Machine-learned quantum cloner

RESEARCH IN PROGRESS

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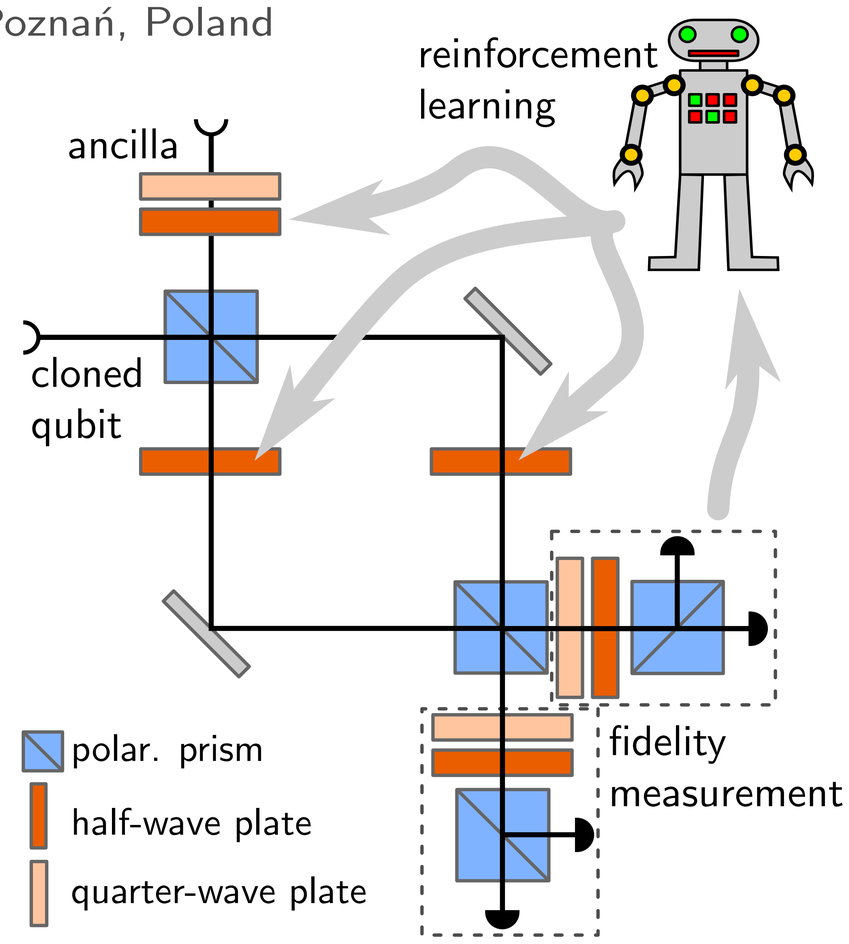
QUANTUM CLONING

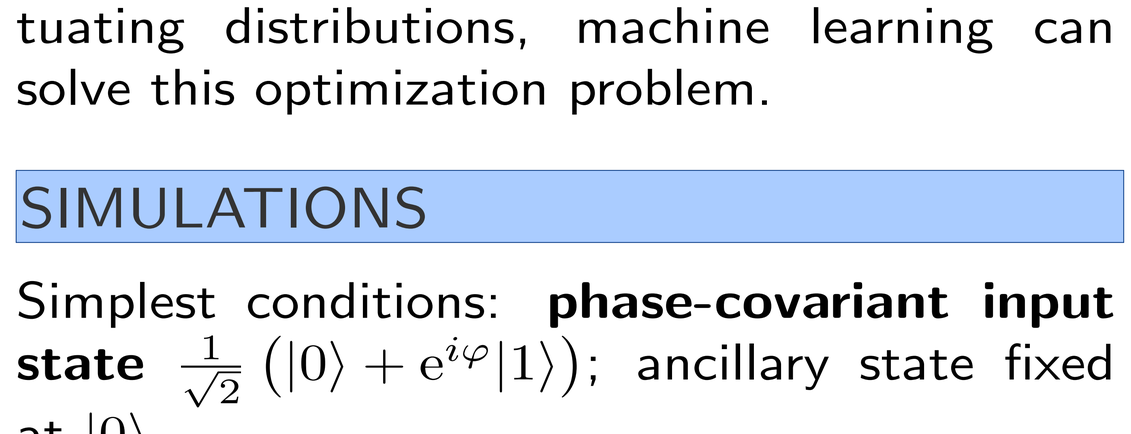
It is **impossible to perfectly duplicate** an unknown quantum state [Zurek1982]. Approximate cloning is however possible and the fidelity usually depends on the size of Hilbert space and **a priori** information about the cloned state [Scarani2005]. For simple/symmetric distributions of a priori knowledge one can analytically optimize the cloning transformation to maximize output state fidelity [Bartkiewicz2010]. For complex or fluctuating distributions, machine learning can solve this optimization problem.

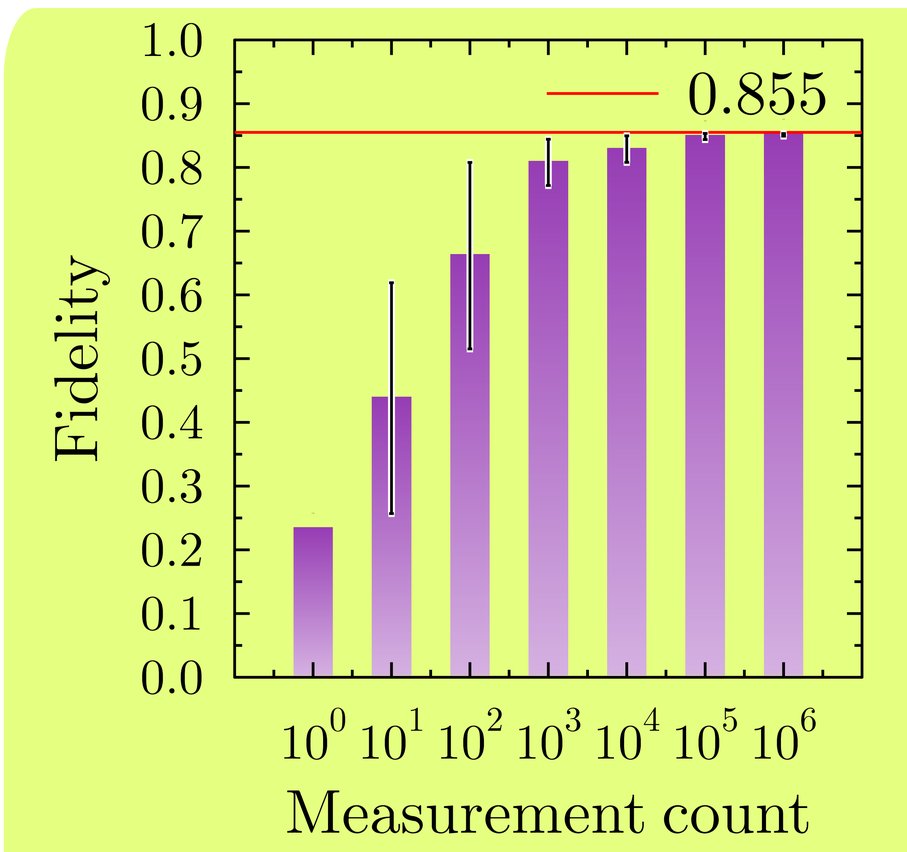


SIMULATIONS

Simplest conditions: **phase-covariant input state** $\frac{1}{\sqrt{2}}\left(|0\rangle + \mathrm{e}^{i\varphi}|1\rangle\right)$; ancillary state fixed at $|0\rangle$.

Optimization feasible even without machine learning – using Nelder-Mead algorithm.



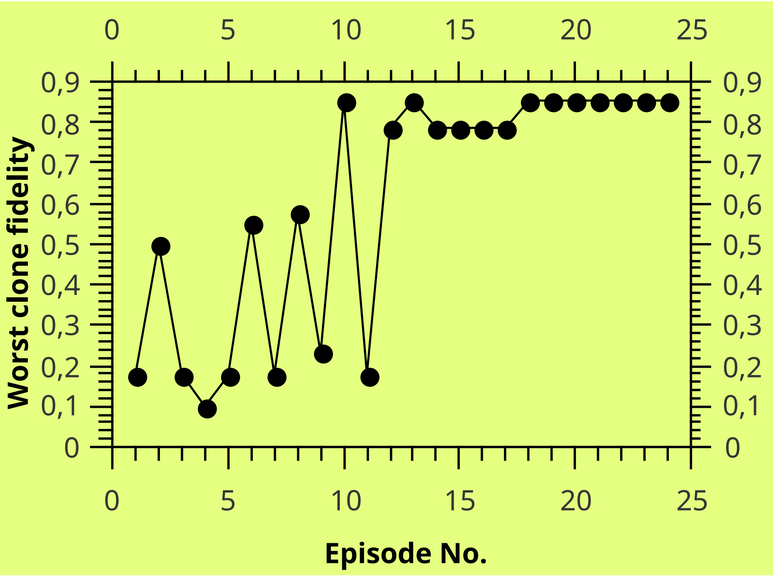


Fidelity is measured by projecting N output states to projections in suitable bases. Projection probability and hence fidelity have Poissonian statistics.

Simulation shows mean final fidelity obtained for a given number of states projected to evaluate fidelity.

Optimization using **reinforced learning** (Q-tables algorithm):

- requires more evaluations (about 1000)
- can deal with low success rate – cases when due to photon bunching fidelity can not be evaluated



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