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Applying Model Selection to Quantum State Tomography: Choosing Hilbert Space Dimension TRAVIS SCHOLTEN, University of New Mexico, Sandia National Laboratories — Reconstructing the quantum state of a continuous variable system (e.g., an optical mode) using quantum tomography presents a unique problem: the dimension of its Hilbert space is infinite. Its density matrix has infinitely many parameters, which cannot all be estimated from finite data. Brute force reconstruction (e.g., via the Radon transform or deconvolution) produces undesirable overfitting artifacts. Smoothing is one solution, but lacks a good theoretical justification. I introduce a statistically well-motivated approach based on model selection and log likelihoods. Maximum likelihood estimates in a sequence of D-dimensional subspaces (spanned by the first D Fock states) are ranked by their log likelihood. This ranking allows one to find an estimate whose dimension is smaller while simultaneously providing a good fit to data. I apply this method to heterodyne tomography and demonstrate the method can indeed eliminate overfitting by choosing a good dimension (D) in which to reconstruct optical states. Sandia is a multiprogram laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the US Department of Energy's National Nuclear Security Administration under Contract No. DE-AC04-94AL85000.

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