Complex and Chaotic Systems: Introduction to the Track

Suleiman K. Kassicieh
Department of Finance, International and Technology Management,
University of New Mexico, Albuquerque, NM 87131-1221
e-mail: kasicieh@unm.edu.
Thomas L. Paez
Experimental Structural Dynamics Department
Sandia National Laboratories, Albuquerque, NM 87185-0577
e-mail:tlpaez@sandia.gov.
Gautam Vora
Department of Finance, International and Technology Management
University of New Mexico, Albuquerque, NM 87131-1221
e-mail: vora@unm.edu.

The world in which we live has a large number of complex and chaotic systems. A number of research streams have been examining models that describe these systems. Predicting future behavior of these systems has been a central concern and is related to the effectiveness of the modelers in identifying the correct system's description and parameters. Several interesting models that use neural networks, genetic algorithms, simulated annealing, among many others have been used to describe these systems in the literature but the field is still at a very early developmental stage.

The minitrack focuses on models that characterize complex and chaotic systems. The minitrack encompasses both theoretical and applied models describing these systems as well as techniques such as artificial neural nets, genetic algorithms, fractals, and other models. Theoretical developments, empirical applications, and experimental designs of physical or economic systems are included.

The topics that the minitrack addresses include modeling of complex and chaotic (C&C) systems, characterization of the behavior of C&C systems, prediction of complex and chaotic systems, optimization of C&C models, optimization of model form, modeling C&C with artificial neural networks, optimization of C&C with genetic algorithms, global optimization approaches and decomposition of complex processes.

This is the first year of the track which includes ten excellent papers. The first session includes papers by Natter; Kappert and Omta; Nuansri, Dillon and Singh; and Kassicieh, Paez and Vora. Natter's "Conditional Market Segmentation by Neural Networks: A Monte Carlo Study" proposes to use market data to simultaneously perform both market segmentation and discriminant analysis. His modeling tool is the artificial neural network, which he trains through back propagation. He shows via a sequence of Monte Carlo studies that simultaneous analysis (as opposed to sequential analysis) yields a more accurate global model, though its training is more computer intensive. The second paper is by Kappert and Omta and is entitled " Neural Network and Business Modeling - An application of Neural Modeling Techniques to Prospect Profiling in the Telecommunications Industry". In the paper, the authors propose a data mining solution to the information overload faced by businesses in a world that has seen many changes in competition, market parameters and technological innovations. The paper describes the use of neural networks to discriminate between customers with a positive attitude and customers with a negative attitude towards a new product. The third paper by Nuansri, Dillon and Singh with the title " An application of Neural Networks and Rule-Based System for Network Management: Application Level Problems" proposes a system to monitor and diagnose problems that occur at the application level in networks. The paper describes a system used to resolve problems in the Domain Name Server by combining an expert system with a neural network. Results from the test bed are still preliminary. The fourth paper by Kassicieh, Paez and Vora is entitled "Investment Decisions Using Genetic Algorithms". The authors describe the importance of switching decisions in financial markets and provide a

Proceedings of The Thirtieth Annual Hawwaii International Conference on System Sciences ISBN 0-8186-7862-3/97 $17.00 © 1997 IEEE

method using a genetic algorithm to provide a decision on switching between the stock market and treasury bills. Data is used to calculate the accumulated wealth that is contrasted to the optimal perfect foresight strategy.

The second session has three papers. The first is by Hunter and is entitled "A nonlinear transformation of multivariate time series to a minimal series of basis waveforms". In this paper, the author has developed a technique for the analysis of nonlinear (and perhaps chaotic) systems based on data measured from the system. The model he proposes is "local linear." At each time step, it searches through training time histories to find the segments most similar to the immediate past, and uses these to create a local linear model - in this case, a canonical variate analysis model. It then uses this model to predict response one step into the future. Examples involving chaotic and non-chaotic are given. The second is by Benjamin, Altman, O'Gorman, Rodeman and Paez. In the "Use of Artificial Neural Networks for Engineering Analysis of Complex Physical Systems", the authors discuss engineering simulation with artificial neural networks, in general, and introduce the connectionist normalized linear spline network, a generalized radial basis function-type network. They investigate the accuracy of simulation of complex systems. They also discuss autoregressive applications, and make some suggestions regarding the decomposition of system behaviors into components that are simple and easier to model. Numerical examples are presented. The third is by Barney, Ferregut, Hunter and Paez with the title "Statistical Validation of System Models". The authors propose a technique for the statistical validation of mathematical models of system behavior. The validation approach assumes that the output (and perhaps input) of a system has been measured. It uses the bootstrap to statistically assess the measured system behavior, makes a hypothesis about the model, analyzes the model, then uses all the information reject or accept the mathematical model as representative of the actual system. A numerical example based on a physical experiment is presented.

The third session has three papers. The first by Kiang, Goul, Kulkarni and Philippakis is entitled "Improving the Effectiveness of Self-Organizing Map Networks Using a Circular Kohonen Layer". In the paper, the authors seek to overcome a weakness in self-organizing map (Kohonen) neural networks - the "boundary effect" wherein nodes near the edges of a network exercise insufficient influence on their nearby neighbors. They overcome this weakness by developing a circular training algorithm. The algorithm wraps the Kohonen layer around itself to create a continuous layer, and increase the number of neighbors for each boundary element. A numerical example is presented. The second is by Drossu and Obradovic. In the "Regime Signaling Techniques for Non-stationary Time series forecasting", the authors consider the problem of artificial neural network model switching in nonstationary, random environments. They consider three actions to execute when signaled by the switching algorithm - switch models, reuse a successful model, or retrain a model. They compare two signaling algorithms, namely, statistics-based and accuracy-based signaling. A numerical example indicates that the accuracy-based switching algorithm yields superior results. The third paper is by Bhargava and Jacobson and is entitled " Genetic Storms: Investigating the Gulf War Syndrome". The authors use a large volume of medical data obtained from the Gulf War veterans and use a genetic algorithm to search for attributes to decide whether a "syndrome" exists or not. Results show that there are many symptoms and diagnoses that merit further medical testing.

The track promises to be an exciting and interesting forum for researchers in many application areas using a multitude of techniques. It is an excellent start to a track that will surely grow and prosper due to the brilliant ideas included in the papers.

Proceedings of The Thirtieth Annual Hawwaii International Conference on System Sciences ISBN 0-8186-7862-3/97 $17.00 © 1997 IEEE