Quantum tomography benchmarking

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Debug tools are very important for the successful implementation and usage of any computing device. Quantum tomography (QT) procedure is at the heart of quantum computers debugging. To date a large amount of QT methods has been proposed. These methods differ from each other by measurement protocols and the measurement data processing algorithms. Quantum states fidelity is the most common way to estimate the tomography accuracy (one could also use it to compare quantum processes). However, sometimes researches use other measures (e.g. see [1, 2, 3, 4, 5]) or even do not consider accuracy at all (e.g. see [6, 7]). An important fact that these measures could significantly depend on the particular form of quantum state or quantum process usually do not attract much attention. Moreover, computational complexity, measurement protocol completeness, statistical significance and some other important aspects of QT are usually omitted as well.

Many QT methods are general, while some of them are especially efficient for the analysis of specific quantum states and processes sub-classes (e.g. low-rank quantum states [8, 9]). Also note that recently some researches face the problem of QT with imperfect measurement setups. Many of the approaches to date consider different noise models and different ways of errors suppression (e.g. see [10, 11, 12]).

The great variety of QT methods as described above makes it difficult to build an overall picture of the efficiency of different approaches. The similar problem arise in the field of machine learning. To deal with it researches resort to use a wide range of unified data sets to test the quality of machine learning algorithms [**?**]. The quality of random number generators for cryptographic applications is also analyzed using standardized tests [13].

In the current work we, in line with these paradigms, propose a set of benchmarks for the testing of QT methods with respect to practical applications. Along with this we develop a unified software for the standardized testing and apply it to compare existing QT methods.

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