BBC NEWS

IBM plans 'brain-like' computers

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IBM has announced it will lead a US government-funded collaboration to make electronic circuits that mimic brains.

Part of a field called "cognitive computing", the research will bring together neurobiologists, computer and materials scientists and psychologists.

As a first step in its research the project has been granted $4.9m (£3.27m) from US defence agency Darpa.

The resulting technology could be used for large-scale data analysis, decision making or even image recognition.

"The mind has an amazing ability to integrate ambiguous information across the senses, and it can effortlessly create the categories of time, space, object, and interrelationship from the sensory data," says Dharmendra Modha, the IBM scientist who is heading the collaboration.

"There are no computers that can even remotely approach the remarkable feats the mind performs," he said.

"The key idea of cognitive computing is to engineer mind-like intelligent machines by reverse engineering the structure, dynamics, function and behaviour of the brain."

'Perfect storm'

IBM will join five US universities in an ambitious effort to integrate what is known from real biological systems with the results of supercomputer simulations of neurons. The team will then aim to produce for the first time an electronic system that behaves as the simulations do.

The longer-term goal is to create a system with the level of complexity of a cat's brain.

Dr Modha says that the time is right for such a cross-disciplinary project because three disparate pursuits are coming together in what he calls a "perfect storm".

Neuroscientists working with simple animals have learned much about the inner workings of neurons and the synapses that connect them, resulting in "wiring diagrams" for simple brains.

Supercomputing, in turn, can simulate brains up to the complexity of small mammals, using the knowledge from the biological research. Modha led a team that last year used the BlueGene supercomputer to simulate a mouse's brain, comprising 55m neurons and some half a trillion synapses.

"But the real challenge is then to manifest what will be learned from future simulations into real electronic devices - nanotechnology," Dr Modha said.

Technology has only recently reached a stage in which structures can be produced that match the density of neurons and synapses from real brains - around 10 billion in each square centimetre.

Networking

Researchers have been using bits of computer code called neural networks that seek to represent connections of neurons. They can be programmed to solve a particular problem - behaviour that appears to be the same as learning.

But this approach is fundamentally different.

"The issue with neural networks and artificial intelligence is that they seek to engineer limited cognitive functionalities one at a time. They start with an objective and devise an algorithm to achieve it," Dr Modha says.

"We are attempting a 180 degree shift in perspective: seeking an algorithm first, problems second. We are investigating core micro- and macro-circuits of the brain that can be used for a wide variety of functionalities."

The problem is not in the organisation of existing neuron-like circuitry, however; the adaptability of brains lies in their ability to tune synapses, the connections between the neurons.

Synaptic connections form, break, and are strengthened or weakened depending on the signals that pass through them. Making a nano-scale material that can fit that description is one of the major goals of the project.

"The brain is much less a neural network than a synaptic network," Modha says.

First thought

The fundamental shift toward putting the problem-solving before the problem makes the potential applications for such devices practically limitless.

Free from the constraints of explicitly programmed function, computers could gather together disparate information, weigh it based on experience, form memory independently and arguably begin to solve problems in a way that has so far been the preserve of what we call "thinking".

"It's an interesting effort, and modelling computers after the human brain is promising," says Christian Keysers, director of the neuroimaging centre at University Medical Centre Groningen. However, he warns that the funding so far is likely to be inadequate for such an large-scale project.

That the effort requires the expertise of such a variety of disciplines means that the project is unprecedented in its scope, and Dr Modha admits that the goals are more than ambitious.

"We are going not just for a homerun, but for a homerun with the bases loaded," he says.

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