

Error Exponents for Broadcast Channels with Degraded Message Sets

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Abstract

We consider a broadcast channel with a degraded message set, in which a single transmitter sends a common message to two receivers and a private message to one of the receivers only. The main goal of this work is to find new lower bounds to the error exponents of the strong user, the one that should decode both messages, and of the weak user, that should decode only the common message. Unlike previous works, where suboptimal decoders were used, the exponents we derive in this work pertain to optimal decoding and depend on both rates. We take two different approaches.

The first approach is based, in part, on variations of Gallager-type bounding techniques that were presented in a much earlier work on error exponents for erasure/list decoding. The resulting lower bounds are quite simple to understand and to compute.

The second approach is based on a technique that is rooted in statistical physics, and it is exponentially tight from the initial step and onward. This technique is based on analyzing the statistics of certain enumerators. Numerical results show that the bounds obtained by this technique are tighter than those obtained by the first approach and previous results. The derivation, however, is more complex than the first approach and the retrieved exponents are harder to compute.

1 Introduction

In the broadcast channel (BC), as introduced by Cover [1], a single source is communicating to two or more receivers. In this work, we concentrate on the case of two receivers. The