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Optimal and probabilistic learning of quantum devices

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Quantum information processing is vastly different from classical information processing. Some of the most prominent differences include the inability to copy unknown quantum information perfectly. This extends to copying of entire quantum operations (i.e. quantum programs).

Currently the main focus of the community is cloning, storage and retrieval of unitary operations. This problem can be stated as follows. Assume we are given a black-box which performs an unknown unitary operation. We are allowed to use the box a fixed number of times and later we will be asked to perform the unknown operation on some unknown input state. This can be seen as storage and retrieval of that unitary operation. We know that this can not be done perfectly. There are two possible approaches to this problem. First, we may want to perform a operation that is as close as possible to the original one. Second, we may want to perform this operation probabilistically. This means that we allow our procedure to fail, but we know that if it succeeds, we performed the operation perfectly.

Another related task is cloning of the unitary operation. Here, we are given one black-box and we are required to implement the action of the box multiple times.

The goal of this project is to study similar scenarios for quantum measurements and to find other families of quantum operations which can be stored and retrieved efficiently.