Generalized quantum PageRank algorithm with arbitrary phase rotations

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Abstract

The quantization of the PageRank algorithm is a promising tool for a future quantum internet. Here we present a modification of the quantum PageRank introducing arbitrary phase rotations (APR) [1] in the underlying Szegedy's quantum walk [2]. We have analyzed the behavior of three APR schemes in scale-free graphs. In these networks, the original quantum PageRank [3] is able to break the degeneracy of the residual nodes and detect secondary hubs that the classical algorithm suppresses. Nevertheless, not all of the detected secondary hubs are real according to the PageRank's definition [4]. Some APR schemes can overcome this problem, restoring the degeneration of the residual nodes and highlighting the truly secondary hubs of the networks. We have also studied the stability of the new algorithms. The original quantum algorithm was known to be more stable than the classical. We have found that one of our new algorithms whose, PageRank distribution resembles the classical one, has a stability similar to the original quantum algorithm.

References

[1] Ortega S. A., Martin-Delgado M.A., Physical Review Research, 5 (2023) 013061

[2] M. Szegedy. 45th Annual IEEE Symposium on Foundations of Computer Science (2004) 32

[3] G. D. Paparo, M. A. Martin-Delgado. Scientific Reports, 2 (2012) 444

[4] S. Brin, L. Page. Computer Networks and ISDN Systems, 30 (1998) 107.

Figures

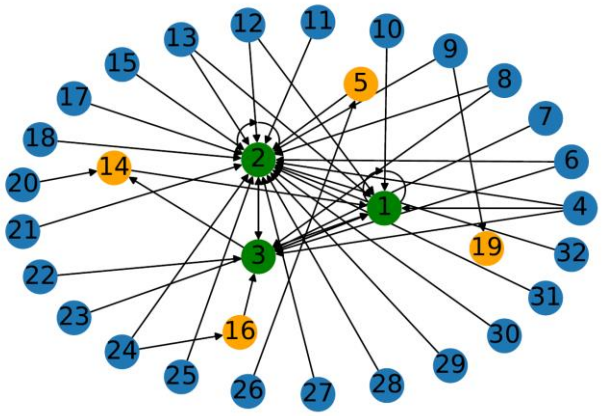

Figure 1: Scale-free network with 32 nodes. The inner (green) nodes correspond to the main hubs. The middle (orange) nodes correspond to secondary hubs. The outer (blue) nodes correspond to residual nodes without links pointing to them.

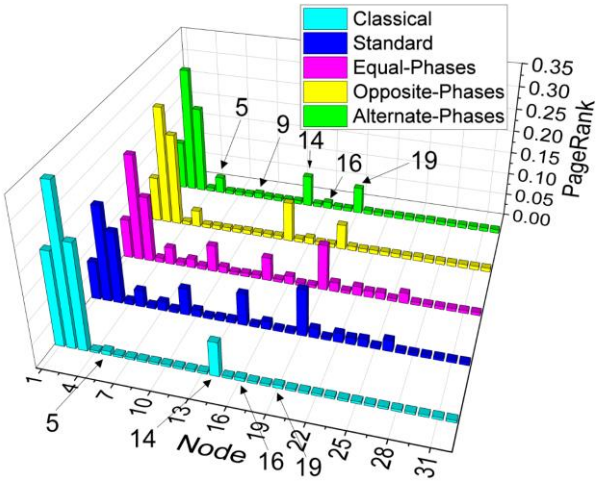

Figure 2: PageRank distributions of the scale-free network. There is a partial restoration of the degeneracy of the less important nodes for the Opposite-Phases and Alternate-Phases schemes.