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Thank you for your report on LD18151

1 message

prl@aps.org <prl@aps.org> Fri, Jul 23, 2021 at 7:19 PM
To: jenca@mat.savba.sk

Here is a copy of your report which you recently submitted via our web server:

Please do not worry if the formatting looks awry; fixed width fonts are required.

Referee: 943792 Dr. Anna Jencova
Current Email: jenca@mat.savba.sk
MsCode: LD18151
Date: 23Jul2021

	-2	-1	0	1	2	
Impact on field:	very low				X	very high
Impact on physics:	very narrow				X	very broad
Innovation:	very low			X		very high
Validity:	not valid				X	valid
Accessibility:	not acc.			X		very acc.

Recommendation:
Submit to Physical Review after substantial revision.

Would you be willing to review the paper again? Yes

Comments for the Editors:

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begin_report

The paper addresses and important question of discrimination of quantum processes that have a causal structure, such processes are described by quantum
combs. This is done under any restrictions on the allowed discrimination strategies. The optimal success probability is formulated as a convex optimization problem so that the techniques of convex programming can be applied. The results of the paper are as follows:

1.The Lagrangian dual is found and it is shown that it has a zero duality gap.
This is applied to three examples: restriction to nonadaptive strategies, not
using the causal structure of the process, and two types of sequential

strategies.
2. Conditions are obtained for existence of a restricted strategy that is globally optimal.
3. It is shown that under certain covariance properties a nonadaptive strategy is globally optimal.
4. The success probability in each such restricted discrimination problem is related to a robustness measure known in resource theories of quantum processes.

The problem of quantum process discrimination is notoriously hard and complicated, especially when various possible restrictions on the testers are taken into account. This paper is a valuable contribution and certainly deserves publication. However, I have some doubts on its suitability for PRL, due to the following issues:

-The use of SDP or convex programming techniques in quantum discrimination problems is quite standard, in discrimination of processes (e.g. Ref. [20]) or discrimination of states by restricted measurements (e.g. also in some papers of the present author). The methods applied here are very similar to those previously used in this context.
The dual formulation of the problem might give some computational advantages (not so much demonstrated here), but no interpretation of the dual is provided and little new insight is gained.
Some insight is provided by the relation to the generalized robustness measure, which in fact is a consequence of this duality, but this is not recognizable from the main text. So I doubt that the dual formulation can be appreciated by non-experts.

- Some of the results (3.,4.) were already observed before (in less general situations), some citations are missing.

- The paper is not very well written, with definitions omitted, unclear notations or vague expressions. See some of the specific comments below.

I think it would be better to publish the results as a regular article, with more space given to necessary definitions and explanations.

Specific comments:

1. It is stated in the abstract that "We also derive a necessary and sufficient condition for an optimal restricted strategy to be optimal within the set of all strategies". This is also repeated in the Introduction. This is slightly confusing: what is proved in Prop. 2 (and also in Sec. V of SM) is a necessary and sufficient condition for -existence-

of a restricted strategy that is globally optimal. Only a sufficient condition
for a -specific- optimal restricted
strategy to be globally optimal is given.

2. p.1, col. 2: "superchannels" is used in some papers for processes transforming channels to channels, I am
not sure that this is a standard notion, so it would be better to explain

3. p.2, col. 1: P_G is not defined

4. p.2, col. 2: "...the set of all combs in...": without specification of the
input and output spaces, this is quite ambiguous. For example, any state is a
comb, or any (Choi matrix of) a channel with any choice of the input/output
spaces in the given composite space \tilde V. These are very different sets. I
guess what is meant here is the set Comb_{W_T,V_T,\dots,W_1,V_1} defined in the
SM. Note here that according to the original definition of a quantum comb in
Ref. [41] this set is in fact the set of all combs where the first input and the
last output spaces are trivial (so one should add the spaces W_0=V_{T+1}=C).

5. p. 3/4, Prop. 2: "... is proportional to some quantum comb" the same remark
as above. In addition, as I
understand, here the "quantum comb" is not an element of
{Comb}_{W_T,V_T,\dots,W_1,V_1} as before, but rather a quantum comb with inputs V_1,\dots, V_T and outputs W_1,\dots, W_T, as are
the processes E_m. I guess some suitable notations for the "sets of combs" is
needed.

6. p. 4, Col. 2: it seems that some related results for relations of robustness
to discrimination of quantum channels were obtained in arxiv:1901.08127

7. SM, p.3: in the diagram (S5) and below, some of the input/output systems are
not labelled correctly (e.g. V
should be V_1 or V_2 in (S5))

8. SM, Sec. IIIB: perhaps it should be noted that this example is somewhat
restricted: all strategies are non-adaptive, since the channel \hat \sigma_2 in
Fig. S1 (a) can always be included in the final POVM \hat\Pi. A sequential
strategy is obtained by a specific choice of the final measurement.

9. SM, Sec. VI: note that a result related to Sec. B (especially Cor. S6) was
already obtained in arxiv:1209.2329.

end_report

The paper could be considered by the Physical Review as a:
(X)PRA ( )PRB ( )PRC ( )PRD ( )PRE ( )PRApplied ( )PRFluids
( )PRMater ( )PRAB ( )PRPER

Which article type?
( )Letter (X)Regular Article