

An Integrated Approach to Computational Intelligence

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The *computational intelligence (CI) paradigm* brings together three technologies—neural networks, fuzzy logic, and evolutionary algorithms—and stresses their seamless integration, resulting in numerous important spin-off commercial applications. In particular, the neuro-fuzzy computing paradigm carefully integrates the merits of neural network and fuzzy logic technologies in order to extend the capabilities of intelligent systems beyond the classical symbolic approach. These systems have the advantage of being able to adapt and operate in dynamic environments where uncertainty prevails. Other hybrids include neuro-evolutionary systems, fuzzy-evolutionary systems, and neuro-fuzzy-evolutionary systems.

The automated identification of the deep and surface structures of integrated neuro-fuzzy systems from numeric input-output data pairs has been suggested in several ways which include the neural network learning based approach, the evolutionary learning approach, and their hybrids. The latter approach results in integrated systems that exploit all three technologies, and which have powerful computational capabilities with diverse application domains. In fact, the introduction of evolutionary algorithms (EAs) in the design of CI systems can help search for a good set of parameters, identify network architectures, and eliminate redundant features through global search. However, EAs don't come for free: they require problem specific careful tuning of parameters, and require vast computational resources. Luckily, the intrinsically parallel nature of EAs permits them to be implemented on computing clusters which are becoming increasingly common in academic and commercial environments.

This talk introduces the essential principles of computational intelligence technologies. Emphasis is placed on the fuzzification of a neural network architecture or its input-output space (fuzzy-neural system), as well as the way to embed neural networks as part of a fuzzy system (neural-fuzzy system), clearly identifying the ways in which additional capabilities such as flexibility, speed, and adaptability arise in the integrated form. In particular, there will be a discussion on the Asymmetric-SuPFuNIS model and its evolutionary hybrid that employs differential evolution learning. The challenge in parallelizing evolutionary-neuro-fuzzy models will be highlighted using a Local Area Multicomputer/Message Passing Interface (LAM/MPI) implementation.