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New and improved Johnson-Lindenstrauss embeddings via the Restricted Isometry Property

The Johnson-Lindenstrauss (JL) Lemma states that any set of p points in high dimensional Euclidean space can be embedded into $O(\delta^{-2}\log(p))$ dimensions, without distorting the distance between any two points by more than a factor between $1-\delta$ and $1+\delta$. We establish a "near-equivalence" between the JL Lemma and the Restricted Isometry Property (RIP), a well-known concept in the theory of sparse recovery often used for showing the success of ℓ_1-minimization. In particular, we show that matrices satisfying the Restricted Isometry of optimal order, with randomized column signs, provide optimal Johnson-Lindenstrauss embeddings up to a logarithmic factor in N. Our results have implications for dimensionality reduction and sparse recovery: on the one hand, we arrive at the best known bounds on the necessary JL embedding dimension for a wide class of structured random matrices; on the other hand, our results expose several new families of universal encoding strategies in compressed sensing.

This is joint work with Felix Krahmer.