Problem solving using hybrid reasoning models

Durga Prasad Sharma & Kapil Khandelwal

Abstract—A single type of knowledge and reasoning method is often not sufficient for a decision support system to address the variety of tasks a user performs. It is often necessary to determine which reasoning method would be the most appropriate for each task, and a combination of different methods has often shown the best results. In this study CBR was mixed with other RBR and MBR approaches to promote synergies and benefits beyond those achievable using CBR or other individual reasoning approaches alone. Each approach has advantages and disadvantages, which are proved to be complementary in a large degree. So, it is well-justified to combine these to produce effective hybrid approaches, surpassing the disadvantages of each component method. In this paper, we briefly outlined popular case-based reasoning combinations. More specifically, we focus on combinations of case-based reasoning with rule based reasoning, and model based reasoning.Further we examined the strengths and weaknesses of various reasoning models, case-based reasoning, rule-based reasoning and model-based reasoning, and discuss how they can be combined to form a more robust and better-performing hybrid.

Keywords—knowledge based systems, hybrid reasoningmodels, case based reasoning, model based reasoning, rule based reasoning, sustained learning, problem solving
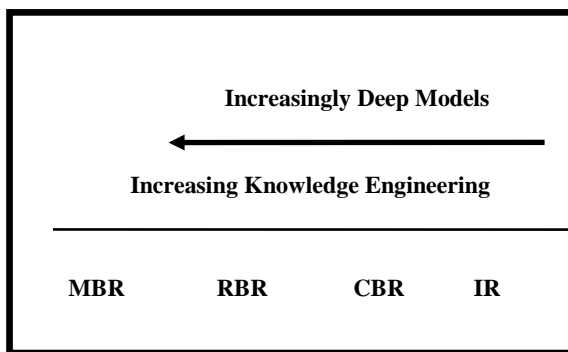
I. **Introduction**

Figure 1.Relationship between different Reasoning Methods

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Hybrid Intelligent System is a combination of two techniques with more strength   and less weakness. Almost every conceivable problem has been approached using some form of hybrid system. Hybrid systems are universally better than conventional approaches. The combination of (two or more) different problem solving and knowledge representation methods is a very active research area in Artificial Intelligence. The aim is to create combined formalisms that benefit from each of their components. It is generally believed that complex problems are easier to solve with hybrid or integrated approaches. The effectiveness of various hybrid or integrated approaches has been demonstrated in a number of application areas.

Rule-based and case-based reasoning are two popular approaches used in intelligent systems. Rules usually represent general knowledge, whereas cases encompass knowledge accumulated from specific (specialized) situations. Each approach has advantages and disadvantages, which are proved to be complementary in a large degree. So, it is well-justified to combine rules and cases to produce effective hybrid approaches, surpassing the disadvantages of each component method.

TABLE I. ADVANTAGES AND DISADVANTAGES OF RULE-BASED AND CASE-BASED APPROACHES

	Rule-based approach	Case-based approach
Expression of General Knowledge	+	-
Expression of Specialized Knowledge	-	+
Naturalness	+	+
Modularity	+	+
Knowledge Acquisition	-	+/-
Unexpected\ Missing Inputs	-	+
Inference Efficiency	+/-	+/-
Maintenance	+/-	+
Updatability	-	+
Provision of Explanations	+	+/-

Model-based reasoning (MBR) is an approach in which general knowledge is represented by formalizing the mathematical or physical relationships present in a problem domain. The CBR-MBR integration improves solution accuracy over that which is possible using either single approach.

TABLE II. APPLICATION DOMAINS AND SYSTEMS USING HYBRID REASONING MODELS

Tools	Domain	Reasoning Models
AIDA	Aircraft design	CBR,RBR
ANAPRON	Speech	CBR,RBR
AUGUSTE Project	Medicine	CBR,RBR
CABARET	Law	CBR,RBR
CAMPER	Menu planning	CBR,RBR
CARE-PARTNER	Medicine	CBR,RBR
CARMA	Entomology	CBR,MBR
CASEY	Medicine	CBR,MBR
CCAR	Life Insurance	CBR,RBR
CORMS AI	Real-Time Marine Environment Monitoring	CBR,RBR
DANIEL	Legal Reasoning	CBR,RBR
ECLAS	Finance	CBR,RBR
EFAES	Equipment Failure Analysis	CBR,RBR
FABEL	Architecture	CBR,MBR, RBR
FORMTOOL	Plastic colorants	CBR,MBR
GREBE	Law	CBR,RBR
GYMEL	Music	CBR,RBR
HIDES	Agriculture	CBR,RBR
IDS	Aircraft Fleet Maintenance	CBR,RBR
MCRS	Personnel Performance Evaluation	CBR,RBR
SAXEX	Music	CBR,RBR
ScheduleCoach	Construction	CBR,RBR
SOPHIST	Bioprocess recipes	CBR,MBR
URS-CBR	Ultrasonic Rail Inspection	CBR,RBR

II. Combined Reasoning Models

A. Sequence Models

In this, in the first step, a rough solution is given, and in the second step, the precise solution is given by refining the rough one.

Figure 2. CBR followed by RBR

Figure 3. RBR followed by CBR

B. Conditional Model

In this, if the solution given in the first step is acceptable then it is used as a solution of the given problem& otherwise next steps are invoked.
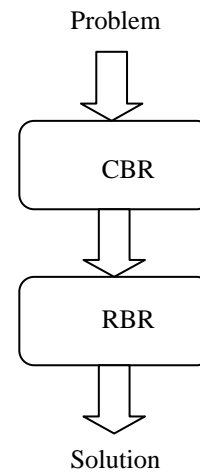
Figure 4. RBR-Controller-CBR

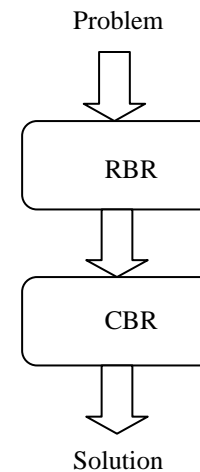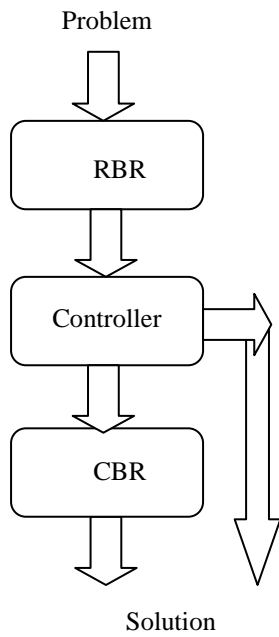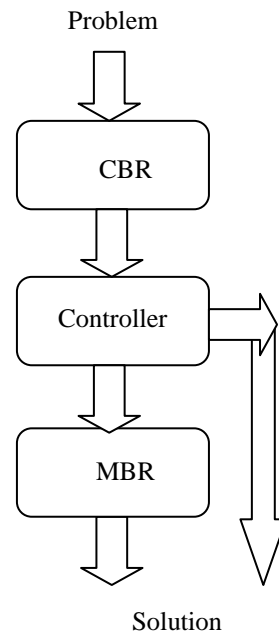Figure 6. CBR-Controller-MBR
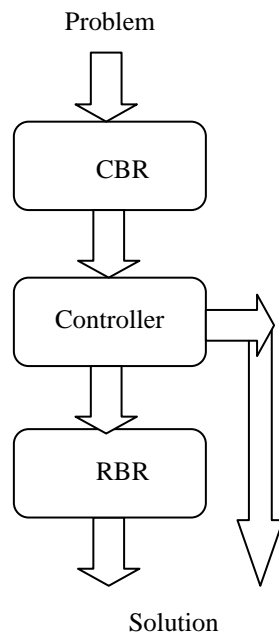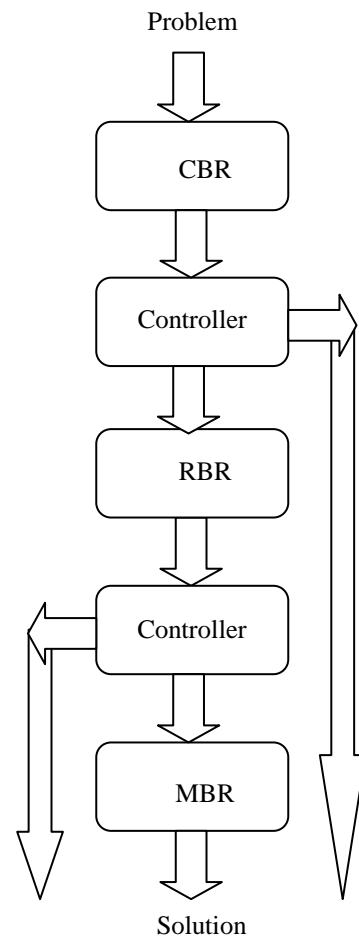
Figure 5. CBR-Controller-RBR

Figure 7. CBR-Controller-RBR-Controller-MBR

III. Proposed Model of Combined Reasoning (CBR, RBR & MBR)

The case-based method is the primary reasoning paradigm in this model; the other methods are used - as separate reasoning methods - only if the case-based method is unable to suggest a solution.
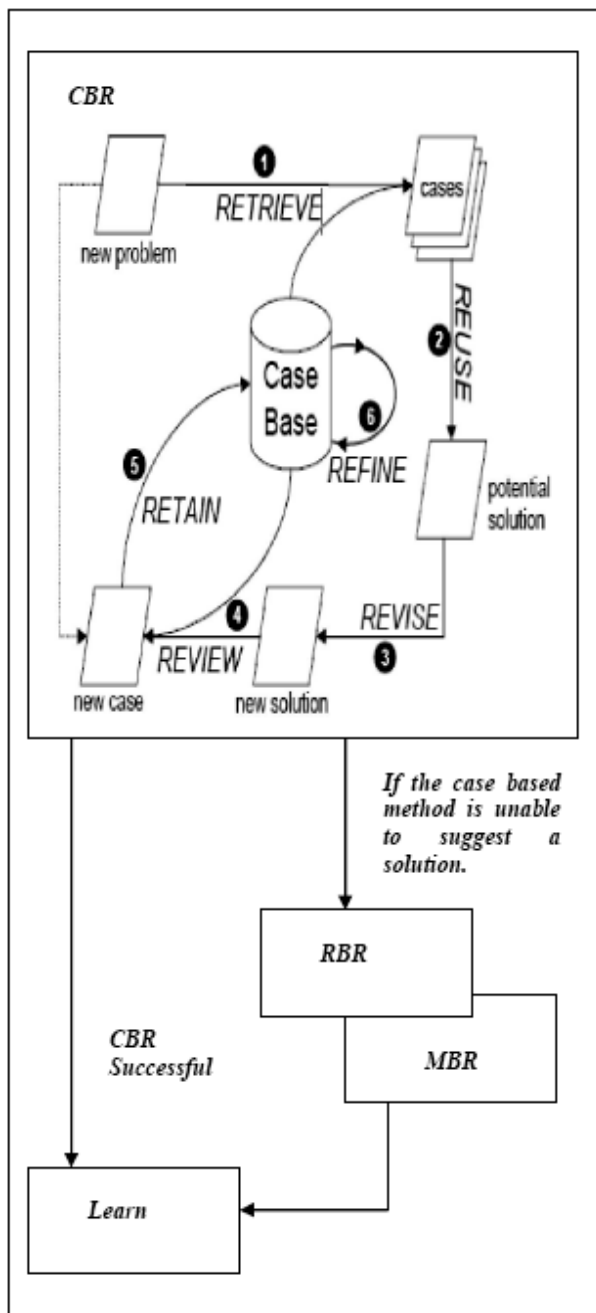

Figure 8. Combined Reasoning in "X" (CBR = Case-Based Reasoning, RBR = Rule-Based Reasoning, MBR = Model-Based Reasoning).

IV. Conclusions

Hybridization is fast becoming the standard, rather than the exception for CBR systems, owing to user expectations as well as to technical advantages. Researchers have uncovered many synergistic ways to combine CBR with other modes of reasoning. In this research we combined CBR with RBR, MBR. In our experiment and analysis, this new CBR integrated hybridized model supporteda wide range of tasks, including interpretation and argumentation, design and synthesis, planning, and management of long term medical conditions. Many useful synergies emerged as different reasoning strategies extend and complement each other. Integrated systems have enabled more accurate modeling of domain knowledge, compensation for incomplete domain models and rule bases, compensation for small case bases, simplification of knowledge acquisition, improved solution quality, improved system efficiency, leveraging of past experiences, and compensation for shortcomings inherent in individual reasoning strategies.Thus integrations of CBR with other reasoning modalities continue to proliferate, providing both practical benefit and insight into multi-modal reasoning processes.

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