

Distillation of Multi-Party Non-Locality With and Without Partial Communication

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Popescu-Rohrlich Box and Non-Locality



S. Popescu
1994



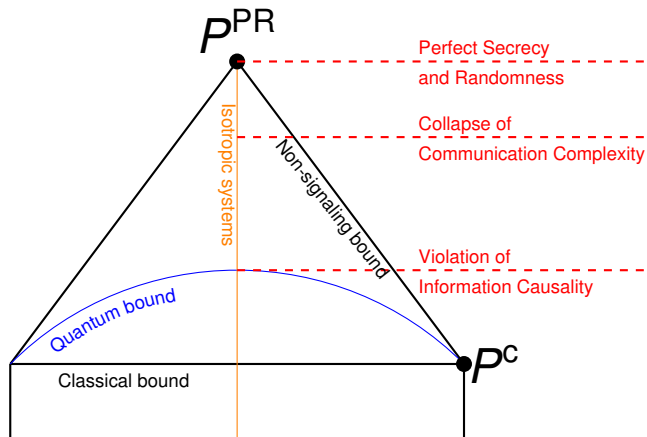
$$A \oplus B = X \odot Y$$



D. Rohrlich

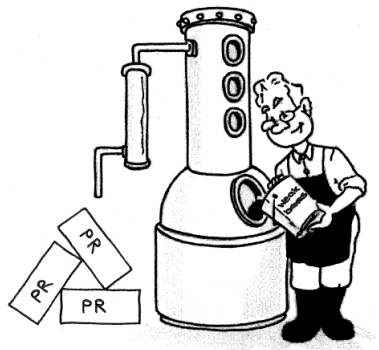
Local strategies: 75%
Quantum strategies: $\sim 85\%$

Motivation for Non-Locality Distillation



Non-Locality Distillation

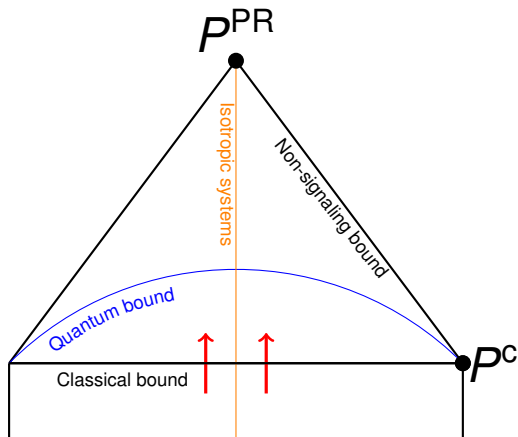
A non-locality distillation protocol takes weak non-local boxes to stronger ones.



Possible tools:

- ▶ copies of the weak box
- ▶ shared randomness
- ▶ preshared information
- ▶ local operations

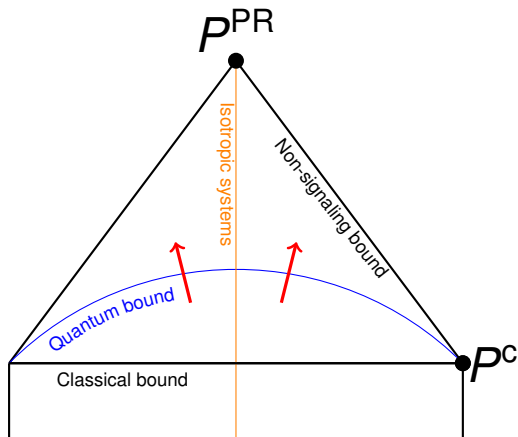
Results for Non-Locality Distillation



Results for Non-Locality Distillation



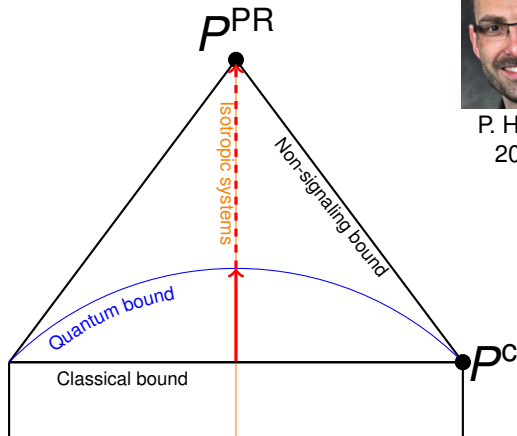
B. Tsirelson
1980



Results for Non-Locality Distillation



D. Dukaric
2008



P. Høyer
2010



J. Rashid

Results for Non-Locality Distillation



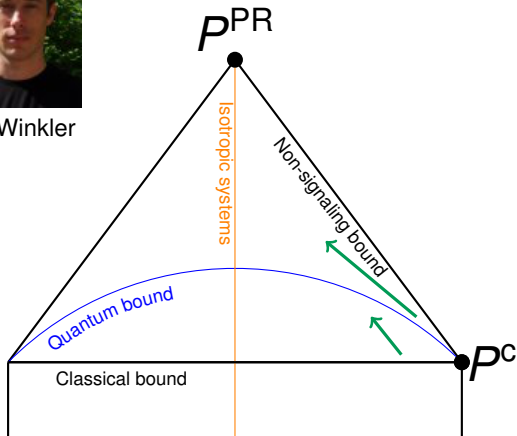
M. Forster
2009



S. Winkler



S. Wolf



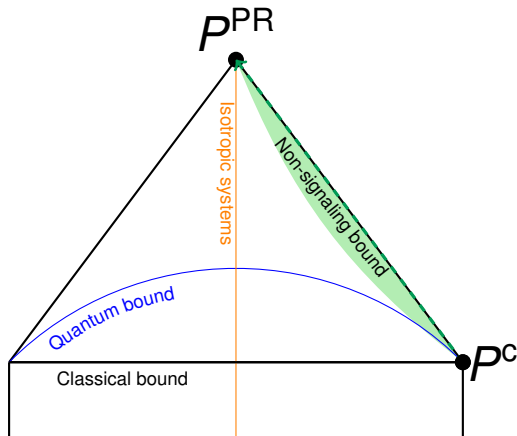
Results for Non-Locality Distillation



N. Brunner
2009

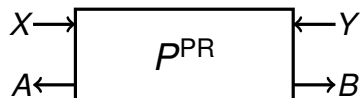


P. Skrzypczyk

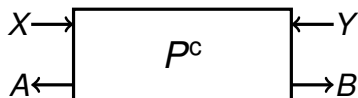


Brunner-Skrzypczyk Protocol

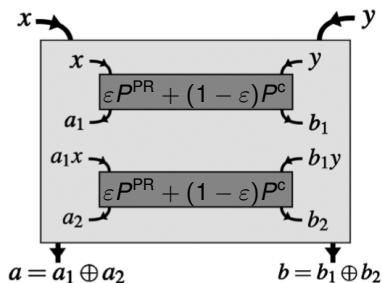
Distillation of a convex combination of these two boxes



$$A \oplus B = X \odot Y$$

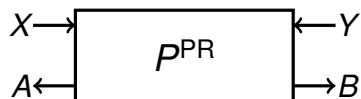


$$A \oplus B = 0$$

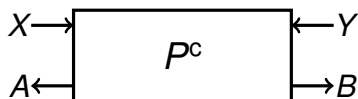


Brunner-Skrzypczyk Protocol

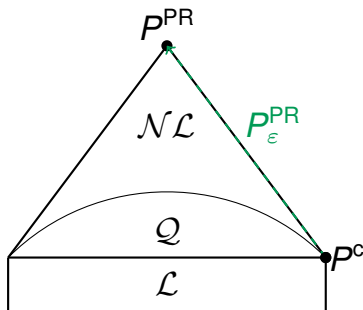
Distillation of a convex combination of these two boxes



$$A \oplus B = X \odot Y$$

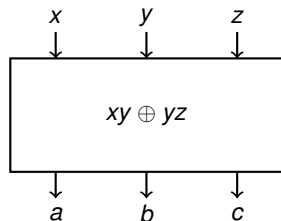


$$A \oplus B = 0$$

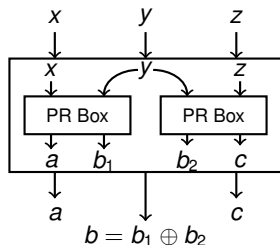


Distillation Using Partial Communication

Simulation of an extremal tripartite box of the non-signaling polytope with PR boxes



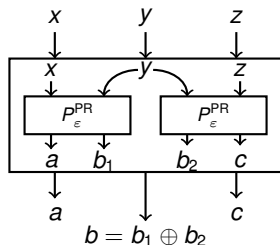
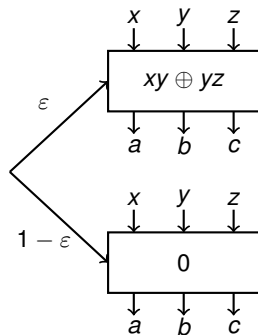
$$a \oplus b \oplus c = xy \oplus yz$$



$$\begin{aligned} a \oplus b_1 &= xy \\ b_2 \oplus c &= yz \end{aligned}$$

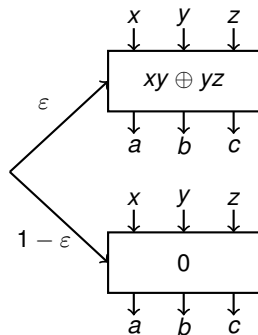
Distillation Using Partial Communication

Simulation of the imperfect extremal box with imperfect PR boxes



Distillation Using Partial Communication

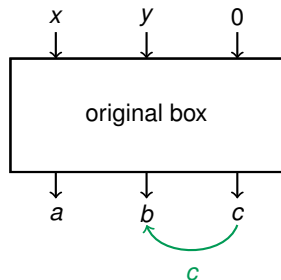
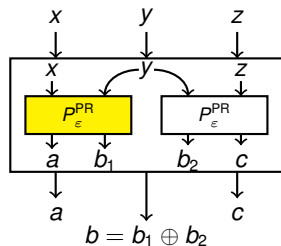
Simulation of the imperfect extremal box with imperfect PR boxes



inputs	$xy \oplus yz$	0
000	0	0
001	0	0
010	0	0
011	1	0
100	0	0
101	0	0
110	1	0
111	0	0

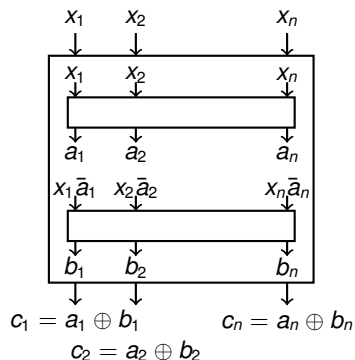
Distillation Using Partial Communication

Simulation of an imperfect PR box using the original box and communication

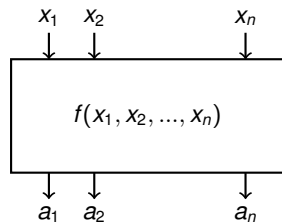


Further Results

Multipartite Generalization of the Brunner-Skrzypczyk Protocol



Distillation of Full-Correlation Boxes using Partial Communication



$$a_1 \oplus \dots \oplus a_n = f(x_1, \dots, x_n)$$

Conclusion

- ▶ Arbitrarily weak multipartite generalizations of the PR box can be distilled arbitrarily closely to the generalized PR box using a generalization of the BS protocol.
- ▶ Full-correlation boxes can be distilled using partial communication.
- ▶ Weak non-local boxes can replace communication.