

A Quick Tour to Understand and Improve CBR Performance

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ABSTRACT

Expert system has abilities to reason about situation to give an expert view. According to the specified requirement of an application different aspect of reasoning is used. CBR is one type of reasoning method which assists the user to solve similar problems. As CBR follow analogical approach instead of following a deductive path. Different types of model and algorithms have been used by CBR. So, the study is based on which and how the different aspect of model and algorithm used in CBR based expert system to make the CBR based system work more appropriately.

Keywords: Expert system, Case Based Reasoning (CBR), Model, Algorithm.

1. INTRODUCTION

Human has the ability of reasoning the past cases to solve the problems. Similarly reasoning is used in an expert system to reason and analysis the cases to gives their expert view. The recent approach of reasoning is case based reasoning which is able to utilize the specific knowledge of previously experienced concrete problem (cases). System uses the past experience as knowledge and tries to find out the solution within that specific domain of knowledge. The knowledge is updated with every new case (problem + solution) so it help in sustaining learning just like an human being. The concept of case based reasoning is taken from the way human being routinely solve their problem. It follows the similar process to solve the problem just like a human being used the past experience to solve a problem. Expert system takes the problem and tries to find out the most similar cases among the previously available cases and the retrieved case is adapted to find out the solution of the problem. Adaptation of a solution as it is from a retrieve case or may it needs the revise of a solution to solve a new similar type of problem. After finding the solution of a new problem, the set of problem and solution is retain as a new experience and will used to solve the future problem. This approach shows the incremental sustained learning of the system. There have been various fields where case based reasoning system was successfully developed. According to the application of an expert system using case based reasoning require to choose models, methods and algorithms so that it is able to find out the appropriate solution of a new problem. So, a study on R4 and R5 model has been done and tries to understand the working process of it. This paper focuses on the models and algorithm used by CBR based system. Section 2 gives the insight about the working process of R4 model. Section 3 explains the working process of R5 model. Section 4 present a tabular form about the application, domain, function, algorithm, model and specific feature of case based reasoning system. Section 5 deals with the observation done in section 4. Section 6 cover the suggestion given to overcome the limitation came in previous model. Section 7 gives the conclusion and section 8 presents the future work.

2. R4 MODEL

Case-based reasoning (CBR) for solving problem emphasizes on the role of past experience i.e. new problem solved by reusing or adapting the solution from similar problems that were solved in the past. One of the process model of the CBR cycle that was used is R4 models [1] which has 4 stages retrieve, reuses, revise and retain. Every stages work in serial manner.

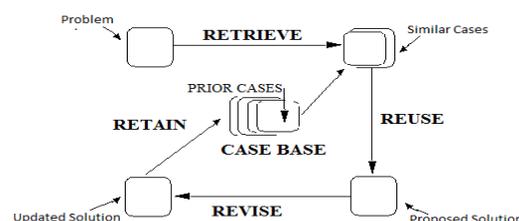


Figure 1 R4 Model (CBR cycle). [1]

The four stages of R4 models

1. **Retrieve:** Specific features of new problem match with the past cases and retrieve the closest past case that used to solve the new problem at the other stages of R4 model.
2. **Reuse:** Now the retrieve case is used to find out the solution for the new problem. It depends whether the solution derived from the past cases is as it is used for a new problem or it should be revised.
3. **Revised:** If the new problem is not exactly matching with the previous case than we try to find out the closest case, in this condition the improvement in the solution is also required, so that the new problem adopts the derived solution appropriately.
4. **Retain:** Now the new solution with the problem retain in the case memory for sustaining learning and it will be further helpful in future for reasoning.

3. R5 MODEL

The process model of CBR cycle model is R5 model. It works out on the case structure. The idea proposed by R5 model is partitioning the possible set of problem and solution by using similarity based reasoning.

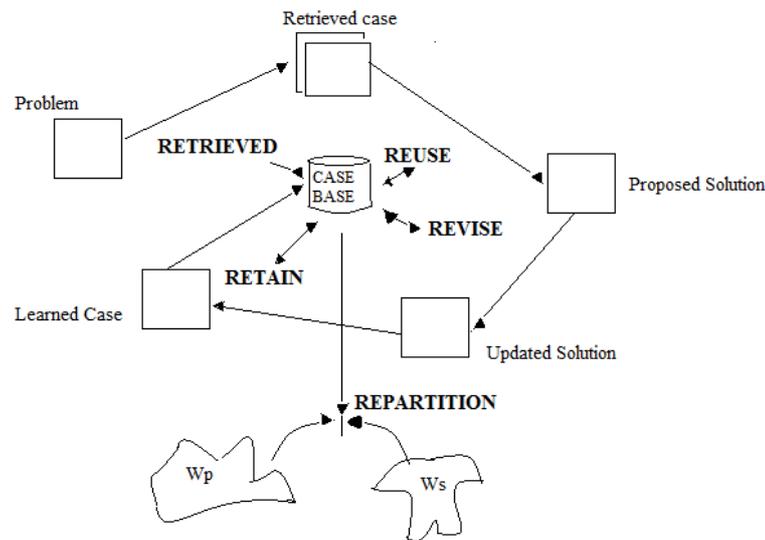


Figure 2 R5 Model (CBR cycle). [2]

The five stages of R5 models

1. **Repartitioning:** The approach of repartitioning is based on similarity relationships. Before retrieving the case it's important to build the structure of cases. The first stage of R5 models is partitioning the cases with the help of content of its collection of cases.
2. **Retrieve:** As repartitioning provide a foundation for the retrieve case. Now in retrieve stage the case is retrieve from the closest similar group of cases. With the help of similarity relationship first choose the most similar group. Then among the cases in similar group choose the closest case.
3. **Reuse:** Reuse the case to attempt to solve the problem. This stage follow the concept of similar problem has similar solution. Similar to R4 model where the solution of previous similar case is applied to new problem. If the new problem is exactly match with the selected previous case then the same solution of previous case is as it is applied to the new problem otherwise the solution need updation to derived the solution for new problem.
4. **Revised:** New problem either adopt the solution of previous similar case as it is or it need some updation to adopt the solution. So the adaptation process is followed here to derived the solution for a new problem
5. **Retain:** Set of problem and solution (case) is store in case memory for further used and found the position in the most similar group of case in case library. [2]

4. APPLICATION BUILT IN CBR

The study of application, domain, function, algorithm, model and specific feature about an CBR based expert system is presents in an tabular form which given below:

Table 1: Application built in cbr

S.NO	Application	Domain	Function	Algorithm	Model	Specific Feature(Reasoning)
1	A design and Implement contexts-Aware Case based u-Health System	Medicine	u-Health System works for biological risk and the case of fire. It monitor the data obtained from the sensor network. [3]	K-Nearest Neighbor Algorithm	R4 Model	Case Based Reasoning
2	Case-based Reasoning for Diagnosis of stress using enhanced cosine and fuzzy similarity	Medicine	Stress Diagnosis system tackle the imprecision and uncertainty in sensor as maintaining its data is quite unmanageable. [4]	Fuzzy Matching function	R4 model	Hybrid case-based reasoning system, fuzzy similarity matching metric, cosine matching function
3	Case Based Reasoning Technology for Medical Diagnosis	Medicine	Proposed a CBR methodology for medical Diagnosis system of cancer and heart diseases that overcome the problem had found in the traditional AI techniques. [5]	Nearest Neighbor matching technique,	Frame(Assign Indexes, Retrieve, Modify, Test, Assign, Explain, Repair or Test)	Rule based , Cased based reasoning
4	Advancements and Trends in Medical Case-Based Reasoning	Medicine	Research had done on influential work of medical CBR domain and identified trends that was followed by medical CBR system. [6]	Nearest Neighbor Algorithm.	R4 model	Case Based Reasoning.
5	Case based reasoning versus artificial neural networks in medical diagnosis	Medicine	Medical Diagnosis system for diagnosis the infection diseases. Survey on current trends on system built by CBR. [7]	Nearest Neighbor Algorithm	R4 model	MEDsys system for image interpretation
6	Case-Based Reasoning for medical knowledge-based systems	Medicine	Proposed MEDsys for Medical diagnosis based on neural network and case base reasoning and comparison of two. [8]	Classification algorithm, ID3,or Nearest neighbour matrices for similar cases	R4 model	Multi Modal Reasoning
7	Using Evolutionary Methods for Design Case Adaptation	Engineering	Proposed a process model by combining idea of genetic algorithm and design a system GENCAD	Genetic case algorithm for adaptation	R4 model	Case Based Reasoning.

			for layout design of residence. [9]			
8	An evolutionary approach to case adaptation	Engineering	Proposed a case adaptation method by integrating idea of genetic algorithm and design system GENCAD for layout design of residence. [10]	GENCAD (genetic case adaptation)	R4 model	Case Based Reasoning.
9	Integrating Case-Based Reasoning, Knowledge-Based Approach and TSP Algorithm for Minimum Tour Finding.	Route Finding	In Travelling Sales Man Problem reduce the require time for finding route with the help of AI knowledge base approach with case based reasoning. [11]	TSP Algorithm	R4 model	Knowledge based and case based reasoning
10	Evolutionary Fuzzy Case-Based Reasoning for Financial Performance Ranking	Finance	System to provide ranking in financial status. [12]	Genetic Algorithm and the fuzzy Nearest Neighbor	Hybrid decision Model	Case based reasoning (CBR) approach.
11	A Hybrid Expert Systems Architecture for Yarn Fault Diagnosis	Fault Diagnosis	Yarn fault Diagnosis system use combination of rule base to diagnosis a fault and case based to support abstraction , reuse and Inheritance feature. [13]	Object Oriented design	R4 model	Rule Based and Case based reasoning.
12	Learning from HOMER, a Case-Based Help Desk Support	Computing Help desk system	HOMER, help support desk system support infrastructure of car development by giving learning capability with the help of CBR. [14]	Object Oriented approach	R4 model	Cased Based Reasoning
13	Improve schedule quality through case Based Reasoning	Job Shop Scheduling	Proposed a framework CABINS to improve scheduling by repair actions and scheduling quality. [15]	K- Nearest Neighbor method	R4 model	Cased Based Reasoning
14	A unifying framework for adaptation in Case-Based Reasoning	Explanation and understanding of stories	Proposed a unifying framework for adaptation process in CBR and also suggest idea for implementation of the framework within a CASE system. [16]	Generic methods in adaptation	R4 model	Knowledge based, Method based and Case based reasoning.

* CBR - Cased Based Reasoning, AI - Artificial Intelligence

5. OBSERVATION

Study that had done is mainly focusing on which types of models and algorithms uses for implementing CBR based expert system. The survey is present in the tabular form in the section 4 and the observation came out through this

study is that most of the application of expert system based on CBR technique work with R4 model and for the retrieval of case, make a use of nearest neighbor algorithm.

6. SUGGESTION

After observing different application of a case based expert system the fact that is came out is there was a lack of concept of case based building and in retrieval process also has a scope of improvement. As the success of CBR based system depends on the performance of case retrieval algorithm used, because the efficient retrieval of the right case at the right time improve the performance of CBR system. [17] Case base building is a one way to improve the retrieval performance by reduce the search time and complexity of case retrieval by reducing the complexity of case database [17] and the other way is to use such retrieval algorithm which will improve the retrieval process. As the retrieval method is a combination of two procedures one is similarity assessment and other one is procedure of searching. Hence, the models and algorithms that were used in the application of case based expert system does needed a improvement in the search area of case base. So, that it will reduced the search needed to find the best case without compromising with the quality. [18] Hence, R5 model and Foot Print based retrieval algorithm stand out in all the mentioned above point. So further will try to used the R5 model and Foot print based retrieval algorithm to improve the retrieval process in an application of CBR based expert system. section VII further describe the comparison of R5 model with most commonly used R4 model and Foot-print retrieval algorithm with the other algorithm that was commonly used in the application of CBR based system.

7. COMPARISON BETWEEN MODELS AND RETRIEVAL ALGORITHM

R4 and R5 models have many similarities and dissimilarities[2][17]. So let’s compare this two model in the tabular form and understand the difference and similarities between two of them.

Table 2: Comparison of R4 and R5 Model

S.NO	R4 Model	R5 Model
1	In R4 model for case retrieval similarity function is applied.	While in R5 model to reduce time complexity while retrieving data at the case retrieval stage similarity function is also applied for case base building.
2	As structure and content of its collection of cases play an important role for a case base reasoner. But in R4 model there is no unified way to integrate it into the model.	While R5 model collect the cases on the basis of structure and content.
3	In R4 model they assume that the case base retrieval are also ready for their first process.	While in R5 model for case retrieval they provide a partitioning of case and case structure in their first stage
4	Repartitioning is not in R4 model so number of searching case for finding the most similar case is become complex and search time for queries become increases.	While clustered of case is made offline before retrieval can start so it may reduce search time for queries.
5	As case base building also play a important and major task but it ignore in R4 model.	Case base building consider in R5 model.
6	As cases increases the complexity of case retrieval is also increases.	While in R5 model the complexity of case database is reduce so that it reduce the complexity of case retrieval.

Comparison of Footprint based retrieval algorithm with the other retrieval algorithm used in CBR based expert system are as follows. [18]

Table 3: Comparison of Foot Print retrieval algorithm and Other Retrieval algorithm

S.NO	Retrieval Algorithm	Foot Print Algorithm
1	Brute Force is most simplest method for retrieval the case but it is not viable for large cases.	While Foot Print can also work well under the situation of large case as it reduced the search area by editing the case base.
2	Decision Tree not able to did well under the situation where had a incomplete case description.	While Foot Print by the cost of sufficient knowledge engineering

		make the retrieval process sufficient and flexible enough to handle the incomplete case description also.
3	In Nearest Neighbor if search area of case base is large than it time consuming to find out the nearest one among all the cases.	While Foot print improve performance by removing the unnecessary cases in the retrieval process.

8. CONCLUSION

All CBR based expert system have to gone through the retrieval process and its success depends upon it, means the right case retrieval at the right time. This paper proposed a study on models and algorithms which was commonly used in an application of CBR based expert system. As there always a scope of improvement , so above study had target the models and algorithms to find out the improvement in the retrieval process. As Section VIII describe how well the R5 model and Foot Print retrieval algorithm work than others. So, further in an application of CBR based expert system will try to work with R5 model and Foot Print retrieval algorithm as it improve the performance.

9. FUTURE WORK

In future will try to examming this theoretical point , how well they able to stand in an application of real environment. So will work on tourism application based on case based reasoning that will make a use of the R5 model and Foot Print retrieval algorithm for better utilization of an system. As R5 model and Foot Print retrieval algorithm is generalized, we can use it in any area of filed. As there is always an scope of an improvement, so will also work on how to further make an improvement on retrieval process.

References

- [1] Ramon Lopez De Mantaras, David Mcsherry, Derek Bridge, David Leadke , Barry Smyrth, Susan Craw, Boi Faltings, Mary Lou Maher Mchael T.Cox, Kenneth Formus, Mark Keane, Agnar Aamodt and Ianwatson: "Retrieval, reuse, revision, and retention in case-based reasoning", The knowledge Engineering Review, Vol. 00:0, 1-2. 2005.
- [2] Gavin Finnie, Zhaohao Sun: "R5 model for case-based reasoning", ELSEVIER SCIENCE, knowledge-Based Systems 16 (2003) 59-65.
- [3] Mi-Rim Song, Jin-Young Moon and Sang-Hyun Bae*: "A Design and Implement Contexts-Aware Case based u-Health System", International Journal of Bio-Science and Bio-Technology, Vol.5, NO.5 (2013), pp. 129-140.
- [4] Mobyen Uddin Ahmed, Shahina Bhegum, Peter Funk Ning Xiong, Bo Von Scheele: "Case-based Reasoning for Diagnosis of Stress using Enhanced Cosine and Fuzzy Similarity", Transactions on Case-Based Reasoning for Multimedai Data, Vol.1, No 1(2008) 3-19.
- [5] Abdel-Badeeh M.Salem: "Case Based Reasoning Technology for Medical Diagnosis", World Academy of Science, Engineering and Technology 31 2007.
- [6] Markuc Nilson, Mikael Sollenborn: "Advancements and Trends in Medical Case-Based Reasoning: An Overview of Systems and System Development", American Association for Artificial Intelligence, 2004.
- [7] Victor Alves, Paulo Novais, Luis Nelas, Moreira Maia and Victor Ribeiro: "CASE BASED REASONING VERSUS ARTIFICIAL NEURAL NETWORKS IN MEDICAL DIAGNOSIS".
- [8] Rainer Schmidt, Stefania Montani, Riccardo Bellazzi, Luigi Portinale, Lothar Gierl: "Cased-Based Reasoning for medical knowledge-based systems", Elsevier Science, International Journal of Medical Informatics 64 (2001) 355-367.
- [9] Andres Gomez de Silva Garza,, Mary Lou Maher: "Using Evolutionary Methods for Design Case Adaptation", ACADIA, 2001.
- [10] Andres Gomez de Silva Garza and Mary Lou Maher: "An Evolutionary Approach to Case Adaptation", Springer-Verlag, July 1999.
- [11] Hossien Erfani: "Integrating Case-Based Reasoning, Knowledge-Based Approach and TSP Algorithm for Minimum Tour Finding", Iranian Journal of Optimization, 2009 151-161.
- [12] Sheng-Tun Li, Hei-Fong Ho, Yi-Chung Cheng: "Evolutionary Fuzzy Case-Based Reasoning for Financial Performance Ranking".
- [13] Nomusa Dlodlo, Lawrance Hunter, Cyprian Cele, Roger Metelerkamp, Anton F.Botha, "A Hybrid Expert Systems Architecture for Yarn Fault Diagnosis", FIBRES & TEXTILES in Eastern Europe April/June 2007, Vol 15, No. 2(61).

- [14] Thomas R. Roth-Berghofer, "Learning from HOMER, a Case-Based Help Desk Support System", Springer-Verlag Berlin Heidelberg 2004, pp.88-97.
- [15] Kazuo Miyashita,, Katia Sycara, "Improving Schedule Quality through Case-Based Reasoning", AAAI , 1993.
- [16] A.Mille, B. FuchS and O.Herbeaux: "A Unifying framework for Adaptation in Case Based Reasoning", ECAI 96. 12th European Conference on Artificial Intelligence, 1996.
- [17] Yongfing Ma, Wembo Zhang Jean Lu & Li Yuan: "Automated generation of Taraffic Incident Response plan based on Case-Based Reasoning & Bayesian Theory", Hindawi publishing corporation, Discrete Dynamics in Nature and Society, Volume 2014,, Article ID 920301, 7 pages.
- [18] Barry Smyth,, Elizabeth McKenna: "Competence guided incremental footprint-based retrieval ", Elsevier Science, 2001, 155-161.