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Mapping contexts to vocabularies to represent intentions

Rallou Thomopoulos\textsuperscript{1} and Marie-Laure Mugnier\textsuperscript{2} and Michel Leclère\textsuperscript{3}

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 \cite{1,4,8}; (ii) the same interpretation can have different truth values in different contexts \cite{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 concept and/or in which purpose). That is to say, different assertions will be used to describe the same 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".

A way of representing contexts in this model by structuring knowledge into levels has been descriptively introduced by \cite{11} and furtherly studied e.g. in \cite{3,10}. The formalization of \cite{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 \cite{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". Two main considerations are noted: (i) a given assertion can lead to several interpretations due to different meanings of terms, depending on the context \cite{1,4,8}; (ii) the same interpretation can have different truth values in different contexts \cite{9,6,12}.
vocabulary seem 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 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 $V_i$ 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:

- For $n = 0$, $V_0$ 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 $\text{noted } \text{crt}$.

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.

Vocabularies can then be built as unions of elementary vocabularies, obtained through specialization criteria that make sense for a given informational purpose (see Section 4.3). 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 $<_{\text{crt}}$) is a restriction of the “kind of” relation obtained by specifying the criterion $\text{crt}$ 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.
4.2 Context-specific querying

For example, in Figure 3, there is one path from Universal to Extruded pasta, with the following "kind of" relations: koR, 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, koA, koT, koT. The alternation of "kind of" relations on these paths is: koR, koC, koA, koT, 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).

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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