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Dictionary Learning and Sparse Signal Recovery for Nonlinear Compressive Measurements

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Sparse representations and dictionary learning have been used widely in linear inverse problems, such as denoising, inpainting, deblurring, or super-resolution. However, they have been less explored for nonlinear measurements. In this talk, we present a new method for signal recovery and dictionary learning from nonlinear measurements, such as clipping (also called saturation), and quantization. Different from conventional methods, where recovering a signal from clipped and quantized measurements is often formulated as a constrained optimization problem, we propose a unified framework for signal recovery from clipped, quantized, as well as linear measurements. With a data-fidelity term that promotes consistency with the nonlinear measurement function, we generalize the linear least-squares loss function commonly used in sparse decompositions, and show that under some conditions on the measurement function, the proposed loss is convex, and continuously differentiable with a closed-form gradient, which makes it suitable for a range of optimization algorithms. This allows us to extend classical sparse decomposition algorithms to deal with nonlinear measurements. We then discuss how to learn a dictionary from the nonlinear compressive measurements, and demonstrate its improved performance for signal reconstruction, over the use of fixed dictionaries.