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PLENARY LECTURE

Quantum strategies for the identification of cause-effect relations

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Identifying cause-effect relations is a fundamental primitive in a variety of areas of science and technology. The identification of causal relations is generally accomplished through statistical trials where alternative hypotheses about the causal relations are tested against each other. Traditionally, such trials have been based on classical statistics. But while classical statistics effectively describes the behaviour of macroscopic variables, it becomes inadequate at the quantum scale, where a richer spectrum of causal relations is accessible. In the past years, there has been increasing interest in the study of causal relations among quantum variables. In this talk, I will show that quantum strategies can greatly speed up the identification of causal relations. As a working example, I will analyse the task of identifying the effect of a given variable, and show that the optimal quantum strategy beats all classical strategies by running multiple equivalent tests in a quantum superposition. The same working principle leads to advantages in the detection of a causal link between two variables, and in the identification of the cause of a given variable. These results open up the study of quantum speedups in causal discovery algorithms, and may have applications to the design of automated quantum machines and new quantum communication protocols.

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