Computer Model for Object Recognition by the Central Nervous System

Peter Schiffman
URI
ELE382-Biomedical Seminar III
03-05-2007

Neuroscience researchers from the McGovern Institute for Brain Research at MIT developed what seems to be a pretty good computer model of the visual system. In the last 50 years, computer science and AI have developed independently of neuroscience. Their work is biologically inspired computer science. Researchers at MIT have developed a model of the visual system that was meant to be useful for neuroscientists in designing and interpreting experiments, but that also could be used for computer science. They chose street scene recognition as an example because it has a restricted set of object categories, and it has practical social applications.

Near-term applications include surveillance and automobile driver's assistance, and eventually visual search engines, biomedical imaging analysis, and robots with realistic vision.

The research team "showed" the model randomly selected images so that it could "learn" to identify commonly occurring features in real-word objects, such as trees, cars, and people. In so-called supervised training sessions, the model used those features to label by category the varied examples of objects found in digital photographs of street scenes: buildings, cars, motorcycles, airplanes, faces, pedestrians, roads, skies, trees, and leaves.

Compared to traditional computer-vision systems, the biological model was surprisingly versatile. Traditional systems are engineered for specific object classes. For instance, systems engineered to detect faces or recognize textures are poor at detecting cars. In the biological model, the same algorithm can learn to detect widely different types of objects. To test the model, the team presented full street scenes consisting of previously unseen examples from the Street Scene Database. The model scanned the scene and, based on its supervised training, recognized the objects in the scene. The upshot is that the model learned from examples, which, is the basis of A.I.

Teaching a computer how to recognize objects has been exceedingly difficult because a computer model has two goals. It needs to create a representation for a particular object that is very specific, such as a horse as opposed to a cow or a unicorn. At the same time the representation must be able to disregard meaningless changes in pose, illumination, size, position, and many other variations in appearances. Even a child's brain handles these contradictory tasks easily in rapid object recognition. Pixel-like information enters from the retina and passes in a fast feed-forward path through the visual cortex. This model mimics the brain specifically, the "layers" within the model replicate the way neurons process input and output stimuli. The model's success validates work in physiology labs that have measured the tuning properties of neurons throughout visual cortex.

The model used in the street scene application mimics only the computations the brain uses for rapid object recognition. The lab is now working on including the brain's feedback loops from the cognitive centers. This slower form of object recognition provides time for mimicking thought processes, such as: if I see a car, it must be on the road not in the sky. Giving the model the ability to recognize such features will give it for real applications, including managing huge amounts of data, work tasks, or even email. The team is also working on a model for recognizing motions and actions, such as walking or talking, which could be used to filter videos for anomalous behaviors or for smarter movie editing.

Sources:
1.www.medgadget.com/archives/2007/02/computer_model_1.html
2.web.mit.edu/mcgovern/html/News_and_Publications/0702_poggio.shtml
3. 2007 IEEE Transactions on Pattern Analysis and Machine Intelligence Vol. 29 Issue 2
http://www.computer.org/portal/site/transactions/menuitem.802944db300bb678c4f34b978bcd45f3/index.jsp?&pName=tpami_home&