Study of Object-Oriented Model for the Knowledge Base System

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ABSTRACT

Based on the analysis of object-oriented model, knowledge base and knowledge base system by using theories on object-oriented and knowledge base, the relationships between object-oriented model and knowledge base are discussed in this paper. The architecture of object-oriented knowledge system is proposed and the Rule-Case-Based Reasoning knowledge base system is designed.

Keywords: object-oriented model, knowledge base, knowledge base system, case-based reasoning

The early computer application is mainly involved in numerical computation, but not in non-numerical data (text, image, video and audio). With the development of computer technologies, real computer application has entered into much more widespread non-numerical fields, such as non-numerical data processing, control, ad hoc the knowledge processing and knowledge system developing as well as the artificial intelligence [1]. In recent years, the organization and development of the knowledge base system through the object-oriented thought becomes the hot issue due to the fact that the object-oriented model is capable of expressing and manipulating the complex knowledge structure. The abilities, such as abstraction and generalization, restriction and reasoning, are just the remarkable merits of the object-oriented model whereas the traditional knowledge base systems are lack of these abilities.

1. INTRODUCTION OF OBJECT-ORIENTED

The object-oriented design thought is very close to the objective world and the usual thinking mode of people. It is convenient for the design and development of computer systems, and is easy to be understood and accepted by end users [2].

The object-oriented thoughts consider that a system is composed of many objects with influences among themselves. The object consists of data and operation which is of encapsulation and dynamic. The basic idea for applying the object-oriented thoughts as methodologies to each process of software engineering is essentially to find objects and the relationships between them. During the stage of requirements analysis, the object-oriented analysis is modeling real world objects. In other words, such analysis is portraying and describing problems from the application point of view, which is much helpful for problem understanding. During the stage of design, the object-oriented methods can be used to design the knowledge base. The object model is portrayed by relationships between objects, inheritances and gatherings. There is a direct mapping between the object model and knowledge base table [3]. When transforming the object model into the knowledge base table, the complete restraints and the model restraints as well as the relations between tables should be considered.

The encapsulation is the key for the object model being applyed to the overall design. This feature makes us ignore the details of information processing inside the objects and meanwhile pay more attention to the definition of interface. Encapsulation can avoid the stiff design results and perform the transformation from most exist system models to future models inside the objects. In addition, encapsulation makes the objects be of more semantic information. The objects as the mapping of real entities in models have all properties and functions of entities themselves. In practical modeling, the objects have different properties and functions in terms of personal different understanding of the corresponding entities and different requests for problems. Information transmission is another important description means for object-oriented methods. In traditional design methods, the flow of the system is connected in a logic way which is the high abstraction of developmental sequence of real events. However, the logic order cannot reflect the reasons why such order is formed, that is initiative

requests or paasive acceptance. So it cannot describe some facts in designing although they exist in real world. The mechanism of information transmission between objects can particularly characterize the dynamic interactive progress between systems. Through the interactivities between objects, the logic time sequence can be represented, such as sequence, concurrency, synchronization and asynchronism and so on.

2. INTRODUCTION OF KNOWLEDGE BASE SYSTEM

Knowledge is the human cognition toward the objective world. Generally speaking, knowledge can be obtained from some information which is processed from the raw data by classification, induction, integration, etc. Such information can be transformed into the knowledge after interpreting, comparing, and reasoning. This process is carried out mainly in the semantic level. The data is normally certain, clear and complete, whereas the knowledge is often fuzzy, indefinite or incomplete. Moreover the knowledge is always dynamic. Solving numerical problems is a kind of solution for the certain algorithm, however solving the knowledge problems is a kind of solution for the uncertain algorithm in which there maybe numbers of ways to the goal. Knowledge problems are solved based on the premises and the constraints, so it is difficult for solving knowledge problems. The object-oriented model can ease this problem since it can effectively describe knowledge and the relationships between them. The knowledge base system based on the object-oriented model can help to establish the effective knowledge expression system and disclose intrinsic relationships between knowledge.

The knowledge base is the set of facts, rules and concepts. From the knowledge memory point of view, the so-called knowledge case is the location for storing and managing the knowledge by representation methods. From the knowledge use point of view, the knowledge base is composed of knowledge and knowledge processing organizations. The knowledge base forms a knowledge domain in which there are not only facts, rules and concepts, but also many knowledge processing methods, such as reasoning, inductive, deductive methods and so on. In the knowledge domain, the knowledge mainly concerns representation methods (e.g., production system, semantic web, neural network, etc) and processing principles (e.g., deduction, induction, fuzzy reasoning, non-monotonous reasoning, etc). Such knowledge is of abstraction and generalization [4].

Knowledge base system is represented by knowledge, which is the generalization and abstraction of objective movement rules by using symbols. Knowledge representation is a model to generalize the human intelligent actions. Due to the flexibilities of intelligent problems, this representation is hard to be classified into a simple theory whereas a set of different theories. The knowledge object is a unity regarding objective entity and its functions, by which the knowledge analogy and reasoning can be done. The knowledge object is not only the basic element for knowledge but also the independent cell for problem solving. The representation and process of knowledge object are the first key problems to be considered for construction of knowledge base system.

3. THE RELATIONSHIP OF OBJECT-ORIENTED MODEL AND KNOWLEDGE BASE SYSTEM

The core of the knowledge base system is the knowledge base and the reasoning process. The knowledge can be stored and managed in the knowledge base, and be processed by the reasoning machine. If a system is capable of interpreting, inferring and further verifying the input data by use of the stored knowledge, this system is called the knowledge base system.

The implementation of knowledge base system mainly involves representation, use and acquisition of the knowledge in order to realize knowledge retrieval and satisfy users' demands. The crucial problem in the knowledge base system is knowledge representation. Knowledge should be represented in a machine-readable format, meanwhile it should be transferred to end users in an understandable way [5].

The object-oriented model provides some techniques for developing the the knowledge base ssytem, like data class, encapsulation, and inheritance. The object model in the knowledge base system is an unified subject about the objective entity and the function of this entity, by which knowledge analogical reasoning can be carried out. So we can say that the object model is not only the fundamental element of the knowledge, but also the independent unit for problem solving. In addition, the object model can disclose the intrinsic relationships between knowledge. The knowledge reasoning is the reasoning process that reasoning machine performs the heuristic search and reasoning by use of the strored knowledge in the knowledge base, and then the reasoning results are directly returned to end users in a friendly way. This process is often not open to the end users. For knowledg reasoning, the most suitable reasoning machine is the case-based and rule-based integrated reasoning machine [6-8].

4. ARCHITECTURE OF OBJECT-ORIENTED MODEL FOR THE KNOWLEDGE BASE SYSTEM

The object-oriented knowledge base system is based on the object-oriented database management system. Through the functions of object-oriented modeling, we can achieve object-oriented knowledge representation and mixes the object-orientedknowledge model and the reasoning based on rules and cases into the knowledge base system.

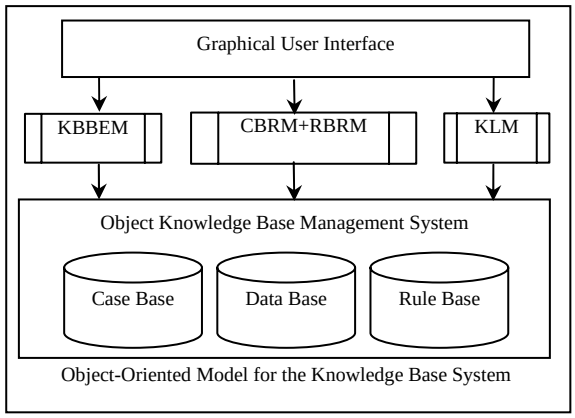

Fig. 1 Architecture of Object-Oriented Model for the Knowledge Base System

Be shown in Figure 1 below, the knowledge base system based on the object-oriented model is composed of three main parts: graphical user interface (GUI), reasoning machine and learning machine, and object knowledge base management system. (1) GUI. GUI is designed based on Windows Server 2003 and Visual Basic.Net, by which the user can interact with the system. In GUI environment, the user can browse and search in the knowledge base, and complete the submission of new problems. In addition, the user can do other things, such as defining each kind of object model, and establishing and maintaining the knowledge base. (2) Reasoning machine and learning machine. This part includs the case-based reasoning module (CBRM), the rule-based reasoning module (RBRM), the knowledge learning module (KLM), and the knowledge base browsing edition module (KBBEM). Its main function is manipulating and searching knowledge. (3) Object knowledge base management system. Different types of object model bases including DB, CB and RB. Here, CB, DB and RB respectively are case base, data base and rule base which are organized based on the object-oriented hierarchical structure. DB is used to store the technical data in application domain; the content of case base contains case classes, case object clusters and practical case objects; rule base is organized according to rule classes.

5. REASONING MECHANISM OF OBJECT-ORIENTED MODEL FOR THE KNOWLEDGE BASE SYSTEM

The object-oriented model for the knowledge base system adopts Rule-Case-Based Reasoning mechanism. The Reasoning Machine is composed of Case-Based Reasoning Model and Rule-Based Reasoning Model.

Applying problems is first solved through RBRM. RBRM starts to work based on the traditional rule-based reasoning mode, that is at first match the trigger conditions one by one in the rule base, and then link and perform rules. If the rule matched, the result can be directly obtained by the rule reasoning mode and therefore is returned to end users. If the result cannot be directly obtained by means of RBRM, then the past experience should be considered for getting new results. The function of RBRM lies in determination of the matching scope and the searching direction. It helps to find the similar instances to old ones in the class. In the object-oriented model system, the latter function is strengthened. And that CBRM is the reasoning method of similitude or analogy, its core consists in solving the new problem by the past similar instance and experiences, it uses the former instance to carry on the inference directly, thereby reduces the knowledge gain workload greatly. Thus reasoning machine can directly improve the reasoning efficiency of the system .

CBR was firstly proposed by Roser Schank in his book named “Dynamic Memory” in 1982, which is thought to be an important human thinking manner now. CBR comes from human’s cognition and psychology activities. When solving a new problem, it is usual for human beings to use the previous experiences of the similar problems they met before. When the new problem is just a simple copy of the past ones, the successful experiences obtained before can directly be used. However, when the solving problem is never met, we have to find one or more similar problems and get some hints, based on which the new problem can be solved under the direction of background knowledge. Certainly, the processed problem can also be recorded as the experience for the future cases. CBR expands the area of problem solving and can form creative answers. Moreover, it can simplify the process of solving, save problem-solving time and improve the answer quality. The results obtained from CBR method can be easily

explained and therefore be accepted by users. So CBR is a better way to building a knowledge base system.

In knowledge base system of Rule-Case-Based Reasoning, the work flow of reasoning machine is shown in Figure 2 below, which improves the reasoning efficiency.

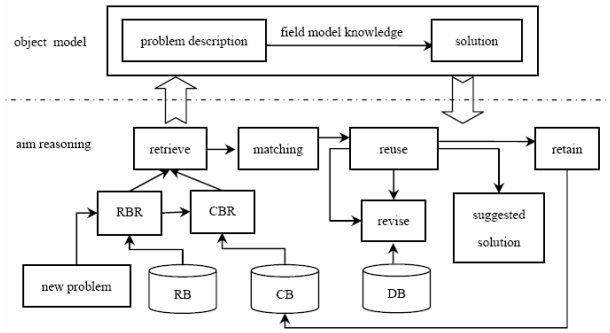

Fig. 2 Reasoning machine work flows

6. CONCLUSION

The knowledge base system is the entity for knowledge store, which is the product of the combination of database technologies and artificial intelligence. The knowledge base technologies are the foundation of artificial intelligence application systems. They make computer application systems be of more intelligence, like intelligent search, intelligent reasoning, intelligent learning and so on. By applying the object-oriented model to knowledge base systems, not only the knowledge involved can be well described, but also the relationships between knowledge can be discovered clearly. The future work is focused on making knowledge acquisition more intelligent by introducing some priori knowledge and widen the application areas of the object-oritended model.

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