Quantum Causal Graph Dynamics

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Résumé

diaporama Consider a graph having quantum systems lying at each node. Suppose that the whole thing evolves in discrete time steps, according to a global, unitary causal operator. By causal we mean that information can only propagate at a bounded speed, with respect to the distance given by the graph. Suppose, moreover, that the graph itself is subject to the evolution, and may be driven to be in a quantum superposition of graphs—in accordance to the superposition principle. We show that these unitary causal operators must decompose as a finite-depth circuit of local unitary gates. This unifies a result on Quantum Cellular Automata with another on Reversible Causal Graph Dynamics. Along the way we formalize a notion of causality which is valid in the context of quantum superpositions of time-varying graphs, and has a number of good properties. Keywords: Quantum Lattice Gas Automata, Block-representation, Curtis-Hedlund-Lyndon, No-signalling, Localizability, Quantum Gravity, Quantum Graphity, Causal Dynamical Triangulations, Spin Networks, Dynamical networks, Graph Rewriting.

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