An Oligo-Agents System with Shared Responsibilities for Knowledge Management

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1 Introduction

Management and information sciences as well as everyday practice in organizations have shown that in the modern information age, knowledge is the most important asset for any business enterprise [1]. However, many employees of companies frequently complain that important and interesting information is not forwarded to them. Simultaneously they sigh about being swamped with useless information that is arriving at their desktops. Their complaints of obtaining too much and too little information is a clear indication that they are not getting the information which is right for their specific interests and the particular tasks which were assigned to them. This is specifically true for the modern information age and the knowledge society where the available information increases dramatically from year to year and the potential speed of distribution appears to be almost unlimited.

In this paper, we propose a possible solution of the knowledge management problem with particular regard to the responsibilities that result from different users cooperating in such systems. In section 2, we present a brief analysis of knowledge management techniques that are often in use nowadays. Section 3 introduces the structure of an oligo-agents system for knowledge management in organizations. In section 4, the cornerstones of proposed system are summarized. Section 5 finishes the paper with a short disussion.

2 Knowledge Management in Multi-User Environments

The problem of getting the *right information* to the *right people* at the *right time* is the central issue of any practical knowledge management endeavor. Although it is not exclusively a technical problem, the new intranet-based technologies can very well help to develop a more complete solution to the distribution and comprehension of information in organizations.

The technologies which are most frequently used these days for the management of information in intranets are *corporate and organizational memories*, *e-mail* (including the possibility of defining *alias lists*), *news systems* and *search engines*. Hierarchical browsing and search engines are used for retrieving some desired information from the organizational memory (information pull). Similar to a traditional newspaper, electronic news systems are used to distribute timely information (categorized according some existing areas of interest, e.g. "rec.music.makers.percussion"). List servers provide similar functionalities for a more local community. Similar to traditional mail, electronic mail is used for sending out individual or bulk letters by alias lists (information push).

Each of these tools has explicitly or implicitly built in certain categorizations or representations about groups of people or groups of documents. For example, the categories of a news system represent the different document classes which are shared between the providers and the consumers of the information in the news system. Other relevant categorizations, e.g. which persons may be interested in obtaining some news are, however, neither explicitly nor implicitly represented in such news systems. E-mail distribution lists in the form of aliases, on the other hand, are typically organized so that the aliases represent groups of people who are interested in obtaining similar information. For the knowledge management task in which the different functionalities are combined, all these different representations are important, even when they are not explicitly or implicitly represented in the specific tool.

In a more technical description, having the right documents at the right people at the right time means that within some given timeframe one achieves 100% recall with regard to a given information base and 100% precision with respect to the particular information consumer. As there is of course the well-known trade-off between precision and recall, this is obviously already a difficult problem for a single user query of an information base and . For multi-user domains it does not become any easier, especially because users may independently have control over one of the parameters as well as different interests whether precision or recall values should be optimized. Although the forementioned information tools (e-mail lists, news systems, etc.) may provide important components for the desired solution, a unifying view which is focused on the concept of time and information responsibility is needed for achieving some significant progress.

3 The Distribution and Comprehension of Documents within an Organization

Because in a multi-user environment different people may have separate control over the recall and precision parameters, not only the technical aspects but also social entities like responsibilities, contracts and agreements are of central importance for successful knowledge management. We therefore need to consider the different *social roles* of the people participating in such a system.

When an intranet is used as an organizational memory, one usually distinguishes between the *authors* (or *information providers*) who supply the various documents, the *administrators* who maintain the memory system (i.e. they serve the function of librarians) and the *information consumers* who read some of the stored documents. Because the distribution of documents is a separate task in its own right, it requires responsible action. This role is taken by a so-called *distributor* who is equipped with the required privileges.

The core task of the proposed system involves assigning groups of *information consumers* to *groups of documents*. As mentioned above, the functions of news systems and alias lists should be combined with a representation of the structure and contents of the organizational memory. These functions will be implemented as an oligo-agents system with *two types of agents*, namely the *global agents* (a global manager GloMa and comprehension assistant) and *individual agents* (termed ConPersonA, ConPersonB, . . . for each information consumer and ProPersonA, ProPersonB, . . . for each information provider, respectively). These agents live in a three-tier client/server architecture. The global agents are located at an *application server* and have access to the organizational memory. The individual agents are located at the *clients* and communicate with the organizational memory via GloMa by using the standard intranet protocols.

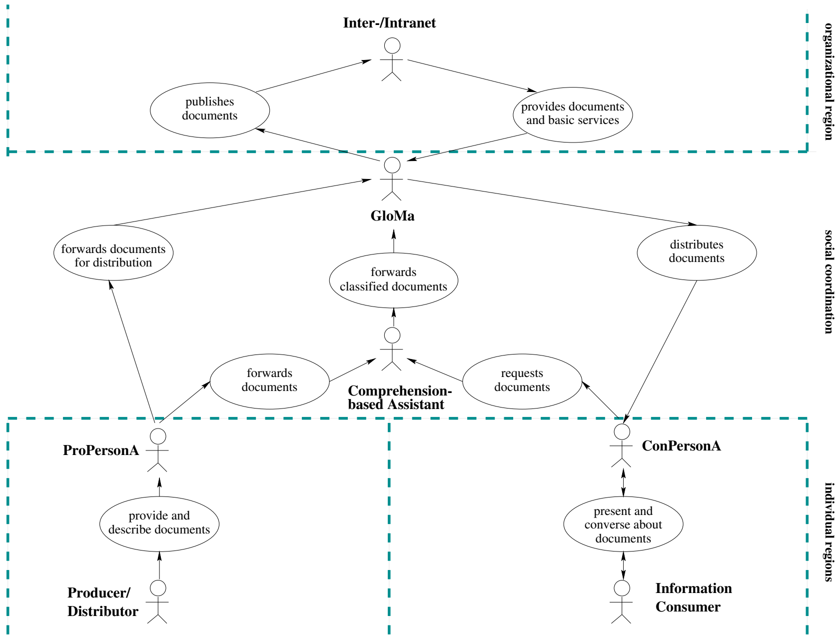

Fig. 1. Structure of the oligo-agents system for distribution and comprehension assistance within an organization

As shown in Figure 1, the issue of individual and social responsibilities is adressed by deviding the system into three regions: The first region embodies the *organizational needs*, e.g. the requirements of the underlying intranet or corporate memory. Individual regions embody the *personal interests* of the different individuals who are involved (information providers, distributors and consumers). A social coodination region serves as a *negotiation space* for discussing conflicting as well as consonant interests. The agents located in this region have access to global knowledge (e.g. about all documents) as well as to different portions of knowledge that belong to individual agents (provided that the individual agents enable them, e.g. in the case of a user query).

In the next section, we give a comprehensive overview of the pivotal properties of the oligo-agents system to accomplish the task of information dissemination.

4 The Oligo-Agents System in a Nutshell

The central data structures of the proposed system are *distribution lists* and *interest lists* which are conceived as relations between information consumer groups and document groups. The lists can be described at *abstract levels* (intensional descriptions) which are based on *concrete descriptions.* These concrete descriptions can easily be matched with the information base and thereby the extensions of the consumer-document relations can be obtained. The **distribution and interest lists** are defined by a) the *attributes* that are already used in the organizational memory for describing the documents (e.g. document type, language, version, brief summary, etc.), b)*structural properties* with respect to the location where the document is stored in the organizational memory and the site where an information consumer is organizationally located (e.g. in the organigram) and c) *automatic contents analysis techniques* that allow a three-level representation of each document.

The content descriptions of the documents are generated by a **comprehension assistant**[2]. This assistant generates word-oriented representations (*surface level*) as well as more abstract representations in discrete (*propositional level*) and continuous (*situational level*) representation spaces.[1] The comprehension assistant coordinates a negotiation process between the different users so that the representation spaces can be specified in a way that they are useful and understandable for the various users. Thereby a mutual understanding may be shared among increasingly more people and increasingly more documents.

The **global manager** GloMa *keeps and maintains repositories* that are used for the definition of user profiles (information consumers), document groups and distribution and interest lists. Thereby it is possible to use the available information, consisting of document attributes, document contents and organizational structures as a whole. Furthermore, GloMa maintains a *continually updated representation of the organizational memory.* Each document that is newly published, updated or translated in the organizational memory must thus be reported to GloMa. Unlike the openess of the world-wide web, an organizational memory allows the formation of a relatively complete representation,

[1] Whereas the propositional level's abstraction are more local (by the application of ontologies and thesauri), the situational level forms abstractions of entire documents by *latent semantic analysis* [3].

because the relevant actions of the various users can in principle all be reported to GloMa.

Documents of the organizational memory that *participate* in the distribution and comprehension assistant are *marked* and can thus be distinguised from those documents that are solely stored (and not to be distributed). Thereby, it is possible to *introduce the assistant function to an increasingly larger set of documents* and the functions of information distribution and storage can be combined in a gradual manner. Since the responsibilities of authors, administrators and distributors are clearly defined, the consequences of the various distribution list are kept under control.

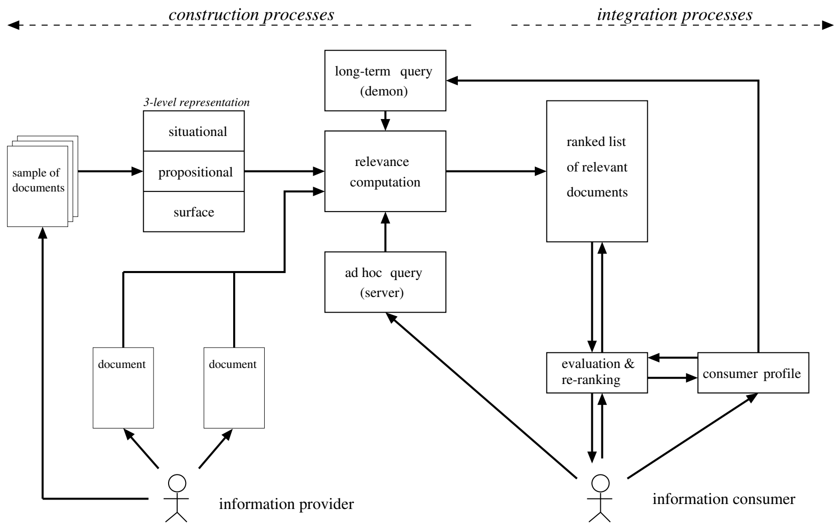

Fig. 2. Knowledge construction and knowledge integration processes for three-level representations as a means for accomplishing mutual understanding among information providers and information consumers

Decoupling of *definition time*, *information-identification time* and *presentation time* (through assisting each of these activities by a specialized agent with an appropriate time concept) allows distribution to be determined either by the individual or as a common responsibility of administrator, author, distributors and information consumers. These responsibilities may concern one-shot distributions as well as periodical repetitions of some general distribution specification.

Figure 2 shows how the document providers and information consumers of the organizational memory can employ the distribution and comprehension assistant to improve their consensual understanding of documents in the organizational memory. An *initial coordination of individual and global concerns* (at the definition time of potential communications in the intranet) is achieved by a more or less representative sample of documents from which a three-level representation. Information-identification is initiated by long-term queries as well as ad hoc queries. The most relevant information (i.e. the right documents) become explicitely specified (information identification time). As in most information retrieval systems, a rather local and simple relevance measure is used, namely the similarity of a particular document and the user query. Integration processes enable an information consumer to converse with the oligo-agents about his individual relevance rankings of the various selected documents on the basis of the three-level representation. Such individual re-rankings can be based on more complex relevance metrics that might consider the whole set of selected documents and therefore allow for more global aspects like the *information gain*.

5 Discussion

In this paper, the problem of knowledge management, especially knowledge dissemination in an organization, is tackled by proposing the coordination of individual and global concerns in an oligo-agents system with shared responsibilities. This system is embedded in an organizational memory. From an application point of view, the functions that are provided by the distribution and comprehension assistant enable the information consumer to get a personalized view of the organizational memory. This view consists of individual aspects that are based upon a semantic document analysis as well as upon organizational aspects in the form of distribution lists in which a distributor determines the portion of information that is delivered to the consumer. Beyond the concept of a personal newspaper, this personalized view is supplemented by a clear assignment of individual and joint responsibilities for different facets of the knowledge management task, including spacial (location of information and users), temporal (decoupling time for the different users) and content-oriented (document comprehension) aspects. The combination of these elements leads to a flexible tool for handling information distribution and information gathering, two of the core problems of knowledge management.

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