Entangled Photons, a New Resource for Social Decision Making

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Photonics is at the core of many quantum technologies for quantum computing [1] as well as quantum communication and cryptography [2]. The relative simplicity of production, modification and transmission of single or multiple quantum photonic states has attracted a lot of interest from the artificial intelligence community to study the potential advantage of quantum information processing over binary information in this respect.

Recent works on single-photon-based decision making [3, 4], in the framework of the Core-to-Core program and of a collaboration with Université Grenoble Alpes, has triggered new discussions on the advantages of using entangled photons as a resource for situations like the Competitive Multi-Armed Bandit problem (CMAB), a typical competitive decision making situation related to resource allocation between isolated, individual decision makers in an uncertain environment. Such configuration raises new questions with respect to the single decision maker, such as fairness, maximum common and individual reward, as well as protection against greedy actions of one player against another.

The 2-arms bandit problem has been experimentally implemented, using a well-known setup design [5] enabling one to produce either single photons, correlated photon pairs or entangled photon pairs using the polarization of light as a quantum state basis. Higher common benefits and equality for entangled photons, as well as near-zero conflict of decision, are demonstrated for entangled photons whereas correlated photon pairs only show similar performances for a restricted set of initial conditions. With entangled photons, greedy actions are shown to be counterproductive with respect to both common and individual reward: in this situation, a given player can never get more benefits than the other whatever its decision. On the other hand, both common and individual benefits can be optimized by autonomous polarization alignment schemes, thus providing error correction protocol without the need for explicit/direct communication between players.

References:

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