A Fuzzy Ontology-Based Platform for Flexible Querying

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ABSTRACT

Flexible queries have recently received increasing attention to better characterize the data retrieval. In this paper, a new flexible querying approach using ontological knowledge is proposed. This approach presents an FCA based methodology for building ontologies from scratch then interrogating them intelligently through the fusion of conceptual clustering, fuzzy logic, and FCA. The main contribution is the definition of the ontology from classes resulting from a preliminary classification of the data and not the initial data. The data cleansing provides a simple ontology and an optimal research of relevant data taking into account the preferences cited by the user in his initial interrogation. To realize this approach, a new platform called “FO-FQ Tab plug-in” is implemented. This plug-in is integrated within the ontology editor Protégé to allow building fuzzy ontologies from large databases and querying them intelligently.

Keywords: Concept Analysis, Flexible Query, Fuzzy Logic, Interrogation, Ontology, Protégé

1. INTRODUCTION

The field of Databases (DB) is changing rapidly since the 70s. With the advent of new information technologies, relational BD (BDR) has shown their limits especially during interrogation (Bosc et al., 1998).

Indeed, the classic interrogation, through the use of Boolean conditions, is a handicap for many applications: (1) the user must know all the details of the schema and the DB; (2) the user wants to express more freely his preferences to have approximate answers for his request. We speak then about flexible queries.

Several systems have highlighted the importance of this flexibility in querying databases. These systems are characterized by approaches that express and evaluate preferences. This flexibility allows introducing linguistic terms called preferences in the search criteria in order to return approximate answers, each answer has a degree of truth.

Hence, it is necessary that flexible query systems become more efficient. This performance can be measured in terms of time response and in terms of quality of the provided information. But, the search for relevant information
is difficult because extracted information and time response depend on the size of databases. Furthermore, users face the problem of information overload when querying these databases, because the amount of available data far beyond their ability to understand.

Recognizing these problems, several approaches have been proposed: 1) Knowledge Discovery in Databases approaches (KDD) (Han and Kamber, 2001); 2) data summary approaches (Rasmussen et al., 1997; Lenz, 1997; Bosc, 1999; Raschia, 2002; Sassi, 2010); 3) data classification techniques (McMueen 1967), ontologies.

Given the success of ontologies in the field of knowledge engineering and the benefits they offer in terms of reusability and sharing of data, “Ontology” formalism in modeling large databases will be used in this paper in order to offer users the most appropriate answers to their questions. Consequently, a new approach that achieves an automatic ontology extraction from large DB and an automatic query answering from this generated ontology is presented.

The challenge is to combine fuzzy logic (Azar AT, 2012, Azar AT, 2010), clustering, FCA (Wille, 1982), Ontology (Gruber, 1993) and KDD to improve the construction of ontology by considering another degree of granularity in the generation process. Compared to similar existing approaches, the proposed ontology is defined between classes resulting from a preliminary classification of the data.

Besides, this work is mainly interested at responding intelligently the user request. Hence, a new approach for flexible querying using the ontological knowledge built from the first approach is defined. This approach provides an optimal research of relevant data taking into account the preferences cited by the user in his initial interrogation.

Finally, to realize this approach, a new platform called FO-FQ-Tab plug-in is integrated in the ontology editor “Protégé” (Noy et al., 2003). This platform allows to build fuzzy ontologies from large databases then queying them intelligently. A classification module have been integrated. This module contains binary and fuzzy clustering algorithms named “Cluster_FCA” (Grissa et al. 2012). It generates a fuzzy concept lattice and a fuzzy ontology and allows generating answers to the initial user’s request. The remainder of the paper is formed as follows: Section 2 introduces the basic concepts of ontology and FCA. Section 3 presents some related works. Section 4 describes the limits of these approaches. Section 5 presents our tool for flexible querying based on an automatic generation of a Fuzzy Ontology of Data Mining and represents the atomization of the approach with its implementation as a plug-in in Protégé. Some conclusions and future works are addressed in the section 6.

2. BACKGROUND

Before starting to present the framework for flexible querying, two basic notions of the new method are introduced: Flexible Querying and Ontology.

2.1. Flexible Querying

A flexible query is a query in which comprise vague descriptions and/or vague terms. Flexible queries facilitate in a novel way, easy and concise querying of databases that have varying structures.

2.2. Ontologies

In 1993, Gruber originally defined the notion of ontology as an “explicit specification of a conceptualization” (Gruber, 1993). In 1997, Borst defined ontology as a “formal specification of a shared conceptualization” (Borst, 1997). This definition additionally required that the conceptualization should express a shared view between several parties, a consensus rather than an individual view. Also, such conceptualization should be expressed in a (formal) machine readable format. In 1998, Studer et al. merged these two definitions stating that: “ontology is a formal, explicit specification of a shared conceptualization” (Studer et al., 1998).
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