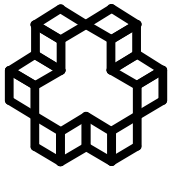
Abstract

This study proposes three novel hybrid learning algorithms with stable learning laws for Adaptive Network based Fuzzy Inference System (ANFIS) as a system identifier. The proposed hybrid learning algorithms are based on the Particle Swarm Optimization for training the antecedent part and the Gradient Descent / Recursive Least Square / Extended Kalman Filter for training the conclusion part. Lyapunov stability theory is used to study the stability of the proposed algorithms.

Comparison results of the proposed approach, Particle Swarm Optimization algorithm for training the antecedent part and Recursive Least Squares or Extended Kalman Filter algorithm for training the conclusion part, with the other classical approaches such as, Gradient Descent, Resilient Propagation, Quick Propagation, Levenberg- Marquardt for training the antecedent part and Recursive Least Squares algorithm for training the conclusion part are provided.

Moreover, it is shown that applying Particle Swarm Optimization, a powerful optimizer, to optimally train the parameters of the membership function on the antecedent part of the fuzzy rules in ANFIS system is a stable approach which results in an identifier with the best trained model. Stability constraints are obtained and different simulation results are given to validate the results. Also, the stability of Gradient Descent, Recursive Least Square and Levenberg- Marquardt algorithms for ANFIS training are analyzed.

Keywords: System Identification, Neuro-Fuzzy Networks, Stability Analysis, Hybrid Learning Algorithm, Particle Swarm Optimization, Gradient Descent, Extended Kalman Filter, ANFIS and Lyapunov Stability.



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Stability Analysis of Neuro-Fuzzy Networks Based on Hybrid Learning Algorithms

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