Two Special Course Sequences From
THE ELECTRIC POWER PROGRAM SERIES

Advances in Design of
Modern Power Utility
Control Centers
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Advanced Application
Functions for Modern
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Expert System
Applications to
Power Systems
September 7 - 9, 1992

Artificial Neural
Networks in Electric
Power Systems
September 9 - 11, 1992

Presented By

DECISION SYSTEMS INTERNATIONAL
Atlanta, Georgia, USA

Instituto de Investigacion Technologica
Madrid, Spain
Artificial Neural Networks in Electric Power Systems
September 9 - 11, 1992

SPEAKERS
Mohamed A. El-Sharkawi (Course Director), University of Washington, USA
Robert J. Marks II, University of Washington, USA

COURSE OBJECTIVES
- To provide an intelligible introduction to the theory, application, and implementation of artificial neural networks.
- To provide a working knowledge of artificial neural networks through software emulation.
- To present and evaluate several proven applications of artificial neural networks to power systems engineering.

WHO SHOULD PARTICIPATE
- Power utilities management and engineers involved in power system planning and operation interested in ANNs and other artificial intelligence techniques in critical applications.
- Consultants and/or software developers involved in applications software for power systems.
- University faculties and advanced students interested in research and/or the development of ANN.

DESCRIPTION
The purpose of this course is to provide an introduction of Artificial Neural Network technology to power systems engineers. The course is composed of two main sections. The first section deals with the analysis of Neural Network architectures, training algorithms and performance evaluation for several types of networks that are suitable for power system applications. The second section deals with specific applications to power system problems described as detection, classification, generalization, regression, and combinatorial optimization.

HANSD-ON
This course will emphasize hands-on experience. The engineers attending this course will have a chance to develop ANN structures and articulate training algorithms. Case studies will be developed and evaluated by the attendee.

COURSE CONTENTS
Introduction to NNs
- History of Neural Networks
  - The Early Days
  - Biological Motivation
  - McCulloch Pitts
  - Mach and Lateral Inhibition
  - Rosenblatt, Widrow, Minsky Paper
- Since 1982
- Neural Network Types
  - Layered Perceptron
  - Hopfield Networks
  - Kohonen Nets
  - Other
  - Bidirectional Memories
  - Alternating Projection NNs
- The Layered Perceptron
  - Rosenblatt’s Perceptrons
  - Concept of Training
  - Memorization vs. Learning (Architecture)
  - Learning Algorithms
    - Steepest Descent and Least Squares Methods
    - Back Error Propagation
    - Conjugate Gradient Descent
    - Random Search
    - Adaptive Learning
    - Genetic Algorithms
  - Problems with the Layered Perceptron
  - Software Emulation
Hopfield NNs
- Combinatorial Search
  - Lateral Inhibition
  - The Eight Queens Problem
  - The Travelling Salesman Problem
  - Animations

Features Extractions
- What is Features Extractions?
- Advantages of Features Extractions
- Feature Selections
- Karhonen Loe’v Extraction
- Comparative Study with and without Features Extractions

Neural Network Implementation
- Emulators
- Analog Electronic
- Digital
- Optronic

Applications to Selected Power System Problems
- Classification
  - Dynamic Security Assessment
  - Static Security Assessment
  - Harmonic Prediction and Evaluation
- Alarm Processing
- Regression
  - Electric Load Forecasting
  - Transient Stability
  - Adaptive Control
- Combinatorial Optimization
  - Capacitor Placement
  - Power Network Observability
  - Unit Commitment
- Challenges of Power System Implementations
  - Scalability
  - Learning vs. Memorization
  - Convergence

Case Studies
- Development of NN for Load Forecasting
- Development of NN for Security Assessment
Mohamed A. El-Sharkawi
Dr. El-Sharkawi is a pioneer in the area of applications of Artificial Neural Networks to Power Systems. Since 1980, he has been a Professor in the Department of Electrical Engineering at the University of Washington. Dr. El-Sharkawi is the Chairman of the IEEE Power Engineering Society task force on "Applications of Neural Networks to Power Systems." He organized and chaired special sessions and panel discussions on the subject in various IEEE conferences. He was the organizer and general chairman of the first conference on "Applications of NI to Power Systems" held in Seattle in July 1991. Dr. El-Sharkawi is an Associate Editor of the IEEE Transactions on Neural Networks. He is a member of the Administrative Committee of the IEEE Council on Neural Networks. He is the chairman of the Video Tutorial committee of the IEEE Neural Networks Council. Professor El-Sharkawi has published numerous papers in the area of neural networks applications to power systems, power system dynamics, power electronics, and electric drives and high performance tracking and control.

Robert J. Marks II
Dr. Marks is a former international authority on Artificial Neural Networks. He is currently a Professor in the Department of Electrical Engineering at the University of Washington, Seattle. He was the Chair of IEEE Neural Networks Committee and was the co-founder and first Chair of the IEEE Circuits & Systems Society Technical Committee on Neural Networks & Applications. Professor Marks was also elected the first President of the IEEE Council on Neural Networks. He is a Fellow of the Optical Society of America and a Senior Member of IEEE. He is co-founder and current President of Multidimensional Systems Corporation. Professor Marks is the Editor-in-Chief of the IEEE Transactions on Neural Networks. He is a former topical editor for Optimal Control for the Journal of the Optical Society of America. He is also a former member of the Editorial Board for The International Journal of Neural Computation. He has published over one hundred journal and proceeding papers in the areas of signal analysis, detection theory, signal recovery, optical computing, signal processing, and artificial neural processing. Dr. Marks has two U.S. patents in the field of artificial neural networks.

Expert Systems

Juan J. Alba
Mr. Alba, from the IIT research staff, has been working in knowledge engineering applications in industry for seven years. He is currently responsible for the knowledge engineering group at IIT. He has been the leader or a participant in projects including applications of knowledge engineering in switching sequences planning in power systems, power systems security analysis, nuclear power plants operation, electronic circuits troubleshooting, space systems design, office buildings risk management, etc. His areas of interest and activity also include machine learning, neural networks, qualitative reasoning and computer communications and networking.

Arnaud Hertz
Dr. Hertz (Member, IEEE) received a civil engineering degree from the Ecole Nationale des Ponts et Chaussées (computer science option), and a Ph.D. degree in Artificial Intelligence from the University of Paris VI, in 1975. He joined the R&D division of ELECTRICITE DE FRANCE as a research engineer in 1976. He has developed operational-research software for the planning of electrical networks. Since 1987, he has directed a team of twelve engineers and researchers dealing with the application of Artificial Intelligence techniques and new algorithmic methods to power systems. He is also involved in "software engineering for power systems. He has published various papers on the above subjects. Dr. Hertz is a member of the AFCET scientific association and a member of the CIGRE Group 38-08.

Miguel-Angel Sanz-Bobi
Mr. Sanz-Bobi, from the IIT research staff, has been working in knowledge engineering applications in power plants for six years. He was the project leader in the development of SEQA (Water Chemistry Expert System) among the first expert systems to be fully operational in a power plant, in 1969. He has also been a research engineer in power plants, for operation of nuclear power plants, etc. His areas of parallel and current activity also include artificial neural networks applications, reliability of power plants, databases and Iber optics.