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Neural Network Evolution:
Some Comments on the Passing Scene

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ABSTRACT

Neural network applications are everywhere. Since this year's *International Conference on Neural Networks* (ICNN) is in Washington D.C., discussion of some political applications is appropriate. Despite undisputed continual growth in application, controversy still exists from outside the field. An explanation is given.

1. Introduction

Research activity in neural networks continue to blossom. In 1994, over 8000 papers were published involving neural networks. That's over thirty papers each working day. The field solidifies with widespread application. In this paper, we discuss

- some fascinating applications of neural networks in United States presidential politics.
- the continuing neural network controversy.
- the need to infuse new ideas.
- the need to recognize fruitless research directions. and
- the history of neural network publication and patent activities.

2. Neural Net Applications

The maturity of a technical field is measured in part by the degree of its use in industry. business and government. The scope of application is astonishing.

This IEEE International Conference on Neural Networks (ICNN) is being held in Washington D.C. in a year when the next President of the United States will be elected. Neural networks are being used in the political contest.

2.1. Neural Networks Predict Clinton will Don Bowling Shirt

The current President of the United States. William Jefferson Clinton. is using neural networks. Syndicated columnist. Robert Novak. wrote in his February 18. 1996 column.

> "PRESIDENT CLINTON'S POLLSTERS HAVE IDENTIFIED THE VOTERS WHO WILL DETERMINE WHETHER HE WILL BE ELECTED TO A SECOND TERM: TWO PARENT FAMILIES WHOSE MEMBERS BOWL FOR RECREATION."

> "USING A TECHNIQUE THEY CALL THE 'NEURAL NETWORK', CLINTON ADVISOR'S CONTEND THAT THESE FAMILY BOWLERS ARE THE QUINTESSENTIAL VOTERS. THEREFORE. THESE ARE THE PEOPLE WHO MUST BE TARGETED BY THE PRESIDENT."

Novak continues:

"A FOOTNOTE: TWO DECADES AGO. ILLINOIS DEMOCRATIC GOVERNOR DAN WALKER
CAMPAIGNED HEAVILY IN BOWLING ALLEYS IN THE BELIEF HE COULD FIND SWING VOTERS
THERE. WALKER HAD NATIONAL POLITICAL AMBITIONS BUT ENDED UP IN FEDERAL PRISON."

No additional comments can be made without revealing my political bent.

2.2. Bad Boys, Bad Boys

The Democrats will hold their 1996 presidential convention in Chicago. Twenty six years ago. in 1968. the Chicago presidential convention was marred by violent clashes between demonstrators and police. A presidential commission called the conflict a "police riot". In 1968. Richard J. Daley was mayor of Chicago. Today. his son. Richard M. Daley. is mayor. In order to belay a repeat incident at this year's convention. the Internal Affairs Department of the Chicago Police Department used a neural network to clasify 'bad cops' who might provoke conflict [1].

"THE (NEURAL NETWORK) PROGRAM FORECASTS WHETHER EACH OF THE 12.500 OFFICERS
ON THE FORCE IS LIKELY TO BEHAVE IN A MANNER SIMILAR TO NEARLY 200 COLLEAGUES
WHO WERE DISMISSED OR RESIGNED UNDER INVESTIGATION DURING THE LAST FIVE YEARS
FOR ACTIONS RANGING FROM INSUBORDINATION CRIMINAL MISCONDUCT."

A total of 91 officers were identified. They were to enroll in a counseling program. The neural network results. though. were challenged. The neural network. as a "black box". contained no causal mechanism to specify the reason or reasons the classification of potential 'bad cop' was made. In the parlance of AI. the neural network lacked an *explanation facility*. Such neural network capability. however. is now available using. for example. certain fuzzy neural network architectures and LAPART.

Consulting income is waiting for the first of us to show the Chicago Police Internal Affairs Department that the objection to using a neural network can be rendered groundless.

3. Neural Networks and Inertia

The dynamics of computational intelligence in general and neural networks specifically sprout dogmatic viewpoints from both neural network technology critics and neural network practitioners.

3.1. Know Thy Enemy

Neural network applications are still steeped in controversy. Professor Bob Bitmead writes [2]

"THE IMAGE THAT IS PORTRAYED IS OF THE ABILITY TO PERFORM MAGICALLY WELL BY THE
INCORPORATION OF 'NEW AGE' TECHNOLOGIES OF FUZZY LOGIC. NEURAL NETWORKS. ...
APPROXIMATE REASONING. AND SELF ORGANIZATION IN THE FACE OF DISMAL FAILURE OF
TRADITIONAL METHODS. THIS IS PURE UNSUPPORTED CLAPTRAP WHICH IS PRETENTIOUS
AND IDOLATROUS IN THE EXTREME. AND HAS NO PLACE IN THE SCIENTIFIC LITERATURE."

This quote clusters well with mutterings of the other following experts.
- "I THINK THERE IS A WORLD MARKET FOR MAYBE FIVE COMPUTERS." Thomas Watson. Chairman of IBM (1943).
- "DATA PROCESSING IS A FAD THAT WON'T LAST OUT THE YEAR." **Prentice Hall** Editor in charge of business books. (1957).
- "COMPUTERS IN THE FUTURE MAY WEIGH NO MORE THAN 1.5 TONS." **Popular Mechanics** forecasing in 1949.
- "THE CONCEPT IS INTERESTING AND WELL FORMED. BUT IN ORDER TO EARN BETTER THAN A 'C'. THE IDEA MUST BE FEASIBLE." A Yale management Professor in response to Fred Smith's paper proposing reliant overnight delivery service. Smith later founded **Federal Express**.
- "WE DON'T LIKE THEIR SOUND. AND GUITAR MUSIC IS ON THE WAY OUT." **Decca Recording Company** rejecting the Beatles (1962).
- "640K OUGHT TO BE ENOUGH FOR ANYBODY." Bill Gates. 1981.

These amusing quotes, and that of Dr. Bitmead, reflect resistance to a new technology - to a paradigm shift. California Supreme Court Justice N. Stanley Mosk said it nicely - when the only tool you have is a hammer, "EVERYTHING LOOKS LIKE A NAIL." With control applications in mind, in response to comments such as those from Bitmead, E.H. Mamdami, the father of fuzzy control, writes [3]

> "IN CONTROL ENGINEERING JOURNALS, MANY OF THE PAPERS HAD NOTHING TO DO WITH TECHNOLOGY OR ENGINEERING WHATSOEVER. THEY WERE INCREASINGLY MATHEMATICAL AND OFTEN ONLY ABOUT MATHEMATICS. ... (FUZZY THEORY'S) DELAYED EXPLOITATION OUTSIDE OF JAPAN TEACHES SEVERAL LESSONS. ... (ONE IS) THE TRADITIONAL INTELLECTUALISM IN ENGINEERING IN GENERAL AND THE *CULT OF ANALYTICITY* WITHIN CONTROL SYSTEM ENGINEERING RESEARCH IN PARTICULAR."

Added emphasis is mine. In assessing the worth of new technologies, we must discern the difference between the wisdom of age and the babbling of the entrenched practitioners swinging their one large hammer.

3.2. Know Thyself

Keeping on the cutting edge requires continual diligence. We should not scoff at those who criticize innovation without periodic self inspection. Neural network practitioners must also be wary of wearing a rut so deep they can no longer see out. Infusion of new ideas from fields outside of computational intelligence must take place continuously. For example, Patrick K. Simpson [4] writes "MOST OF THE SCIENTISTS AND ENGINEERS IN THE FIELD OF NEURAL NETWORKS ARE BIOLOGICALLY IGNORANT."

In terms of engineering applications, the undisputed neural network winner is the layered perceptron and its kin. Included are radial basis function neural networks, cascade correlation, functional link nets and recurrent neural networks. Numerous applications have been made and probably include the predicting of Clinton's swing voting group and identification of bad Chicago cops. A number of other applications wait.

Brutal identification of the apparent neural network failures must also be made. Simpson is, to my knowledge, the first who has dared to do so. Due to the inertia of silicon and the linearity of free space optics, he notes "OPTICAL AND ELECTRO-OPTICAL IMPLEMENTATIONS OF NEURAL NETWORKS HAVE ALMOST DISAPPEARED." In regard to Hopfield and bidirectional associative memories (BAM's), Simpson writes

> "ALTHOUGH THERE ARE STILL SOME RESEARCHERS ATTEMPTING TO SHINE A SPOTLIGHT INTO CORNERS OF THIS WELL-LIT ROOM, THIS AREA HAS NEVER MET THE POTENTIAL PROJECTED"

4. Application Monitoring

The engineering success of neural networks is measured by the degree of application. One of the better metrics of neural network application in general is patent activity. Patent counting, though, also includes patents on neural network implementation. Shown in Figure 1 is the patent activity in the fields of neural networks, fuzzy systems and artificial intelligence from 1986 through 1994. The data for the figure was obtained from a word search in the CASSIS patent data base and is an update on similar data published previously [5]. The data shows that patents numbers in fuzzy systems and neural networks continue to grow whereas artificial intelligence patents have reduced in number the past few years.
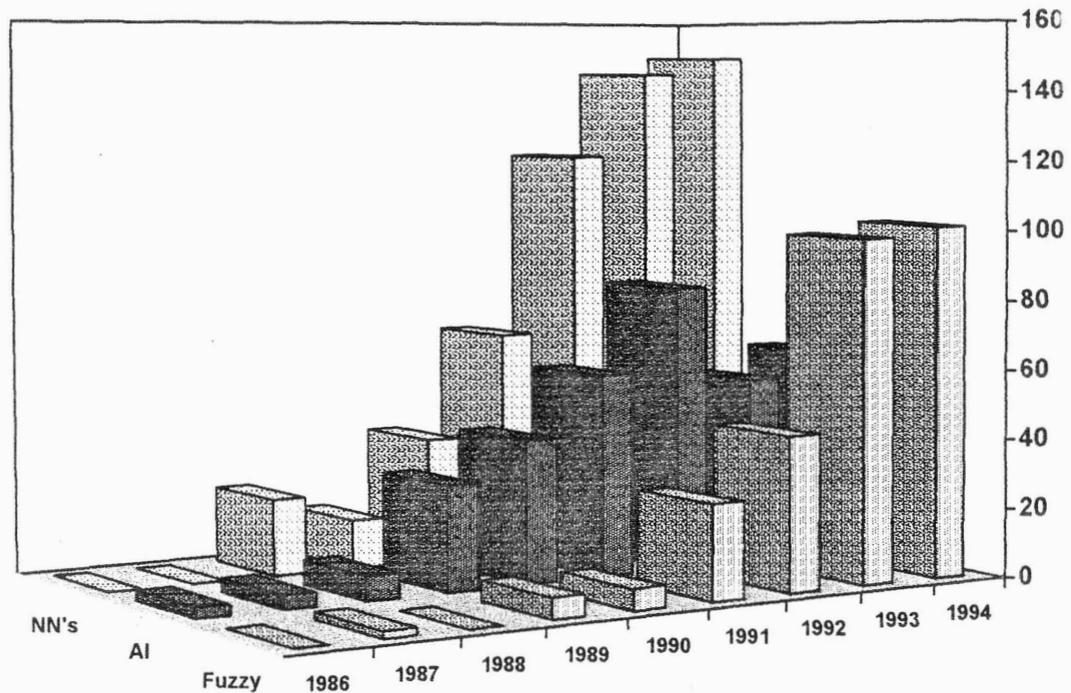
Figure 1: Patents in the fields of neural networks, fuzzy systems and artificial neural networks.

Patents activity clearly is not a complete measure of applications. Neither the applications of the Chicago Internal Affairs Department or Clinton's advisors have been patented.

5. Publication Activity

Neural net activity assessment is also measured by the number of publications. These are shown in Figure 2. The count was determined from the INSPEC data base using the search words used in [5]. Neural networks, computational intelligence and evolutionary computation are all experiencing a healthy growth.

We in the field of neural networks have certainly published a lot. A plot for the total number of papers listed in INSPEC, dating from 1989 to present, are plotted in Figure 3. Some criticize that too many neural networks papers are accepted in conferences. There is less agreement on which papers should be rejected. A striking illustration indicates just how much we do publish. The three volumes 1993 ICNN Proceedings measures 4 3/8 inches and contains 1987 pages. In Figure 3, there are 50,000 papers and books published in computational intelligence. If we assume, on the average, a length of six pages per paper (book), the stack of computational intelligence publications stacks 55 feet. Neural networks (37,600) stacks to 41 feet. All IEEE publications (281,700) stack to 310 feet. These stacks, in comparison with the United States capitol building (about 300 feet) , are shown in Figure 4. During the conference, visit the building and visualize. You'll agree we've been very prolific. We pale in comparison, however, to those generating biomedical literature. Their one year production, when stacked, *exceeds* the height of the Washington Monument (555 1/2 feet or 169 meters) by 200 feet! [6].
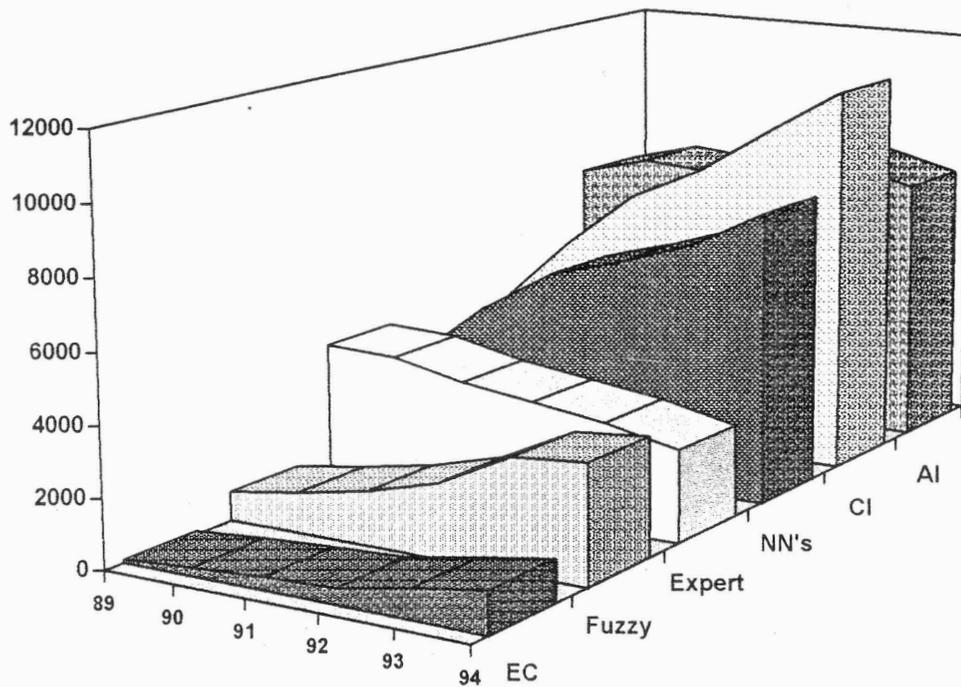
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Figure 2: Publications in neural networks and related fields obtained from the INSPEC data base
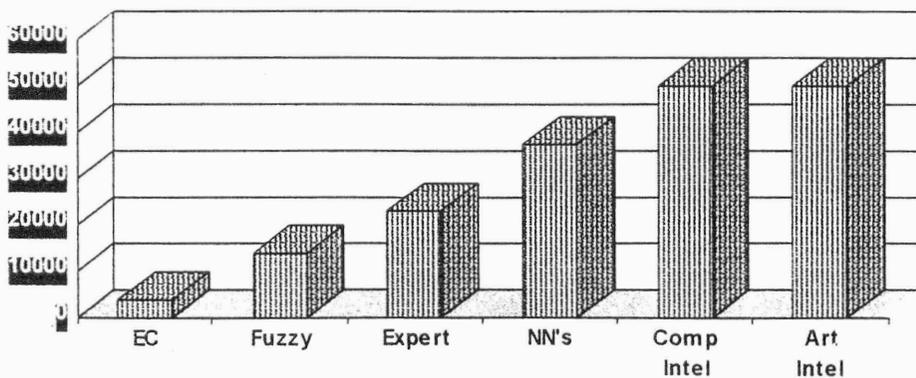(March 1996)

Figure 3: The total number of publications in neural networks and its related fields. The data was
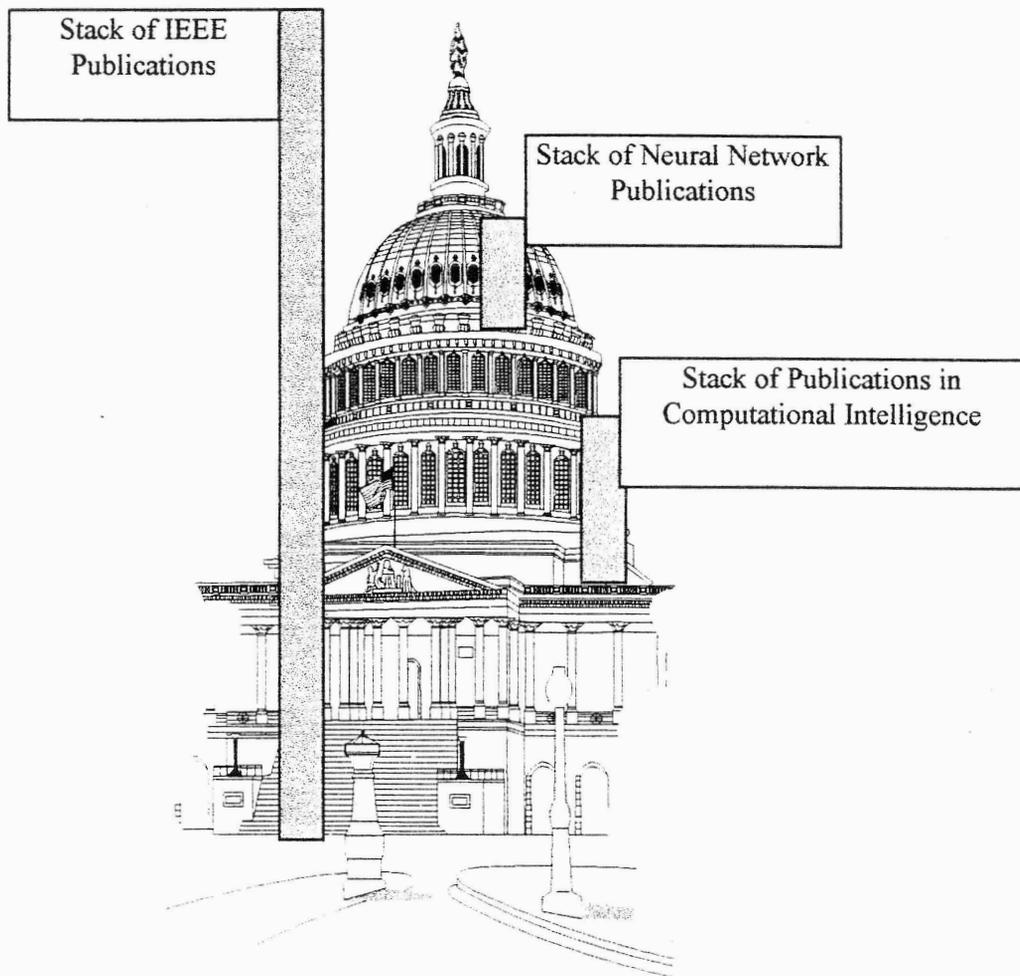obtained from the INSPEC data base.
(March 1996)

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Figure 4: How neural networks publications stack at the United State's capital building.

6. References

1. *Scientific American* , December 1994. (p.44).

2. Bob Bitmead. *IEEE Control Systems Magazine*. June 1993. p.7.

3. E.H. Mamdami. "Twenty Years of Fuzzy Control: Experiences Gained and Lessons Learnt", reprinted in **Fuzzy Logic Technology and Applications**. R.J. Marks II, Editor. (IEEE Technical Activities Board. New York, 1993).

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5. R.J. Marks II, "Intelligence: Computational Versus Artificial", *IEEE Transactions on Neural Networks*. vol. 4, p 737 (September, 1993).

6. *Scientific American* , December 1994. (p.108).