v1 [quant-ph]



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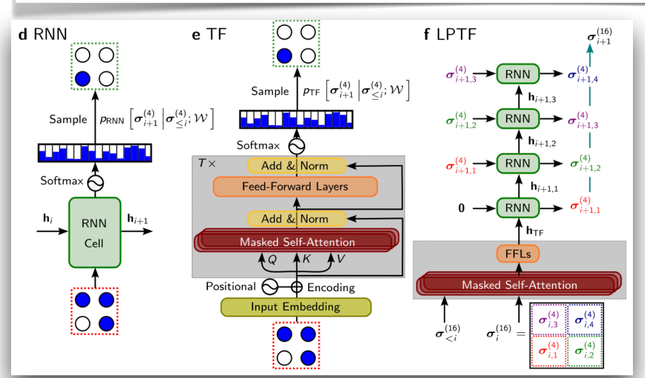

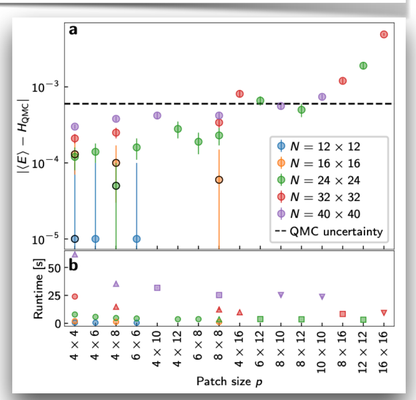

Attention-based quantum tomography

Peter Cha[6,1], Paul Ginsparg[2], Felix Wu[2], Juan Carrasquilla[3,4], Peter L McMahon[5] and Eun-Ah Kim[1]

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Machine Learning: Science and Technology, Volume 3, Number 1

Transformer quantum state: A multipurpose model for quantum many-body problems

Yuan-Hang Zhang and Massimiliano Di Ventra

Phys. Rev. B **107**, 075147 – Published 22 February 2023

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Attention-Based Transformer Networks for Quantum State Tomography

Hailan Ma, Zhenhong Sun, Daoyi Dong, Chunlin Chen, Herschel Rabitz

Transformer variational wave functions for frustrated quantum spin systems

Luciano Loris Viteritti, Riccardo Rende, Federico Becca

Towards Neural Variational Monte Carlo That Scales Linearly with System Size

Or Sharir, Garnet Kin-Lic Chan, Anima Anandkumar

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What to expect in the future

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- Artificial intelligence will play a significant role in advanced quantum computation and quantum simulation

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Stefanie Czischek, Andreas Baumbach, Sebastian Billaudelle, Benjamin Cramer, Lukas Kades, Jan M. Pawlowski, Markus K. Oberthaler, Johannes Schemmel, Mihai A. Petrovici, Thomas Gasenzer, Martin Gärttner

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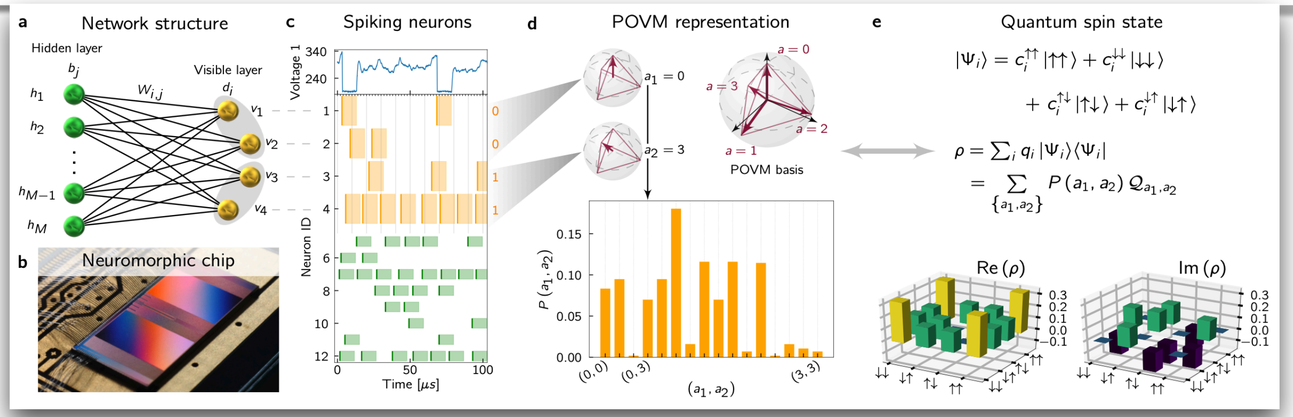

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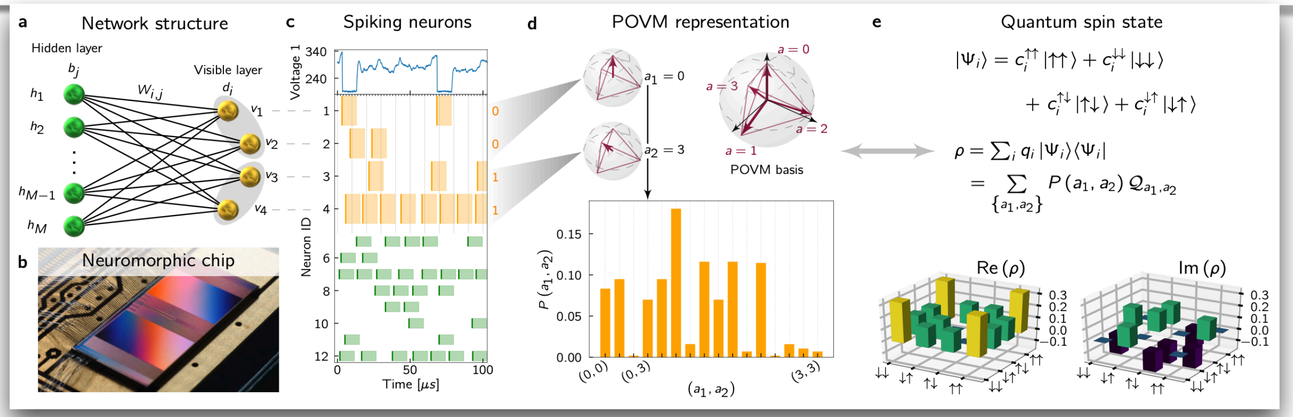

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And you can be a part of it!

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