

FI: Fuzzy Object Oriented Database (Food) Index

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Abstract: Fuzzy Object Oriented Database (FOOD) is the database model which allows complex objects and various hierarchies like aggregation, generalization and inheritance to be implemented on the database. Along with it various types of uncertainties present in the data can be well handled by the proposed model. Due to the implementation of fuzziness, the proposed model is enhanced to access the objects fast from the database. To increase the performance based on speed to access the objects from FOOD model, indexing technique based on R tree indexing is implemented.

Index Terms: Fuzzy Set theory, Fuzzy queries, Indexing, R tree, Object oriented database.

I. INTRODUCTION

In an Article on Marketing Communication on global scale, it is said that Object-oriented databases as a technology is on the rise, well suited for the emerging Internet age. Among various database models, OOD has been on the focus of researchers as it supports a semantic modelling of data with abstraction mechanisms more powerful than traditional data models. At the same time, they offer tools to manage hierarchies of structured objects in an efficient way through the inheritance relation [1]. The object-oriented database model, which provides powerful data modeling features, has gained more popularity in recent years [2], [3].

Most of the existing database models are designed under the assumptions that the data/information stored is precise and queries are crisp. In fact, these assumptions are often not valid for many of the next generation information systems since they may involve complex information with uncertainty. Consider an example: While cooking, we used to put salt as per taste and the taste varies from person to person. Thus the amount of salt in the dish varies. Hence we can't predict or certainly define the amount of salt. To deal with such uncertainties, there is a need of fuzzy model to be implemented along with degree of membership.

In general, data/ information in databases may be uncertain for the following reasons:

- A decision in many knowledge-intensive applications usually involves various forms of uncertainty.
- Integrating data from various sources is not usually a crisp process, while unifying various heterogeneous data into an integrated form, due to possible semantic differences (and other reasons), sometimes forcing data to be completely crisp may result in falsity and useless information.
- Information in some non-traditional applications is inherently both complex and uncertain, i.e., representing subjective opinions and judgments concerning medical diagnosis, economic forecasting, or personal evaluation.
- In natural languages, numerous linguistic terms with modifiers (e.g., "very," "more or less," etc.) and quantifiers (e.g., "many," "few," "most," etc.) are used when conveying vague information.

II. RELATED WORK

Handling uncertainty in databases was first proposed on relational-based database models [4], [5], [6].

The indexing of Fuzzy object oriented databases has not received much attention yet. Index structures allow fast access to data by content. The current crisp index structures [7] developed for OODBs are inappropriate to represent and efficiently access fuzzy data for the Fuzzy Object Oriented Database model i.e. FOOD model. Fuzzy querying allows one to express vague predicates represented by fuzzy sets. Conventional index structures cannot be used directly since fuzzy predicates may not refer to the entry values of the index. Therefore, an efficient indexing mechanism for the Fuzzy Object Oriented Database model is needed to allow fast access to the objects with crisp or fuzzy values. In order to support exact, range, and fuzzy queries efficiently, a index structure that can use both crisp and fuzzy attributes as organizing attributes of objects should be used. Therefore, in this proposed work a new index structure, dealing with different kinds of fuzziness in the Fuzzy Object Oriented Database model i.e. FOOD model is introduced. The Index structure handles various types of flexible queries including crisp, range, and fuzzy queries.

In the literature very few indexing techniques are available for fuzzy Object Oriented Databases. The indexing techniques defined in the framework of object-oriented data models are either structural [8], [9], [12], [13], or behavioral [11].

- **Structural indexing:** Structural indexing [8], [12], [13] is based on object attributes and can be classified into techniques supporting nested predicates, such as the ones presented in [4] and techniques supporting queries issued against an inheritance hierarchy [9].

- **Behavioral indexing:** Behavioral indexing [11] aims at efficient execution of queries containing method invocations. It is based on precomputing or caching the results of a method and storing them in an index. The major difficulty in this approach is the detection of changes in invalidating the results of a method.

The fuzzy indexing structure proposed in [10] uses one index per fuzzy predicate tied to an attribute. This indexing structure only deals with homogeneous domains and assumes that the underlying relations are crisp.

III. PROPOSED MODEL

The Architecture of the proposed model for Indexing Technique for Fuzzy Object Oriented Database is given in Fig I.

A. FOOD Model

The FOOD model is similarity-based [14]. For fuzzy attributes, fuzzy domains and similarity matrices are defined. Similarity matrices are used to represent vague relationships within the fuzzy attributes. The domain, dom , is the set of values that the attribute may take, irrespective of the class it falls into. The range of an attribute, rng , is the set of allowed values that a member of a class, i.e., an object, may take for an attribute. A range for each attribute of the class is defined as a subset of a fuzzy domain. The range definition for attribute a_i of class C is represented by the notation, $rng_c(a_i)$, where $a_i \in Attr(C) = \{a_1, a_2, \dots, a_n\}$

$Attr(C)$ refers to the attributes of class C . Similar objects are grouped together to form a class. An object belongs to a class with a degree of membership. Fuzziness may occur at three different levels in the FOOD model; the attribute level, the object/class level, and the class/superclass level.

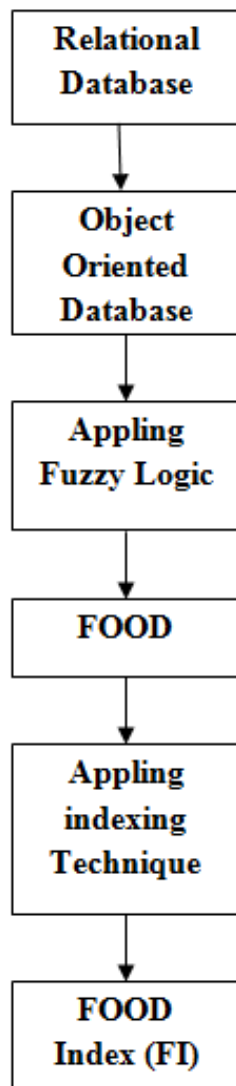


Fig. I. Architecture of ITFOOD model

Similarity Matrix of fuzzy valued attribute colour can be given as shown in table I. The degree of membership of the attribute is given manually by the user. The similarity matrix for the fuzzy attributes can be developed as given in table I.

	Red	Orange	White
Red	1	0.6	0
Orange	0.6	1	0.1
White	0	0.1	1

TABLE I: Similarity Matrix for Fuzzy valued attribute Colour.

B. Attribute Definitions of FOOD Model

A fuzzy object can have attributes in the form of a set of values from a fuzzy domain. The similarities between the elements in that fuzzy domain are represented using a similarity matrix. For instance, consider a class, BOOK, with an attribute defined in the domain, Colour = {red, orange, white}, with the similarity matrix shown in Table I. According to the table, the degree of similarity between the elements “red” and “orange” is 0.6.

Every class has a range definition for each of the fuzzy attributes with the corresponding relevance values indicating the importance of that attribute in the definition of that class. Range values show ideal values of a class. However, an attribute of a class can take any value from a domain without considering the range values. Object/class MDs are calculated from the similarity of object values to the range values using formula (I). Similarly, class/superclass MDs are calculated from the similarity of range values of two classes. In this model, semantics is associated with range definitions to permit a more precise definition of a class. When an attribute is multi-valued, semantics defines the relationships among these values. There are three semantics used in the FOOD model: AND, OR, and XOR. AND semantics requires objects to have all the values given in the range definition, OR semantics requires objects to have at least one of the values given in the range definition, and finally, XOR semantics requires objects to have exclusively one of the values given in the range definition. The details of the attribute representations and the other features of the FOOD model are described in [15].

Yazici et.al has well explained the relationship between class/object and superclass/subclass [15],[16].

C. FOOD Index

Indexing in OODBS is a lot more complicated than in RBDS. One difference between objects and relational tuples is that objects are not flat. Therefore one should be able to index on instance variables that are nested several levels deep in an object to be indexed.

Indexing for OODBS is first proposed for the GemStone data model. It is a generalization of an indexing technique for path expressions [17].

FOOD index is developed using R tree:

- R tree is height balanced tree similar to B tree.

- Each node in the R-tree represents a rectangular region in space that encloses a group of uncertain objects [19].
- R tree is well suited for secondary memory. It makes R tree applicable for large database where index is too large to fit in main memory [18]. The basic structure of R tree is shown in fig. II.

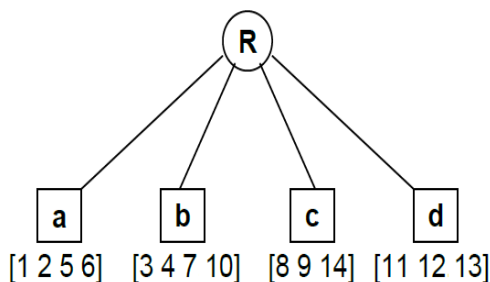
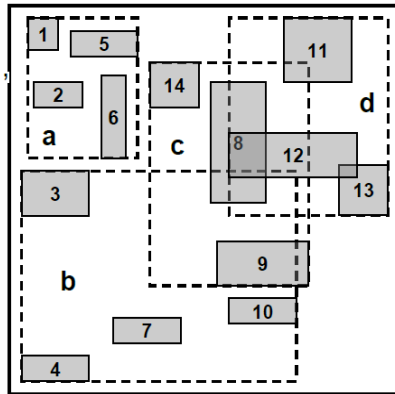


Fig. II. Structure of R Tree

IV. APPLICATIONS

A. Web Mining

The Web is the largest information repository available to us. Finding the relevant information on World Wide Web in short time span is not an easy task. Various problems are encountered by user while finding the information on the web such as low recall due to the improper indexing of web data. Thus ITFOOD can provide the performance based indexing to overcome these problems and can serve as a good indexing technique for mining the web data along with object oriented approach.

B. Search Engine

The primary goal of search engines is to provide relevant information to the users to cater to their needs. Therefore, finding the content of the Web and retrieving the users' interests and needs have become increasingly important. But after submitting the query to the search engine, it takes long time to search the results and numbers of results are found from which some of them are relevant while others are not Thus ITFOOD can provide a fast access to the web contents to be searched by user on the search engine and can provide relevant results as fuzzy is introduced.

V. CONCLUSION

In this work, we introduced the FOOD Model and also provide indexing on FOOD model using R tree indexing

technique. Thus complex objects along with various types of hierarchies like inheritance, aggregation has been implemented which results in good performance. By introducing Fuzziness in OOD, it helps to enhance the speed to access the objects in and by applying indexing on FOOD model the speed to access the objects is increasing. Hence to provide fast access ITFOOD can serve as a good solution.

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