XXXXXXXXXX

David Ittah
ETH Zurich
david.ittah@mail.mcgill.ca

Thomas Häner
Microsoft Quantum
thhaner@microsoft.com

Vadym Kliuchnikov
Microsoft Quantum
v.kliuchnikov@gmail.com

Torsten Hoefler
ETH Zurich
htor@inf.ethz.ch

摘要： Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

关键词：Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

1. 前言

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

外文著录

[1]A. V. Aho, M. S. Lam, R. Sethi, and J. D. Ullman, Compilers: principles, techniques, and tools, 2nd ed. (Addison-Wesley Longman Publishing Co., Inc., USA, 2006).

[2]M. Amy, D. Maslov, and M. Mosca, "Polynomial-time t-depth optimization of clifford+t circuits via matroid partitioning", IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems **33**, 1476–1489 (2014) 10.1109/TCAD.2014.2341953.

[3]M. Amy, D. Maslov, M. Mosca, and M. Roetteler, "A meet-in-the-middle algorithm for fast synthesis of depth-optimal quantum circuits", Trans. Comp.-Aided Des. Integ. Cir. Sys. **32**, 818–830 (2013) 10.1109/TCAD.2013.2244643, https://doi.org/10.1109/TCAD.2013.2244643.

[4]S. Beauregard, "Circuit for shor's algorithm using 2n+3 qubits", Quantum Info. Comput. **3**, 175–185 (2003).

[5]B. Bichsel, M. Baader, T. Gehr, and M. Vechev, "Silq: a high-level quantum language with safe uncomputation and intuitive semantics", in Proceedings of the 41st acm sigplan conference on programming language design and implementation, PLDI 2020 (2020), pp. 286–300, 10.1145/3385412.3386007, https://doi.org/10.1145/3385412.3386007.

[6]C. Developers, Cirq, version v0.14.1, See full list of authors on Github: https://github .com/quantumlib/Cirq/graphs/contributors, Apr. 2022, 10.5281/zenodo.6599601, https://doi.org/10.5281/zenodo.6599601.

[7]T. G. Draper, Addition on a quantum computer, 2000, 10.48550/ARXIV.QUANT-PH/0008033, https://arxiv.org/abs/quant-ph/0008033.

[8]S. Forest, D. Gosset, V. Kliuchnikov, and D. McKinnon, "Exact synthesis of single-qubit unitaries over clifford-cyclotomic gate sets", J. Math. Phys. **56**, 82–201 (2015) 10.1063/1.4927100.

[9]M. Treinish, J. Gambetta, P. Nation, qiskit-bot, P. Kassebaum, D. M. Rodríguez, S. de la Puente González, J. Lishman, S. Hu, K. Krsulich, J. Garrison, L. Bello, J. Yu, M. Marques, J. Gacon, D. McKay, J. Gomez, L. Capelluto, Travis-S-IBM, A. Mitchell, A. Panigrahi, lerongil, R. I. Rahman, S. Wood, T. Itoko, A. Pozas-Kerstjens, C. J. Wood, D. Singh, D. Risinger, and E. Arbel, Qiskit/qiskit: qiskit 0.39.4, version 0.39.4, Dec. 2022, 10.5281/zenodo.7416349, https://doi.org/10.5281/zenodo.7416349.

[10]A. Geller, Introducing quantum intermediate representation (qir), 2020, https://devblogs.microsoft.com/qsharp/introducing-quantum-intermediate-representation-qir/.

[11]C. Gidney and M. Ekerå, "How to factor 2048 bit RSA integers in 8 hours using 20 million noisy qubits", Quantum **5**, 433 (2021) 10.22331/q-2021-04-15-433, https://doi.org/10.22331%2Fq-2021-04-15-433.

[12]A. S. Green, P. L. Lumsdaine, N. J. Ross, P. Selinger, and B. Valiron, "Quipper: a scalable quantum programming language", in Proceedings of the 34th acm sigplan conference on programming language design and implementation, PLDI '13 (2013), pp. 333–342, 10.1145/2491956.2462177, https://doi.org/10.1145/2491956.2462177.

[13]T. Häner, T. Hoefler, and M. Troyer, "Assertion-based optimization of quantum programs", Proc. ACM Program. Lang. **4**, 10.1145/3428201 (2020) 10.1145/3428201, https://doi.org/10.1145/3428201.

[14]T. Häner, S. Jaques, M. Naehrig, M. Roetteler, and M. Soeken, "Improved quantum circuits for elliptic curve discrete logarithms", in Post-quantum cryptography, edited by J. Ding and J.-P. Tillich (2020), pp. 425–444.

[15]T. Häner, D. S. Steiger, K. Svore, and M. Troyer, "A software methodology for compiling quantum programs", Quantum Science and Technology **3**, 20–501 (2018) 10.1088/2058-9565/aaa5cc, https://dx.doi.org/10.1088/2058-9565/aaa5cc.

[16]R. Iten, R. Colbeck, I. Kukuljan, J. Home, and M. Christandl, "Quantum circuits for isometries", Phys. Rev. A **93**, 32–318 (2016) 10.1103/PhysRevA.93.032318.

[17]A. J. Abhari, A. I. Faruque, M. J. Dousti, L. Svec, O. Catu, A. Chakrabati, C.-F. Chiang, S. Vanderwilt, J. Black, and F. Chong, "Scaffold: quantum programming language", in (2012), https://www.cs.princeton.edu/research/techreps/TR-934-12.

[18]A. JavadiAbhari, S. Patil, D. Kudrow, J. Heckey, A. Lvov, F. T. Chong, and M. Martonosi, "Scaffcc: a framework for compilation and analysis of quantum computing programs", in Proceedings of the 11th acm conference on computing frontiers, CF '14 (2014), 10.1145/2597917.2597939, https://doi.org/10.1145/2597917.2597939.

[19]N. Killoran, J. Izaac, N. Quesada, V. Bergholm, M. Amy, and C. Weedbrook, "Strawberry Fields: A Software Platform for Photonic Q uantum Computing", Quantum **3**, 129 (2019) 10.22331/q-2019-03-11-129, https://doi.org/10.22331/q-2019-03-11-129.

[20]C. Lattner and V. Adve, "Llvm: a compilation framework for lifelong program analysis & transformation", in International symposium on code generation and optimization, 2004. cgo 2004. (2004), pp. 75–86, 10.1109/CGO.2004.1281665.

[21]C. Lattner, M. Amini, U. Bondhugula, A. Cohen, A. Davis, J. Pienaar, R. Riddle, T. Shpeisman, N. Vasilache, and O. Zinenko, "Mlir: scaling compiler infrastructure for domain specific computation", in Proceedings of the 2021 ieee/acm international symposium on code generation and optimization, CGO '21 (2021), pp. 2–14, 10.1109/CGO51591.2021.9370308, https://doi.org/10.1109/CGO51591.2021.9370308.

[22]A. McCaskey and T. Nguyen, "A mlir dialect for quantum assembly languages", in 2021 ieee international conference on quantum computing and engineering (qce) (2021), pp. 255–264, 10.1109/QCE52317.2021.00043.

[23]G. Meuli, M. Soeken, M. Roetteler, and T. Hä ner, "Enabling accuracy-aware quantum compilers using symbolic resource estimation", Proc. ACM Program. Lang. **4**, 10.1145/3428198 (2020) 10.1145/3428198, https://doi.org/10.1145/3428198.

[24]Y. Nam, N. J. Ross, Y. Su, A. M. Childs, and D. Maslov, "Automated optimization of large quantum circuits with continuous parameters", npj Quantum Information **4**, 23 (2018) 10.1038/s41534-018-0072-4, https://doi.org/10.1038/s41534-018-0072-4.

[25]M. A. Nielsen and I. L. Chuang, Quantum computation and quantum information, 10th Anniversary Edition (Cambridge University Press, 2010), 10.1017/CBO9780511976667.

[26]A. Paetznick and K. M. Svore, "Repeat-until-success: non-deterministic decomposition of single-qubit unitaries", Quantum Info. Comput. **14**, 1277–1301 (2014).

[27]J. Paykin, R. Rand, and S. Zdancewic, “Qwire: a core language for quantum circuits”, SIGPLAN Not. **52**, 846–858 (2017) 10.1145/3093333.3009894, https://doi.org/10.1145/3093333.3009894.

[28]J. Preskill, “Quantum Computing in the NISQ era and beyond”, Quantum **2**, 79 (2018) 10.22331/q-2018-08-06-79, https://doi.org/10.22331/q-2018-08-06-79.

[29]M. Reiher, N. Wiebe, K. M. Svore, D. Wecker, and M. Troyer, “Elucidating reaction mechanisms on quantum computers”, Proceedings of the National Academy of Sciences **114**, 7555–7560 (2017) 10.1073/pnas.1619152114, eprint: https://www.pnas.org/doi/pdf/10.1073/pnas.1619152114, https://www.pnas.org/doi/abs/10.1073/pnas.1619152114.

[30]R. S. Smith, M. J. Curtis, and W. J. Zeng, A practical quantum instruction set architecture, 2016, 10.48550/ARXIV.1608.03355, https://arxiv.org/abs/1608.03355.

[31]D. S. Steiger, T. Häner, and M. Troyer, “ProjectQ: an open source software framework for quantum computing”, Quantum **2**, 49 (2018) 10.22331/q-2018-01-31-49, https://doi.org/10.22331/q-2018-01-31-49.

[32]K. Svore, A. Geller, M. Troyer, J. Azariah, C. Granade, B. Heim, V. Kliuchnikov, M. Mykhailova, A. Paz, and M. Roetteler, “Q#: enabling scalable quantum computing and development with a high-level dsl”, in Proceedings of the real world domain specific languages workshop 2018, RWDSL2018 (2018), 10.1145/3183895.3183901, https://doi.org/10.1145/3183895.3183901.

[33]V. von Burg, G. H. Low, T. Häner, D. S. Steiger, M. Reiher, M. Roetteler, and M. Troyer, “Quantum computing enhanced computational catalysis”, Phys. Rev. Res. **3**, 33–55 (2021) 10.1103/PhysRevResearch.3.033055, https://link.aps.org/doi/10.1103/PhysRevResearch.3.033055.