# Ludmila Botelho

# Curriculum Vitae

## Education

- 2021–Now Ph.D. in Information and Communication Technology, Institute of Theoretical and Applied Informatics, Polish Academy of Sciences, Poland Main Subjects: Quantum Computation Theory, Optimization, Quantum Algorithms Supervisor: Jarosław Miszczak
- 2018–2020 Ph.D. in Physics, Universidade Federal de Minas Gerais, Brazil Main subjects: Quantum Information Theory, Entanglement and Optimization Supervisor: Reinaldo Oliveira
- 2016–2018 M.Sc. in Physics, Universidade Federal de Minas Gerais, Brazil Main subjects: Quantum Information Theory, Tomography, Continuous Variable Systems Dissertation Title: Tomography on Continuous Variable Quantum Systems
- 2014–2015 **Student Exchange**, *Waseda University*, Japan Title: *Theory of Many-Particle Quantum Systems*. Supervisor: Kazuya Yuasa
- 2011–2016 **B.S in Physics**, *Universidade Federal de Minas Gerais*, Brazil Scientific Initiation
  - 2013-2014. Title: Typical Bell Inequality Violations for Many Parts Quantum States. Supervisor: Raphael Drumond

# Experience

2020-Now Scientist/Programmer, IITIS PAN, Poland

Research on Quantum Computation Theory, Quantum Algorithms and its applications. • Error mitigation and Quantum Approximate Optimization Algorithms

- Research and applications of Error Mitigation with Post-Selection for Variational Quantum Circuits
- Algorithm design and Quantum Circuit simulations with Qiskit
- Developed simulations and optimizations for quantum circuits on Julia with Optim and BinaryOptimization
- Music and Quantum Annealing
  - Researched and development of music composition on Quantum Annealing devices
  - Research and development job scheduling algorithm applied to music reduction on Quantum Annealing and Simulated Annealing devices
  - Mathematical formulation of the problem (QUBO and LIP)
  - Parsing data with Music21 and setup experiments
- Railroad scheduling optimization
  - Built initial parsing data code and setup for railroad optimization
- $\odot$  Data management and analyses in Python with Pandas, NumPy and Matplotlib
- Conducted study group about Conventional Quantum Algorithms

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- 2016–2020 Scientist/Physicist, INFOQUANT, UFMG, Brazil Main topic on Quantum Information Theory and its applications.
   Worked on tomography for continuous variable states and phase space representation
   Applied semidefinite programming approach for state reconstruction optimization
   Developed programs on MATLAB using MOSEK, YALMIP, Qlib and QETLAB.
   2012–2017 Tutor, FREELANCER, Brazil Tutoring of Mathematics and Physics subjects
  - 2016 **Teacher**, ESPAÇO EDS, Brazil, Internship Tutoring of Mathematics and Physics subjects
- 2012–2013 Radio Host Assistant, RÁDIO ITATIAIA, Brazil, Internship Played the role of character "Atenciosa" at the talk show "Universo Fantástico"
  Communication with audience via email and phone
  Guests management
  Research, documentation and scripting
- 2012–2013 Monitor, Observatório Astronômico Frei Rosário UFMG, Brazil, Internship

Tutoring of astronomy and telescope maintenance

# Research Projects

- 2022 Application of the Hybrid Algorithm Based on the Quantum Annealing to Solve a Metropolitan Scale Railway Dispatching Problem Coordinator: Krzysztof Domino
- 2021 *Music Composition Using Quantum Annealing* Coordinator: Özlem Salehi
- 2021 Impact of input data alteration and modification of the algorithm parameters on the efficiency of quantum programs Coordinator: Jarosław Miszczak Research project founded by the Polish National Science Centre under the OPUS call, 30.01.2020–29.01.2023.
- 2016–2019 Correlations and Dynamics in Quantum Systems of Many Bodies: Non-Markovianity, Mode Entanglement and Discord, Tomography with Incomplete Information for Continuous Variable. Coordinator: Reinaldo O. Vianna
- 2013–2014 Typical Bell Inequality Violations for Many Parts Quantum States. Coordinator: Raphael C. Drumond

# Accessibility and Inclusion Projects

2020 Support Program for Inclusion and Promotion of Accessibility. Coordinator: Pablo Saldanha

#### Computational Skills

Programming PYTHON, JULIA, MATLAB, BASH, C++, HTML OS Unix, Windows, MacOS

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Technology Git, Keras, Pandas, Spark, CUDA, QuTip, Qiskit, Pennylane, Matplotlib, Scipy, and Tools Music21, Optim.jl, NumPy, Pytest, PyUnit, CPPUnit, gprof, gdb, Valgrind, VIM, Visual Code, Atom, \u03c4TFX, Libre Office

#### Publications and Preprints

- 2023 O Akash Kundu, Ludmila Botelho, Adam Glos, *"Hamiltonian-Oriented Homotopy QAOA"*, arXiv preprint arXiv:2301.13170 (2023)
- 2022 O Ludmila Botelho, Adam Glos, Akash Kundu, Jarosław Adam Miszczak, Özlem Salehi, and Zoltán Zimborás, *"Error mitigation for variational quantum algorithms through mid-circuit measurements"*, Phys. Rev. A **105**, 022441 (2022)
  - Arya, A., Botelho, L., Cañete, F., Kapadia, D., Salehi, Ö. "Applications of Quantum Annealing to Music Theory". In: Miranda, E.R. (eds) Quantum Computer Music. Springer, Cham. (2022)
- 2020 O Ludmila Botelho and Reinaldo Vianna, Eur. Phys. J. D , "Efficient quantum tomography of two-mode Wigner functions". **74**, 42 (2020)

# Courses and Certifications

- 2022 CERN School of Computing 2022
- 2022 Fundamentals of Accelerated Computing with CUDA C/C++, NVIDIA
- 2020 Machine Learning Stanford University, Coursera
- 2019-2020 Deep Learning Specialization Coursera
  - Sequence Models
  - Convolutional Neural Networks
  - Structuring Machine Learning Projects
  - Improving Deep Neural Networks: Hyperparameter tuning, Regularization and Optimization
  - Neural Networks and Deep Learning

# Poster Presentations

- 2022 Near-term Quantum Computing 2020(+3) Title: *"Hamiltonian-Oriented Homotopy QAOA"*
- 2022 ICTP Conference on Adiabatic Quantum Computation & Quantum Annealing Title: *"Fixed interval scheduling problem with minimal idle time with an application* to music arrangement problem"
- 2021 International Conference on Unconventional Computation and Natural Computation 2021

Title: "Self-Organized Maps and Quantum States Classification"

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- 2021 Summer School: Machine Learning in Quantum Physics and Chemistry 2021 Title: "Self-Organized Maps and Quantum States Classification"
- 2021 24th Annual Conference on Quantum Information Processing Title: "Efficient Quantum Tomography of Continuous Variable Quantum States"
- 2020 Q-Turn 2020 Title: "Efficient Quantum Tomography of Continuous Variable Quantum States"
- 2020 15th Conference on the Theory of Quantum Computation, Communication and Cryptography
   Title: "Tomography and Entanglement Detection on Continuous Variable Quantum State"
- 2019 Workshop on Skills for Young Scientists Title: *"Tomography and Entanglement Witnesses for Continuous Variable States"*
- 2019 VII Paraty Quantum Information School and Workshop Title: *"Tomography and Entanglement Witnesses for Continuous Variable States"*
- 2019 III Postgraduate Workshop in Physics Title: *"Tomography and Entanglement on Continuous Variable Quantum States"*
- 2018 Modern Topics in Quantum Information Workshop Title: *"Tomography on Continuous Variable States"*
- 2017 VI Paraty Quantum Information School Title: *"Tomography Toolbox for Continuous Variable States"*
- 2013 XXII Scientific Initiation Week. Title: *"The Quantum Teleport"*

# Talks

- 2022 QWorld Quantum Science Days 2022 Title: *"Fixed interval scheduling problem with minimal idle time with an application to music arrangement problem"*
- 2022 QWorld Quantum Science Days 2022 Title: "Applications of Quantum Annealing to Music Theory"
- 2022 Institute of Computer Science AGH and IBM Software Laboratory in Krakow Title: *"Applications of Quantum Annealing to Music Theory"*
- 2021 Politechnika Śląska Title: "Quantum Annealing and music reduction for chiptune"
- 2021 1st International Symposium on Quantum Computing and Musical Creativity Title: "Applications of Quantum Annealing to Music Theory"
- 2021 QWorld Quantum Science Days 2021 Title: "Infeasible space reduction for QAOA through encoding change"
- 2021 7th Qoffee O Clock QIndia Title: *"Tomography and Continuous Variable Quantum State"*
- 2019 Universidade de São Paulo Title: *"Tomography and Entanglement on Continuous Variable Quantum States"*

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- 2019 III Postgraduate Workshop in Physics Title: *"Tomography and Entanglement on Continuous Variable Quantum States"*
- 2015 Winter Festival of Curralinho Title: "The Brazilian Flag Stars"
- 2015 IV Cultural Week of Catas Altas Title: *"Easy Physics: How does a Telescope Works?"*
- 2013 XXII Scientific Initiation Week. Title: *"The Quantum Teleport"*

# Conferences, Schools and Workshops

- 2022 CERN School of Computing 2022, Kraków, Poland
- 2021 Summer School: Machine Learning in Quantum Physics and Chemistry 2021, Warsaw, Poland
- 2020 School on Quantum Information Theory and Thermodynamics at the Nanoscale
- 2019 III Postgraduate Workshop in Physics at *Universidade Federal de Minas Gerais, Physics Department*
- 2019 Workshop on Skills for Young Scientists/Increasing Diversity in STEM
- 2019 VII Paraty Quantum Information School and Workshop
- 2018 Q-Turn: changing paradigms in quantum science
- 2018 Minicourse on Quantum Computation and Simulability
- 2018 Modern Topics in Quantum Information Workshop
- 2017 VI Paraty Quantum Information School
- 2014 Summer School at Universidade Federal de Pernambuco, Physics Department
- 2013 XXIV Winter School at Universidade Federal de Minas Gerais, Physics Department
- 2013 Summer School at *Instituto de Matemática Pura e Aplicada* Linear Algebra and Foundations of Probability
- 2013 XXII Scientific Initiation Week at Universidade Federal de Minas Gerais, Physics Department
- 2012 XXIII Winter School at Universidade Federal de Minas Gerais, Physics Department

#### Interests

- Professional I am interested in vanguard science and technologies, such as development and researching of new technologies, methods, algorithms, proofs and etc. I mostly deal with data analysis, statistical analysis, inference schemes and information architecture. I have a some experience analysing and performing optimisations. I am also interested in high performance computing, parallelism and distributed algorithms.
  - Personal On my free time, I like playing and listening to music. I also enjoy computer gaming and I would like to develop my own game some day. I also practiced many different martial arts, nowadays I am focused on Capoeira. I have rats as pets. I love cycling and I think it is perfect to commute.

# **Professional References**

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- Dr. Adam Glos
   Algorithmiq
   adamglos92@gmail.com
- Dr. Özlem Salehi Institute of Theoretical and Applied Informatics, Polish Academy of Sciences ozlemsalehi@gmail.com