Machine Learning for Lattice Gauge Theory in Japan

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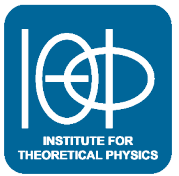
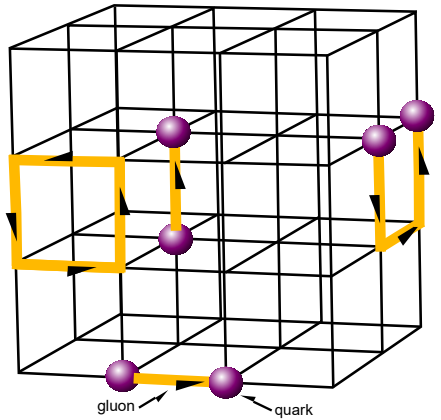
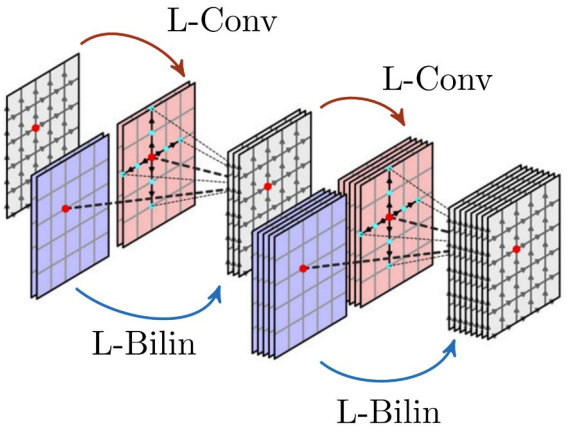
Japanese Science Day
Vienna, 5 October 2024



Lattice Gauge Theory and Neural networks



- Study Quantum Chromodynamics on discretized space-time
- Quarks sit on lattice sites; gluons connect them along the links.
- Large lattices lead to exponential growth in computational cost and requires supercomputers.
- Applications: study hadron structure, phase transitions, and fundamental constants.

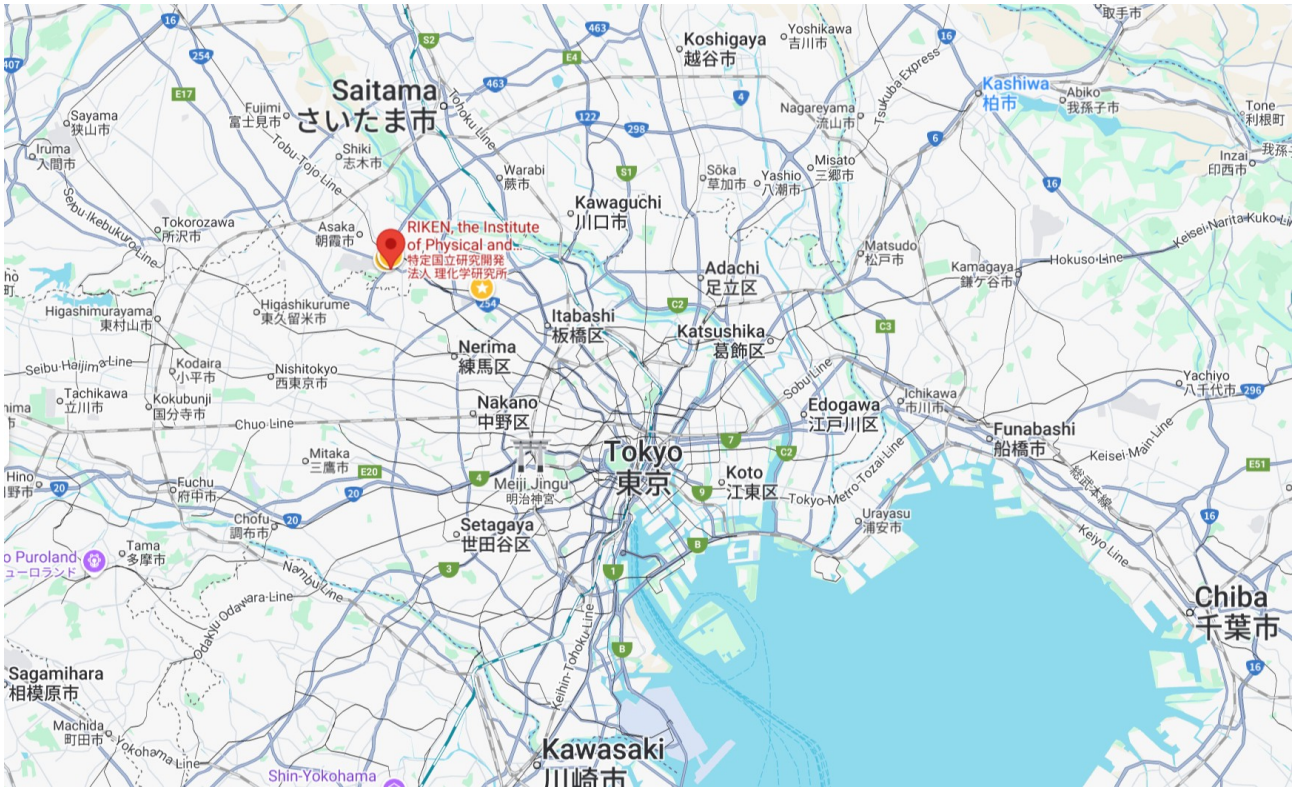


- Lattice gauge equivariant neural networks encode gauge symmetry directly into the neural network architecture.
- Efficiently processes lattice data while preserving physical invariances.
- Applications: accelerating simulations, solving inverse problems in physics.

Favoni, AI, Müller, Schuh,
Phys.Rev.Lett. 128 (2022) 032003

Riken iTHEMS

- Riken is a national scientific research institute.
- 3,000 scientists on seven campuses across Japan.
- Riken Wako Campus located in Saitama.
- About 1h by train to Tokio main station.

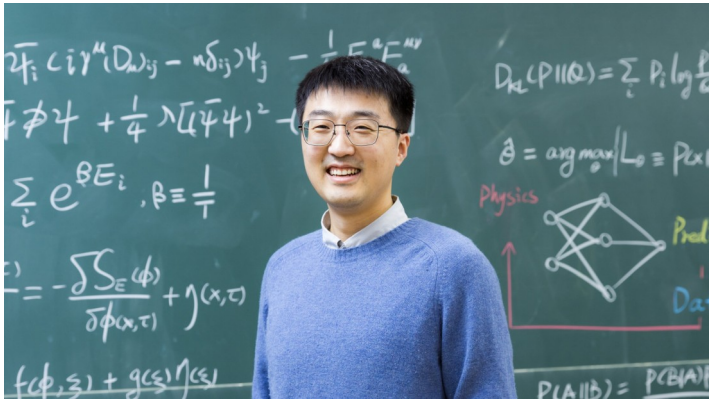


- Interdisciplinary Theoretical and Mathematical Sciences Program (iTHEMS)

Scientists at RIKEN

Tetsuo Hatsuda

- Program director of the RIKEN Interdisciplinary Theoretical and Mathematical Sciences Program (iTHEMS)
- Expert on Lattice QCD with strong interdisciplinary collaborations in theoretical and mathematical sciences.



Lingxiao Wang

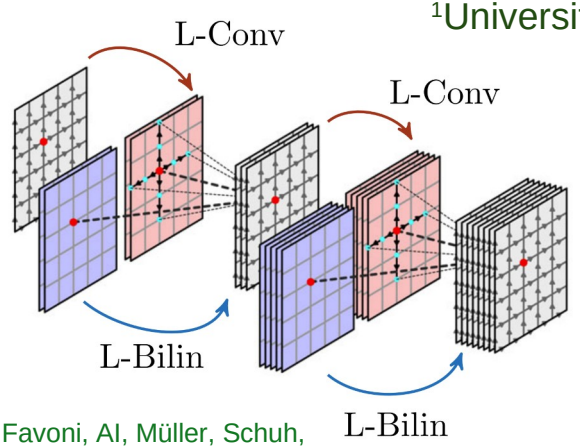
- Leads the working group „Deep learning for inverse problems in sciences (DEEP-IN)“
- Expert on machine learning applied to nuclear physics and other complex systems.

Research stay at RIKEN iTHEMS

Riken Wako,
July 2024

Learning a fixed point action for SU(3) gauge theory with lattice gauge equivariant convolutional neural networks

Kieran Holland[1], **Andreas Ipp**[2], David I. Müller[2] and Urs Wenger[3]
[1]University of the Pacific, [2]TU Wien, [3]University of Bern



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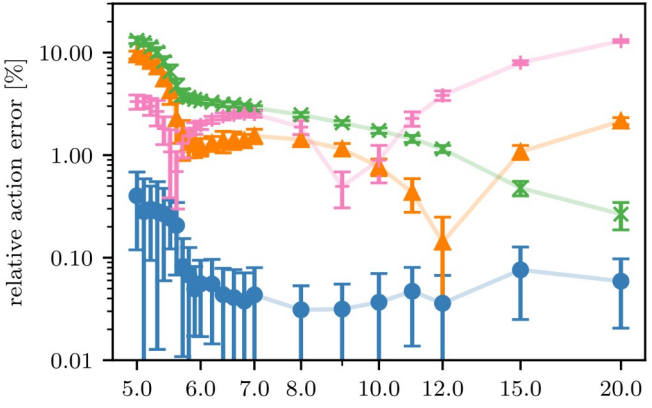


Holland, AI, Müller, Wenger, arXiv:2401.06481

Learning with machines

Renormalization group

Improves our results

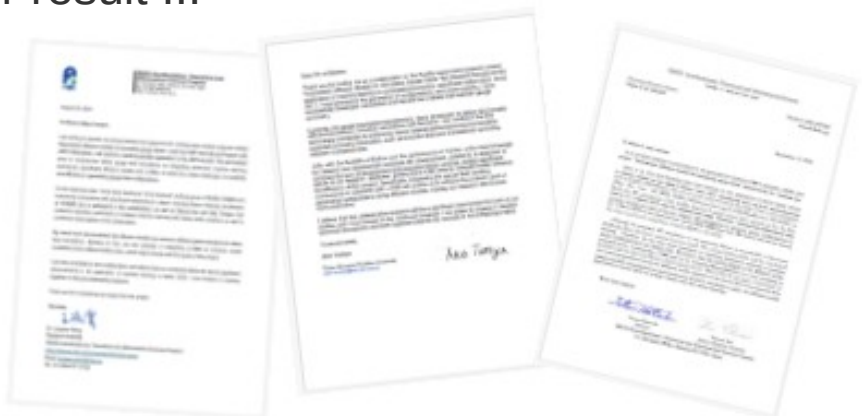
学習機　　がくしゅうき

繰り込み群で　　くりこみぐんで

成果上げ　　せいかあげ

Joint proposal FWF - JSPS

- During research stay: Plan for submitting International Principal Investigator Project Proposal between Austrian Science Fund (FWF) and Japan Society for the Promotion of Science (JSPS)
- Collected collaboration letters from Japanese colleagues
- Proposal submitted in September 2024:
  „Equivariant diffusion models for simulating gauge fields“
- Waiting for result ...



FWF
Der Wissenschaftsfonds.

JSPS