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Quantum Schrödinger bridges: Large deviations and time-symmetric ensembles

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Quantum counterparts of Schrödinger's classical bridge problem have been around for the better part of half a century. During that time, several quantum approaches to this multifaceted classical problem have been introduced. In this presentation, we will show how to unify, extend, and interpret several such approaches through a classical large-deviations perspective. To this end, we consider time-symmetric ensembles that are pre- and postselected before and after a Markovian experiment is performed. Then, the Schrödinger bridge problem is that of finding the most likely joint distribution of initial and final outcomes that is consistent with the obtained endpoint results. The derived distribution provides quantum Markovian dynamics that bridge the observed endpoint states in the form of density matrices. The solution retains its classical structure in that density matrices can be expressed as the product of forward-evolving and backward-evolving matrices. In addition, the quantum Schrödinger bridge allows inference of the most likely distribution of outcomes of an intervening measurement with unknown results. This distribution may be written as a product of forward- and backward-evolving expressions, in close analogy to the classical setting, and in a time-symmetric way.
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