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Control Strategies to Ground an Expert System

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Abstract:

The study presents the possibility to use the forward, backward and joint control strategies, for the knowledge basis, by an expert system inference motive. The practice showed that the expert system is able to emulate the judgment types used by the people (through analogy, formal and methodological). Due to the lack of the standardization in this field there are more tackling for the model of the expert system development process. The expert systems ground consists in the giving off phase development: project starting, analysis and projecting, rapid standardization, development, application and fast application. The information within this work can be applied in both business and financial domains.

Keywords: knowledge basis, inference motive, dialogue interface, acquisition module, explanatory module, facts basis.

1. Introduction

It is often used for an expert system the calling of system based on knowledge. A system based on knowledge is a system which tries to reproduce intelligent activities specific for the human experts. From the conceptual point of view, the expert systems have as purpose the judgment reconstitution on an expertise basis obtained from the human experts. The expert systems possess the knowledge and the possibility to develop human intellectual activities. They are also organized for the knowledge acquisition and used in a certain field called problem field; they have methods through which appeal the knowledge and express the examination, behaving as a qualified consultant [1]. The expert systems are based on the knowledge separation principle (knowledge basis) from the program, which treat it (inference motive). The expert systems are able to memorize the knowledge, to establish links between them and to elaborate conclusions, solutions, recommendations and advice - cause of certain phenomenon and situations, by having facts as a base, and uncertain knowledge taking over. In the first figure we can observe an analogy between the human experts and the expert systems.

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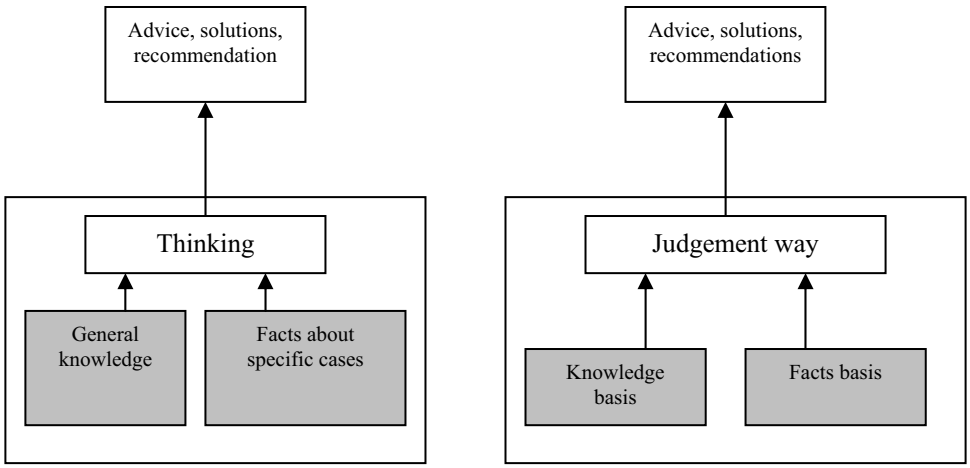

Figure 1. Analogy between the human expert and the expert system

2. Main Control Strategies Analysis

The most used inference strategies (of judgment control) for the expert systems are the forward strategy and the backward strategy. Some expert systems use a combination of the two strategies, the so-called mixed control strategy. The composition of the expert system, able to execute strategies like these for the knowledge basis control, is the inference motive. This one decides whether certain rules have to be activated and released, and uses the most adequate searching strategies to identify the solution. The majority of the expert systems have inference devices able to use with the help of the rules interpreter the deductive method as a judgment, called modus-ponens. Even the principle of rules concatenation to the execution is directed by the modus-ponens method. The information received will be analyzed and compared with the ones memorized, accordingly to a rule, which value of truth will be determined in this way. This control is realized by means of one of the strategies; forward control strategy and backward control strategy [2].

2.1 Backward Control Strategy

During this strategy, the inference motive verifies first which of the rules contain the purpose, next it connects once with the execution the rules starting with one which contains the aim, by searching whether they satisfy the identified goal. This strategy is also called *strategy oriented on aim.*

2.2 Forward Control Strategy

The forward control strategy is *one based on facts*. The inference motive starts first to work with the facts in this way the whole attention is lead to the rules starting. An action rule constitutes only a passing reason to another starting of another rule. Thus, the motive uses the starting of a rule to identify the starting of another rule, which has to fit with the action of the first rule, then, it searches whether that rule starting fits the aim. The forward searching is useful when the expert system has to respond to new facts, or when it has to find a solution to investigate a lot of paths until the aims could be listed.

2.3 Joint Control Strategy

The joint control strategy connects the two basic strategies so that during the searching through the knowledge basis their difficulties could be removed and only their advantages memorized. The most part of the expert systems use both types of strategies, especially during the applications, where the problems alternative solving is necessary, by "facts guidance" or "aim guidance". The two methods are combined either by incorporating some fields in which they action accordingly to a "forward" manner or by elaborating separate systems.

2.4 The Cases Based on Judgment

The expert systems based on case uses the memorized solutions for cases like these and adjust them with a view to solve the new similar problems. An expert occur also to some similar previous cases, by comparing their solution with the most adequate solving of the current problem and asks questions when the inferences don't succeed. The judgment based on cases is, algorithmically, a technique through which are registered and gathered evidence cases in this field, and then only the ones which present an interest for the present problem are accessed, in order that their usefulness in new cases solving to be controlled.

Except the case basis, there could be a general knowledge, as well, in the shape of model rules or restrictions available for the using. The case basis and this general knowledge constitute the field partial model, which as a consequence consists in the fact that there cannot exist the supposition of a close world for the cases, based on judgment systems. The problems solving with the help of the cases based systems is done accordingly to the process model as in the second figure.

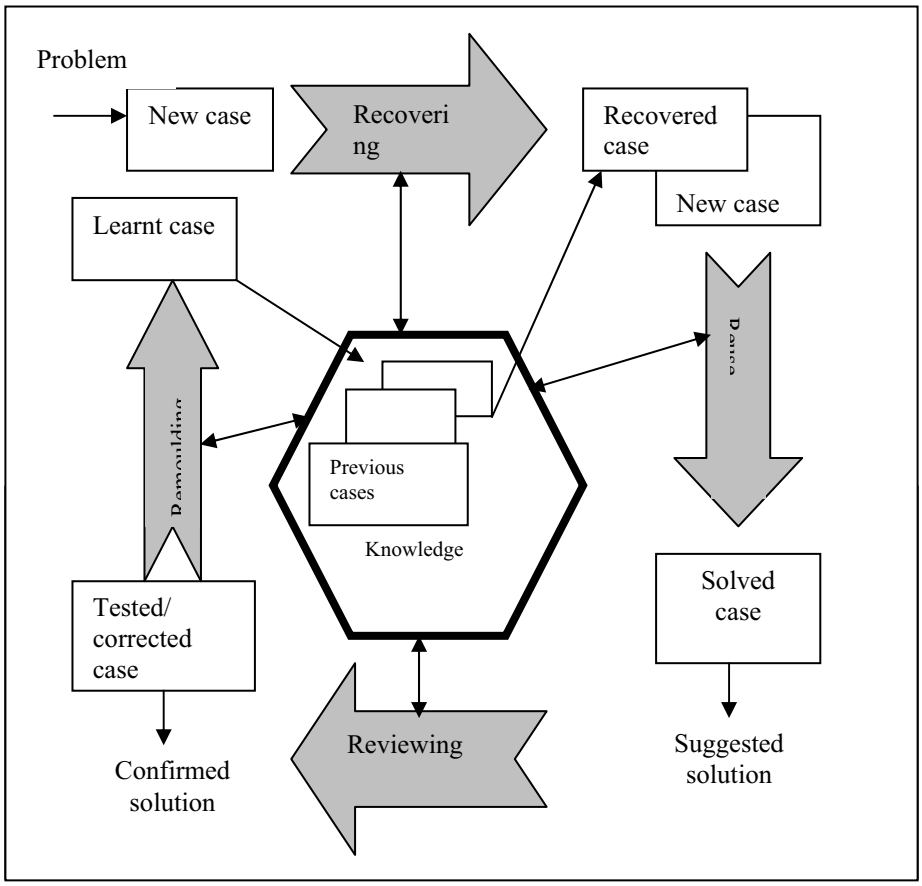

Figure 2. R4 Model of the based on cases judgment process

The new appeared problem is described as a part of a new case (which can be sometimes called interrogation). Proceed to the old cases recovering, which contain similar problems with the new one, and the most adequate existing solution is proposed as a solving of the new problem. The process called R4 model (recovering, reusing, reviewing and re memorizing) supposes three phases:

1. Cases recovering, similar to the new problem describing part, cannot be done neither with instruments for relational data bases nor with instruments for the classic information recovering.

2. Reviewing/ adjusting the new recovered problem is necessary in the fields of application, in which the solution constitute more than a class name, sometimes accompanied by a previous remedy. The reviewing can suppose the adjusting of some parameters according to some formula or values requests, or even the complete using of a base of knowledge.

3. Re-memorizing of the learned cases and re-organizing the case base are to become automatically important during the applications.

The methods for recovering the cases were identified and experimented quiet recently. They have specific names proposed by the researchers, such as[3]:

- *kd-treess method* combine the judgment based on cases with the induction and uses the decisional trees to discover the similarity (it is important in diagnosis applications);
- *Fish-and-Shrink method* developed during FABEL project, important in projecting applications
- *Case Retrieval Nets method* useful for electronic trade applications, which uses the textual knowledge (documents recovering, knowledge management, etc.).

There are now expert systems generating sets based on cases, from which the only one merchandized is Expert Ease (Edinburgh University, Scotland), which uses an induction algorithm. Another functional system is SMART (Compaq Computer). Nowadays, many more researches from the automatic learning field use the judgment based on cases. The systems based on knowledge are conceived to guide the users to a formal model for the problems solving process and for the fundamental knowledge in the application field. In the real applications world, there are attached to the field knowledge and dates adjectives as: “probable”, “possible”, “incomplete”, etc., which creates the uncertainty. The production rules inference was not practical in the case of the diagnosis applications and industrial machines and installations controlling, even because the dates obtained from the sensors can be accuracy-less and need their comparison with the standard values of the function parameters. Approaches like the Pareto law for the problems’ fragmentation or attaching the priorities help to formulate methodological rules based on experience. These ones could be sometimes a result of a experience and formal approaches like the line programming. The models based on judgment have a number of advantages on other approaches. They can generate information by using some equations, which approximate the present conditions. They need less time and less restriction, by assuring a good consistence from an application to another, and the results interpretation is easier (the process starts with used models knowledge). The development of the methodological rules is encouraged because the models help to harmonize the relative importance of the articles, thus constituting an important alternative to the expert systems based on rules. The most important quality of the models based on judgment is its ability to increase the field expert judgment power. However, this judgment does not want certain problems, such as: the calculation time being very big when it uses algorithm judgments of a great complexity and the necessary model creation can need a deep knowledge and a much bigger effort or the model is not simply known.

3. Strategies to Develop the Explanations

The explanations represent a component of the knowledge basis and as following, all the knowledge, which offers explanations, must be a derived one from the knowledge base content. The last is obtained during the development phases. There more evolved explicative systems are necessary, able to offer *trace,* j*ustification* and *strategic knowledge*. The explanations are used by the users and have a big influence on the system success and performance. The expert systems must endow thus, with an explicative module able to offer three types of explanations [4]:

1. Trace that contains suggestive graphic elements, easy to understand them, which respond to the question "*How?"* That is the inference process diagram, to clarify the content of this process.

2. Profound and justifying, that responds to the question "*Why?"* That is information which justifies the judgments for which it suggests a solution or an action and the suitable context to the solution;

3. *Strategic explanation*, meta-knowledge that clarifies the solving strategy of the present problem and its structure representation [5]. There are different criteria to classify the explanations. These may be: the explicative question nature (what, why, how, where, when, what happens if?) and the explicative answer nature (terminological, field description, problem description). The strategy must also concentrate on the explanations offer manner as a part of the connection between the system and the users. In this way the explanations can be presented in two manners in order to be used during the instruction process: before and after the inference process. In the first table we have presented the explanations differences together with their corresponding strategies.

Table 1: Strategies for the explanation development

1. Explanations:	
EXPLANATIONS TYPE	DEFINITION
Before the process	It is presented to the user before the inference process rewind; It is focused on the entrances necessary to the system; It is not solving a certain case.
After the process	It is presented to the user after the inference process rewind; It is focused on the system exits; Solves the result of a concrete case.
2. Development strategies:	

STRATEGIES TYPE	DEFINITION
Forward "why?"	Justifies the system entrance information importance and necessity, which will be used during the inference process
Forward "how?"	Details the manner in which the user must introduce information in the system and the next executing procedure.
Forward "strategy"	As well as the manner in which every entrance influences the process, clarifies the manner in which the system entrances are structured and organized.
After "why?"	Justifies the importance and clarifies a certain conclusion or solution implications, which represent an interest to the user.
After "how?"	Explains the route followed by the inference chain, including its inference phases through which a certain conclusion or solution was brought up.
After "strategy"	Clarifies the aim structures, which are pursued by the system to attend to a certain solution or conclusion.

The main characteristic of an expert system is to dispose of the expertise, which gives to it the ability to execute a well determined work. The expertise includes not only the ability to solve a problem but the performing in a shorter period of time. The expertise also supposes that the riches of knowledge about the problem field must be profound and comprehensive. Thus, an expert system must be *robust* (not having abilities in only one problem but using solving methods and general knowledge to attend to a solving by following own principles) and must be *profound* (ability to extend the existing knowledge in order to deduce new knowledge)[6]. Another characteristic of the expert systems is represented by the *symbols manipulation* (the solving of problems is done by symbols manipulation and not through proper mathematical calculations). This state of facts doesn't mean that an expert system cannot do known logic- mathematical operations or algorithmic problems, as well. Essentially, an expert system can be characterized through the ways presented in the second table.

Table 2: An expert system characterization

Expert systems characterization ways	Description
Purpose	Human experts aping.
Cards and data basis comparison	Knowledge automatically interpretation.
Methods	The separation of the problem solving method from the expert knowledge.
Characteristics (properties, attributes)	Transparence, flexibility, easy using, competence.
Comparison with conventional programs	For unstructured fields.

4. The knowledge basis role in the expert systems architecture

The originality of the expert systems consists in the existence of the five components and their relationships. There are three basic components: the knowledge basis, the inference motive and the dialogue interface with the users and two supplementary components such as: the knowledge acquisition module and the explicative one. The objectives of an expert system are the easily knowledge acquisition by expressing as directly as possible the expertise obtained from human experts; the efficient knowledge collection exploitation and easily support of operations range over the knowledge. *The knowledge basis* serves to stock all the knowledge pieces, specific to a certain application field. The knowledge basis contains the expertise overtaken from human experts accordingly to the field of the problem that as well as methodologies describes real situations, real or suppositional facts. The knowledge can be memorized in the shape of some production rules and then, the knowledge basis contains two components: *the fact basis and the rules basis*, and the inference motive is also called *rules interpreter*.

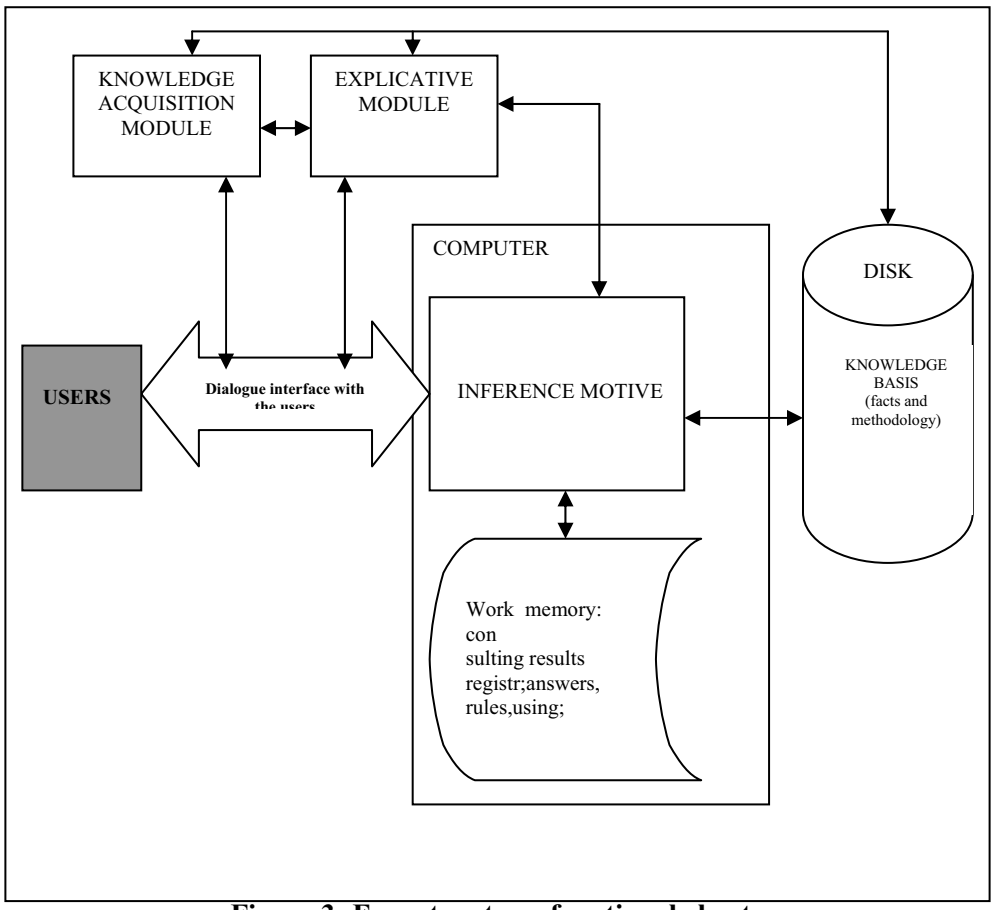

Figure 3: Expert systems functional chart

The inference motive is a program, which contains the control, procedural or operational knowledge and exploits the knowledge basis and is destined for the knowledge combination and connection in order to produce new knowledge by judgments, plans demonstrations, decisions and predictions. It is a program or even a micro-programmed integrated circuit, which disposes by general inference mechanisms to process the knowledge with the most different judgments, determining the knowledge modification in order to solve the problem.

The inference mechanisms are the ones that finally offer reports, texts, graphs and lists listed on the screen or on the printing set.

The inference motive has two principal components:

1. The knowledge basis administration system, which execute automatic organizing operations, control and knowledge renewal, starts some researches to control the relevance on the judgment lines, on which the symbolic inference processor works.

2. The symbolic inference processor that offers a processing method through which the judgment lines are provided. When the dates and the real world knowledge are indefinite, certain inference methods can use different certitude grades in order to rule the inference mechanism.

5. Conclusions

The most of the expert systems dispose the mechanisms capable to use thought methods so called "modus-poneus". The inference motive is represented by the program, which contains and explores the knowledge basis and is devoted to the combination, unchaining, knowing having as purpose the new thoughts, plans, demonstrations and decisions producing. The work has as main original, theoretical/applicative contributions some of the aspects: a wide and easy to understand corpus integration of theoretical and practical aspects, which aim control strategies in order to introduce an expert system. As well as - the part of the knowledge basis definition in the expert systems architecture and the effects analysis on the integration possibility of the based on knowledge systems, on the data basis and on the oriented numerical calculations program, also method exposition on the based cases systems.

The study presents the possibility to use the forward, backward and joint control strategies, for the knowledge basis, by an expert system inference motive. The practice showed that the expert system is able to emulate the judgement types used by the people (through analogy, formal and methodological). Due to the lack of the standardization in this field there are more tackling for the model of the expert system development process. The expert systems ground consists in the giving off phase development: project starting, analysis and projecting, rapid standardization, development, application and fast application. The information within this work can be applied in both business and financial domains.

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