A FIRST STEP TOWARDS A FUZZY FRAMEWORK FOR ANALYZING COLLECTIONS OF JSON DOCUMENTS

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ABSTRACT

JSON is a light-weight format for data interchange on the Web, widely adopted by most portals to make their data collections accessible through APIs, each one providing their own data structures. The consequence is that different data sets, even related to the same domain, may have different structures, even though they describe the same information. Thus, analysts must collect and face heterogeneous data structures during the analysis process. Although JSON stores are schema free by definition, their query languages still lack suitable constructs for flexibly querying heterogeneous repositories of JSON documents by expressing linguistic and/or imprecise predicates. In this work, we try to define a first proposal for a flexible query language, based on J-CO-QL, aimed at exploiting the flexibility offered by Fuzzy Set Theory to exploit imprecise (linguistic) concepts or to deal with uncertainty. J-CO-QL is the query language of the J-CO framework, designed to query and transform large and heterogeneous JSON data sets.

KEYWORDS

Collections of JSON Documents, JSON Document Stores, Flexible Query Language, Fuzzy Set Theory

1. INTRODUCTION

JSON (JavaScript Object Notation) is a light-weight format for data interchange on the Web. JSON is completely language independent, and it is easy to understand and generate. In the last years, JSON has been preferred to XML (the eXtensible Mark-up Language) for several reasons: JSON does not use tags, is shorter, quicker to read and write, and can use arrays. Furthermore, an XML document is represented in main memory by the DOM (Document Object Model) data structure, which is difficult to handle, while a JSON document can be easily de-serialized into a main-memory variable of any object-oriented programming language.

For all these reasons, today most portals adopt JSON to make their data collections accessible through APIs (Application Programming Interfaces), each one based on their own data structures; for example, Twitter freely provides tweets, that can be further analyzed (Cuzzocrea, et al., 2015). The consequence is that different source data sets, even related to the same application domain, may present a different structure, even though they describe the same information (e.g., books on sale). Thus, analysts must first collect the data sets coming from different sources and, then, face heterogeneous data structures during the analysis process.

The need for flexible querying has been widely studied both in relational databases (Bordogna & Psaila, 2008), and in XML Retrieval (Marrara & Pasi, 2016). The aim was to overcome the inadequacy of both SQL and XQuery caused by the classical Boolean conditions (also said *crisp* conditions) on which they are founded that neither allow for inexact matching between query and data, nor provide a ranking mechanism of the retrieved results with respect to their relevance to the informative needs of the users.

Currently, *NoSQL Document Stores*, able to natively store and query collections of JSON documents, have become very popular, in particular *MongoDB*¹ and *AWS DocumentDB*². However, although these systems are schema free by definition, their query languages still lack suitable constructs for flexibly retrieving heterogeneous JSON documents with high-level and analyst-oriented instructions. The J-CO framework was designed to provide a unique framework to integrate and transform data sets described as collections of

¹ <https://www.mongodb.com/>

² <https://aws.amazon.com/documentdb/>

(possibly geo-tagged) JSON documents, stored within NoSQL databases. The idea is that a unique query language (named J-CO-QL), whose execution engine is independent of storing technology but can seamlessly connect to several storage systems, is the solution to overtake the isolation of different database systems. Second, it can overtake the limitation of the query languages supported by each single system. Furthermore, the language provides native support to process geo-tagging of JSON documents (Bordogna, et al., 2017) (Bordogna, et al., 2018) (Psaila & Fosci, 2018).

However, J-CO-QL is still a crisp language, i.e., conditions are still based on classical Boolean logic. In this work, we try to define a first proposal to transform J-CO-QL into a flexible query language, aimed at exploiting the flexibility offered by Fuzzy Set Theory to exploit imprecise (linguistic) concepts. The reason why we propose to extend the J-CO-QL language is simple: its flexibility in dealing with heterogeneous and possibly geo-tagged JSON documents, joined with the flexibility provided by Fuzzy Set Theory, may provide, in perspective, a very flexible language for querying and transforming collections of JSON documents.

The main advantage of this solution lies in the simplicity with which the user can express selection conditions based on vague concepts; furthermore, JSON documents are implicitly ranked on the basis of their closeness to user's wishes. In this paper, we present a first step towards such an extension, as a preliminary validation of the approach. In Section 2, we discuss the related work and present some basic concepts concerned with Fuzzy Set Theory. In Section 3, we briefly introduce the fundamentals of the J-CO-QL language. In Section 4, a (basic) extension to J-CO-QL with Fuzzy Set Theory concepts is proposed. Finally, Section 5 draws the conclusions.

2. RELATED WORK

Most relational database management systems adopt the Boolean logic to formalize queries. This means that a query condition can be either satisfied or not satisfied. By using Boolean logic, it is not possible to have a flexible semantics of relational operations, to express preferences and to rank query results. In many real-world situations, queries are expressed by humans by means of imprecise words. User's intention is not merely to find the tuples that satisfy a given query; in contrast, the user could wish to estimate how much each tuple satisfies the conditions in the query (its satisfaction degree), for possibly ranking tuples.

There are several approaches to represent imprecise and vague concepts in *Information Retrieval* (IR). A first approach defines similarity or proximity relations between pairs of imprecise and vague items. In the vector space model, for instance, documents and queries are represented as points in a space of terms and the distances between the points representing the query and the documents are used to quantify their similarity (Salton, 1994). Another category of approaches adopts the notion of *Fuzzy Set*. Fuzzy Set Theory is an extension to classical set theory (Zadeh, 1975). The notion of fuzzy set has been used to represent vague concepts expressed in a flexible query for specifying *soft selection conditions* (Rijsbergen, 1979). The objective here is to quantify the closeness of the information carried by the proposition with the considered reality. *Possibility Theory* (Fuhr, 1989; Zadeh, 1965) together with the concept of a *linguistic variable* defined within fuzzy set theory (Zadeh, 1975), provides a complete formal framework to manage imprecise, vague and uncertain information (Buell, 1985).

There are two alternative ways to model the retrieval activity. (i) One possibility is to model the query evaluation mechanism as an uncertain decision process. The concept of relevance is defined as a binary (crisp) condition, since the query evaluation mechanism computes relevance probability of a document d with respect to a query q . Such an approach, which does model the uncertainty of the retrieval process, has been introduced and developed by using *probabilistic IR models* (Dubois & Prade, 1988; Herrera & Herrera-Viedma, 1997; Waller & Kraft, 1979). (ii) Another way is to interpret the query as the specification of soft constraints that the representation of a document can satisfy to a certain degree, and to consider *term relevance* as a *gradual (vague) concept*. This is the approach adopted in *fuzzy IR models* (Bordogna & Pasi, 1995). In this latter case, the decision process performed by the query evaluation mechanism computes the degree with which the query is satisfied by the representation of each document. A very good survey regarding the adoption of Fuzzy Sets in IR can be found in (Kraft, et al., 2015).

A well defined context, in which dealing with uncertainty and vagueness is quite common, is *XML Retrieval*. When defining query languages for XML documents, the problem of querying data collections without a well-defined structure, or with a heterogeneous structure, was soon evident.

To tackle this problem, Fuzzy Set Theory was a fairly immediate choice. In (Damiani & Tanca, 2000) the authors presented an approach in which XML documents are modeled as labeled graphs; their structure is selectively extended by computing fuzzy estimates of how much the information provided by XML tags is important. The results of such an extension are *fuzzy labeled graphs*. Query results are sub-graphs of these fuzzy labeled graphs, presented as a ranked list according to their matching degree with respect to the query.

In a different perspective, the approaches presented in (Campi, et al., 2009; Marrara & Pasi, 2016) propose flexible XML selection languages, which allow for formulating flexible constraints on both structure and content of XML documents. In this way, users can formulate queries that are able to retrieve XML documents that provide information *close* to users' information needs.

According to many research papers (Kacprzyk & Zadrozny, 1995; Medina, et al., 1994) there are two main ways to apply Fuzzy Set Theory in the context of database management systems. The first way consists in developing a fuzzy database model to manage imprecise data (Bosc & Prade, 1997).

The second way develops a fuzzy querying interface on top of a conventional relational database (Bosc & Prade, 1997); the advantage of this approach is evident in the SoftSQL proposal (Bordogna & Psaila, 2009). Other extensions of SQL have been proposed: FSQL (Galindo, 2006) and SQLf (Bosc & Pivert, 1995).

2.1 A Brief Introduction on Fuzzy Sets

Fuzzy Set Theory was introduced by Zadeh (Zadeh, 1975), and soon applied to different areas, such as artificial intelligence, natural language processing, decision making, expert systems, neural networks, control theory, and so on. In this section, we briefly review the main concepts, useful to understand the approach proposed in this paper.

From now on, we denote by X a non-empty universe, either finite or infinite.

Definition 1: A fuzzy set (or type-1 fuzzy set) $A \subseteq X$ is a mapping $A: X \rightarrow [0, 1]$. The value $A(x)$ is referred to as the membership degree of the element x to the fuzzy set A .

Therefore, a fuzzy set A in X is characterized by a membership function $A(x)$ which associates each element $x \in X$ with a real number in the interval $[0, 1]$; in other words, given x , the value $A(x)$ represents the *degree of membership* of x to A .

A fuzzy set is empty if and only if its membership function is identically zero on X . Two fuzzy sets A and B are equal, written as $A = B$, if and only if $A(x) = B(x)$ for all $x \in X$.

The complement of a fuzzy set A is denoted as A' and is defined by $A'(x) = 1 - A(x)$.

As in the case of ordinary sets, the notion of containment plays a central role in the case of fuzzy sets.

Definition 2: A is contained in B (or, equivalently, A is a subset of B , or A is smaller than or equal to B) if and only if $A(x) \leq B(x)$, for each $x \in X$.

Definition 3: The union (resp. intersection) of two fuzzy sets A and B with respective membership functions $A(x)$ and $B(x)$ is a fuzzy set C , written as $C = A \cup B$ (resp. $C = A \cap B$), whose membership function is related to those of A and B by $C(x) = \max(A(x), B(x))$ (resp. $C(x) = \min(A(x), B(x))$), for all $x \in X$.

The intersection is used to express the logical AND operator, the union formalizes the logical OR operator while the complement set represents the logical NOT operator.

3. THE J-CO-QL LANGUAGE

The J-CO-QL language is a rich language to query and transform collections of complex, possibly geo-tagged, JSON documents. Here, we briefly introduce some basic constructs by means of an example. For a complete introduction to the language, the reader can refer to (Bordogna, et al., 2017) (Bordogna, et al., 2018) (Psaila & Fosci, 2018).

Suppose we have a collection named `Hotels`, stored within a database named `MyDB`. The documents in this collection describe hotels located worldwide. A sample document is reported in Listing 1.

```
{
  "HotelName": "Mini Excelsior",
  "AveragePrice": 100,
  "Rooms": 80,
  "CityName": "City 1",
  "Country": "Italy",
  "~geometry": { "type": "Point",
                 "coordinates": [9.17529749573575, 45.527028643302899]}
}
```

Listing 1. sample document in collection `Hotels`

Notice the presence of the `~geometry` field: it is a standard JSON field describing the geometry (e.g., points, polylines or regions) of the document, by relying on the `GeometryDefinition` defined in the GeoJSON format³. However, it assumes a specific role in our language: if present, it is automatically processed by the spatial operations provided by J-CO-QL. In this paper, we do not focus on spatial operations; we will consider them in our further extensions of the language. Note that field names beginning with `~` are fully compliant JSON field names; thus, any JSON document store is able to store them.

The following query generates a new collection, named `ItalianHotels`. Let us discuss it.

```
GET COLLECTION Hotels@MyDB;

FILTER
CASE WHERE WITH .Country AND .Country = "Italy"
GENERATE { .HotelName, .AveragePrice, .Rooms, .CityName }
  DROPPING GEOMETRY
DROP OTHERS;

SAVE AS ItalianHotels@MyDB;
```

Listing 2. J-CO-QL query that creates a collection of documents describing Italian Hotels

The query reported in Listing 2 contains three instructions, performing either simple tasks or complex tasks. The underlying semantics is the following: each instruction starts from an Execution State s_i , and produces a new execution state $s_{(i+1)}$. Each execution state contains several information, including also the *Temporary Collection*, i.e., a collection of JSON documents that constitutes the input of the instruction. Thus, each instruction may use this collection and may generate a new temporary collection.

We can now describe the query in Listing2.

- The `GET COLLECTION` instruction retrieves the collection named `Hotels` from the database named `MyDB`. This collection becomes the *temporary collection* of the process.
- The `FILTER` instruction selects and transforms the documents in the temporary collection, generating a new temporary collection. In this case, since the temporary collection contains documents describing hotels, the `CASE WHERE` clause selects documents having the `Country` field (by means of the `WITH` predicate) whose value is `"Italy"`.

The selected documents are restructured by the `GENERATE` action, in order to slightly simplify them. Specifically, we keep all fields except `Country`; furthermore, the option `DROPPING GEOMETRY` says that we do not want the `~geometry` field in the output documents.

The `DROP OTHERS` option, at the end of the instruction, means that documents not selected by the `CASE WHERE` clause must be discarded from the new temporary collection produced by the instruction. Listing 3 shows a sample document appearing in the new temporary collection.

³ <https://tools.ietf.org/html/rfc7946>

- Finally, the temporary collection produced by the `FILTER` instruction (that contains only Italian hotels) is saved into the MyDB database with name `ItalianHotels`.

Notice the dot notation `.Country` to refer to fields: this is motivated by the fact that documents can contain nested documents and fields; the dot notation allows for referring to nested fields, for example `.A.B` (the initial dots means that the `A` field is root in the root level).

```
{
  "HotelName": "Mini Excelsior",
  "AveragePrice": 100,
  "Rooms": 80,
  "CityName": "City 1"
}
```

Listing 3. sample document in obtained after the JOIN instruction

4. EXTENDING THE J-CO-QL LANGUAGE WITH FUZZY SETS

We can now address the main goal of this paper, i.e., to propose an extension of J-CO-QL to support fuzzy sets. First of all, we have to extend the data model.

4.1 Data Model

J-CO-QL was designed to work on JSON documents. However, in order to manage geometries of geo-referenced documents, we had to introduce a special field, named `~geometry`, which is implicitly considered by the instructions, but it is still a JSON-compliant field and can be accessed by expressions and conditions, irrespective of its particular role. Hereafter, we adopt a similar approach to represent fuzzy sets which documents belong to.

A JSON document d can belong to one or more fuzzy sets $A_1, A_2, \dots, A_n$. For each fuzzy set A_i , d belongs to A_i with a certain membership degree $A_i(d) \in [0, 1]$. To represent the multiple membership degrees of d , a special root-level field named `~fuzzysets` is introduced: it is a nested document, containing only numerical fields; each field denotes the membership degree of the JSON document to the fuzzy set named as the field.

As an example, consider the following JSON document.

```
{
  "HotelName": "Mini Excelsion",
  "AveragePrice": 100,
  "Rooms": 80,
  "CityName": "City 1",
  "~fuzzysets": {
    "Cheap_Hotel": 0.8,
    "Medium_Hotel": 0.5
  }
}
```

The document describes a hotel that belongs to two fuzzy sets named `Cheap_Hotel` and `Medium_Hotel`. The membership degree is 0.8 for the `Cheap_Hotel` fuzzy set (for example we could say that with an average price less than 80 Euros the hotel would be considered as fully cheap, while with an average price of 100 Euros the hotel is considered partially cheap). The membership degree is 0.5 for the `Medium_Hotel` fuzzy set, meaning that the hotel is partially “medium”, but not completely (for example, we could say that a hotel is fully medium with at least 40 rooms and at most 75 rooms).

Notice that the document does not say how the membership degrees of fuzzy sets were evaluated, but only that it belongs to some fuzzy sets with some membership degrees.

The advantage of this solution is that the document is still a standard JSON document: it can be stored into database collections and retrieved from them.

Figure 1. a) classical trapezoidal membership function and b) enhanced membership function as supported by J-CO-QL

4.2 Creating Fuzzy Operators

In order to evaluate if a document belongs to a fuzzy set, it is necessary to define some operators able to compute the membership degree of a document with respect to a fuzzy set.

A classical solution, proposed in previous literature on relational database extended with fuzzy sets, is to define a trapezoidal function in the codomain $[0, 1]$ (see Figure 1.a, for an example). Here, we propose an extended interpretation of this approach, where we allow for the definition of an arbitrarily long polyline with codomain $[0, 1]$, as reported in Figure 1.b, in order to model more complex real contexts.

The J-CO-QL language offers a new specific construct to create fuzzy operators.

```
CREATE FUZZY OPERATOR Is_Medium_Hotel
PARAMETERS Number_of_Rooms AS Integer
PRECONDITION .Number_of_Rooms >=0
EVALUATE .Number_of_Rooms
RANGE (0, 150)
POLYLINE (0,0), (20,0), (35,0.5), (40,1), (75,1), (80, 0.5),
          (100,0), (150,0);
```

The construct defines the new fuzzy operator `Is_Medium_Hotel`. In the following, we explain the definition of the fuzzy operator.

First of all, the `PARAMETERS` clause specifies the formal parameters received by the operator. Specifically, the `Is_Medium_Hotel` operator receives one single parameter, named `Number_of_Rooms`, defined as an integer value. When the operator is invoked, all parameters are assembled into one JSON document, having the formal parameters as fields and the actual parameters as values. In our case, this JSON document will have only the `Number_of_Rooms` field.

In order to obtain the membership degree, we have to evaluate an expression based on these parameters. The `EVALUATE` clause specifies this expression. In our case, the value of the `Number_of_Rooms` parameter is kept untouched. Notice that we still use the dot notation `. Number_of_Rooms` to refer to the parameters (as in the other instructions of J-CO-QL): in fact, the expression actually works on the JSON document obtained by assembling formal and actual parameters.

However, not all values of the input parameters are valid: the `PRECONDITION` clause specifies a condition to be verified before performing the evaluation. If the condition is false, no membership value is generated and the operator generates an evaluation error.

The `RANGE` clause specifies the range within which the result of the `EVALUATE` expression is mapped to the corresponding membership degree, by means of the polyline function defined in the subsequent `POLYLINE` clause. In this case, we consider a range between 0 and 150 rooms.

Finally, the `POLYLINE` clause defines the polyline used as membership function. It is defined as a sequence of pairs (x, y) , where x is a coordinate in the range specified by the `RANGE` clause, while y is a value specified in the range $[0, 1]$. The first pair has the value of the x coordinate that coincides with the left bound of the range, while the last pair contains a value for the x coordinates that is equal to the right bound of the range. This way, it is possible to define the membership function as a polyline, where the y coordinates denotes the final membership value.

For example, the membership function for the `Is_Medium_Hotel` operator is depicted in Figure 1.b: notice the points of the polyline that correspond to the sequence of pairs. If we suppose that the actual value of the `Number_of_Rooms` parameter is 50, the corresponding y coordinate is 1 (the membership degree), i.e., the hotel fully belongs to the set of medium hotels; if the value for the `Number_of_Rooms` parameter is 10, the corresponding membership degree is 0, meaning that the hotel does not belong at all to the set of medium hotels. And so on.

We assume that in case of values of the expression specified in the `EVALUATE` clause that are lower than the left bound (greater than the right bound, resp.), the y value of the left bound (right bound, resp.) is the membership value. For example, if the `Number_of_Rooms` parameter is 200, the membership value is 0.

4.3 Extending the FILTER Operator

Consider the `ItalianHotel` collection generated by the query reported in Listing 2 (a sample document in this collection is reported in Listing 3). We want to evaluate the degree with which hotels belong to the fuzzy set named `Medium_Hotel`. The following J-CO-QL query does this work.

```
GET COLLECTION ItalianHotels@MyDB;

FILTER
  CASE WHERE WITH .HotelName, .AveragePrice, .Rooms, .CityName
  GENERATE { .HotelName, .AveragePrice, .CityName }
  CHECK FOR FUZZY SET Medium_Hotel
  USING Is_Medium_Hotel( .Rooms )
  DROP OTHERS;
```

Listing 5. J-CO-QL query to create the `Medium_Hotel` fuzzy set

The above query contains two instructions. First of all, the `GET COLLECTION` instruction retrieves the `ItalianHotels` collection from the `MyDB` database.

Then, the `FILTER` instruction transforms the documents in the temporary collection. If a document satisfies the `WHERE` condition in the `CASE` clause, it is processed and will appear in the output temporary collection, otherwise it is discarded (as specified by the `DROP OTHERS` option).

The `WHERE` condition is satisfied if the document contains the fields named `HotelName`, `AveragePrice`, `Rooms` and `CityName`. If so, it is restructured by the `GENERATE` action, by keeping only fields `HotelName`, `AveragePrice` and `CityName`.

At this point, the novel `CHECK FOR FUZZY SET` action adds the new fuzzy set to the output document. The fuzzy set is named `Medium_Hotel`; its membership degree is evaluated by the fuzzy logic condition reported in the `USING` sub-clause. The fuzzy logic condition can contain fuzzy operators, fuzzy set names and classical crisp comparison predicates (in this case, the membership degree 1 corresponds to *true*, while the membership degree 0 corresponds to *false*), connected by the fuzzyfied `AND`, `OR` and `NOT` operators.

In the instruction, the fuzzy condition specified in the `USING` sub-clause simply exploits the `Is_Medium_Hotel` operator previously defined, by using the `Rooms` field of the current document as actual value of the `Number_of_Rooms` formal parameter. Since the documents in the source temporary collection do not belong to any fuzzy set, the `~fuzzysets` field is created; within it, a unique field named `Medium_Hotel` is present, whose value is the degree with which the document belongs to the fuzzy set (the membership degree is obtained by evaluating the fuzzy operator `Is_Medium_Hotel`). Listing 6 reports the document obtained by transforming the document depicted in Listing 3.

```
{
  "Hotel_Name": "Mini Excelsior",
  "AveragePrice": 100,
  "CityName": "City 1"
  "~fuzzysets": {
    "Medium_Hotel": 0.5
  }
}
```

Listing 6. Sample document belonging to one fuzzy set

To appreciate the usefulness of the new constructs, consider Listing 7 extending the querying Listing 5.

```
FILTER
CASE WHERE WITH .AveragePrice
CHECK FOR FUZZY SET Cheap_Hotel
USING Is_Cheap( .AveragePrice )
DROP OTHERS;

FILTER
CASE WHERE WITHIN FUZZY SETS Medium_Hotel, Cheap_Hotel
CHECK FOR FUZZY SET Desired_Hotel
USING Medium_Hotel AND Cheap_Hotel
ALPHA-CUT 0.7 ON Desired_Hotel
DROP FUZZY SETS Medium_Hotel, Cheap_Hotel
DROP OTHERS;

SAVE AS DesiredHotels@MyDB;
```

Listing 7. Second part of the J-CO-QL query based on fuzzy sets

Suppose we have defined another fuzzy operator named `Is_Cheap_Hotel`, whose goal is to evaluate if a hotel is cheap on the basis of its average price per night. The first `FILTER` instruction reported in Listing 7 further extends documents in the temporary collection by adding a new fuzzy set, named `Cheap_Hotel`. The resulting documents now contain two fuzzy sets, i.e., `Medium_Hotel` and `Cheap_Hotel`. Notice that the `GENERATE` action is missing: this means that the structure of documents into the output temporary collection does not change.

At this point, we want to focus only on hotels of interests. For example, we would like to find out *hotels that are both medium hotels and cheap*.

The second `FILTER` instruction in Listing 7 evaluates a third fuzzy set, named `Desired_Hotel`: as specified in the `USING` fuzzy condition, a hotel must be both in the `Medium_Hotel` fuzzy set and in the `Cheap_Hotel` fuzzy set. This is expressed by the fuzzy `AND` condition (remember that the resulting membership degree is the minimum one). However, we are not interested in all hotels, but only in those whose membership degree to the `Desired_Hotel` fuzzy set is at least 0.7: the `ALPHA-CUT` specification discards documents with lower membership degree.

Furthermore, the `DROP FUZZY SETS` sub-clause specifies the fuzzy sets that are removed from the output documents (thus, only the `Desired_Hotel` fuzzy set appears in the output documents).

Notice the presence of the `WITHIN FUZZY SETS` predicate in the `WHERE` condition: this is a novel crisp predicate that is true if a document has a membership degree greater than 0 for the specified fuzzy sets.

The query terminates by saving the temporary collection into the `MyDB` database with name `DesiredHotels`.

The reader can see that by evaluating the belonging of documents to various fuzzy sets, it is possible to filter documents by expressing soft conditions, based on linguistic concepts (medium and cheap). Furthermore, the final membership degree could be also used to sort the results in reverse order of importance. This shows that the proposal, although it is the early stage of the extension of `J-CO_QL` to support fuzzy concepts, seems to be on the right way.

5. CONCLUSIONS

In this work, we propose a first solution to the problem of how to query heterogeneous collections of JSON documents in a flexible way, by means of vague concepts. The aim of the paper is to propose a first extension of the `J-CO_QL` language: we try to define a flexible query language, aimed at exploiting the flexibility offered by Fuzzy Set Theory to exploit imprecise (linguistic) concepts or to deal with uncertainty. The `J-CO_QL` language, due to its flexibility in dealing with heterogeneous and possibly geo-tagged JSON documents, joined with the flexibility provided by Fuzzy Set Theory, may become, in perspective, a very flexible language for querying and transforming collections of JSON documents.

In this paper, we presented a first step towards such an extension, as a preliminary validation of the approach. Future work will further extend this preliminary proposal into a powerful and complete fuzzy query language, also providing a complete formal definition. We will also test efficiency, in order to evaluate the overhead caused by the introduction of fuzzy constructs.

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