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J. Mira J. Cabestany A. Prieto (Eds.)

New Trends in Neural Computation

International Workshop on Artificial Neural Networks, IWANN '93
Sitges, Spain, June 1993
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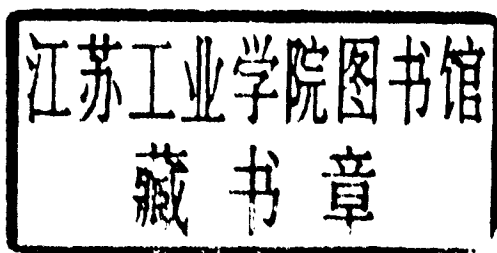
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Preface

Neural computation arises from the capacity of nervous tissue to process information and accumulate knowledge in an intelligent manner. Perception, learning, associative memory, self-organization, fault tolerance and self-repair, planning, reasoning and creativity are basic properties of biological systems computed by the neural tissue. By way of contrast, computational machines with von Neumann architecture and conventional external programming, including knowledge based systems, have encountered enormous difficulties in duplicating these functionalities.

In an effort to escape this impasse, the scientific community has turned its attention to the anatomy and physiology of neural networks and the structural and organizational principles at the root of living systems. This has given rise to the development of the field of Artificial Neural Networks (ANN), where computation is distributed over a great number of local processing elements with a high degree of connectivity and in which external programming is replaced with supervised and non-supervised learning.

The papers presented here are carefully reviewed versions of the talks delivered at the International Workshop on Artificial Neural Networks (IWANN '93) organized by Universities of Cataluña (Politécnica, Autónoma and of Barcelona) and the Spanish Open University at Madrid (UNED) and held in Sitges (Barcelona), Spain, from 9 to 11 June, 1993. More than 160 papers were submitted, of which 111 were accepted for oral presentation and are included in these proceedings. Extended papers originated from invited talks related to the main topics considered are also included as introductions to the corresponding sections.

This workshop has been organized in cooperation with the Spanish RIG of the IEEE Neural Networks Society, and the IFIP WG 10.6, and has been sponsored by the Spanish CICYT, the Catalan CIRIT, and the organizing universities.

Collaboration of the Spanish chapter of the IEEE Computer Society, the UR&RI Communication chapter of IEEE, and the AEIA (Spanish Association for Computing and Automation) has been obtained.

We would like to thank all the authors as well as all the members of the International Program Committee for their labour in the production, evaluation and refinement of the papers. Furthermore, the editors would like to thank Springer-Verlag, in particular Alfred Hofmann, for excellent cooperation.

The papers published in this volume present the current state in neural computation and are organized in seven sections:

- Biological perspectives,
- Mathematical models,
- Learning,
- Self-organizing networks,
- Neural software,

- Hardware implementation,
- Applications:
 - Signal processing and pattern recognition,
 - Communications,
 - Artificial vision,
 - Control and robotics,
 - Other applications).

We begin with biological perspectives, including studies of the anatomical and physiological roots of neural computation. The biophysical level is enhanced and some claims on more realistic models of natural computation are included.

Thus far we have examined biology. Now we turn our attention to the world of mathematical models and organizational principles. A strong theoretical perspective is needed to seek organizational knowledge that will enable us to reproduce through synthesis some of the properties observable in living beings. Self-organization, continuous learning, and genetic algorithms are the topics more frequently addressed.

Learning is the key to neural computation. If we say that learning (self-programming) should substitute external programming, we must develop algorithms and methods of local learning comparable in clarity, completeness, and efficiency to those in conventional computation. It is true that local training requires more complex connections and redundant computations, but it simplifies the global design, includes intrinsic parallelism, and goes closer to biology. As long as the learning algorithms are executed in a general purpose computer separated from the network we are far from biology.

The next step in the proceedings is related to the development of neural software (languages, tools, simulations and benchmarks) and hardware implementations. Programming environments are usually classified as application-oriented, algorithm-oriented, and general programming systems. The simulation of neural networks in conventional computers can only be considered as a first step in the training and evaluation of models, architectures, and algorithms on the pathway towards intrinsically parallel hardware implementations.

The implementation of neural networks depends directly on which neural model and learning algorithm we seek to implement. In other words, it is necessary to distinguish between (a) what we want to implement and (b) how we do it. Once we have agreed on which computational model and what degree of autonomy we want to implement, the next step is how to do it. In all the cases the implementation can be analog, digital, or hybrid and is within a concrete technology (electronic or optical). There are two options, which we could call the simple model and the complex model.

In the first case, it is accepted that there is little autonomy. If the second option (complex model) is selected, we are forced to think in terms of neurocomputers, specifically designed for the implementation of neural networks with local computation, structural and functional parameters adjustment, and several modes of functioning (initialization, training/learning and use). Between this level (nothing in

the host, all in the network) and the software simulations in conventional computers previously mentioned (nothing in the network, all in the host) there should be an ample range of intermediate situations (specific and general purpose neurocomputers) so that the closer we come to “all in the network”, the closer we will be to the biological computation from which we drew inspiration.

The last part in the proceedings is related to applications. The basic question here is: what type of applications possess the computational requirements for the solution of which it would be advisable to use neural networks? Not all functions are capable of being distributed.

The majority of application tasks in neural computation can be formulated as multilayer classification functions in which a set of input configurations $X = \{ X_m \}$ associates itself to a set of classes $Y = \{ Y_n \}$ after supervised or unsupervised learning. Signal and image processing and pattern recognition are the known examples in this line. Artificial vision, adaptive control, systems identification, and sensory-motor control loops are also adequate tasks to be solved using neural nets.

The most serious computational problem in the field of artificial neural nets (ANN) is the lack of theory, with direct and inverse constructive theorems. Given a specific computational family, which would be the map of individual functions and learning algorithms such that – when they operate linked by the data – they synthesize the global function)? Conversely, given a net of thousand of individual processors with local learning, which would be the global computation that emerges as a results of the cooperative integration of these local computations? It is clear that an enormous amount of work still remains to be done in neural computation, and this is a challenge for all of us.

Madrid, April 1993

J. Mira
J. Cabestany
A. Prieto

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Contents

1. Biological Perspectives

Biophysics of Neural Computation (Invited Paper) <i>K.N. Leibovic</i>	1
Integrated Learning in Rana Computatrix <i>F.J. Corbacho and M.A. Arbib</i>	12
A Model for Centering Visual Stimuli Through Adaptive Value Learning <i>A. Murciano, J. Zamora and M. Reviriego</i>	20
A Model for the Development of Neurons Selective to Visual Stimulus Size <i>M.A. Andrade and F. Morán</i>	24
An Invariant Representation Mechanism After Presynaptic Inhibition <i>R. Moreno-Díaz Jr. and O. Bolívar Toledo</i>	30
The Pancreatic B-Cell as a Voltage-Controlled Oscillator <i>J.V. Sánchez-Andrés and B. Soria</i>	37
Approximation of the Solution of the Dendritic Cable Equation by a Small Series of Coupled Differential Equations <i>J. Hoekstra</i>	43
A Neural Network Model Inspired in Global Appreciations About the Thalamic Reticular Nucleus and Cerebral Cortex Connectivity <i>J. Ropero Peláez</i>	49
Towards More Realistic Self Contained Models of Neurons: High-Order, Recurrence and Local Learning <i>J. Mira, A.E. Delgado, J.R. Alvarez, A.P. de Madrid and M. Santos</i>	55
McCulloch's Neurons Revisited <i>R.J. Scott</i>	63
Biologically Motivated Approach to Face Recognition <i>N. Petkov, P. Krüzinga and T. Lourens</i>	68
Learning by Reinforcement: A Psychobiological Model <i>F.J. Vico, F. Sandoval and J. Almaraz</i>	78
A Neural State Machine for Iconic Language Representation <i>I. Aleksander and H. Morton</i>	84

Variable Binding Using Serial Order in Recurrent Neural Networks <i>J. Lòpez-Moliner and J.M. Sopena</i>	90
2. Mathematical Models	
Region of Influence (ROI) Networks. Model and Implementation <i>F. Castillo, J. Cabestany and J.M. Moreno</i>	96
A Node Splitting Algorithm that Reduces the Number of Connections in a Hamming Distance Classifying Network <i>H. Hüning</i>	102
A High Order Neural Model <i>F.J. Lopez Aligué, M.I. Acevedo Sotoca and M.A. Jaramillo Moran</i>	108
Higher-Order Networks for the Optimization of Block Designs <i>P. Bofill and C. Torras</i>	114
Neural Bayesian Classifier <i>C. Jutten and P. Comon</i>	119
Constructive Methods for a New Classifier Based on a Radial-Basis-Function Neural Network Accelerated by a Tree <i>P. Gentic and H.C.A.M. Withagen</i>	125
Practical Realization of a Radial Basis Function Network for Handwritten Digit Recognition <i>B. Lemarié</i>	131
Design of Fully and Partially Connected Random Neural Networks for Pattern Completion <i>C. Hubert</i>	137
Representation and Recognition of Regular Grammars by Means of Second-Order Recurrent Neural Networks <i>R. Alquézar and A. Sanfeliu</i>	143
Connectionist Models for Syllabic Recognition in the Time Domain <i>J. Santos and R.P. Otero</i>	149
Sparsely Interconnected Artificial Neural Networks for Associative Memories <i>D. Liu and A.N. Michel</i>	155
Dynamic Analysis of Networks of Neural Oscillators <i>A. Arenas and C.J. Pérez Vicente</i>	161

Optimised Attractor Neural Networks with External Inputs <i>A.N. Burkitt</i>	167
Non-Orthogonal Bases and Metric Tensors: An Application to Artificial Neural Networks <i>K. Weigl and M. Berthod</i>	173
✓ Genetic Synthesis of Discrete-Time Recurrent Neural Network <i>F.J. Marín and F. Sandoval</i>	179
✓ Optimization of a Competitive Learning Neural Network by Genetic Algorithms <i>J.J. Merelo, M. Patón, A. Cañas, A. Prieto and F. Morán</i>	185
Adaptive Models in Neural Networks <i>P.A. Ligomenides</i>	193
3. Learning	
Self-Organizing Grammar Induction Using a Neural Network Model <i>C. Mannes</i>	198
The Role of Forgetting in Efficient Learning Strategies for Self-Organising Discriminator-Based Systems <i>G. Tambouratzis and T.J. Stotham</i>	204
Simulation of Stochastic Regular Grammars Through Simple Recurrent Networks <i>M.A. Castaño, F. Casacuberta and E. Vidal</i>	210
Local Stochastic Competition and Vector Quantization <i>M. Graña, A. D'Anjou, F.X. Albizuri, F.J. Torrealdea and M.C. Hernandez</i>	216
MHC - An Evolutionary Connectionist Model for Hybrid Training <i>J.M. Ramírez</i>	223
Fast-Convergence Learning Algorithms for Multi-Level and Binary Neurons and Solution of Some Image Processing Problems <i>N.N. Aizenberg and I.N. Aizenberg</i>	230
Invariant Object Recognition Using Fahlman and Lebiere's Learning Algorithm <i>K. Ito, M. Hamamoto, J. Kamruzzaman and Y. Kumagai</i>	237
Realization of Surjective Correspondence in Artificial Neural Network Trained by Fahlman and Lebiere's Learning Algorithm <i>M. Hamamoto, K. Ito, J. Kamruzzaman and Y. Kumagai</i>	243

Bimodal Distribution Removal <i>P. Slade and T.D. Gedeon</i>	249
A Simplified Artmap Architecture for Real-Time Learning <i>A. Guazzelli, D. Barone and E.C. de B. Carvalho Filho</i>	255
B-Learning: A Reinforcement Learning Algorithm, Comparison with Dynamic Programming <i>T. Langlois and S. Canu</i>	261
Increased Complexity Training <i>I. Cloete and J. Ludik</i>	267
Optimized Learning for Improving the Evolution of Piecewise Linear Separation Incremental Algorithms <i>J.M. Moreno, F. Castillo and J. Cabestany</i>	272
A Method of Pruning Layered Feed-Forward Neural Networks <i>M. Pelillo and A.M. Fanelli</i>	278
Tests of Different Regularization Terms in Small Networks <i>J.L. Crespo and E. Mora</i>	284
4. Self Organizing Networks and Vector Quantizer	
On the Distribution of Feature Space in Self-Organising Mapping and Convergence Accelerating by a Kalman Algorithm <i>H. Yin and N.M. Allinson</i>	291
A Learning Algorithm to Obtain Self-Organizing Maps Using Fixed Neighbourhood Kohonen Networks <i>P. Martin-Smith, F.J. Pelayo, A. Diaz, J. Ortega, and A. Prieto</i>	297
Analysing a Contingency Table with Kohonen Maps: A Factorial Correspondence Analysis <i>M. Cottrell, P. Letremy and E. Roy</i>	305
Dynamics of Self-Organized Feature Mapping <i>R. Der and T. Villmann</i>	312
Comparative Study of Self-Organizing Neural Networks <i>C.-D. Wann and S.C.A. Thomopoulos</i>	316
✓ GANNet: A Genetic Algorithm for Optimizing Topology and Weights in Neural Network Design <i>D. White and P. Ligomenides</i>	322

Vector Quantization and Projection Neural Network <i>P. Demartines and J. Héroult</i>	328
Constructive Design of LVQ and DSM Classifiers <i>J.-C. Perez and E. Vidal</i>	334
Linear Vector Classification: An Improvement on LVQ Algorithms to Create Classes of Patterns <i>M. Verleysen, P. Thissen and J.-D. Legat</i>	340
Non-Greedy Adaptive Vector Quantizers <i>Z. Wang</i>	346
5. Neural Software	
Hybrid Programming Environments (Invited Paper) <i>P.C. Treleaven and P.V. Rocha</i>	351
Automatic Generation of C++ Code for Neural Network Simulation <i>S. Dreiseitl and D. Wang</i>	358
URANO: An Object-Oriented Artificial Neural Network Simulation Tool <i>L. Fuentes, J.F. Aldana and J.M. Troya</i>	364
Realistic Simulation Tool for Early Visual Processing Including Space, Time and Colour Data <i>W. Beaudot, P. Palagi and J. Héroult</i>	370
Language Supported Storage and Reuse of Persistent Neural Network Objects <i>C. Burdorf</i>	376
Flexible Operating Environment for Matrix Based Neurocomputers <i>J.C. Taylor, M.L. Recce and A.S. Mangat</i>	382
A Parallel Implementation of Kohonen's Self-Organizing Maps on the Smart Neurocomputer <i>E. Filippi and J.C. Lawson</i>	388
Simulation of Neural Networks in a Distributed Computing Environment Using NeuroGraph <i>P. Wilke</i>	394
Full Automatic ANN Design: A Genetic Approach <i>E. Alba, J.F. Aldana and J.M. Troya</i>	399

6. Hardware Implementation

Hardware Implementations of Artificial Neural Networks (Invited Paper) <i>D. Del Corso</i>	405
A Neural Network Chip Using CPWM Modulation <i>M. Chiaberge, D. Del Corso, F. Gregoretti and L.M. Reyneri</i>	420
Hardware Implementation of a Neural Network for High Energy Physics Application <i>J. Carrabina, F. Lisa, V. Gaitan, L. Garrido and E. Valderrama</i>	426
MapA: An Array Processor Architecture for Neural Networks <i>J. Ortega, F.J. Pelayo, A. Prieto, B. Pino and C.G. Puntonet</i>	432
Limitation of Connectionism in MLP <i>C.V. Regueiro, S. Barro and A. Yáñez</i>	441
High Level Synthesis of Neural Network Chips <i>M.E. Nigri and P.C. Treleaven</i>	448
Neural Network Simulations on Massively Parallel Computers: Applications in Chemical Physics <i>B.G. Sumpter, R.E. Guenther, C. Halloy, C. Getino and D.W. Noid</i>	454
A Model Based Approach to the Performance Analysis of Multi-Layer Networks Realised in Linear Systolic Arrays <i>D. Naylor and S. Jones</i>	459
The Temporal Noisy-Leaky Integrator Neuron with Additional Inhibitory Inputs <i>C. Christodoulou, G. Bugmann, T.G. Clarkson and J.G. Taylor</i>	465
Architectures for Self-Learning Neural Network Modules <i>T.G. Clarkson and C.K. NG</i>	471
The Generic Neuron Architectural Framework for the Automatic Generation of ASICs <i>M.M.B.R. Vellasco and P.C. Treleaven</i>	476
A Risc Architecture to Support Neural Net Simulation <i>M. Pacheco and P.C. Treleaven</i>	482
Hardware Design for Self-Organizing Feature Maps with Binary Input Vectors <i>S. Rüping, U. Rückert and K. Goser</i>	488

7. Applications

7.1. Pattern Recognition and Signal Processing

The Kolmogorov Signal Processor (Invited Paper) <i>M.A. Lagunas, A. Pérez-Neira, M. Nájar and A. Pagés</i>	494
Projectivity Invariant Pattern Recognition with High-Order Neural Networks <i>G. Joya and F. Sandoval</i>	513
Rejection of Incorrect Answers from a Neural Net Classifier <i>F.J. Smieja</i>	519
Nonlinear Time Series Modeling by Competitive Segmentation of State Space <i>C.J. Pantaleón-Prieto and A.R. Figueiras-Vidal</i>	525
✓ Identification and Prediction of Non-Linear Models with Recurrent Neural Network <i>O. Adam, J.-L. Zarader and M. Milgram</i>	531
Use of Unsupervised Neural Networks for Classification of Blood Pressure Time Series <i>M.J. Rodríguez, F. del Pozo and M.T. Arredondo</i>	536
Application of Artificial Neural Networks to Chest Image Classification <i>J.J. Fernandez-Rodriguez, A. Cañas, E. Roca, F.J. Pelayo, J. Fernandez-Mena and A. Prieto</i>	542
Combination of Self-Organizing Maps and Multilayer Perceptrons for Speaker Independent Isolated Word Recognition <i>J. Tuya, E. Arias, L. Sánchez and J.A. Corrales</i>	550
An Industrial Application of Neural Networks to Natural Textures Classification <i>G. Yahiaoui and B. Borocco</i>	556
Use of a Layered Neural Nets as a Display Method for N-Dimensional Distributions <i>L. Garrido, V. Gaitan, M. Serra-Ricart and X. Calbet</i>	563
MLP Modular Versus YPREL Classifiers <i>Y. Lecourtier, B. Dorizzi, P. Sebire and A. Ennaji</i>	569
How Many Hidden Neurons are Needed to Recognize a Symmetrical Pattern? <i>J. Patinel, G. Leone and M. Milgram</i>	575