Chapter 5

Semantic Extension for the Linked Data Based on Semantically Enhanced Annotation and Reasoning

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ABSTRACT

Linked Data, a new form of knowledge representation and publishing described by RDF, can provide more precise and comprehensible semantic structures. However, the current RDF Schema (RDFS) and SPARQL-based query strategy cannot fully express the semantics of RDF since they cannot unleash the implicit semantics between linked entities, so they cannot unleash the potential of Linked Data. To fill this gap, this chapter first defines a new semantic annotating and reasoning method which can extend more implicit semantics from different properties and proposes a novel general Semantically-Extended Scheme for Linked Data Sources to realize the semantic extension over the target Linked Data source. Moreover, in order to effectively return more information in the process of semantic data retrieval, we then design a new querying model which extends the SPARQL pattern. Lastly, experimental results show that our proposal has advantages over the initial Linked Data source and can return more valid results than some of the most representative similarity search methods.

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**INTRODUCTION**

With the increasing amount of information, how can we find meaning in these terabytes (Kusiak, 2017)? To answer this question, we should consider from two aspects: On one hand, the World Wide Web (WWW) must be more structured and machine-readable contrasting with the traditional Web. Driven by these demands, semantic web (SW) (Berners-Lee et al., 2001) is proposed and widely used, which aims to develop techniques to incorporate semantics into Web design. On the other hand, confronting the sea of online information, users prefer to get knowledge which is more clear and meaningful rather than pages with unstructured text. To counter this requirement, there is a need for new querying techniques to improve traditional keyword-based search (Tran et al., 2011).

From the WWW Consortium’s vision of the Web of Linked Data (Rahoman & Ichise, 2018), SW presents a revolutionary opportunity for deriving value from data and activity has gained momentum with the widespread publishing of structured data as RDF (Klyne & Carroll, 2014). In recent years, an increasing number of data providers like (Bollacker et al., 2007; He et al., 2018; Hoffart et al., 2013; Lehmann et al., 2015; Nebot & Berlanga, 2016; Wiemann & Bernard, 2016; Zhang et al., 2017) have published and connected their data into Web of Linked Data and, ultimately, into the SW. Promoted by the eager demand, many Linked Data-oriented techniques have been researched such as (Assaf et al., 2016; Auer et al., 2014; Nguyen & Ichise, 2017; Sande et al., 2016; Santipantakis et al., 2017; Yang et al., 2017).

The aforementioned developments bring the upsurge to the query for Linked Data. So, the works presented in this paper will make a further study on Linked Data querying from semantics. The rest of the chapter is organized as follows. Section 2 briefly reviews related works and highlights the difference between our study and these exiting works. Section 3 introduces some preliminaries about Linked Data and provides our research questions and research methodology. In Section 4 we present some new notions to depict the properties between different predicates and establish the Semantic Matrix for Predicates (SMP). The Semantically-Extended Scheme for Linked Data Sources (SES LDS) and the details of rules about semantically-enhanced reasoning strategy are presented in Section 5. In Section 6 we design a well-defined framework as the formalized expression of our query model and present the details of processing algorithms of our querying method. Section 7 is devoted to evaluating our method. Finally, we draw our conclusion and outline the future work in Section 8.

**RELATED WORK**

In April 1998, the first draft of the RDF Schema (RDFS) specification was published as a W3C Working Note (Ciobanu et al., 2016). The focus of the work was to extend the RDF vocabulary and detect some semantics of user-defined relationships between classes and properties. As being heavily modified in later versions, the subsequent RDFS specification was accepted as a W3C Recommendation in early 2004 (Dan & Guha, 2004) and remained ever since (Klyne & Carroll, 2014). RDFS extends RDF with four key terms (Kejriwal & Miranker, 2015) and makes more detailed description about the RDF Semantics (Hayes et al., 2004).

The list of four relationships and some of their corresponding rules are shown in Table 1. The interested reader can see Section 7 in (Hayes et al., 2004) for all.
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