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Recovery of functions in high dimensions via compressive sensing

Compressive sensing predicts that sparse vectors can be recovered efficiently from highly undersampled measurements. It is known in particular that multivariate sparse trigonometric polynomials can be recovered from a small number of random samples. Classical methods for recovering functions in high spatial dimensions usually suffer the curse of dimension, that is, the number of samples scales exponentially in the dimension (the number of variables of the function). We introduce a new model of functions in high dimensions that uses "sparsity with respect to dimensions". More precisely, we assume that the function is very smooth in most of the variables, and is allowed to be rather rough in only a small but unknown set of variables. This translates into a certain sparsity model on the Fourier coefficients. Using techniques from compressive sensing, we are able to recover functions in this model class efficiently from a small number of samples. In particular, this number scales only logarithmically in the spatial dimension - in contrast to the exponential scaling in classical methods.