

# Parameter Estimation in terms of Machine Learning and its illustration in Quantum Dynamics

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## 1 Introduction

Classical Machine Learning (ML) rephrases the classical parameter estimation problem. On the quantum side, a practical Quantum Machine Learning (QML) scheme to rephrase the quantum parameter estimation problem is lacking. I would like to explore a way to address this issue. Such an attempt could also be beneficial in exploring new implications for quantum metrology.

## 2 Learning the Parameters

Many recent research works on learning parameters of quantum systems are conducted using Bayesian inference or neural networks. We may choose to apply Quantum Reservoir Computing (QRC), an emerging practical QML scheme that harnesses the quantum dynamics of a generic quantum system for learning the parameters of the dynamics, which could pertain to the system itself or some external system.

This approach would involve three parts:

- Identifying and applying suitable model systems for effective parameter learning,
- Finding adequate measurements of relevance to best extract the quantum information,
- Finding suitable tasks (or protocols). This is the major part that could guide the previous two.

The nature of the QRC scheme makes it a candidate for rephrasing the quantum parameter estimation problem in a rather direct and practical way in terms of QML.

### 3 Keywords

- quantum metrology
- quantum Fisher information
- information geometry
- quantum statistical inference
- quantum reservoir computing
- open quantum system