Chapter VIII

Dynamic Knowledge Discovery in Open, Distributed and Multi-Ontology Systems: Techniques and Applications

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Abstract

In open distributed systems like peer-to-peer networks and Grids, many independent peers, possibly spanned across multiple organizations, need to share information resources (e.g., data, documents, services) provided by other nodes. By dynamic knowledge discovery we mean the capability of each node of finding knowledge in the system about information resources that, at a given moment, best match the requirements of a request for given target resource(s). The chapter will focus on describing models and

techniques for ontology metadata management and ontology-based dynamic knowledge discovery in open distributed systems, by describing the architecture of a toolkit for information resource discovery and sharing developed in the HELIOS peer-based system.

Introduction

In open distributed systems like peer-to-peer networks and Grids, many independent peers, possibly spanned across multiple organizations, need to share information resources (e.g., data, documents, services) provided by other nodes. In such a distributed context, a key problem is related to *dynamic knowledge discovery*. By dynamic knowledge discovery we mean the capability of each node of finding knowledge in the system about information resources that, at a given moment, best match the requirements of a request for given target resource(s). As shown in Figure 1, we can define an open distributed system as a network of many independent peers with equal role and capabilities. Each peer exposes to the system the shared information resources together with a set of corresponding metadata, and interacts with the other parties with the intention to (1) discover peers containing relevant knowledge with respect to a target request, and (2) acquire the information resources of interest provided by the other peers. To this end, the knowledge discovery process is based on a query/answer paradigm in which each peer in the system acts both as a client and as a server interacting with other nodes directly, by submitting queries containing a request for one or more concepts of interest and by replying to queries with concepts relevant to (i.e., matching) the target.

The following features affect knowledge discovery and sharing in open distributed systems: (1) *dynamism of the system*, regards the fact that peers are allowed to join and leave the network at any moment; (2) *autonomy of nodes*, in that each peer is responsible for its own knowledge management and representation; (3) *absence of a-priori agreement*, about ontology specification vocabulary and language to be used for knowledge specification; (4) *equality of node responsibilities*, no centralized nodes with coordinating tasks are recognized and each peer enforces interaction facilities with other nodes for knowledge sharing. In this context, the following main requirements need to be addressed by providing appropriate techniques:

- **Ontology metadata management.** In order to provide a semantically rich representation of exposed information resources in terms of metadata descriptions, each peer defines a *peer ontology*. The peer ontology

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