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Dictionary Learning and Sparse Signal Recovery for Nonlinear Compressive Measurements

Dr. Wenwu Wang
University of Surrey, UK.

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.