Multidimensional scaling by particle swarm optimization

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Multidimensional scaling (MDS) is a dimension reduction method for representing n points in a low dimension space, given a matrix of nxn distances or dissimilarities [1]. Several methods have been proposed for solving this problem by the minimization of a minimum sum of squares criterion, called stress; however, these methods usually stack in local minima of stress. We use the particle swarm optimization [3] paradigm for minimizing stress in metric multidimensional scaling. For this, we use particles in a very high dimensional space identifying particles to solutions of the MDS problem and tune the approximation of the optimum by weighting the terms of the iterative velocity equation. The method performs well, and we illustrate the results on several data sets. Comparisons are made with some well-known methods for MDS, as well as with other metaheuristics applied to MDS, such as simulated annealing, tabu search and genetic algorithms [2], [4].

References

[1] Borg, I., Groenen, P. J. F., & Mair, P. (2013). Applied multidimensional scaling. Springer Science + Business Media. Doi: https://doi.org/10.1007/978-3-642-31848-1

[2] Groenen, P.J.F., Mathar, R. & Trejos, J. (2000). "Global optimization methods for multidimensional scaling applied to mobile communications", in: W. Gaul, O. Opitz & M. Schader (Eds.) Data Analysis. Scientific Modeling and Practical Application, Springer, Berlin: 459-469. Doi: https://doi.org/10.1007/978-3-642-58250-9_37

[3] Kennedy, J. & Eberhart, R. (1995). "Particle swarm optimization", Proceedings of ICNN'95 - International Conference on Neural Networks vol.4, pp. 1942-1948, doi: https://doi.org/10.1109/ICNN.1995.488968

[4] Trejos, J., Castillo, W., González, J., & Villalobos, M. (2000). "Application of simulated annealing in some multidimensional scaling problems", in: H.A.L. Kiers, J.-P. Rasson, P.J.F. Groenen, & M. Schader (Eds.): Data Analysis, Classification and Related Methods. Springer, Berlin: 297-302. Doi: https://doi.org/10.1007/978-3-642-59789-3_47