Knowledge Update in Collaborative Knowledge Sharing Systems

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ABSTRACT

In a collaborative knowledge sharing system each source is associated with knowledge base system that participates in knowledge sharing with other sources. Acquaintances of sources build a collaborative knowledge sharing system or network in which each source is acquainted with other sources. The network of sources can be either acyclic or cyclic, meaning that they can contain acquaintance chains that are acyclic or cyclic. Updating knowledge in the sources involved in an acyclic logical network of sources is done by propagating an update from the originating source until the update reaches the leaves of the network. However, cyclic cases may create complexities due to conflicts that may arise between different versions of propagated updates. The author examines update propagation in both cyclic and acyclic networks. Moreover, the authors considers cases where a source is temporarily unavailable or offline. Here the author’s propagation mechanism keeps track of every source even if the source is not available for a certain period of time until that source becomes available. Once a source comes back online the system must propagate the update destined to the returning sources to keep its knowledge consistent with other sources. The author has implemented this mechanism and evaluated it on a small collaborative knowledge sharing system.

Keywords: Collaborative Systems, Data Management, Data Sharing, Data Update, Knowledge Management, Peer to Peer

1. INTRODUCTION

Knowledge sharing deals with the knowledge exchange between heterogeneous Knowledge Base Systems (KBSs). Sharing of knowledge between knowledge base systems are different from the data integration systems (Lenzerini, 2003; Halevy, Ives, Suciu, & Tatarinov, 2003). Schema-level mapping and data-level mapping, a.k.a mapping tables are considered for creating acquaintances between knowledge bases systems, where the knowledge update between two systems is processed pair-wise. Schema-level mapping (Miller, Haas, & Hernandez, 2000) is used to resolve knowledge structure heterogeneity between two knowledge sources and mapping tables are used as the form of data-level mappings (Kementsietsidis, Arenas, & Miller, 2003) for different knowledge vocabularies, which contains a set of data associations between data values in two sources. The use of mapping tables in the case of query answering or data updates introduces

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the following ideas. 1) Semantics of query answering or updates in autonomous knowledge base system which relies on the translation of queries or updates queries between sources through the mapping tables. 2) The notions of sound and complete translation are to characterize the relationship between translated queries or updates. 3) The definition of the mapping tables is not only the association between data values but also the association between pairs of translated queries and updates.

2. SYSTEM MODEL

The system architecture under consideration is shown in Figure 1. Our cooperative KBS consists of a set of sources with local knowledge base system \( \{KBS_i \} \) for \( 1 \leq i \leq m \), where each \( KBS_i \) is a pre-existing autonomous knowledge management system contains knowledge data source. Each system provides a set of services to share and access its knowledge locally and remotely. For example each system provides acquaintance services for creating acquaintances with other systems, query service for retrieving information over the network, and update service for updating local and remote knowledge. Once a system joins the network, it can establish acquaintances with other systems exchanging their schemas and use services exists in local system and its acquaintances. An acquaintance is a connection between two systems and is established by generating mapping tables (Kementsietsidis et al., 2003) on both systems. The acquaintances are transient since each system is fully autonomous and joins or leaves the network at its own will. Formally, we can define our collaborative KBS as follows.

**Definition 1:** A collaborative KBS is a pair \((N,M)\). Here, \( N = \{(K,L)\} \) is an undirected graph, where \( K = \{KB_1, \ldots, KB_n\} \) is a set of knowledge base system or simply called sources, \( L = \{(KB_i, KB_j) | KB_i, KB_j \in K\} \) is a set of acquaintances. Each source \( KB_i \) is associated with a knowledge database with schema \( KDB_i[W] \), and each acquaintance \((i,j)\) is associated with a set \( M_{ij} \in M \) of mapping tables.

2.1. Topology Discovery and Knowledge Update

At the beginning, when a source joins a collaborative knowledge base system, it is only aware of its acquaintance. Compare to the discovery protocol (Kantere, Kiringa, & Mylopoulos, 2003), actual knowledge update is different from two perspectives. 1) Update algorithm continues its operation until it reaches a fixed point while discovery algorithm stops when a source is reached twice. 2) Actual queries and propagation is not performed by the discovery algorithm.

2.2. Mapping Tables and Its Characteristics

To support the knowledge sharing, it is required to translate the local query and update into the vocabulary of the other sources, which involves translating both the structure of the query to use the schema elements of the associated sources. It is often not possible to make this data conform to the local schema. For conformance the local knowledge base system must have anticipated the structure of all possible answers to the query. Mappings are required to fit the structures into the local schema (Kementsietsidis & Arenas, 2004). The basic algorithm (Kementsietsidis et al., 2003) has the following properties that has been developed to generate the mapping tables: Mapping tables are generated on demand which means entire tables are generated in each step from existing ones. Mapping tables represent expert knowledge that is typically created by domain specialists. Mapping table’s creation is also time consuming and is performed manually by a
Before the Internet: The Relevance of Socio-Technical Systems Theory to Emerging Forms of Virtual Organisation
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CHIS: Cultural Heritage Information System
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