NewsBytes

Automating Scientific Discovery

Robots already have a place in many labs, automating tedious tasks such as pipetting samples. But a new system designed at Aberystwyth University in the United Kingdom has taken laboratory automation a step further.

"The idea of using a robot is not news, but what's different about ours is the robot was also involved in developing hypotheses and experiments on its own," says **Ross King**, **PhD**, head of computational biology at Aberystwyth University's computer science department. The work was published in the April 2009 issue of *Science*.

The robot, named ADAM, was programmed to find the genes that encode "orphan" enzymes in yeast. Armed with information from bioinformatics databases such as KEGG (the Kyoto Encyclopedia of Genes and Genomes), ADAM hypothesized, from sequence similarities, which genes could encode the enzymes.

ADAM owes its brainpower in part to databases of formalized knowledge. One component is a detailed model of yeast metabolism written in the logic language Prolog; another is an ontology describing laboratory experiments, based on the open-source project EXPO. The robot also recorded its own experimental information as it worked. "One of the advantages of a robot scientist is that you get all that metadata for free," says King. "We can understand far more about the structure of the experiment than we would if only humans had been involved."

ADAM's four computers directed the experiments, with robot arms moving yeast mutants from freezer to incubators to plate readers. Ultimately, it found 12 gene-enzyme pairings that the authors were able to confirm. In some cases, the link between gene and enzyme was found to be supported by literature even though it was missing from ADAM's starting data. For others, the authors double-checked ADAM's results by purifying and testing the protein themselves.

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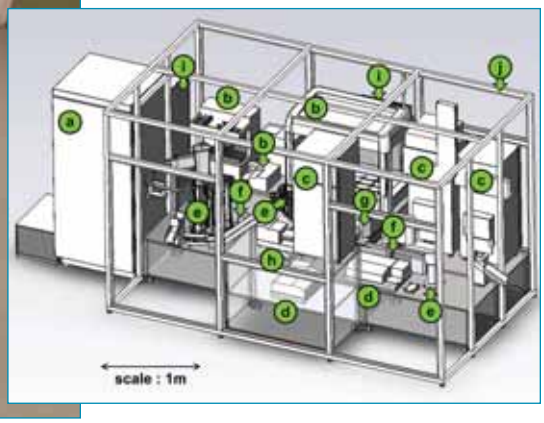
The successful matches "are mostly to do with odd pieces of biochemistry that hadn't been sorted out yet," King says, which explains why the enzymes remained orphans for so long. Some were isozymes, with more than one gene encoding the same function, and others were promiscuous enzymes that catalyze more than one reaction.

King and his collaborators have started work on the next generation of robot scientists, beginning with a robot called EVE that will work to discover new drugs for tropical diseases.



ADAM is a 5-meter-long robot whose equipment includes cameras, sensors, and computers in addition to (a) an automated -20°C freezer, (b) three liquid handlers, (c) three automated +30°C incubators, (d) two automated plate readers, (e) three robot arms, (f) two automated plate slides, (g) an automated plate centrifuge, (h) an automated plate washer, (i) two air filters, and (j) a plastic enclosure. Diagram reprinted with permission from King, RD,* et al., *The Automation of Science,* Science, *324:85 (2009). Photo: Courtesy of Aberystwyth University.

As King describes it, "ADAM and EVE are special purpose, but our goal for the future is to make more general purpose automation."

"People ask if this is going to put scientists out of business, but the answer is no," says **David Waltz, PhD**, director of the Center for Computational Learning Systems at Columbia University. Instead, he says, "this will make scientists more productive," but they would also have to learn new skills. "Scientists would have to learn to be proficient in Artificial Intelligence and to create formal representations of knowledge."

—By Beth Skwarecki