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Fuzzy RDBMS Design: SQL Add-On

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***Abstract*:**
In this paper we are applying classical as well as fuzzy queries on the database. A Relational Data Base Management System (RDBMS) is a software system that provides a convenient and effective method of defining, storing and retrieving precise information stored in the database. But sometimes users need to use vague or imprecise or fuzzy terms in the query. Our work gives the users the flexibility to query the database in natural language using FRDB, whichpermits to have a range of answers in order to offer to the user all intermediate variations. We also show that fuzzy query on classical database enhance the expressiveness of human expression, with nearly no effect on searching time. Fuzzy query interpreter helps to convert fuzzy query into SQL query without need to learn a new query language. So automatic mapping of existingrelational database can be done with FRDB, which in turn saves time and increase the efficiency of query.

***Index Terms*— FRDBMS, Fuzzy Degree, SQL, Membership Function**

I.INTRODUCTION

Databases hold data that represent properties of real-world objects. Fuzzy relational database is extension of relational database which include fuzzy conditions or fuzzy predicates under shapes of linguistic expressions. So Fuzzy Relational Data Base Management System (FRDBMS) uses flexible queries that allows the user to have a range of answers (each one with its membership degree) offering all intermediate variations between the completely satisfactory and dissatisfactory values. [2]

FRDBMS is considered first of all a database. It must be made up of core of database which permits to execute the classical operations of the DBMS and to store, manipulate the fuzzy attributes [1]. We can add flexibility in database in many forms. The simplest one is to add a fuzzy membership degree to each record (an attribute in range [0, 1]). Fuzzy query being a querying tool, it improves the meaning of the query as well as extracts additional valuable information. [11] Linguistic expressions and degrees of truth are being used to select the wanted scenario for the user. These linguistic expressions have logical meaning for user and define a data selection process in the natural language. [8]

II.BASIC CONCEPTS

1) Database: A classical database is a structured collection of information (record or data) stored in a computer.

2) Fuzzy Database: A fuzzy database is a database which is able to deal with uncertain or incomplete information using fuzzy logic.

3) Traditional logic: It can only deal with information that is totally true or totally false; it is not possible to handle information inherent to a problem that is imprecise or incomplete but this type of information contains data that would allow a better solution to the problem. A characteristic function assigns values of true or false to each element of the set in traditional logic.

4) Fuzzy Logic: Fuzzy logic is derived from fuzzy set theory by Zadeh (1965) dealing with reasoning that is approximate rather than precisely deduced from classical predicate logic. It can be thought of as the application side of fuzzy set theory dealing with well thought out real world expert values for a complex problem (Klir 1997). A membership function

assigns degree of membership to each element of the set in fuzzy logic.

5) FRDB: It is an extension of the relational database. This extension introduces fuzzy predicates under shapes of linguistic expressions that, at the time of a flexible querying, permits to have a range of answers (each one with a membership degree) in order to offer to the user all intermediate variations between the completely satisfactory answers and those completely dissatisfactory.

6) FRDBMS: It is an extension of the relational DBMS in order to treat, store and interrogate imprecise or fuzzy data.

7) Fuzzy Degrees: Fuzzy attributes, whose domain is in the interval [0, 1], although other values over this unit interval (such as possibility distributions) are also possible, which may be related to specific linguistic labels (like "a lot," "normal," etc.). So to keep it simple, usually only degrees in the interval [0, 1] are used.

   The important meanings of degrees used are: fulfillment degree, uncertainty degree, Possibility degree and Importance degree.

8) Membership Function: Fuzzy membership function is being used to express fuzziness in the query. Zadeh proposed a series of membership functions that could be classified into two groups: those made up of straight lines, or "linear," and Gaussian forms, or "curved." [6]

III.FRDBMS ARCHITECTURE

An FRDBMS is a database which provides many functions such as description of data (DDL-Data Description Language), manipulation of data (DML-Data Manipulation Language), [5] integrity maintenance of FRDB using integrity rules, confidentiality by verifying access rights, management of competition of access, security in case of breakdown and user help. FRDBMS is capable of representing fuzzy information in many shapes and offers an adequate setting for storing and representing the information. [1]

A. ARCHITECTURE:

The new architecture of FRDBMS is based on *GEFRED* model [7] which was first proposed by *Bosc* and then by *Medina et al.* FSQL is being used as language of description and manipulation of data. FRDBMS can model RDB as well as FRDB. A software layer transforms the command written by user in FSQL language in their equivalent written in SQL.[3]

The new architecture of FRDBMS is shown in figure 1.

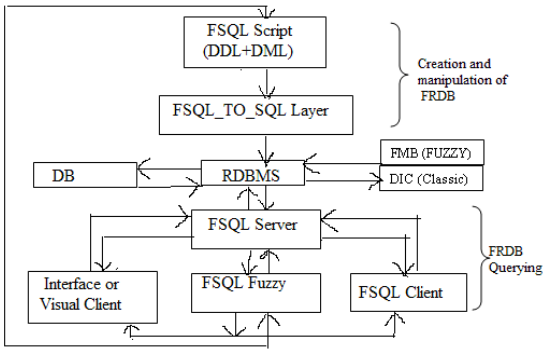


Figure 1 the FRDBMS Architecture

[1] [9]

B.PRINCIPLE OF FUNCTIONING:

The principle of functioning is as follows:

Begin

Read each instruction in the SQL query:

Copy it in a file (SQLQuery.sql); if it contains a classic attribute

Else

Divide the Fuzzy attribute query in two parts:

a) Classic attributes: Copy the part of SQL with classic attributes to SQLQuery.sql.

b) Translation with FMB: A script will translate each fuzzy attribute by compiling it with the Fuzzy Meta Data Knowledge Base and the output containing SQL equivalent of the fuzzy query will be written in the file (FMBOutput.sql).

END. [1] [5]

As a result we will get two files one containing DDL part of DB and second containing modification being done by Fuzzy Metadata Knowledge Base (FMB).

IV. COMPARISON OF SQL QUERY AND FUZZY QUERY

The comparison of SQL Query and Fuzzy Query over data base is being explained with the help of a simple example. Schema of relation used for this purpose is as follows:
Student_schema= (Sid, Marks, Branch) where **Marks** is thefuzzy attributeand others are crisp. **Sid** is a **primary key** of the relation.An example of a sample student relation is shown in Table 1. [10]

Table 1: Student Relation

Sid	Marks	Branch
1001	30	CSE
1002	27	CSE
1003	78	IT
1004	97	IT
1005	10	ECE
1006	52	ECE
1007	82	CIVIL
1008	24	CIVIL

A. SQL QUERY:

Give details of students whose marks are less than or equal to 30.

Corresponding SQL Query is as below -

*Select * from Student*
Where Marks<=30

[8]

The result of SQL query is shown in Table II.

Sid	Marks	Branch
1001	30	CSE
1002	27	CSE
1005	10	ECE
1008	24	CIVIL

B.Fuzzy Attribute And Membership Functions

The fuzzy query approach is based on the fuzzy Generalized Logical Condition (GLC). Fuzzy membership functions are a tool to express fuzzy attributes. We use four linguistic terms over fuzzy attribute **Marks**. They are **"*poor*"**, **"*average*"**, "**good",** and **"*excellent*"**. Range of these terms is: poor (0-30), average (20-60), good (50-75) and excellent (above 75). Fuzzy membership functions characterizing Marks are shown in figure 2.

The membership function over fuzzy attribute Marks is shown below: [4] [10]

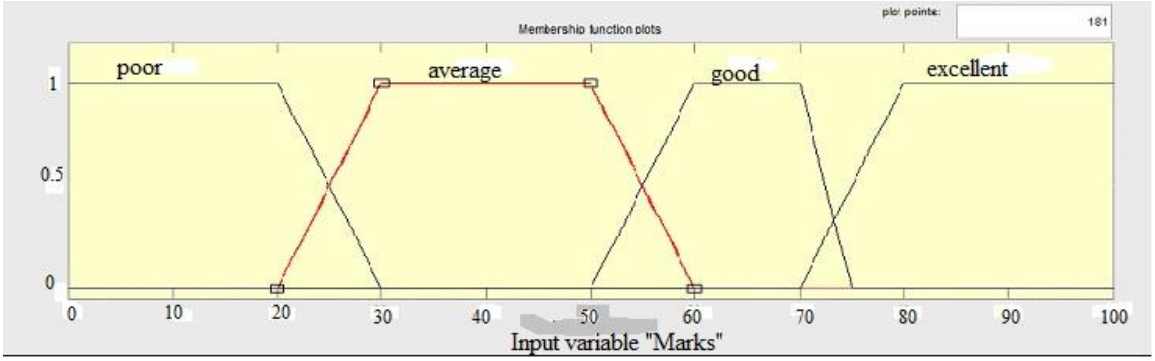
1.**Degree of membership for poor performer:**
If (x>0 & x<=20) then degree of membership=1.
Else (20<x<=30) then degree of membership = (30-x)/10.

2. **Degree of membership for average performer**:
If (x<20 & x>=60) then degree of membership=0.
Else If (20<x<=30) then degree of membership=(x-20)/10.
Else If (30<x<=50) then degree of membership=1.
Else (50<x<=60) then degree of membership= (60-x)/10.

3. **Degree of membership for good performer:**
If (x<=50 & x>75) then degree of membership=0.
Else If (50<x<=60) then degree of membership=(x-50)/10.
Else If (60<x<=70) then degree of membership=1.
Else (70<x<=75) then degree of membership= (75-x)/5.

4. **Degree of membership for excellent performer**:
If (x<70) then degree of membership=0.
Else If (70<x<=80) then degree of membership=(x-70)/10.
If (80<x<=100) then degree of membership=1.

Figure 2 Fuzzy membership functions characterizing attribute **Marks**



C.Fuzzy Query

I. Give details of students who are poor performers:

Corresponding fuzzy SQL Query is as below -

*Select * from Student*
Where Marks FEQ $poor

This query will give only those tuples whose degree of membership function for poor performers is greater than 0. The result of this Fuzzy query is shown in Table III.

TABLE III: Output of fuzzy Query (poor performer)

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Sid	Marks	Branch	Degree of Membership function
1002	27	CSE	0.3
1005	10	ECE	1
1008	24	CIVIL	0.6

It is easier to say poor performer than to tell marks of each student who scored less than 30. Moreover from result of query user is able to know to what extent a student is poor. A student having membership degree 0.6 is poorer performer than one having 0.3 membership degree. So, Fuzzy queries are more expressive than SQL queries as these help in representation of natural language. Fuzzy query further enhance the expressiveness by using the threshold value of degree as explained in the example below.

II. Give details of students who are poor performers with threshold degree greater than 0.4.

Corresponding fuzzy SQL Query is as below -

*Select * from Student*
Where Marks
FEQ $poor THOLD 0.4

This query will give those tuples whose membership degree is greater than 0.4 and who are poor performers. The result is shown in Table IV.

TABLE IV: Output of fuzzy Query (threshold greater than 0.4)

Sid	Marks	Branch	Degree of Membership function
1005	10	ECE	1
1008	24	CIVIL	0.6

V.CONCLUSION

When users work with usual software tools they have to change their many valued logical thinking (approximate reasoning) into the two-valued computer logic. The SQL requires the crisp specification of a query criterion, while for users a query is best described in terms of a natural (or quasi) natural language with ambiguities and uncertainties.

In this paper, the user is being given a powerful and easy to use data mining tool which allows him to query data from databases by using linguistic expressions in order to improve the quality of selection process.A fuzzy query interpreter is developed to transform fuzzy queries to the SQL ones. Another advantage is that the user does not need to learn a new query language.

The further studies done in this area would be continued in following directions:

1) The web application with a fuzzy module for data usage is a way of improving fuzzy query approach.
2) The automatic mapping of existing relational DB to FRDB may be implemented.

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