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Knowledge engineering for an intelligent case-based system for help desk operations

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Abstract

Help desks are computer-aided environments in customer support centers that provide frontline support to external and internal customers. The paper reports on an automated help desk system developed at an information technology company. With the proliferation of diverse software and hardware, the center provides support to a large variety of client systems. The number of calls increases while the turnover rate of employees is high, which means the cost of training escalates. The objective of this project is to develop an automated case-based help desk system to support both call center personnel and customers. The system would contribute to shortening the response time on incoming calls and reduce training time for new employees. The focus of the paper is on the knowledge engineering process of the system. We discuss in detail the knowledge acquisition, knowledge representation, system implementation and verification processes, and we emphasize the structured and automated development methods adopted. © 2000 Elsevier Science Ltd. All rights reserved.

Keywords: Case-based reasoning; Help desk automation; Knowledge engineering

1. Introduction

Case-based reasoning (CBR) is a computerized method that attempts to study solutions that were used to solve problems in the past so as to solve, by analogy or association, current problems (Ketler, 1993). Compared to rule-based system, a case-based system is more similar to actual human decision processes, and its knowledge acquisition (KA) process is easier for it is not necessary to abstract rules from the available information. Maintenance is likely to be more straightforward because it is easier to incorporate new knowledge into an existing knowledge base. It has been proposed as an approach that can overcome the weaknesses of the traditional rule-based reasoning method. Case-based reasoning is more suited for unstructured and poorly understood domains and has already been used in a wide variety of domains, such as knowledge acquisition, diagnosis, design, planning, repair and adaptation. Some of these applications will be presented in the literature section.

The objective of this paper is to present the Case-Based Help Desk (CBHD) system which is an automated decision support system to help call center or customer service representatives to quickly diagnose problems in computer systems and suggest viable solutions. This paper proceeds as follows. Section 2 describes some background literature relevant to the project. Section 3 discusses the problem domain this project tackles. In Section 4, the development processes are discussed. Section 5 gives the conclusion and discusses some possible directions for future work.

2. Background literature

According to Watson and Marir (1994), CBR can be presented as a cyclical process consisting of retrieving the most similar cases, reusing the cases to attempt to solve the problem, revising the proposed solution if necessary, and retaining the new solution as a part of a new case. When faced with a new problem, a CBR system will retrieve similar cases to help solve the problem (CBR, 1998). The major issues in CBR include how to represent cases and structure relationship between cases, how to handle massive case bases and develop general adaptation heuristics for modifying previous cases. It is suggested that if CBR can be integrated with other reasoning paradigms and information systems, it would improve efficiency of case base retrieval.

The rule-based method and case-based method can be integrated so as to take advantage of the reasoning power of both systems. The authors used this method in a portfolio management domain, which was a poorly understood domain. Chi, Chen and Kiang (1993) incorporated domain

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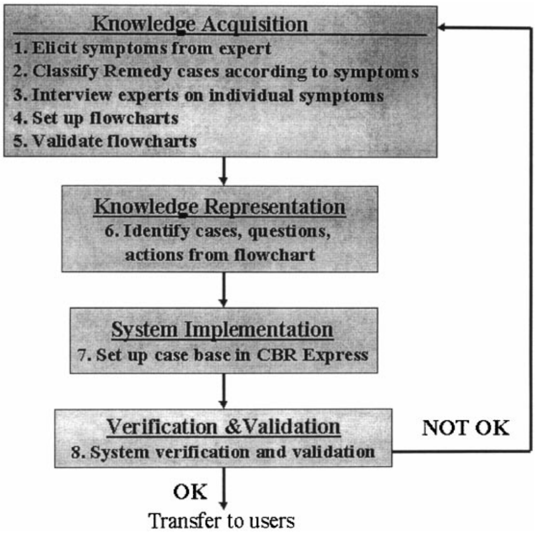
Knowledge Acquisition
1. Elicit symptoms from expert
2. Classify Remedy cases according to symptoms
3. Interview experts on individual symptoms
4. Set up flowcharts
5. Validate flowcharts
Knowledge Representation
6. Identify cases, questions, actions from flowchart
System Implementation
7. Set up case base in CBR Express
Verification &Validation
8. System verification and validation
NOT OK
OK
Transfer to users

Fig. 1. Case-Based Help Desk (CBHD) system development procedure.

theories represented as generalization rules to improve the problem solving ability of the system. With these rules, previous experience represented as existing cases can be generalized so that the possibility of solving a new case is higher than it would be when either case-based reasoning or rule-based reasoning is used alone.

McCartney (1993) developed a CBR real-time planning system called Cookie to solve planning problems by reusing previous episodes. The planning problem involves finding a sequence of primitive actions that leads to some specified results, which include goals to be accomplished and constraints to be satisfied. Cookie is an integrated planning, execution, and learning system that operates in the domain of meal planning and preparation. It uses an episodic representation scheme that provides for flexible use of knowledge and supports real-time performance, as well as simplifies the case acquisition process.

Case-based reasoning was also used in the model formulation domain. Vellore, Vinze and Sen (1993) proposed a CBR system called Modeler for model formulation which transforms a problem description into a suitable representation or form that is interpretable and executable by available tools. The authors proposed a case-based cognitive model of the planning process in an attempt to integrate experiences with planning. This model includes features from CBR and opportunistic control to provide a flexible planing method for model formulation.

Allemang (1994) combined CBR and task-specific architectures in the fabric-fault-diagnosis system. In task-specific architectures, a task corresponds to a goal and is either decomposed into sub-tasks or specifies some knowledge that is applicable for achieving this task. A case-based reasoning system stores cases rather than rules, therefore it replaces the knowledge acquisition problem with an indexing problem. The author adopted task-specific architectures as the indexing mechanism in an attempt to address the knowledge acquisition bottleneck and problem of robustness in traditional rule-based expert systems.

Yoon and Acree (1993) developed a case-based expert system, service, for a service coordination help desk which assists service coordinators in dispatching technicians. When the medical centers call in to complain about a machine disorder, the dispatcher must, according to the message, decide which technician to dispatch. The decision needs to satisfy the requirement of dispatching a qualified technician while incurring the least cost. The objective of service is similar to the CBHD system to be presented in this paper. However, while Yoon and Acree (1993) emphasized the structure and mechanism of the case-based system, this article focused on the development process in terms of knowledge engineering.

3. Problem domain

The CBHD system was developed for a major information technology company and system integrator in Canada and USA. The company offers a comprehensive range of solutions, services and support capabilities to customers. With the proliferation of diverse types of computer software and hardware products for personal computers, the types of printers and servers supported have multiplied rapidly. There is also a high turn over rate for the company workers, which means training of new employees is critically important. The first call a customer makes to the Help Desk is called a tier 1 call, which costs US$ 18. If the problem is not solved during the first call, extra money and time is spent when the call is elevated to Tier 2. At the same time, customer satisfaction may be adversely affected. This is a primary concern for the company.

To test feasibility of automating the Help Desk operations, a case-based reasoning approach was adopted. The paper reports on this feasibility study which focuses on the PC LAN help desk and one word processing software, WordPerfect 6.1 (trademark by Corel Corporation) within the environment of one client of the information technology company.

4. System development

The basic idea of CBR is to remember and adapt solutions that were used to solve old problems and use them to solve new problems. A case is the primary knowledge-base element for a case-based reasoning application system. The description of cases is different depending on the development environments and tools. The tool adopted in this project was CBR Express Case Point 3.5 (by Inference Corp. USA), so the system architecture and development method is largely adapted for this environment (see Fig. 1). The steps for developing the system are summarized as follows and presented in detail in the subsections.

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