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Aktuelne teme/
Current topics

INTERNATIONAL CONFERENCES ON NEURAL NETWORKS (NEURELs) IN SERBIA: A ROLE OF BIOMEDICAL ASPECTS IN NEUROCOMPUTING

INTERNACIONALNE KONFERENCIJE O NEURALNIM MREŽAMA (NEURELI) U SRBIJI: ULOGA BIOMEDICINSKOG ASPEKTA U NEURORAČUNARSTVU

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*Invited Paper

INTRODUCTION

Humans, particularly educated people, have been hardly interested to know and to investigate how human brain works. Different questions occupied humans, such as: How can we remember words, facts, faces, events and episodes? How are these events memorized in our brain? How can we recall memorized events? …

The study of the human brain dates back thousands of years. There are pieces of hard evidence that Ancient Egypt physicians (around 3000 B.C.) were able to set broken bones and studied brain structure (see, for instance, The Edwin Smith Surgical Papyrus, http://www.touregypt.net/edwinsmithsurgical.htm). Different "thinking machines", and human-like structures, such as animated statues, humanoid automatons (self-operating machines, later on called autonomous robots), were constructed and used for different religious and entertainment purposes through hundreds and thousands of years. But, all those structures have been only machines, performing predefined acts and working with very precise programs. When changing external conditions such machines were useless and even dangerous for their surroundings.

Although the end of the nineteenth century was hardly marked by enormous inventions in different fields, among others in medicine, particularly in psychology and physiology of the brain, and although many mechanisms in human nervous system were investigated, the modern era of neural network, or artificial intelligence, began in the mid of twentieth century, after 1943, when Warren S. McCulloch, a neurophysiologist, and young Walter Pitts, a student of mathematics, published their famous paper [1]. In this paper they established five postulates of the artificial neuron activities, which are valid even today, and showed that it was possible to construct a neural network using only formal mathematics and algorithms. By using their model of formal neuron, standard logical relations: AND, OR, NOT, and their combinations are possible to be realized.

The next major development in neural networks related to the training mechanism (only on a psychological level) arrived in 1949 with a book, "The Organization of Behavior" written by Donald Hebb [2], a Canadian psychologist. By following McCulloch-Pitts work, Hebb suggested how the brain can learn tasks. When two neurons, connected to each other, fire at the same time, their connection (synapse) is strengthened and thereby there is a greater possibility that the same two neurons will fire again. Hebb's book was used a lot by psychologists, but unfortunately it gained insufficient interest among engineers.

From that time, the research into artificial neural networks is growing up. In 1954 Marvin Minsky wrote a doctoral thesis [3] and in 1960 a scientific paper [4] which was one of the first papers to discuss artificial intelligence (AI) in detail.

The next hard acceleration of neural network research started after the Dartmouth Summer Research Conference on Artificial Intelligence, in 1956 (http://www-formal.stanford.edu/jmc/history/dartmouth/dartmouth.html), initiated by several scientists: John McCarthy, from Dartmouth College, Hanover, New Hampshire, Marvin Minsky (Harvard Junior Fellow), Claude Shannon (Bell Telephone Laboratories), and Nathaniel Rochester (IBM Corporation, Poughkeepsie, New York). In 1958 Frank Rosenblatt, a neurobiologist at Cornell University, began working on the new concept of neural networks, the so-called the Perceptron, inspired by the fly's eye [5]. The perceptron was the first

”practical” artificial neural network built using the somewhat primitive hardware, from nowadays point of view, but using the hardware available at the time. This network was capable of solving different classification problems.

Despite the efficiency of the perceptron, some drawbacks and limited capabilities, described in Marvin Minsky and Seymour Papert's book ”Perceptrons” (1969) [6], hardly stopped the interest in neural networks. In this book M. Minsky and S. Papert showed that the perceptron was incapable of solving XOR problem and also has serious problem in training: if the number of inputs increased, the time to train the network increased exponentially, limiting the efficiency of the network. After that, the enthusiasm in researching of the neural network disappeared and some “dark era” arisen. Only limited number of scientists continued the research, unfortunately, with small financial funds.

The first significant improvement in perceptron networks was obtained with multilayer percerptron, by introducing hidden neurons between inputs and outputs. For instance, the XOR problem was easily solved then. Furthermore, a problem with training hidden neurons was efficiently solved with the introduction of the back propagation (of errors) algorithm. This algorithm, introduced by Paul Werbos in 1974 [7], gave a neuron permission to let its errors propagate back to former layers of the network. Many scientists continued the research in the field of neural network and artificial intelligence. In 1982, Teuvo Kohonen, from Helsinki University of Technology, introduced the unsupervised neural network called self-organizing map (SOM) [8,9], a computational method for the visualization and analysis of high-dimensional data, especially experimentally acquired information. With some modifications Kohonen network was used in multi-input single-output node in telecommunication network [10].

Very interesting work was that of John Hopfield of Caltech, who proposed two basic types of neural networks in which he stated that the approach to AI should not be to purely imitate the human brain but instead to use its concepts to build machines that could solve different complex problems. The discrete model of the Hopfield net [11] can be used as content-addressable (associative) memories, while its continuous model [12] is an efficient computational tool for solving a broad class of optimization problems. With relatively simple network he solved even the Travelling Salesman Problem, which is computationally very hard if a number of cities (nodes) is large. With some modifications the Hopfield neural network can be used for solving different problems in communication networks (for instance, routing in large scale networks [13]).

The work of John Hopfield, and other scientists, definitely reanimated neural networks. Many advances into the research and development of artificial neural networks occur all over the world. The challenge today lies in finding ways to electronically implement the principals of neural network technology. Electronics companies are working on three types of neuro-chips namely, digital, analog, and optical. With the prospect that these chips may be implemented in neural network design, the future of neural network technology looks very promising. Computational power of neural networks is based on parallel work of many simple processing elements (neurons, or cells). But, note that even in the simulation over digital computers (which are sequential machines) many neural network algorithms, meaning based on non-algorithmic and non-analytic approaches, can be superior over classical computer approach. Digital computers are extremely efficient in solving numerical problems but they fall down when solving logical problems. By combining digital computers and neural networks powerful devices for solving different algorithmically undefined problems are possible, which is a challenge of future period.

Neural Network Conferences (NEURELs) in Serbia

The scientific community of Serbia was interested in neural network paradigms very early, in 1980s. As a result of enthusiastic work of several professors, particularly of our late professor Rajko Tomović (1919-2001), who recognized the power of neural networks in solving different complex problems without the need for special purpose algorithms, the first seminar on neurocomputing was organized in Belgrade, in December 1990, Fig. 1. In this two-day's event (later on called NEUREL as an acronym of the full name Neural Networks and their Applications in Electrical Engineering), 17 papers was presented. Unfortunately, just after this seminar, the Civil War in former Yugoslavia stopped many intellectual, cultural and scientific activities. Surprisingly, despite the disintegration of former Yugoslavia, NEUREL events survived: the second NEUREL was held in winter 1992/93, while an enormous economic inflation was running in Serbia, as a weekend series of lectures, held from Saturday-to-Saturday, under the leadership of our late professor Mirko Milić (1932-1993), Fig. 2.

Fortunately, after 1994 the situation in our region became better and the third NEUREL was held under almost normal conditions in September 1995, Fig. 3. This event was a real success, having 36 papers, and encouraged us to continue NEUREL symposia. Next NEURELs (in 1997, 2000, 2002) were organized by the IEEE* Yugoslavia Section (now Serbia and Montenegro, SME, Section) and its CAS-SP Chapter. From 2004 the CI Chapter of the IEEE SME Section was co-organizer as well. From the fourth NEUREL, in 1997, these events were technically co-sponsored by several IEEE Societies (SP-S, CAS-S, CI-S), as well as by the IEEE Region 8. Front pages of conference proceedings are depicted in Figs 4-9.

All manuscripts sent to NEUREL conferences have been reviewed and only high-ranked papers were accepted and printed in the conference proceedings. Among regular papers, a number of invited papers, lectures and/or tutorials were presented. Notice that special sessions, targeted to some specific topics, have had significant place in NEURELs.

Just from the beginning, papers from NEUREL symposia have been dedicated to three main topics: theoretical aspects of NNs, realizations of NNs, and applications of NNs. Although papers consider neural networks mainly from the technological point of view, significant attention

*IEEE (the Institute of Electrical and Electronics Engineers), the world's largest professional association of electrical and electronics engineers, founded under this name on 1 January 1963, by merging the AIEE (American Institute of Electrical REngineers, founded in the spring of 1884) and the IRE (Institution of Radio Engineers, founded in 1912), http://www.ieee.org/about/ieee history.html. Today,the IEEE had about 400,000 members in 160 countries

was devoted even to biological aspects of neural networks. Among the use of neural network in analyzing different electrophysiological signals of humans, papers considering the possibility of the use of technical methods and devices for control and/or stimulation of nervous system are presented. For instance, the use of external electrical signals for controlling neural prosthesis, which is initiated by late prof. Rajko Tomovic, is successfully continued and extended by professors Dejan and Mirjana Popovic. In NEUREL 2008, they organized very successful special session *External Control of Movement: Use of Artificial Neural Networks*. Among invited papers from session organizer, this session contained six papers mainly devoted to the use of neural networks in control of external prosthesis for handicapped people.

Among a number of papers and lectures from NEURELs, we can select several of them related to biomedical aspects of NNs, for instance, the use of magnetic stimulation of pineal complex of the brain which is suggested as a potential method for controling Alzheimer's disease [14], then very instructive lectures of prof. Paul Cristea, with the focus on genomic signal processing [15] and prof. Srdjan Stankovic [16], relating to the cooperative collective intelligence of groups of simple agents, and the paper of prof. Dejan Rakovic, describing the connection between quantum physics and the processes in the brain [17].

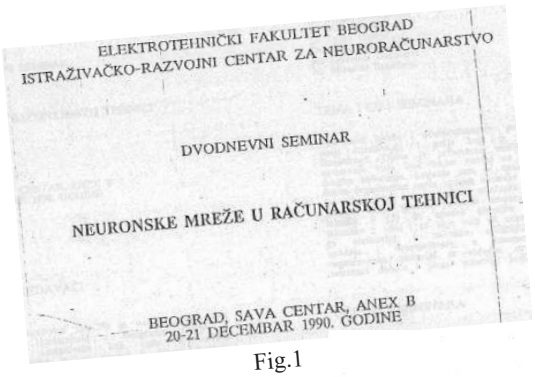
The NEUREL 2010 will be held in September, 23-25, 2010, at the Faculty of Electrical Engineering, University of Belgrade, Fig 10. We celebrate double jubilee of NEURELs: the tenth NEUREL and twenty years of the NEUREL events. Such jubikees are quite respectable even in the international scene.

Note that NEUREL 2010 will be co-sponsored by several IEEE entities: CAS-S, IM-S, SP-S, and the IEEE Region 8. Among regular sessions in NEUREL 2010 we expect two special sessions in the field of biomedical engineering. One session will be devoted to the mutual analysis of cardiac signals from electrocardiograms (ECG), phonocardiograms (PCG) and mechanocardiograms (MCG), combined with ultrasound signals (echo cardiograms), and the second one will be in the field of electrical stimulations of motor nerves for helping paralyzed people in everyday activities.

We do hope that NEUREL 2010 will be at least successful as previous NEURELs or be even better.

CONCLUSION

Symposia on neural networks and their applications, NEUREL, are highly significant scientific events not only for engineers but also for other scientists, particularly medical doctors. We are the witnesses that the combination of technical sciences and medicine is a winning combination. Many new electronic devices and signal processing methods dramatically help medical doctors in forming diagnosis. Nowadays the team work of engineers and physicians is a necessity and benefits are evident both for healthy and ill people. We strongly believe that the forthcoming NEUREL 2010 will give some small contribution to the whole community.


ELEKTROTEHNIČKI FAKULTET BEOGRAD
ISTRAŽIVAČKO-RAZVOJNI CENTAR ZA NEURORAČUNARSTVO

DVODNEVNI SEMINAR

NEURONSKE MREŽE U RAČUNARSKOJ TEHNICI

BEOGRAD, SAVA CENTAR, ANEX B
20-21 DECEMBAR 1990. GODINE

Fig.1


Faksimil: 011-455-789
Telefon: 011-138-912
Teleks: 12042 YUSAVCEN

SEMINAR: NEURONSKE MREŽE U RAČUNARSKOJ TEHNICI

SC SAVA CENTAR

ETF

SAVA CENTAR
Kongresne delatnosti
Milentija Popovića 9
11000 Beograd

Fig.2

PROGRAM

20. DECEMBAR 1990.

8:00 - 9:00 Registracija učesnika

9:15 Uvodna reč (J. Dujmović)

9:30 Neuronske mreže: nova oblast u računarskoj tehnici (R. Tomović)

10:00 Tipovi neuronskih mreža (M. Milosavljević)

10:45 Algoritmi obučavanja neuronskih mreža (S. Stanković)

11:30 Pauza i osveženje

12:00 Neuroračunari: arhitektura i mogućnosti (V. Milutinović)

12:45 Primene neuronskih mreža (J. Dujmović)

16:00 Heurističke metode za kontrolu lokomocije neuronskim mrežama (D. Popović)

16:45 Neuronska mreža za upravljanje industrijskim manipulatorom (R. Tomović i M. Branković)

17:15 Primena neuronskih mreža u analizi stabilnosti elektroenergetskih sistema (D. Ostojić)

18:00 VLSI implementacije neuronskih mreža (V. Milutinović)

21. DECEMBAR 1990.

9:00 Preferencijalne neuronske mreže (J. Dujmović)

10:00 Neuronske mreže u lingvistici (G. Lukatela , M. Savić)

10:30 Analiza i prepoznavanje govora, sa demonstracijom sistema M (M. R. Matausek)

11:30 Pauza i osveženje

12:00 Matematički problemi konvergencije algoritama obučavanja (S. Stanković, M. Milosavljević)

13:30 PARIS: Interaktivni sistem za obučavanje neuronskih mreža: Prikaz i demonstracija (Lj. Buturović)

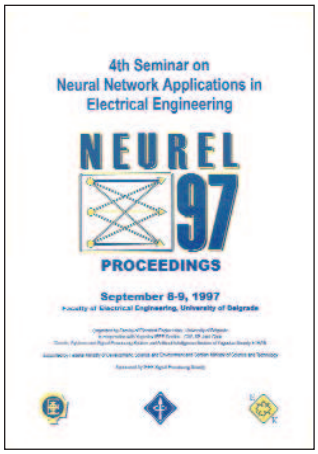
16:00 Neuronske mreže i moždani talasi: modeliranje stanja svesti (D. Raković)

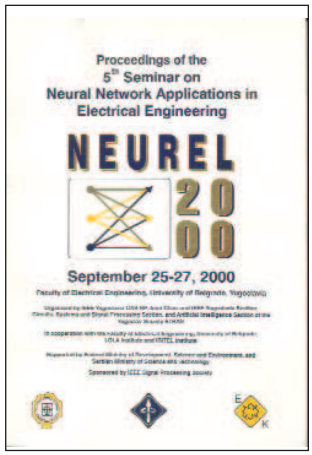
17:00 Neuronske mreže i težinski grafovi (D. Cvetković)

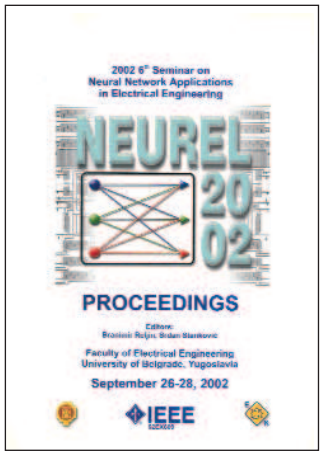
18:00 Hopfieldove mreže za rešavanje problema linearnog programi (M. Milić)

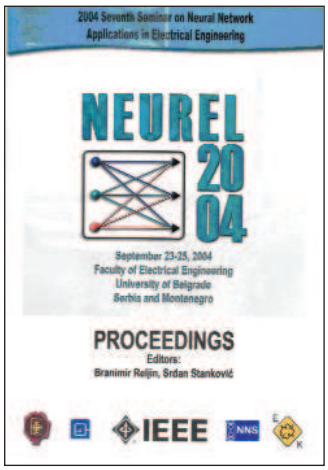
18:45 Zaključak seminara i diskusija

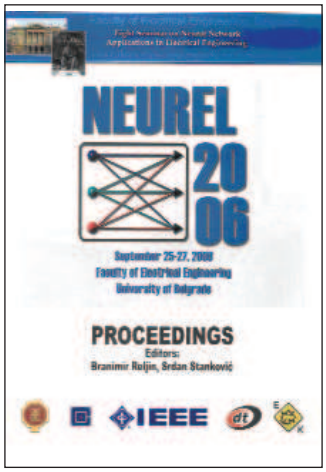
Fig.3

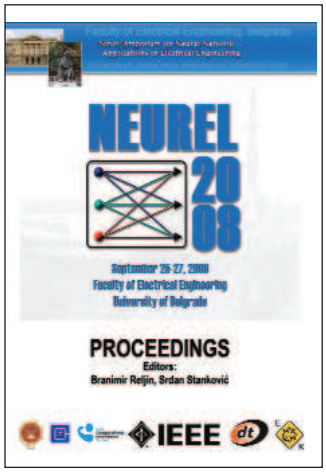












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