Playing nonlocal games with quantum resources

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Based on joint works with Harry Buhrman, Troy Lee, Fernando de Oliveira-Filho, Ben Toner, Frank Vallentin and Thomas Vidick
What is a nonlocal game? Example:

- Two non-communicating players: Alice and Bob
What is a nonlocal game? Example:

- Two non-communicating players: Alice and Bob
- We give Alice a picture of either
- We give Bob a picture of either
- The players reply 0 or 1
- If BOTH got Dutch items their answers must DIFFER
- OTHERWISE their answers must AGREE
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Excellent framework for many interesting problems

- Quantifying the power of quantum entanglement
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- Making quantum key distribution protocols secure
Quantifying the power of quantum entanglement

- Alice and Bob can determine their answers by doing experiments on private quantum systems.

$$|0\rangle|0\rangle + \sqrt{2}|1\rangle|1\rangle$$ can give a strict advantage over "classical" players.
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- If the quantum systems are entangled, their answers can be correlated in a “non-classical” way (Bell’64).
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- An EPR pair (Einstein-Podolsky-Rosen’35)

\[
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- Classical players can win the Dutch-or-Not game with prob. at most 0.75

- With an EPR pair, with prob. \( \cos(\pi/8)^2 \approx 0.85 \)

Nonlocal games can exhibit a key difference between classical and quantum physics: entanglement
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- In the context of nonlocal games, one can show that it can be approximated well efficiently!
Thank you!

Nonlocal games: An excellent framework for many interesting problems