Xiaotong Ni

副研究员
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Research interests

Quantum error correction (QEC) / Quantum information
Machine learning & optimization
Simulation and experimental calibration of superconducting qubits

Education

Technical University Munich & Max-Planck Institute for Quantum Optics
Munich, Germany
Ph.D. in Physics, 2013-2017

Thesis: Design and Optimization of Quantum Memory

Advisor: Ignacio Cirac

Technical University Munich & Max-Planck Institute for Quantum Optics
Munich, Germany
Master of Science in Applied and Engineering Physics, 2011-2012

Thesis: Quantum Computation with Commuting Operations

Tsinghua University / Beijing, China
Bachelor of Science in Mathematics and Physics, 2006-2010

Thesis: Exponential quadratic operators and evolution of bosonic systems coupled to a heat bath

Advisor: Xiang-Bin Wang

Research/work experience

Alibaba Quantum Lab / Hangzhou, China 2019-2023
Research scientist

- Simulated the time-evolution of QEC experiments on superconducting processors and assessed the impact of correlated errors on the logical error rates. See https://arxiv.org/abs/2312.04186 .
- Developed a Python library for performing gradient optimization of qubit parameters and control parameters, utilizing the aforementioned logical error rate simulation. In particular, the library simulates and optimizes correlated errors in simultaneous gates.
- Contributed significantly to device measurement and gate calibration, with a primary focus on data processing, automation and error analysis. Our team achieved a fidelity of 99.5% on the 2-qubit iSwap gate.

Delft University of Technology / Delft, Netherlands 2017-2019
Postdoc
Advisor: Barbara Terhal

- Developed scalable neural network decoders for quantum error correcting codes. The underlying techniques can likely help e.g. Google's recent transformer decoder to overcome the limitation of small code distances.

RWTH Aachen / Germany 2017-2017
Postdoc
Advisor: Barbara Terhal

Publications

(Link to my Google Scholar)

Superconducting processor design optimization for quantum error correction performance
Xiaotong Ni, et al. https://arxiv.org/abs/2312.04186

Integrating quantum processor device and control optimization in a gradient-based framework
Xiaotong Ni, et al. npj Quantum Information (2022)

Fluxonium: An Alternative Qubit Platform for High-Fidelity Operations
Alibaba quantum lab. Physical review letter (2022)

Alibaba Cloud Quantum Development Platform: Surface Code Simulations with Crosstalk
Cupjin Huang, **Xiaotong Ni**, et al. arXiv:2002.08918

A Classical Architecture For Digital Quantum Computers
Fang Zhang, et. al. ACM Transactions on Quantum Computing , 2023

Quantum instruction set design for performance
Cupjin Huang, et. al. Physical Review Letter , 2023

Efficient parallelization of tensor network contraction for simulating quantum computation
Cupjin Huang, et. al. Nature Computational Science , 2023

Neural Network Decoders for Large-Distance 2D Toric Codes
Xiaotong Ni, Quantum, 2020

Scalable Neural Network Decoders for Higher Dimensional Quantum Codes
Nicolas Breuckmann, **Xiaotong Ni (equal contribution)**, Quantum, 2018

Using Recurrent Neural Networks to Optimize Dynamical Decoupling for Quantum Memory
Moritz August, **Xiaotong Ni (equal contribution)**, Physical Review A , 2016

Preparing topologically ordered states by Hamiltonian interpolation

Xiaotong Ni, Robert Kȍnig, Fernando Pastawski, Beni Yoshida, New Journal of Physics, 2016

A Non-commuting Stabilizer Formalism
Xiaotong Ni, Oliver Buerschaper, Maarten van den Nest, Journal of Mathematical Physics, 2015

Commuting quantum circuits: efficient classical simulations versus hardness results
Xiaotong Ni, Maarten van den Nest, Quantum Information & Computation, 2013

Exponential quadratic operators and evolution of bosonic systems coupled to a heat bath
Xiaotong Ni, Yuxi Liu, Leong Chuan Kwek, Xiangbin Wang, Physical Review A, 2010

A unified quantum NOT gate
Zongwen Yu, **Xiaotong Ni**, Leong Chuan Kwek, Xiangbin Wang, Journal of Physics A: Mathematical and Theoretical, 2009

Presentations
(partial list)

A Non-commuting Stabilizer Formalism, Quantum Information Processing **(top conference for quantum information), 2015**

Superconducting processor design optimization for quantum error correction performance, Quantum computation conference, Hefei National Lab, 2024 (**Invited talk**)

Integrating Quantum Processor Device and Control Optimization in a Gradient-based Framework, IEEE International Conference on Quantum Computing and Engineering, 2022

Designing neural decoders for large-distance toric codes, Machine Learning for Quantum Technology, Max-Planck Institute Erlangen, 2019

Preparing topologically ordered states by Hamiltonian interpolation, Quantum error correction workshop, Benasque, 2016

Using Recurrent Neural Networks to Optimize Dynamical Decoupling for Quantum Memory, University of Innsbruck, 2016

Teaching experience

Organizing and presenting in the QEC summer school in Hangzhou, China (2023)

Supervised an Phd student intern Zi'ang Wang in Alibaba during the work "Superconducting processor design optimization for quantum error correction performance"

Supervised the bachelor thesis "*The simulation of quantum random access memory*" of Tumi Aluko at TU Delft

Teaching assistant of quantum computing course, TU Delft, 2019

Teaching assistant of quantum mechanics course, TU Munich, 2016

Programming language
(Link to my Github)

fluent - Python, machine learning libraries (Jax, Tensorflow).

Familiar with writing codes in a large group and using version control

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Awards

Tsinghua University freshman scholarship

7th Asian Physics Olympiad - gold medal