Optimization of Self-organizing Fuzzy Polynomial Neural Networks with the Aid of Granular Computing and Evolutionary Algorithm

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Abstract. In this study, we introduce and investigate a class of intelligence architectures of Self-Organizing Fuzzy Polynomial Neural Networks (SOFPNN) that is based on a genetically optimized Fuzzy Polynomial Neurons(FPNs), develop a comprehensive design methodology involving mechanisms of genetic algorithms and information granulation. With the aid of the information granulation, we determine the initial location (apexes) of membership functions and initial values of polynomial function being used in the premised and consequence part of the fuzzy rules respectively. The GA-based design procedure being applied at each layer of SOFPNN leads to the selection of preferred nodes with specific local characteristics (such as the number of input variables, the order of the polynomial, a collection of the specific subset of input variables, and the number of membership function) available within the network.

1 Introduction

The challenging quest of how to construct models that come with significant approximation and generalization abilities as well as are easy to comprehend has been within the community for decades [1]. GMDH-type algorithms have been extensively used since the mid-1970's for prediction and modeling complex nonlinear processes [2]. While providing with a systematic design procedure, GMDH comes with some drawbacks. To alleviate the problems associated with the GMDH, Self-Organizing Neural Networks (SONN, called "SOFPNN") were introduced by Oh and Pedrycz [3], [4], [5] as a new category of neural networks or neuro-fuzzy networks.

In this study, in considering the above problems coming with the conventional SOFPNN, we introduce a new structure and organization of fuzzy rules as well as a new genetic design approach. The new meaning of fuzzy rules, information granules melt into the fuzzy rules. That is, we determine the initial location (apexes) of membership functions in the premise part and the initial values of polynomial function of consequence part of the fuzzy rules by information granulation. In a nutshell, each fuzzy rule describes the related information granule. The determination of the optimal

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values of the parameters available within an individual FPN (viz. the number of input variables, the order of the polynomial, a collection of preferred nodes, and the number of MF) leads to a structurally and parametrically optimized network through the genetic approach.

2 The Conventional SOFPNN with Fuzzy Polynomial Neuron (FPN) and Its Topology

The FPN consists of two basic functional modules. The first one, labeled by **F**, is a collection of fuzzy sets that form an interface between the input numeric variables and the processing part realized by the neuron. The second module (denoted here by **P**) is about the function – based nonlinear (polynomial) processing. The detailed FPN involving a certain regression polynomial is shown in Table 1.

Table 1. Different forms of regression polynomial building a FPN

No. of inputs Order of the polynomial		1	2	3
Order	Type			
0	Type 1	Constant	Constant	Constant
1	Type 2	Linear	Bilinear	Trilinear
2	Type 3	Quadratic	Biquadratic-1	Triquadratic-1
	Type 4		Biquadratic-2	Triquadratic-2

1: Basic type, 2: Modified type

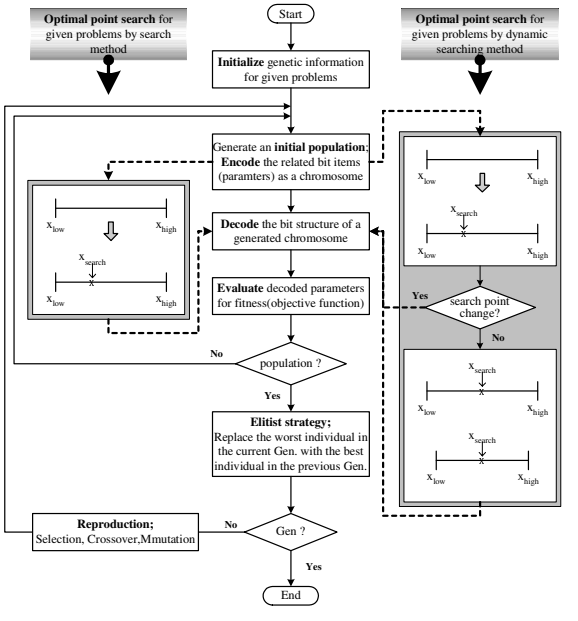

Fig. 1. Optimization of SOFPNN parameter by GA with dynamic searching range