Expert computers emerge from shells

By Bruce Holman
(Special to the Herald)

From categorizing fossils to sifting through intelligence data — so-called "expert" computer systems are taking on more and more tasks once thought to be the private domain of the highly trained human mind.

Expert systems are being developed to diagnose your medical problems or teach you how to operate a sailboat or show you how to coach your kids' hockey team more effectively. Other systems analyze information on taxes, rocks or seismic soundings, and can even be adapted to oenology, the eclectic study of wine. But what is an expert system and how does it work?

"Basically you have a knowledge base, which consists of facts and rules . . . on a particular topic or domain," says Dr. Mildred Shaw, a University of Calgary expert systems specialist. The knowledge base must be able to accommodate rules that are contradictory. This is done by attaching probability values to rules.

Thus, the system can determine which outcome is most likely in a particular case. This is roughly the same way people operate.

"We consider inconsistencies and contradictions and we get a lot out of this," says Shaw. "It doesn't make us less viable, it makes us more viable."

On top of the rule base, one builds what is called an inference system. Its purpose is to derive facts from those that have already been entered into the computer, Shaw says. Another component is the planning system, which decides the best way for the inference system to carry out a particular task.

"And, these days, one would not recognize something as an expert system if it did not have an explanation system," she says. "This isn't in any sense a deep level of explanation. If you ask it 'why?' at a certain point, it'll show you what rules it's used."

One of the earliest, most successful applications of an expert system was a program called MYCIN. It was designed to diagnose and recommend treatment for blood infections.

"If you take MYCIN, for example, and you tip out all the facts, then you've got what's called an expert system shell, called EMYCIN," Shaw says. "And then you can put other facts in there about some other topic and use the same planning, inference, and explanation systems."

Many systems have incorporated the EMYCIN shell since it was developed in the mid-1970s. Now, other shells are being actively developed in both the academic and business world.

However, it was difficult for someone to correct MYCIN's rules if it had diagnosed an infection improperly. This led to the 1982 development of a "metasystem," which allows the user to "talk" to MYCIN about where the incorrect rule or lack of information might be.

Getting the rules into the system in the first place so that the computer understands them is a complicated business. Almost invariably, it requires the expertise of a knowledge engineer.

Shaw's trying to develop a computer program that would eliminate the need for a knowledge engineer, so the expert and the computer could interact directly.

One of the reasons this kind of software is needed is that the demand for expert systems is outstripping the supply of knowledge engineers. Another is that information can be "lost" or misunderstood by a knowledge engineer translating the expert's rules into a form the computer can use.

Shaw is working closely with Dr. Brian Gaines, another computer expert, to develop a program that relies on certain psychotherapeutic techniques. Specifically, it uses personal construct psychology, a system developed in the 1950s by Dr. George Kelly.

"He would talk about the 'significant others' in your life. 'How are they similar and different from each other? How do you see them?' " Shaw says.

According to Kelly's theory, each of us carries a "personal scientist" in our head. Our imaginary "scientist" establishes answers to these questions by developing ideas about how the world operates and then checks them against the information at hand. Ideas that don't agree with the information are either modified or thrown away.

In some sense, the expert in a particular field can be seen to do the same thing. Shaw's program asks the same sorts of questions of the expert. "How are your tasks similar, and how are they different?" This encourages the expert to systematically analyse his job functions.

Using a 'mouse' to manipulate information on the screen, the expert can classify and rate the various tasks that make up his expertise. In this way, a knowledge base is established in the expert shell.

"At the moment, expert systems only deal with what's called shallow knowledge," says Shaw. "Any deep knowledge related to underlying principles is very difficult to represent."

Expert systems using shallow knowledge are popping up like mushrooms.

For example, FOSSIL is an expert system developed at Imperial College in London for use in paleontology. Collectors can query or update the system and students can use it as a tutor.

The Tyrrell Museum of Paleontology's head of display services says the Drumheller institution doesn't have anything comparable to FOSSIL. But Monty Reid says he plans on "getting ahold of these people and finding out exactly what they have and whether it's compatible with anything we've got in place."

Other expert systems under development include:

● SATS, Signal Analyst Tutoring System, developed by the U.S. Air Force to train intelligence analysts more efficiently;

● SKIPPER, a prototype sailing instructor, developed by RCA;

● a system is being designed in California to help doctors predict the outcome of eye surgery;

● the University of Waterloo is using expert systems to control robots working in hazardous environments;

● MITRE Corporation is attempting to streamline transit bus maintenance with expert systems;

● the space shuttle manipulator arm is controlled by a highly effective expert collision avoidance system;

These are expert systems currently in use or being developed — but what of the future?

John Reising and Richard Moss work in the Flight Dynamics Laboratory at the Wright-Patterson Air Force Base in Ohio. In a recent article they outlined what the cockpit of a fighter aircraft might be like in the year 2010. It will be quite a change from today's aircraft.

"By far the biggest difference will lie in the crew's composition. All fighters of this era will have two crewmembers — one human and one electronic. Advancements in computer technology will have taken such strides that the electronic backseater will be able to perform many of the tasks previously assigned to his human counterpart. Examples of these are navigation, communications, weapons management and sensor data fusion." They say the machine will respond to "thought commands" issued by the pilot.

"Throughout the mission, the crewmembers, human and electronic, will have such intimate knowledge of how to work with each other they will function as smoothly as an Olympic figure skating pair, each anticipating the moves of the other while striving for the same goal."

Dr. Brian Unger, a computer simulation specialist at the U of C, takes these kinds of predictions with a grain of salt.

"In the 1950s everybody thought that we were going to write computer programs that could translate from English to Russsian in about five years," he said, "and it turns out we're not doing it yet."

It was also felt expert chess programs would be unbeatable by the mid-1960s. Although they've reached a level of performance equivalent to a master level of play, Unger says it took three times longer than expected. And they still haven't achieved grandmaster ability.

Although the timing is debatable, the idea that we could become a society hooked on expert systems doesn't seem unreasonable.

And it's a sure bet that all the related problems and issues will be at least as fascinating as those we've had to grapple with when the computer first took the limelight not so many years ago.



Mike Fiala, Calgary Herald

Specialist Shaw offers lighthearted toast to computer's wide-ranging applications

Systems sharpen competitive edge

(Special to the Herald)

Expert systems are being used by an increasing number of businesses as the latest tool to sharpen their competitive edge.

Touche Ross Management Consultants is hustling to put together a strategy to help clients get the right system for the job.

"It's an emerging field and at this point it would be unfair to say we have any in-depth experience," says company spokesman Ed Bottrell, of Toronto.

"However, virtually every client we have in the financial institutions has identified these sorts of needs," he says. "And we're within weeks or months — certainly not years — from beginning some of these efforts."

Bottrell says the role of his company will be to guide the client through the maze of details that must be considered in selecting an expert system, including the important task of choosing the right expert shell.

The accounting firm of Coopers and Lybrand has developed a system for its own use called EXPERTax. Forty tax experts were used to construct the knowledge base, says Don Brown, also of Toronto. He says EXPERTax was designed by Coopers in the U.S. for use in that country.

There are no plans to develop a comparable system in Canada at the present time, "partly because their tax system is quite different from ours in the whole way it operates.

"Plus, to be quite brutal, the cost of putting together one of these things is astronomic." Brown estimated it cost Coopers about $2 million to develop EXPERTax.

"Shells are coming out fast and furious now," he says, "but at that time there was not one on the market that was suitable."

Expert systems are also being put to work in the oilpatch. Schlumberger of Canada has created a program called DIPMETER ADVISOR.

"What we're really trying to do is build up the geometry of the reservoirs," says spokesman Eric Standen. It is "first and foremost a very fast graphics system."

It allows a good interpreter to interpret the log (a log is a record of data collected in the field) much more quickly.

New name on Fridays

Friday's Life Today section, since it will be devoted to a specific area of interest, has also been renamed.

Every Friday, the New Waves section of the Herald will be devoted to articles about new ideas in science, medicine, education and psychology.

The New Waves section will also carry a number of brief items on research breakthroughs as well as two other Life Today staples — the Ann Landers and Dr. Donohue columns.

U of C team designs electronic ally for coaches

(Special to the Herald)

Community hockey coaches will one day be able to routinely consult with a professional "trainer," thanks to an expert computer system being developed at the University of Calgary.

But when this system is complete, it will have applications that stretch far beyond the skating arena.

Physical education instructor Dr. Joan Vickers is in charge of the project. The idea is to capture Calgary Dinosaurs coach Dr. George Kingston's hockey expertise on computer.

"You know for sure that when George is talking to you about ice hockey, he actually sees the players," Vickers says. "So what you're trying to do is capture what someone sees. Put it into the system so that other people can then see it."

The system will consist of a videodisc player controlled by a MacIntosh II computer.

The novice hockey coach will be able to use it in three ways.

First, he'll be able to scan the videodisc material. This will give him a feel for the way in which all the techniques and tactics a hockey player must know have been visually analysed.

Under the heading of "skating," for example, 29 different kinds of footwork have been identified and will be carefully demonstrated and explained. This part of the program is called ActionView. It will also give the coach a chance to get acquainted with the software.

The second segment is called ActionMark. It will provide the coach with guidelines for systematically assessing the physiological condition and technical ability of each team member.

Results from these evaluations will be entered into the computer where they'll be compared to various recognized standards of performance for a given age. The coach can also enter his training objectives for each athlete and ActionMark will track that person's progress.

The program's third component will draw on the visual and statistical information of the previous sections. ActionAdvisor will help the user develop sound teaching or coaching plans. It will encourage his perceptual analysis of the skills of each athlete and suggest ways of providing individual and team assistance.

Vickers emphasizes that the system won't be a silicon-based know-it-all delivering edicts to the coach.

"It's being designed for . . . coaches first, and for athletes second. It's an important point because I don't think any of our educational packages will work unless instructors become completely sold on them."



John Skrypnyk, Calgary Herald

Vickers, assistant record Russia-Canada hockey game

Developing an expert system is not done in a few weeks or even a few months. The hockey "coach" has been in the works for six years and Vickers says it still has a long way to go. It's been a particularly challenging project because it involves analysing motion as well as information.

She hopes to have side one of the first videodisc ready in time for a presentation at the Olympics next year. She wants it to be "totally different than anyone's ever seen, so that people who are steeped in ice hockey will say, 'Finally someone has shown what we know — finally it's happened.' "

Vickers supervised the filming of a recent Canada-Russia hockey game at the Saddledome to use as part of the ActionView segment. Players were photographed going up against each other in one-on-one, one-on-two, and two-on-two situations.

The camera scrutinized these world-class athletes using the very skills that coach Kingston thinks are important in each kind of encounter. Vickers says that certain specific techniques too fast to catch will be re-enacted later in a controlled environment using high-speed photography.

When it's finally assembled on the videodisc, together with graphic overlays and a sound track, this material will "accent the things George sees," Vickers says.

The target audience for the finished product "is mom and dad," who want to coach hockey to neighborhood kids. "They go out for one practice and say, 'My goodness. This is extremely . . . complex.' "

Vickers says this can cause perfectly well-meaning people to become angry and frustrated. Instead, she would like her system to provide the means for a coach to say, " 'We need to work on A, B, C, D' and very matter-of-factly know how to help those kids."

The purchase price of a typical unit is expected to be around $10,000. Because of the cost, the coaches' "coach" will initially be available only in public facilities such as universities, libraries, arenas, and through sport governing bodies. But Vickers thinks the price will eventually come down and this will increase accessibility.

The completion date depends on the availability of research funds, but is being measured in years.

She says the project has been very much a joint effort involving Calgary Flames coach Bob Johnson, Team Canada coach Dave King, computer scientist Dr. Brian Gaines, and many others.

According to Vickers, this system could easily be adapted to any sport. In fact, she says it has applications in a wide range of fields, from construction to medicine to the military — anywhere complex physical skills are part of the job.

One study claims laser videodisc technology can help an individual acquire skills 20- to 30-per-cent faster than with conventional techniques.

"Where you're spending real dollars to train people, that's a lot of money saved," Vickers says.

In the meantime, the day-to-day job of putting the prototype together continues. Despite the myriad of details that must be attended to — unending paperwork, jangling telephones, people popping in the office with a message about this or that — Vickers has come to a conclusion about the nature of the software that potential users might find reassuring.

"Somehow I think, really deep down inside, that what we're doing is not complex at all," she says.

"The information is complex, yes. But the ideal program to show and share that with others will be simple. It will be very, very simple."