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To cite this version:
Siyuan Niu, Adrien Suau, Gabriel Staffelbach, Aida Todri-Sanial. A Hardware-aware Heuristic for the Qubit Mapping Problem in the NISQ Era. 6th International Conference for Young Quantum Information Scientists (YQIS 6 or YQIS 2021), Apr 2021, Online, United States. lirmm-03197069

HAL Id: lirmm-03197069
https://hal-lirmm.ccsd.cnrs.fr/lirmm-03197069
Submitted on 13 Apr 2021

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A Hardware-aware Heuristic for the Qubit Mapping Problem in the NISQ Era

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• Hardware-Aware (HA) mapping transition algorithm.
• Cost function

\[ H = \frac{1}{|F|} \sum_{g_1 \in F} D(\pi(g_1)|\pi(g_2)) + W \times \frac{1}{|E|} \sum_{g_2 \in E} D(\pi(g_1)|\pi(g_2)) \]
• Distance matrix

\[ D = a_1 \times S + a_2 \times \epsilon + a_3 \times T \]
  \( S \): SWAP matrix, \( \epsilon \): SWAP error matrix, \( T \): SWAP execution time matrix
• Selection between SWAP and Bridge gate.

• Hardware-aware Simulated Annealing (HSA) initial mapping.
• Hardware-aware get_neighbor method.

Results
• Comparison of number of additional gates on IBM Q 20 Almaden (large benchmarks).

Conclusion
• Map the most used qubit of the mapped circuit to the most connected physical qubit.
• Apply CNOT gates on qubits that are directly connected and with reliable interconnects.
• If a CNOT cannot be applied on two neighbor qubits, apply on two qubits whose distance is two.

Acknowledgement
This work was supported in part by the Region of Occitanie, Direction de la Recherche, du Transfert Technologique et de l’Enseignement Superieur, France, under the Grant “Quantum CAD”, in part by a Research Collaboration Grant between TOTAL, LIRMM, and CERFACS, and in part by the QuantUM Initiative of the Region Occitanie, University of Montpellier, and IBM Montpellier.