

Approaches for Personalised Knowledge Retrieval

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Abstract

This paper proposes a hybrid approach for managing knowledge within companies based on communication between people. In addition to traditional Knowledge Management Systems our concept supports employees not only in finding information but also in establishing contact between the person requesting information and a person or community that can help solve the problem. This hybrid approach consists of a machine part and a network of human Knowledge Brokers (KBs). The machine part could answer requests about an area of expertise if the system has already recorded relationships to experts in this field. We use different search methods to offer a *Personalised and Interactive Knowledge Retrieval* to the user.

Keywords

Knowledge management, knowledge broker, knowledge broker network, hybrid man machine system, semantic network, semantic search, knowledge retrieval

1. Introduction

Many companies tend to force the employees to enter their knowledge into an IT system. Therefore many companies set up a *Knowledge Management System* (KMS). This KMS consists of existing information systems such as ERP systems, document management systems, workflow management systems, groupware, Intranet etc. and a system which is able to connect all these systems using their interfaces and provide the possibility of a common access point for the user.

In our approach we assume the solution to complex problems cannot normally be found in stored information or documents within a KMS, rather it is the result of communication and collaboration between different people.

2. The “Knowledge Broker Network” Approach

According to many literature findings we “focus more on people and not on technology” (Sunassee and Sewry, 2003; see also Tiwana, 2000 and Nonaka and Takeuchi, 1995). Therefore our approach tries to establish contacts between a person requesting information and an expert who can help solve the problem, or a community of experts (if available). This means that we are extending traditional Knowledge Management using communication to enable knowledge transfer within companies in practice.

Queries are handled by our so-called *Knowledge Broker* (KB) which is a hybrid between an

automated solution and a network of people (*Knowledge Broker Network, KBN*). This is our “*hybrid*” approach: an automated system is used, or else if there is no adequate information available then a person will be included in the process to support the user.

In this paper we will focus on the automated part of the concept. The network of people and communication between user, KB and experts is described in Loew *et al.*, 2005.

The core of the automated part is a KMS using a semantic network. Semantic networks are directed graphs, consisting of nodes, links and link labels. A node describes an object of the real world, while links represent relationships between two nodes. A link label describes the type of the relationship and the direction of that link (Winston, 1993). The KMS chosen allows the representation of knowledge structures (Maier, 2001) based on an Ontology (Gruber, 1995). We offer a special portal (as shown in Loew *et al.*, 2005) to retrieve information within the KMS. The portal supports user communication with KBs and other employees or experts (see Figure 1).

The retrieval functionality of our system will be shown in section 4. Using this retrieval functionality a user is able to search for information and documents as well as for people who can provide help. If a user can find a person then the system supports him to establish a relationship with this expert. The system first asks the expert whether he would like to be contacted to help solving the problem of the user seeking help. If the expert agrees the system will establish a first communication using the KBN portal or ask the expert to contact the user seeking help.

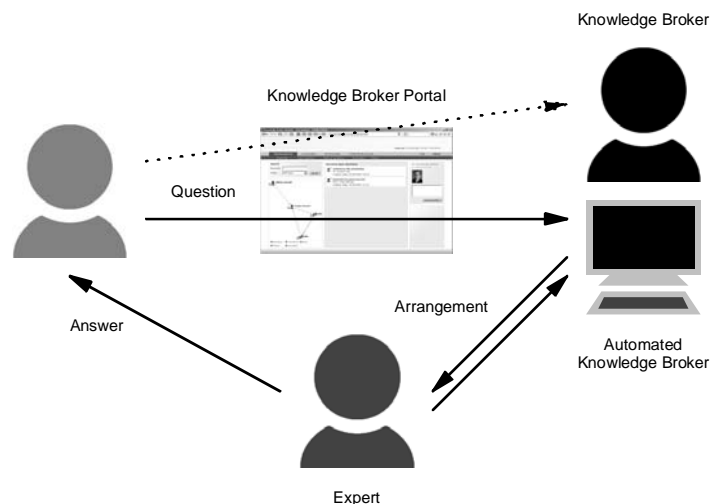


Figure 1: Overview of KBN Principle.

In addition the Personal Knowledge Broker could be addressed for support by the user at any time using the KBN Portal to improve usability of the KBN.

3. K-Infinity – Our Used Tool and its Search Features

We have chosen the semantic network based tool K-Infinity from Intelligent Views GmbH because it achieves the requirements described above. K-Infinity provides the enhancement of functionality

and the structure. It also has the capacity to use several search modes which will be described in this section. Figure 2 shows the various available search modes.

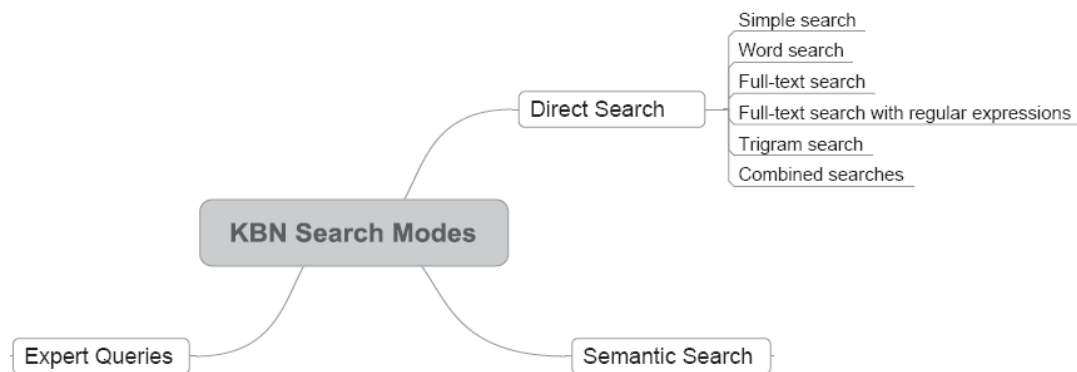


Figure 2: Search modes of the Knowledge Broker Network.

Besides the well-known search modes “simple search”, “word search”, “full-text search”, “full-text search with regular expressions” K-Infinity provides a trigram search which search for three letter sequences and is able to use combinations of all these search modes (Intelligent Views GmbH, 2004). There are two other interesting search modes:

Semantic search: The basis for the semantic search is a semantic network. The semantic search uses the links between concepts and instances in the semantic (knowledge) network and therefore does not interpret the search terms individually and independently from one another, but searches for links between them, for example in the form of a relation (or a shortcut relation, which combines several “simple” relations). Concepts or instances connected to each other using a relation move nearer to each other. By this, they stand in a thematic context and constitute in most cases a very good search result. The semantic search processes the result of a direct search or a combined search.

Expert queries: The expert query facilitates the compilation of concepts, instances, relations and attributes to build complex, static search queries, whose results only change when the knowledge network itself changes (for example by addition of new instances or creation of relations).

4. Knowledge Retrieval Methods for the Knowledge Broker Network

Using the methods described in section 3 we offer several retrieval options to the users. The standard search of the KBN is the simple search (specified above). (Rein, 2005) concludes that the simple search is most suitable for general requests.

4.1 Searching for documents

The search for documents is a fuzzy search. The first step of this semantic search is a simple search (see Rein, 2005) which provides the direct hits. The search result is limited to documents. A filter prevents personal details being displayed as results. As indirect hits, all relations with distance $k=1$ starting from the direct hits are included.

4.2 Searching for people

Searching for Experts

Searching for experts is very similar to searching for documents. Only the filter settings are different. Contact details are displayed instead of documents. Contact to an expert via the KBN-Portal can then be arranged.

Searching for other Knowledge Brokers

With this search a user or a Knowledge Broker is able to find other Knowledge Brokers. It is a focused search (not fuzzy like the semantic searches). Therefore you have to enter the area of expertise.

Searching for expert communities

The search for communities of experts is also a focused search. By entering the name of the desired community or the subject of the community all persons in this community are listed. A community is defined in KBN as a voluntary association of experts specialising a special topic.

Searching for departments

The search for departments is similar to the community search. The results are all persons of a specified department.

4.3 Personalised and Interactive Knowledge Retrieval – The Automated KB

As described above the Knowledge Broker is divided in two parts: the Personal Knowledge Broker (a human) and the automated Knowledge Broker (computer based). The automated component is available for every user of the KBN-Portal.

Finding information or experts could be optimised using *Personalisation*. This means that the user's behaviour has to be observed and stored to a user profile. This profile contains information about

- areas of expertise and interests;
- a history of the user's navigation through the KMS;
- remarks to information provided by other users (for instance: important to me or not); and
- relationships to other users (KBs, Experts and colleagues).

Using this information we can avoid displaying the same information recurrently to a user. Also we avoid displaying information which has been marked as unimportant by the user. If the user wants to establish a contact to an expert the system prefers to suggest experts to which the user already has an existing relationship.

Most KMS and internet search engines use only the last user interaction, for instance, a set of keywords as a search string. Usually there is only the option of searching within the results returned by the search engine. Our approach includes the **history of last interactions** to enhance the results and provide the possibility to **rate results** as :

- very important,
- important,
- not important in the current search context,

- wrong in the current search context and
- never important for the user (by clicking on 'YES' at a confirmation dialog this node is hidden for the user in the future).

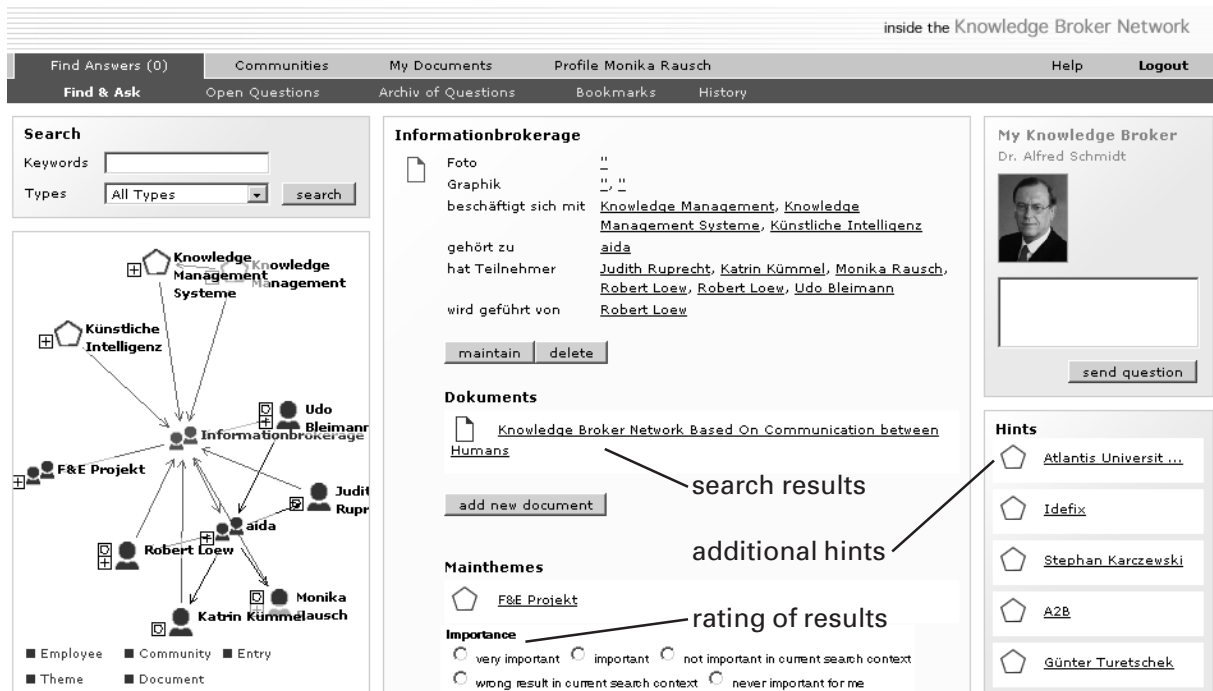


Figure 3: KBN Portal.

In addition to the normal search results we give hints to the user referring to his last interactions within a search context. These hints link to experts or other important knowledge network nodes. Figure 3 shows a screenshot of our portal with search results in a text-based form in the middle column, an extract of the semantic network for graphical navigation through this network in the left-hand side and our additional hints on the right-hand side.

The information required for providing these hints is a rating of the nodes into the semantic network. The designer of the semantic network structure marks classes of relations as important (for instance "is-expert-in"). Nodes attached to these relations are "important nodes". Users of the system are allowed to explicitly mark important nodes within their area of expertise.

We will now show an example algorithm which is extremely simplified to enhance its understanding. We call it "Search Assistance Algorithm (SAA)".

The **goal of this algorithm** is to support the user with a small number of **additional important hints**. The algorithm starts after at least two user interactions. A user interaction can either be by typing in some search keywords or by clicking on a link within the last search results.

Figure 4 shows a part of an example semantic network with nodes found by "standard search methods" (muffins, cookies, brownies) and "other important nodes" found nearby (recipes, chocolate, blueberry).

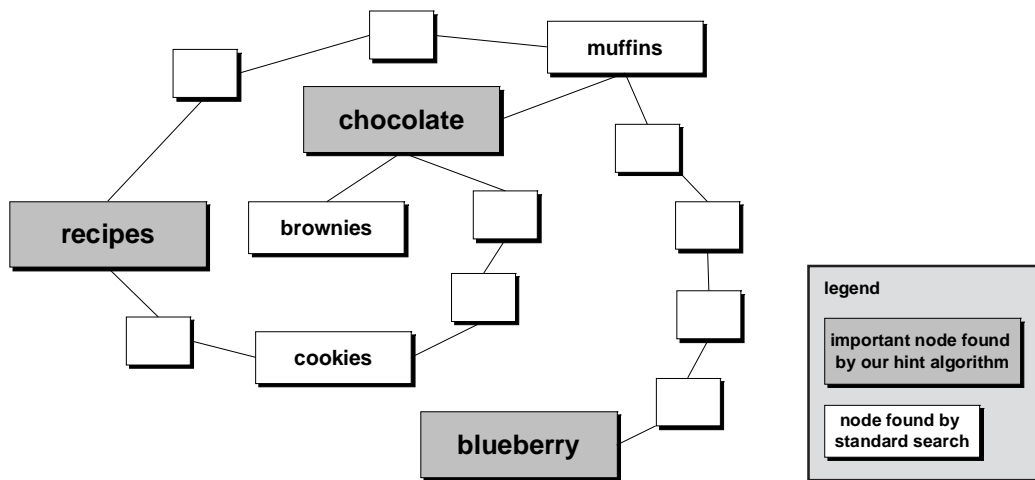


Figure 4: Example Semantic Network.

Figure 5 shows how to build the table for our algorithm. In this example the user types in the keywords »baking cakes« and get the node »muffins« as highest ranked result. Our algorithm now uses the node »muffins« as starting point and starts to search other important nodes near this node. Every important node that is found will be added to a column of the table. In the cells of the table we enter the distance between the resulting node of the standard search and the found important node (in our example 3 between muffins and recipes, 1 between muffins and chocolate and 5 between muffins and blueberry). For simplification we declare the distance between two nodes as 1, in practise relations can have different distances with more significance leading to less distance. Now the user types in other keywords : »baking cakes square« and gets the node »cookies« as highest ranked result. The same procedure starts and we add a line in the table with »cookies« and the distances between this node and the found important nodes nearby (that are the same in this simple example as found in the first step). Then the user types in »baking cakes brown« as search string and get »brownies« as highest ranked result. Therefore we add another line to the table with the node »brownies« and its distances to the important nodes.

	hint recipes	hint chocolate	hint blueberry
muffins	3	1	5
		hint recipes	hint chocolate
			hint blueberry
muffins	3	1	5
cookies	2	3	9
		hint recipes	hint chocolate
			hint blueberry
muffins	3	1	5
cookies	2	3	9
brownies	6	1	7
sum	11	5	21

Figure 5: Example Algorithm Introduction.

Now we build a table where every line represents the (highest ranked) result of one user interaction with the distance between the highly ranked node found (muffins ...) to other important nodes

nearby (recipes ...) in the cells. Then we add all cells of each column and recommend the node with the lowest sum (node chocolate in the example in Figure 5).

Our system now can display this node as a hint in addition to the normal search results. How many hints the system displays depend on the user's profile. If they usually use only 2 or 3 hints then the system will display up to 5 hints at a time. If they have used more than 5 hints in the past the system will display up to 10 hints.

For the following details we want to abstract the model using characters and digits instead of the node descriptions. According to our example in Figures 4 and 5 Figure 6 shows the same content in a more abstract model.

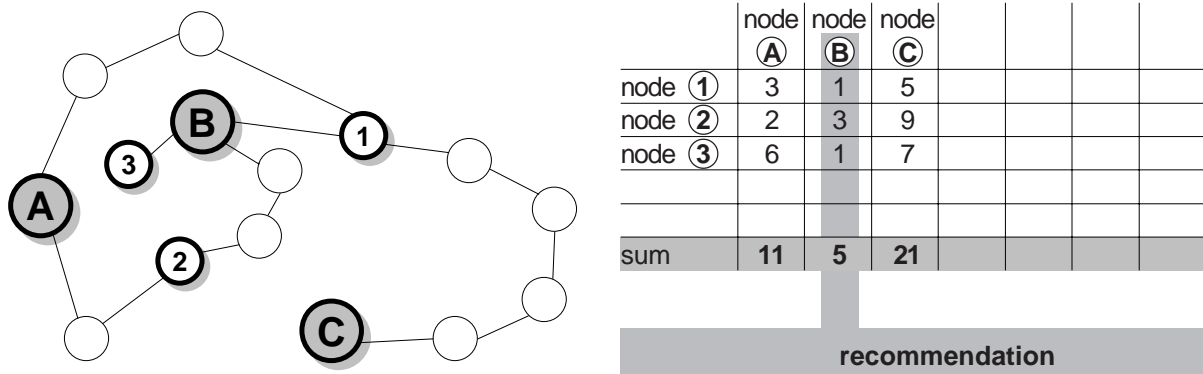


Figure 6: Example in a more abstract picture.

If the user has made an interaction within the same search context we have to search for important nodes. They will be added to the table and the distances to the earlier found nodes will be calculated to support the evaluation of the best recommendations.

In practise semantic networks consists of a huge amount of nodes. In our example we use a maximum distance of 6 between a search result node and an important node as criteria whether an important node has to be added to the table or not. In practise we have to use greater distances depending of the structure of the semantic network. There may be a lot of abstract relations in the structure comparable to relations in databases. Therefore we need a strategy to reduce the complexity of the tables.

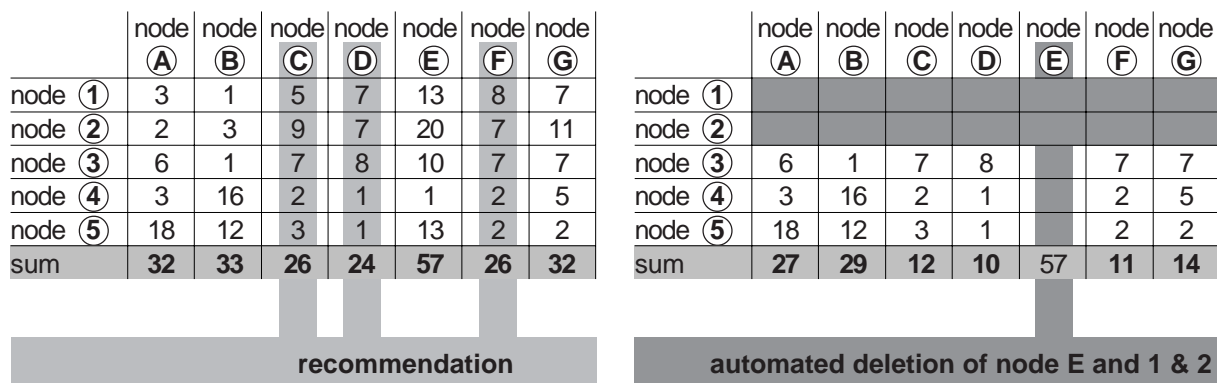


Figure 7: Complexity Reduction step of KBN Knowledge Retrieval Example Algorithm.

Figure 7 shows on the left-hand side that there is a high probability that more than one node will be recommend if a user has made some interactions. In this case the system makes a decision which hints are to be displayed based on the user's profile.

If the table expands the system can decide to delete columns with high sums of distances according to predefined policies. Furthermore the system can delete some of the first lines in the history as shown on the right-hand side of Figure 7 because of the assumption that the user's last interactions can better find the target.

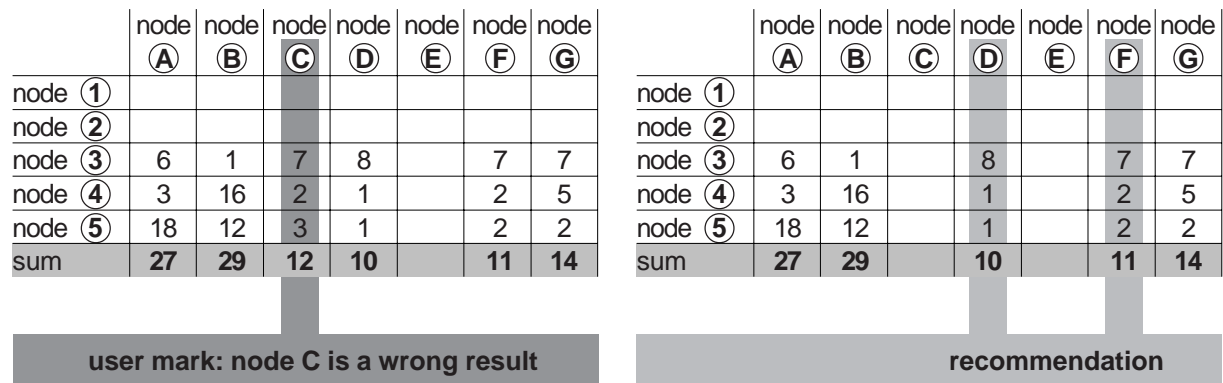


Figure 8: User Interaction in KBN Knowledge Retrieval Example Algorithm.

As mentioned before a user is able to mark results, which are shown on left-hand side of Figure 8. The right-hand side of Figure 8 shows the resulting recommendation of our example algorithm.

If the user wants to start a new search context he could tell this to the system or this could be detected automatically using the distance between the two used parts of the knowledge network. Of course it is possible to work within more than one context in parallel - simply using a browser window for every search context. Also the user is able to store a search context and to reassume it later on.

In practise we enhance the efficiency of this algorithm by using not only the highest ranked node found by standard search methods but using at least the three highest ranked results. One can imagine this as three layers of the table and summing up the individual sums of all layers to seek for recommended nodes.

4.4 Related Approaches in Internet Search Engines

There are some internet search engines which are providing some personalisation features like A9 (A9, 2005) which offers the possibility to store searching processes and combine them with new keywords.

Yahoo! Research (Yahoo! Research, 2006) is developing methods to interact with the search engine within a session to improve the results. As an example in Yahoo! MINDSET one can use a slider from “shopping” to “researching” to tell the search engine that the user is more interested in how to buy something or how to find information about something.

Google's “Page Rank Algorithm” (Brin, Page, 1998) is based on a rating of the network nodes, as is our algorithm. The nodes in Google's approach are websites with links between these sides. A website is rated higher if it is linked by another website with a high ranking.

5. Conclusion and Further Outlook

This paper presents one of many aspects of the automated part of our approach “Knowledge Broker Network” to support employees during knowledge retrieval.

Currently our research project is a joint project run by the AIDA team in Darmstadt, the Cork Institute of Technology, Ireland and different industrial partners. We are planning to implement a knowledge broker network in one of the participating companies and as an additional part of the website of the Darmstadt University of Applied Sciences.

The result of our user research (see Loewet *et al.*, 2005) demonstrates that people would prefer to first ask team members and colleagues. Hence our approach supports employees seeking help from other employees who can help them and provides collaboration communication. As next preference people voted for Internet searches. Therefore one aspect we are particularly interested in is how to integrate external information especially Internet search engines and their results.

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