Chapter 5
Semantic Methods for Data Mining in Smart Spaces

ABSTRACT

This chapter shows the role of semantic methods in delivering AmI. The smart spaces paradigm applies ontological modeling for representing available IoT resources as shared information. This way, resources are virtualized by local information hubs, which are deployed on existing devices. The virtualization benefits from semantics since relations between resources are also represented, forming a semantic network. In turn, various ranking models can be implemented for information search and knowledge reasoning (e.g., based on such well-known algorithms as PageRank). The structural properties of the semantic network leads to advanced AmI support for constructing proactive services: discovery of certain structures (e.g., cycles) can be interpreted as formation of specific knowledge that initiates service construction and delivery.

INTRODUCTION

The Internet of Things (IoT) concept shows the role of distributed service construction based on the data produced from multiple heterogeneous sources by multiple dynamic participants (Sethi & Sarangi, 2017). The smart spaces suit of technologies is used for creating a certain class of intelligent service-oriented environments (Augusto, Callaghan, Cook, Kameas, & Satoh, 2013).

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A shared view on information is provided to all participants via a semantic information broker (SIB), which supports the information-driven interaction by producing, processing, and consuming this shared information with focus on its semantics (Korzun, Balandin, Kashevnik, Smirnov, & Gurtov, 2017).

In IoT environments, a service-oriented application can be created as a smart space. The latter forms a sparse-connected multi-agent system deployed on various digital devices, including mobile and embedded IoT-enabled equipment (Augusto, Callaghan, Cook, Kameas, & Satoh, 2013; Korzun, Balandin, Kashevnik, Smirnov, & Gurtov, 2017). Software agents run on the devices and interact over the shared information content to create services together.

This type of interaction involves—in parallel and asynchronously—many informational sources and destinations. Information sharing makes the interaction indirect, based on a semantic information broker (SIB) that supports publish/subscribe (pub/sub) model (Eugster, Felber, Guerraoui, & Kermarrec, 2003). The pub/sub model is widely accepted for organizing multi-part interactions in distributed systems and now become applied in development of smart spaces in IoT environments (Pellegrino, Huet, Baude, & Alshabani, 2013; Esposito, Platania, & Beraldi, 2014; Roffia et al., 2016).

Smart services can be developed based on semantic network interlinking the set of available resources in IoT environment. The semantic network enhances the shared vision on information. The network is subject to data mining needed for selection of appropriate information as a result provided by services constructed by agents in a smart space.

A service can be considered as providing a search extend of the shared information collected in the smart space. Several most appropriate information facts are found for a given problem. It is close to the $k$-optimization approach (several top solutions are used).

**BACKGROUND**

Service construction in a smart space can be formulated in terms of flows of information changes (Korzun, 2014). It follows the vision of event-driven and information-driven programming. The events to react are ontologically represented in the smart space. This event-based interaction can be enhanced to information-driven interaction. The reaction is not on a simple event (some values are updated) but on forming a certain informational or knowledge
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