Quantum Information and Communication Complexity

Richard Cleve
cleve@cpsc.ucalgary.ca

Department of Computer Science, University of Calgary
2500 University Drive N.W., Calgary, Alberta, Canada T2N 1N4

A distributed information processing task is one where two or more physically separated parties each receive some input data and they are required to compute some quantities based on this data. A simple two-party example is where each party receives a binary string and their goal is to determine whether or not the strings are identical. It is clear that this particular task cannot be accomplished without some communication occurring between the parties. In communication complexity, the amount of communication required to perform distributed information processing tasks is quantified.

I review recent advances in communication complexity in a setting where quantum information is available. Even though Holevo's Theorem implies that n qubits) cannot convey more classical information than n bits, there exist information processing tasks that require communication and for which using qubits instead of bits results in substantial savings. It is also natural to view Bell's Theorem about nonlocality in the context of communication complexity, and we give examples of scenarios where quantum entanglement can be used to circumvent communication entirely.