Quantum Distributed Computing: Potential and Limitations

François Le Gall
Graduate School of Mathematics, Nagoya University, Japan

Abstract

The subject of this talk is quantum distributed computing, i.e., distributed computing where the processors of the network can exchange quantum messages. In the first part of the talk I survey recent results [3, 4, 5, 6, 8] and some older results [1, 7] that show the potential of quantum distributed algorithms. In the second part I present our recent work [2] showing the limitations of quantum distributed algorithms for approximate graph coloring. Finally, I mention interesting and important open questions in quantum distributed computing.

2012 ACM Subject Classification Theory of computation → Distributed algorithms; Theory of computation → Quantum computation theory

Keywords and phrases Quantum computing, distributed algorithms, CONGEST model, LOCAL model

Digital Object Identifier 10.4230/LIPIcs.OPODIS.2023.2

Category Invited Talk

References

1 Michael Ben-Or and Avinatan Hassidim. Fast quantum byzantine agreement. In *Proceedings of the 37th Annual ACM Symposium on Theory of Computing (STOC)*, pages 481–485, 2005. doi:10.1145/1060590.1060662.

2 Xavier Coiteux-Roy, Francesco d'Amore, Rishikesh Gajjala, Fabian Kuhn, François Le Gall, Henrik Lievonen, Augusto Modanese, Marc-Olivier Renou, Gustav Schmid, and Jukka Suomela. No distributed quantum advantage for approximate graph coloring. *CoRR*, abs/2307.09444, 2023. doi:10.48550/ARXIV.2307.09444.

3 Taisuke Izumi and François Le Gall. Quantum distributed algorithm for the All-Pairs Shortest Path problem in the CONGEST-CLIQUE model. In *Proceedings of the 38th ACM Symposium on Principles of Distributed Computing (PODC 2019)*, pages 84–93, 2019. doi:10.1145/3293611.3331628.

4 Taisuke Izumi, François Le Gall, and Frédéric Magniez. Quantum distributed algorithm for triangle finding in the CONGEST model. In *Proceedings of the 37th International Symposium on Theoretical Aspects of Computer Science (STACS 2020)*, pages 23:1–23:13, 2020. doi:10.4230/LIPICS.STACS.2020.23.

5 François Le Gall and Frédéric Magniez. Sublinear-time quantum computation of the diameter in CONGEST networks. In *Proceedings of the 37th ACM Symposium on Principles of Distributed Computing (PODC 2018)*, pages 337–346, 2018. doi:10.1145/3212734.3212744.

6 François Le Gall, Harumichi Nishimura, and Ansis Rosmanis. Quantum advantage for the LOCAL model in distributed computing. In *Proceedings of the 36th International Symposium on Theoretical Aspects of Computer Science (STACS 2019)*, pages 49:1–49:14, 2019. doi:10.4230/LIPICS.STACS.2019.49.

7 Seiichiro Tani, Hirotada Kobayashi, and Keiji Matsumoto. Exact quantum algorithms for the leader election problem. *ACM Transactions on Computation Theory*, 4(1):1:1–1:24, 2012. doi:10.1145/2141938.2141939.

8 Xudong Wu and Penghui Yao. Quantum complexity of weighted diameter and radius in CONGEST networks. In *Proceedings of the 42nd ACM Symposium on Principles of Distributed Computing (PODC 2022)*, pages 120–130, 2022. doi:10.1145/3519270.3538441.