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Compressed sensing with generative models and Fourier measurements: provable guarantees under incoherence

In work by Bora et al. (2017), a mathematical framework was developed for compressed sensing guarantees when the measurement matrix is Gaussian and the signal structure is the range of a Lipschitz function (with applications to generative neural networks (GNNs)). We consider measurement matrices derived by sampling uniformly at random rows of a unitary matrix (including subsampled Fourier measurements as a special case). We prove the first known restricted isometry guarantee for compressed sensing with GNNs and subsampled isometries, and provide recovery bounds. Recovery efficacy is characterized by the coherence, a new parameter, which measures the interplay between the range of the network and the measurement matrix. Furthermore, we propose a regularization strategy for training GNNs to have favourable coherence with the measurement operator. We provide compelling numerical simulations that support this regularized training strategy: our strategy yields low coherence networks that require fewer measurements for signal recovery. This, together with our theoretical results, supports coherence as a natural quantity for characterizing generative compressed sensing with subsampled isometries.