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News in Review

A Look at Today's Ideas and Trends

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When Computer Vision Imitates Life

Artificial intelligence researchers at the Massachusetts Institute of Technology have designed a system for computer vision that allows a machine to recognize objects in pictures as accurately as the human brain does, even when the background is filled with visual clutter or the picture is shown sideways.

Perhaps it should be no surprise that this promising model emerged only after someone tried to reproduce what already exists in nature, the human visual system. The model's designers endeavored to include the key neurobiological mechanisms of visual signal propagation and neural computation in the brain. (Previous systems have been guided more by the architecture of computers than of the visual system.)

But the effort to supersede the limits of earlier approaches to computer vision produced results that have been startling nonetheless, said the lead author of two recent reports about the computer-vision system.[1,2] Specialized, immediate-recognition testing has shown that the software can identify objects in pictures just as often as humans do (i.e., about 80 percent of the time).

"The goal of this work is to develop a computational model of the visual cortex, one that tries to take into account all the known facts about the visual system. So the model is really a neurobiological model," said Thomas Serre, PhD, a postdoctoral research associate in MIT's Center for Biological and Computational Learning.

"The surprise for us was how well it worked," Dr. Serre added. "There was no guarantee that a model that put all the biological information together would perform well. The excitement is because the system was able to deal with real-world visual situations. These aren't bar-lines or gratings, which earlier models used."

The researchers first "trained" their software to recognize faces and objects, and then showed it standardized picture-sets to gauge the accuracy of its identifications. The computer was as accurate as previous artificial-vision systems at detecting airplanes, motorcycles and certain facial images (95.9 to 98.2 percent accurate). However, it was 5 to 19.7 percentage points better than the earlier systems at seeing leaves, cars and a second set of faces.

After fine-tuning the software, the scientists put it up against the "gold standard," human vision. Twenty-four volunteers were asked to determine whether there was an animal in 1,200 images flashed before them for 20 ms each. The photos ranged from close-ups, to cluttered landscapes containing a small animal. Subjects answered by pushing a yes or no button. (The computer model also "saw" the pictures for 20 ms, but the limits of processing power delayed the answers several seconds.)

The researchers kept the glimpses short in order to isolate the visual cortex's first processing stage, which the computer model mimics, and assure comparability between the two data sets, Dr. Serre said.

"If you flash the picture fast enough, there is just enough information to let a person's brain know what the image is, but not enough time for a neural feedback loop to become active," he said. Often, the subjects had no conscious awareness of seeing anything. Despite this fact, the humans registered correct answers at an over- all rate of 80 percent. The artificial system scored 82 percent.

Even the studies' senior author, longtime artificial intelligence researcher Tomaso Poggio, Ph.D., professor of brain and cognitive sciences at MIT, was surprised at the match between the biological and

the engineered, Dr. Serre recalled. "Until this, Dr. Poggio and many others in the field would have told you that biology and computer vision are not likely to interact at any point," Dr. Serre said. "Conversely, one could think: Evolution has been shaping the visual system for many thousands of years, so if there is one set of neurobiological parameters that is optimal in life, it should be pretty good for machines, too."

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1 Serre, T. *et al.* IEEE Trans Pattern Anal Mach Intell 2007;29(3):411–426.
2 Serre, T. *et al.* Online April 2, 2007. Proc Natl Acad Sci USA.