An algorithm for clustering of the phase trajectory of a dynamic system

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Abstract. This paper describes an approach to quantitative analysis of multivariate dynamic system in phase space. The system is used as mathematical model for various living systems. The model is used in various applications. One of the related problems is to represent a phase trajectory as a sequence of clusters to classify the system's state.

The algorithm for partitioning a phase trajectory into clusters is presented. Input data for the algorithm is a data matrix which is corresponds to a set of sequential samples of the given phase trajectory. Optional parameters are dimension of the space in which the clusters lie, and phase trajectory noise variance. The algorithm results in a tree-like graph. The graph nodes contain given phase trajectory clusters and might be used for system's state classification.

Phase trajectory of a dynamic system with Lorenz attractor is considered as a test problem to demonstrate the approach. The initial phase trajectory lies in 3D-space. It was projected into N-dimensional space and distorted with non-correlated additive Gaussian noise. The given phase trajectory was partitioned into clusters using the described algorithm. The clusters make a tree T. The root of the tree corresponds to the phase trajectory that lies in r-dimensional space R_r. The next level of the tree consists of cluster nodes that lie in (r-l)-dimensional space, etc., up to the last level that corresponds to one-dimensional cluster nodes. An example of the tree is presented.

The algorithm was examined with various test trajectories. It is currently being applied to assess temporal dynamics of social and economical systems under extreme conditions.