A Design of Criminal Investigation Expert System Based on CILS

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***Abstract*—Based on the theoretical research and actual developing status of artificial intelligence and expert system, this paper discusses several issues in the development of criminal investigation expert systems (CIESs). In particular, we focus on a cooperative intuition learning system (CILS) which employs domain knowledge of recidivism in the crime analysis system. Using the elicited domain knowledge, the CILS tool uses deductive reasoning techniques to make inferences and provide suggestive courses of action to support the investigatory functions of police, attorneys, or probation officials. In this paper, we present an experience mapping intuitive inversion principle (EMII), and we describe the rationale for developing the CIESs, why we focus on the criminal analysis system, the methodology for eliciting CILS domain knowledge and experience, and a scenario of what we are implementing as a proof of intuition learning system. A series of elicitation sessions which epitomize the CILS have been discussed in the paper. After presenting an overview of the system and the major research choices, we describe in detail the system's modules and present examples of its potential**

***Index Terms*—CIESs; extension intelligence; intuition learning system; RMI; cooperative intuition reasoning**

I. Introduction

In recent years, with the wide application of computers in the public security area of China, constructions of criminal investigation expert systems (CIESs) have been made an important point. However, conventional environment of information conduction is "man around computer", which is difficult to deal with the information featured by procedures of brain thinking. Because of the almighty ability of computers while processing digital information, people depend on computers to a great extend. When the results from computers are different from the reality significantly, people will doubt it. This is the reason of the occurrence of the incompatible problems when traditional information conducting ways are applied to process crime information.

To mimic the problem solving capacity of human being is one of the most basic and important task of artificial intelligence (AI) and expert system (ES). From the research achievements of AI and ES in recent years [1-28], the original intention of researchers is that computers can substitute for the intelligence of human beings, thus acquire the decision-making capacity of human experts and also overcome the limitation of experts in the field, so that to reach the level of true experts. However, to study the expert system as an issue in computer science has hampered the system development. No matter in the aspects of knowledge acquisition and knowledge expression, or in uncertain reasoning, though great research achievements have been obtained (especially the introduction of artificial neural network and fuzzy system provides many new tools for development of expert system [5, 6]), few successful expert systems are available.

Expert systems are improving as technology advances. In the past, expert systems have received criticism and some negative publicity because of the failures that were highly publicized. Unfortunately, the successes are less publicized, because companies want to maintain their competitive edge. Expert systems are a great tool for companies especially, as depicted here, companies in finance. It is important for companies to remember, however, that humans should make the final decision, and not the computer. Humans still have the insight and intuition that computers are unable to possess for now, anyway [5, 7]. Many scholars [1-24] believe that the key to build expert system is the selection and effective use of knowledge. The "effective use" means whether the rule in the system synchronize with the thinking of the actual users, which is also the difficulty in expert system development [1]. research shows that ES in case solving is neither merely a pure reasoning algorithm, nor completely relies on some formatters. The establishment of cooperative relationship can be regarded to be the identification and evaluation of fact inversion and evolution.

AI has achieved great success in formatted reasoning, but in reality, there are too few cases with fixed format. Does this prove that the research is going farther and farther away from our goal? Any kind of advanced and effective theory and method must have its generative background, and also can better reflect the reality. In the research and development of CIESs, it has been found that the formation of specific technique and method comes from the feeling and experience of people in dealing with routine duties, and this feeling and experience is nonlinear. In addition, knowledge and common sense are different from each other. Do all problems in reality correspond to some complete knowledge? Experiences in the field for different objects are obviously inconsistent. Accordingly, in the development of applied expert systems, the first thing is the self-organization of knowledge system and the self-learning of experience system [9, 10, and 11].

This work was completed with the supported of the research foundation from Ministry of Public Security (Grant No. 2009YYCXLNST023).

doi:10.4304/jsw.6.8.1586-1593

This paper discusses the development of criminal investigation expert system through practical examples of criminal investigation and gives some new points of view which are believed to be applicable in the research and development of expert system in many fields.

The remainder of this paper is structured as follows: section 2 provides a review of related works CIESs. Section 3 gives a description of the mapping-inversion method based on intuitive learning. Section 4 presents the proposed algorithm CIESs in details. The section afterwards describes how the algorithm has been adopted for criminal investigation. Section 6 concludes our work.

Ⅱ. BACKGROUNDS AND REVIEW

In this section, we review prior work in knowledge engineering, association identification, heuristic approach and personal construct psychology. We also provide a brief review of the CIESs.

A. The Knowledge Acquisition and Management Bottleneck

When the rule set for an expert system is written, the knowledge of humans is observed. Video tapes, interviews, protocol, and other techniques are used to try to capture the thought process of experts. A problem with expert systems is writing the rules themselves. Thought processes that are highly rule oriented are easier to write than ones that rely more on creativity or intuition. Another problem is that often experts themselves disagree. Different experts might take different courses of action or go through different thought processes when given the same problem to solve. Thus there is disagreement in the professional community about the validity of expert systems.

Literature [5-16] proposed architecture for a knowledge management system to provide support for crime fighting strategies in a developing country. We identified important issues that must be addressed. Although the proposed architecture does not address all the areas that concerns knowledge (KM), such as how to motivate user contribution, how to keep the knowledge repositories up to date and cultural issues, we believe that the integrated system that we have proposed offers the possibilities for a more effective knowledge supported approach to crime fighting, by such a system. The proposed architecture comprises several knowledge bases and knowledge applications to address these issues. Some of these components have been adapted from the works of other researchers.

Literature [17-22] is to propose several techniques for automated link analysis: the co-occurrence analysis approach and a heuristic approach for the identification of associations between crime entities, and a shortest path algorithm for association path search. In particular, the heuristic approach helps incorporate crime investigators' domain knowledge into a link analysis system for judging association strength automatically. Determining the importance of heuristic between crime entities is highly dependent on the domain knowledge and experience of crime investigators. The domain knowledge includes not only what factors can be used to make a judgment but also how to judge based on the factors (Wildemuth, 2004). In an expert system, the approaches for incorporating expert knowledge have been primarily ad-hoc. As reviewed earlier, Goldberg and Senator (1998) used a heuristic-based approach in the expert systems. The word "heuristic" comes from Greek and means "to know", "to find", "to discover" or "to guide an investigation". Specifically, heuristics are techniques which seek good (near-optimal) solutions at a reasonable computational cost without being able to guarantee either feasibility or optimality, or even in many cases to state how close to optimality a particular feasible solution is." These heuristics were used by investigators to manually uncover associations but were not really incorporated into the system for automated link analysis. In cases with large datasets, investigators still face the problems of information overload and high search complexity.

B. CIESs Based on DSS

Developers of CIESs are aware of the limitations of a reasoning process based on production rules or similar types of formal language. There are few researchers left who think a CIESs should act as a kind of oracle. On the contrary, an CIESs should be designed as a criminal investigation decision support system (CIDSS) or a facilitator of tasks (He Ping, 2002), and users of expert systems should be cautious when using them, because the knowledge modeled in the CIES, especially the knowledge about the crime, is limited (He Ping, 2003). To the users a CIES may have the appearance of an intelligent machine. Police department often expect intelligent behavior from a machine that appears to be intelligent. Thus, it is to be expected that users disregard some of the limitations of expert systems. Police tend to let the expert system take charge. To help users to judge the limitations of an expert system, most expert systems provide explanation functions.

This is seen as an important aspect of expert systems. However, even when the argumentation of the expert system is known, it is difficult to judge whether the advice is useful to solve a certain problem. Therefore, it is doubtful whether these explanation functions are sufficient to help users to judge the limitations of the expert system's advice. Ddecision support systems (DSSs) for crime investigation are difficult to construct because of the almost infinite variation of plausible crime scenarios. Thus existing approaches avoid any explicit reasoning about crime scenarios. They focus on problems such as intelligence analysis and profiling. We propose a novel model based reasoning technique that takes reasoning about crime scenarios to the very heart of the system, by enabling the DSS to automatically construct representations of crime scenarios. It achieves this by using the notion that unique scenarios consist of more regularly recurring component events that are combined in a unique way. It works by selecting and instantiating generic formal descriptions of such component events, called scenario fragments, from a knowledge base, based on a given set of available evidence, and composing them into plausible scenarios. This approach addresses the robustness issue because it does not require a formal representation of all or a subset of the possible scenarios that the system can encounter. Instead, only a formal representation of the possible component events is required. Because a set of events can be composed in an exponentially large number of combinations to form a scenario, it should be much easier to construct a knowledge base of relevant component events instead of one describing all relevant scenarios [23,24].

C. Expert system Based on Cognitive Science

The role of personal construct psychology in computer research and applications concerned with the development of 'expert systems' and their beginnings in 'artificial intelligence' and 'cognitive science' are covered in [9]. Research on expert systems led to the identification of the 'knowledge acquisition bottleneck,' that it was generally extremely difficult to make overt the presumed knowledge of human experts in order to program it for computers.

Literature [9] shows that expert systems were recognized as a breakthrough in artificial intelligence, in programming computers to emulate human thinking. However, they were based on a form of cognitive science that took mathematical logic as its foundations and was not well-suited to modeling the full richness of human behavior. Personal construct psychology developed over the same time period but was not recognized by those working on artificial intelligence and cognitive science as a complete psychological system providing more effective foundations for cognitive science and expert systems. Repertory grid elicitation *was* recognized as a valuable knowledge acquisition technique with which to develop rules for expert systems, but the knowledge transferred in the form of rules was static and brittle, and did not lead to the systems being open to experience. It would be timely to adopt personal construct psychology as the foundations of cognitive science and use it to build expert systems that fully emulated the capabilities of human experts, not only to solve problems but also to be effective in dealing with new problems as they arise. As a final comment, it is noteworthy that while the expert system community has focused on emulating the capabilities of those with expertise of value to industry, the technology developed is useful for modeling the psychological processes of any person. Kelly noted that all people may be construed as 'scientists' in their processes of modeling their worlds and validating those

In investigator's subjective approaches to criminal information (CI) [6] points out four basic psychological functions: **sensing** – function that tells us something exists; **intuition** – reveals the possibilities which may exist in what has been perceived; **thinking** – tells us what this something is; **feeling** – tells us how to relate to what we have perceived based on our own subjective value system. The same source also states that intuition and thinking are most important in the creative and selective phases of CI – alternative generation, analysis of outcomes and decision selection. Literature [5] points out that intuition is a key investigator's feature in CI, and, while being far from simple to define more exactly, intuition lends itself to being indirectly supported.

III. Cooperative Intuition Learning Based on Knowledge Systems

The purpose of this section is to discuss an "Cooperative Intuition Learning (CIL)" concept to establishing the new ideas and approach of CIESs. This approach will include domain knowledge mapping, experience-inversion and intuition-based cooperative learning.

A. Expert System Based on Extension Intelligence

There are many different definition of intelligence in expert system, but none of them give the answer acceptable by a scientific community. First of all, intelligence is a fuzzy term. In some cases it is very difficult to draw a line between intelligent and non-intelligent natural and artificial systems. For example, biological adaptation or any kind of evolution can be presented as learning intelligent ability or non-intelligent process. It is difficult to determine when ES became an AI system. All intellectual activities are triggered by the goal. A ES can be intelligent only in relation to a defined goal [3].

In fact, there are two components of intelligence: experience-based intelligence (basic-intelligence) that is inherited at past activities process, and knowledge-based intelligence that can be improved by learning (learning-intelligence). All kinds of intellectual activities in the specific area are based on knowledge rule system, but ES is not knowledge system. Knowledge is a "tool" of ES. If you don't understand a goal, you are not capable to reach it. An ability to learn is an important intellectual ability that can improve knowledge. Knowledge reinforces intellectual activities. There are three attributes of the recognition to the expert system with intelligence, knowledge, experience and intuition. The attribute of experience reflects the recognition to the characteristics of the basic behavior. The attribute of knowledge reflects the learning recognition to the characteristics of the intelligent behavior. The intuitive attribute based on experience and knowledge is called "extension" attribute of intelligence, on the other word, the intelligence with extension attribute is called "Extension Intelligence" (EI). See figure 1.

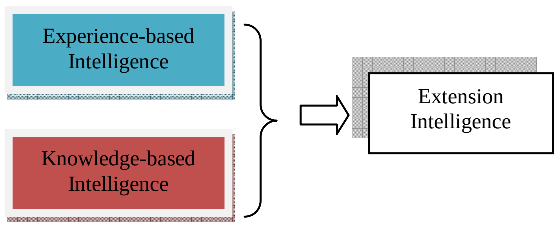


Figure 1. Extension Intelligence

In fact, extension intelligence is an intelligent with the function of human-computer cooperative, and it's aimed is structured to extension cooperative intelligence (ECI). We don't believe that intelligent decision comes naturally. But we are sure it can be learned from experience based on incorporates empirical knowledge and domain knowledge.

For example, A CIESs which is called here an “Extension Intelligent ES” incorporates extension intuition based on empirical knowledge obtained through experience into an EIES as its explicit subsystem. More specifically, knowledge association is focused on as a sample of human intuitive ability. This EIES is designed to allow human extension intuitive abilities to cooperate with computer logical functions, thereby facilitating human extension activities to solve problems in real world environment.

In order to do this, a guide function of human extension intuition is devised and incorporated into the computer. This is called cooperative mapping. The experience association process base on knowledge (from initial experience activities or situation 1 to association experience activities or situation 2) is divided into two processes. When initial experience action is given, the human role is to related rule, called keywords, as indicators/hints or cues to already be stored in the computer to help the user. The computers first role, which is called cooperative guidance, is to provide suggestions to stimulate or guide this human intuition. The computer s second role is to search the knowledge base to find cooperative knowledge by using the keywords.

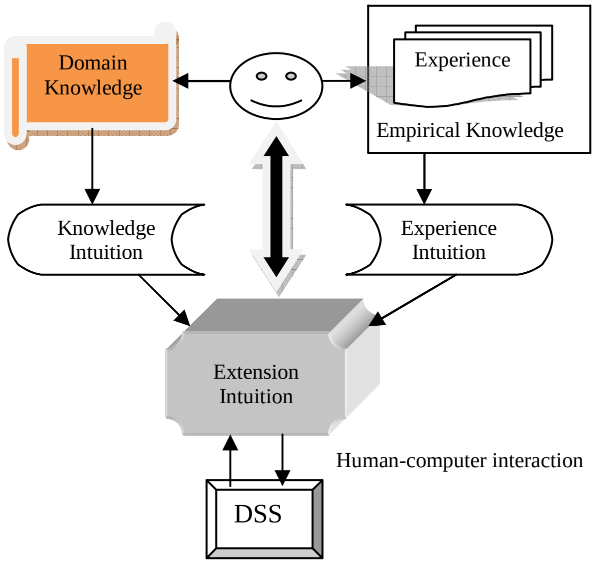


Figure 2. The architecture of a EIES

B. The Mathematical Model of EIES

1) The Basic-Model of expert system

In the CIESs [4, 5, 6], traditional methods imitate these inexact and uncertain problems by building mathematics model, and then solve them by statistics and probability. However, these imitations require a lot of hypotheses and approximates, and at last, the model is different from the reality largely. Obviously, traditional quantitative ways cannot satisfy the needs of solving these complex, unstructured problems. Because of the shortage and uncertainty of the information, it isn’t possible to build exact mathematical models; at the same time, because the aims of these problems are relatively inaccurate, it is not necessary to build accurate mathematical models. One practical way is to building some qualitative models to analysis qualitatively, so that some beneficial analysis results are made, and we can make best use of the knowledge we grasp.

Problem solvers using formal models are applied in many application domains when optimal solutions cannot be found within a reasonable amount of time. Productivity in optimization modeling is low: reality is complex, and it usually takes a lot of trials to find a satisfactory mathematical description of the phenomenon under consideration. Due to this complexity, modeling has to be done by specialists who are required to speak three “languages”: the language of mathematics in which the model is originally described, a programming language or an input-language to a standard package which is needed to solve the particular case, and the language of the user who is ignorant of these “internal representations”, presents his problem in “user-terms” and also needed the relevant features of the model depicted via e.g. graphic means. After all that, the optimization model obtained can only be used for the particular situation and has to be adapted for a new application should relevant factors change. In most cases this means redoing the whole identification and estimation process.

From a decision maker’s point of view these costs associated with making a precise mathematical model require a high utility in terms of good decisions. However, the data and/or the theory are often not so good in practice. Thus cheaper methods like flexible queries in data-bases or simple, deterministic models implemented with spreadsheet programs are often preferred to more sophisticated ways of arriving at decisions: patricians judge a method not only according to its "precision" or "optimality", but also consider implementation and maintenance costs, reliability and transparency [12,13].

Standard application packages are designed to overcome these problems. However, while being definitely beneficial in the sense that they make the process of making applications easier and sometimes even possible, they only support one part of the implementation-process - computing - but do not cover important tasks like data management, model-structure selection, or education of the users. Sometimes these new computing facilities have even turned out to be dangerous, as now users who are unaware of the theoretical background and thus of the limiting assumptions underlying the methods, have started modeling. Uncritical interpretations and the usage of inappropriate methods are the unpleasant side of the wide-spread availability of numerical software [15].

Much greater help would be offered by programs that are able to compare empirical data and verbal evidence with theoretical properties of mathematical structures. Based on this comparison they can decide what model structure is appropriate for handling a certain situation and subsequently, how the numerical results are to be interpreted. Decision support systems that allow mathematical modeling by providing theoretical guidance, computer aided teaching-programs which allow the student to develop his modeling skills under proper assistance, and systems that automate the routine-parts of an analysis could become a reality. But how should such a "modeling expert system", i.e. a numerical package enhanced by routines covering model-selection and model management, work ?

2) Relationship Mapping-Inversion Principle (MIP)

Then what logic methods should be employed to describe this question? Should it be signs, arithmetic, or rules?

Relationship mapping inversion principle (RMIP) [He Ping, 2003], a universally used method or rule in problem analysis, belongs to the category of universal scientific methodology.

In establishment of investigation expert system [1, 2], we have discussed relevant issues of the selection of knowledge and cooperative reasoning. Here, the key is the good combination of human and computer, and what methodology should be adopted to reach the goal of criminal investigation and to fully unfold the intellectual behavior of the expert system. Research shows that RMIP is an effective thrust tool to construct this intellectual behavior. Here, let's first give a hypothesis that, in actual criminal investigation, the investigator conceives a simulation of a specific case by analysis of the case attributes, and constructs a simulated model approximate to the original case. Usually, it is impossible for the investigator to witness the entire process of the case. After the crime, people can experience the scene again, and only by simulative reconstruction can we learn and grasp its changing patterns. The occurrence of a case gives birth to the latent image of the specific criminal event in a certain space. It is determined by the initial structure of the criminal type. Here, the suspect relationship can be termed as initial image relationship, and the latent image of the criminal event from the scene is called image relationship. If the image can be determined by the mapping relation, the initial image can be obtained by the image. And this initial image is the suspect of this case. This mechanism is called RMIP of criminal investigation [14,17].

Abstraction of this principle can be described as follows:

Let R denotes the relationship structure of initial images of a group of criminal suspects (or suspect initial image system), which includes the intuitive suspect initial image (I) to be determined. If M denotes a kind of mapping, then the image relationship structure R^* of the criminal behavior can be determined by M, which, of course, comprises the image (I^*) of the unknown suspect initial image (I). If I^* can be decided, then the corresponding I can be decided by M^{-1} (inverse mapping). This is the basic framework of RMIP of criminal investigation (Figure 3) [3].

For real expert system, the mapping and inversion have plentiful contents. The cooperative intuition reasoning rule based on criminal investigation knowledge and experience is the product of the combination of human and computer. Its formation process might as well be regarded as mapping accomplished by the human-computer interaction. Thus, the result of cooperative intuition reasoning based on knowledge and experience is the image of the initial image of the suspect system. Inversely mapping the results of cooperative reasoning to the suspect system, the criminal suspect can be determined. This is called mapping inversion process in the expert system.

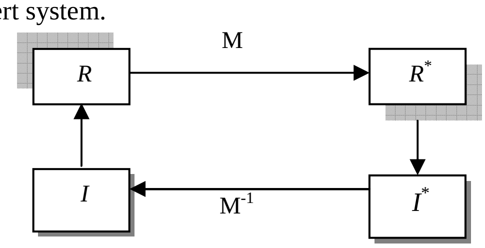


Figure 3. Experience mapping inversion principle

The actual criminal case is nonreversible. Time is one-dimensional and unrepeatable. The system (R) consisting of the criminal X may not be a static relation structure, but an evolutional dynamic one with specific criminal attributes and case characters. Moreover, different cases contain different information of the criminal attributes. Here, R can be considered as the relation structure in the initial state and R^* is the image of this structure. But R^* is not enough to determine the image (I^*) of the true criminal suspect (I). In order to determine I^*, some particular information (C^*) of the true criminal should be added into (R^*). Accordingly, the extending information (C) should be complemented to R. Thus particular attributes of different criminal cases are extended.

As described above, C^* and C are information for specific criminal case, determined by human-computer interaction. Here, experience and intuition can be relied on. The previous knowledge and experience is necessary, but information for actual cases is variable, embodying the process from existence to evolution.

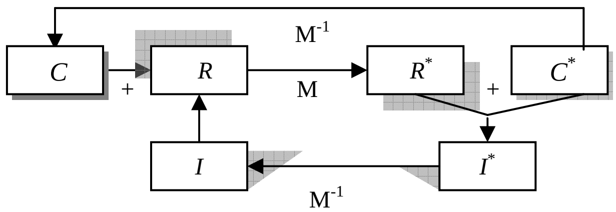


Figure 4. Confirmative inversion structure

The self-organizing process of the human-computer interaction of the expert system can help to reach the intended target repeatedly. A number of knowledge-learning methods in AI can be applied in mapping inversion principle. It is believed that the self-learning method of artificial neural network is an effective tool for this principle. The relationship mapping inversion principle can be described in detail as follows:

A correspondence between the elements of two sets can be defined as a mapping. Assume ψ is a mapping from the set $S= \{a$ onto $S^* = \{a^*\}$, where a^* is the image of a, and a is the initial image. If S is still a relationship structure, and ψ is a mapping from S onto S^*, then $S^* = \psi(S)$, and S^* is called image relationship structure. If the relationship structure S contains an unknown object x, it is the objective to be determined in the expert system, called objective initial image and $X^{*} = \psi(X)$ is called objective image.

If the objective image can be determined from the image relationship structure S^* by the automatic reasoning in the expert system, then the mapping method ψ is a confirmative mapping. Accordingly, the relationship mapping inversion principle in the investigation expert system can be stated as follows: Given a relationship structure S that includes the objective initial image X, if the reasoning of a confirmative mapping ψ from S into or onto S^*can be found, then the objective image $X^* = \psi(X)$ can be determined from S^* by certain cooperative reasoning, so that the criminal X can be determined by inversion (namely, $X = \psi^{-1}(x^*)$).

Ⅳ. Application

In this section we are mainly, but not exclusively situated in the descriptive perspective of analysis of the deciding process and we're therefore trying to accredit the following ideas:

● Experience, intuition and empirical Knowledge can have a positive influence in practice, in successfully completing a deciding process (although those entire three elements cannot be formalized and included in a normative model);

● Reaching maximum efficiency by the decider may be the outcome of an apparently limited irrationality based on experience, intuition and imagination;

● The promoters of the deciding process formalizing models and procedures (the normative perspective) should have a more flexible attitude towards the deciding act (not everything excessively formalized automatically leads to maximum efficiency).

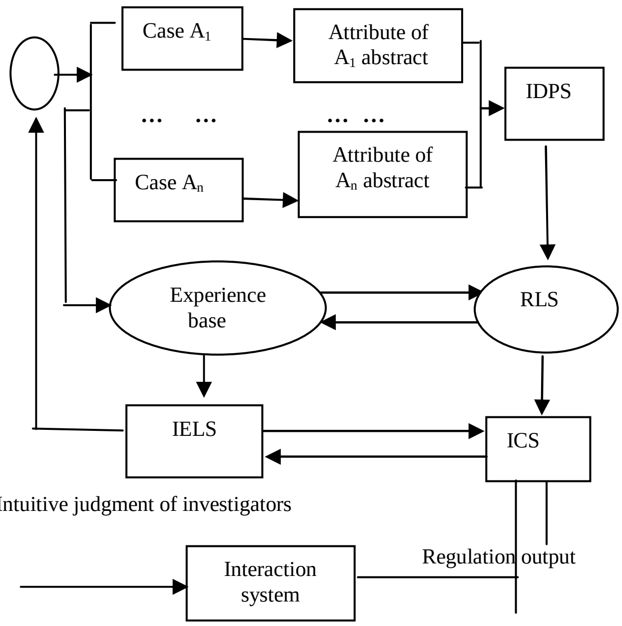
A. Cooperative Intuition Learning is the Core of Investigating Expert System

Previously, the criminal investigation work took intuitive reasoning as the core. Under the condition that the criminal case has occurred, the investigator frequently applies the theoretical knowledge and practical experience, makes judgment on basis of the relevant facts and phenomena, and obtains new judgment according to the known facts or confirmed judgment, so that to further disclose the inside information of the crime. The reasoning mechanism in the investigating expert system should by no means be alienated from the reality of investigation inference. We should fully use the existing uncertain reasoning method in the current

The investigator or medico legal examiner just input the information of the scene into the computer and the system will give a correct estimation of postmortem phenomena by knowledge reasoning, which is not from experiential reasoning. According to the requirements of knowledge reasoning, the selection of knowledge in the expert system can be classified into two categories: social knowledge and scientific knowledge, both of which involve specialized knowledge and general knowledge. Specialized knowledge mainly denotes principles of criminal investigation, science of trace, judicial ballistics, graphology, medical jurisprudence, forensic psychiatry, judicial chemistry, investigative psychology, preliminary interrogation science and photography on criminal inspection, etc. In expert system, the more abundant the knowledge base is, the more accurate the analysis and estimation of the case and the more reliable the reasoning is, and, consequently, the more powerful and applicable the expert system is. Experience can be categorized into investigative experience and life experience. Some of the experiences accumulated in daily life are self-conscious, but more are brought into the actual investigation unconsciously. The emergence of repetitive experience will produce a psychological reflection, which is intuition. And the concrete manifestation of intuition is to constitute cooperative reasoning mode by human-computer interaction. A scene of a specific criminal case will show us the implementing process of building expert system by the previous investigative reasoning method.

B. The Design of Systems

The key to develop the investigation expert system is to make it operable, so that to satisfy the practical needs of real criminal investigation. Accordingly, the application of RMIP combined with cooperative reasoning in the investigation expert system is realized as follows:



(IDPS: Intuition discrimination of process similarity; RLS: Rule learning system; IFLS: Intuitive experience learning system; ICS: Intuition concept space of criminal)

Figure 5. Structure of the interactive intelligent analysis system

C. Results

A scene of a specific criminal case will show us the implementing process of building expert system by the previous investigative reasoning method [3, 4].

A murder was committed in some county of Sicuan Province. The scene was remotely located at the ruins in an earth-built blockhouse on the top of Shibeigang *mountain. The mountain was perilous and precipitous. The murdered body laid face down at the west side of the blockhouse. There's a back bag one meter on the right side of the body. The bag was half filled of grass for pigs. The grass on the surface had revived. On the grass was placed a hook. Three meters to the south of the blockhouse was there a broken winebottle. No traces of fight were found at the scene. According to forensic examination, the deceased is a young woman around twenty. She was wearing three coats and two pairs of blue trousers made of a single layer cloth, and gym shoes on the feet. In her pocket, there was a slip of paper on which was written 'It is raining. What shall we do next? Please reply to give me your decision.' in blue ink with pen. The entire body was highly decayed. The frontal bone was broken, and the bone mark was obvious. On the occiput was a wedge-shaped wound, and the bone mark is not obvious. After autopsy, a seven-month-old male fetus was taken out of her abdomen.*

The above was all the information of the murder scene provided by the investigator. Then how to establish the reasoning mode in the expert system and how to conduct the inference?

(Input information 1) The occiput of the victim was severely wounded. Then the system concludes that the wound can not be caused by the deceased herself and so it must be a homicide.

(Output information 1) The conclusion is knowledge reasoning, deriving from the medicolegal knowledge in the knowledge base.

(Input information 2) The corpse was severely decayed and the surface layer of grass had revived. The system will give the conclusion that the postmortem interval is over twenty days.

(Output information 2) This conclusion is a combination of knowledge reasoning and experiential reasoning, a combination of medicolegal knowledge and life experience.

There is a formation mechanism of knowledge and experience in a certain range in the expert system. Because different people have different understanding of experience, the dominant role of experience must be determined by human-computer interaction.

(Input information 3) The scene was at the rural area. Input the characteristics of the victim into the computer. The human-computer interaction is an If-Then recursive form, i.e, if the woman carries the grass with a back bag, then the woman is a local female member; if the woman is confirmed to be a local member, then she doesn't live far away.

(Output information 3) Then the deceased was murdered when cutting grass for pigs.

The above human-computer dialogue belongs to experiential reasoning. This kind of experiential reasoning derives from local custom and life common sense.

(Input information 4) The slip of paper in the pocket of the dead.

The human-computer dialogue is as follows: If there is a note without signature in the pocket of the dead, then the note may be for a date and there must be something hidden behind the note.

If the deceased had a fetus in her abdomen, and there were no traces of fight, and a winebottle was found at the scene.

(Output information 4) Then the case has something to do with abortion, and the murder is a kill because of amour or love dispute.

The above human-computer dialogue belongs to experiential reasoning, deriving from social experience and intuition (psychological reasoning).

In the expert system, there should be a case simulation field that can train the intuitive latent factors of the scene personnel.

(Input information 5) The scene was located on the top of a high mountain, not a place to cut grass for pigs.

The human-computer dialogue begins:

(Output information 5) If the deceased with the back bag went to a place without grass for pigs, then the deceased went to this place passively, she might be lured to this place.

If there was a deadly wound on the forehead of the victim and there were no traces of fight, then the murderer was acquainted with the deceased and committed the crime when the victim was unsuspecting.

If the forehead and occiput were both wounded, then the murderer might attack the forehead of the deceased with the axe head first, and then, for fear that the victim was not dead, chopped her occiput with the axe edge.

The above dialogue is a combination of knowledge reasoning and experiential reasoning, namely, cooperative reasoning, derived from medicolegal knowledge and social experience.

An integration of the output information indicates that the murderer might have an amour with or be in love with the deceased.

The expert system gives clues to solve the case as follows:

1. To investigate whether the handwriting on the note in the pocket is the victim's.
2. To investigate who had a close relationship with the victim before her death.
3. To learn when the victim was murdered and where those closely related with the victim has gone.
4. To check whether the handwriting on the note was that of one of her acquaintances.

Investigation of this case reveals, eventually, that Wu (a married man) in the same community as the victim had been in an intimate relationship with the victim. The writing on the note was his handwriting. And his whereabouts around the time of the murder was unknown. Therefore, Wu was considered as a prime suspect of this crime. And it was finally confirmed that Wu had an adultery affair with Guo (the victim), and because of failure in abortion, he killed Guo to cover up the affair.

The above analysis shows that the cooperative intuition learning in the expert system can obtain the effect of the investigative expert in solving a crime, which indicates that the reasoning process in the investigation expert system conforms to reality.

V. CONCLUSIONS

This paper discusses the critical issues in establishment of expert system that should be paid attention to through practice of criminal investigation work. The development of the expert system must be grounded on identification, otherwise this work is of little significance or value. Simultaneously, the knowledge reasoning should be distinguished from experiential reasoning. For different cases, experiential reasoning is variable. Only by combining the two together with intuition to reach cooperative reasoning can they possibly play their roles in reality. Besides, the operation mechanism of the expert system should apply the RMI principle, a very useful intellectual system, which is certain to play a guiding role in the development of automatic reasoning computer. Because of the limitation of length of this paper, the detailed procedure is not given and those who are interested can contact the author for more information.

ACKNOWLEDGMENT

This work was completed with the supported of the research foundation from Ministry of Public Security (Grant No. 2009YYCXLNST023). Author would like to thank professor Kang shuhua for producing silhouettes with the developed method.

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