Chapter 1.10
Artificial Neural Networks:
Applications in Finance and Manufacturing

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ABSTRACT

The primary aim of this chapter is to present an overview of the artificial neural network basics and operation, architectures, and the major algorithms used for training the neural network models. As can be seen in subsequent chapters, neural networks have made many useful contributions to solve theoretical and practical problems in finance and manufacturing areas. The secondary aim here is therefore to provide a brief review of artificial neural network applications in finance and manufacturing areas.

INTRODUCTION

Since the seminal work by Rumelhart, McClelland, and the PDP research group (1986), artificial neural networks (ANNs) have drawn tremendous interest due to the demonstrated successful applications in pattern recognition (Fukumi, Omatu, & Nishikawa 1997), image processing (Duranton, 1996), document analysis (Marinai, Gori, & Soda, 2005), engineering tasks (Jin, Cheu, & Srinivasan, 2002; Zhenyuan, Yilu, & Griffin, 2000), financial modeling (Abu-Mostafa, 2001), manufacturing (Kong & Nahavandi, 2002), biomedical (Nazeran

& Behbehani, 2000), optimization (Cho, Shin, & Yoo, 2005), and so on. In recent years, there has been a wide acceptance of ANNs as a tool for solving many financial and manufacturing problems. In finance, domain notable applications are in (1) trading and forecasting including derivative-securities pricing and hedging (Steiner & Wittkemper, 1997), (2) future price estimation (Torsun, 1996), (3) stock performance and selection (Kim & Chun, 1998), (4) foreign exchange rate forecasting (Kamruzzaman & Sarker, 2003), (5) corporate bankruptcy prediction (Atiya, 2001), (6) fraud detection (Smith & Gupta, 2000), and so on. Many commercial software based on ANNs are also available today offering solutions to a wide range of financial problems. Applications in manufacturing includes (1) condition monitoring in different manufacturing operations such as metal forming (Kong & Nahavandi, 2002), drilling (Brophy, Kelly, & Bryne, 2002), turning (Choudhury, Jain, & Rama Rao, 1999), and tool wearing and breaking (Choudhury, Jain, & Rama Rao, 1999; Huang & Chen, 2000), (2) cost estimation (Cavalieri, Maccarrone, & Pinto, 2004), (3) fault diagnosis (Javadpour & Knapp, 2003), (4) parameter selection (Wong & Hamouda, 2003), (5) production scheduling (Yang & Wang, 2000), (6) manufacturing cell formation (Christodoulou & Gaganis, 1998), and (7) quality control (Bahlmann, Heidemann, & Ritter, 1999).

Although developed as a model for mimicking human intelligence into machine, neural networks have excellent capability of learning the relationship between input-output mapping from a given dataset without any knowledge or assumptions about the statistical distribution of data. This capability of learning from data without any *a priori* knowledge makes neural networks particularly suitable for classification and regression tasks in practical situations. In most financial and manufacturing applications, classification and regression constitute integral parts. Neural networks are also inherently nonlinear which makes them more practical and accurate in modeling complex data patterns as opposed to many traditional methods which are linear. In numerous real-world problems including those in the fields of finance and manufacturing, ANN applications have been reported to outperform statistical classifiers or multiple-regression techniques in classification and data analysis tasks. Because of their ability to generalize well on unseen data, they are also suitable to deal with outlying, missing, and/or noisy data. Neural networks have also been paired with other techniques to harness the strengths and advantages of both techniques.

Since the intention of this book is to demonstrate innovative and successful applications of neural networks in finance and manufacturing, this introductory chapter presents a broad overview of neural networks, various architectures and learning algorithms, and some convincing applications in finance and manufacturing and discussion on current research issues in these areas.

ARTIFICIAL NEURAL NETWORKS

ANNs offer a computational approach that is quite different from conventional digital computation. Digital computers operate sequentially and can do arithmetic computation extremely fast. Biological neurons in the human brain are extremely slow devices and are capable of performing a tremendous amount of computation tasks necessary to do everyday complex tasks, commonsense reasoning, and dealing with fuzzy situations. The underlining reason is that, unlike a conventional computer, the brain contains a huge number of neurons, information processing elements of the biological nervous system, acting in parallel. ANNs are thus a parallel, distributed information processing structure consisting of processing elements interconnected via unidirectional signal channels called connection weights. Although modeled after biological neurons, ANNs are much simplified and bear only superficial resemblance. Some of the major