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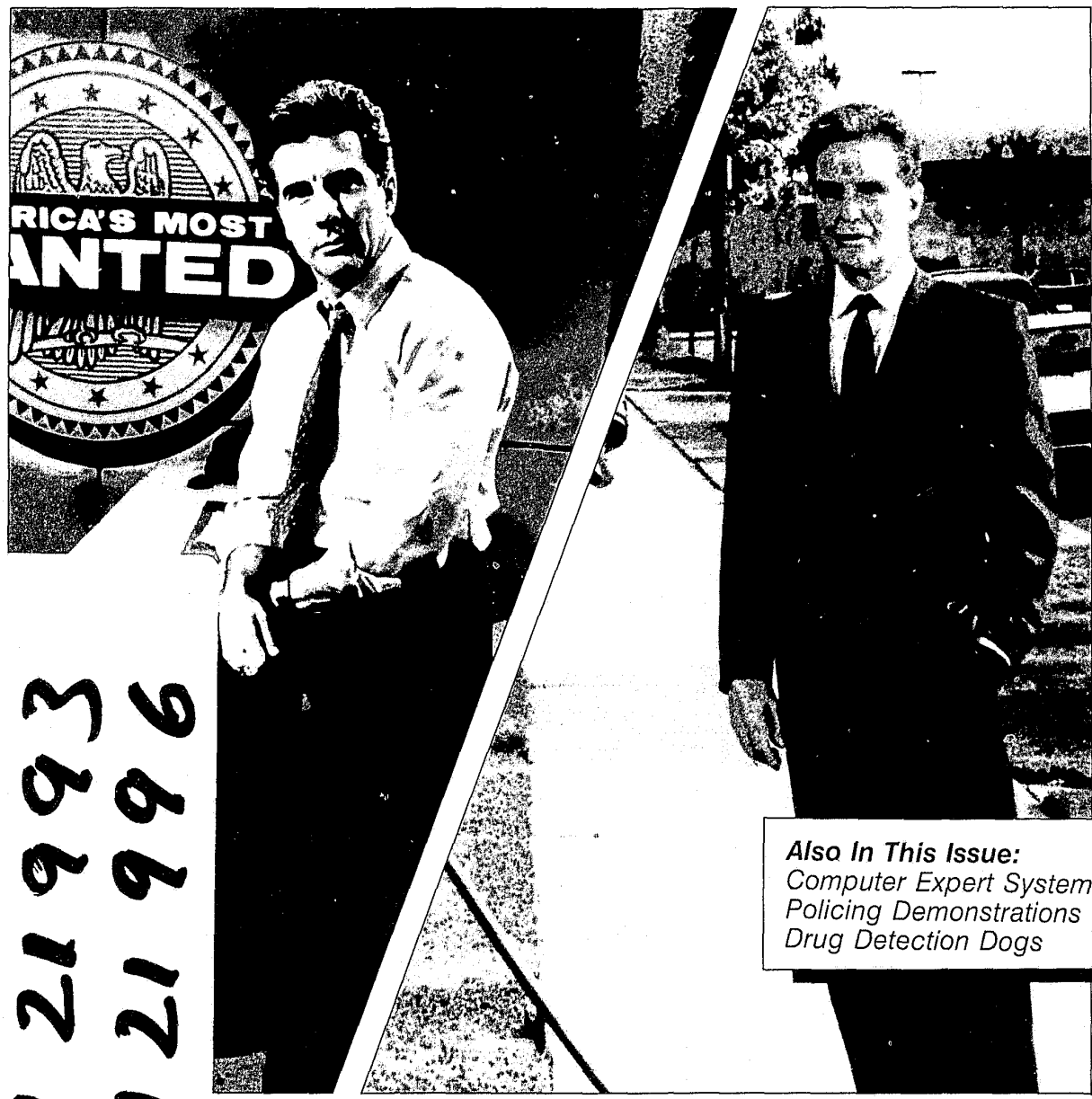
FBI Law Enforcement Bulletin



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Expert Systems For Law Enforcement

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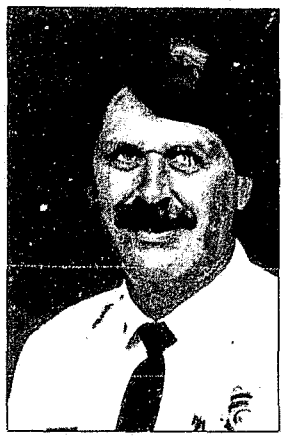
In a large eastern city, a police detective enters into a computer approximately 25 informational items about a burglary he investigated that morning. Once the data are in the computer, an "expert system" compares the modus operandi (m.o.) of this burglary with the known m.o.'s of suspects currently operating in the area. Within seconds, the computer responds with 10 possible suspects listed in order of probability. By the end of the day, the suspect listed first has been found in possession of the stolen articles and is in custody.

The expert system that made this apprehension possible is a new form of computer software that will revolutionize the use of computers by law enforcement agencies and help propel the profession into the 21st century.[1] By greatly increasing productivity, this problem-solving tool will become part of every progressive law enforcement agency's arsenal against crime.

Expert systems are part of a domain referred to as "artificial intelligence," or AI.[2] Computers use AI to solve problems in specific areas in a way that simulates the processes of human intelligence. An excellent example is MYCIN, a system that diagnoses diseases of the blood rapidly and effectively.[3] In describing MYCIN, Buchanan and Shortliffe explain that an expert system is "... an AI program designed (a) to provide expert-level solutions to complex problems, (b) to be understandable, and (c) to be flexible enough to accommodate new knowledge easily."[4]

The heart of such a system is human knowledge derived from experts. This forms a "knowledge base" consisting of 1 to 500 rules.[5] Each rule is an "if-then" statement, e.g., "If the patient's temperature is over 100°, then an infection may be present." The user, however, never sees the rules when using the program. Instead, the system queries the user about the case and eventually arrives at a diagnosis. At any stage, the user can ask the system why it is making a particular query or how it reached a particular decision.

Dr. Reboussin



Chief Cameron

Expert systems have a number of advantages over human thought processes. First, the system preserves the expert's knowledge, so that if the expert eventually leaves the organization, a large proportion of his or her expertise is retained. For example, just prior to retirement from a major national corporation, one professional helped to create a system that he estimated retained approximately 90 percent of his knowledge.[6]

Another benefit of the expert system is that it can be more accurate than any one person for a number of reasons. First, the system retains simultaneously the extensive knowledge of several persons; it never forgets and never overlooks anything. Nor does it jump to conclusions. Also, since experts continually update information, the system is kept current. Thus, the system has the potential to be "more expert" than any one human being. That is the situation with MYCIN right now—not at some time in the future. Harmon and King state: "The various evaluations that have been undertaken all suggest that MYCIN is as good or better than the most very skilled human experts."[7]

However, an inherent weakness in such programs is that the expertise is strictly confined. In the case of MYCIN, its domain is limited to the diagnosis of meningitis and prescription of appropriate drugs.

Today, in the commercial world, expert systems are used to do many tasks—to search for good mineral sites, to design computer systems, to navigate aircraft, to land the space shuttle, to drill for oil, to troubleshoot complex electronic and mechanical systems, etc. The DuPont Corporation has 200 expert systems currently running and expects to have 2,000 operating by 1990. The estimated savings in manufacturing processes per year for each system is $100,000.[8]

Expert Systems at the NCAVC

At the National Center for the Analysis of Violent Crime (NCAVC), there is considerable interest in adapting AI systems for use in criminal investigative analysis, formerly referred to as psychological profiling or criminal personality profiling.[9] Criminal investigative analysis has been described in a number of recent publications.[10] Simply put, it is the process of identifying major personality and behavioral characteristics of an individual who has committed a homicide or other violent crime through detailed analysis of the crime scene and related evidence.

The rationale for this process is that behavior reflects personality. The same rationale underlies any projective test or task. That is, given a standard task, much is learned about an individual by observing how he or she performs this task. Those who have seen this task performed many times and have a broad background of experience can relate the way the task is performed to the characteristics of the person performing it.

Information about the victim and the crime scene is essential to the analysis process. With detailed information as to age, sex, occupation, and daily habits of the victim, the autopsy report, and a specific description of the crime scene, the behaviors of both victim and offender during the crime can be reconstructed.

The result of this analysis is a description of the person who committed the crime, which includes physical characteristics (age, sex, and race), behavioral characteristics (whether the offender lives near the scene of the crime, lives alone, or is unemployed), and personality traits and characteristics (the nature of relationships with women or volatile temper). An intermediate trait would be the nature of the offender's relationship with the victim. It should be stressed that the analysis does not identify a spe-

cific individual; rather, it identifies a particular type of person. Local authorities must then relate the description provided to a particular individual.

NCAVC is currently developing an expert system to perform this type of investigative analysis. This system, called PROFILER, has the potential to analyze better than any one person for reasons previously mentioned. In addition, there is another reason that is more interesting because it deals with the actual analysis process.

After the NCAVC has created a large database of violent crimes, the expert system will be able to derive the probabilities for individual rules empirically. At the present time, these probabilities are derived clinically, that is, they are based on the experience and wisdom of individual analysts. For example, consider the rule, "If the body has been placed or arranged face down, then the assailant knew the victim." Say for now that this rule is assigned a probability of .70, based on the judgment of NCAVC analysts. However, the ideal future system database will be able to run all cases in which the victim was arranged face down and the offender was eventually identified and will be able to calculate the actual probability based on the data.

Certainly, the PROFILER system will never replace skilled human investigative analysts, nor is it intended to do so. Rather, the system will function as an analyst's assistant or consultant in several ways. First, the system can assist in training apprentice analysts by comparing their results with the system's, and by giving reasons for the conclusions drawn. Second, the system can aid skilled analysts in much the same way. By studying the discrepancies between their conclusions and those of the system, experienced analysts may be led to consider other possible variables. This may help create a better profile, revise the knowledge base, or both. Finally, when proven both reliable and valid, the system allows human analysts to spend less time developing the profile and more time working on other aspects of the case.

Developing an Expert System

There are two main steps in developing an expert system. First, the agency should consider purchasing a shell, which is essentially a pre-written expert system program into which one can plug a set of rules. It is not as flexible as writing a program, but with the shell, the system becomes operational immediately. Later, if the package is too limited, additional programming can be added. With the experience gained using the shell, a more complete package can be obtained from a programmer.

Shells range in price from $99 to $65,000. However, spending more than $500 initially would not be cost-effective. It is better to start with a small and inexpensive system that operates on the department's PC. When the first shell is outgrown, then an agency can move up in range.[11]

The second step is creating a knowledge base, that is, a set of rules. In order to do this, first locate a true expert who is willing to cooperate. Then, collect the expert's knowledge into a set of rules. Once this is accomplished, all other problems are trivial. However, if this is not done, the proposed expert system will not function.

Most of the rules for PROFILER, for example, were developed by observing the investigative analysis process in a group setting. Individual analysts checked the rules, making suggestions, revisions, and deletions to come up with approximately 150 rules in the PROFILER prototype.

After developing a set of rules, the knowledge base is entered into the shell. Initially, there may be problems getting used to the syntax. However, once familiar with the syntax, the user can proceed to the main task—making use of the system to its fullest potential.

> ***"Expert systems have a number of advantages over human thought processes."***

How Can an Expert System Help You?

Basically, an expert system can be built to solve any problem complicated enough to make the system cost-effective, but simple enough so that the task can be specified in a set of rules the computer can understand. As an example, in rape investigations, an expert system could analyze the modus operandi for the rape and suggest the most likely suspects from among a group whose m.o.'s are known.

The Baltimore County, MD,

Police Department currently uses such a system to solve burglaries. The system contains about 110 rules and has a database of information on burglaries, suspects, and m.o.'s. Information on a reported burglary is entered into the system, which then gives a list of possible suspects.

A system could be designed to represent the expertise of any person or group in a department, such as detectives investigating specific crimes (sex offenders, other violent crimes, property crimes) who share a certain expertise. When codified, this expertise forms the basis for a fairly complex expert system.

This, in fact, is what the Baltimore County Police Department did in developing its burglary system. The rules in their system were developed from the expertise and accumulated knowledge of its burglary detectives. In addition to identifying burglars, a system like this, with only slight modifications, could be used to train detectives newly assigned to burglary investigations. In fact, many other training situations lend themselves to automation with an expert system, e.g., patrol procedures, arrest techniques, or search methodology.

However, difficulties can materialize. While expertise in computer science is not a prerequisite, developing a knowledge base (the set of rules) and transferring it to the computer requires a certain amount of effort. Then the system must be developed so that it grows from the "toy" prototype into a system that provides useful information, which takes a minimum of 6 months of full-time work.

Developing an expert system could require the cooperation of a number of units within a department. Cooperation not only reduces the manpower needed to develop a system, but once a system is developed, it could be shared and used more effectively and efficiently.

> ***"The expert system ... will revolutionize the use of computers by law enforcement agencies...."***

Expert Systems and the Future of Law Enforcement

In a provocative article on artificial intelligence and its future use in law enforcement, Tafoya states:

> "The well informed, intelligent use of computer technologies, such as artificial intelligence and expert systems, could make a significant difference in the manner in which the law is enforced and the public served.[12]

Law enforcement agencies in America, already heavily committed to the use of computers, must plan now to take advantage of the new developments in artificial intelligence. The versatility and increased power of expert systems provide American law enforcement agencies the edge they will need in the 21st century. FBI

Footnotes

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[10]J.E. Douglas, et. al., "Criminal Profiling from Crime Scene Analysis," *Behavioral Sciences and the Law*, vol. 4, 1986, pp. 401–421; J.E. Douglas and A.E. Burgess, "Criminal Profiling: A Viable Investigative Tool Against Violent Crime," *FBI Law Enforcement Bulletin*, vol. 55, No. 12, December 1986, pp. 9–13; R.R. Hazelwood, et. al., "Criminal Personality Profiling: An Overview," in *Practical Aspects of Rape Investigation: A Multidisciplinary Approach*, eds., R.R. Hazelwood and A.E. Burgess (New York: Elsevier, 1987), pp. 137–149.

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[12]Tafoya, supra note 1, p. 12.