Josep Lumbreras Zarapico

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Professional summary

My research is focused on rigorous theoretical results at the intersection of Reinforcement/Machine Learning and Quantum Information. One of my main lines of research is the application of stochastic bandits to quantum learning tasks, as well as contributions to the classical problem of stochastic bandits. Additionally, I work on the generalization of Hidden Markov Models and Partially Observable Markov Decision Processes into quantum and general probabilistic theories. Although my work is primarily theoretical, it is driven by practical applications, aiming to contribute both to academic advancements and real-world implementations into fields such as recommender systems, quantum machine learning, stochastic processes prediction and more generally artificial intelligence.

Positions

October 2025 – present — **Research fellow** *Nanyang Technological University* Under the project "Quantum-Enhanced Learning, Agents and Intelligence" led by Prof. Mile Gu.

Education

Sep 2020– Aug 2025 — **Ph.D. in Physics** in Centre for Quantum Technologies, National University of Singapore.
Supervisor: Prof. Marco Tomamichel. Thesis title : *Bandits roaming Hilbert space*.

Sep 2019 – Jul 2020 — **Master in Astrophysics, Particle Physics and Cosmology** in University of Barcelona.
Thesis title: *Chaos in two dimensional conformal field theories.*

Sep 2013 – Jan 2019 — **Bachelor's degree, Mathematics** in University of Barcelona.
Thesis title: *Efficient unitary approximations in quantum computing: the Solovay-Kitaev Theorem*.

Bachelor's degree, Physics in University of Barcelona.
Thesis title: *Scaling of the energy and entropy errors in quantum circuits*.

Visits and internships

Sep 2 – Sep 6 2024 — **Visiting Researcher.** *University of Nagoya* Quantum Mathematical Informatics Group (hosted by Francesco Buscemi).

Jul 4 – Jul 5 2024 — **Visiting Researcher.** *University of Calgary.* Institute for Quantum Science and Technology (hosted by Barry C. Sanders).

Apr 11 – Apr 15 2022 — **Visiting Researcher.** *ETH Zürich.* Quantum Information Theory group (hosted by Renato Renner).

Jan 2022 – Jun 2022 — **Visiting Researcher.** *Quantum Information group (GIQ) Autonomous University of Barcelona.* I worked with Prof. Andreas Winter on separiations of stochastic processes generated by finite memeory systems including classical (hidden markov models), quantum and general probabilistic models.

Dec 2019 – July 2020 — **Research intern.** *Institute of Cosmos Sciences, University of Barcelona.* I received a research collaborator grant from ICCUB in order to do my master thesis. In this project, I studied the phenomena of quantum chaos in 2-dimensional conformal field theories under the supervision of Dr. Tomeu Fiol.

Visits and internships (continued)

Sep 2018 – Aug 2019 **Research intern.** *Barcelona Supercomputing Center.* Project on the error scaling in variational quantum circuits under the supervision of Prof. Jose Ignacio Latorre.

Research Publications and Talks

Journal Articles

1. **J. Lumbreras**, R. Huang, Y. Hu, M. Gu, and M. Tomamichel, "Quantum state-agnostic work extraction (almost) without dissipation," *arXiv preprint arXiv:2505.09456*, 2025.
2. S. Brahmachari, **J. Lumbreras**, and M. Tomamichel, "Quantum contextual bandits and recommender systems for quantum data," *Quantum Machine Intelligence*, vol. 6, no. 2, p. 58, 2024. DOI: 10.1007/s42484-024-00189-6.
3. M. Fanizza, **J. Lumbreras**, and A. Winter, "Quantum theory in finite dimension cannot explain every general process with finite memory," *Communications in Mathematical Physics*, vol. 405, no. 2, pp. 1–24, 2024. DOI: https://doi.org/10.1007/s00220-023-04913-4.
4. **J. Lumbreras**, M. Terekhov, and M. Tomamichel, "Learning pure quantum states (almost) without regret," *arXiv preprint arXiv:2406.18370*, 2024.
5. M. Fanizza, N. Galke, **J. Lumbreras**, C. Rouzé, and A. Winter, "Learning finitely correlated states: Stability of the spectral reconstruction," *arXiv preprint arXiv:2312.07516*, 2023.
6. **J.Lumbreras**, E. Haapasalo, and M. Tomamichel, "Multi-armed quantum bandits: Exploration versus exploitation when learning properties of quantum states," *Quantum*, vol. 6, p. 749, 2022. DOI: 10.22331/q-2022-06-29-749.
7. C. Bravo-Prieto, **J. Lumbreras**, L. Tagliacozzo, and J. I. Latorre, "Scaling of variational quantum circuit depth for condensed matter systems," *Quantum*, vol. 4, p. 272, 2020. DOI: 10.22331/q-2020-05-28-272.

Conference Proceedings

1. **J. Lumbreras** and M. Tomamichel, "Linear bandits with polylogarithmic minimax regret," in *Proceedings of Thirty Seventh Conference on Learning Theory (**major TCS conference**)*, ser. Proceedings of Machine Learning Research, vol. 247, 2024, pp. 3644–3682.

Contributed talks without proceedings

1. *Learning finitely correlated states*, ICC25, Workshop on Quantum-Enhanced Agents and Recurrent Computation, 2025.
2. *Learning pure quantum states (almost) without regret*, CQT and IMPRS-MCQST Joint Workshop, 2025.
3. *Learning pure quantum states (almost) without regret*, Quantum Techniques in Machine Learning (**20% acceptance rate**), 2025.
4. *Quantum state-agnostic work extraction (almost) without dissipation*, Quantum Resources Workshop, 2025.
5. *Quantum state-agnostic work extraction (almost) without dissipation*, Institute of Physics Singapore Meeting, 2025.
6. *Quantum state-agnostic work extraction (almost) without dissipation*, 25th Asian Quantum Information Science Conference, 2025.

7. *Quantum state-agnostic work extraction (almost) without dissipation*, Quantum Techniques in Machine Learning (**20% acceptance rate**), 2025.
8. *Learning finitely correlated states: Stability of the spectral reconstruction,* Beyond IID in Information Theory 12 (given by co-author), 2024.
9. *Learning pure quantum states (almost) without regret*, 24th Asian Quantum Information Science Conference (**long talk**), 2024.
10. *Quantum theory in finite dimension cannot explain every general process with finite memory*, Institute of Physics Singapore Meeting, 2023.
11. *Quantum theory in finite dimension cannot explain every general process with finite memory*, 18th Theory of Quantum Computation, Communication and Cryptography (TQC, **major QI conference**), 2023.
12. *Multi-armed quantum bandits: Exploration versus exploitation when learning properties of quantum states*, Institute of Physics Singapore Meeting, 2022.
13. *Multi-armed quantum bandits: Exploration versus exploitation when learning properties of quantum states*, 21th Asian Quantum Information Science Conference (**long talk**), 2021.
14. *Multi-armed quantum bandits: Exploration versus exploitation when learning properties of quantum states*, Beyond IID in Information Theory 12, 2021.
15. *Multi-armed quantum bandits: Exploration versus exploitation when learning properties of quantum states*, Quantum Techniques in Machine Learning, 2021.

Invited talks

1. "Bandits roaming hilbert space," Lunch seminar, Centre for Quantum Technologies, National University of Singapore, 2025.
2. "Bandits roaming hilbert space," Télécom Paris, Quoriosity team, 2025.
3. "Learning pure quantum states (almost) without regret," 2025 INFORMS International Meeting, 2025.
4. "Bandits roaming hilbert space," Nagoya University, 2024.
5. "Learning pure quantum states (almost) without regret and the exploration-exploitation dilemma," Quantum Innovation Centre, A*STAR - Agency of Science, Technology and Research, Singapore, 2024.
6. "Linear bandits with polylogarithmic minimax regret," Vincent Y. F. Tan seminar, ECE National University of Singapore, 2024.
7. "Mulit-armed stochastic bandits and their applications to quantum information," Complexity Institute at the School of Physical and Mathematical Sciences, Nanyang Technological University, 2024.
8. "Mulit-armed stochastic bandits and their applications to quantum information," Quantum Science and Technology Seminar Series, University of Calgary, 2024.
9. "Online learning of pure quantum states without regret," GIQ seminar, Autonomous University of Barcelona, 2023.
10. "Multi-armed quantum bandits: Exploration versus exploitation when learning properties of quantum states," GIQ seminar (Universitat Autonoma de Barcelona), 2022.
11. "Multi-armed quantum bandits: Exploration versus exploitation when learning properties of quantum states," Quantic seminar (Barcelona Supercom- puting center), 2022.
12. "Multi-armed quantum bandits: Exploration versus exploitation when learning properties of quantum states," Quantum information group seminar, ETH, Zurich, 2022.

13 "Multi-armed quantum bandits: Exploration versus exploitation when learning properties of quantum states," CQT CS seminar, National University of Singapore, 2022.

14 "Multi-armed quantum bandits: Exploration versus exploitation when learning properties of quantum states," Jens Eisert QML seminar, Freie Universitat, Berlin, 2021.

15 "Multi-armed quantum bandits: Exploration versus exploitation when learning properties of quantum states," Vincent Tan group seminar, National University of Singapore, 2021.

Skills

Languages — Full professional proficiency on English and native level at Spanish and Catalan.

Coding — Python, Wolfram Mathematica, LaTeX

Miscellaneous Experience

Journal and Conference Reviewer

Quantum, TQC, QIP, ICALP, NeurIPS, Qcrypt, IEEE Transactions on Information Theory.

References

Available on Request