Adaptivity gap of the SBFE problem

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Abstract

We study the adaptivity gap of the Stochastic Boolean Function Evaluation (SBFE) problem. In the SBFE problem, we need to investigate the value of a Boolean function based on unknown input $X = (x_1, \ldots, x_n)$. For each $x_i \in X$, we know that with an independent probability p_i, $x_i = 1$, and need to pay a positive cost c_i to learn the value of x_i. Hence the goal of the SBFE problem is to design a strategy that determines the value of the Boolean function with minimum expected cost over all possible strategies.

Both adaptive and non-adaptive strategies can be given for the SBFE problem. A strategy is adaptive if the choice of test to perform can depend on the results of previously performed tests; a non-adaptive strategy is a fixed sequence of tests that are executed regardless of the results of previous tests. The adaptivity gap captures the performance gap between adaptive and non-adaptive strategies, as the ratio between the expected cost of the optimal non-adaptive strategy and the expected cost of the optimal adaptive strategy.

We prove lower bounds on the adaptivity gap for the SBFE problem for classes of DNF formulas and read-once formulas. The result for read-once formulas also implies a lower bound on the adaptivity gap for a source-destination connectivity problem in a stochastic network.