Preface

Artificial neural networks (ANNs) have attracted increasing attentions in recent years for solving many real-world problems. ANNs have been successfully applied in solving many complex problems where traditional problem-solving methods have failed or proved insufficient. With significant advances in processing power, neural networks research has been able to address problems that were often tackled by using simplified assumptions in the past. This has resulted in a wealth of new approaches based on neural networks in many areas, particularly in finance and manufacturing. This is evidenced by the exponential growth of scientific literature covering applications of neural networks in these areas.

Research and development works in ANNs are still growing rapidly due to an increasing number of successful applications of these techniques in diverse disciplines. This book is intended to cover basic theory and concepts of neural networks followed by recent applications of such techniques in finance and manufacturing. The book contains 15 chapters divided into three parts as follows:

- Section I: Introduction
- Section II: ANNs in Finance
- Section III: ANNs in Manufacturing

Section I gives an introduction to neural networks and their basic components. The individual neuron operation, network architecture, and training algorithms are discussed in the first part of Chapter I. The second part of this chapter provides a brief review of ANN applications in finance and manufacturing. Chapter II introduces one of the latest research areas in this field, which is evolving ANNs. In this chapter, the authors investigate the simultaneous evolution of network architectures and connection weights in ANNs. In simultaneous evolution, they use the well-known concept of multiobjective optimization and subsequently evolutionary multiobjective algorithms to evolve ANNs.

The results are promising when compared with the traditional ANN algorithms. It is expected that this methodology would provide better solutions to many applications of ANNs.

Section II of this book consists of seven chapters on ANN applications in the financial domain. Chapter III investigates the use of ANNs for stock market return forecasting. The authors examined neural network models, for level estimation and classification, to provide an effective forecasting of future values. A cross-validation technique was also employed to improve the generalization ability of the models. The results show that the classification models generate higher accuracy in forecasting ability than the buy-and-hold strategy, as well as those guided by the level-estimation-based forecasts of the neural network and benchmark linear regression models.

In Chapter IV, the authors investigate the development of novel reliable and efficient techniques to model the seemingly chaotic behavior of stock markets. They considered the flexible neural tree algorithm, a wavelet neural network, local linear wavelet neural network, and finally a feed-forward artificial neural network. The particle swarm optimization algorithm optimized the parameters of the different techniques. This chapter briefly explains how the different learning paradigms can be formulated using various methods and then investigated as to whether they can provide the required level of performance. Experimental results revealed that all the models considered could represent the stock indices behavior very accurately.

In many situations, financial time-series data is characterized by nonlinearities, discontinuities, and high-frequency multi-polynomial components. The conventional ANNs have difficulty in modeling such complex data. Chapter V provides an appropriate approach that is capable of extracting higher-order polynomial coefficients in the data. The authors later incorporated piecewise continuous activation functions and thresholds, and as a result, they are capable of modeling discontinuous (or piecewise continuous) data with a higher degree of accuracy. The performance of their approach was tested using representative financial time-series data such as credit ratings and exchange rates.

In Chapter VI, an intelligent Hierarchical Neural Network system for prediction and modeling of interest rates is presented. The proposed system was developed to model and predict 3-month (quarterly) interest-rate fluctuations. The system was further trained for 6-month and 1-year periods. The authors nicely analyzed the accuracy of prediction produced by their approach.

Although many works exist on the issue of modeling the yield curve, there is virtually no mention in the literature on the issue of forecasting the yield curve. In Chapter VII, the authors applied neural networks for the purpose of forecasting the zero-coupon yield curve. First, the yield curve was modeled from the past data using the famous Nelson-Siegel model. Then, forecasting of the various parameters of the Nelson-Siegel yield curve was performed using two different techniques — the multilayer perceptron and generalized feed-forward network. The forecasted Nelson-Siegel parameters were then used to predict the yield and the price of the various bonds. Results show the superiority of generalized feed-forward network over the multilayer perceptron for the purposes of forecasting the term structure of interest rates.

In Chapter VIII, the authors investigated an ANN-based prediction modeling of foreign currency rates using three different learning algorithms. The models were trained from

historical data using five technical indicators to predict six currency rates against the Australian dollar. The forecasting performance of the models was evaluated using a number of widely used statistical metrics. Results show that significantly better prediction can be made using simple technical indicators without extensive knowledge of the market data. The trading profitability of the neural-network-based forex model over a forecasted period was also analyzed.

Chapter IX deals with another important financial application — analysis of stock return for investment. The author applies neural networks for stock selection in the Singapore market. This chapter shows that neural networks are able to infer the characteristics of performing stocks from the historical patterns. The performance of stocks is reflective of the profitability and quality of management of the underlying company. Such information is reflected in financial and technical variables. A neural network based on a moving window selection system is used to uncover the intricate relationships between the performance of stocks and the related financial and technical variables. Historical data such as financial variables (inputs) and performance of the stock (output) is used to train the model. Experimental results show the model is capable of selecting stocks that yield better investment return.

Section III of the book contains six chapters on ANN applications in a manufacturing environment. The first chapter in this part (Chapter X) is a review chapter that discusses a number of examples of the use of neural networks in manufacturing operations.

Chapter XI presents an application of neural networks to the industrial-process modeling of high-pressure die casting. The model was implemented in two stages. The first stage was to obtain an accurate model of the die-casting process using a feed-forward multilayer perceptron from the process-condition monitoring data. The second stage was to evaluate the effect of different process parameters on the level of porosity in castings by performing sensitivity analysis. The results obtained were very encouraging to model die-casting process accurately.

The estimation of the unit production cost of a product during its design phase can be extremely difficult, especially if information on similar products previously produced is missing. In Chapter XII, the authors applied ANNs to determine the correlation between a product's cost and its characteristics. The test results seemed very good.

In Chapter XIII, a framework for design optimization is introduced that makes use of neural-network-based surrogates in lieu of actual analysis to arrive at optimum process parameters. The performance of the algorithm was studied using a number of mathematical benchmarks to instill confidence on its performance before reporting the results of a spring-back minimization problem. The results clearly indicate that the framework is able to report optimum designs with a substantially low computational cost while maintaining an acceptable level of accuracy.

In Chapter XIV, a neuro-adaptive scheduling methodology for machines is presented and evaluated by comparing its performance with conventional schedulers. The authors employed a dynamic neural network model and subsequently derived a continuous-time neural network controller and the control-input discretization process that yield the actual dispatching times. The developed algorithm guarantees system stability and controller-signal boundedness and robustness. The algorithm was evaluated on an industrial test case that constitutes a highly nonacyclic deterministic job shop

with extremely heterogeneous part-processing times. The simulation study, employing the idealistic deterministic job-shop abstraction, provided extensive comparison with conventional schedulers over a broad range of raw-material arrival rates and, through the extraction of several performance indices, verified its superb performance in terms of manufacturing system stability and low makespan, low average lead times, work-in-process inventory, and backlogging costs. Eventually, these extensive experiments highlighted the practical value and the potential of the mathematical properties of the proposed neuro-adaptive controller algorithm and its suitability for the control of non-trivial manufacturing cells.

The final chapter (Chapter XV) describes the application of neural networks to recognition of lubrication defects typical to industrial cold forging process. The neural-network-based model learned from different features related to the system was able to recognize all types of lubrication errors to a high accuracy. The overall accuracy of the neural network model was reported to be around 95% with almost uniform distribution of errors between all lubrication errors and the normal condition.

It is hoped that this book will trigger great interest in neural network applications in finance and manufacturing areas, leading to many more articles and books.

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Editors