

Chapter 17

Managing Collective Intelligence in Semantic Communities of Interest

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ABSTRACT

In this paper, the authors present a reference P2P architecture based on autonomous, self-emerging semantic communities of interest (CoIs) for collective intelligence creation and management. An approach for enabling knowledge organization and management at the level of a single peer is presented in the paper, as well as techniques for supporting a peer to participate to the construction of a shared community vocabulary, according to the terminological preferences automatically extracted from its personal knowledge. Furthermore, an application example in the e-health domain is presented in the framework of the iCoord system for P2P semantic coordination to show the use of a manifesto-based collective intelligence for enforcing effective collaboration in a real case study.

INTRODUCTION

In a modern vision, P2P systems are seen as effective collaboration platforms where data and knowledge belonging to a possibly large set of peers can be shared in an effective way

(Androutsellis-Theotokis & Spinellis, 2004). In this context, the traditional approaches based on peer-to-peer knowledge discovery and data exchange are being replaced by more articulated architectures where the notion of *semantic community of interest (CoI)* is introduced to explicitly give shape to the *collective intelligence* of a group of peers with similar expertise/resources

DOI: 10.4018/978-1-4666-1577-9.ch017

(Avrithis, Kompatsiaris, Staab, & Vakali, 2008). Semantic CoIs allow to shift from a network of units to a network of coalitions where the community itself (and not the peers on their own) has the role to support queries and specific collaboration needs that can rise in a given moment. Creation and maintenance of a community-level collective intelligence push a novel attention to the critical aspects of distributed knowledge management in the P2P environment, where the goal of establishing a shared agreement among a set of peers conflicts with the intrinsic P2P nature that pursues peer autonomy, communication scalability, and rapid change propagation. In this direction, recent approaches based on P2P communities show interesting solutions to improve the efficiency of query distribution and to increase data availability, apart from the accessibility of the single peers (Aiello & Alessi, 2007; Das, Nandi, & Ganguly, 2009). However, methods and techniques for collaboratively building and negotiating any form of P2P community intelligence are still at a basic level of development and only preliminary results are currently available (Aleman-Meza, Halaschek-Wiener, & Arpinar, 2005; Ren, Anumba, & Ugwu, 2002).

In this paper, we propose a reference P2P architecture for collective intelligence creation and management based on autonomous, self-emerging semantic CoIs. In our architecture, a semantic CoI emerges from the P2P network by aggregating those peers that autonomously agree to contribute with their own data and knowledge to the construction of a collective intelligence about a certain topic of interest. The collective intelligence of a semantic CoI is made explicit in the form of a *community manifesto*, containing both an ontological description of the community interests and a shared community vocabulary. An approach for enabling knowledge organization and management at the level of a single peer is presented in the paper, as well as techniques for supporting a peer to participate to the construction of a shared community vocabulary, according

to the terminological preferences automatically extracted from its personal knowledge. As far as we know, the capability of enabling a group of independent peers to autonomously define a shared community vocabulary without relying on any centralized authority is an original contribution per sé. Furthermore, an application example in the e-health domain is presented in the framework of the iCoord system for P2P semantic coordination, to show the use of a manifesto-based collective intelligence for enforcing effective collaboration in a real case study. For the sake of clarity, an appendix is finally provided to summarize the notations adopted in the overall paper.

REFERENCE P2P ARCHITECTURE AND KNOWLEDGE MODEL

In the field of P2P systems, the notion of community refers to the capability of the network to autonomously recognize and aggregate groups of peers with common interests and similar resources to share (Castano & Montanelli, 2005; Gu & Wei, 2006). We borrow this notion of P2P community and we define a *semantic community of interest*, from now on simply called *CoI*, as a community of peers where the term “semantic” denotes that the peers participating to the community agree on the “meaning” of the resources to share, and such a meaning is formalized through an ontology-based manifesto. The manifesto gives shape to the *collective intelligence* of a CoI, which is gradually set up in a collaborative way through progressive enrichments performed by all the community members.

For creation and management of a collective intelligence in a CoI, we propose the reference P2P architecture shown in Figure 1, where the upper layer, namely the *Collective Knowledge space*, is in charge of managing CoI formation and management, and the lower layer, namely the *Peer Knowledge space*, is in charge of ensuring

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