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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A Fuzzy Ontology Based Semantic Data Integration System:

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 **Providing Semantic Links to the Invisible Geospatial Web** Francisco J. López-Pellicer,Rubén Béjar,2012 **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 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 visions for cutting edge research in ubiquitous healthcare The topics emphasize large scale architectures and high performance solutions for smart healthcare healthcare monitoring using large scale computing techniques Internet of Things IoT and big data analytics for healthcare Fog Computing mobile health large scale medical data mining advanced machine learning methods for mining multidimensional sensor data smart homes and resource allocation methods for the BANs The book contains high quality chapters contributed by leading international researchers working in domains such as e Health pervasive and context aware computing cloud grid cluster and big data computing We are optimistic that the topics included in this book will provide a multidisciplinary research platform to the researchers practitioners and students from biomedical engineering health informatics computer science and computer engineering *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 **Ontology-Based Semantic Data Integration** Marcello Leida,2010-05 This book embraces several aspects of Data Integration focusing on semantic heterogeneity A first step toward solving the problem of semantic heterogeneity is to formally specify the meaning of the terminology used in the integration system and to use that definition to access the integrated information Ontologies are the most promising technology to achieve this aim Real Time data translation is obtained through a mapping which contains the necessary instructions about the localisation of the information the assembling directives and how the final data is presented Therefore the quality of mapping reflects accuracy and reliability of the data integration system This book provides several contributions to research in data integration systems starting from the architectural point of view we define a system based on several ontologies that are used to describe the meta data involved in the different integration steps A novel formalisation of mapping language able to deal efficiently with different data semantics is then presented along with an innovative approach to automatically generate the mapping schema Data Warehousing Design and Advanced Engineering Applications: Methods for Complex Construction Bellatreche, Ladjel,2009-08-31 Data warehousing and online analysis technologies have shown their effectiveness in managing and analyzing a large amount of disparate data attracting much attention from numerous research communities Data Warehousing Design and Advanced Engineering Applications Methods for Complex Construction covers the complete process of analyzing data to extract transform load and manage the essential components of a data warehousing system A defining collection of field discoveries this advanced title provides significant industry solutions for those involved in this distinct research community Computer and Information Technology Prasad Yarlagadda,Seung Bok Choi,Yun Hae Kim,2014-02-06 Selected peer reviewed papers from the International Forum on Computer and Information Technology IFCIT 2013 December 24 25 2013 Shenzhen China *Database and Expert Systems Applications* Abdelkader Hameurlain,Stephen W. Liddle,Klaus-Dieter Schewe,Xiaofang Zhou,2011-08-19 This book constitutes the refereed proceedings of the 22 International Conference on Database and Expert Systems Applications DEXA 2011 held in Toulouse France August 29 September 2 2011 The 52 revised full papers and 40 short papers presented were carefully reviewed and selected from 207 submissions The papers are organized in topical sections on XML querying and

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Table of Contents A Fuzzy Ontology Based Semantic Data Integration System

1. Understanding the eBook A Fuzzy Ontology Based Semantic Data Integration System
    - The Rise of Digital Reading A Fuzzy Ontology Based Semantic Data Integration System
    - Advantages of eBooks Over Traditional Books
2. Identifying A Fuzzy Ontology Based Semantic Data Integration System
    - Exploring Different Genres
    - Considering Fiction vs. Non-Fiction
    - Determining Your Reading Goals
3. Choosing the Right eBook Platform
    - Popular eBook Platforms
    - Features to Look for in an A Fuzzy Ontology Based Semantic Data Integration System
    - User-Friendly Interface
4. Exploring eBook Recommendations from A Fuzzy Ontology Based Semantic Data Integration System
    - Personalized Recommendations
    - A Fuzzy Ontology Based Semantic Data Integration System User Reviews and Ratings
    - A Fuzzy Ontology Based Semantic Data Integration System and Bestseller Lists
5. Accessing A Fuzzy Ontology Based Semantic Data Integration System Free and Paid eBooks
    - A Fuzzy Ontology Based Semantic Data Integration System Public Domain eBooks
    - A Fuzzy Ontology Based Semantic Data Integration System eBook Subscription Services
    - A Fuzzy Ontology Based Semantic Data Integration System Budget-Friendly Options

6. Navigating A Fuzzy Ontology Based Semantic Data Integration System eBook Formats
    - ePub, PDF, MOBI, and More
    - A Fuzzy Ontology Based Semantic Data Integration System Compatibility with Devices
    - A Fuzzy Ontology Based Semantic Data Integration System Enhanced eBook Features
7. Enhancing Your Reading Experience
    - Adjustable Fonts and Text Sizes of A Fuzzy Ontology Based Semantic Data Integration System
    - Highlighting and Note-Taking A Fuzzy Ontology Based Semantic Data Integration System
    - Interactive Elements A Fuzzy Ontology Based Semantic Data Integration System
8. Staying Engaged with A Fuzzy Ontology Based Semantic Data Integration System
    - Joining Online Reading Communities
    - Participating in Virtual Book Clubs
    - Following Authors and Publishers A Fuzzy Ontology Based Semantic Data Integration System
9. Balancing eBooks and Physical Books A Fuzzy Ontology Based Semantic Data Integration System
    - Benefits of a Digital Library
    - Creating a Diverse Reading Collection A Fuzzy Ontology Based Semantic Data Integration System
10. Overcoming Reading Challenges
    - Dealing with Digital Eye Strain
    - Minimizing Distractions
    - Managing Screen Time
11. Cultivating a Reading Routine A Fuzzy Ontology Based Semantic Data Integration System
    - Setting Reading Goals A Fuzzy Ontology Based Semantic Data Integration System
    - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of A Fuzzy Ontology Based Semantic Data Integration System
    - Fact-Checking eBook Content of A Fuzzy Ontology Based Semantic Data Integration System
    - Distinguishing Credible Sources
13. Promoting Lifelong Learning
    - Utilizing eBooks for Skill Development
    - Exploring Educational eBooks
14. Embracing eBook Trends
    - Integration of Multimedia Elements

- Interactive and Gamified eBooks

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