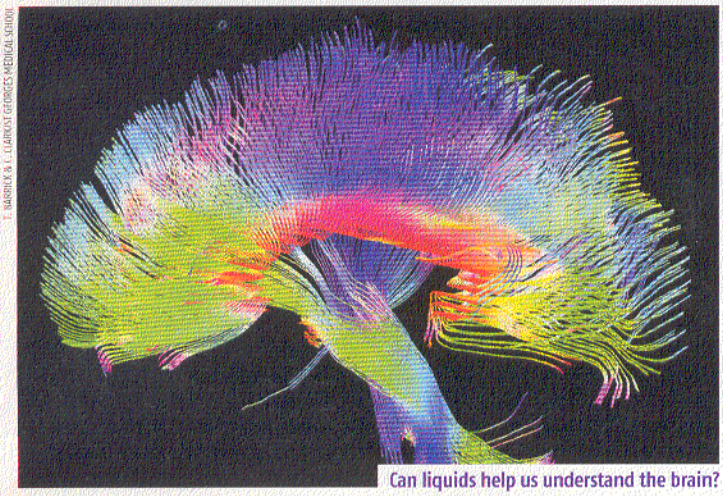
Neural nets learn better with waves



E. BARNEA & J. CLARKE/ST GEORGES MEDICAL SCHOOL

Can liquids help us understand the brain?

DUNCAN GRAHAM-ROWE

HOW do you improve the performance of a simple neural network? Use a tank of water to train it, say computational neurobiologists who believe the discovery may help us understand more about how the brain processes information.

The experiment carried out by Chrisantha Fernando and Sampsa Sojakka at the University of Sussex, UK, involved a type of neural net known as a perceptron, which can be "trained" by example to produce a specific output in response to a number of different inputs.

There are well-known limits to what a perceptron can be trained to do. For example, a perceptron can learn to mimic the behaviour of a logic gate known as an AND gate, which produces an output of 1 when both its inputs are 1 but otherwise produces an output of 0. This type of simple link between inputs and output is called a linear relationship.

However, a perceptron cannot learn to mimic the behaviour of another type of logic gate known as an Exclusive OR, or XOR, in which the input and output are linked in a non-linear way. When both inputs are 0 or both are 1, an XOR gate generates a zero, but otherwise it produces a 1. Although this kind of symmetry is easy for humans to see, it is impossible for a perceptron to detect when trained with sample input and outputs combinations.

But the Sussex team found a way round this limitation. Instead of feeding the inputs directly into the perceptron, Fernando and Sojakka connected them to wave generators in a ripple tank to create different patterns. So an input of 1 and 0 created waves from one side of the tank but not the other, and so on (see Diagram). They filmed the pattern, broke it down into a checkerboard of 718 squares and used the light intensity of each of these as the inputs into the perceptron.

This change makes all the difference – the perceptron is suddenly able to learn the behaviour of the XOR gate. Fernando says that displaying the inputs as a two-dimensional array allows the perceptron to "see" the symmetry, and this extra information is all it needs to solve the problem. He presented the work at a meeting on non-linear computers in Bristol last week.

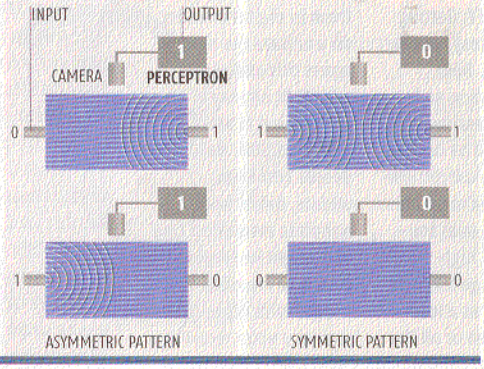
The idea that the properties of liquid can be exploited to carry out calculations was first proposed last year by Wolfgang Maass, a computational neuroscientist at Graz University of Technology in Austria. He suggested that "liquid-state" machines might throw light on the way the human brain carries out complex calculations despite being made up of simple neurons.

Andy Clark, a neural network expert at Indiana University in Bloomington, says: "If this model of computation works then it seems to me to be a stunningly powerful and important area for cognitive science to pursue." ●

FLUID THINKING

A neural net known as a perceptron cannot learn to produce the outputs below from the inputs alone. But if the inputs are translated into waves, that changes

Instead of sending the inputs directly to the neural net, a ripple tank translates them into a pattern of waves. This pattern is recorded by a camera and fed into the neural net. The neural net can then be trained to "see" the difference between symmetric and asymmetric patterns, and this allows it to mimic the behaviour of a logic gate known as an Exclusive OR, or XOR. Such a feat is impossible using the 0 and 1 inputs alone



INVENTION

SNIFFING OUT STOWAWAYS

One way to catch illegal immigrants is to sniff them out, says Hitachi of Tokyo (EP 1321766). Not to put too fine a point on it, when stowaways hide for long periods in an enclosed space they produce a distinctive body odour. The idea is to look for this smell signature in air samples. Immigration officials would take samples via a narrow tube that they poke through any vent into a container or a lorry. Hitachi's device then identifies the gases in a mass spectrometer. Any trace of body-odour chemicals would prompt further checks on the container or lorry.

ANTHRAX KILLER

Following the anthrax attacks in the US two years ago, mail rooms have been looking for ways to make sure incoming letters are safe. One way to kill anthrax is to irradiate it, but this can also destroy inks, making letters unreadable. The Xenon Corporation of Massachusetts has found that carefully timed pulses of intense ultraviolet light will kill biowarfare pathogens, including anthrax bacteria, inside letters without affecting writing or print (WO 03/061382). Suspect objects are put on a conveyor that passes under a high-intensity UV lamp. The lamp repeatedly zaps the object, and the movement of the conveyer changes the angle of illumination to prevent some bacteria shielding others.

MAGNETIC BRAKES

Motorists would cut down on maintenance bills if their cars never needed new brake pads or drums. Visteon Global Technologies of Dearborn in Michigan thinks it knows how to make this possible with the help of some simple electromagnetics (GB 2386000). The company's idea is to surround a rotating brake drum with many small electromagnets. When the electromagnets power up, they induce an "eddy current" in the rotating drum. These currents interact with the magnetic field to oppose the drum rotation, slowing down the car. The company provides an ordinary mechanical pad brake as an emergency back-up in case the power fails.