Stochastic quantum processor

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Abstract

A quantum processor is a device with a data register and a program register. The input to the program register determines the operation, which is a completely positive linear map, that will be performed on the state in the data register. The main point is that quantum states of the program system are used to control the dynamics of the data system, i.e. the dynamics is not driven by external classical parameters, but rather by states of another quantum system. Therefore, the evolution is controlled in a coherent way. It can be shown that no *universal quantum processor* can be designed.

However, we will show that a *probabilistic universal quantum processor* exists. By measuring the program output register the number of realized quantum operations can be increased. Due to the probabilistic feature of quantum measurements the probabilities enter into the description of the processor. This is the cost for the universality. In the probabilistic regime not all quantum states encode a quantum operation, i.e. a completely positive tracepreserving linear map. We will show that those that are not useful for our purposes can be used to perform a generalized measurement described by positive operator valued measure (POVM).

The general theory of quantum processors will be demonstrated on a specific example of *quantum information distributor* `QID`. In particular, we will show that the (`QID`) possesses the property of universality. The amplification of the probability of success in conditioned loops will be discussed. We will show how to exploit `QID` to perform a complete state reconstruction of data state. That is, we will specify a state of the program register that encodes the POVM that completely discriminate input quantum states of data register.