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Universal Decoding for Source–Channel Coding with Side Information *

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Abstract

We consider a setting of Slepian–Wolf coding, where the random bin of the source vector undergoes channel coding, and then decoded at the receiver, based on additional side information, correlated to the source. For a given distribution of the randomly selected channel codewords, we propose a universal decoder that depends on the statistics of neither the correlated sources nor the channel, assuming first that they are both memoryless. Exact analysis of the random–binning/random–coding error exponent of this universal decoder shows that it is the same as the one achieved by the optimal maximum a–posteriori (MAP) decoder. Previously known results on universal Slepian–Wolf source decoding, universal channel decoding, and universal source–channel decoding, are all obtained as special cases of this result. Subsequently, we outline further generalizations of our results in several directions, including: (i) finite–state sources and finite–state channels, along with a universal decoding metric that is based on Lempel–Ziv parsing, (ii) arbitrary sources and channels, where the universal decoding is with respect to a given class of decoding metrics, and (iii) full (symmetric) Slepian–Wolf coding, where both source streams are separately fed into random–binning source encoders, followed by random channel encoders, which are then jointly decoded by a universal decoder.

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