Imaging Software That Learns By Example

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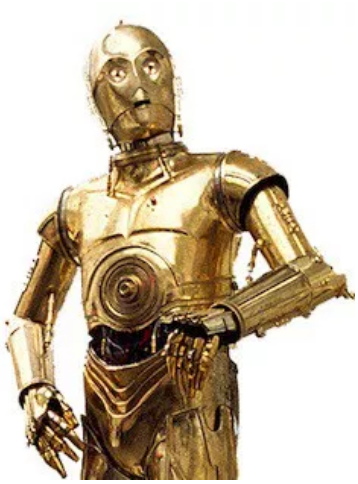

How does a machine learn? Asking that question brings up visions of artificial intelligence and robots like C3PO or the Terminator, but computer software that "learns" from data is no longer the realm of science fiction. Huge data centers at Amazon analyze what you browse and buy on their website to suggest other items you might like. Facebook looks at your network of friends to suggest new connections and display ads.

Software can even analyze medical images to help physicians and radiologists identify trouble spots for further investigation. Machine learning plays an important role in medical imaging, and one researcher at the University of Chicago Department of Radiology has pioneered a method to help imaging software learn less like a machine and more like a human.

Medical imaging software typically uses machine learning to classify items in an image as abnormal or normal, benign or malignant, and so on. The software takes measurements of the size, area, curvature or contrast of these features and compares them to a mathematical model that describes common shapes (think geometry). It can then flag areas of interest for a physician to help with diagnosis.

It's easy to represent a mathematical equation with computer code. The learning part of this process happens when the algorithm is adjusted to accommodate variables for different or less common shapes. The software can break complex shapes into segments and calculate their features separately, but this can lead to errors as the shapes become more complex.

To overcome this limitation, Kenji Suzuki, PhD, assistant professor of radiology, has developed software that uses the actual pixels in medical images to identify features instead of calculating them from an equation. This pixel-based method learns by comparing these images directly to training examples, much like the way people identify objects visually.

For example, say someone gave you a picture of a child's room and told you to pick out a ball. You could do this right away because you already know what a ball looks like. You compare items in the picture to the image of a ball you have in mind and categorize them quickly.

But say you had never seen a ball, and could go by only a description of the shape and curvature of a sphere. Given time (and the right math skills) you could pick out most of the ball-shaped objects, but would you be able to separate a ball from, say, a round lamp? Maybe, but not having seen a ball you would probably flag the lamp just to be safe.

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Using pixel-based machine learning, the software picks out lesions, nodules and polyps in a medical image by comparing them to examples from other images, the same way you compare the image of a ball to the image you already know. The conventional machine learning method has to rely on descriptions of those items, which can lead to more false positives, i.e. picking out a round lamp instead of a ball.

Suzuki said that while pixel-based machine learning is an improvement over the conventional method, the two work best together.

"We've observed that pixel-based machine learning gets higher performance for all of the applications we tried, so it's more advanced over conventional methods," he said. "But we also observed that pixel-based machine learning alone doesn't give the best result. Combining the conventional approach with it gives the best result."

The University of Chicago has licensed pixel-based machine learning to several companies who are developing computer-aided image diagnosis software. It is being used for several applications, such as enhancing images to define bones or blood vessels more clearly, and reducing false positives for various shapes.

While the software can learn to identify images like a human, it provides guidance only. An actual human physician or radiologist will still make the final diagnosis for the foreseeable future, albeit with a helping hand from an eager, computerized student.

This is our final installment in a series about technology and radiology here at the University of Chicago Medicine. In June, we wrote about the Human Imaging Research Office that helps researchers with imaging needed for clinical studies, and earlier this month we wrote about a pilot project that could bring medical image sharing out of the technical dark ages.

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Kenji Suzuki (2012). Pixel-Based Machine Learning in Medical Imaging *International Journal of Biomedical Imaging, 2012* DOI: 10.1155/2012/792079

machine learning software

About Matt Wood (519 Articles)

Matt Wood is a senior science writer at the University of Chicago Medicine and nonfiction editor for Another Chicago Magazine.