Implementation of a Case-Based Reasoning System using Multi-agent System Technology for a Buyer – Seller Negotiation System

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Abstract: A case-based justification (CBR) is one of the techniques of artificial intelligence and is inherent in solving problems. It handles new cases using the previous cases stored in the memory. The CBR is seen in a number of problem solving areas as one of the most powerful techniques to be employed. At the same time, the CBRS becomes less performer due to partial reasoning and it may consume a lot of efforts for revising if the problem is complex. In this paper, integration of Multi-agent-systems (MAS) with the CBR system is studied and this will help improving the capability of the Case based reasoning system in solving problems that uses the abilities of agents such as intelligence, interaction, cooperation and coordination . An architecture is designed that can be used in integrating MAS in CBRS (MAS-CBRS) to resolve complex problems. Two main software tools are used in order to establish how the integration of CBRS and MAS are successful in resolving complex problem of buyer – seller negotiations in the Purchase system. At the time of solving, it has been established how so many of agents work together with CBR system.

Keywords: Case based reasoning system, multi-agent systems, JADE , jCOLIBRI.

I. INTRODUCTION

A case-based reasoning (CBR) is one of the AI techniques in solving a problem by matching the problem description to a previously solved case, using the case base in which solved cases are already stored (Aamodt et. Al 1994). After each problem solving session you learn from case-based reasoning by retaining relevant information from a newly resolved problem for future problem solving. An important step in a CBR process involves finding a good match for a new problem and adapting an earlier solution in order to solve the new problem, index and store a new case to be retrieved later.

Given a new problem, a person often recollects a previous problem similar to the one at hand. For example: A Librarian after having examined several book sellers gets a reminding to a seller that he purchased a few months ago. If the reminding was caused by a cost of a book he intends to purchase, discount he offers and delivery, the librarian uses the list of book sellers of the purchases to determine the cost, discount and delivery of the purposed purchase. The example above illustrates how reasoning by re-using or revising past experiences is a powerful and frequently applied technique for human problem solving. This claim has supports from results of cognitive psychological research. Analogy based learning is closely related to case based reasoning, but the study issues differ in the two disciplines since a main research issue in analogy by leaning is the mapping of a current problem description to a known problem in a particular domain while case-based methods are used to index and match domain-specific strategy cases (Richter et. al, 2016).

The main principle behind case-based methods in AI is based on the methodology for machine-learning and case-based reasoning (CBR) is a machine-learning subfield. CBR teaches how to solve problems. The CBR system comprises a number of methods used to organize, index, retrieve, revise and use past experience. The solution obtained from the past case can be matched directly with the current problem or revised based on differences between the two cases. A comprehensiveness of the domain knowledge is required to produce sufficient arguments for why two cases match and how close this match is to find and match cases based on semantical similarities and other related features. The fig.1 depicts how a case is retrieved, matched, reused or revised and retained [10].

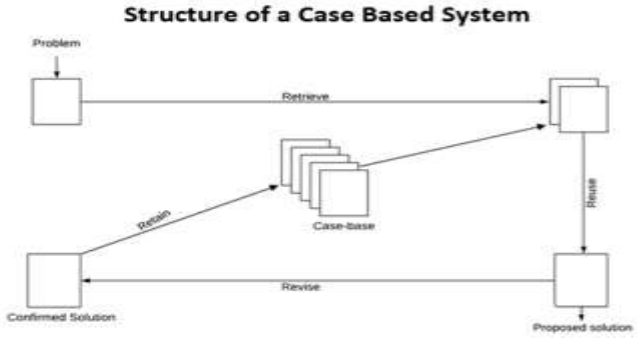


Figure. 1 Case base reasoning system architecture

II. CBR AND JCOLIBRI

The paper uses an open source jCOLIBRI, an object-oriented Java-based framework for building CBR systems and aims to determine how powerful it is for any given application. jCOLIBRI's design is based on a broad spectrum framework that supports several CBR systems, from a simple nearby method to a complex, knowledge-intensive structure.

JCOLIBRI provides a process of development that is less complex and is dependent on reuse of previous designs. It offers a clear structure for CBR knowledge, a description of the CBR tasks at the knowledge level and a library of recurring problem solving methods (PSMs). This CBR knowledge is directed towards classes within the framework. [10]. The graphical interface supports the instantiation of the framework and guides the setup of an individual CBR system. Among others, we are using jCOLIBRI to build the Purchase Domain Buyer Seller System, a popular CBR-community example.

A. jCOLIBRI

For CBR applications to be built, jCOLIBRI is open source software becomes necessary. JCOLIBRI is COLIBRI's technology evolution and a 3-stage architecture with object-oriented Java framework and a range of GUI tools to mount reusable CBR components. JCOLIBRI is intended for CBR system designers. A CBR application can be developed by installing the frame, or using GUI-based setup tools. The application can be easily built. At the same time, it must be constructed by using program methods and incorporating them into the framework of a highly complex CBR system or problematic methods which are not available in the framework.

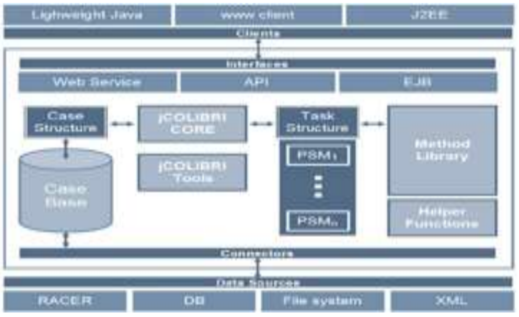


Figure2. jCOLIBRI Framework Structure

The system's architecture as shown in the Fig. 2, based on the elements below:

- Case, database and connectors. The stored cases may be accessed efficiently by CBR systems. JCOLIBRI divides the Case Base management problem into two components: connectors and the memory organization for the persistence mechanism. For the memory organization the system provides various connectors and data structures
- Structure of the case and measures of similarity. Cases are represented in hierarchy as simple cases of plain attribute value, text cases or complex structures where attributes are connected to the system requirement. Similarity functions can be used to compare case attributes.
- Problem solving structure and methods (PSM). The following are the main tasks in a CBR system: preprocess cases, querying, retrieving, recycling, reviewing, retaining and calculating the like .. For each task, a method to solve it must be configured in the CBR system.
- Functions of library method and helper. The operational level of problem solving methods is included in the library on the level of knowledge. The help function supports the development of new methods and functions for similarity.
- The core and the techniques. Fig.1 shows architecture for a particular CBR application , the application generator, and the architectural design of jCOLIBRI. It is easy to create a new application with jCOLIBRI tools, defining the case structure, connector settings and task framework.Configuration data is transformed into XML files which are used to run the CBR application as the input to the framework core [6].

III. MULTI-AGENT SYSTEM

An agent is a physical or virtual entity able to act in an environment, communicate with other agents, perceive its environment only in part, have specific skills and services. Agents are Autonomous that are able to perform its functionality independently and tries to achieve its goals autonomously. They are Intelligent; it means the agents are designed, trained, or fitted for one particular knowledge in one or more application fields (Byrski et. al 2015). The agents can collect information or are reactive on conditions of its environment. They are generally reactive so they react depending on the inputs from its environment. The agents are Pro-activity and goal orientated. The agents are bound to change its behavior based on its earlier experience. They are mobile, it means that agents to move themselves from one node to another in he given network. The important features are that agents are generally communicative and cooperative. Multiagent system (MAS) consists of agents in which several agents interact with each other to solve problems. Agents in MAS are designed in such a way that they know when and how to interact with which agents. The main features of agents in multiagent systems are their inherent distribution and complexity. The nature of multiagent systems is that agents are distributed and flexible and so generally MAS performs in increased speed, robustness, scalability and reusability. Agents have only partial information and their Control and data are decentralized.

A. JAVA AGENT FRAMEWORK (JADE)

The java-based MAS.JADE is a feature that supports technological development, a middleware for developing and run-time peer-to-peer applications based on a paradigm of agents that can work seamlessly and interact wirelessly. FIPA Application programmer's interface, FIPA Interaction Protocols Library, such as Contract Net and Graphical User Interface for managing several agents from the same Remote Management Agent are just some of the functionalities of the distributer platform that can be spaced to several machines. Fig. 3 depicts its internal architecture. This architecture includes agents which possesses unique name, residing in container. The collection of containers is called a platform. It has a unique container called main container. The remaining containers must register their names in the main container [8].

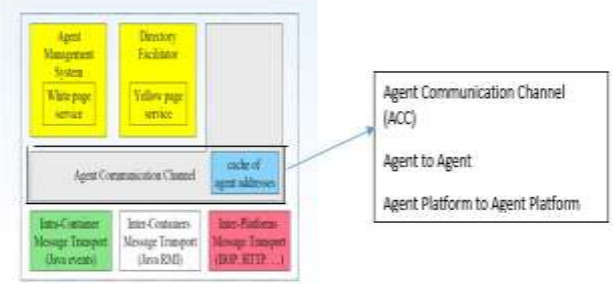

Agent Management System
White page service
Directory Facilitator
Yellow page service
Agent Communication Channel
cache of agent addresses
Intra-Container Message Transport (Java events)
Inter-Containers Message Transport (Java RMI)
Inter-Platforms Message Transport (IIOP, HTTP, ...)
Agent Communication Channel (ACC)
Agent to Agent
Agent Platform to Agent Platform

Figure3. JADE Framework Structure

Jade includes the main packages available in JADE.
Jade.proto, jade.wrapper, jade.gui, jade.lang.acl, jade.content,jade.domain, jade.gui.

IV. INTEGRATION OF CBRS AND MIS

This research paper presents some of the critical points to be faced at different levels of integration of CBR techniques with Multi-agent system components and techniques for building up a full-fledged Buyer – Seller negotiation system. The integration requirement at the level of system components is identified from the integration requirements at the level of specific stages in the CBR problem solving cycle. In this paper it is described how these aspects have been dealt inside jCOLIBRI and JADE. JADE for MAS and jCOLIBRI for CBR system for Buyer – Seller negotiation system are considered for the discussion on how MAS and CBR system are integrated .The framework shown in the fig. 4 illustrates how the integration takes place in this scenario [9].

In the framework of Buyer – Seller negotiation system, it is shown how the integration of JADE and jCOLBIRI works (Abutair et. al, 2017). The buyer agent uses Retrieving agent to pick up information from case base of jCOLBIRI . Afterwards the negotiation begins with seller agent for the purchase of a book [7].

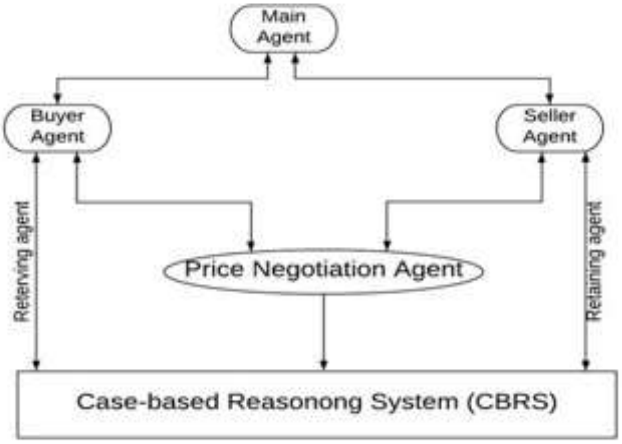


Figure4. CBR – MAS Integration architecture

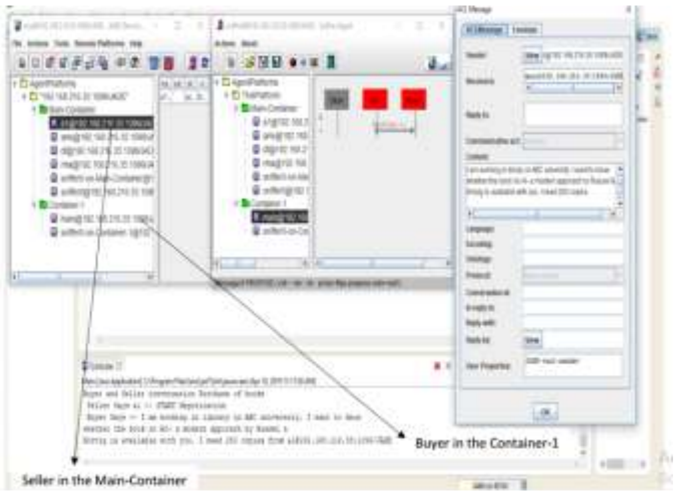


Figure5. Buyer – Seller negotiation

In a JADE the Buyer and Seller agents are created in which seller agent resides in Main container while buyer resides in container 1. It is shown in the fig.5.

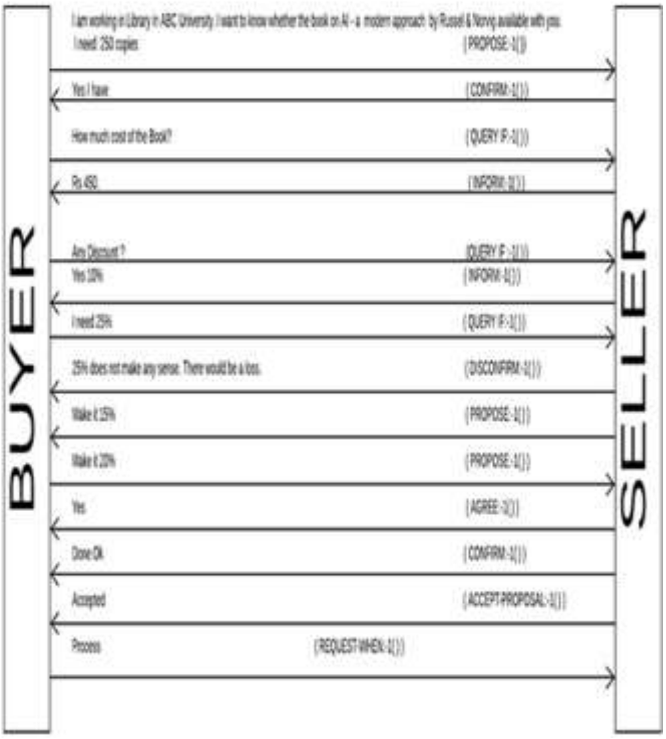
A Buyer and Seller Negotiation System

The Buyer agent who wants to buy a book traces out the best seller from casebase of jCOLIBRI and start negotiating with a particular seller agent. The entire negotiation process is illustrated in fig. 6.

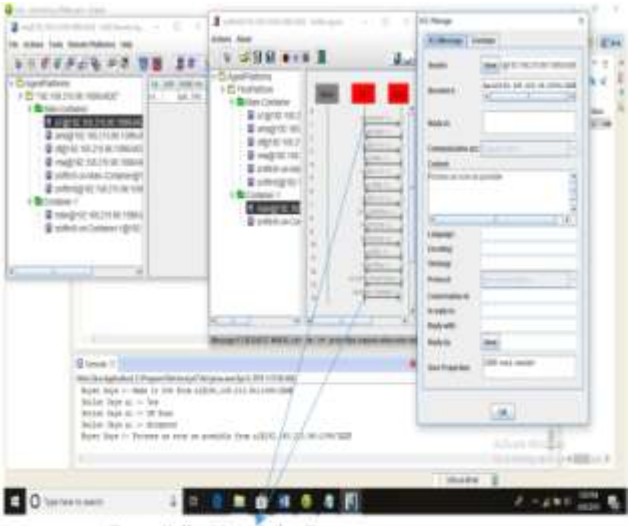
The fig.7 shows how successfully the buyer negotiated with seller in the JADE environment [11].

Figure6. Conversion between Buyer and Seller

Figure7. Buyer and Seller Negotiation



I am working in Library in ABC University. I want to know whether the book on AI - a modern approach by Russel & Norvig available with you. I need 250 copies (PROPOSE-1())
Yes I have (CONFIRM-1())
How much cost of the Book? (QUERY IF-1())
Rs 450 (INFORM-1())
Any Discount ? (QUERY IF-1())
Yes 10% (INFORM-1())
I need 25% (QUERY IF-1())
25% does not make any sense. There would be a loss. (DISCONFIRM-1())
Make it 15% (PROPOSE-1())
Make it 20% (PROPOSE-1())
Yes (AGREE-1())
Done Ok (CONFIRM-1())
Accepted (ACCEPT-PROPOSAL-1())
Process (REQUEST-WHEN-1())



Buyer Seller Negotiation Process

The Retrieving agent picks up a case from casebase of jCOLIBRI . The Buyer – Seller agent negotiation is established [3]. The fig. 8 brings out how successfully the negotiation is done and the result is brought out .

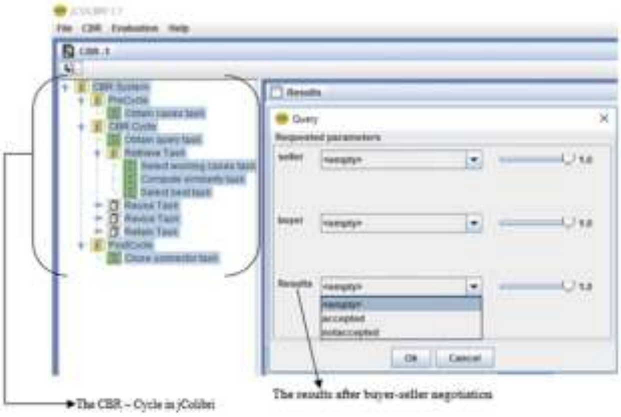


Figure8. Buyer – seller negotiation result

V. Conclusion

The CBR has a mechanism for rationalizing preceding situations or difficulties with new situations. It is seen in various problem-solving tasks and applications as a successful tool. However, with poor case-by-case and reasoning engine quality, the problems with reliability, inaccuracy and the extent of a limited application remain limited. A multi-agent system improves the CBR's ability to address complex problems with precision and accuracy. The first approach is to distribute agents through all phases of the CBR cycle and to apply the two different approaches. The agents work together to improve the four steps of the CBR cycle. Each agent develops in the second approach the ability to find similar cases to achieve its objective. This paper has studied varieties of techniques and methods by combining MAS and CBR to solve difficult issues in different domains. This paper contains an overview of several CBR integration methods with MAS in several areas. There are many functionalities of agents, like scalability, adaptation, reactivity, proactive, collaborative, reusability, distribution, and autonomy. The CBR, on the other hand, has several features, such as direct representation and extensive of knowledge. In order to integrate both CBR and MAS, some of the exceptions to the CBR and MAS can be overcome, which usually involve unreliability, inaccuracy, limited application and poor administration. The retrieval mechanism also contributes to improving the quality of the solutions obtained. For future work, the MAS-CBR model may be used in different domain construction applications.

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