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DESIGN OF A RECURRENT FUNCTIONAL NEURAL FUZZY NETWORK USING MODIFIED DIFFERENTIAL EVOLUTION

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Abstract. *In this paper, a recurrent functional neural fuzzy network (RFNFN) with modified differential evolution (MDE) method is proposed to solve the prediction problems. The proposed RFNFN model adopts a functional link neural network (FLNN) to the consequent part of the fuzzy rules. FLNN uses orthogonal polynomials and linearly independent functions to form a functional expansion. Thus, the consequent part is a nonlinear combination of input variables. This model also adds feedback connections in the membership function layer to memorize past information for solving temporal problems. Moreover, an efficient learning algorithm, called modified differential evolution (MDE), is proposed to speed up the learning curve and to improve the prediction accuracy. Finally, the RFNFN model is applied to prediction problems of the chaotic time series and the forecast of the sunspot number. The simulation results show that the RFNFN model has a superior performance than DE1 and DE2 methods.*
Keywords: Neural fuzzy networks, Functional link neural network, Recurrent networks, Differential evolutionary algorithm, Prediction.

1. **Introduction.** Recently, neural fuzzy networks [1-8] have become a popular research topic. Two typical neural fuzzy networks are the Mamdani-type and the TSK-type networks. Many researchers [2,3] have shown that TSK-type neural fuzzy networks offer better network size and learning accuracy than Mamdani-type neural fuzzy networks do. In the typical TSK-type neural fuzzy network, which is a linear polynomial of the input variables, the model's output is approximated locally by the rule hyperplanes. Nevertheless, the traditional TSK-type neural fuzzy network does not take full advantage of the mapping capabilities that may be offered by the consequent part. Introducing a nonlinear function, especially a neural structure, to the consequent part of the fuzzy rules has yielded the NARA [9] and the CANFIS [10] models. These models [9,10] apply multilayer neural networks to the consequent part of the fuzzy rules. Although the interpretability of the model is reduced, the representational capability of the model is markedly improved. However, the multilayer neural network has such disadvantages as slower convergence