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Ancilla dimension in quantum channel discrimination

Single-shot quantum channel discrimination is a fundamental task in quantum information theory. It is well known that entanglement with an ancillary system can help in this task. Thus, a fundamental question is: For a given pair of channels with the same input and output spaces, how much entanglement is necessary to optimally discriminate them? I will present results on a specific formulation of this question: Given a pair of channels, what is the minimum ancilla dimension necessary for optimal discrimination? It is known that, in general, an ancilla with dimension equal to that of the input space of the channels is always sufficient (and is sometimes necessary) for optimal discrimination. A natural question to ask is whether the same holds true for the output dimension. That is, in cases when the output dimension of the channels is (possibly much) smaller than the input dimension, is an ancilla with dimension equal to the output dimension always sufficient for optimal discrimination? I will present a family of counterexamples which show that the answer to this question is no. This family contains instances with arbitrary finite gap between the input and output dimensions, and still has the property that in every case, for optimal discrimination, it is necessary to use an ancilla with dimension equal to that of the input.