

Analysis of Matched and Mismatched Estimation Errors Using Gradients of Partition Functions

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ABSTRACT

We consider the problem of signal estimation (denoising) from a statistical-mechanical perspective, in continuation to a recent work on the analysis of mean-square error (MSE) estimation using a direct relationship between optimum estimation and certain partition functions. Using this relationship, along with methods from large deviations theory, and random matrix theory, we rigorously derive single-letter expressions of the asymptotic MMSE and the mismatched MSE under two different models. The first model is of a codeword (from a randomly selected code), corrupted by a Gaussian vector channel, and the second model is of a compressed signal which is again corrupted by a Gaussian vector channel. Finally, we provide several examples to demonstrate phase transitions in the behavior of the MSE. These examples enable us to understand more deeply and to gather intuition regarding the roles of the real and the mismatched probability measures in creating these phase transitions.

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