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Random Projections for Manifold Learning

We propose a novel method for linear dimensionality reduction of manifold modeled data. First, we show that with a small number M of random projections of sample points in RN belonging to an unknown K-dimensional Euclidean manifold, the intrinsic dimension (ID) of the sample set can be estimated to high accuracy. Second, we rigorously prove that using only this set of random projections, we can estimate the structure of the underlying manifold. In both cases, the number of random projections required is linear in K and logarithmic in N, meaning that $K < M \ll N$. To handle practical situations, we develop a greedy algorithm to estimate the smallest size of the projection space required to perform manifold learning. Our method is particularly relevant in distributed sensing systems and leads to significant potential savings in data acquisition, storage and transmission costs.

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