Cover

ARTIFICIAL neural networks, the subject of this Special Issue, have recently become very popular due to their ability to somewhat easily solve problems that might be very difficult to solve by other means. For example, they can learn the general characteristics of classes of signals, such as electrocardiograms, and use these to classify signals which differ in secondary features from the learned signals, for example, by classifying nonstandard electrocardiograms as to their representation of different diseases of the heart. This is done in most cases via what one might call parallel processing, where the primary characteristics of what is desired to be classified are stored directly in the signal processing paths, so that checks to memory are essentially bypassed and the speed of analog signal processing can be used. The key to this processing is the artificial neuron, the main processing element, which is to be considered as a mimic of the neurons of biological neural systems.

During the 1960's, artificial neurons were extensively studied, but in many cases these were simulations of biological neurons that attempted to take into account all the many and varied nuances of real neurons. Or, in some cases the neurons were oversimplified but the accompanying algorithms were not suitably developed. What has changed is that stress has more recently been placed upon the algorithmic structures needed for adequate performance of neural networks. In this, very simple neurons are now considered with the result that emphasis has shifted away from the neuron itself toward the interconnections of the neurons and the weighting of their inputs. Thus the present day treatments of neural networks normally place stress upon how to choose the interconnection of neurons and the weights to attribute to the connection of one neuron to the remaining ones. However, these types of treatments have reached a somewhat saturated level of development so that we believe there will be a return to the development of biological properties, not to the point of complete simulation but to the point of improved mimicry of more and more elaborate neuron properties. In this regard we believe the pioneering work of H. Crane [1], which sets up a pulse coded system via the "neuristor" and upon which we have based our own neural-type circuits and systems, is worth further development.

It is well worth noting here that a majority of the recent developments have been toward software with comparatively little emphasis upon what can be made in hardware. Since one of the goals of the field is to produce hardware that mimics the signal processing capabilities of the brain where millions of neurons are present, it is clear that the field will be driven by the development of circuits that are simple and can be readily realized in VLSI.

Consequently, in organizing this Special Issue we have paid special attention to new classes of hardware and their ties to algorithmic-based theories. Thus the majority of papers fall into two classes, those that are hardware-based and those that are algorithmic-based but with relevance toward hardware realization and design. In many instances, these two bases are well mixed, which reinforces our belief that the two should be developed hand in hand. For future developments we also believe that the ties to physiology must be strengthened. For this latter reason we have incorporated a specially recruited paper that develops the physiological base of neural networks in terms of electrical circuit parameters, this being the paper of D. K. Hartline. Since it is also important to understand limitations, we have included several papers with this orientation; see, for example, the paper by M. L. Brady, R. Reghavan, and J. Slawny. And since digital circuits have proven themselves in VLSI, we have included a couple of papers which place emphasis upon digital technology; see the paper by D. E. Van den Bout and T. K. Miller, III, and the one by M. K. Habib and H. Akel. Because we believe it important to know of significant alternatives, we have included the paper by A. R. Stubberud and R. J. Thomas which uses a contraction mapping approach to associative recall, in what a reviewer refers to as a masterpiece of development. Unfortunately, we have not had room for all of the excellent papers received nor have we been able to cover all of the concepts one would wish. Barely touched upon, for example, are the important adaptive algorithms (which allow for self-organization) and the pulse-coding techniques (which give a degree of noise immunity).

Although it is perhaps proper that we include a tutorial introduction to the field, this has not been possible for several reasons, one being the time frame in which this issue was developed. Nevertheless, the paper by M. A. Maher serves as an introduction to a major aspect of the field. Elsewhere there are a number of excellent tutorial treatments now available; for example, we recommend that of R. Lippman [2]. The field has undergone very rapid expansion recently and one can also find a number of other special issues, among which are [3]–[5], and a number of special sessions at international meetings, such as recent ISCAS and CDC's. There are also a number of commercial programs and plug-in boards for personal computers, and we would recommend that an engineer seriously interested in the field might invest in one of these systems. Finally, we mention that over the years there have been a number of neural networks papers in the IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS and we are aware of a number of others to appear in the near future.

This Special Issue owes a lot to a large number of people, only some of whom we can acknowledge here. First and foremost is Professor Rui de Figueiredo who had suggested it at the lunch meeting of the IEEE CAS Technical Committee on Robotics and Automation at ISCAS

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1987 in Philadelphia. Although the Technical Committee on Neural Networks was subsequently formed and has taken on this activity, the original idea was Professor de Figueredo's. Subsequently, the IEEE CAS Society administrative and editorial officers and committees endorsed the undertaking, giving us considerable encouragement for speedy development of the issue. We had an excellent response via submitted papers and those that survived went through an extensive review process, in most cases there being a sequence of three revisions. For their efforts in this regard we owe the authors a special debt of gratitude as we do also the numerous and very conscientious reviewers who greatly assisted us. Finally almost every paper in the issue was studied by the Biomedical Engineering Seminar at the University of Maryland, where each student of the seminar worked through in detail and then presented one of the papers to the attendees. This also led to a number of helpful comments for authors. In the end we believe that the best possible papers have resulted through intensive development over a very short time span. Our belief is that the end result will be much greater than just the sum of each part and we are appreciative of all the help so many people have given toward making this possible.

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Ms. El-Leithy is a member of several honor societies and has received several awards including the Teacher of the Year Award at GWU and the International Distinguished Young Leadership Award from the American Biographical Society.

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