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Statistical Physics of Random Binning *

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Abstract

We consider the model of random binning and finite–temperature decoding for Slepian–Wolf codes, from a statistical–mechanical perspective. While ordinary random channel coding is intimately related to the random energy model (REM) – a statistical–mechanical model of disordered magnetic materials, it turns out that random binning (for Slepian–Wolf coding) is analogous to another, related statistical mechanical model of strong disorder, which we call the random dilution model (RDM). We use the latter analogy to characterize phase transitions pertaining to finite–temperature Slepian–Wolf decoding, which are somewhat similar, but not identical, to those of finite–temperature channel decoding. We then provide the exact random coding exponent of the bit error rate (BER) as a function of the coding rate and the decoding temperature, and discuss its properties. Finally, a few modifications and extensions of our results are outlined and discussed.

Index Terms Slepian–Wolf codes, error exponent, bit–error probability, finite–temperature decoding, random energy model, phase transitions, phase diagram.

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