

# Ruslan Shaydulin

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## Profile

PhD candidate in computer science, expecting to graduate in August 2020. My research focusses around the intersection between (hyper)graph problems, optimization, machine learning, quantum and high-performance computing. I have extensive experience designing and implementing hybrid quantum-classical algorithms, with particular interest in variational and decomposition-based approaches (including multilevel).

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## Peer-reviewed Publications

Justin Sybrandt, **Ruslan Shaydulin**, Ilya Safo. Hypergraph Partitioning With Embeddings. In *IEEE Transactions on Knowledge and Data Engineering*, 2020. DOI: [10.1109/TKDE.2020.3017120](https://doi.org/10.1109/TKDE.2020.3017120)

Zain Saleem, Kaiwen Gui, **Ruslan Shaydulin**, Martin Suchara. Comparing Constrained and Unconstrained Quantum Approximate Optimization Algorithms. In *Proceedings of the 2nd International Workshop on Quantum Resource Estimation (QRE 2020)* (co-located with *International Symposium on Computer Architecture (ISCA) 2020*) (to appear).

**Ruslan Shaydulin**, Caleb Thomas, Paige Rodeghero. Making Quantum Computing Open: Lessons from Open-Source Projects. In *Proceedings of First International Workshop on Quantum Software Engineering (Q-SE 2020)* (co-located with *ICSE 2020*) (to appear). Preprint: [arXiv:1902.00991](https://arxiv.org/abs/1902.00991)

Sami Khairy, **Ruslan Shaydulin**, Lukasz Cincio, Yuri Alexeev, Prasanna Balaprakash. Learning to Optimize Variational Quantum Circuits to Solve Combinatorial Problems. In *Proceedings of Thirty-Fourth AAAI Conference on Artificial Intelligence (AAAI-20)*, 2020. **Acceptance rate: 20.6%**  
DOI: [10.1609/aaai.v34i03.5616](https://doi.org/10.1609/aaai.v34i03.5616)

Sami Khairy, **Ruslan Shaydulin**, Lukasz Cincio, Yuri Alexeev, Prasanna Balaprakash. Reinforcement-Learning-Based Variational Quantum Circuits Optimization for Combinatorial Problems. In *Proceedings of the Machine Learning and the Physical Sciences workshop at Conference on Neural Information Processing Systems (NeurIPS 2019)*, 2019. ([link](#))  
Preprint: [arXiv:1911.04574](https://arxiv.org/abs/1911.04574)

**Ruslan Shaydulin**, Yuri Alexeev. Evaluating Quantum Approximate Optimization Algorithm: A Case Study. In *Proceedings of the 2nd International Workshop on Quantum Computing for Sustainable Computing (QCSC 2019)* (in conjunction with *10th International Green and Sustainable Computing Conference (IGSC 2019)*), 2019  
DOI: [10.1109/IGSC48788.2019.8957201](https://doi.org/10.1109/IGSC48788.2019.8957201)

Sami Khairy, **Ruslan Shaydulin**, Lukasz Cincio, Yuri Alexeev, Prasanna Balaprakash. Reinforcement Learning for Quantum Approximate Optimization. *Research Poster, Supercomputing '19*, 2019 ([available in Proceedings](#))

**Ruslan Shaydulin**, Ilya Safo, and Jeffrey Larson. Multistart Methods for Quantum Approximate Optimization. In *Proceedings of 2019 IEEE High Performance Extreme Computing Conference (HPEC)*, 2019  
**Best Student Paper** (of ~50 student papers). DOI: [10.1109/HPEC.2019.8916288](https://doi.org/10.1109/HPEC.2019.8916288)

**Ruslan Shaydulin**, Hayato Ushijima-Mwesigwa, Christian F.A. Negre, Ilya Safo, Susan M Mniszewski, and Yuri Alexeev. A Hybrid Approach for Solving Optimization Problems on Small Quantum Computers. *Computer*, 52(6):18-26, 2019.  
**Cover Feature**. DOI: [10.1109/MC.2019.2908942](https://doi.org/10.1109/MC.2019.2908942)

Ruslan Shaydulin, Hayato Ushijima-Mwesigwa, Ilya Safro, Susan Mniszewski, and Yuri Alexeev. Network Community Detection on Small Quantum Computers. *Advanced Quantum Technologies*, 2(9):1900029, 2019.

DOI: [10.1002/qute.201900029](https://doi.org/10.1002/qute.201900029)

Ruslan Shaydulin, Hayato Ushijima-Mwesigwa, Ilya Safro, Susan Mniszewski, and Yuri Alexeev. Community Detection Across Emerging Quantum Architectures. In *Proceedings of the 3rd International Workshop on Post Moore's Era Supercomputing (in conjunction with Supercomputing '18)*, 12-14, 2018. Preprint [arXiv:1810.07765](https://arxiv.org/abs/1810.07765)

Ruslan Shaydulin and Ilya Safro. Aggregative Coarsening for Multilevel Hypergraph Partitioning. In *Proceedings of 17th International Symposium on Experimental Algorithms (SEA 2018)*, 103:2:1-2:15, 2018.

DOI: [10.4230/LIPIcs.SEA.2018.2](https://doi.org/10.4230/LIPIcs.SEA.2018.2)

Ruslan Shaydulin, Jie Chen, and Ilya Safro. Relaxation-Based Coarsening for Multilevel Hypergraph Partitioning. *Multiscale Modeling & Simulation*, 17(1):482-506, 2019. DOI: [10.1137/17M1152735](https://doi.org/10.1137/17M1152735)

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## Invited Articles

Yuri Alexeev, Jeffrey Larson, Sven Leyffer, and Ruslan Shaydulin. Solving Combinatorial Optimization Problems on Quantum Computers. In *SIAM News Vol. 53 #6 July/August 2020*

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## Online Preprints and In-Submission Works

Hayato Ushijima-Mwesigwa, Ruslan Shaydulin, Christian F. A. Negre, Susan Mniszewski, Yuri Alexeev, Ilya Safro. Multilevel Combinatorial Optimization Across Quantum Architectures. *In submission*. Preprint: [arXiv:1910.09985](https://arxiv.org/abs/1910.09985)

Zirou Qiu, Ruslan Shaydulin, Xiaoyuan Liu, Yuri Alexeev, Christopher S. Henry, Ilya Safro. ELRUNA: Elimination Rule-based Network Alignment. *In submission*. Preprint: [arXiv:1911.05486](https://arxiv.org/abs/1911.05486)

Ruslan Shaydulin, Justin Sybrandt. To Agile, or not to Agile: A Comparison of Software Development Methodologies. Preprint: [arXiv:1704.07469](https://arxiv.org/abs/1704.07469)

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## Education

### Clemson University, SC

Summer 2020

PhD in Computer Science, advisor: Ilya Safro

Master of Science in Computer Science en route to PhD

Fall 2019

Research in algorithms, high performance computing, big data analysis and quantum computing

Relevant coursework: Design & Analysis of Algorithms, Data Mining, Distributed & Cluster Computing, Parallel Architecture, Network Science

### Moscow Institute of Physics and Technology

Summer 2016

Department of Control and Applied Math,

Bachelor of Science in Applied Mathematics and Physics

Minor: Computer Science and Data Analysis

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## Work Experience

### Research Intern, IBM Research – Quantum

Summer 2020

- Working on Clifford circuit optimization under the supervision of Dmitri Maslov

**Intern, Quantum Artificial Intelligence Lab (QuAIL)****Spring 2020****NASA Ames Research Center (KBR)**

- Developed novel analysis connecting the symmetries in problem instance structure to the performance of Quantum Approximate Optimization Algorithm under the supervision of Salvatore Mandra
- Performed extensive numerical simulations using HPC resources

**Research Aide, Argonne National Laboratory****Summer 2018, 2019**

- Developed quantum-accelerated frameworks for network community detection and graph partitioning under the supervision of Yuri Alexeev
- Co-authored 6 papers on quantum optimization and machine learning (5 first author)
- Contributed to multiple proposals

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## Contributed Talks and Posters

**Quantum Computing Tutorial** *Argonne National Laboratory***Jun 15, 2020**Led [a tutorial on Quantum Approximate Optimization Algorithm](#).**SIAM Conference on Parallel Processing for Scientific Computing (PP20)** *Seattle, WA***Feb 13, 2020**

Gave talk "Multilevel Hybrid Quantum-Classical Algorithms on Graphs"

**Information Science and Technology Institute Seminar** *Los Alamos National Laboratory***Nov 26, 2019**

Gave talk "Practical Optimization on Near-term Quantum Computers"

**Supercomputing '19** *Denver, CO***Nov 17-22, 2019**Gave talk "Hybrid Quantum-Classical Algorithms for Graph Problems: Forging a Path to Near-Term Applications" at the [Clemson booth](#) and at the [SC Theater](#)**Mathematics and Computer Science Seminar** *Argonne National Laboratory***Nov 15, 2019**

Gave talk "Practical Optimization on Near-term Quantum Computers"

**Quantum Computing Seminar** *Oak Ridge National Laboratory***Nov 4, 2019**

Gave talk "Practical Optimization on Near-term Quantum Computers"

**International Green and Sustainable Computing Conference (IGSC 2019)** *Alexandria, VA***Oct 22, 2019**

Presented poster "Reinforcement Learning for Quantum Approximate Optimization"

**Chicago Quantum Exchange Meeting** *University of Chicago***June 12, 2019**

Presented poster "Practical Quantum Approximate Optimization"

**SIAM Conference on Computational Science and Engineering (CSE19)** *Spokane, WA***Feb 25-28, 2019**Presented poster "[Quantum Local Search for Graph Community Detection](#)"**Quantum Computing Tutorial** *Argonne National Laboratory***Dec 10-11, 2018**Gave talk "[QAOA Algorithm Introduction](#)"**Supercomputing '18** *Dallas, TX***Nov 11-16, 2018**

Gave talk "Community Detection Across Emerging Quantum Architectures" at Clemson booth

**Quantum Computing Workshop** *Argonne National Laboratory*

Jul 25-27, 2018

Presented preliminary results on "[Machine Learning on Near-Term Quantum Computers](#)"**32nd Clemson Mini-Conference on Discrete Mathematics and Algorithms** *Clemson University*

Nov 4, 2017

Presented poster "Relaxation-Based Coarsening for Multilevel Hypergraph Partitioning"

**58th Scientific Conference** *Moscow Institute of Physics and Technology*

Nov 23-28, 2015

Gave talk "IPC (Inter-Process Communication) in OS X"

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## Leadership and Service

**Requested Reviewer (peer review)**

- [Quantum](#) journal
- npj Quantum Information
- IEEE Transactions on Computers
- IEEE Transactions on Quantum Engineering

**Supercomputing '19** *Denver, CO*

Nov 17-22, 2019

Student volunteer, run tutorials, technical program session and Birds-of-Feather

**SIAM Conference on Parallel Processing for Scientific Computing (PP20)** *Seattle, WA*

Feb 12-15, 2020

Led and co-organized a minitutorial "[Combinatorial Optimization on Quantum Computers](#)"**SIAM Conference on Parallel Processing for Scientific Computing (PP20)** *Seattle, WA*

Feb 12-15, 2020

Co-organized a minisymposium "Recent Advances and Trends in Hybrid Quantum-Classical Algorithms"

**Quantum Computing Tutorial** *Argonne National Laboratory*

May 14, 2019

Led and co-organized a [hands-on tutorial for Qiskit, a framework for quantum computing](#)**Mathematics Teacher, Summer School** *Kostroma, Russia*

Summer 2014

School administrator, organized extracurricular activities.

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## Teaching

**Network Science CPSC 8480** *Clemson University*

Fall 2018, 2019

Teaching Assistant responsible for grading and answering students' questions during office hours

**Design and Analysis of Algorithms CPSC 8400** *Clemson University*

Spring 2019

Teaching Assistant responsible for grading and answering students' questions during office hours

**Algorithms and Data Structures CPSC 2120** *Clemson University*

Spring 2019

Teaching Assistant responsible for running the lab section, grading and answering students' questions during office hours

**Mathematics Teacher, Summer School** *Kostroma, Russia*

Summer 2014

Created and taught a course on basics of graph theory, combinatorics and number theory to middle and high school students.

## Languages and Technologies

C , Python

Prior experience: C++, MATLAB, Objective-C, Swift, Bash, IBM QISKit

Limited prior experience: R, SQL, yacc, bison, AWS, Google Cloud Engine, Rigetti PyQuil

Technologies and tools: UNIX/Linux, MPI, OpenMP

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## Honors and Awards

- International Green and Sustainable Computing Conference (IGSC 2019) student travel award, *recipient*
- Best Student Paper at IEEE HPEC 2019 (of ~50 student papers), *recipient*
- IBM Teach-the-Qiskit-Teacher training program, *selected to represent Argonne National Laboratory*
- Upsilon Pi Epsilon CS Honor Society, *member*
- Supercomputing '19 Student Volunteer Travel award, *recipient*
- SIAM CSE '19 Broader Engagement Travel award, *recipient*
- Clemson CCIT Supercomputing '17, '18 and '19 travel award, *recipient*
- Clemson Graduate Travel Grant, Spring '19, *recipient*
- Moscow Institute of Physics and technology Abramov scholarship - Top 300 students in the university, based on high academic achievement, *recipient*