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FUZZY LOGIC AND NEURAL NETWORK INTEREST GROUP

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Our First Year

Looking Forward (and Backward)

As 1993 draws to a close, the FLANNIG membership must feel proud of our first year of existence. At our initial meeting, held in February, we gave ourselves a name, decided on our structure, and elected officers. We also decided that our first speaker should be none other than the inventor of fuzzy logic, Dr. Lotfi Zadeh. Our first formal meeting, held in April, was attended by over 100 people who turned out to hear Dr. Zadeh's philosophical words on approximate reasoning and the nature of uncertainty. Our May meeting hosted Boeing's Dr. Tom Caudell giving a fascinating talk on applications of neural networks at Boeing. In June, Buster Greene gave an introduction to genetic algorithms. After summer break, our own secretary, Tyler Folsom, spoke on vision in biological systems. In October, we broke from the standard meeting format of hosting a speaker, and held a rather lively roundtable discussion featuring a panel of 5 fuzzy logic practitioners from industry, moderated by Dr. Bob Marks from the University of Washington. Based on this success, we will host a roundtable talk on neural networks in '94.

Our final speaker of 1993 was Professor Jenq-Neng Hwang from the University of Washington, speaking on practical issues of back-propagation learning.

In addition to this program of activities, we have positioned ourselves for a prosperous future. Our coffers are full, and we have secured funding from the Local IEEE Section as well as from the Neural Networks Council of IEEE (our parent body.) These funds are in addition to the funds provided by our $10 annual membership fee.

So, as we look to 1994, we can plan an exciting program. Indeed, several activities are already set. Our January meeting will host Dr. Mike Healy of Boeing speaking on artificial life. In February, Dr. Hammerstrom of Adaptive Solutions, Inc. will speak. Our May meeting will feature Dr. George Klir, world renowned fuzzy logician. In addition, 1994 will see another roundtable discussion.

The rest of the schedule is wide open and we will have a newly elected executive committee giving its energy, enthusiasm and its own perspective to the group. If you want to have your say on what gets planned, get involved! Come to the December election meeting, give your inputs, or best yet, run for Office.

—Colin Wiel

Roundtable Brings Fuzzy Logic Into Focus

We recently conducted a roundtable discussion of applying fuzzy logic to real life problems. ***Dr. Bob Marks*** of the University of Washington lead the questioning of the five member panel. The experience of our panel members ranged from creating software to explore fuzzy logic to making hardware embedded fuzzy systems, and from control systems of large manufacturing kilns to the braking of airplanes. The panel members, with the direction of Dr. Marks, offered commentary on the stability of systems, ease of training, problems encountered, and the possible future of fuzzy systems.

The participants were:

Dave Lenartz of Byte Dynamics
Mr Lenartz has worked to develop software which can be used to build a fuzzy system. Its graphical representations make it easy to explore fuzzy logic decisions.

Ivan Rozek of Savantek
Mr. Rozek uses fuzzy logic to control large rotary kilns used in the manufacture of paper pulp and cement.

Jim Peckol of Oxford Consulting
Oxford Consulting is a research company which provides analysis, design, project leadership, training and expert services in embedded systems and fuzzy logic.

Suray Bhatia of Boeing
Dr. Bahtia teaches fuzzy logic at Boeing, and has used fuzzy logic in several control system designs.

Colin Wiel, Independent Consultant
Before becoming independent, Mr. Wiel worked at Boeing where he designed fuzzy systems used for automatic braking and anti-skid braking.

Dr. Marks started the discussion with the comment that fuzzy logic is offering a paradigm shift; a new way of thinking. The general view of the panel was that the new way of thinking was meeting with resistance. Fuzzy logic is not being accepted because it is not "mathematical" or "logical". Fuzzy systems are difficult to model and predict, and there is a lack of proofs showing that they are effective and robust.

Dr. Marks presented an amusing illustration of the life cycle of a new idea: it enjoys immense popularity when introduced and everyone expects great results, then falls into disrespect when it fails to meet the initial expectations, and finally rises back into use in the appropriate applications. Jim Peckol commented that fuzzy logic won't solve all of our problems, but that doesn't mean that it should be abandoned completely. We need to understand the technology and apply it where appropriate.

Renew your membership for 1994!
Network with *Flannig*

Our Next Speaker

Wednesday, Dec 15
Executive Elections

Wednesday December 15, 1993
6:30 Meeting Time
Round Table Pizza
5111 25th NE, Seattle

To prepare for the next year of activities, we will hold elections for officers of FLANNIG. Positions will be open for chairperson, treasurer, secretary, and newsletter editor. As an added incentive, the meeting will be conducted at Round-Table pizza in Seattle. (Parking is available, so don't let that deter you!) We look forward to involving a new set of officers in FLANNIG. Take advantage of our successes and add your influence to this interest group.

January 1994
Dr. Mike Healy

Dr. Healy works for Boeing and will discuss Artificial Life.

February 1994
Dr. Hammerstrom

Dr. Hammerstrom is cheif technical officer of Adaptive Solutions, Inc. ASI builds the worlds fastest neurocomputer, the CNAPPS.

Watch the IEEE DataLink for the dates of these talks.
For more information contact Tyler Folsom at 543-2176, 545-7228, or 872-9500. His e-mail address is: *tfolsom@maxwell.ee.washington.edu*

What Problems Are Fuzzy Logic Appropriate For?

Both Ivan and Dave have had success using fuzzy logic in the control of manufacturing processes. Ivan uses it to control large rotary kilns, and Dave uses it in high temperature furnaces at Kaiser Aluminum. Both were working with manufacturing systems which are impossible to model accurately, yet the general process is well understood.

Another problem was that the test measurements on the kilns were fairly fallible. Ivan tried many other probability based control methods, but eventually settled with fuzzy because it allowed for the decoupling of the inputs. One faulty reading of a test measurement would not cause the whole control system to fail in the fuzzy systems.

How Stable are Fuzzy Systems?

Fuzzy systems model human behavior - they model a system as a person would run it. This design creates a very stable system if it is designed by a person who knows exactly how the system should behave. The makeup of our panel demonstrated that fuzzy systems designed by experts are successful.

Unfortunately, there are many applications where the system is unknown. For these cases it would be useful to train a fuzzy system, or tune it. Tuning is difficult because of the number of variables: there are membership functions for each input, and decision rules for the interactions. Dr. Marks found over 200 references to tuning fuzzy systems through a literature search, but it was clear that the most popular fuzzy systems in use today are designs which copy the experience of experts.

General agreement among the panelists was that using fuzzy logic does not absolve one of understanding the problem. However, for those interested in more daring uses of fuzzy systems, Dr. Marks suggested several ideas for tuning fuzzy systems such as using back propagation or setting up a fuzzy system within a neural network, deriving the fuzzy system from the trained network.

Where in the World is Fuzzy Logic Accepted if not in America?

The unanimous answer was Japan where Zadeh is compared to Edison, and "Fudgie" logic is used in everything from helicopters and trains to vacuum cleaners. Research in America is being conducted through institutions such as the Federal Bureau of Mines, NASA, DARPA, and some small industrial companies as shown by our panelists. Dave has received inquiries about using fuzzy systems in the biomedical field, but fears that it may not be pursued because the FDA may find fuzzy logic objectionable.

How Difficult is it to Create a Fuzzy System?

Colin was introduced to the problems of braking airplanes at Boeing armed with a bachelor's degree, a little knowledge of control systems, and Suray's teaching of fuzzy logic. He was able to create a fuzzy system which improved auto-braking and anti-skid performance of the planes.

One panel member commented that it is easy to adjust the system and find problems since the system is designed by someone who knows how it should work. Dr. Marks was ready to apply fuzzy logic as a research tool to relatively unknown systems, but that area will have to be explored thoroughly before it is ready to be applied to the industrial arena.

More Information:

Dr. Bob Marks offers courses through the University of Washington.

Oxford Consulting offers courses and consulting services.

Byte Dynamics offers a software package called "Fuzzy Logic Designer". Their advertisement appears in this newsletter.

The book "Fuzzy Sets, Uncertainty and Information" by George Klir and Tina Folger was recommended.

Best of all, IEEE will publish next year a collection of articles on applications of fuzzy logic in a wide variety of areas.

—*Wendy Bannister*

In Through the Out Door

Practical Issues of Back-Propagation Learning

Jenq-Neng Hwang has been with the University of Washington for five years, and teaches a course on Neural Networks there. During his talk, he discussed several innovations in neural networks starting with the standard Multi Layer Perceptron (MLP), progressing to the Cascaded Correlation Learning Network (CCLN), and finally presenting his Projection Pursuit Learning Network (PPL).

> *Projection Pursuit Learning uses orthoginal Hermite polynomials at each node combined with sequential construction of nodes in the hidden layer.*

A single artificial neuron consists of a number of inputs which are multiplied by appropriate weights, summed, then passed through a nonlinear function before being output as a new signal. In the most commonly used neural network, the Multi-Layer Perceptron, these outputs feed into another layer of neurons, or to output nodes.

Each node in a MLP most commonly uses a sigmoidal function as the nonlinearity. Dr. Hwang suggested letting each node of a network have its own non-linear function. When these functions are taken to be Hermite polynomials, high dimensional data can be interpreted through well chosen lower dimensional projections. This increases the power of the network dramatically and gives it the same effectiveness as a larger network using sigmoid functions.

One drawback to using neural networks is that they are not easy to optimize. Although they can be easily and automatically trained, there is no way to determine the optimal size of a standard MLP other than to build several and choose the one with the best performance. This is especially problematic when each network may take 3 to 5 days to train!

As the MLP is trained, one training object is put into the network, and all of the nodes are updated to minimize the error at the output layer. With this training method, the network is of a fixed size during the entire training process. An alternate method is to build the network one node at a time. Each node can have the weights updated, or new nodes can be added. This conveniently provides a way to implement a stopping criteria - when the network performance stops improving, stop adding nodes. This method is incorporated in the CCLN.

Proffessor Hwang's latest version, Projection Pursuit Learning, uses orthoginal Hermite polynomials at each node combined with the sequential construction of nodes in the hidden layer. This ensures that the first N hidden neurons extract the most relevant data features. Nodes added subsequently will refine the classification. Several examples were given showing superior performance for this method.

It was clear from his presentation that Dr. Hwang is dedicated to promoting the use of NNs, and spends considerable effort trying to improve them because he believes in their potential. He admitted that some of the problems could be solved more easily by other methods, but he also said that he believes that NNs can also solve those problems; they simply need to be given a chance. In the solution of these problems, he hopes to improve the power of NNs to a point where they can be used more easily in a wide variety of applications.

For the remainder of the talk, he introduced many different applications of NNs which he is involved in to give us an idea of the variety of applications possible if the effort is applied. One project was to train a neural network such that points on the boundary of a 3-d object recieved a value of 0, while points further away recived higher values. New objects could be input to this network and a measure of how closely they match the original results. Another project was to use a NN to generate energy functions which could be applied to find boundary points, such as defining the outline of lips for a lip-reading program.

He wanted to show that by trying different methods, analyzing the application, and deciding what to modify, dramatic improvements can be made to the performance of a basic method. Thanks for the illustration of what's possible when a person is persistent!

—*Wendy Bannister*