Introduction to Computational Intelligence for Decision Making

Witold Pedrycz1, Nikhil Ichalkaranje2, Gloria Phillips-Wren3, and Lakhmi Jain4

1 Department of Electrical and Computer Engineering, University of Alberta, Edmonton, Canada
2 Research Statistics and Technology Branch, Department of Communications, IT and the Arts, GPO Box 2154, CANBERRA ACT 2601
3 The Sellinger School of Business and Management, Loyola College in Maryland, Baltimore, MD 21210, USA
4 School of Electrical and Information Engineering, Knowledge Based Intelligent Engineering Systems Centre, University of South Australia, Mawson Lakes, SA 5095, Australia

Summary. Computational intelligence techniques are increasingly extending and enriching decision support through such means as coordinating data delivery, analyzing data trends, providing forecasts, ensuring data consistency, quantifying uncertainty, anticipating the user’s data needs, providing information to the user in the most appropriate forms, and suggesting courses of action. This chapter provides an introduction to computational intelligence to enhance decision making.

3.1 Introduction

A refined class of computational intelligence techniques is revolutionalizing the support of decision making, especially under uncertain conditions, by such means as coordinating data delivery, analyzing data trends, providing forecasts, ensuring data consistency, quantifying uncertainty, anticipating the user’s data needs, providing information to the user in the most appropriate forms, and suggesting courses of action. This chapter provides an introduction to computational intelligence techniques and applications that can support decision making. Other chapters in the book explore research associated with advances in methods such as neural networks, evolutionary computing and intelligent agents that can be utilized in decision making support.

Computational intelligence paradigms are used to mimic the behavior of humans in some limited yet meaningful manner. These include tools such as symbolic logic, artificial neural networks (ANNs), evolutionary computing, intelligent agents and probabilistic reasoning models (Jain and De Wilde, 2001; Jain and Martin, 1999). In conventional programming methodologies,
explicit logic and numerical calculations are provided to solve a problem. In contrast, an ANN mimics some biological systems by solving problems using training and learning to generalize for new problems.

Uncertain and imprecise knowledge can be represented with fuzzy logic (Jain, 1995) and ANNs (Hammerstrom, 1993). They are effective ways of describing complex behavior that is difficult to describe mathematically using conventional methods. Evolutionary computing techniques (Jain and Martin, 1999) evolve a solution to a problem guided by algorithms such as optimization of a multi-dimensional problem. A widely reported category of evolutionary algorithm is a genetic algorithm (GA).

Computational intelligence paradigms have been used successfully to solve problems in many disciplines including business, management, engineering design, medical diagnosis, decision making and web-based systems (Hammerstrom, 1993; Jain and Jain, 1997; Tonfoni and Jain, 2003; Abraham et al., 2005; Jain et al., 2000, Phillips-Wren and Jain, 2005). One fruitful area of research appears to be the fusing of these paradigms using hybrid agents (Jain and Jain, 1997).

### 3.2 Computational Intelligence in Decision Making

The application of computational intelligence to decision making is certainly not new. Recent advances have made computational intelligence techniques accessible to a wider audience as seen by the increase in the number of applications in such areas as intelligent decision support systems. Computational intelligence is being used in decision support for tasks such as aiding the decision maker to select actions in real-time and stressful decision problems; reducing information overload, enabling up-to-date information; providing a dynamic response with intelligent agents; enabling communication required for collaborative decisions; and dealing with uncertainty in decision problems. Leading computational intelligence professional organizations recognize the current effort in “focusing on problems, not on hammers. Given that we (i.e. Artificial Intelligence researchers) do have a comprehensive toolbox, issues of architecture and integration emerge as central” (Mackworth, 2005). Several applications are given in later chapters in this book demonstrating the pragmatic applications of various computational intelligence techniques.

Other recent examples include an expert system to automate the operations of petroleum production and separation facilities (Chan, 2005). Such systems provide access to plants in remote areas by automatically collecting, transmitting and analyzing data for analysis. The system is able to monitor operations, detect abnormalities, and suggest actions to the human operator based on domain-specific expertise acquired during development of the system. A preliminary evaluation of the system showed satisfactory results.

Case based reasoning (CBR) is being applied to health services in a variety of areas (Bichindaritz and Marling, 2006). Current application of