

Simplified Erasure/List Decoding

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Abstract

We consider the problem of erasure/list decoding using certain classes of simplified decoders. Specifically, we assume a class of erasure/list decoders, such that a codeword is in the list if its likelihood is larger than a threshold. This class of decoders both approximates the optimal decoder of Forney, and also includes the following simplified subclasses of decoding rules: The first is a function of the output vector only, but not the codebook (which is most suitable for high rates), and the second is a scaled version of the maximum likelihood decoder (which is most suitable for low rates). We provide single-letter expressions for the exact random coding exponents of any decoder in these classes, operating over a discrete memoryless channel. For each class of decoders, we find the optimal decoder within the class, in the sense that it maximizes the erasure/list exponent, under a given constraint on the error exponent. We establish the optimality of the simplified decoders of the first and second kind for low and high rates, respectively.

Index Terms

Erasure/list decoding, mismatch decoding, random coding, error exponents, decoding complexity.

I. INTRODUCTION

An ordinary decoder must always decide on a single codeword, and consequently, its decision regions form a partition of the space of output vectors. In his seminal paper [1], Forney defined a family of generalized decoders with decision regions which do not necessarily satisfy the above property. An *erasure* decoder has the freedom not to decode, and so, its decision regions are disjoint but not necessarily cover of the space of channel output vectors. A *list* decoder may decide on more than one codeword, thus its decision regions may overlap. An erasure/list decoder can practically be used in cases where an additional mechanism is used to resolve the ambiguity left after a non-decisive decoding instance. For example, if the transmitted codewords at different times are somewhat dependent, then an outer decoder may recover from an erasure by “interpolating” from neighboring codewords, or eliminate all codewords in the list, but one. Such a case is present in concatenated codes where the inner decoder may be an erasure/list decoder. As another example, consider the case where a feedback link may signal the transmitter on an