Machine Learning Techniques Applied to Quantum Physics

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This talk will provide a **brief pedagogical overview of Machine Learning** (ML) and, at the end, a few applications of ML to quantum Physics. Additional information is available in [1-10]. Special emphasis will be on [3,6,7,10]. Regarding [10]: Autonomous quantum error correction (AQEC) protects logical qubits by engineered dissipation and thus circumvents the necessity of frequent, error-prone measurement-feedback loops. Bosonic code spaces, where single-photon loss represents the dominant source of error, are promising candidates for AQEC due to their flexibility and controllability. Here, we propose a bosonic code for approximate AQEC by relaxing the Knill-Laflamme conditions. Using reinforcement learning (RL), we identify the optimal bosonic set of code words (denoted here by RL code), which, surprisingly, is composed of the Fock states $|2\rangle$ and $|4\rangle$. As we show, the RL code, despite its approximate nature, successfully suppresses single-photon loss, reducing it to an effective dephasing process that well surpasses the break-even threshold. It may thus provide a valuable building block toward full error protection.

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