Title: How to estimate quantum systems with adaptive/learning procedures

Date: Aug 27, 2008 05:15 PM

URL: http://pirsa.org/08080102

Abstract:

How to estimate quantum systems with adaptive/learning procedures

Wed
27
05:00 pm

(/user/23)

Is it possible to efficiently estimate large quantum systems with learning strategies? Specifically can we adjust the basis of experimental settings by learning from the previous outcomes in order to reduce the overall number of experimental configurations and/or repetitions?

(Submitted by **masoud** (/user/29) on Mon, 08/25/2008 - 19:23.)

(/user/14)
aephraim (/user/14)
Tue, 08/26/2008 - 16:21

And I'd like to hear people's opinions on the following related question... I have long argued that it makes intuitive sense to try to characterize a density matrix in a basis where it's sparse (don't waste time measuring necessarily small coherences between already-measured small populations, for instance), but that one would have to adaptively rotate the basis in order to try to find one where many of the diagonals vanished (assuming the state has a small # of significant eigenvalues to begin with, otherwise hopeless).

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But I don't know of any one having either proved the first or tried the second.

(I would try the second, but I don't even have a good protocol to start with.)

(/user/23)
dariano (/user/23)
Tue, 08/26/2008 - 13:28

I have a couple of transparencies to show you about adaptive tomography, and I'd like to tell you about "quantum learning".

Mauro

QUit
quantum information theory group

Adaptive techniques

Adaptation strategies

- Passive adaptive
- Active adaptive
- Learning

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Problems

- Parameter estimation
- Expectation estimation
- Complete estimation

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- Averaging
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- Hardware: POVMs

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Coarse-graining sparse matrices

- Algebraic (irreps of G-symmetries, Lie-alg.)
- Covariance
- Constraints
- Parameterization
- Equivalence classes
- Focus observables

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Benchmarking

- Fidelity
- Statistical efficiency

Active adaptive

Quantum Physics

Title: State estimation for large ensembles

Authors: R. D. Gill, S. Massar
(Submitted on 18 Feb 1999 (v1), last revised 26 Oct 1999 (this version, v2))

Abstract: We consider the problem of estimating the state of a large but finite number N of identical quantum systems. In the limit of large N the problem simplifies. In particular the only relevant measure of the quality of the estimation is the mean quadratic error matrix. Here we present a bound on the mean quadratic error which is a new quantum version of the Cram\'er-Rao inequality. This new bound expresses in a succinct way how in the quantum case one can trade information about one parameter for information about another parameter. The bound holds for arbitrary measurements on pure states, but only for separable measurements on mixed states--a striking example of non-locality without entanglement for mixed but not for pure states. Cram\'er-Rao bounds are generally derived under the assumption that the estimator is unbiased. We also prove that under additional regularity conditions our bound also holds for biased estimators. Finally we prove that when the unknown states belong to a 2 dimensional Hilbert space our quantum Cram\'er-Rao bound can always be attained and we provide an explicit measurement strategy that attains our bound. This therefore provides a complete solution to the problem of estimating as efficiently as possible the unknown state of a large ensemble of qubits in the same pure state. For qubits in the same mixed state, this also provides an optimal estimation strategy if one only considers separable measurements.

Comments:	23 pages, latex
Subjects:	Quantum Physics (quant-ph)
Journal reference:	Phys.Rev. A61 (2002) 042312
Report number:	ULB-TH/99-04
Cite as:	arXiv:quant-ph/9902063v2

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