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Quantum tomography with small number of copies: a simple estimator for qubit states HUI KHOON NG, Centre for Quantum Technologies, National University of Singapore, BERTHOLD-GEORG ENGLERT, Centre for Quantum Technologies and the Department of Physics, National University of Singapore — In quantum tomography, one performs repeated measurements on N copies of a given but unknown state and constructs an estimator for the state from the gathered data. A common way of converting the data into an estimator is the maximum-likelihood (ML) method, where the estimator is the state with the largest probability of giving rise to the observed data. ML methods methods work well for large N, since the likelihood function for large N is sharply peaked around its maximum. For small N, however, there is a significant neighborhood of states around the maximum with nearly equal probability of giving rise to the data. One can then imagine using the likelihood function as a weight to construct an estimator as an average over states. This motivates the introduction of the "mean estimator," also previously discussed for quantum tomography in the spirit of Bayesian estimation by Blume-Kohout [NJP 12, 043034(2010)]. Here, we extend the mean estimator for a classical die problem to an estimator for qubit states, and demonstrate its advantage over ML estimators. We also discuss a way of overcoming the common complaint of rank-deficiency in ML estimators for our estimator. This simple estimator should be useful as a convenient first estimate for any qubit tomography experiment.

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