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Introduction

Applications of artificial neural networks and genetic algorithms to agricultural systems

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Agricultural systems, such as an environment-plant system, are quite complex and uncertain and they can be considered as ill-defined systems. They are characterized by non-linearities, time-varying properties and many unknown factors. It is, therefore, difficult to quantify the complex relationships between the input and the output of a system based on analytical methods. Recently, intelligent system control based on artificial intelligence (AI) has been one of the most prosperous technologies in the complex system science.

System science is a mission within the International Federation of Automatic Control (IFAC) and two technical committees (TCs) relating to agricultural engineering have been organized in the coordinating committee on life support systems of IFAC. Several workshops and symposia on AI-applications in agricultural systems have been planned by these TCs. Several interesting papers were presented at these meetings as well as at the CIGR, ASAE and EurAgEng meeting. Therefore, it may be timely and reasonable that this special issue is focused on AI and the use of artificial neural network (ANN) and genetic algorithm (GA) in the system science approach in agriculture.

In recent years ANN, mimicking the work of biological brains, has shown to be effective as an exciting alternative to deal with complex systems. With their high learning ability, they have the capability of identifying and modeling the complex nonlinear relationships (or behaviors) between the input and the output of a system (Rumelhart et al., 1986; Chen et al., 1990; Hunt et al., 1992). Cybenko (1989) shows

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that a three-layer neural network with one hidden layer allows any continuous function to be successfully identified. It can be also said that they are essentially applicable to multi-input and multi-output systems because they process many inputs and outputs in parallel.

In addition, GA offers an exciting alternative in the search for an optimal value. The imitation of a natural evolution process based on a crossing and a mutation provides a rapid search for an optimal value. Using the GA, an optimal value can be searched for in parallel with a multi-point search technique, rather than a single point procedure (Holland, 1992; Goldberg, 1989; Krishnakumar and Goldberg, 1992). Even if the objective function has many peaks, the multipoint search technique permits the focus of attention on the most valuable parts of the solution space and consequently, the global optimal value can be rapidly and efficiently sought from a very large search space. The GA requires only the objective function to guide its search. There is no requirement to formulate a mathematical equation or any a priori knowledge for the objective function.

It should be noted that for complex systems the ANN and GA mentioned above have many advantages over traditional analytical approaches.

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