Chapter 59
Artificial Intelligence Methods and Their Applications in Civil Engineering

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ABSTRACT

Simulation of material properties generally involves the development of a mathematical model derived from experimental data. In structural mechanics and construction materials contexts, recent experiments have reported that fuzzy logic (FL), artificial neural networks (ANNs), genetic algorithm (GA), and fuzzy genetic (FG) may offer a promising alternative. They are known as artificial intelligence (AI). In civil engineering, AI methods have been extensively used in the fields of civil engineering applications such as construction management, building materials, hydraulic, optimization, geotechnical and transportation engineering. Many studies have examined the applicability of AI methods to estimate concrete properties. This chapter described the principles of FL methods that can be taught to engineering students through MATLAB graphical user interface carried out in a postgraduate course on Applications of Artificial Intelligence in Engineering, discussed the application of Mamdani type in concrete technology and highlighted key studies related to the usability of FL in concrete technology.

INTRODUCTION

For many years, concrete has been known as one of the main materials in construction industry (Petcherdchoo, 2013). Concrete has a wide range of application in the area of construction and is considered a basic construction material that requires attention and diligence at every stage, from production to implementation. Concrete has an important place among all possible materials that form the basis of

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modern societies. In our environment, many civil infrastructures such as buildings, roads, bridges, dams, power plants, retaining walls, water tanks, ports, airports, etc. are made with concrete (Metha, 1986; Binici, Durgun, Rızaoğlu, & Koluçolak, 2012). Concrete researchers know that it is not always easy to perform experiments to obtain data on the physical and mechanical properties of concrete. As a result, in the past two decades, different modeling methods based on soft computing have become popular and have been used by many researchers to obtain a variety of data on the properties of concrete.

This chapter focuses on the some approaches for solving the civil engineering problems by using computing techniques. It firstly describes the principles of FL methods that can be taught to engineering students through MATLAB graphical user interface carried out in a postgraduate course titled *Applications of Artificial Intelligence in Engineering*, then discusses the application of Mamdani type in concrete technology and finally highlights key studies related to the usability of FL in concrete technology.

Soft Computing is a combination of methodologies that were designed to model and identify solutions to real world problems. The main aim of soft computing is to devise methods of computation that lead to an acceptable solution at low cost in the shortest time possible. Unlike existing methods, it is tolerant of imprecision, uncertainty, partial truths, and approximations. Soft Computing is basically an optimization technique to find solutions to problems which tend to be complex (TheShodhganga@ INFLIBNET Centre, 2014).

The definition of soft computing is not precise. Lotfi A. Zadeh, the inventor of the term soft computing, describes it as follows:

Soft computing is a collection of methodologies whose aim is to exploit the tolerance for imprecision and uncertainty to achieve tractability, robustness, and low solution cost. Its principal constituents are FL, neuro computing, and probabilistic reasoning. Soft computing is likely to play an increasingly key role in many application areas, including software engineering. The model for soft computing is the human mind. (Zadeh, 1994inCevik, Göğüş, Güzelbey, & Filiz, 2010, p. 528).

Soft computing approaches in decision making have become increasingly popular in many disciplines. This is evident from vast number of technical papers appearing in journals and conference proceedings in all areas of engineering, manufacturing, science, medicine, and business. Soft computing is a rapidly evolving field that combines knowledge, techniques, and methodologies from various sources, using techniques from neural networks, fuzzy set theory, approximate reasoning, and using optimization methods such as genetic algorithms.

The integration of these and other methodologies forms the core of soft computing (Nguyen, Hung, Prasad, Walker, & Walker, 2003). One of the most popular soft computing techniques is fuzzy logic (FL). Because of its multidisciplinary nature, fuzzy inference systems are associated with a number of different labels such as fuzzy-rule-based systems, fuzzy expert systems, fuzzy modeling, fuzzy associative memory, FL controllers, and simply (and ambiguously) fuzzy systems (MATLAB, 2012). Fuzzy set theory that was proposed by Zadeh (1965) is a mathematical tool that allows work to be carried out in an uncertain environment. As opposed to classical logic, in which an element belongs (1) or does not belong (0) to a set, a fuzzy set is a set without a crisp, clearly defined boundary i.e., it can contain elements with only a partial degree of membership (a number between 0 and 1) (Garzón-Roca, Marco, & Adam, 2013).