

# New programme for neural network computers?

- DARPA report puts aside hype
- New hardware for brain-like computers

## Washington

A \$400 million programme to take neural network computers out of the laboratory and into wide-scale, practical use is under consideration by the US Department of Defense. The programme is mapped out in a 586-page report\* commissioned by the Defense Advanced Research Projects Agency (DARPA) and previewed at the Second IEEE International Conference on Neural Networks held in San Diego at the end of last month.

The seven-year programme would establish a neural network office, managed by DARPA, that would fund research within the universities, national laboratories and industry. Equivalent amounts spent by other agencies would be likely to push government expenditure on neural network research to over \$1,000 million over seven years; up from the current total of \$40 million a year.

Jasper Lupo, director of DARPA's Tactical Technical Office, who commissioned the report, compared the creation of neural network computers to the invention of the 'atomic bomb' when speaking before an audience of enthusiasts at the San Diego IEEE conference. But the study itself goes out of its way to repudiate exaggerated claims made for neural network computing.

The study director, Bernard Widrow, of Stanford University, prefaced the report by pointing to the "dark shadow" cast by the "hyperbole and extravagant claims" made for neural network systems.

The actual performance of neural network computers is described as "far from awesome". But the belief remains, as Lupo puts it, that they will provide "the next major advance in computing technology". What are now needed are machines powerful enough to test whether building computers inspired by biological nervous systems can provide the human-like abilities that have proved so hard to model in conventional computers.

A neural network computer consists of many simple processors, fully or sparsely connected, whose function is determined by the strength and pattern of their connections. Each simple processor is, in essence, a neuron, and each of its inputs a single synapse, whose weighted input can change with experience. Unlike a conventional computer, with one central processor carrying out operations in sequence,

neural network computers carry out operation in parallel and are generally designed to be trained, — rather than programmed — until a particular input produces a desired output.

But an enormous disparity in computing power divides even the most sophisticated neural network computers from real nervous systems. Computers cannot match a fly's brain, let alone a human's.

The DARPA report estimates that the human brain contains 100,000 million neurons ( $10^{11}$ ), each having roughly 1,000 dendrites that form 100 million million ( $10^{14}$ ) synapses. In neural network terminology that gives the brain a storage potential of  $10^{14}$  'interconnects', a measure of the number of weighted inputs in the system. And given the rate at which nerves fire (100 Hertz), a human brain has the potential to make 10,000 million million ( $10^{16}$ ) interconnects per second. A fly's brain can manage  $10^7$  interconnects, and  $10^9$  interconnects per second which is still way ahead of the most advanced supercomputer — a Cray XMP 1-2, for example runs at  $2 \times 10^6$  interconnects, and  $50 \times 10^6$  interconnects per second. Of course, a Cray supercomputer has not been designed with neural network programming in mind. Special purpose computers now under development should achieve interconnect values twenty times higher in the near future.

But the DARPA report calls for speeds in the  $10^9$ – $10^{11}$  interconnects per second range within three to five years, and of  $10^{12}$  interconnects per second in six years. To do so requires ambitious technology development; in the shorter range gallium arsenide, charge-coupled device and analog-digital hybrid chips, and in the longer-run, optical technology, which will allow a much higher density of interconnects.

Specific applications considered by DARPA are necessarily military, although the report stresses that they would have to be built on generic applications in vision, speech and robotics. Non-military applications are potentially enormous. And, if the US government and industry is not prepared to back development. There may be others who will. It was not lost on those attending the San Diego IEEE conference that representatives were present from the full range of Japanese electronics and industrial companies as well as from Japanese technical magazines and newspapers. Alun Anderson

## Shuttle test failure

THE 20-second flight readiness test firing on 4 August of the space shuttle Discovery's main engines was cancelled when the countdown reached *t* minus 5 seconds because a valve in one of the shuttle's three main engines apparently failed to close.

Technicians at the Cape Canaveral launch pad replaced the faulty valve and its sensor over the weekend, and the critical test has been rescheduled for this week. J.P.

## Molecular ageing

A EUROPEAN network of collaborative research in the molecular biology of ageing and age-related diseases is to be formed with the aim of reducing costs and increasing the international competitiveness of European research. Collaboration will be initiated at the first meeting of the Eurage Molecular Biology Group, to be held in Crete on 7–10 October. At the meeting, recent developments will be outlined by experts in the field from both in and outside Europe and the exchange of materials will be discussed. C.McG.

## Frog suit croaks

A CALIFORNIA court has dismissed a lawsuit against a southern California high school brought by a student who claimed that a class exercise in frog dissection violated her religious freedom. In dismissing the case, the judge said that to push the issue further would border on the absurd.

The lawsuit, filed in June 1987, gained considerable notoriety for Jenifer Graham, a 16-year-old animal-rights advocate. The publicity over her case inspired legislation that passed the California legislature in March, recommending that teachers offer alternative lessons when possible for students who object to animal dissection.

During a pre-trial hearing, the judge asked Graham if she would object to dissecting a frog that died of "natural causes", and she said no. But Davis said the school will steer clear of that option. "What constitutes natural causes", he said. "Hit by a car? Drowned in a swimming pool? There would probably have to be another court case to determine the definition of that."

M.B.

## Ciba head appointed

DR DEREK Chadwick has been appointed director of the Ciba Foundation, a scientific and educational charity which promotes international cooperation in medical and chemical research. Currently at the University of Liverpool, Chadwick's main fields of interest have been in structural, synthetic and computational organic chemistry. With a commitment to international cooperation in science, he has worked and lectured widely throughout Europe, North America and Africa. He will succeed Dr David Evered. C.McG.

\* DARPA Neural Network Study to be published next month by AFCEA International Press, Fairfax, Virginia.