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## Abstract

The multiplication of annotation schemes and coding formats is a severe limitation for interoperability. We propose in this paper an approach specifying the annotation scheme in terms of *typed feature structures*, that are in a second step translated into XML schemas, from which data are encoded. This approach guarantees the fact that no information is lost when translating one format into another.

## 1 Introduction

Many annotation schemes have been proposed, answering the needs of specific projects: facial expressions (FACS), gestures (MUMIN), dialogue acts (DAMSL), etc. A first problem comes form the fact that these schemes often have a close relation with concrete encoding: in many cases, the annotation scheme is presented as a tagset (see for example (ISLE, 2002)). The scheme is even in some cases specified in order to fit with the restrictions of annotation tools. For example, encoding recursive structures is not direct due to the fact that most of the tools encode information in terms of layers or tracks. As a consequence, annotation schemes are often considered as annotation guides, and vice-versa (see for example (Dipper, 2007)).

This aspect can be a problem: each specific domain or project lead to a specific annotation scheme according to the granularity of the information, the way it is encoded, etc. This scheme multiplication renders interoperability problematic. On the other hand, it is not realistic to think possible the specification of a unique generic scheme. Our proposal goes in the direction of a higher level of generality when specifying a scheme, independently from the constraints of the coding procedure.

The second issue concerns tools. Linguistic annotation, especially when dealing with multiple domains such as prosody, syntax, gestures, etc., makes use of different tools during a same project (e.g. Praat, Anvil, Elan, etc.).

None of these tools are directly interoperable, each using a native format. One solution consists in developing higher level approaches (e.g. GrAF, see (Ide, 2007)) or annotation graphs based formats on top of which conversion routines between tools can be developed (see the *Atlas Interchange Format* (Schmidt, 2009)). However, these experiments still remain very programmatic.

Interoperability of linguistic annotated resources requires over all to be independent from the coding format. This means two kinds of prerequisites:

- specify and organize the information to be encoded independently from the constraints or restriction of the format (or the annotation tool)
- encode the information into an exchange format, readable whatever the edition or annotation system

We present in this paper a two-step approach consisting first in defining the linguistic information at a general level by means of *typed feature structures*, and second automatically generating the XML schema implementing this information. Encoding annotation using such high level schema is an element of answer to the question of interoperability: it constitutes an interchange format that guarantees that any information required by any tool is encoded.

## 2 Representing information with TFS

Linguistic knowledge is represented by means of three different types of information:

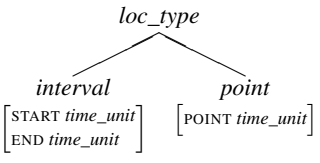
- *Properties*: the set of characteristics of an object
- *Relations*: the set of relation an object has with other objects
- *Constituents*: complex objects are made with other objects, their constituents

This information can represented by means of *typed feature structures* (see for example (Carpenter, 1992)): properties are encoded by features, constituency is implemented with complex features, and relations make use feature structure indexing.

We present in the following the main characteristics of a TFS representation of multidomain linguistic annotation. Information representation given here comes from the OTIM project (Blache, 2009) aiming at developing schemes and tools for multimodal annotation.

### 2.1 The *object* type

The *object* type is the most general one. All elements of the linguistic information is an *object* subtype. In terms of location, an object can be situated by means of two different kinds of position, depending on the fact they correspond to an interval (for example a syllable), or a point (e.g. a tone). In the first case, interval boundaries are represented by the features START and END, with temporal value (which value being label or milliseconds, depending on implicit or explicit time encoding). The following type hierarchy presents the location type and its two subtypes (*interval* and *point*), together with their appropriated features.




### 2.2 Phonetics

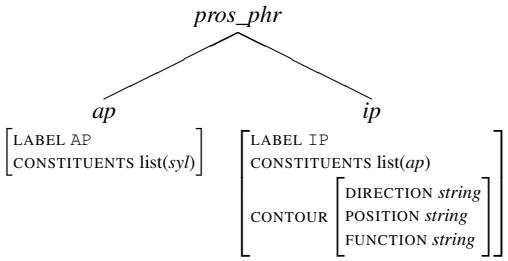
The phoneme is used as primary data in most of the cases: this object is at the lowest level of the constituent hierarchy: most of the objects are set of phonemes. The following FS proposes a representation of the main phoneme properties:

$$
\textit{phon}\begin{bmatrix}
\text{SAMPA\_LABEL } \textit{sampa\_unit} \\
\text{CAT} \left\{ \textit{vowel, consonant} \right\} \\
\text{TYPE} \left\{ \textit{occlusive, fricative, nasal, etc.} \right\} \\
\text{ARTICULATION} \begin{bmatrix}
\text{LIP} \begin{bmatrix} \text{PROTUSION } \textit{string} \\ \text{APERTURE } \textit{aperture} \end{bmatrix} \\
\text{TONGUE} \begin{bmatrix} \text{TIP} \begin{bmatrix} \text{LOCATION } \textit{string} \\ \text{DEGREE } \textit{string} \end{bmatrix} \\ \text{BODY} \begin{bmatrix} \text{LOCATION } \textit{string} \\ \text{DEGREE } \textit{string} \end{bmatrix} \end{bmatrix} \\
\text{VELUM } \textit{aperture} \\
\text{GLOTTIS } \textit{aperture}
\end{bmatrix} \\
\text{ROLE} \begin{bmatrix} \text{EPENTHETIC } \textit{boolean} \\ \text{LIAISON } \textit{boolean} \end{bmatrix}
\end{bmatrix}
$$

Phonemes being at the lowest level, they do not have any constituents. They are not organized into precise subtypes. The feature structure represent then the total information associated with this type.

### 2.3 Prosody

As seen above, prosodic phrases are of two different subtypes: *ap* (accentual phrases) and *ip* (intonational phrases). The prosodic type hierarchy is represented as follows:




Accentual phrases have two appropriate features: the label, which value is simply the name of the corresponding type, and the list of constituents, in this case a list of syllables. The objects of type *ip* contain the list of its constituents (a set of *ap*s) as well as the description of its contour. A contour is a prosodic event, situated at the end of the *ip* and is usually associated to an *ap*.

The prosodic phrases are defined as set of syllables. They are described by several appropriate features: the syllable structure (for example CVC, CCVC, etc.), the position of the syllable in the word, their possibility to be accented or prominent:

$$
\textit{syl}\begin{bmatrix}
\text{STRUCT } \textit{syl\_struct} \\
\text{POSITION} \begin{bmatrix} \text{RANK} \left\{ \textit{integer} \right\} \\ \text{SYL\_NUMBER} \left\{ \textit{integer} \right\} \end{bmatrix} \\
\text{ACCENTUABLE } \textit{boolean} \\
\text{PROMINENCE } \textit{boolean} \\
\text{CONSTITUENTS list}(\textit{const\_syl})
\end{bmatrix}
$$

Syllable constituents, objects of type *const_syl*, are described by two different features: the set of phonemes (syllable constituents), and the type of the constituent (onset, nucleus and coda). Note that each syllable constituent can contain a set of phonemes.

$$const\_syl\begin{bmatrix}\text{PHON list}(phon)\\ \text{CONST\_TYPE}\{\text{onset, nucleus, coda}\}\end{bmatrix}$$

## 3 From TFS to XML via a graphical representation

The TEI consortium proposes guidelines for implementing feature structures in XML (see TEI Guidelines P5). However, we decided not to encode TFS this way for several reasons. First, type hierarchies and inheritance are not easily and directly represented. Second, it is not realistic, or even possible, to encode all information by means of a feature structure, that rapidly becomes huge and intractable. This last argument is important in the perspective of interoperability: annotation tools mainly focus on properties annotation (the encoding of object characteristics). Only some of them propose solution for constituency representation (e.g. in terms of primary/secondary tracks). None implement typing machinery. We think then preferable a decentralized representation in which objects are represented separately, their hierarchization being encoded independently from their properties. Such an encoding offers the advantage to be close to the traditional way of encoding annotations without losing the richness of TFS representation. Our proposal, presented in this section, relies on an object-oriented representation, capable of generating automatically the XML schema of the annotation scheme.

### 3.1 Motivations

As seen above, TFS proposes to represent a precise level of annotation for the different domains and modalities (phonetics and phonology, prosody, morphology, syntax, discourse, gesture, etc). It is well suited to take into account the heterogeneous characteristics of annotated data. Each domain is represented as a hierarchical model and the global view comes from the various hierarchical organizations proposed. Unfortunately, representing with TFS the entire multimodal annotation schema is difficult, and the global interdependencies are hard to visualize. We propose then to complete this representation by means of a graphical view.

Such a graphical representation makes the reading less time consuming and easily understandable. Its disadvantage lies in its lack of details: for example, TFS describes the object's types (boolean, string, integer, etc.) which are omitted in the graphics. Concretely, we chose as modeling language UML (*Unified Modeling Language*). The idea consists in translating automatically the representation into a XML schema following specifications proposed by TFS and UML model. The XML implementation and, more specifically, the XML schema, is then a specific rendering of a very detailed model.

### 3.2 UML representation

UML relies on two different views. The static one describes the static structure in terms of objects, attributes, operations and relationships. This view includes the class diagram. The dynamic view emphasizes the dynamic behavior of a system. One of its advantages is that the language includes a set of graphical notation techniques to create and share intuitive visual models.

We can represent a TFS description by a set of UML class diagrams by means of the following mapping:

- to each complex TFS corresponds a class;
- to each TFS atomic attribute corresponds a class attribute;
- the inheritance relationship defined on the TFS is represented by an inheritance relationship on the classes;
- the constituency relationships between TFS are represented by aggregation relationships on classes.

Figures 1 shows the UML representation of phonetics and prosody domains (for clarity, the articulation gesture feature has not been developed). This graphical representation provides a global view of the two domains and suitable way for experts to share their knowledge. Some classes are represented in the two figures, their background is white (others are gray).

### 3.3 From UML to XML

In our approach, the process generates an XML schema for each domain such as phonetics and

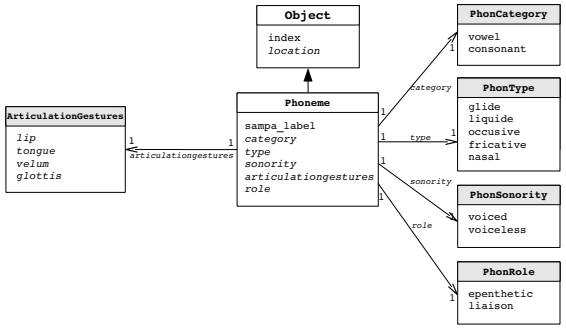



Figure 1: *UML representation of phonetics*

prosody. Data are then represented in different document structures, which is motivated by two important points: (i) this representation provides a high level of modularity for applicative requirements and enables to modify only the structure / schema needed; (ii) recents works on multistructured documents open a way for dynamically linking and aggregating various documents with different structure. Within such a framework, it is possible to deal with a TFS-like XML representation and to process data as standard XML documents.

Our XML schema, generated from TFS via UML, can be seen as the "third component" mentioned as a perspective in (Schmidt, 2009). This component, besides a basic encoding of data following AIF, encode all information concerning the organization as well as the constraints on the structures. In the same way as TFS are used as a tree description language in theories such as HPSG, the XML schema generated from our TFS representation also plays the same role with respect to the XML annotation data file. On the one hand, basic data are encoded with AIF, on the other hand, the XML schema encode all higher level information. Both components (basic data + structural constraints) guarantee against information lost that otherwise occurs when translating from one coding format to another (for example from Anvil to Praat).

## 4 Conclusion

We propose in this paper the use of a general description level, representing the annotation scheme by means of *typed feature structures*. Such a representation is independent from coding languages and tools. It guarantees the definition of a precise semantics in which type and constituent hierarchies are clearly distinguished. Moreover, such a representation makes it possible to propose a strict conversion towards an XML schema: TFS are directly coded into UML structures which are automatically translated into an XML schema.

This schema is then used as a description language over the coding scheme itself: it contains all information relative to the organization, the hierarchies as well as feature values restrictions that the annotated data have to follow. As a result, this approach, on top of providing a semantics to the schemes, completes the concrete encoding: it makes it possible to describe data at a low level (for example using AIF) and complete the description in giving the entire structuration following the TFS definitions.

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