Toby Howard on developments in neural networks and the latest creatures in the cyber Ark.

The neural zoo

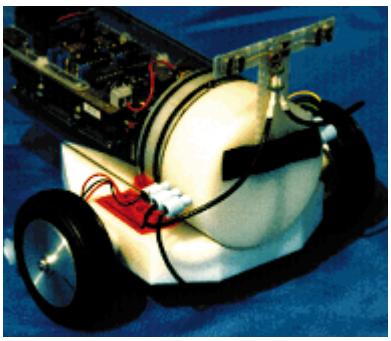
Surely something called 'Robo-lobster' cannot be serious — it must be one of those clumsy monsters Godzilla is always fighting. But no. It *is* serious. It is one of a new breed of artificial creature which exhibits unusually complex behaviour. They're called 'biobots' and they may be the missing link between biology and artificial life.

The robo-lobster spends most of its time submerged in a tank at Boston's Massachussets Institute of Technology <w3.`mit.edu/seagrant/www/robolob.htm>. The brainchild of Dr Thomas Consi, it's a shoebox-sized self-contained robot designed to mimic the ability of lobsters to sense chemicals in the water around them. What makes it unusual is that it is programmed using techniques inspired by the way biological systems work. This is 'soft computing', where answers don't need to be precise and where logic is fuzzy <web.cps.msu.edu/~miagkikh/SC_AL/>.

Robo-lobster now has a cousin, cyber-cricket. Researchers at Edinburgh University's Mobile Robot Group <www.dai.ed.ac.uk/groups/mrg/> have built a robot which successfully mimics the behaviour of female crickets which fly towards males who sing a mating song. The cyber-cricket is actually a three-wheeled laboratory robot called a Khepera, about half the size of a computer mouse <diwww.epfl.ch/Khepera/>. Its 'brain' is a Motorola 68000 processor running a neural network.

Neural nets have their origins in attempts to model the real nerve cells found in animal brains. The net comprises a number of interconnected simple processing elements, each of which has a set of inputs and outputs. Each of an element's inputs has a certain 'importance level', or 'weight', associated with it, and when the weighted sum of any signals present on its inputs exceeds a threshold value, the element 'fires' just like a real brain-cell and sends a signal to its outputs. These transmit a signal to other elements in the net which behave in a similar way, and so on. Eventually, the outermost elements in the net signal the 'answer'.

Neural nets are special because they can recognise patterns in the data fed to them. This is achieved by an initial 'training' period, supplying the net with sample datasets and repeatedly revising the weights of the inter-element connections to improve response.



▲ ROBO-LOBSTER IS BEING USED TO TEST BIOLOGICALLY INSPIRED ALGORITHMS FOR AUV GUIDANCE USING CHEMICAL SIGNALS. THE VEHICLE IS DESIGNED TO MIMIC THE BASIC FEATURES OF A LOBSTER RELEVANT TO CHEMICAL SENSING AND ASSOCIATED BEHAVIOURS

They make their decisions by weighing the evidence, rather than obeying fixed sequences of program instructions like traditional computers do.

The Edinburgh team has fitted tiny microphones to the cyber-cricket and trained its neural net to respond only to the calling song of males of a particular species of cricket. Placed in an environment containing random noise as well as real crickets chirping their love songs, the cyber-cricket successfully recognises the real crickets and trundles towards them. Amazingly, the cyber-cricket's neural net has only four elements: two for its left side and two for its right. Each pair is interconnected, and their inputs are fed from the robot's ears and their outputs control the robot's wheels.

Machines like cyber-cricket and robo-lobster are exciting because they demonstrate that multiple behaviours can arise from single mechanisms. For example, it's long been believed that the cricket must use two information-processing systems for performing the separate tasks of recognising a male cricket's call, and then locating its position in order to move towards it. The cyber-cricket, however, uses its single neural net for both jobs.

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We must be careful about drawing conclusions. Just because a robot equipped with a simple neural net can exhibit the same behaviour as a biological organism, it doesn't follow that the organism works in the same way. What it shows is that unexpectedly complex behaviour can result from simple processes. It's a pat on the back for the theory of evolution, too, since the neural net 'learns' by using genetic algorithms which simulate the copying and mutation processes of DNA. If researchers are on the right track, more complex artificial creatures will soon be scuttling about. Let's hope Godzilla isn't among them. □