Review 1

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Review of “Operational applications of the diamond norm and related measures in quantifying the non-physicality of quantum maps”

for *Quantum*, completed on Mar 29, 2021

Author will not see the reviewer's name or the date completed.

Overview questions

only editors will see response

Overall rating

★★★★★

For this manuscript I recommend...

accept

Comments to editor

This paper establishes a framework for quantification of non-physicality of hermitian linear maps. For this, ideas from convex resource theories are used, namely the robustness measure. Here it is connected to the diamond norm.

Open response questions

Note: if you prefer to submit a free-form review instead of filling in this form, simply reply to the invitation email with your report as an attachment. Due to Scholastica's limitations, please make sure that you send it from the same address at which you received the invitation. If that's not possible, you can email the review to info@quantum-journal.org . Otherwise, just write "ok" in the reply to this question and proceed to the rest of the form.

only editors will see response

ok.

Summary: what are the main questions posed by the manuscript and how does it answer them?

intended for the author

The aim of this paper is to introduce a framework for characterization of unphysical maps, that is, maps that are not completely positive. For this, robustness measures are introduced, inspired by similar quantities defined in quantum resource theories of processes. It is shown that these measures are closely related to the diamond norm and can be computed efficiently by SDP. An operational interpretation of the considered measures is established as the simulation cost of the unphysical map with quantum channels and as the advantage of the map over all channels in input-output games. The results are applied to some specific cases: simulation of positive maps, error mitigation cost and for characterization of non-markovian evolutions. Examples are presented where the measures can be directly computed.

What is your assessment of the paper? If you recommend acceptance, make a case that this work does indeed make a significant technical or conceptual contribution to scholarship (including experimental methods and/or mathematical tools).

intended for the author

Unphysical maps are encountered in various situations: e.g. as entanglement witnesses, in quantum error correction or as reduced dynamics of correlated systems. In such cases, it is of importance to assess the non-physicality of a given map and the possibility of its approximation by quantum channels, or some subset of these. The paper provides a convenient framework, using quite naturally the ideas comming from

convex resource theories, where the robustness measures are studied. The measures can be computed by SDP, which leads to some rather easily obtainable lower and upper bounds on these quantities. The relation to the diamond norm provides further insight to the structure of the measures, but also the diamond norm itself. The framework can be also readily adapted to situations where only a subset of physical maps can be used for the simulation, which may be closer to practical applications.

The authors also propose an interesting simulation strategy, where the unphysical map is represented as an application of a channel on the input state tensored with a Hermitian operator of unit trace. The simulation cost, expressed as the smallest trace norm of the Hermitian operator in such a representation, turns out to be the same as in the standard approach, but the present scheme has the advantage that only the input states are changed in each round, while the channel remains fixed. This is a simple but clever idea, that might by also of a practical importance.

To what extent have you checked the technical correctness of the paper?

intended for the author

I have checked the proofs and find them correct.

Comment on the presentation of the paper. Is it well written? Are the main results clearly laid out? Does the manuscript clearly describe assumptions and limitations? Is the literature review adequate?

intended for the author

The paper is quite well written, the presentation is clear and readable. The background and main results are well explained, references to related literature relevant and adequate.

If the submission includes numerical or physical experiments, does it provide sufficient details such that they could be reproduced by readers? This includes for example source code, documentation, experimental data, experimental setup specifications, etc.

intended for the author

There are no physical or numerical experiments in the paper.

Suggested changes, corrections, and general comments.

intended for the author

This is a well written paper on interesting applications of robustness measures. I did not find any mistakes or typos.

As a comment:
I think that it is a well known fact that the base norm given by the set of channels within the generated subspace is the diamond norm. That is precisely why the diamond norm measures distinguishability of channels, in the same way that the trace norm determines distinguishability of states.

Would you be willing to referee an updated version of this work before a final decision is made?

only editors will see response

Yes, if it is necessary.

Do you think this is an outstanding work that deserves to be highlighted? If this work is accepted, would you be willing to write a short Perspective (opinion piece similar to a viewpoint or editorial) based on your report? For examples, see: http://quantum-journal.org/category/Editorial,Perspective/

only editors will see response

This is a good work, but I would not exactly call it outstanding.

How was your reviewing experience? Is there anything you would like us to improve?

only editors will see response

I could not find any possibility to save the review and continue later.

×

Help