Noise classification in three-level quantum networks by Machine Learning

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Abstract: Using supervised learning, we classify various classical dephasing noises on a three-level quantum system with 99% accuracy, but cannot discriminate Markovian noise correlations. Our robust approach works with limited samples, facilitating spatial noise correlation characterization.

We investigate a machine learning based classification of noise acting on a three-level system with the aim of detecting spatial or multilevel correlations, and the interplay with Markovianity. We control a three-level system by inducing coherent population transfer exploiting different pulse amplitude combinations as inputs to train a feedforward neural network. We show that supervised learning can classify different types of classical dephasing noise affecting the system. Three non-Markovian ((1) quasi-static correlated, (2) quasi-static anti-correlated and (3) quasi-static uncorrelated) and (4) Markovian noises are classified with more than 99% accuracy. On the contrary, Markovian (4a) correlated and (4b) anti-correlated noise cannot be discriminated with our method. **Fig. 1** shows the confusion matrix representing the classification outcomes of our supervised learning approach for each noise class.

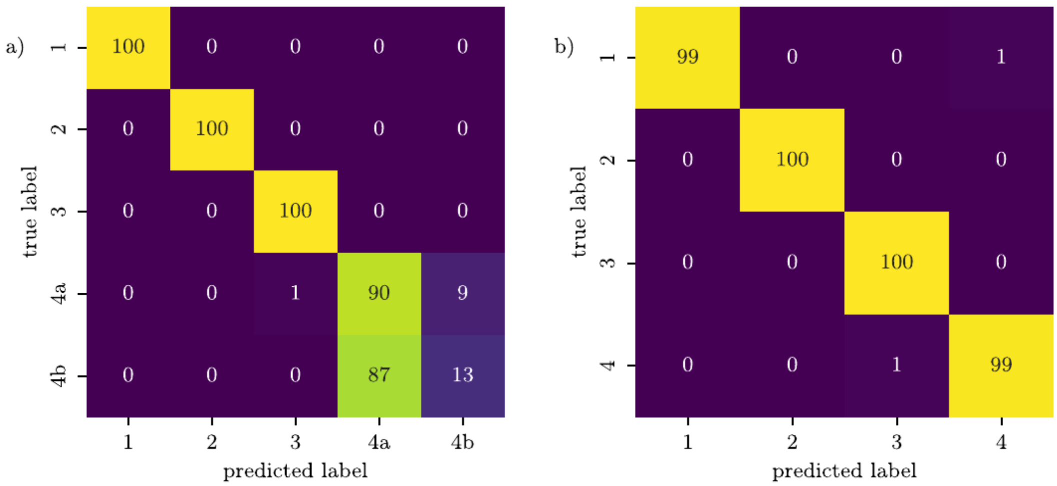

Fig. 1. Confusion matrix for the MLP model for the classification of the classes of noise considered in this work. Each row of the matrix represents the instances of the true classes, while each column represents the instances of the predicted classes. It is apparent that classes 4a and 4b, i.e. Markovian correlated and anti-correlated, are not easily distinguishable.

Our approach is robust to statistical measurement errors and retains its effectiveness for physical measurements where only a limited number of samples is available making it very experimental-friendly. Our result paves the way for classifying spatial correlations of noise in quantum architectures.