Beyond Determinism in Measurement-based Quantum Computation

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Information preserving evolutions play a fundamental role in quantum information processing. Unitary evolutions, which are deterministic reversible evolutions, are information preserving. In this presentation we consider two more general classes of information preserving evolutions. Indeed some non unitary evolutions which produce classical outcomes can be information preserving when one knows the classical outcomes. Such evolutions are called *equi-probabilistic* – when each classical outcome occurs with probability $1/2$ – or *constant-probabilistic* in the general case.

A priori non information preserving evolutions like quantum measurements can be combined in such a way that they induce an information preserving evolution, like in the quantum teleportation protocol [1] and in the one-way model [6] of quantum computation for instance. The former is a quantum protocol which transfers any quantum state from Alice to Bob, while the implementation of this protocol essentially consists in applying the so called Bell measurement. The latter is a universal model of quantum computation which consists in performing local measurements over a large entangled state represented by a graph and called graph state [3]. Any unitary evolution can be implemented by a one-way quantum computation. However, only few one-way quantum computations implement an information preserving evolution. A sufficient condition for a given graph state to guarantee a unitary evolution have been proved in [2, 5]: if the underlying graph has a certain kind of flow, called gflow, then a unitary evolution can be performed on the corresponding entangled state.

In this talk, in order to have a better understanding of the *flow of information* from the input to the output of a one-way quantum computation, I will present simple combinatorial conditions for equi-probabilistic and constant-probabilistic evolutions by means of excluded violating sets of vertices. I will show, in the particular case where the number of input and output qubits are the same, that graphs guaranteeing equi-probabilism and unitarity are the same.

This presentation is based on a joint work with Mehdi Mhalla, Mio Murao, Masato Someya, Peter Turner [4].

References

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