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A case-based reasoning system for conflict resolution: design and implementation

Sara Ross[a], Liping Fang[a,b,*], Keith W. Hipel[a]

[a] Department of Systems Design Engineering, University of Waterloo, Waterloo, Ont., Canada N2L 3G1
[b] Department of Mechanical, Aerospace and Industrial Engineering, Ryerson University, 350 Victoria Street, Toronto, Ont., Canada M5B 2K3

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Abstract

A case-based reasoning system for conflict resolution called GMCRCBR is presented. The system is developed to provide real-time feedback to assist in the structuring and modeling of a conflict situation. A system architecture integrating the decision support system GMCR II, which implements a methodology called the graph model for conflict resolution, and the GMCRCBR system is developed. The issues of case representation, case storage, case retrieval, and case reuse are considered. Information on 104 conflict cases that have been analyzed using the graph model for conflict resolution is collected and stored. The system is first tested and verified using the case base and then the system's ability to retrieve similar cases is evaluated.

Keywords: Case-based reasoning; Conflict resolution; Case representation; Case storage; Case retrieval; Case reuse; Conflict cases; The graph model for conflict resolution; Conflict modeling

1. Introduction

The study of conflicts and their resolution is one that transcends all areas of human endeavor. In fact, conflict seems to occur any time two or more human beings interact. The graph model for conflict resolution methodology (Fang et al., 1993) is developed for systematically studying real-world strategic conflicts. The basic components of a graph model for conflict are the decision-makers (DMs), the states, the possible state transitions and the decision makers who can unilaterally affect them, and the decision makers' relative preferences over states. The graph model is currently implemented in practice by utilizing the decision support system GMCR II (Hipel et al., 1997, 2001; Peng, 1999). In GMCR II, a state is represented by a combination of options that are controlled by decision-makers.

A large number of real-world conflicts have been documented and analyzed by utilizing the graph model for conflict resolution. During the initial modeling phase of a graph model, decision-makers, their options, the possible state transitions, and the decision-makers' relative preferences over states must be identified. The identification of the decision-makers and their available options can be a time-consuming and difficult activity. An even more significant challenge is to ascertain the relative preferences that each decision-maker has for the feasible states. To overcome these challenges, it is useful to identify similar cases that have been analyzed using the graph model methodology.

Case-based reasoning (CBR) utilizes the specific case information available as historical precedence for proposing solutions to current problems. The most important aspects of the existing cases are first stored and indexed. New problem situations are then presented and similar, existing cases are identified from the knowledge base. Finally, the previous problem solutions are adapted and the revised solutions are proposed for the current situation.

The major objective of this paper is to present an interpretive CBR system for structuring and modeling a

*Corresponding author. Department of Mechanical, Aerospace and Industrial Engineering, Ryerson University, 350 Victoria Street, Toronto, Ont., Canada M5B 2K3. Tel.: +1-416-979-5000x7215; fax: +1-416-979-5265.
E-mail address: lfang@ryerson.ca (L. Fang).

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conflict. The system is proposed as a means to help overcome challenges in modeling a conflict with the graph model methodology by utilizing information provided in previous cases. The CBR system (GMCRCBR) is designed to transparently integrate with the existing decision support system (GMCR II), in order to provide real-time feedback during the modeling process. When providing advice to a client on how to strategically handle a conflict situation, an analyst or consultant would first have to develop in real-time a model of the dispute. More specifically, the analyst, based on information obtained from the client, would use the CBR system to enter a limited amount of information on a current case, including the involved decision-makers, as well as to retrieve similar cases that have been modeled and analyzed and to provide suggestions on the options that are available to them. Information from similar cases identified could assist the analyst and client in structuring and modeling the current conflict. As the model is developed and both the analyst and client will begin to understand the conflict better, intelligent feedback furnished by the system would be used to further refine the model that is later used as a basis for analyzing and generating strategic advice. It is anticipated that this CBR "guidance" will speed up and simplify the analysis process.

Following an overview of CBR, a brief introduction to the graph model for conflict resolution is presented in Section 3 and two representative conflict cases are outlined in Section 4. The development of the CBR system for conflict resolution is described in Section 5 while the results of retrieval experiments for 104 cases are given in the next section.

2. Case-based reasoning

One commonly employed technique for developing an expert system is rule-based reasoning (Kolodner, 1993). Rule-based systems are created by extracting generalized rules from available data, and applying these rules to current problem situations. CBR takes a much different approach by utilizing the most specific case data available as historical precedence for proposing solutions to current problems (Kolodner, 1993; Kolodner and Leake, 1996). CBR achieves this task by first storing and indexing the most important aspects of the available cases. New problem situations can then be presented and similar, existing cases are identified from the knowledge base. Adaptation of the previous problem solutions can then be made to the current situation. This technique thus avoids the exhaustive task required in most expert systems of analyzing existing data and developing a set of applicable rules.

A CBR system can be used in two different types of situations: problem solving and interpretive situations. In problem solving situations, CBR is used to propose a solution to a current problem, based on previous problem solutions. This process involves adapting old problem solutions to the current one, and evaluating the proposed solution. Interpretive CBR is used to identify similar cases for the purpose of further understanding, assessing, and/or comparing with the current situation.

CBR techniques can be used to collect the knowledge of domain experts who may not always be available for consultation. Moreover, CBR systems can be used to assist a user in developing a solution to a new problem. CBR has been successfully applied in medical diagnosis (Koton, 1988), engineering design (Maher et al., 1995; Gebhardt et al., 1997), mechanical fault diagnosis (Quinlan, 1993; Liao et al., 2000), environmental resource management (Meyer and Flanagan, 1992), customer technical support (Simoudis, 1992), and strategic military analysis (Goodman, 1989). A number of CBR systems and their applications can also be found in a special issue of *Engineering Applications of Artificial Intelligence* (Bergmann, 1999).

Two CBR systems that have been developed in the area of conflict resolution are the MEDIATOR (Kolodner and Simpson, 1989) and PERSUADER (Sycara, 1990). The MEDIATOR was developed to provide common-sense advice in conflict situations involving resource disputes. The PERSUADER was developed as a mediator in labor negotiations. Both the MEDIATOR and the PERSUADER were developed to resolve conflicts within a limited problem domain.

3. The graph model for conflict resolution

As aforementioned, the graph model for conflict resolution was developed for modeling and analyzing real-world conflicts. The graph model represents the states of a conflict as the vertices of a graph. The state transitions are the arcs on the graph connecting the vertices. The graph model is more formally described as follows (Fang et al., 1993). Let $N = \{1, 2, 3, \ldots, n\}$ denote the set of decision-makers and $U = \{1, 2, \ldots, u\}$ be the set of states in the conflict. A set of finite directed graphs $D_i = (U, A_i)$, $i \in N$ is used to model the conflict. The payoff function for each decision-maker i is $P_i : U \rightarrow R$ where R is the set of real numbers. The combination of the set of directed graphs and the set of payoff functions constitutes the graph model.

A decision support system called GMCR II has been developed to allow a user to easily build a graph model for a conflict situation and carry out extensive analyses. GMCR II is user-friendly, Windows-based program that guides an individual through the steps necessary in modeling a conflict situation (for more information on GMCR II, please see Hipel et al. (1997, 2001) and Peng (1999)).