

Constrained Best Euclidean Distance Embedding On A Sphere: A Matrix Optimization Approach

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Abstract:

Euclidean distance matrices (EDM) are matrices of squared distances between points. EDM appears in many high-profile applications, among which is the data representation on a low dimensional manifold in high dimensional space. This technique is significant in data visualisation and analysis. In this talk, I'm going to talk about a spherical EDM embedding, which is a problem of data representation on a sphere of unknown radius. This problem arises from various disciplines such as Statistics (spatial data representation), Psychology (constrained multidimensional scaling), and Computer Science (machine learning and pattern recognition).

The best representation often needs to minimize a distance function of the data on a sphere as well as to satisfy some Euclidean distance constraints. It is those spherical and Euclidean distance constraints that present an enormous challenge to the existing algorithms. We reformulate the problem as an Euclidean distance matrix optimization problem with a low rank constraint. We then propose an iterative algorithm that uses a quadratically convergent Newton-CG method at its each step. We study fundamental issues including constraint nondegeneracy and the nonsingularity of generalized Jacobian that ensure the quadratic convergence of the Newton method. We use some classic examples from the spherical multidimensional scaling to demonstrate the flexibility of the algorithm in incorporating various constraints. Circle fitting is also an interesting application that we would like to present.