Colloquium

Non-Convex Riemannian Approach to Quantum State Tomography

Dr. Ming-Chien Hsu (徐銘鍵)

Hon-Hai Research Institute, Taiwan

Date: 2025/12/02 (Tue)
Venue: S4-625
Time: 14:00

Abstract :
In this talk, I will give a brief introduction to quantum state tomography (QST), the recovery of an unknown density matrix. It can require huge computational resources for large systems. State-of-the-art performance has been achieved with the Factored Gradient Descent (FGD) algorithm and its variants since they are able to mitigate the dimensionality barrier by utilizing some of the underlying structures of the density matrix. Despite its theoretical guarantee of a linear convergence rate, convergence in practical scenarios is still slow, where the total number of iterations needed to achieve the estimation error ε can be as large as $O(\sqrt{\kappa}\ln(1/\varepsilon))$. To improve the time efficiency, we derive a QST scheme that comes from the application of non-convex Riemannian gradient descent (RGD). Consequently, our approach improves the dependence on κ to the logarithmic scale. We provide theoretical guarantees and numerical results showing extremely fast convergence and nearly optimal error bounds.