Supporting Material for: Bayesian Denoising: From MAP to MMSE Using Consistent Cycle Spinning

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Abstract

In this document, we present additional simulations supporting the results of the paper *Bayesian Denoising: From MAP to MMSE Using Consistent Cycle Spinning* submitted to IEEE Signal Processing Letters. Throughout this document, we refer to the method proposed in the main paper as CCS-MMSE.

Additional Experimental Results

In Section IV of the main paper, we present the MSE performance of the CCS-MMSE algorithm for denoising Lévy processes. We then illustrate the MMSE performance of CCS-MMSE by comparing it against the message-passing (MP) algorithm, which is a computational method for obtaining the MMSE estimator. In all of our simulations, CCS-MMSE perfectly matches MP, while reaching the result much faster.

In this supplement, we address the issue of convergence of the algorithm. The proof of convergence of the alternating scheme that is used to obtain CCS-MMSE is challenging. However, the manual investigation of the MSE computed by the algorithm shows that it decreases until reaching a fixed point. This was observed across all noise levels and signal models. Figures 1 (a), (b), and (c) below illustrates the evolution of the MSE over 100 iterations for three signal models compared in the main paper for $\sigma^2 = 1$. Note that the algorithm typically converges within first 10 iterations. Thus, the empirical evidence indicates that CCS-MMSE converges to the MMSE solution. The theoretical confirmation of this observation requires more in-depth investigation, which remains an open question and a topic for future research.

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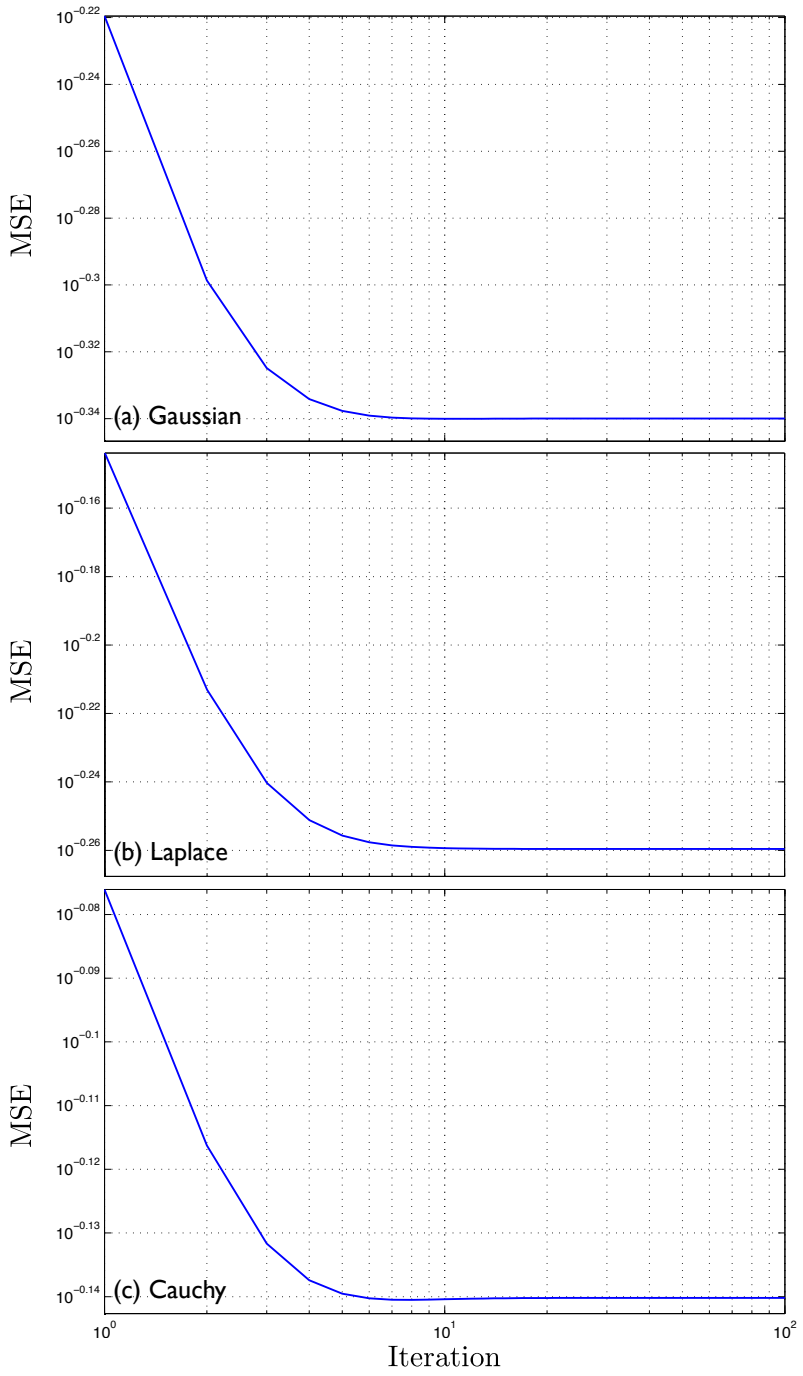

Figure 1: Denoising of Lévy processes with CCS-MMSE for AWGN variance of $\sigma^2 = 1$. Evolution of MSE is plotted against iteration number for (a) Gaussian, (b) Laplace, (c) Cauchy increments.