RECONSTRUCTION IN RGG: BREAKING THE $\Theta(r)$ ERROR

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Abstract. Embedding graphs in a geographical or latent space, i.e., inferring locations for vertices in Euclidean space or on a smooth submanifold, is a common task in network analysis, statistical inference, and graph visualization. We consider the classic model of random geometric graphs where n points are scattered uniformly in a square of area n, and two points have an edge between them if and only if their Euclidean distance is less than r. The reconstruction problem then consists of inferring the vertex positions, up to symmetry, given only the adjacency matrix of the resulting graph. We give an algorithm that, if $r = n^\alpha$ for $\alpha > 0$, with high probability reconstructs the vertex positions with a maximum error of $O(n^\beta)$ where $\beta = 1/2 - (4/3)\alpha$, until $\alpha \geq 3/8$ where $\beta = 0$ and the error becomes $O(\sqrt{\log n})$. This improves over earlier results, which were unable to reconstruct with error less than r. Our method estimates Euclidean distances using a hybrid of graph distances and short-range estimates based on the number of common neighbors. We sketch proofs that our results also apply on the surface of a sphere, and (with somewhat different exponents) in any fixed dimension.

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