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DENFIS: Dynamic Evolving Neural-Fuzzy Inference System and Its Application for Time-Series Prediction

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Abstract— This paper introduces a new type of fuzzy inference systems, denoted as dynamic evolving neural-fuzzy inference system (DENFIS), for adaptive online and offline learning, and their application for dynamic time series prediction. DENFIS evolve through incremental, hybrid (supervised/unsupervised), learning, and accommodate new input data, including new features, new classes, etc., through local element tuning. New fuzzy rules are created and updated during the operation of the system. At each time moment, the output of DENFIS is calculated through a fuzzy inference system based on m-most activated fuzzy rules which are dynamically chosen from a fuzzy rule set. Two approaches are proposed: 1) dynamic creation of a first-order Takagi-Sugeno-type fuzzy rule set for a DENFIS online model; and 2) creation of a first-order Takagi-Sugeno-type fuzzy rule set, or an expanded high-order one, for a DENFIS offline model. A set of fuzzy rules can be inserted into DENFIS before or during its learning process. Fuzzy rules can also be extracted during or after the learning process. An evolving clustering method (ECM), which is employed in both online and offline DENFIS models, is also introduced. It is demonstrated that DENFIS can effectively learn complex temporal sequences in an adaptive way and outperform some well-known, existing models.

Index Terms—Dynamic evolving neural-fuzzy inference system (DENFIS), hybrid systems, online adaptive learning, online clus- tering, time series prediction.