Chapter 7

P2P Semantic Coordination for Collective Knowledge Organization

Silvana Castano
Università degli Studi di Milano, Italy

Alfio Ferrara
Università degli Studi di Milano, Italy

Stefano Montanelli
Università degli Studi di Milano, Italy

ABSTRACT

In this chapter, we present a P2P coordination approach for setting up and exploiting collective peer knowledge provided by autonomously emerging semantic communities. This approach aims at providing a practical means for allowing a peer to move from a restricted peer knowledge space, where it is considered as a single agent with its personal knowledge, towards an intermediate collective knowledge space, where it is considered as a member of a community storing a part of the overall collective knowledge, up to a final collective peer-knowledge space, where the peer builds its personal and coordinated view of the collective knowledge of interest harvested from the underlying communities. In this respect, ontologies and Semantic matching techniques are exploited to set up collective knowledge and to effectively enforce distributed resource sharing.

INTRODUCTION

In open and networked infrastructures, each single agent needs to evolve its ontology knowledge over time not only by adding new concepts on its own, but also by (re)using external knowledge chunks provided by other partners as a result of collaborative activities (Arenas, et al., 2003; Castano, Ferrara, & Montanelli, 2006b). In this sense, there is the need of shifting from rigid data integration architectures to more flexible knowledge coordination platforms where agents are organized in semantic communities of interest defined to explicitly give shape to the collective knowledge of groups of peers with similar expertise/resources.

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- **Semantic community formation and management.** This is related to the capability of recognizing group of peers with similar interests and maintaining semantic links with selected peers storing relevant knowledge. In the chapter, we present handshake techniques to enforce semantic community formation. In contrast with most existing solutions, our notion of semantic community is lightweight, in the sense that community membership is open and approval/rejection of a peer is not determined by the decision of a supervisor. This way, community maintenance is efficient due to the fact that peers can autonomously join/leave communities at any moment, without requiring community reorganization or structural adjustment.

- **Community-based knowledge harvesting.** This is related to the capability of discovering peers that can provide prominent knowledge on-demand for satisfying a given need. In the chapter, we present a routing-by-community mechanism based on ontology matching techniques for the automatic selection of the most appropriate communities to query. This allows peers to harvest the relevant collective knowledge of existing communities which is acquired in the form of knowledge chunks, each one representing a pertinent unit of knowledge (i.e., a concept) provided by an external peer source.

**P2P knowledge coordination.** This is related to the capability of supporting a peer in building its own view of a specific concept of interest by coordinating the collective knowledge harvested from the underlying communities. In the chapter, we present clustering-based techniques to abstract a collective concept out of a set of underlying matching knowledge chunks. Semantic links are maintained by the peer to keep track of the source node from which the various knowledge chunks composing a collective concept have been acquired during harvesting. Collective concepts constitute the user-level interface for querying and accessing information resources spread over the network and to mediate between their possibly heterogeneous representations. For gradual improvement of the system effectiveness, coordination is cyclically performed to refine the collective concepts by including new knowledge chunks acquired from recently added members of communities.

**BACKGROUND**

Work related to the issues addressed in this chapter is mainly concerned with semantics-based P2P systems, with particular focus on those systems where the notion of peer community is supported for enforcing formation and maintenance of groups of nodes with similar interests (Khambatti, Ryu, & Dasgupta, 2002; Crespo & Garcia-Molina, 2004; Wang & Vassileva, 2004; Liu, Bhaduri, Das, Nguyen, & Kargupta, 2006). In this context, peer communities (when supported) are conceived as
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