Compressed Sensing meets Quantum Information

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The coherent manipulation of quantum states is necessary if for example the provable security of a key transmission in a quantum communication scenario has to warranted and if quantum computation schemes are to be performed, devised to increase the computational speed of specific algorithms with regards to classical computers. In the latter case, the most prominent examples are the Shor algorithm, allowing a speedup in the factorization of numbers and the Grover algorithm, allowing to reduce quadratically the number of queries for a search of entries in a database. Nevertheless, the main limitation of these schemes is not only the increase in the number of qubits that need to be controlled coherently in order to prepare the required quantum states. The complexity of quantum state estimation of these states grows as well, as their Hilbert space dimension increases exponentially with the number of qubits. The corresponding increase in the measurement and reconstruction time limits the complete characterization of these states, and therefore the effective operation time of quantum computation and communication schemes. It is here that compressed sensing offers to reduce the reconstruction effort for a high fidelity state reconstruction, making use of the low rank of most density matrices of prepared quantum states. The scheme is applied on experimentally prepared photonic entangled states, allowing a speedup by a factor between 2.6 to 4 with respect to a full tomographic reconstruction. A further adaptive state characterization scheme, based on making use of intrinsic properties of quantum states, is presented and shown to outperform a compressed sensing based scheme.