

Multi-expert System and its Knowledge Organization

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Abstract: A brief introduction about the strong point and main structure of Multi-Expert System is given in this paper. For management and control problem in multi-experts system, a concept: MCK management & control knowledge is introduced to us. MCK's definition, classification, acquisition and representation are studied. It is Multi-Expert System that has MCK. It can be used to manage and control the cooperation of Multi-Expert System or the execution of mono-expert system.

Keywords: Multi-Expert System, Management and Control Knowledge (MCK), Knowledge Representation

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I. Introduction

Although expert systems have been widely used in many fields and achieved good results, their scope of solving problems is strictly limited. The main reasons are lack of knowledge and improper methods to solve problems, that is, they can't properly use their existing knowledge or lack of knowledge. At present, most expert systems have a single problem-solving method, which is difficult to meet the requirements of complex fields. Multi-expert system is one of the ways to solve the problems faced by the existing expert system. The characteristic of joint cooperative multi-expert system is that each expert system has only one problem-solving method, but it fully understands its own limitations and the advantages of cooperative experts, so as to know when and how to transfer the problem.

II. Multi-Expert system

The main purpose of multi-expert system is to improve the ability of expert system to solve problems by coordinating the cooperation of multi-expert systems, especially when a single expert system is difficult to solve problems effectively. It has the following characteristics: potential possibility of parallel processing, scalability of the whole system, autonomy of a single node, sharing of knowledge and resources, fast knowledge processing speed and strong processing ability. Generally, multi-expert system is composed of control system, blackboard system and multiple front-end processors, as shown in Figure 1.

As can be seen from the figure, each part is connected with other parts through the communication module. The control system is responsible for managing the cooperation and communication between expert systems and managing the operation state of the whole system, including task decomposition, scheduling, deadlock handling, etc. Blackboard system stores and manages the information required by the control system and the shared information between expert systems, which ensures the consistency of information.

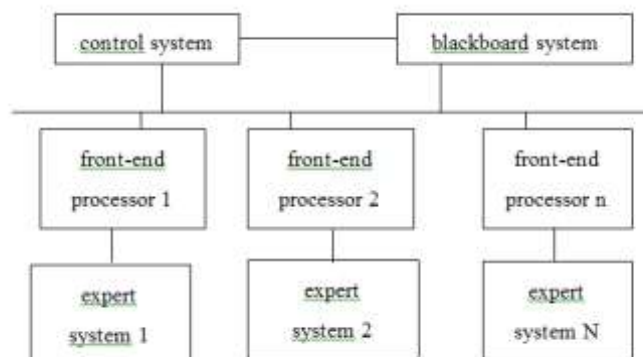


Figure 1: general structure of multi-expert system

The working process of multi expert system is: an expert system can independently solve problems in a specific field. If an expert system encounters a task that cannot be solved, it will first ask the control system for help, then the control system will check and convert, and then entrust the task to an appropriate expert system.

After the expert system is solved, the result will be sent back to the control system, The control system makes necessary conversion and result synthesis, and sends the final result back to the expert system applying for help. Each front-end processor is responsible for managing and connecting a pre-existing heterogeneous and autonomous expert system. Each expert system can not only solve problems in specific fields independently, but also cooperate with other expert systems.

It can be seen that a multi-expert system must have the functions of knowledge acquisition, information processing, decomposition and synthesis of tasks, task evaluation and allocation, sub task scheduling and blackboard interpretation system. For a single expert system, it needs to have a lot of domain knowledge in this field. The key to its role is how to effectively represent domain knowledge; Accordingly, for multi-expert systems, because the knowledge structures of each sub expert system have their own emphasis and are interrelated, how to clearly and accurately express the control source knowledge, control and coordinate the cooperation among multiple expert systems has become an important topic in the research of multi-expert systems. The coordination problem of establishing multi-expert system includes the following contents: task decomposition and allocation; Communication and transmission of data and knowledge; Synthesis and evaluation of results and treatment of uncertainty and inconsistency; Change of working state of expert system, etc.

III. Examples

The following introduces a specific multi-expert system for multi-task execution and scheduling multiple experts for joint solution, and introduces its knowledge organization mode in management and control in detail. It adopts an extended blackboard control structure, and its overall structure is shown in Figure 2.

3.1 management control knowledge

In multi-expert system, knowledge is divided into two levels: single expert knowledge level and multi-expert knowledge level. The single expert knowledge layer mainly includes the professional target knowledge of the expert field; Multi-expert knowledge layer mainly includes management & control knowledge (MCK). MCK is a unique knowledge in multi-expert system. It is responsible for the management, control and scheduling of multi-expert system. The research on multi-expert knowledge layer has become an important topic in multi-expert knowledge base system.

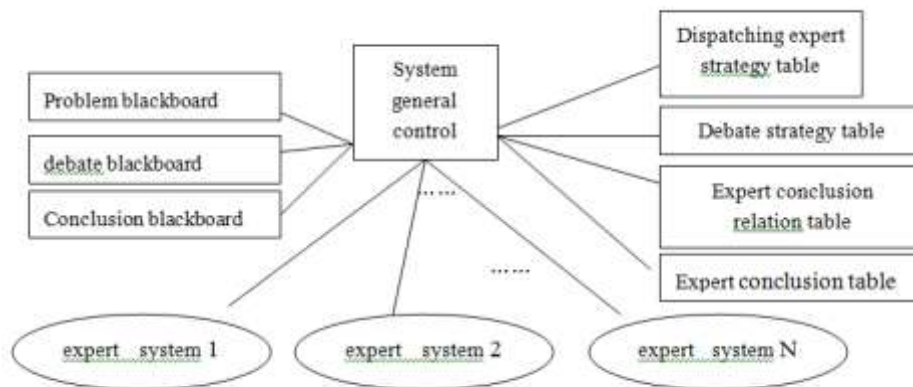


Figure 2: example of multi-expert system structure

In multi-expert system, the knowledge about a specific field is called domain expert knowledge, and the knowledge of managing and controlling expert systems in different fields is called management control knowledge. The description and definition of management control knowledge are as follows:

Management control knowledge (MCK) is the knowledge used to manage and control experts in different fields. It includes two types: one is about the content, scope, knowledge representation form, reasoning mode and reliability of expert systems in different fields; The other is about how to use the knowledge of known domain experts, including which domain experts' knowledge (scheduling), how to use (control), how to manage the cooperation of experts in different domains, and how to plan, organize and select the tasks to be completed in order to solve specific problems.

According to different functions, management control knowledge can be divided into five categories:

- (1) Select the knowledge of experts in different fields. MCK manages multiple domain experts, so you must have corresponding knowledge about which domain experts to choose.

(2) Knowledge of expert system implementation in control field. MCK can control the execution process of a domain expert system.

(3) Knowledge of expert system cooperation in control field. MCK supports multiple domain expert systems to work in a cooperative manner. If there are conflicting opinions among expert systems, debate algorithm is used to determine the outcome.

(4) Manage the knowledge of multi expert system. MCK provides the knowledge of managing multiple expert systems, including blackboard management, network interface management, etc.

(5) Knowledge of error checking. MCK can detect errors during system execution at any time. These errors include the errors of a single domain expert system itself and the errors of multiple domain experts in the process of cooperative problem solving.

These five kinds of management control knowledge play a decisive role in the implementation of management control single expert system and the cooperation of multi expert systems.

3.2 acquisition of management control knowledge

Generally speaking, there is no essential difference between the acquisition of management control knowledge and the acquisition of domain knowledge, which can be obtained in the following three ways:

(1) Provided by domain experts. Since MCK is the knowledge used to manage and control expert systems in various fields, the domain experts providing MCK must have the following two points:

① Understand the basic contents of experts in each leading city.

② Rich experience in multi expert cooperation.

(2) Machine learning provides. During the operation of multi-expert system, the characteristics of the system, the characteristics of each expert system and the characteristics of multi-expert cooperation can be accumulated through machine learning.

(3) Provided by knowledge engineer. Familiar with the background of experts in various fields, through the analysis and acquisition of target knowledge in different fields, and gradually put forward the design scheme of multi expert system. In the process of establishing multi expert system, the knowledge of experts in various fields of management and control is also obtained.

3.3 management control knowledge representation

In order to facilitate the management and flexible control of the system, the system provides three forms of MCK: knowledge source, framework representation knowledge and function knowledge. The latter two are mainly introduced below.

3.3.1 framework representation language

There are two ways to describe management control knowledge: descriptive knowledge and control knowledge.

The framework representation adopts a special domain definition method that is easy to use by most domain experts. These are powerful support for the description of additional feature attributes required to express control knowledge and dynamic control scheduling. In addition, the framework itself has a collective description of the description objects, which lays a foundation for object-oriented control scheduling and management. The information stored in the framework is usually regarded as the "database" of the knowledge system, while the control of reasoning is left to other parts of the system. This method is helpful to explain the semantics of the framework structure and organize and store knowledge.

In the management and control of multi-expert system, many knowledge is used to control or dispatch single experts and multi-expert execution and cooperation. Therefore, the description of control knowledge has special significance in multi-expert system. Framework based representation can not only describe descriptive knowledge, but also organize controlling knowledge. The language is represented by a new framework, which is divided into descriptive framework and control framework according to descriptive knowledge and control knowledge. The two frameworks are defined separately. This method of describing the control framework independently can provide a clear control representation technology, make the process control easy to understand, and play a role of planning and dispatcher for multiple work objects.

3.3.2 function knowledge

Here, the knowledge called by the control framework is represented by functional representation. From the perspective of users using multi-expert systems, each expert system can have its own knowledge representation and reasoning strategy. Users use the functional knowledge provided by multi-expert systems to manage and control each expert system and the cooperation between experts. Here, these function knowledge is called basic function knowledge. From the perspective of use, the basic function knowledge has the following four categories:

(1) Initialization class: the function knowledge corresponding to various preparations made by the system to

solve the problem after the user inputs the evidence of the problem.

(2) Control expert class: including the function knowledge corresponding to the call manager and any qualified expert.

(3) Control class: including the function knowledge corresponding to single expert execution and multi expert cooperation.

(4) Management class: including the function knowledge corresponding to multi-expert system management.

These function knowledge can be used independently or embedded in the control framework.

Basic function knowledge can be designed and implemented using appropriate programming languages such as LISP and Prolog.

3.4 summary

As the unique knowledge of multi expert system, management control knowledge conforms to the knowledge stratification principle of multi-expert system, and can manage and control the cooperation of multiple expert systems and the implementation process of single expert system.

IV. Outlook

The application of multi-expert collaboration mechanism can solve problems in more fields;Based on mature network technology, it will be more widely used.

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