

Jinguo Liu (刘金国)

POSTDOC FELLOW IN HARVARD UNIVERSITY

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“朝正确的方向努力，而不是去摘下垂的果实。”

Education

Nanjing Institute of Technology

Nanjing

B.S. IN SOFTWARE ENGINEERING

2008–2012

I was a pioneer of the open-source software movement in my institute. Deeply impressed by the beautiful computation framework in the book "Quantum Computation and Quantum Information" by Michael A. Nielsen, I was eager to learn more about quantum computing.

Nanjing University

Nanjing

PH.D. THEORETICAL PHYSICS

2012–2017

Advised under Prof. Qianghua Wang, I built up my interest in algorithms for solving quantum many-body systems. I mastered tensor networks algorithms and renormalization group theories and became a geek in simulating quantum many-body systems. Most of my works are about designing new algorithms to solve problems in physics, like the multi-channel Kondo problem and fractional topological excitation. In the last year as a doctoral candidate, I won the first prize in the ZTE fantastic algorithm challenge, which reflects my solid algorithmic background in matrix computation and combinatorial optimization.

Skills

Programming Julia, Python, Fortran

Language Chinese, English

Knowledge Tensor Networks, Differential Programming, Quantum computing, Computational complexity, Condensed matter physics, Combinatorial optimization, High performance computing

Experience

Institute of Physics (IOP), Chinese Academy of Sciences (CAS)

Beijing

POSTDOC

2017–2019

I became a postdoc in [Lei-Wang's](#) group, one of the smartest people I knew. Besides providing valuable advice about research, Lei also provides opportunities for me to give lectures and talks at international conferences and summer schools. At that time, my research interest is automatic differentiation and quantum algorithms.

QuEra Computing Inc.

Waterloo

CONSULTANT

2020.01–2020.07

Due to the COVID, I was trapped in Waterloo - a wild place where you can see wild animals on the streets. QuEra kindly offered me a full-time consultant job. I worked on stochastic optimizers for variational quantum algorithms and classical benchmarking quantum approximation optimization algorithm (QAOA).

Harvard university

Boston

POSTDOC

2020.08–

QuEra also sponsored my Postdoc in Mikhail Lukin's group. Working at Harvard is a unique experience for me. While my skills helped experimentalists and theorists in Misha's group, I learned more exciting stuff from people around me every day.

- I developed generic tensor networks (tensor networks with generic element types) to understand the solution space properties of the maximum independent set problem. I learned their approach to analyzing hardness from the solution space geometry: the overlap gap property and adiabatic gap analysis.
- I mapped the maximum independent set problem on a general graph to the one with restricted geometry of diagonal-coupled unit-disk grid graph that Rydberg atom arrays can implement (has been patented). I learned how to reduce many other hard problems to the maximum independent set problem.
- I improved SLM hologram computation for generating arbitrary optical traps (will be patented). I learned how Fourier optics plays a role in the Rydberg atom experiment works in turn.

Honors & Awards

2007 **First prize**, Physics Olympiad

JiangSu, China

2016 **Academic Excellence Scholarship**, Nanjing University

NanJing

2017 **First prize (out of 8000 teams, 100,000 RMB award)**, ZTE Fantastic Algorithm Challenge

Xi An, China

Open Source Contributions

Yao.jl

ONE OF THE MAIN DEVELOPERS

Yao.jl is the most popular quantum circuit simulation framework in the Julia community. The Yao repository has 650+ Github stars, and the paper has 50+ citations. It is fast, generic, GPU accelerated, and differentiable.

OMEinsum.jl and OMEinsumContractionOrders.jl

MENTOR OF OMEINSUM.JL, MAIN DEVELOPER OF OMEINSUMCONTRACTIONORDERS.JL

OMEinsum.jl is a generic, differentiable einsum library with GPU support. It was developed by Andreas Peter (mentor under me) on the [Google Summer of Code \(GSoC\)](#) project about differential programming tensor networks. This project is a successful one and now its Github repo has 100+ stars. **OMEinsumContractionOrders.jl** is its extension for contraction order optimization that many state-of-the-art algorithms implemented in it.

GenericTensorNetworks.jl

MAIN DEVELOPER

GenericTensorNetworks.jl is a package using generic tensor network contraction for solving graph properties. It comes together with the paper: “Computing solution space properties by generic programming tensor networks” (see section “Selected Publications”).

Selected Presentations

The FOR 1807 Winter School on Numerical Methods for Strongly Correlated Quantum Systems

Marburg

LECTURER

2018

Lecture: “Deep learning and quantum many body systems”.

March Meeting

Boston

SPEAKER

2019

Talk: “Differential Quantum Circuits and Generative Modeling”

Juliacon

Baltimore

SPEAKER

2019

Talk: “Differential Programming Tensor Networks”

Deep Learning and Quantum Programming: A Spring School

Dongguan

LECTURER

2019

Lectures on the quantum computing part, one of the main organizers of “happy fatty night” (coding party for resolving student’s issues).

Selected Publications

Maximum independent sets: from unit disk graphs to arbitrary connectivity

Unpublished

JINGUO LIU, MIN-THI NGUYEN, SHENGTAO WANG ET AL AND HANNES PICHLER

2022

It is a computational complexity paper about reducing the problem of finding maximum independent sets on a general graph to that on a diagonal-coupled unit-disk grid graph. The overhead of the proposed method is the pathwidth of the source graph, which is much better than the previously known n^8 reduction. We show this mapping scheme is optimal up to a constant factor if the exponential hypothesis is true. With this mapping scheme, a general maximum independent set problem can potentially be solved faster on a quantum device (see [arXiv: 2202.09372](#)).

Computing solution space properties by generic programming tensor networks

arXiv: 2205.03718

JINGUO LIU, XUN GAO, SHENGTAO WANG, MIDELYN CAIN AND MIKHAIL LUKIN

2022

Tropical tensor network for ground states of spin glasses

Phys. Rev. Lett. 126, 090506

JINGUO LIU, LEI WANG AND PAN ZHANG

2021

Yao.jl: Extensible, Efficient Framework for Quantum Algorithm Design

Quantum

XIUZHE LUO, JINGUO LIU, PAN ZHANG AND LEI WANG

2020