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Path integral control for open quantum systems

We consider the generic problem of state preparation for open quantum systems. As is well known, open quantum systems can be simulated by quantum trajectories described by a stochastic Schrödinger equation. In this context, the state preparation problem becomes a stochastic optimal control (SOC) problem. The SOC problem requires the solution of the Hamilton-Jacobi-Bellman equation, which is generally challenging to solve. A notable exception are the so-called path integral (PI) control problems for which one can estimate the optimal control solution by sampling. We derive a class of quantum state preparation problems that can be solved with PI control. Since our method only requires the propagation of state vectors ψ, it presenting a quadratic advantage over density-centered approaches, such as PMP. Unlike most conventional quantum control algorithms, it does not require computing gradients of the cost function to determine the optimal controls. We illustrate the practicality of our algorithm through multiple examples for single- and multi-qubit systems.