Quantum Alternation: Prospects and Problems

We propose a notion of quantum control in a quantum programming language which permits the superposition of finitely many quantum operations without performing a measurement. This notion takes the form of a conditional construct similar to the IF statement in classical programming languages. We show that adding such a quantum IF statement to the QPL programming language simplifies the presentation of several quantum algorithms. This motivates the possibility of extending the denotational semantics of QPL to include this form of quantum alternation. We give a denotational semantics for this extension of QPL based on Kraus decompositions rather than on superoperators. We show that this construct is non-monotone in the Löwner order which makes recursion problematic. Finally, we clarify the relation between quantum alternation and recursion, and discuss the possibility of lifting the semantics defined by Kraus operators to the superoperator semantics defined by Selinger. This is joint work with Costin Badescu.