

io-port 02200948

Pedrycz, Witold

Logic-oriented fuzzy neural networks.

Int. J. Hybrid Intell. Syst. 1, No. 1-2, 3-11 (2004).

Summary: The recent trend in the development of neurofuzzy systems has profoundly emphasized the importance of synergy between the fundamentals of fuzzy sets and neural networks. The resulting frameworks of the neurofuzzy systems took advantage of an array of learning mechanisms primarily originating within the theory of neurocomputing and the use of fuzzy models (predominantly rule-based systems) being well established in the realm of fuzzy sets. Ideally, one can anticipate that neurofuzzy systems should fully exploit the linkages between these two technologies while strongly preserving their evident identities (plasticity or learning abilities to be shared by the transparency and full interpretability of the resulting neurofuzzy constructs). Interestingly, this synergy still becomes a target yet to be satisfied. This study is an attempt to address the fundamental interpretability challenge we encountered in neurofuzzy systems. Our underlying conjecture is that the transparency of any neurofuzzy system links directly with the logic fabric of the system, so the logic fundamentals of the underlying architecture become of primordial relevance. Having this in mind, the development of neurofuzzy models hinges on a collection of logic driven processing units named here fuzzy (logic) neurons. These are conceptually simple logic-oriented elements that come with a well-defined semantics and plasticity. Owing to their diversity, such neurons form essential building blocks of the networks. The study revisits the existing categories of logic neurons, provides with their taxonomy, helps understand their functional features and sheds light on their behavior when being treated as computational components of any neurofuzzy architecture. The two main categories of aggregative and reference neurons are deeply rooted in the fundamental operations encountered in the technology of fuzzy sets (including logic operations, linguistic modifiers, and logic reference operations). The developed heterogeneous networks come with a well-defined semantics and high interpretability (which directly translates into the rule-based representation of the networks). As the network takes advantage of various logic neurons, this imposes an immediate requirement of structural optimization, which in this study is addressed by utilizing various mechanisms of genetic optimization (genetic algorithms). We discuss the development of the networks, elaborate on the interpretation aspects and include a number of illustrative numeric examples.

Keywords: fuzzy neurocomputing; network transparency; interpretability; logic neurons