Reconstruction of Multiway Arrays from Incomplete Information Using the Tucker Tensor Decomposition

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Abstract

Tensor decomposition models for multidimensional datasets (multiway arrays) have a long history in Mathematics and applied sciences. While these models have recently been applied to multidimensional signal processing, they were developed independently of the theory of sparse representations and Compressed Sensing (CS). We discuss and illustrate recent results revealing connections among tensor decompositions models, recovery of low-rank multidimensional signals and CS theory. It is shown that, if a multidimensional signal has a good low rank or sparse multilinear representation, in the sense of the Tucker decomposition model, then it can be reconstructed from incomplete measurements. We discuss reconstructions methods for the cases where only a subset of fibers (mode-n vectors) in each dimension of the signal are available (Fiber Sampling Tensor Decomposition - FSTD), or when only the values of a limited set of entries are known (Tensor completion or multidimensional inpainting problem) or when measurements are given in a compressed multilinear format (Kronecker CS). We illustrate these methods by computer simulations taken on real world multidimensional signals including Magnetic Resonance Imaging (MRI) datasets and Hyperspectral images of natural scenes.

References

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