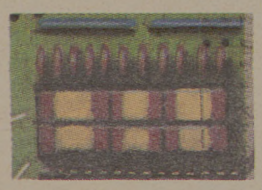
ARTIFICIAL INTELLIGENCE

(Continued from cover) design circuits, but can you trust it with your health? One medical expert system, CADUCEUS, contains the medical know-how of Jack Meyers of the University of Pittsburgh: 125,000 facts about internal medicine.



The program, capable of recognizing 500 diseases by analyzing 3500 symptoms, is known familiarly as 'Jack in the Box'.

Another expert system, DENDRAL, which identifies chemicals through their mass spectrographs, is a 'generator-based' rather than rule-based system. It generates 'ideal' spectral patterns and then tries to match them to the real pattern it is analyzing. Some AI experts believe a generator-based system is closer to human intelligence than a rule-based system: to recognize a chair, a human compares it to an abstract concept of a chair.

Nevertheless, rules are still important. Even DENDRAL has to apply simple rules to narrow down the immense field of possibilities before it begins the time-consuming and expensive chore of generating possible spectrographs.

Furthermore, one big advantage of rule-based systems is that information can be added one piece at a time, as it is obtained and also subtracted one piece at a time, to see how important each is to the total system.

Other programs, like TEIRESIAS, designed by Randall W. Davis of MIT, make expert systems almost self-replicating. TEIRESIAS keeps statistics on the frequency of incidence and correlation of symptoms, providing the basis for new rules.

It also helps the programmer analyze new rules. For instance, it might say, "You have said nothing about how the disease enters the body, whereas in most diseases with rules like that one, you have specified how the disease entered the body."

"Artificial intelligence techniques are becoming simply good engineering practice."

Davis is now pioneering yet a third method, a 'model-based' expert system, to diagnose computer hardware problems. Given the plan of a microcircuit and its inputs, the program builds a model of how it is supposed to behave and calculates the outputs.

If the calculated outputs do not match the real outputs, the program switches off each component of the simulation one at a time to locate the problem. The AI of the program is that the rules come from electrical engineers and that it communicates in English.

Yet another development has been getting machines to imitate the brain's ability to do many things at once. Researchers have started to design computers to process 'in parallel', executing many instructions at the same time rather than walking straight through a program one line at a time.

Supercomputers, like the Crays, a family of number-crunching machines used for such monumental tasks as cracking cipher and solving high-level physics problems, have proven this architecture is faster.

Parallel processing has been carried to its logical end by the Thinking Machines Corporation (TMC), an artificial intelligence firm founded by AI guru Marvin Minsky. They have built what they call The Connection Machine, which consists of one million interconnected processors executing symbolic instructions for pattern recognition and learning.

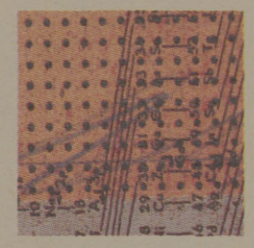
Even their test methods are illustrative of the power of these machines. "We have database jocks who feed it dictionaries and telephone books and then look things up to see how fast it is," said a TMC programmer.

Most expert systems are programmed to explain their reasoning on request, making them educational tools as well. "If you ask a program how it makes its decisions, it will tell you," said one expert. Another researcher commented, "Lots of people have requested the code for DENDRAL because it's a great advanced spectromentry course."

Many AI researchers share the hope that building computer simulations of intelligence may provide a way to understand human intelligence better. In order to write an expert system program, an AI specialist must first analyze how an expert thinks. This forces the programmer to define 'gut feelings' very precisely or organize vague concepts into specific steps.

Using artificial intelligence programs to simulate the workings of the human mind has other advantages for the researcher. "Computer programs exhibit unlimited patience. They require no feeding, and they do not bite," noted MIT's AI LAB Director Patrick H. Wilson.

But some are skeptical of the benefits of AI for cognitive science. "When you made a mechanical mouse that moved, it didn't help you understand mice better," says noted MIT physics professor Philip Morrison.



It is unclear whether AI will ever produce a duplicate of the human brain, but the possibility and number of years required for a project of this magnitude are hot topics of debate in AI circles.

However long it takes, the race is clearly on to see who will be the first to make a computer walk and chew gum at the same time. ◀

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How to Prepare for a Career in AI

As in all fields of computer science, industry needs AI specialists faster than universities can turn them out. A degree in computing is almost a prerequisite for breaking into the field. If you want to start work right away, you should major in computer science as an undergraduate, and try to get a thesis or coop job in artificial intelligence.

However, if you have the patience for a four-year graduate program in artificial intelligence, you can approach the field from an undergraduate background in psychology, cognitive science, linguistics, philosophy or mathematics.

You can throw out your BASIC and FORTRAN programming manuals. The languages of choice in artificial intelligence are LISP and PROLOG. These languages are designed to promote symbolic processing of logical concepts--the **sine qua non** of artificial intelligence.

Another popular option is writing your own language, tailored to the specific AI application.

Who's Hiring in AI

The biggest user of AI talent, currently funding almost all AI research, is the military. The Pentagon wants to build an electronic co-pilot for combat aircraft to take over the pilot's complex array of cockpit tasks. They plan to use the 'Star Wars' Strategic Defense Initiative to spawn a variety of new machines for battlefield operations.

"We want some architectures that are good for building semantic memories, memories that can hold knowledge, [and] we want architectures that can do very rapid signal processing [and] structures that can handle very, very large amounts of data in communications," said Defense Advanced Research Projects Agency (DARPA) computer director Robert Kahn.

However, the demand for AI is everywhere, from small entrepreneurial software firms to giants like Control Data and IBM. MIT Artificial Intelligence Lab Director Patrick H. Winston predicts tremendous growth in expert systems for finance and banking. Financial analyst Andrew Tobias has already put himself on a disk.

Advances in machine vision and motion will revolutionize traditional engineering industries. And, in another instance of self-replication, expert systems for circuit design are taking over the tedious details of laying out transistors on a chip, allowing engineers to focus on the overall design.

Says Kenneth J. Meltsner, an MIT graduate student in materials science who is writing a thermodynamics simulator to help sophomore engineering students grasp complex concepts, "Artificial intelligence techniques are becoming simply good engineering practice." ◀