Lockheed Martin Looks To The Human Brain To Solve Complex Computing Challenges

In the 1939 film adaptation of L. Frank Baum's The Wonderful Wizard of Oz, the Scarecrow imagines a life "if I only had a brain." Now 70 years later, engineers at Lockheed Martin's Advanced Technology Laboratories (ATL) are using brain-inspired computing techniques to enable machines to think like humans.

And thinking like humans is vital if we expect computers to evolve from mere number crunching tools to partners capable of ferreting out and then reasoning about critical bits of information from staggering volumes of data from thousands of sources.

Computers have a big advantage over humans when it comes to processing large amounts of data accurately and quickly. Unlike humans, however, computers lack the intellectual wherewithal to deduce and predict from that data an object's behavior and patterns.

That's why brain-inspired computing is so important. It blends the processing capability and speed of computing with the cognitive sophistication of a human. Computers also have limited resources and can usually only solve comparatively narrow, well-defined problems. They cannot learn as humans do, cannot draw from past experiences, and have difficulty accurately and consistently processing incomplete -- or fuzzy -- information.

The ramifications for national and local security will be significant if technologists are able to someday apply the unique capabilities of the human brain to help computers analyze the uncertainties and complexities of global conflict, homeland security, terrorism, or local public safety.

In England, for example, there are about 4.2 million closed-circuit television cameras that monitor a number of public venues, such as streets. The sheer volume of video data gathered is staggering. But a relatively small number of individuals view those video feeds -- and then must then make spot decisions about suspicious behavior, patterns of activity, or events that could trigger illegal activity or hostile action.

By mimicking the intricate network of the brain's neural pathways and processes, ATL engineers are teaching computers to learn, manage information overload, discover patterns, and discern human intent.

In short, these are computers that are beginning to think like humans. ATL's research into brain-inspired computing extends into four areas. While the areas target defense-related applications, the resulting technologies could someday be applied to public venues where health and safety are important concerns.

Brain Box: Teaching Computers to Learn. ATL engineers are teaching computers to learn by using a building-block approach -- much the same way sentences combine to form paragraphs. This lets computers adapt previously learned concepts to new situations by reusing concepts that have meaning and relevance. For example, children have a much easier time tying a bow on a gift if they have already learned to tie their shoes.

Sensor Box: Managing the Overload. When faced with data overload, humans routinely discount all but the most essential data needed to perform a task. Computers cannot. ATL researchers are developing feature-extraction technology that will let computers find prominent patterns in raw data and transform them into single characteristics that can be classified.

Attentional Analysis: What's in That Image? With more visual data flooding command centers than analysts can review, filtering portions of unimportant imagery would save time, money, and mean greater mission success. ATL engineers are using features -- color, line orientation, and brightness -- to determine the relative importance of an image just as a human's visual attention system tells the eyes where to look after turning on the living room lights. Using this program, computers could analyze huge volumes of imagery and only present analysts with the most relevant images.

Brain-Inspired Attentional Search: Mind Reading That Works. To search an image database, a human uses a key word to find a particular photograph, assuming that someone earlier correctly annotated the images for them to be found. At the rate that visual data pours into command centers, annotating every image is nearly impossible. ATL engineers are developing a Brain-Inspired Attentional Search technology that will -- in effect -- read a person's mind for the image being searched as related images flash by. Sensors monitor the brain's electrical activity and chart a spike when the analyst sees the desired image, even if the analyst didn't consciously "see" it. Moving at a rate of 10 images per second, an analyst could search 600 photos a minute.

Headquartered in Bethesda, Md., Lockheed Martin is a global security company that employs about 146,000 people worldwide and is principally engaged in the research, design, development, manufacture, integration and sustainment of advanced technology systems, products and services. The corporation reported 2008 sales of $42.7 billion.

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