Enriching Traditional Databases with Fuzzy Definitions to Allow Flexible and Expressive Searches

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Abstract: Although the relevance of fuzzy information to represent concepts of real life is evident, almost all databases contain just crisp information. The main reason for this, apart from the tradition, is that fuzzy information is most of the times subjective and storing all users points of view is unfeasible. Allowing fuzzy concepts in the queries increases the queries' expressiveness and asking for cheap products, big size, close hotels, etc is much more interesting that asking for products with a price under X, of the size Y, hotels at most X kilometers far, etc. The way we propose for achieving this more expressive databases' queries is adding to the basic knowledge offered by a database (e.g. distance to hotel is 5 km) the link between this crisp concept and multiple fuzzy concepts that we use in real life (e.g. close hotel). We present FleSe, a framework for searching databases in a flexible way, thanks to the fuzzy concepts that we can define. In this paper we describe the easy procedure that let us define fuzzy concepts and link them to crisp database fields.

1 INTRODUCTION

Databases are, in principle, for storing crisp data, not fuzzy data. So, we cannot ask which are the restaurants close to our place, but which ones are at most 2km far from our place. Adding a column of text type and storing inside the value "close" could be a solution for examples like this one, but it does not work always because of the inherent subjective character of fuzzy attributes. Take, for example, Andrew's height: 1'90 cm. There is no problem in storing this crisp value (it is just a float number), but it is no so easy if we try to store if Andrew is "tall", "very tall", "no tall at all" or any other fuzzy value, because it might not be true for all the people retrieving the value from the database. Elsa, whose height is 1'41 cm, might consider him very tall, while Luzia, whose height is 1'72, might consider him just tall.

Our proposal to allow querying the database with fuzzy concepts relies on knowing the link between any of them and the non-fuzzy concept stored in the database. This link is what we (humans) use to determine how much the fuzzy concept is satisfied. We present here a framework for encoding this relations, always with the subjective characteristic of fuzzy concepts in mind. The main difference with respect to other approaches is that we do not provide a complex syntax for querying the database nor a free text area field to enter the query. We evaluate the information in the configuration file and in the database to determine all the possible queries that a user can perform and provide a form to enter any of this queries.

The paper is structured as follows: In preliminaries (Sec. 2) we introduce to the ideas our framework is based on. In implementation details (Sec. 3) we talk about the underlying infrastructure needed for the framework to work as expected. We explain just after how to use the framework from a developer point of view (Sec. 4) and the search engine a general user can use to ask queries (Sec. 5). Conclusions and current work go in last place (Sec. 6), as usual.

2 PRELIMINARIES

It was Lotfi Zadeh in 1965 who introduced fuzzy set theory (Zadeh, 1965), proposed their division in type-1 and type-2 fuzzy sets and systems (Zadeh, 1975) and justified its existence in his paper "Is there a need for fuzzy logic?" (Zadeh, 2008).

In this section we talk a little bit about history, focusing in what matters for our contribution: Fuzzy Queries to Regular Databases (Subsec. 2.1), and Priorities in Fuzzy Logic (Subsec. 2.2).

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2.1 Fuzzy Queries to Regular Databases

Getting fuzzy answers for fuzzy queries from non-fuzzy information stored in non-fuzzy databases has been studied in some works, as SQLF, presented by P. Bosc and O. Pivert in (Bosc and Pivert, 1995), FQL, presented by Takahashi (Takahashi, 1991), FIIS, presented by M. Zemankova (Zemankova, 1989), FIRST, presented by D. Lucarella and R. Morara (Lucarella and Morara, 1991), the tool proposed by Chen and Jong (Chen and Jong, 1997) and others. Very good revisions of this ones and some other proposals are the works of Leonid Tineo (Tineo, 2005) and Herrera-Viedma and López-Herrera (Herrera-Viedma and López-Herrera, 2010).

Most of the works mentioned before focus in improving the efficiency of the existing procedures, in including new syntactic constructions, in allowing to introduce in the queries the conversion between the non-fuzzy values needed to execute the query and the fuzzy values in the query, or in improving the translation of the fuzzy query into the SQL syntax (so any regular database can answer it). Our proposal focus less on the technical aspects (so we cannot compare the evaluation speed or the resources consumption of ours against any of them) because it tries to present the user an interface intelligent enough to allow the user to pose only the queries that we can answer from the knowledge introduced in the configuration file and the information in the database. It is, the framework is able to determine the whole set of queries that it can answer from the knowledge introduced in the configuration file and presents the user a web interface to pose easily any of this queries.

Our work is maybe more similar to works related to information retrieval, like the one of Ropero, Gómez, Carrasco and León (Ropero et al., 2012) or the one of Zadrozny and Nowacka (Zadrony and Nowacka, 2009), although we consider it rather different. Most of the works in this line focus in creating an index for answering queries by using different term weighting procedures (even logic-based ones). Their goal is obtaining an index with enough information to answer any query, some of them analyzing it previously by using natural language processing and some others by providing a slightly complicated query syntax. Ours, as told before, focus in providing an easy to use interface allowing the user to represent with it any query that can be answered from the knowledge introduced in the configuration file.

When starting the development of our proposal we wanted to do it under the logic programming paradigm, because we know that it is more declarative [1]than the other ones. The frameworks for fuzzy logic allowing the developer to code programs under the logic programming paradigm (called fuzzy logic systems) we know about are Flopper (Morcillo and Moreno, 2008), Fuzzy Prolog (Guadarrama et al., 2004), Rfuzzy (Muñoz-Hernández et al., 2011) and FuzzyDL (Bobillo and Straccia, 2008).

2.2 Priorities in Fuzzy Logic

The inherent subjective character of fuzzy concepts needs to be taken into account when performing fuzzy searches. Some users might want to redefine or personalize some concepts, but some others might not want to. So, we might give more priority to the concepts redefined by users, but only when they are the ones posing the query.

In (Muñoz-Hernández et al., 2011) the authors extend the multi-adjoint satisfaction and immediate consequences operator in (Medina et al., 2004; Medina Moreno and Ojeda-Aciego, 2002) to take care of conditions and introduce a three levels priority system. These three levels were designed to distinguish results computed by rules that do not rely on other rules (highest priority), rules that rely on others (medium priority) and rules used when no other rule was able to obtain a valid result (lowest priority). The proposal was adequate but, as the same authors pointed out in (Pablos-Ceruelo and Muñoz-Hernández, 2011), insufficient for modelling user preferences. This is why in (Pablos-Ceruelo and Muñoz-Hernández, 2011) they changed the three symbols by a real number between 0 and 1, in the direction proposed by the authors of (Theodorakopoulos and Baras, 2004). We take the idea of using priorities to represent user preferences from (Pablos-Ceruelo and Muñoz-Hernández, 2011; Theodorakopoulos and Baras, 2004).

3 IMPLEMENTATION DETAILS

The framework we present runs on a computer with a Linux Operating System and is divided in two applications: the first one written in Java and running on a Tomcat server and the other one written in Prolog (Lloyd, 1987; O'Keefe, 1990; Sterling and Shapiro, 1987) and executed by demand of the first one. The

[1]We say that it is more declarative because we know that it is not fully declarative yet. It removes the necessity to specify the flow control in most cases, but the programmer still needs to know if the interpreter or compiler implements depth or breadth-first search strategy and left-to-right or any other literal selection rule.

database is managed directly by the Prolog code, which allows us to use the Prolog facilities for linking to it: we are not restricted to any database or database interface.

The justification of using Prolog lies on the fact that it is one of the most successful programming languages for representing knowledge in computer science. Its main advantage with respect to the other ones is being a more declarative programming language. Prolog is based on logic. It is usual to identify logic with bi-valued logic and assume that the only available values are "yes" and "no" (or "true" and "false"), but logic is much more than bi-valued logic. In fact we use fuzzy logic (FL), a subset of logic that allow us to represent not only if an individual belongs or not to a set, but the grade in which it belongs. Supposing the database contents in Table. 1, the definition for "close" in Fig. 1 and the question "Is restaurant X close to the center?" with FL we can deduce that Il tempietto is "definitely" close to the center, Tapasbar is "almost" close, Ni Hao is "hardly" close and Kenzo is "not" close to the center. We highlight the words "definitely", "almost", "hardly" and "not" because the usual answers for the query are "1", "0.9", "0.1" and "0" for the individuals Il tempietto, Tapasbar, Ni Hao and Kenzo and the humanization of the crisp values is done in a subsequent step by defuzzification.

Table 1: Restaurants' database contents.

name	distance	price avg.	food type
Il_tempietto	100	30	italian
Tapasbar	300	20	spanish
Ni Hao	900	10	chinese
Kenzo	1200	40	japanese
Zalacain	2000		
Don_Jamon			spanish

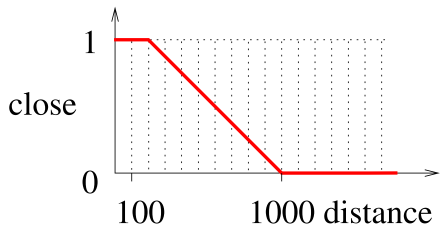


Figure 1: Close fuzzification function.

Choosing Java instead of other programming languages is a decision guided by the necessity to have a good communication between Prolog and the user interface. Since we decided to have a web user interface and use Asynchronous Ajax for improving the user experience, and Java has very well management of asynchronous http petitions and libraries to control Prolog, the decision was easy.

4 THE FRAMEWORK

We present here how to define the links between the fuzzy concepts and the fields in the database. Since Prolog offers us to access the database as if a predicate it was, we take this as a fact and start by the definition needed by the framework to understand what is stored in each database column.

The construction in Eq. 1 serves to define what is stored in each database column. In the construction pT is the name of the database table or virtual database table (vdbt)[2], pA is the arity of the vdbt, pN is the name assigned to a column of the vdbt pT and pT' is the type of the information stored in the column, (a basic type, one of $\{$ $boolean\_type$, $enum\_type$, $integer\_type$, $float\_type$, $string\_type$ $\}$). We provide an example in Eq. 2 to clarify. In the example we define the restaurant database with four columns. The first for its name, the second for the food type served there, the third for the restaurant's price average and the last one for the distance to the city center from that restaurant.

$$define\_database(pT/pA, [(pN, pT')]) \qquad (1)$$

$$\begin{aligned}&define\_database(\ restaurant/4,\\ &(name,\ string\_type),\\ &(food\_type,\ enum\_type),\\ &(price\_average,\ integer\_type),\\ &(distance\_to\_the\_city\_center,\ integer\_type)]). \quad (2)\end{aligned}$$

The previous construction (Eq. 1) serves too to define the non-fuzzy predicates we can use when linking fuzzy and non-fuzzy concepts. In addition to the links we can define truth values for some fuzzy predicates and under some conditions. The construction in Eq. 3 serves to define the rare situation in which for all the individuals in the vdbt we have the same result. It is usually limited to some individuals by using the constructions in Eqs. 4, 5 and 6 as tails (explained below). In Eq. 3 the variable pT means the same as in Eq. 1, TV is the truth value (a float number between 0 and 1) and $fPredName$ is name of the fuzzy predicate we are defining. In Eq. 7 we present an example in which we say that all the restaurants are cheap with a truth value of 0.5.

[2]We usually name the database "virtual database table" (vdbt) because the database that we define can be mapped to more than one database by using Prolog to database libraries. We do not enter here into these low-level details.

$$fPredName(pT) :\sim value(TV) \quad (3)$$
$$if(\ pN(pT)\ \ comp\ \ value). \quad (4)$$
$$with\_credibility(credOp,\ credVal) \quad (5)$$
$$only\_for\_user\ 'UserName' \quad (6)$$
$$cheap(restaurant) :\sim value(0.5) \quad (7)$$

The constructions in Eqs. 4, 5 and 6 serve as tails for the constructions in Eqs. 3, 11, 13, 16, 17, 19, 20 and 23. The tail in Eq. 4 (not applicable to the construction in Eq. 23) serves to limit the individuals for which we want to use the fuzzy clause or rule (limits its application to subsets of the set of individuals in the vdbt). In the construction *pN* and *pT* mean the same as in Eq. 1, *comp* can take the values “*is_equal_to*”, “*is_different_from*”, “*is_bigger_than*”, “*is_lower_than*”, “*is_bigger_than_or_equal_to*” and ”*is_lower_than_or_equal_to*” and *value* can be of type *integer_type*, *enum_type* or *string_type*. The only restrictions are that the type of *value* must be the same as the one given to to the column *pN* of *pT* and that if they are of type *enum_type* or *string_type* the only available values for *comp* are “*is_equal_to*” and “*is_different_from*”. We show an example in Eq. 8 in which we say that the restaurant Zalacain is cheap with a truth value of 0.1.

$$cheap(restaurant) :\sim value(0.1)$$
$$if(name(restaurant)\ is\_equal\_to\ zalacain). \quad (8)$$

The tail in Eq. 5 serves to define a credibility for a clause, together with the operator needed to combine it with its truth value. In its syntactic definition in Eq. 5 *credVal* is the credibility, a number of float type, and *credOp* is the credibility operator.[3] We show an example in Eq. 9 in which we say that the restaurant Don Jamon is cheap with a truth value of 0.3 but this rule has a credibility of 0.8 and the operator that must be used to combine the credibility with the truth value is the minimum (called too Gödel conjunctor).

$$cheap(restaurant) :\sim value(0.3)$$
$$if(name(restaurant)\ is\_equal\_to\ don\_jamon)$$
$$with\_credibility(min,\ 0.8). \quad (9)$$

The tail in Eq. 6 is aimed at defining personalized rules, rules that only apply when the user logged in and the user in the rule are the same one. In the construction *Username* is the name of any user, a string.

[3]The credibility operator (called conjunctor in most of the papers cited in Sec. 1) is a mathematical functions that must be monotone and non-decreasing in their coordinates. Immediate examples for conjunctors that come to mind are product, Łukasiewicz conjunctor and Gödel conjunctor. All of them are included in the framework. They can be used by writting “prod”, “luka” and “min” in the field “credOp”.

We show an example in Eq. 10 in which we say that Lara considers that the restaurant Zalacain is not close to the center. So, if it is she who poses a query to the system asking for restaurants close to the city center she will obtain that the Zalacain restaurant is not.

$$close\_to\_the\_city\_center(restaurant) :\sim value(0)$$
$$if(name(restaurant)\ is\_equal\_to\ zalacain)$$
$$only\_for\_user\ 'Lara' \quad (10)$$

The links between non-fuzzy values the individuals in the database have and the fuzzy concepts is done by means of the constructions called fuzzifications, of the form shown in Eq. 11. This fuzzification functions allow us to know how much satisfied is a fuzzy predicate for some individual stored in our database, from a non-fuzzy value that we have in the database for that individual. In Eq. 11 *pN* and *pT* mean the same as in Eq. 1, *fPredName* is the name of the fuzzy predicate that we are defining (the fuzzification), $[(valIn,\ valOut)]$ is a list of pairs of values such that *valIn* belongs to the domain of the fuzzification function and *valOut* to its image[4]. An example in which we compute how cheap is a restaurant from its average price is presented in Eq. 12. The graphical representation corresponding to this example is in Fig. 2.

$$fPredName(pT) :\sim function(\ pN(\ pT\ ),$$
$$[\ (valIn,\ valOut)\ ]). \quad (11)$$
$$cheap(restaurant) :\sim function($$
$$price\_average(restaurant),$$
$$[(0,\ 1),(10,\ 1),(20,\ 0.9),(50,\ 0),(200,0)]). \quad (12)$$

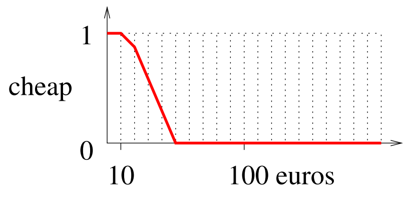


Figure 2: Cheap function (for restaurant).

When defining the satisfiability of a fuzzy predicate from a value stored in a database we can get an unexpected behaviour if the database contains a null value. To avoid this malfunctioning of the system we provide syntax for defining the satisfaction of the fuzzy concepts in this cases. We usually say that this constructions (shown in Eq. 13) are for defining default truth values for the fuzzy concepts. In Eq. 13 *pT* means the same as in Eq. 1, *fPredName* the same

[4]$[(valIn, valOut)]$ is basically a piecewise function definition, where each two contiguous points represent a piece.

as in Eq. 11 and TV the same as in Eq. 3. We provide two examples in Eqs. 14 and 15 in which we say that, in absence of information, we consider that a restaurant will not be close to the city center (this is what the zero value means) and that, in absence of information, a restaurant is considered to be medium cheap[5].

$$fPredName(pT) :\sim defaults\_to(TV) \quad (13)$$

$$close\_to\_the\_city\_center(restaurant) :\sim defaults\_to(0). \quad (14)$$

$$cheap(restaurant) :\sim defaults\_to(0.5). \quad (15)$$

In addition to the definition of fuzzy concepts from non-fuzzy concepts, the definition of their satisfaction in special cases and the definition of default values to avoid that the inference process stops when a needed value is missing, we can define fuzzy concepts from other fuzzy concepts. The possibility to do this allows us to increase the number of fuzzy predicates that can be used to query the database. We can do that by using rules, synonyms and antonyms.

Rules allow us to define the satisfaction of a fuzzy predicate from the satisfaction of other fuzzy predicates. We have two syntactical forms for defining rules, the first one used when the body depends on more than one fuzzy predicate, shown in Eq. 16, and the second one when it depends in just one, shown in Eq. 17. In Eq. 16 *aggr* is the aggregator used to combine the truth values of the fuzzy predicates in *complexBody*, which is just a conjunction of names of fuzzy predicates (and the vdbt they are associated to, represented by pT), while in Eq. 17 *simplexBody* is just the name of a fuzzy predicate (and the vbdt it is associated to). In both of them pT means the same as in Eq. 1 and $fPredName$ the same as in Eq. 11. We show an example in Eq. 18 in which we say that a restaurant is a tempting restaurant depending on the worst value it has between being close to the center and being cheap, which means that a restaurant must be close to the center and cheap at the same time to consider it a tempting restaurant.

$$fPredName(pT) :\sim rule(aggr, complexBody) \quad (16)$$

$$fPredName(pT) :\sim rule(simpleBody) \quad (17)$$

$$tempting\_restaurant(restaurant) :\sim rule(\ min, (\ close\_to\_the\_city\_center(restaurant), cheap(restaurant)\ )) \quad (18)$$

The syntax for defining a fuzzy predicate from a synonym is shown in Eq. 19 and the one for defining it from an antonym in Eq. 20. In Eqs. 19 and 20 pT means the same as in Eq. 1, *credOp* and *credVal* the same as in Eq. 5 and $fPredName$ the same as in Eq. 11, while $fPredName2$ is the fuzzy predicate from which we are defining the synonym or antonym. Its name must be different from $fPredName$. In the examples in Eqs. 21 and 22 we define an unexpensive restaurant as a cheap restaurant and an expensive one as the opposite of a cheap one.

$$fPredName(pT) :\sim synonym\_of(\ fPredName2(pT), crepOp, credVal\ ) \quad (19)$$

$$fPredName(pT) :\sim antonym\_of(\ fPredName2(pT), crepOp, credVal\ ) \quad (20)$$

$$unexpensive(restaurant) : synonym\_of(cheap(restaurant), prod, 1). \quad (21)$$

$$expensive(restaurant) : antonym\_of(cheap(restaurant), prod, 1). \quad (22)$$

Apart from the definition of fuzzy concepts, we might be interested in allowing the user to search for individuals that have a characteristic similar to the characteristic they enter in the query. Suppose we are looking for a "Mediterranean" food restaurant and we have in the database the values "Spanish", "Italian", "Portuguese", etc. We want to allow the user to ask for restaurants serving food similar to the "Mediterranean" one, so we need to tell the system about this relation. This is what the construction in Eq.23 serves for. In Eq. 23, pT and pT' mean the same as in Eq. 1, TV the same as in Eq. 3 and $value1$ and $value2$ are two values for the vdbt column pT' of the vdbt pT. In the example in Eq. 24 we say that the food type mediterranean is 0.6 similar to the spanish one (but not in the other way. If we want to say that the spanish food is 0.6 similar to the mediterranean one we need to add another line of code saying that).

$$similarity\_between(pT,\ pT'(value1),\ pT'(value2), TV). \quad (23)$$

$$similarity\_between(\ restaurant, food\_type(mediterranean), food\_type(spanish),\ \ 0.6). \quad (24)$$

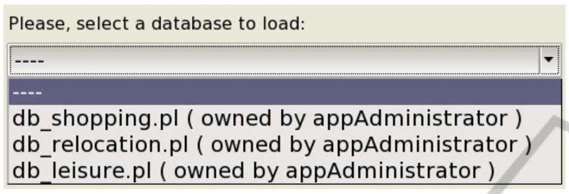
5 THE FRAMEWORK USER INTERFACE

The framework user interface gets a lot of information from the framework, providing the final user an inter-

[5]We include two examples here so if one builds a program by taking all the examples in the contribution the rule in Eq. 18 the framework is able to obtain results for all the restaurants in our database.

face “intelligent” enough to allow him to perform any query that the framework can solve with the knowledge it has.

Suppose, for example, that we are looking for a restaurant near the city center and with a menu price under 25 €. We start choosing the database we want to query, “db_leisure” (Fig. 3).


Please, select a database to load:

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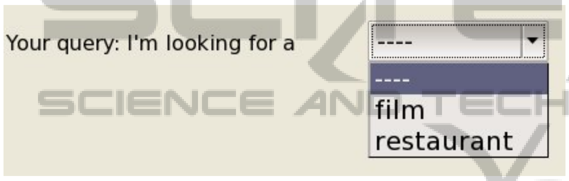
db_shopping.pl (owned by appAdministrator)
db_relocation.pl (owned by appAdministrator)
db_leisure.pl (owned by appAdministrator)

Figure 3: Choosing the database.

Once selected the user interface allows us to select what are we looking for (a restaurant this time, Fig. 4).


Your query: I'm looking for a

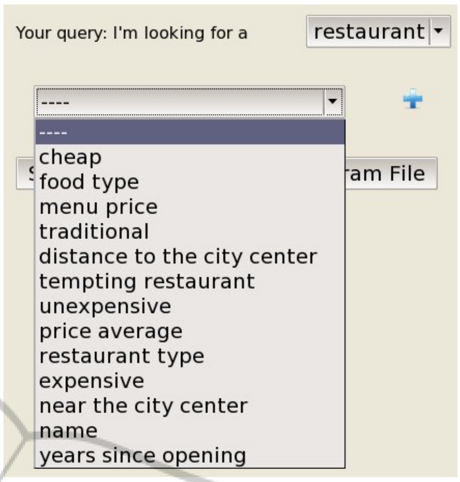
----
film
restaurant

Figure 4: Choosing what we are looking for.

The interface shows then a combo for choosing a fuzzy or non-fuzzy attribute of the individuals and a plus sign to the right (Fig. 5). The attributes are the names we give to the columns by using the construction in Eq. 1 and the fuzzy predicates defined by using the constructions in Eqs. 3, 11, 13, 16, 17, 19, 20 and 23 (although we can use multiple sentences to define a fuzzy predicate it will appear only once). The plus sign serves to add more conditions to the query (it only has a line at the beginning) and the “show options” label can be used to switch the operator we use to combine the truth values from minimum to product, Łukasiewicz or any other (it needs to be previously defined in the framework).

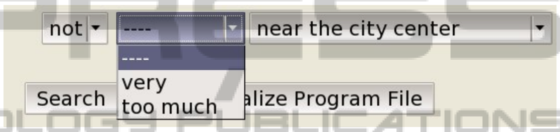
One of the most interesting characteristics of the framework user interface is that it interacts with the framework, so it knows if the attribute selected is fuzzy or not. In case the predicate is fuzzy it shows to its left two combos, one for choosing negation and the other one for choosing a modifier (Fig. 6), while if it is a non-fuzzy one it shows a combo for choosing a comparison operator and, depending on the operator chosen, a combo with the available values or a free text field for entering a value (Fig. 7). We show in Fig. 8 the query we want to pose to the system.

After posing the query (Fig. 8), we need to press the button labelled “search”. The search engine then shows the query results, grouped in five tabs: “10 best


Your query: I'm looking for a restaurant

----
cheap
food type
menu price
traditional
distance to the city center
tempting restaurant
unexpensive
price average
restaurant type
expensive
near the city center
name
years since opening

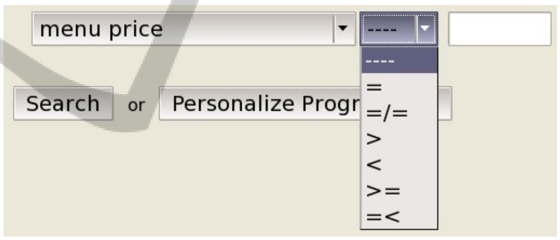
Figure 5: The available attribute(s) for writing the query.


not ---- near the city center

----
very
too much

Search

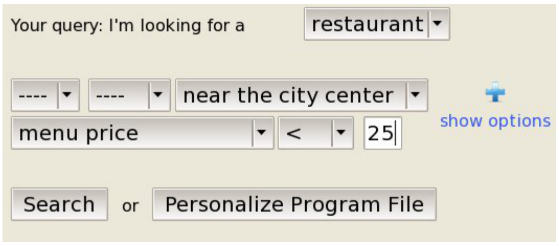
Figure 6: Available modifiers for the fuzzy attribute.


menu price ----

=
=/=
>
<
>=
=<

Search or Personalize Progr

Figure 7: Available comparison operators for the non-fuzzy attribute.

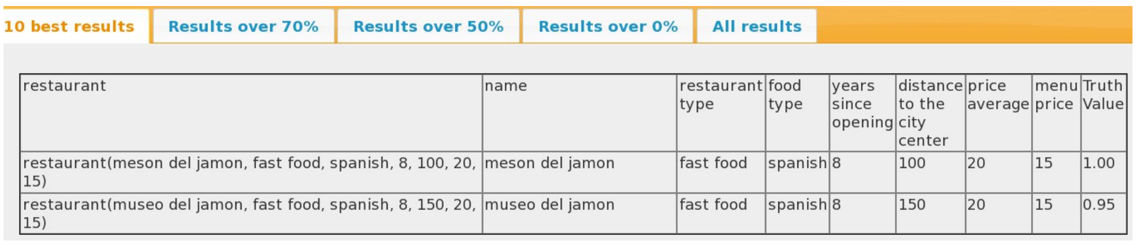

Your query: I'm looking for a restaurant

---- ---- near the city center
menu price < 25
show options

Search or Personalize Program File

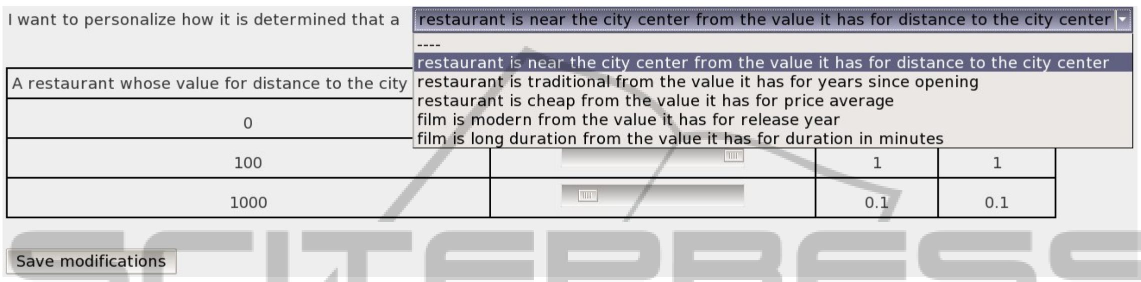
Figure 8: Query example.

results”, “results over 70%”, “results over 50%”, “results over 0%” and “all results”. This allows the user to select the results that best fit his query or, if they do not satisfy his expectations, to navigate through results that do not satisfy the query entered but might be the ones he is looking for. We show in Fig. 9 the results for the query entered in Fig. 8. The data in the first column corresponds to the information in the virtual database table. The user can choose between seeing it or not.



restaurant	name	restaurant type	food type	years since opening	distance to the city center	price average	menu price	Truth Value
restaurant(meson del jamon, fast food, spanish, 8, 100, 20, 15)	meson del jamon	fast food	spanish	8	100	20	15	1.00
restaurant(museo del jamon, fast food, spanish, 8, 150, 20, 15)	museo del jamon	fast food	spanish	8	150	20	15	0.95

Figure 9: Answers returned for the query example in Fig. 8.



I want to personalize how it is determined that a restaurant is near the city center from the value it has for distance to the city center

----
restaurant is near the city center from the value it has for distance to the city center
restaurant is traditional from the value it has for years since opening
restaurant is cheap from the value it has for price average
film is modern from the value it has for release year
film is long duration from the value it has for duration in minutes

A restaurant whose value for distance to the city			
0			
100		1	1
1000		0.1	0.1

Figure 10: Selection of the fuzzy attribute the user wants to personalize and introduction of the user definition.

The button "Personalize Program File" allows the user to introduce his point of view about a fuzzy concept. In this way the user can personalize how the framework translates the non-fuzzy attributes stored in the database into the fuzzy ones he uses in his query. When pressing the button the interface shows a pop-up window (Fig.10) in which it asks the user which fuzzy predicate he wants to personalize and his preferences for the fuzzification of the values stored in the database.

At last, but not least important that the previous facilities, we allow any user to use our application for querying any existing (and available) database. The only requisite is that they need to upload their program file to our application, for which they need to write a program in the syntax explained in Sec. 4, access our application (the url is shown in Sec. 6) and upload the file.

6 CONCLUSIONS

We have presented FleSe, a framework that allows to enrich regular queries to databases with the use of fuzzy concepts. FleSe allows the user to perform fuzzy and non-fuzzy queries to regular databases by linking the regular non-fuzzy concepts for which we store values in databases with fuzzy concepts. By doing this we can query the database about fuzzy concepts and the framework will take care of translating the fuzzy concepts into queries that the database can answer.

The framework offers to developers a clear syntax with sound and complete semantics that allows them to define satisfaction values for fuzzy concepts from values stored in databases, from the configuration file itself, from the configuration file when a null value is found in the database for some individual (or database row), and from other fuzzy concepts.

A beta version of FleSe is available at https://fake.url.for.double.blinded.process, where we have the examples presented here, some others and the possibility to personalize them and/or include your own examples. We hope this contribution helps to improve the existing search mechanisms for databases, specially the possibility to use human-oriented attributes (cheap, fast, ...) instead of computer-oriented attributes (price under X, speed over Y, ...).

Our current work goes in the direction of offering via the web interface the possibility to create and manage the program files (we only offer now the possibility to upload them). With this facility any final user could develop his own fuzzy concepts for querying the database, just by knowing database structure he wants to query.

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