

Linear Index Coding via Semidefinite Programming

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In the index coding problem, introduced by Birk and Kol (INFOCOM, 1998), the goal is to broadcast an n bit word to n receivers (one bit per receiver), where the receivers have side information represented by a graph G . The objective is to minimize the length of a codeword sent to all receivers which allows each receiver to learn its bit. For linear index coding, the minimum possible length is known to be equal to a graph parameter called minrank (Bar-Yossef et al., FOCS, 2006).

We show a polynomial time algorithm that, given an n vertex graph G with minrank k , finds a linear index code for G of length $\widetilde{O}(n^{f(k)})$, where $f(k)$ depends only on k . For example, for $k=3$ we obtain $f(3) \sim 0.2574$. Our algorithm employs a semidefinite program (SDP) introduced by Karger, Motwani and Sudan (J. ACM, 1998) for graph coloring and its refined analysis due to Arora, Chlamtac and Charikar (STOC, 2006). Since the SDP we use is not a relaxation of the minimization problem we consider, a crucial component of our analysis is an upper bound on the objective value of the SDP in terms of the minrank.

At the heart of our analysis lies a combinatorial result which may be of independent interest. Namely, we show an exact expression for the maximum possible value of the Lovasz theta-function of a graph with minrank k . This yields a tight gap between two classical upper bounds on the Shannon capacity of a graph.

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