Contribution ID: **38** Type: **not specified**

Machine-Learning enhanced Quantum State Tomography: Covariance matrix approach

Wednesday, 13 March 2024 16:15 (5 minutes)

Machine learning (ML) has emerged as a powerful tool in quantum state tomography (QST), facilitating the extraction of comprehensive information about quantum states. Leveraging ML architectures such as convolutional neural networks, we present a rapid and robust QST approach for continuous variables using experimentally measured data from balanced homodyne detectors. Our method offers significant and alternative points of view to the traditional maximum likelihood estimation or the reconstruction model, avoiding truncation problems and focusing on the statistical measurement of the uncertainties. Through ML-enhanced QST, we retrieve the Wigner function for quadrature data of the validation set, showing that the performance in order to describe the squeezed state and its squeezing angle was accurate. Furthermore, we introduce a model generating target matrix components to bypass complexities associated with large Hilbert spaces while preserving high-precision feature extraction. Covariance matrix method demonstrates consistency, affirming the diagnostic utility of ML-QST for diverse applications ranging from quantum information processing to macroscopic quantum state generation and advanced gravitational wave detectors.

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Session Classification: Poster

Track Classification: Poster section