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Statistical and Machine Learning Methods for Quantum Sensing

The field of quantum sensing is built around the idea of using quantum systems to measure physical quantities, such as electric and magnetic fields, temperature and pressure, with resolutions and sensitivities beyond those achievable by classical sensors. Beyond fundamental demonstrations, practical quantum sensing technologies require fast measurements with high signal-to-noise ratio of what are usually—alas—'fragile' quantum states afflicted by decoherence and low throughput. Here, I present a series of approaches based on statistical analysis and machine learning to extract information—accurately and efficiently—from sets of data that are scarce and extremely noisy. I will present a few case studies that utilize color centers in diamond and hexagonal boron nitride to perform quantum-based measurements of temperature, optically detected magnetic resonance (ODMR) and fluorescence intermittency (blinking). I will show how the proposed methods can be successfully applied to measure certain physical quantities with better accuracy, higher resolution and/or overall fewer data points than standard approaches based on statistical inference. I will also discuss the increasingly important role machine learning is taking in the context of (quantum-based) data processing, with specific focus on both its merits and its limits.

Keyword-1

Diamond

Keyword-2

Hexagonal Boron Nitride

Keyword-3

Machine Learning

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