Design Optimization of Fuzzy Models in System Identification

by

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Abstract

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Fuzzy systems are a type of general structure for modeling. A special characteristic of fuzzy systems, which makes it accepted by scientists and engineers, lies in that it can make effective use of human knowledge. Data-driven techniques are always adopted for fuzzy modeling since the human knowledge (or experience) may not be enough to describe the entire system, especially the systems with high complexity. This thesis studies two problems involved in data-driven modeling for fuzzy systems. The first and most important problem is the data generation. Under the condition that little information about the system is given, Latin Hypercube Sampling (LHS) contributes in how to distribute less data points to collect more important information is selected to generate training data sets. Simulation results show that the training data is significantly reduced by LHS design while the performance of the developed model is satisfactory. The second problem, which relates with system complexity, requires the designer to extract the rules as less as possible with guaranteed accuracy (maximum absolute error) requirement. Wan et al. [27] give an approach inspired from computation geometry to design the Mamdani type fuzzy systems for the requirement.

The so-called tunnel algorithm finds the minimum number of rules inside the added auxiliary tunnel which is a polygon encircles the given training data. The tunnel is analyzed to be unnecessary and limit the performance. Hence, we propose a new scheme to break the tunnel and extract the global minimum number of rules. The proposed testing point (TP) algorithm is able to be applied to not only the Mamdani type fuzzy systems but also the TSK type fuzzy systems with any order. Numerical experiments show the proposed algorithm can extract less number of fuzzy rules.

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