Mapping Contexts to Vocabularies to Represent Intentions

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Abstract.

In the framework of multi-target use of a given ontology, this paper proposes a representation of vocabularies based on the identification of elementary vocabularies, which can be equivalently defined using specializations of the "kind of" relation. It defines a way of combining contexts and vocabularies that allows context-specific querying.

1 INTRODUCTION

A given assertion holds in a given "context". This single affirmation can be interpreted in various ways, leading to a disparate literature about contexts. We can note two main considerations: (i) a given assertion can lead to several interpretations due to different meanings of terms, depending on the context [1, 4, 8]; (ii) the same interpretation can have different truth values in different contexts [9, 6, 12].

In this paper, our concern is to represent that, for the same piece of information, different descriptions will be given, different aspects will be highlighted, depending on the context, which can be seen as the target the piece of information will be used for (for which public and/or in which purpose). That is to say, different assertions will be used to describe the same piece of information, not because of the ambiguity of terms, nor due to the relativity of truth, but because different aspects will be important to retain, depending on the intention of the message vehiculated in each context. As a consequence, the vocabulary used in each context should be appropriate. Not all terms of the domain ontology are in accordance with the purposes of a given context: the presence of unappropriate terms, that do not conform to the intended use of information, can reveal a possible diversion out of the scope of the context, and thus not be pertinent, not understandable or not useful. For example, information intended for general public should not be too technical, terms that translate a judgement (positive, bad, ...) are expected in evaluation contexts, etc.

The aim of this paper is to propose a way of representing vocabularies and associating them with contexts. The examples, although simplified, come from a real-world application in food science. The paper is built as follows. Section 2 presents related work on contexts and ontologies. Section 3 defines the proposed representation of vocabularies. Section 4 proposes a mapping between contexts and vocabularies and shows context-specific querying that ensues.

2 RELATED WORK

2.1 Context representation

The context model we use is based on the definition of contexts as nesting types [2] in the conceptual graph model, which is a knowledge representation model based on labelled graphs. The conceptual graph model is composed of two parts: the *support*, which contains the terminological knowledge – and constitutes a part of the domain ontology –, and the *conceptual graphs*, which contain the assertional knowledge. Figure 1 shows a part of the set of concept types, noted T_C, which is part of the support.

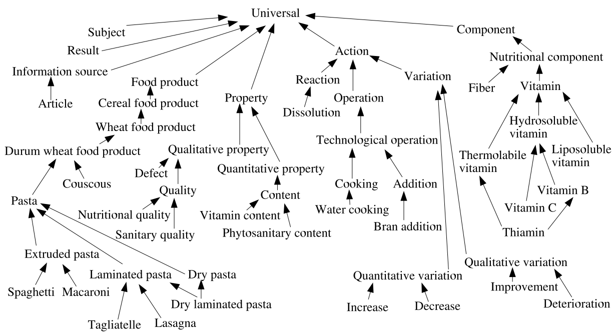

Figure 1. Part of the "food science" concept type set

A way of representing contexts in this model by structuring knowledge into levels has been descriptively introduced by [11] and furtherly studied e.g. in [3, 10]. The formalization of [2] defines a logically founded knowledge representation formalism based on nested graphs, thus providing operations for reasoning with nested graphs.

At first level, a conceptual graph gives an overall description of a fact. Zooming in on certain concept vertices provides more details, also described by conceptual graphs. A conceptual graph that is nested in a concept vertex is thus described in the context defined by this concept. Typed nestings [2] allow specifying the relationship (description, explanation, ...) between the surrounding vertex and one of its descriptions. A new type set is thus added to the support, the *set of nesting types*. In the following, a context is considered to be represented as a nesting type and expresses the target (public and/or purpose) the nested piece of information is intended for.

An example of nested conceptual graphs, built using the concept type set of Figure 1, is given in Figure 2. It represents the following piece of information: "an article, whose subject is a wheat food product that is cooked in water, has a result, whose nutritional observation is that the vitamin content of this wheat food product decreases, whose biochemical explanation is that this wheat food product contains hydrosoluble vitamin that is dissolved, and whose nutritional evaluation is that the nutritional quality of this wheat food product is deteriorated".

The set of conceptual graphs is partially pre-ordered by the *specialization relation* (noted $\leq$), which can be computed by the *pro-*

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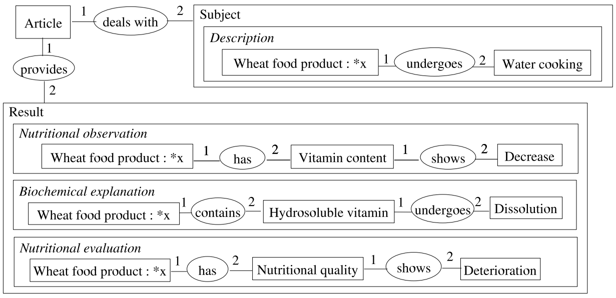

Figure 2. An example of nested conceptual graphs

jection operation (a graph morphism allowing the restriction of the vertex labels). The projection is a ground operation in the conceptual graph model since it allows the search for answers, which can be viewed as specializations of a query (see Section 4.2).

2.2 Ontology structure

The question of combining different vocabularies is a major concern of ontology integration. Several studies (e.g. [7, 5]) have proposed distinguishing between different kinds of terminologies according to their level of generality, the top-level being usable for large communities of users, whereas the more specific ones are obtained by specializing the more general levels and used for more specific needs.

However, pertinent vocabulary, for a given use, does not always depend on its depth in the ontology. An example is the following. To express information intended for a general public, we can note that, besides top-level concept types (see Figure 1), several other concept types are pertinent because they correspond to commonly used categories (Spaghetti, Lasagna ...), although they are more specific than concept types that correpond to technical categories (Extruded pasta, Laminated pasta ...) and hence cannot be used. In this example, this is due to the fact that Spaghetti or Lasagna are appellations, they do not explicitely express technical criteria.

3 VOCABULARY REPRESENTATION

Due to this consideration, an alternative basis to characterize pertinent vocabulary for a given use, other than its depth in the ontology, seems coherent to us. We propose a construction of vocabularies based on the specialization criteria used to obtain the concept types that compose them (appellation, technology, ...). We will firstly define "vocabularies", then propose two equivalent ways of constructing them.

3.1 Identification of elementary vocabularies

Definition 1 *A vocabulary is a subset of the concept type set T_C. A vocabulary V_1 is more specific than V_2 if $V_1 \subseteq V_2$.*

According to this definition, a vocabulary composed of top-level concept types is not more general than a vocabulary composed of more specific concept types: the two vocabularies are not comparable. The most general vocabulary is T_C, as it contains all the others. This is in accordance with conceptual graph specialization and projection (illustrated in Section 4.2).

As mentioned in previous works (see part 2.2), in practice ontologies are constructed by successive specializations from top to bottom level. Moreover considering that several direct specializations of a given concept type can have related meanings seems sensible. To conserve these notions, we consider that vocabularies are composed of elementary vocabularies built by successive specializations, in a top-down way, of the concept type set.

Definition 2 *T_C is partitioned into a set of elementary vocabularies V_i built as follows:*
- V_0 is composed of the Universal *concept type;*
- For $n > 0$, V_n is obtained by defining specializations of concept types of one elementary vocabulary V_k ($k < n$), or common specializations of several given elementary vocabularies, through a given specialization criterion[4] *(noted crt).*

An example is given in Figure 3 for a small part of the set of concept types. The criterion used for each vocabulary is noted in brackets. In this example, each elementary vocabulary is built by specializing one preceding elementary vocabulary.

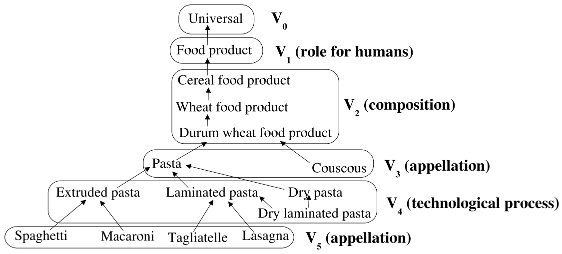

Figure 3. Example of vocabulary construction

Vocabularies can then be built as unions of elementary vocabularies, obtained through specialization criteria that make sense for a given informational purpose (see Section 4). The use of the same specialization criterion in the definition of different elementary vocabularies (for instance in Figure 3, vocabularies V_3 and V_5) can explain why categories that are at different depths in the ontology may be pertinent for the same uses.

3.2 An equivalent definition

The main idea being that the depth in the ontology is not so important as the specialization criterion, we propose to formalize the notion of criterion as a specialization of the "kind of" relation.

Definition 3 *A specialization of the "kind of" relation (noted $<_{crt}$) is a restriction of the "kind of" relation obtained by specifiying the criterion crt used to establish it.*

In Figure 3, 4 direct specializations of the "kind of" relation are used to define the elementary vocabularies: "kind of, with regard to role for humans" (noted koR), "kind of, with regard to composition" (noted koC), "kind of, with regard to appellation" (noted koA), "kind of, with regard to technological process" (noted koT). They could themselves be specialized, as proposed in Figure 4.

Elementary vocabularies can now be re-defined on the basis of the specializations of the "kind of" relation (more simply called: "kind of" relations, in the following) used to define them.

[4] declaratively defined.

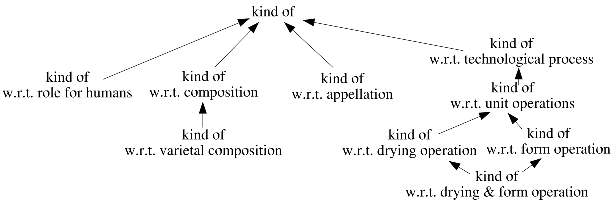

Figure 4. Specializations of the "kind of" relation

Definition 4 *Given: (i) a set of "kind of" relations, and (ii) a set of concept types T_C in which each pair (t, t'), where t' is a direct specialization of t, is associated with the "kind of" relation used to specialize t into t',*
an elementary vocabulary is a set of elements of T_C having the same alternation[5] *of "kind of" relations on their paths from* Universal.

For example, in Figure 3, there is one path from *Universal* to *Extruded pasta*, with the following "kind of" relations: koR, koC, koC, koC, koA, koT. The alternation of "kind of" relations on this path is thus: koR, koC, koA, koT. From *Universal* to *Dry laminated pasta*, there are 2 paths (one through *Laminated pasta* and one through *Dry pasta* that both have the same "kind of" relations: koR, koC, koC, koC, koA, koT, koT. The alternation of "kind of" relations on these paths is: koR, koC, koA, koT. As *Extruded pasta* and *Dry laminated pasta* have the same alternation of "kind of" relations on their paths from *Universal*, they belong to the same elementary vocabulary according to Definition 4.

Definitions 2 and 4 of an elementary vocabulary can be shown to be equivalent.

4 MAPPING CONTEXTS TO VOCABULARIES

4.1 A mapping between contexts and vocabularies

A vocabulary, built as unions of elementary vocabularies, makes sense for a given informational purpose, corresponding to a given context (nesting type). Hence we propose to associate a vocabulary with each nesting type.

Definition 5 *Each nesting type is associated with a vocabulary through a mapping noted v from the set of nesting types to the set of (non-elementary) vocabularies, satisfying: given two nesting types n and n', if n' is more specific than n then $v(n') \subseteq v(n)$.*

For example, the general nesting type *Description* can be associated with T_C. The vocabulary associated with the more specific nesting type *Nutritional description* excludes sanitary and biochemical elementary vocabularies (Sanitary quality, Phytosanitary content, Thermolabile vitamin, Hydrosoluble vitamin ...). The vocabulary associated with *Nutritional observation* excludes the evaluation elementary vocabulary (Improvement, Deterioration, Quality ...). This is illustrated by Figure 2.

4.2 Context-specific querying

The so-called "projection" mechanism of conceptual graphs, which is the basis of querying in that model, remains unchanged using this representation of vocabularies. This is due to the fact that the vocabulary associated with a nesting type (that appears in a query for instance) includes the vocabulary associated with a more specific nesting type (which can appear in an answer to this query), which avoids having answers whose vocabulary is unknown to the query.

Figure 5 gives an example of a query that expects answers (about food products) to be in the nutritional field. The conceptual graph of Figure 2 provides two answers, contained in the *Nutritional observation* and *Nutritional evaluation* nestings (these types are more specific than *Nutritional description* present in the query).

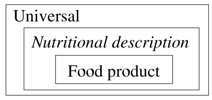

Figure 5. Example of nutrition-specific query

5 CONCLUSION AND PERSPECTIVES

This work has proposed two equivalent ways of defining vocabularies, the first one based on the identification of elementary vocabularies, the second one on specializations of the "kind of" relation. A mapping between contexts, represented as nesting types, and vocabularies has been proposed, which is in accordance with the querying mechanism of the conceptual graph model.

This work, emerging from user needs in an application in food science, should evolve in several directions. A first perspective is an extension in order to provide complementary answers during the querying, e.g. answers from other contexts – that is, from nestings with a non-comparable nesting type – that have compatible vocabularies (common concept types) and that effectively only use concepts that are allowed in the context of the query.

An important issue will be to give the user the choice of the "kind of" relations used in the querying, that can be different from one part of a query to another, so as to allow a rich expression of needs.

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[5] i.e. if the same 'kind of" relation appears several times consecutively in the path, it is considered only once