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Entanglement-tuned quantum walks

Quantum walks were originally developed as quantum-mechanical counterparts of classical random walks. In the early days of this cross-disciplinary research field, quantum walks were used just as a mathematical tool to develop sophisticated algorithms. Later on and in stark contrast to the algorithmic properties of classical random walks, it was proved that quantum walks constitute a universal model for quantum computation.

Quantum entanglement is expected to play a key role in the formulation of quantum algorithms that are faster than their classical counterparts. Although some aspects of quantum entanglement and computational speed up have been studied, we lack a general framework to explicitly manipulate quantum entanglement for building quantum algorithms, being the ultimate purpose of such framework to provide quantum programmers with mathematical descriptions and subroutines in order to build algorithms for solving complex problems.

The role of entanglement in quantum walks and quantum walk-based algorithms is an open area of research. Motivated by the wish to further study the effect of entanglement in discrete quantum walks, in this paper we shall present a preliminary framework for manipulating quantum walk parameters via quantum entanglement together with a succinct yet complete review of the state-of-the-art on the role of quantum entanglement in the definition and dynamics of quantum walks.