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Takeshi Yamakawa
Gen Matsumoto

IIZUKA'96

Proceedings of the 4th International Conference on Soft Computing

Vol. 2

Methodologies for the Conception, Design, and Application of Intelligent Systems

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International Fuzzy Systems Asscociation (IFSA)

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IIZUKA'96

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of the 4th
International
Conference on
Soft Computing
Vol. 2

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ABOUT THE CONFERENCE SYMBOL

Objects and concepts change their shapes and aspects in accordance with viewpoints. The most significant interest of computer scientists lies on the human brain. A human brain is dissected to be examined and analyzed by neurophysiologists, physicists, mathematicians and engineers. One of the viewpoints is that the brain is seen namely through the glasses of weighting and "sigmoidal thresholding" (the right wall of the symbol) as a massively parallel signal processor. From another viewpoint, the brain is seen as a nonlinear dynamical system typically discussed in terms of a "logistic map"(the left wall of the symbol) and also "evolutions" (over view of the symbol). Other researchers describe and estimate a conceptual behavior of a human brain with if-then rules including fuzzy linguistic terms. These terms are characterized by "membership functions", the typical shape of which can be found out on two walls of the symbol. By turning the viewpoints and harmonizing the scenery, we may look through the scenery at a post-digital human friendly computer.

Takeshi Yamakawa, Ph.D.

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A Message from the Honorary Chairman

Prof. Walter J. Freeman
University of California, Berkeley

The organizers of this Conference extend a cordial welcome to worldwide participants in our continuing efforts to bring machine intelligence to its full potential in the service of mankind. The break-throughs in programmable computers 50 years ago totally transformed our societies in ways that were not foreseen at that time. By separating the concept of information from the concept of meaning, Shannon and Weaver enabled our predecessors to expand and elaborate our capacities to accumulate and analyze immense data bases rapidly and efficiently, to spread the results to workers in all parts of the globe via Internet, and to support interactive communication to achieve flexibility and cooperation in applications of the data.

Now we work at the threshold of a second revolution, which will have effects on our societies of even greater magnitude. Like primitive mammals among the dinosaurs we have seen in the past decade the developing algorithmic systems based equally in digital technology and in the new understanding of brain function, which is steadily growing in the neurosciences. Fuzzy logic and neural networks have already become established as secure disciplines having important practical applications in a wide range of industrial, commercial, and economic activities, because they incorporate into rigid digitally based programs the flexibility of judgement and response, the immediate access to extensive data bases, and the capacities to learn and adapt that characterize human thinking.

The next steps will incorporate more fully the emerging disciplines of contemporary studies of brain function, particularly nonlinear neurodynamics, which goes beyond transistor-like neurons and describes in mathematical form the operations of great populations of interactive neurons. Emphasis in these studies is placed on the capabilities of neural populations for self-organization, by which they create endogenous patterns of activity through sequential state transitions. Each state is characterized as having a transitory attractor and a surrounding basin, at the edge of which critical instability occurs, leading to a new state. The activity by itself changes the synaptic web and thereby alters the new states, so that each brain continuously evolves along its individual trajectory into the future. The sensory input that is constantly sought by brains shapes these alterations and new states, enabling brains to comprehend the environment by changing themselves through learning. Even more importantly, brains, by their motor actions, alter the environment to correspond to their needs and creative visions.

Our mathematical descriptions of these operations give us the opportunity to build new machines which have these properties and thereby to create fully competent forms of artificial intelligence. We have a long road to follow before we can reach that goal, which is why we are assembling in this Conference to communicate, challenge each other's ideas, and plan new tasks. One intermediate goal will be to simulate the operations of the vertebrate sensory cortices, thereby to give our digital machines the eyes and ears that they will need to interface effectively with the infinitely complex environment that we all share. This cannot be done with the finite stores of representations, which constitute the backbone of current AI. It must be done with nonrepresentational dynamics, through which new

Greetings from the Organizing Committee Chairman

Prof. Dr. Takeshi Yamakawa
Dean of Computer Science and Systems Engineering,
Kyushu Institute of Technology, Iizuka
also
Chairman of Fuzzy Logic Systems Institute (FLSI)

On behalf of the Organizing Committee of the 4th International Conference on Soft Computing (IIZUKA'96), I would like to welcome you to this conference.

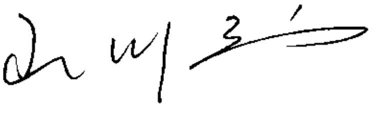
The intelligent systems behaves so that the users may desire. The first generation of intelligence was based on the program. The more complicated the system becomes to be, the longer program it needs, which may not be designed logically in some cases. The more number of intelligent machines becomes to be, the more the programs should be developed. This aspect leads our computer society to the so called software crises. To cope with this problem, system establishment without program should be achieved. By the bio-mimetic approach, we are establishing the design methodology, in which we have only to present training data to the system, otherwise we have only to present what function it should possess finally. Thus the learning approach and GA approach provide us with the possibility of new system establishment which is too complicated to achieve, at the sacrifice of a long time elapsed.

The bio-mimetic approach will also implies us the ***consciousness*** which will enhance the effect of learning, recognition, data acquisition and other intelligent behaviors of the system. The new paradigm of intelligence in this conference is the effect of the consciousness on the intelligent behaviors. A hardware or a software system is a product created by human beings and it does not ordinarily give any feelings and spirit. In order to develop human friendly systems and establish a computer society for human beings, but not a human society for computers, research on ***emotion*** is very important. ***Consciousness and emotion*** are two paradigms of intelligence of this conference, which will be the key words to open the door to future computer science.

Scientific program aiming at this topics has been established by the supports and suggestions of members of the Organizing and Program Committees. Session organizers also contributed to this program arrangement. Paper reviewers worked so hard to select the excellent papers for proceedings. I would express my sincere thanks to all of these contributors.

Monbusho (The Ministry of Education, Science, Sports and Culture) provided us with significant financial support, encouraging our creation of new paradigm in computer science. I must especially acknowledge the financial support of Monbusho.

I would like to thank all the staffs in Fuzzy Logic Systems Institute (FLSI), especially Secretary General Mr. Goto, for their devotedly hard work. Finally, I want to thank my wife Tamae for her work as the Social Program Committee Chair and also my two sons Toshitaka and Tsuyoshi for understanding my important work as the Organizing Committee Chair of IIZUKA'96 during these two years.



Takeshi Yamakawa, Ph.D.
Organizing Committee Chairman

Preface by the Program Committee Chairman

Dr. Gen Matsumoto
Chief Scientist
Electrotechnical Laboratory, Tsukuba
Japan

Brain Computing

The brain is an automatic algorithm acquisition system. Acquired algorithm is represented both as configurational and as activity changes in the neuron networks. The organism has another automatic algorithm acquisition system, genetic information system, where the algorithm is expressed in terms of base sequence of DNA. The acquisition modes of algorithm in both systems differ from each other in its strategy and representation.

One of the essential strategies for the brain to acquire algorithms is learning. The brain acquires algorithms through learning, and represents them in the form of configurations and activities of the neural networks. New in-coming information is used as a sort of trigger for activating some of the existing neuronal circuits, which enables the brain to provide output in the form of behavior. Giving an output will exercise a learning effect, to rewrite the algorithm. That is to say, the brain compiles a conversion table in advance on the basis of learning, and the in-coming information allows to select one of pre-arranged responses, which has the highest correlation with itself as an output. Giving an output results in a learning effect, and permits to modify responses in the repertory in accordance with the effects of output.

Lets us examine the nature of learning, which is genetically provided as a brain strategy for acquiring algorithm. The learning effect is induced when a neuron or a neural network or a brain receives a "significant" stimulus. Here, the matter concerns what a significant stimulus is, and what a learning effect is. The learning effect may be defined as a factor to cause a change (reinforcement or attenuation) in the signal transmission efficiency between neurons, and the "significant" stimulus may be defined as an input information causing a neuron or a neural network or a brain launch an output.

A neuron checks the amount of synaptic memory at the input end in the moment an output is given out, and either reinforces or attenuates the coupling depending upon the memory amount. In this way, signals coming into a neuron in temporally separated manner are integrated when the neuron gives an output. The rule of time-sequence learning is dependent on the output, and creates an asymmetrically coupled neuron circuit. As the activity in the neural circuit induced in time sequence propagates unidirectionally, it seems that putting things in the temporary order is "brain-compatible" based on this principle. The rule of time-sequence learning is very interesting when considering how the brain perceives time. While a physical time span is the same for both the young and the aged, the quantity of information received by a young brain as "significant stimuli" is far greater than that received by an aged brain, inducing much more intensive learning effect and impressing much greater amount of relevant information in the brain. If an aged person feels that a year in the past was too short, it means that the amount of information of which correlation had been established through learning and which had been stored in the brain as memory of experience was very small. Living "rich" in time depends upon how far the learning effect has been enhanced through moving or impressive experience, and how much "engram" has been

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