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TITLE:

Fast Quantum Algorithm for Predicting Descriptive Statistics of Stochastic Processes

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ABSTRACT:
Stochastic processes are used as a modeling tool in several sub-fields of physics, biology, and finance. Analytic understanding of the long term behavior of such processes is only tractable for very simple types of stochastic processes such as Markovian processes. However, in real world applications more complex stochastic processes often arise. In physics, the complicating factor might be nonlinearities; in biology it might be memory effects; and in finance is might be the non-random intentional behavior of participants in a market. In the absence of analytic insight, one is forced to understand these more complex stochastic processes via numerical simulation techniques. In this paper we present a quantum algorithm for performing such simulations. In particular, we show how a quantum algorithm can predict arbitrary descriptive statistics (moments) of N-step stochastic processes in just $O(\sqrt{N})$ time. That is, the quantum complexity is the square root of the classical complexity for performing such simulations. This is a significant speedup in comparison to the current state of the art.