# Chapter 6.2
# Computational Intelligence Applications in Business:
## A Cross-Section of the Field

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## ABSTRACT

We present an overview of the literature relating to computational intelligence (also commonly called artificial intelligence) and business applications, particularly the journal-based literature. The modern investigation into artificial intelligence started with Alan Turing who asked in 1948 if it would be possible for "machinery to show intelligent behaviour." The computational intelligence discipline is primarily concerned with understanding the mechanisms underlying intelligent behavior, and consequently embodying these mechanisms in machines. The term "artificial intelligence" first appeared in print in 1955. As this overview shows, the 50 years of research since then have produced a wide range of techniques, many of which have important implications for many business functions, including finance, economics, production, operations, marketing, and management. However, gaining access to the literature can prove difficult for both the computational intelligence researcher and the business practitioner, as the material is contained in numerous journals and discipline areas. The chapter provides access to the vast and scattered literature by citing reviews of the main computational intelligence techniques, including expert systems, artificial neural networks, fuzzy systems, rough sets, evolutionary algorithms, and multi-agent systems.

## INTRODUCTION

Although its intellectual roots can be traced back to Greek mythology (McCorduck, 2004), the modern investigation into artificial intelligence started at the beginning of the computer era, when Alan Turing (1948, 1950) first investigated the question "as to whether it is possible for machinery to show intelligent behaviour" (Turing, 1948, p. 1). Many of

Turing's insights in that remarkable (unpublished) 1948 manuscript became central concepts in later investigations of machine intelligence. Some of these concepts, including networks of artificial neurons, only became widely available after re-invention by other researchers. For those new to the field, there are many excellent introductions to the study of computational intelligence (Callan, 2003; Engelbrecht, 2002; Hoffmann, 1998; Konar, 2000; Luger & Stubblefield, 1998; Munakata, 1998; Negnevitsky, 2002; Poole, Mackworth, & Goebel, 1998).

Artificial intelligence can be defined as "the scientific understanding of the mechanisms underlying thought and intelligent behavior and their embodiment in machines" (American Association for Artificial Intelligence, n.d.). The term "artificial intelligence" first appeared in print in 1955, in conjunction with a research program at Dartmouth College (McCarthy, Minsky, Rochester, & Shannon, 1955). Recently the term "computational intelligence" has been proposed as more appropriate for this field of study (Poole et al., 1998). As they state, "[t]he central scientific goal of computational intelligence is to understand the principles that make intelligent behavior possible, in natural or artificial systems" (Poole et al., 1998, p. 1).

Poole et al. (1998) feel that "artificial intelligence" is a confusing term for a number of reasons: artificial implies "not real," but the field of study looks at both natural and artificial systems; artificial also "connotes simulated intelligence" (p. 2), but the goal is not to simulate intelligence, but to "understand real (natural or synthetic) intelligent systems by synthesizing them" (p. 2). As they state: "[a] simulation of an earthquake isn't an earthquake; however, we want to actually create intelligence, as you could imagine creating an earthquake. The misunderstanding comes about because most simulations are now carried out on computers. However … the digital computer, the archetype of an interpreted automatic, formal, symbol-manipulation system, is a tool unlike any other: It can produce the real thing" (p. 2). Computational intelligence also has the advantage of making the "computational hypothesis explicit in the name" (p. 2). For these reasons, we prefer (and use) the term computational intelligence (CI).

Debates about terminology aside, 50 years of study into "the principles of intelligent behavior" have led to the development of a wide range of software tools with applications relevant for most business disciplines. The chapter provides references to the many reviews of CI applications available in the literature. This cross-section of the field (as opposed to a comprehensive review) will briefly outline some of the different "tools of intelligence" and show examples of their applications across a broad spectrum of business applications.

## TOOLS OF INTELLIGENCE

The study of computational intelligence has led to a number of techniques, many of which have had immediate practical applications, even though they fall far short of the type of intelligent behavior envisaged by early enthusiastic artificial intelligence practitioners and popular fiction. Some of the CI techniques derive from abstract systems of symbol processing (e.g., frame-based systems, rule-based systems, logic-based systems, the event calculus, predicate calculus, fuzzy logic, and rough sets). More recent techniques have emulated natural processes (e.g., neural networks, evolutionary algorithms, auto-immune systems, ant colony optimisation, and simulated annealing). Just to add to the confusion of terminology, some of these latter techniques are also referred to as "soft computing" (Tikk, Kóczy, & Gedeon, 2003). In addition, a specific sub-branch of CI is referred to as machine learning (Flach, 2001). This section provides a brief overview of some of these tools of intelligence, with references to the literature for those readers interesting in pursuing some of the techniques in depth. The next section