No-FSQL: A Graph-based Fuzzy NoSQL Querying Model

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ABSTRACT

NoSQL (Not only SQL) is an efficient database model for storing and manipulating huge quantities of precise data. However, most NoSQL databases scale well as data grows and often are flexible enough to accommodate imprecise and ambiguous data. This comprehensive hands-on guide presents fundamental concepts and practical solutions for using fuzziness with NoSQL to deal with fuzzy databases (FDB). In this paper, the authors present a graph-based fuzzy NoSQL model to deal with large fuzzy databases while extending the NoSQL one. The authors consider the cypher declarative query language proposed for Neo4j which is the current leader on this market to query fuzzy databases.

KEYWORDS

Flexible Querying, Fuzzy Sets, Graph Model, NoSQL

INTRODUCTION

In recent years, a lot of attention has been attracted to Fuzzy DataBases (FDB) that generalize the classical relational data model by allowing uncertain and imprecise information to be represented and manipulated.

Data is often partially known, vague or ambiguous in many real-world applications. In this case, fuzziness is introduced in the classical model to deal with such imprecise information and several extensions of the model which are available in literature (Bosc & Pivert, 1995; Takahashi, 1991; Carrasco et al., 2003; BenAli-Sougui et al., 2014).

A graph-based data model although being fairly new has many solutions to improve business applications that have a huge amount of data with a high correlation degree. A graph is a set of nodes, which represent entities, and relationships that connect them. The main advantage is that connectedness between elements is the core of the design. It has also a high degree of scalability and flexibility. It means that, in an era, where the amount of data is so big, graph databases could propose some solutions to manage and store this data.

NoSQL (Not only SQL) is an efficient database model for storing and manipulating huge quantities of precise data (Näsholm, 2012; Maletras, 2012). However, most NoSQL databases scale well as data grows and often are flexible enough to accommodate imprecise and ambiguous data. This comprehensive hands-on guide presents fundamental concepts and practical solutions for using fuzziness with NoSQL to deal with fuzzy FDB.

The contribution of this paper concerns the proposition of a graph-based fuzzy NoSQL model to deal with large fuzzy databases while extending the NoSQL one. We consider the cypher declarative query language proposed for Neo4j which is the current leader on this market to query fuzzy databases.
query language proposed for Neo4j which is the current leader on this market to querying fuzzy databases. It allows for expressive and efficient querying and updating of the graph store. It is a relatively simple but still very powerful language. Very complicated database queries can easily be expressed through Cypher. It is designed to be a humane query language, suitable for both developers and professionals operations (Bruchez, 2013).

The rest of the paper is organized as follows: section 2 highlights related word on fuzzy graph and the NoSQL graph databases and the limit of the relational model. Section 3 describes our fuzzy NoSQL database model, called FNoSQL (Fuzzy NoSQL) based on graph storage model of the NoSQL one. Section 4 describes how querying fuzzy databases with FNoSQL. Section 5 concludes the paper and gives some future work.

RELATED WORK

The notion of fuzzy graph was introduced in 1975 by Kochen (Kochen, 1975). Fuzzy analogues of many structures in crisp graph theory, like bridges, cut nodes, connectedness, trees and cycles were developed after that.

Fuzzy trees were characterized by Sunitha and Vijayakumar (Sunitha & Vijayakumar, 1999). The authors have characterized fuzzy trees using its unique maximum spanning tree. A sufficient condition for a node to be a fuzzy cut node is also established. Center problems in fuzzy graphs, blocks in fuzzy graphs and properties of self-complementary fuzzy graphs were also studied by the same authors. They have obtained a characterization for blocks in fuzzy graphs using the concept of strongest paths (Sunitha & Vijayakumar, 2005).

Bhutani and Rosenfeld (Bhutani & Rosenfeld, 2003) have introduced the concepts of strong arcs, fuzzy end nodes and geodesics in fuzzy graphs. The authors have defined the concepts of strong arcs and strong paths.

As far as the applications are concerned (information networks, electric circuits, etc.), the reduction of flow between pairs of nodes is more relevant and may frequently occur than the total disruption of the flow or the disconnection of the entire network.

Specific databases have been designed to handle such data relying on big dense network structures, especially within the NoSQL world (Hecht & Jablonski, 2011). These databases are built to remain robust against huge volumes of data, against their heterogeneous nature and the high speed of the treatments applied to them, thus coping with the so-called Big Data paradigm (Castelltort & Laurent, 2014).

They are currently gaining more and more interest and are applied in many real world applications, demonstrating their power compared to other approaches. NoSQL graph databases are known to offer great scalability (Rodriguez & Neubauer, 2010).

Among these NoSQL graph databases, Neo4j appears to be one of the most mature and deployed (Bruchez, 2013). In such databases, as for graphs, nodes and relationships between nodes are considered. Neo4j includes nodes and relationships labeling with the so-called types. Moreover, properties are attached to nodes and relationships (Justin, 2013).

However, there are some efforts to create the property graph model, unifying most of the different graph implementations. The information in a property graph is modeled using three basic building blocks:

- Node;
- Relationship: with direction and type;
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