Fuzzy Rule Base Networks - Overview and Perspectives

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***Abstract*—Most fuzzy systems nowadays are Single Rule Base (SRB) systems. They have either one rule base, e.g. a Multiple Output (MO) fuzzy system, or a number of independent rule bases, e.g. Single Output (SO) fuzzy systems. In this context, the most distinctive feature of a SRB system is the isolated nature of its rule bases. However, some processes can be better modelled by a Multiple Rule Base (MRB) system, i.e. a system with some interconnections between its rule bases. This is usually the case of multi-stage processes where the outputs from a particular stage are also inputs to other stages. MRB systems used for describing such processes are usually referred to as 'chained fuzzy systems' but the more general term 'MRB systems' will be used here for generality.**

I. Theme

A MRB system can be described by a Fuzzy Rule Base Network (FRBN) whereby all rule bases in a row represent a level and all rule bases in a column represent a layer. The arrangement of levels is from top to bottom whereas the numbering of layers is from left to right. Interconnections may exist between rule bases residing in the same layer as well as between rule bases in different layers. Some of these interconnections can be in a forward direction, i.e. from a particular layer to one or more subsequent layers. Other interconnections can be in a backward direction, i.e. from a particular layer to the same layer or to preceding layers. In this context, the interconnections reflect the nature of the multi-stage process being modelled [1], [2], [5].

The layers in a FRBN represent a temporal hierarchy, i.e. processes that take place sequentially in time. As opposed to this, the levels in a FRBN represent a spatial hierarchy, i.e. processes that are subordinated to each other. Although this spatial subordination is relevant mainly within a particular layer, it is often propagated across the whole network structure by means of the interconnections between the rule bases [3], [4].

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The above two types of network hierarchy can be used for modelling systems with the purpose of reducing their complexity. In this sense, the network structure of the fuzzy rule base is either a straightforward reflection of the system being modelled or a design decision aimed at achieving better effectiveness or higher efficiency.

In order to define a FRBN fully, each of the individual rule bases must be given. Also, the interconnections between the rule bases must be defined by specifying which outputs from which rule bases are which inputs to which rule bases.

Interconnections can be either local or global. If an output from a rule base is fed back into an input to the same rule base, the interconnection is local. However, if an output from a rule base is fed back into an input to another rule base residing in the same or a different layer, the interconnection is global.

II. Objective

The panel will discuss the capabilities of FRBNs as a novel technique for modelling complex systems and will highlight some related emerging research areas such as fuzzy multi-agent systems (FMASs).

III. Timeliness

FRBNs are still relatively unknown although they have a high potential for a fairly sophisticated and advanced level of modelling complex systems by taking explicitly into account the interactions between the subsystems.

IV. Suitability

FRBNs represent a promising new direction in the modern theory and applications of fuzzy systems, which are the main focus of the IEEE International Conference on Fuzzy Systems 2007.

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