NL-Ridge: a novel statistical patch-based approach for image denoising

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We present a novel statistical patch-based approach for image denoising [1]. The state-of-the-art unsupervised methods that only use a single noisy image are two-step algorithms [2] [3]. Leveraging the Stein's unbiased risk estimate (SURE) [4] for the first step and the "internal adaptation", a concept borrowed from deep learning theory [5], for the second one, we show that our NL-Ridge approach enables to reconcile several previous patch-based methods for image denoising. In the second step, our closed-form aggregation weights are computed through multivariate Ridge regressions. Experiments on artificially noisy images demonstrate that NL-Ridge may outperform state-of-the-art unsupervised denoisers such as BM3D [2] and NL-Bayes [3], and recent unsupervised deep learning methods such as Noise2Self [6], Self2Self [7], and Deep Image Prior [8] as well as supervised techniques such as DnCNN [9], while being much more simple conceptually.

Noisy / 22.09 dB | BM3D[2] / 31.72 dB | Self2Self[7] / 31.62 dB | DnCNN[9] / 31.06 dB | **NL-Ridge**[1] / **32.06 dB**

Figure 1: Denoising results (in PSNR) for *Barbara* corrupted with additive white Gaussian noise ($\sigma = 20$).

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