Case Based Reasoning and Knowledge Management: Re-Aligning the Technologies

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Introduction

It is with some regret that CBR has, since the early 1990's, been viewed as being synonymous with Knowledge Management and especially so in commercial deployments of CBR systems. Infact, it is often the *knowledge management* aspect of the technology that is emaphasised and marketed with secondary references to CBR's merits as a reasoning and learning AI technology. Whilst this analogy is not entirely mistaken, we try here to briefly unravel the over zealous combination of these two technologies and attempt to provide a more realistic alignment.

Where CBR offers benefits

CBR solves new problems by searching a repository of cases and adapting these previously successful cases to provide new solutions. Its advantages are that knowledge implementation generally consists of identifying key features to describe the cases in the repository. There is no explicit domain model and so acquisition of knowledge is then reduced to the gathering of a large number of suitable cases for the particular context. The cases are stored for efficient access via optimised database algorithms. Hence the knowledge implementation and maintenance is far easier than various other symbolic reasoning systems. Learning within the CBR system can be perceived in one of two ways: the system can remember new cases and adapt cases to provide a new solution(HH90). Its strength and intelligence lie in these adaptation algorithms(Kol93).

However, a useful application of CBR does depend on large volumes of case histories and all this knowledge needs to be explicitly acquired, structured into cases and the repository of cases needs to accordingly updated. In an environment where any number of people may contribute to the repository, this structure

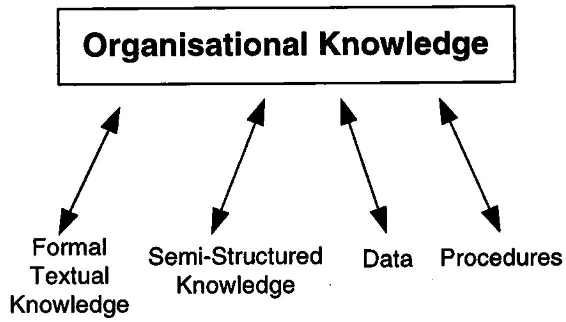

Figure 1: The Typical Knowledge Descriptions of an Organisation

provides the ability to suitably segment the repository and enable independent construction or maintenance of the segments. This can often provide a more manageable view on the entire repository - especially for larger knowledge bases. However on the negative side, the same attributes that allow us to neatly segment the maintenance load easily leads to the widespread duplication of knowledge caused by the very disjoint view that most contributors may have of the repository and the knowledge added to the repository will eventually reflect this.

CBR applications work well within moderately small, well defined problem domains. Within these it is easy to collect the necessary cases to form a large repository for adequate reuse or adaptation. Helpdesks with well contained problem areas often provide good applications of the technology (Dor98). The knowledge within these applications is typically informal and volatile with rapid churn and caters well for the semi-structured knowledge often possessed by workers within such an organisation (see Figure 1).

The Management of Knowledge

Large organisations typically have vast amounts of knowledge and information that constitute their assets

(Figure 1) and the application of knowledge management is usually from a desire to exploit and share this knowledge for the benefit of the organisation's services. Knowledge management strives to attach a form and structure to what may be large shift in workflow and attitude.

We focus here on Knowledge Management as the science of managing knowledge and not the people-centric social aspects of this vast field such as that described in (Sve97).

Knowledge Management aims to provide the structures and strategies necessary for efficient and productive knowledge construction and exploitation. To this end, there are various process oriented strategies such as those described in (Sky98) and the Balance Scorecard (an interesting application of this is described in (Mor98)). In its most generic form a knowledge management lifecycle spans through the acquisition or creation of knowledge, the development of this knowledge in order to mould it for suitable exploitation (knowledge engineering in AI) and the correct storing of this knowledge to make it conducive to sharing.

However, Knowledge Management also provides a holistic view to dealing with knowledge - dealing with all the forms of knowledge that commonly exist in the organisation's memory. The knowledge and expertise about a particular subject is rarely completely attributable to just one of these types of knowledge shown in Figure 1 especially when dealing with complex technical environments. More realistically this knowledge consists of

- semi-structured knowledge held by experts
- formal rules and procedures for various situations
- historical data - numerical or otherwise
- internal (formal or informal) and reference documents in textual format.

A sound and thorough Knowledge Management initiative must deal with all these instances.

Another dimension that is often forgotten in KM applications is the ability to manage and share various levels of knowledge:

- concrete knowledge that addresses specific applications
- abstract knowledge that addresses more general issues.

The ability for all users to traverse these levels of knowledge and the awareness that one piece of knowledge can be both concrete and abstract in different contexts is not just a usability issue but a fundamental part of KM and correct knowledge representation. The reusability of concrete and abstract knowledge assets is thoroughly considered in (Boi98).

Finally, we must consider the desired effect of good knowledge management and sharing initiatives - creating new knowledge and innovative solutions. The intention is that in sharing organised information we may then extrapolate and form new semantic connections to form new or previously unknown knowledge (as we do in many data mining techniques). KM systems must provide an arena conducive to such learning. This may include an area to share knowledge outside of a formal system and also various views on the knowledge within the system.

Deploying CBR Systems

Successful large scale CBR deployment relies on the application of KM from the very beginning in the form of a strategy (Jon97). This strategy must address the purpose of the system and circumvent the problem area. It must also deal with the lifecycle aspects of the knowledge and the personnel attached to this cycle. This is imperative for an up-to-date and consistent knowledge base, especially when there are several or more authors.

As we noted above, the knowledge applied in a CBR system is primarily semi-structured; textual or procedural knowledge and data are not handled well in CBR applications, although there are notable document retrieval CBR systems (WW97) and efforts to combine CBR with systems that reason with formal rules(LK98). So from Figure 1 we note that a large portion of organisational knowledge is not dealt with solely by CBR.

CBR systems are traditionally queried by textual or numerical strings that a user types in. The system returns with possible solutions, or if it is a dialogue CBR system, with a series of questions to further streamline the search. There is rarely an opportunity for more than one view to the knowledge contained in the case base. The knowledge is stored and returned as cases. This provides only one view for the user.

CBR systems provide little in the way of support for nurturing innovative ideas since solutions are entirely based on things that have worked and succeeded before.

CBR $\subseteq$ KM Enabling Technologies

In the previous section we commented on how large scale CBR projects need supporting Knowledge Management strategies, but it is also appropriate to consider what CBR offers towards the management of

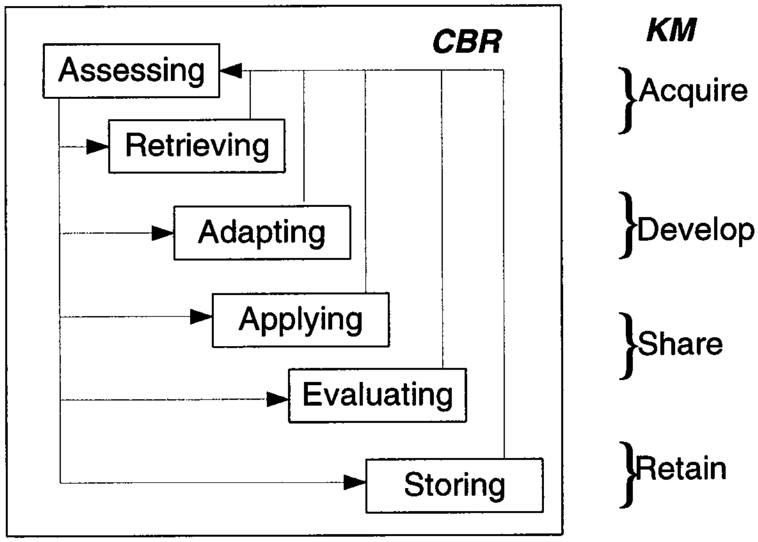

Figure 2: KM and CBR working alongside eachother.

knowledge.

Figure 2 shows how the generic process of knowledge management may be supported by CBR. We can see that the KM processes of acquiring knowledge, developing, sharing and retrieving knowledge are all catered for at varying degrees by a CBR system. We *acquire* knowledge when we assess new knowledge to be added to the system or in retrieving knowledge from the CBR system. *Developing* the knowledge can involve adaptation in a CBR application or knowledge engineering in a CBR application without explicit case adaptation. The very process of evaluating the knowledge for suitability is an instance of *sharing* the knowledge in the system. So although we have stated that the application of KM processes are imperative to the success of CBR programs it is also true to note that some of these processes are intrinsic to the way CBR systems survive.

Much of these KM activities lie outside the system itself, for example, acquiring and developing knowledge is invariably done by knowledge authors. CBR excels at the retrieving of semi-structured knowledge and provides an environment for sharing knowledge.

Knowledge Management requires crossing borders with other disciplines and AI being one of the founding motivations behind KM needs to be adequately represented - not just by CBR but the many other technologies and algorithms that deal with all the other types of knowledge that we have referred to in this paper. We conclude here that although CBR provides a self-contained, easily accessible method of maintaining a subset of organisational knowledge, it is misleading to view it as an all encompassing solution to Knowledge Management. It is perhaps more precise to classify it as one of a set of enabling technologies for Knowledge Management.

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