

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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**Abdelkader Hameurlain, Stephen W.
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A Fuzzy Ontology Based Semantic Data Integration System:

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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

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

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