CBR-TM: A new Case-Based Reasoning System for Help-Desk Environments

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Abstract. In this paper, a new CBR system for help-desk environments is presented. This CBR system provides intelligent customer support for multiple domains. It is also portable and flexible. The system is implemented as a module of a complete help-desk application to make it as independent as possible of any change in the help-desk system. Each phase of the reasoning cycle is also separated as an independent module, making the CBR system easy to update. The system has been tested in a real call center managed by the Spanish company TISSAT S.A.

1 Introduction

Customer support has become a profitable business. A quick and accurate response to customer problems ensures their satisfaction and a good reputation for the company. Companies usually attend to customers via a call center, where a number of operators manage the queries using a help-desk application. To provide high-quality customer support the operators must be trained. Moreover, the knowledge of experienced operators should be saved in order to maintain it over the course of time or if the operators leave the company. Reusing successful past solutions may be a suitable method to improve the performance of a customer support system.

A Case-Based Reasoning system (CBR) tries to solve a new problem (case) by means of reusing the solution of a past similar case. This solution is previously stored in a case memory (case-base) and can either be retrieved and directly applied to the current problem, or revised and adapted to fit the problem. The successful application of CBR systems in help-desks for managing call centers has proved the suitability of these systems since the 90s \cite{2,5}. There are also many companies that sell software for applying CBR to help-desks. We were asked to implement a new CBR system as generic as possible to provide intelligent customer support to a help-desk environment without using any copyrighted software or any CBR tool that is only available for research purposes. Even though it has been tested in a specific help-desk that provides technical support for computer systems, one of our main objectives was to develop a modular CBR system which can be easily adapted and applied to any domain related to customer support.

2 The CBR-TM module

The Spanish company TISSAT S.A \cite{3} provides customer support for public administration organizations and private companies. In order to improve the service, TISSAT has developed a help-desk toolkit called I2TM (Intelligent and Integrated Ticketing Manager, version 6). Each request received by TISSAT is called ticket and is tracked by means of the I2TM application. This application works with either queries related to computer errors (network systems failures and personal computer problems) or with requests of citizens about public services (such as the international emergency phone number 112 of the Valencia region, which covers the emergencies of over four and a half million people). Therefore, I2TM must be able to rapidly solve requests from very diverse domains.

The CBR system that we have developed, called CBR-TM (Case Based Reasoning for Ticketing Management) acts as an intelligent module for the I2TM system, helping it with the problem-solving process. Implementing CBR-TM as a module allows both systems to be changed and updated independently. We have integrated CBR-TM into I2TM using webservices. This approach was chosen because of its flexibility and distributed access possibilities. The webservices work as a bridge between I2TM and CBR-TM. The overview of the entire system architecture is shown in Figure 1.

![Figure 1. I2TMv6 architecture overview](image)

The CBR methodology for problem solving is typically divided into the phases of the CBR cycle \cite{1}: Retrieve, Reuse, Revise and Retain. The design decisions adopted for each phase in CBR-TM were principally influenced by the customer support domain and our goal to provide flexibility. In CBR-TM, a case is the prototyped representation of a set of tickets with the same features and the same successfully applied solutions. Each case has a set of attribute-value pairs (variables of any value type) that describe the characteristics

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of the problem. The indexing schema hierarchically organises the cases in the computer memory to facilitate the retrieval. The indexing process in our system consists of establishing a set of categories for each ticket that classifies it as belonging to a certain type of problem, which is currently being done manually. These categories are also stored in each case as attributes.

The main goal of the retrieval phase is to obtain the set of stored cases that are similar to the new one. Due to the multiple domains of the requests that the I2TM system receives, the CBR-TM module must be able to work with heterogeneous tickets and must also be able to compute the similarity among them. Moreover, the ticket attributes may have missing values. It would be desirable to have a modular system into which we could insert different types of retrieval algorithms, without the inconvenience of having to redesign the entire system if a new representation space is considered. Thus, we have adapted and tested several known distance measures to work with heterogeneous data. The most similar case or cases are selected by means of a $k$-nearest neighbour algorithm using these distance measures to compute the similarity among cases. Currently, we have implemented two Euclidean-based similarity measures (Normalized and Classic) and a similarity measure based on the ratio model proposed by Tversky [4].

Once the most similar case is selected, its solution is proposed to solve the new problem that has been reported to the system, in a simple reuse phase. At this time, the solution is copied and applied to the new problem without any changes, but it is also configurable and, if necessary, any adaption process can be introduced. When a solution has been provided, the customer must indicate to the system whether that solution has really solved the problem. By means of this revision phase, the system can learn the degree of suitability of the responses that CBR-TM provides. Finally, if there is not a case that is similar enough to the new ticket, the system stores this ticket and its solution in the case-base during the retention phase.

3 Discussion

In order to evaluate the CBR-TM module, we used a synthetic database of tickets that came from computer errors. Note that a ticket of this database is not equivalent to a case, since a case is the prototyped representation of a set of tickets with the same features and the same solution that has been applied satisfactorily in the past.

We used the ticket database to test the CBR-TM performance. This performance may be influenced by the number of tickets processed by the system or the number of customers sending requests simultaneously. The tests were performed using a cross-partition technique separating the ticket database into two databases for training (loading the case-base) and testing the system. We repeated the tests for each similarity measure implemented in order to analyse its behaviour in the computer error domain.

The top graph of Figure 2 shows that as the number of tickets in the case-base of the CBR-TM system increases, the mean error in the answers provided by the system decreases. This fact demonstrates that the system knowledge goes up as the amount of processed data increases and, thus, CBR-TM is learning effectively. The bottom graph of Figure 2 shows the response time when the number of customers making simultaneous requests increases. As expected, this time increases in proportion to the number of simultaneous customers. In addition, this test shows that CBR-TM is able to answer the requests quickly even when there are a considerable number of simultaneous requests. The results of the tests also show that all the similarity measures behave in a very similar way and any of them might be suitable for this domain.

![Figure 2](image-url)

Although the CBR-TM system has been tested in a help-desk whose purpose is to solve computer errors, TISSAT plans to use it in different domains in the near future. Moreover, since this system has been recently implemented, more intensive research to improve the algorithms and the techniques applied will be performed. One of our main interests is to change the manual categorisation for an automatic one. This would prevent CBR-TM from making mistakes due to human error.

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References