Wavelet Neural Networks

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With Applications in Financial Engineering, Chaos, and Classification

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Preface

Wavelet networks are a new class of networks that combine classic sigmoid neural networks and wavelet analysis. Wavelet networks were proposed as an alternative to feedforward neural networks, which would alleviate the weaknesses associated with wavelet analysis and neural networks while preserving the advantages of each method.

Recently, wavelet networks have gained a lot of attention and have been used with great success in a wide range of applications: financial modeling; engineering; system control; short-term load forecasting; time-series prediction; signal classification and compression; signal denoising; static, dynamic, and nonlinear modeling; and nonlinear static function approximation—to mention some of the most important.

However, a major weakness of wavelet neural modeling is the lack of a generally accepted framework for applying wavelet networks. The purpose of this book is to present a step-by-step guide for model identification for wavelet networks. We describe a complete statistical model identification framework for applying wavelet networks in a variety of ways. Although vast literature on wavelet networks exists, to our knowledge this is the first study that presents a step-by-step guide for model identification for wavelet networks. Model identification can be separated into two parts: model selection and variable significance testing.

A concise and rigorous treatment for constructing optimal wavelet networks is provided. More precisely, the following subjects are examined thoroughly: the structure of a wavelet network; training methods; initialization algorithms; variable significance and variable selection algorithms; model selection methods; and methods to construct confidence and prediction intervals. The book links the mathematical aspects of the construction of wavelet network to modeling and forecasting applications in finance, chaos, and classification. Wavelet networks can constitute a valuable tool in financial engineering since they make no a priori assumptions about the nature of the dynamics

that govern financial time series. Although we employ wavelet networks primarily in financial applications, it is clear that they can be utilized in modeling any nonlinear function. Hence, researchers can apply wavelet networks in any discipline to model any nonlinear problem.

Our goal has been to make the material accessible and readable without excessive mathematical requirements: for example, at the level of advanced M.B.A. or Ph.D. students. There is an introduction or tutorial to acquaint nonstatisticians with the basic principles of wavelet analysis, and a similar but more extensive introduction to neural networks for noncomputer scientists: first introducing them as regression models and gradually building up to more complex frameworks.

Familiarity with wavelet analysis, neural wavelets, or wavelet networks will help, but it is not a prerequisite. The book will take the reader to the level where he or she is expected to be able to utilize the proposed methodologies in applying wavelet networks to model various applications.

The book is meant to be used by a wide range of practitioners:

- By quantitative and technical analysts in investment institutions such as banks, insurance companies, securities houses, companies with intensive international activities, and financial consultancy firms, as well as fund managers and institutional investors.
- By those in such fields as engineering, chemistry, and biomedicine.
- By students in advanced postgraduate programs in finance, M.B.A., and mathematical modeling courses, as well as in computational economics, informatics, decision science, finance, artificial intelligence, and computational finance. It is anticipated that a considerable segment of the readership will originate from within the neural network application community as well as from students in the mathematical, physical, and engineering sciences seeking employment in the mathematical modeling services.
- By researchers in identification and modeling for complex nonlinear systems, wavelet neural networks, artificial intelligence, mathematical modeling, and relevant Ph.D. programs.

Supplementary material for this book may be found by entering ISBN 9781118592526 at booksupport.wiley.com.

During the preparation of the book, the help of my (A.K.A.) wife, Christina Ioannidou, was significant, and we would like to thank her for her careful reading of the manuscript.

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