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Experimental Quantum Principal Component Analysis via Parametrized Quantum Circuits

Professor LU Dawei (鲁大为), Southern University of Science and Technology, China

Professor LU Dawei is currently an Associate Professor in Shenzhen Institute for Quantum Science and Engineering and Department of Physics at Southern University of Science and Technology (SUSTech). He received the B.Sc. degree and Ph.D. degree in physics from University of Science and Technology of China (USTC) in 2007 and 2012, respectively. From 2012 to 2017, he was a postdoctoral fellow in Institute for Quantum Computing (IQC) at University of Waterloo. In August 2017, he joined SUSTech as an Assistant Professor and was promoted to Associate Professor in May 2019. His research interests lie in quantum computing, quantum simulation, quantum control and quantum machine learning. He is an experimentalist in spin-based magnetic resonance systems, including the nuclear magnetic resonance (NMR) and nitrogen-vacancy (NV) centers in diamonds. He has published more than 50 peer-reviewed papers, and has disseminated the research findings in 20+ invited talks and lectures.

Abstract:

Principal component analysis (PCA) is a widely applied but rather time-consuming tool in machine learning techniques. In 2014, Lloyd, Mohseni, and Rebentrost proposed a quantum PCA (qPCA) algorithm [Lloyd, Mohseni, and Rebentrost, Nat. Phys. 10, 631 (2014)] that still lacks experimental demonstration due to the experimental challenges in preparing multiple quantum state copies and implementing quantum phase estimations. Here, we propose a new qPCA algorithm using the hybrid classical-quantum control, where parameterized quantum circuits are optimized with simple measurement observables, which significantly reduces the experimental complexity. As one important PCA application, we implement a human face recognition process using the images from the Yale Face Dataset. By training our quantum processor, the eigenface information in the training dataset is encoded into the parameterized quantum circuit, and the quantum processor learns to recognize new face images from the test dataset with high fidelities. Our work paves a new avenue toward the study of qPCA applications in theory and experiment.