

22 e 23
OUTUBRO

encontro de computação avancada 2025



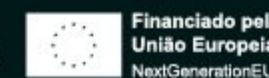
Universidade de Aveiro,
Edifício da Reitoria



Parceiro:



Apoios:



Exploring the quantum world

Inês Dutra
Department of Computer Science - FCUP



Parceiro:



Apoios:



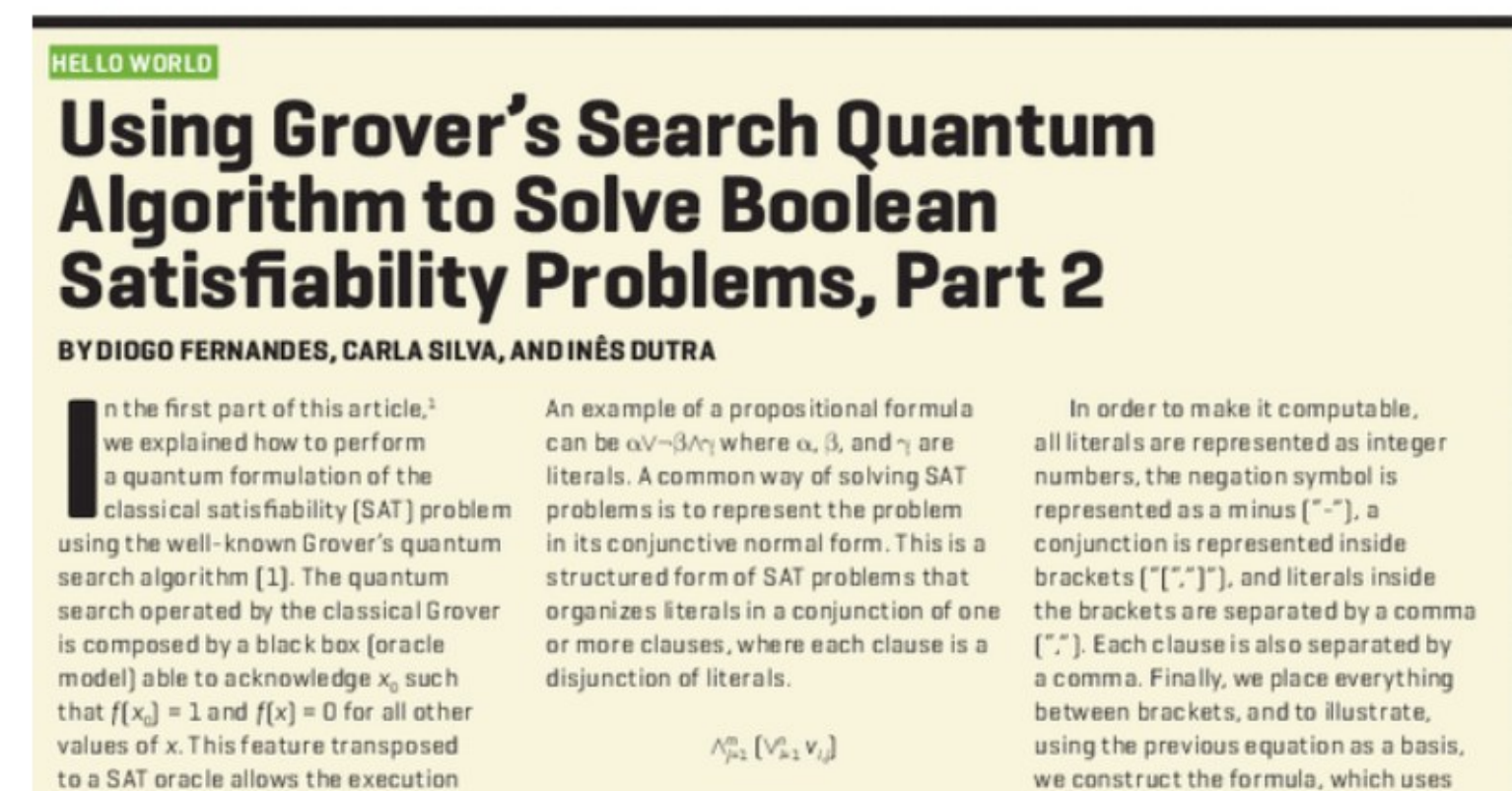
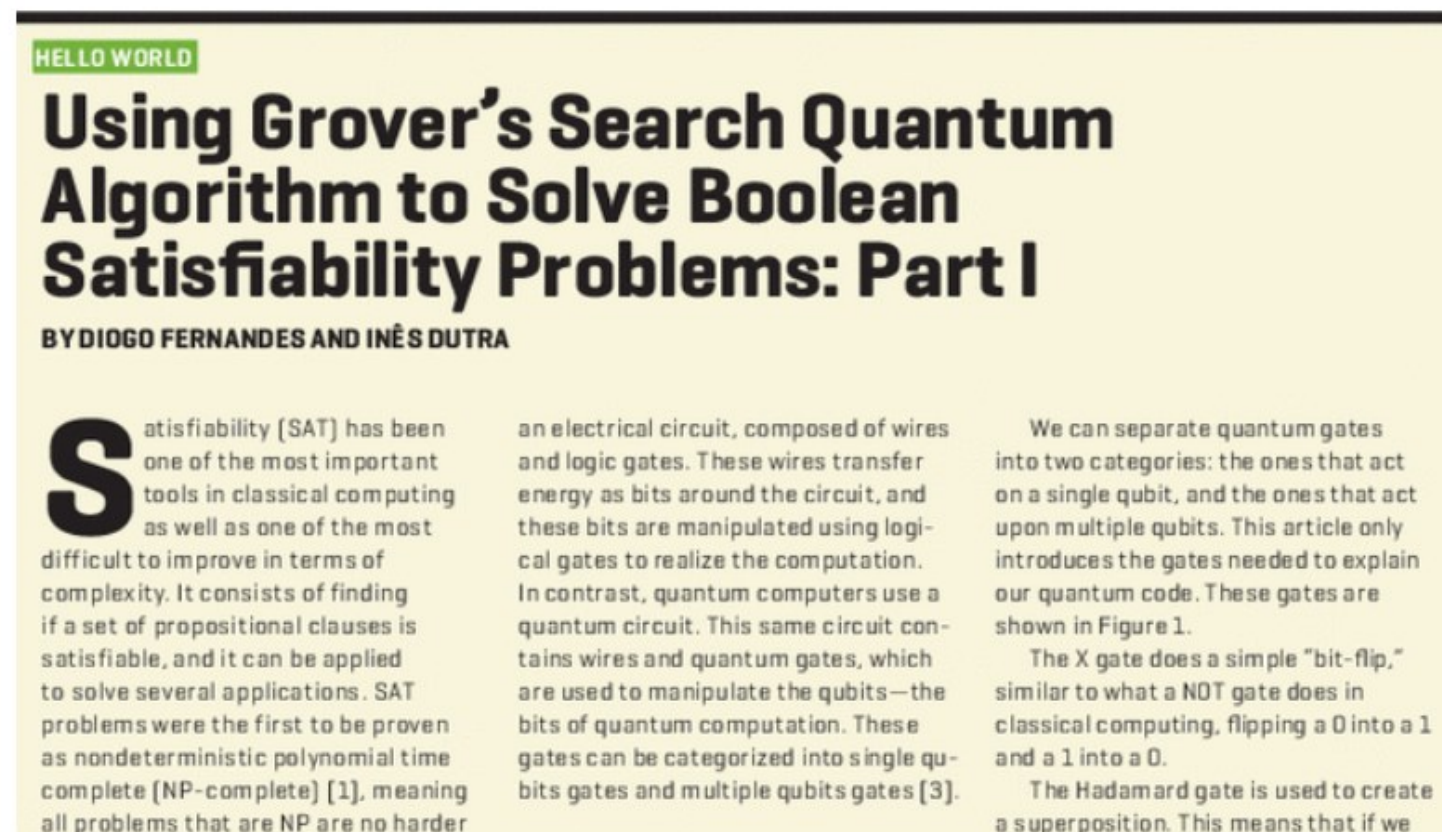


Explorations (1)

- Quantum satisfiability

- Diogo Fernandes (participação no IJUP) + Carla Silva

- Diogo Fernandes and Inês Dutra. 2019. Using Grover's search quantum algorithm to solve Boolean satisfiability problems: Part I. XRDS 26, 1 (Fall 2019), 64–66. DOI:<https://doi.org/10.1145/3358251>
 - Diogo Fernandes, Carla Silva, and Inês Dutra. 2019. Using Grover's search quantum algorithm to solve Boolean satisfiability problems, part 2. XRDS 26, 2 (Winter 2019), 68–71. DOI:<https://doi.org/10.1145/3368085>





Explorations (2)

- IBM Q Teach Me Quantum Challenge
 - [Set of introductory slides to quantum computing using python examples over IBM qiskit](#)
- M.Sc. Dissertation
 - Vanda Azevedo
 - [Quantum Transfer Learning for Breast Cancer Detection](#)
(M.Sc. In Computer Science, DCC/FCUP)
- Ph.D. thesis
 - Carla Silva
 - [Quantum Machine Learning: Mapping AI applications](#)
(Ph.D. in Computer Science, PDCC/FCUP)



Explorations (3)

- V Azevedo, C Silva, I Dutra (2022). Quantum transfer learning for breast cancer detection. *Quantum Mach. Intell.* **4**, 5 (2022). <https://doi.org/10.1007/s42484-022-00062-4>
- C Silva, A Aguiar, I Dutra (2021). Quantum Binary Classification (Student Abstract). *Proceedings of the AAAI Conference on Artificial Intelligence*, 35(18), 15889-15890. <https://doi.org/10.1609/aaai.v35i18.17941>
- C Silva, A Aguiar, PMV Lima *et al.* Mapping a logical representation of TSP to quantum annealing. *Quantum Inf Process* **20**, 386 (2021). <https://doi.org/10.1007/s11128-021-03321-8>
- C Silva, A Aguiar, PMV Lima, I Dutra (2020). Mapping graph coloring to quantum annealing, *Quantum Machine Intelligence* 2 (2), 1-19.
- C Silva, I Dutra, MS Dahlem (2018). Driven tabu search: a quantum inherent optimization, QML workshop at the 24th ACM SIGKDD Conference on Knowledge Discovery and Data Mining, London, UK
- QuantaLab member (Uminho), QCTalk member (UPorto)
- Recently, registered as a Deucalion user
- SMBQ 2020: <https://smbq2020.dcc.fc.up.pt/>



Explorations (4)

- C Botelho, L Schonhofen, H Santos, G Lucca, A Yamin, R Reiser (2025). Toward a Quantum Fuzzy Approach for Emotion Modeling in Parent-Child Interactivity. Proc. 17th ICAART
- C Botelho, L Schonhofen, H Santos, G Lucca, A C Yamin, R H S Reiser (2025). Quantum-Fuzzy Integration for Emotion-Aware in Computational Intelligent Systems. Proc. IEEE Int. FUZZ-IEEE
- J S Buss, B Novack, H S Santos, G Lucca, L Oliveira, A C Yamin (2025). IBM-Qiskit Simulations for Quantum-Fuzzy Interpretations of X(N)or-Connectives using Overlapping and Grouping Aggregations. Proc. FUZZ-IEEE
- E M Monks, B M P de Moura, G B Schneider, H S Santos, A C Yamin, R H S Reiser (2022). Towards Interval-Valued Fuzzy Approach to Video Streaming Traffic Classification. Proc. FUZZ-IEEE
- R R Bastos, B M P Moura, H S Santos, G Lucca, A C Yamin, R H S Reiser (2026). Enhancing a fuzzy system through computational intelligence-based feature selection for decision-making in cloud computing environments. Future Generation Computer Systems.
- R C de Moura, L de S Oliveira, G B Schneider, M L Pilla, A C Yamin, R H S Reiser (2021). Intf-HybridMem: Page migration in hybrid memories considering cost efficiency. Sustainable Computing: Informatics and Systems.



New collaborations

- **UFPel**
 - Renata Reiser
 - Helida Salles
 - Adenauer Correa Yamim
 - Cecília Botelho
- **QUANTUMHEALTH (Q4H)**
Exploring Quantum Science and Technologies for better healthcare
(Call: HORIZON-CL4-2025-03 — Supporting Digital Partnerships in Quantum technologies (RIA)
- HORIZON-CL4-2025-03-DIGITAL-EMERGING-03) – external reader
 - Henrique Martins
 - Joana Camilo
 - Jorge Fonseca
 - Maria Moura



Machines explored

- IBM 16 (14) qubits gate-based
- D-Wave adiabatic 2048 qubits graph-based
 - Chimera and Pegasus graphs



Findings

- IBM 16 bits gate-based
 - Quantum binary classification – iris and traffic datasets
 - Amplitude encoding
 - Good accuracy results with as few as 2 qubits
 - Transfer learning for breast cancer classification
 - Amplitude encoding
 - Good AUROC results with the quantum version



Findings

- Adiabatic
 - Map coloring and TSP
 - Propositional logic representation compiled to a neural network
 - Objective: minimize energy equation
 - Both simulated annealing and quantum annealing produced good solutions
 - For TSP, the quantum version shows a slight advantage when finding optimal solutions



Findings

- Extending of the qFuzzyAnalyser library
 - Integrating multivalued fuzzy logic with quantum computing through circuit-based simulations
- Evaluating of simulations on HybriD-GM hardware,
 - High-performance computing (HPC) clusters for large-scale considering supercomputing
- Quantum simulation platforms integrated to qFuzzyAnalyser specifications
 - Design of new quantum gates that model fuzzy membership degrees directly on qubits.
- Extending Int-FLBCC framework supporting server consolidation in cloud-computing environments.
 - Integration of the Hybrid-FLBCC architecture, combining machine learning to flexible decision-making.
 - Implementation of the ANFIS-FLBCC, merging adaptive neuro-fuzzy inference mechanisms with intelligent reasoning systems.



Opportunities

- Use of HPC to improve quantum simulators
- Study of the potential of quantum machines
 - Architecture
 - Compilation
 - Software stack
 - Mapping / Encoding of applications



Acknowledgements

- Carla Silva (former PhD student)
- Vanda Azevedo (former MSc student)
- Diogo França (former BSc student)
- Marcus Dahlem (MTS-IMEC, Carla's co-supervisor)
- Ana Aguiar (FEUP-IT, Carla's co-supervisor)

- UMinho team (QuantaLab)
 - Luís Barbosa
 - Luís Paulo Santos

- FEUP
 - Rui Maranhão

- Priscila M.V. Lima (COPPE-UFRJ)

dutra@fc.up.pt

Thank you.

For more information about FCT services developed by FCCN, visit fccn.pt/en or scan the QRCode.



fccn.pt/en/servicos