A Fuzzy Ontology-based Semantic Data Integration System

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Abstract

Data integration becomes even more necessary given the increasing availability of data from distributed and heterogeneous sources. To address such heterogeneity, crisp ontologies have been employed in order to represent the semantics of integrated data. However, it is interesting to use fuzzy logic concepts in these ontologies, for a more expressive representation of vague information relevant to some domains. In this context, this paper presents DISFOQuE system for data integration based on fuzzy ontology, which provides a homogeneous view of data sources and also performs query expansions in order to retrieve more comprehensive answers to the user. We have executed a real experiment in the domain of watershed analysis, which provided a homogeneous view of the watershed data sources and more effective answers to researchers.

Keywords: Data Integration, Fuzzy Ontology, Query Expansion, Semantic Information Processing

1. Introduction

The goal of data integration systems (DIS) is to provide a unique, transparent and homogenous view of a set of heterogeneous data sources [1] [2]. Data integration is becoming even more necessary given the increasing availability of data from distributed and heterogeneous sources, as experienced in the development of the Internet. Such characteristics make it difficult to search for desired information since queries might be inappropriately answered or may have incomplete results if each data source is analyzed in isolation.

Among the approaches to the development of DIS, there are some researchers that use ontologies to represent a homogeneous view of data sources [1] [2]. Ontologies, as considered by the Computer Science community, comprise elements such as classes, individuals, properties and relationships [3], which can be used to model the semantics of the domain related to integrated data sources.

These ontologies are considered *crisp* since they are based on classical logics, which only represent exact information ("false" or "true" statements). However, there are domains that require some imprecise or vague information to describe them. For this purpose, representing fuzzy sets concepts [4] in ontologies is a feasible approach to express imprecise concepts and relationships, e.g. the similarity degree between two parameters of water quality in a watershed analysis domain. By analyzing such fuzzy ontology constructs, it is possible to expand user queries in DIS and then retrieve approximate results [5].

Facing this context, this paper presents DISFOQuE system, a data integration system based on fuzzy ontology, developed to provide a homogeneous view of distributed and heterogeneous data sources. DISFOQuE system analyzes the fuzzy ontology in order to perform semantic query expansions, aiming to retrieve similar results that are relevant to user requirements. To present more details of the developed system, the remainder of this paper is organized as follows. Section 2 describes existing data integration systems and discusses how fuzzy ontology can be applied to handle some of their limitations. Section 3 presents the DISFOQuE system, explaining its architecture and operation. A case study is detailed in Section 4. Finally, section 5 describes our conclusions along with future works.

2. Using Fuzzy Ontology for Data Integration

Data integration systems (DIS) deal with two main problems: combining data located in different sources and providing the user with a unified view of gathered results [1] [2]. By providing a unique, transparent and homogeneous view of heterogeneous data sources, it is possible to retrieve richer information, since different sources can have complementary data. In order to build an integrated view of data sources, some conflicts must be addressed, such as syntactic (schematic and structural) [6] and semantic ones [7].

To handle some of these conflicts, several DIS-related researches are based on ontologies [8] [9], including

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New Trends in Databases and Information Systems Tatjana Welzer,Johann Eder,Vili Podgorelec,Robert Wrembel,Mirjana Ivanović,Johann Gamper,Mikołaj Morzy,Theodoros Tzouramanis,Jérôme Darmont,Aida Kamišalić Latifić,2019-09-03 This book constitutes the thoroughly refereed short papers workshops and doctoral consortium papers of the 23rd European Conference on Advances in Databases and Information Systems ADBIS 2019 held in Bled Slovenia in September 2019 The 19 short research papers and the 5 doctoral consortium papers were carefully reviewed and selected from 103 submissions and the 31 workshop papers were selected out of 67 submitted papers The papers are organized in the following sections Short Papers Workshops Papers Doctoral Consortium Papers and cover a wide spectrum of topics related to database and information systems technologies for advanced applications   Hybrid Artificial Intelligent Systems Francisco Martínez-Álvarez,Alicia Troncoso,Héctor Quintián,Emilio Corchado,2016-04-14 This volume constitutes the refereed proceedings of the 11th International Conference on Hybrid Artificial Intelligent Systems HAIS 2016 held in Seville Spain in April 2016 The 63 full papers published in this volume were carefully reviewed and selected from 150 submissions They are organized in topical sections on data mining and knowledge discovery time series bio inspired models and evolutionary computation learning algorithms video and image classification and cluster analysis applications bioinformatics and hybrid intelligent systems for data mining and applications   **Providing Semantic Links to the Invisible Geospatial Web** Francisco J. López-Pellicer,Rubén Béjar,2012   Methods in Biomedical Informatics Indra Neil Sarkar,2013-09-03 Beginning with a survey of fundamental concepts associated with data integration knowledge representation and hypothesis generation from heterogeneous data sets Methods in Biomedical Informatics provides a practical survey of methodologies used in biological clinical and public health contexts These concepts provide the foundation for more advanced topics like information retrieval natural language processing Bayesian modeling and learning classifier systems The survey of topics then concludes with an exposition of essential methods associated with engineering personalized medicine and linking of genomic and clinical data Within an overall context of the scientific method Methods in Biomedical Informatics provides a practical coverage of topics that is specifically designed for 1 domain experts seeking an understanding of biomedical informatics approaches for addressing specific methodological needs or 2 biomedical informaticians seeking an approachable overview of methodologies that can be used in scenarios germane to biomedical research Contributors represent leading biomedical informatics experts individuals who have demonstrated effective use of biomedical informatics methodologies in the real world high quality biomedical applications Material is presented as a balance between foundational coverage of core topics in biomedical informatics with practical in the trenches scenarios Contains appendices that function as primers on 1 Unix 2 Ruby 3 Databases and 4 Web Services   **Handbook of Large-Scale Distributed Computing in Smart Healthcare** Samee U. Khan,Albert Y. Zomaya,Assad Abbas,2017-08-07 This volume offers readers various perspectives and

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