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Behavior of the Maximum Likelihood in Quantum State Tomography TRAVIS SCHOLTEN, ROBIN BLUME-KOHOUT, Sandia Natl Labs — Quantum state tomography on large systems e.g. multiple qubits, or optical modes is hard because it demands resources (number of measurements, offline data processing time, etc.) that grow with the number of parameters in the density matrix, and thus with the dimension of the systems Hilbert space. We can eliminate some of those parameters by using statistical model selection. We investigated the behavior of a canonical model selection technique based on ratios of maximum likelihoods (loglikelihood ratio statistics), and discovered state tomography violates crucial assumptions necessary for using this technique – and others similar to it – due to the nature of the state space boundaries. We derived an expression for the expected value of the loglikelihood ratio statistic (roughly, the logarithm of the maximum likelihood), which could be used as a complexity penalty, e.g. to select an effective Hilbert space dimension (d) for tomography.

Travis Scholten
Sandia Natl Labs

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