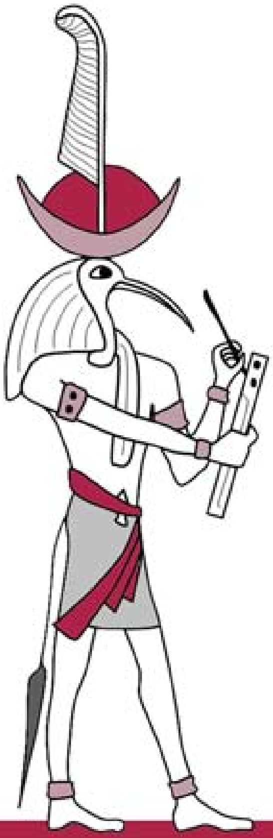

TOTh 09

Terminologie & Ontologie : Théories et Applications

Actes de la troisième conférence TOTh - Annecy - 4 & 5 juin 2009

Institut Porphyre
Savoir et Connaissance

Dans un monde où la communication et le partage d'information sont au cœur de nos activités, les besoins en terminologie se font de plus en plus pressants. Il est devenu impératif d'identifier les termes employés et de les définir de façon consensuelle et cohérente tout en préservant la diversité langagière.

La terminologie, en tant que discipline scientifique, se fonde sur une conceptualisation d'un domaine et sur les mots pour en parler. Elle se doit donc de concilier un point de vue linguistique et un point de vue ontologique. Elle doit également, dans une société numérique où les connaissances constituent la principale richesse, pouvoir être opérationnalisée à des fins de traitement de l'information.

Les conférences TOTh se situent dans le prolongement des colloques annuels de la Société française de terminologie organisés en décembre à Paris (Ecole normale supérieure de la rue d'Ulm). Planifiées à mi-parcours, au mois de juin à Annecy (Polytech'Savoie), elles en complètent l'offre et proposent des conférences avec appel à communications, comité de lecture et publication des actes.

Les conférences TOTh ont pour objectif de rassembler industriels, chercheurs, utilisateurs et formateurs dont les préoccupations relèvent à la fois de la terminologie et de l'ontologie et, de façon plus générale, de la langue et de l'ingénierie des connaissances. Elles se veulent un lieu d'échange et de partage où sont exposés problèmes, solutions et retours d'expériences tant sur le plan théorique qu'applicatif ; ainsi que les nouvelles tendances et perspectives des disciplines associées : terminologie, langues de spécialité, linguistique, intelligence artificielle, systèmes d'information, ingénierie collaborative, etc.

Christophe Roche, Président du Comité Scientifique

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- Association Européene de Terminologie
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Avant propos

Dès la troisième édition, les conférences TOTh ont trouvé une structuration qui traduit bien à la fois le caractère scientifique et pluridisciplinaire de la terminologie et l'intérêt de notre communauté pour d'autres domaines partageant des préoccupations communes.

Ainsi, la conférence d'ouverture a été donnée par une personnalité invitée issue d'une discipline différente de la nôtre – ici la phylogénèse – mais pour laquelle le langage et la pensée jouent également un rôle primordial.

Les contributions se sont réparties naturellement, et par le jeu des évaluations de façon équitable, en trois groupes ayant donné lieu à trois sessions.

Le premier groupe a rassemblé les articles portant principalement sur la dimension linguistique de la terminologie. Ont été abordés l'extraction terminologique à partir de dictionnaire, la place accordée aux corpus dans la construction de terminologies, l'acquisition de connaissances à partir de textes et l'apport des ressources linguistiques issues du web.

La deuxième session s'est donc logiquement intéressée à la dimension conceptuelle de la terminologie. Les notions de concept, de relation, d'ontologie ont été au cœur des présentations portant sur les cartes conceptuelles pour les bibliothèques numériques, les relations dynamiques et les graphes conceptuels, l'alignement d'ontologies et l'accès multilingue aux ontologies.

Enfin, la troisième session a été consacrée à la présentation de plusieurs applications terminologiques pour des secteurs aussi différents que l'ingénierie nucléaire, l'informatique, le domaine bancaire ou l'agriculture biologique. Il est à souligner que ces applications ont permis d'aborder différents points théoriques tels que la variation terminologique, la diachronie ou la structure des dictionnaires.

La richesse des débats qui ont animé ces deux jours de conférence – chaque présentation, questions comprises, s'est vue allouer plus de quarante cinq minutes de temps de parole – a été certainement une des plus belles récompenses pour les participants de TOTh 2009.

Christophe Roche

Président du Comité Scientifique

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Dynamic Concept Relations : A Definition and Representation Proposal

Chiara Messina

Résumé : Terminology standards and reference books mainly deal with static concept relations, such as generic (or hierarchical) and partitive relations. Ontological (or associative) concept relations have been seldom dealt with. Still, they play a fundamental role in the concept systems of many domains, thus requiring a deeper analysis. In particular, standards for categorization and representation of ontological relations are needed, in order to allow both terminologists and knowledge engineers to manage these relations in cooperative work.

In this paper we take up the distinction between static and dynamic situation proposed by (Jouis 2007) and further analyze dynamic concept relations and their representation. Our aim is to contribute to this research topic by suggesting a starting point for further analysis and by highlighting the issues that have to be tackled. After a brief overview of the previous work, we will outline a definition proposal for dynamic concept relations and propose a way of representing them using conceptual graphs. We shall then present a case study where conceptual graphs are used to represent dynamic relations between terms belonging to law field. In this case study, we shall use some of the concepts collected at the University of Genoa within the last edition of our Specialization degree course and University Master degree course in Legal Translation and their Italian and English designations.

Mots-clés : terminology, dynamic concept relations, conceptual graphs, ontology

1. Introduction

Most terminology standards and reference books mainly deal with static concept relations and leave little room to non-hierarchical or associative concept relations, which are usually dealt with in a concise and less detailed way.

Hierarchical relations offer the fundamental structure to design a concept system, as they help classify super-ordinate and subordinate concepts, but they still lack the necessary expressive power to describe complex concept systems or dynamic subject fields. For example, they are suitable for describing domains featuring clear structures, such as highly technical product information, catalogues, etc. With regard to this, we fully agree with (Arntz *et al.* 2004) : "Da die Terminologielehre in ihrer Entstehungsphase stark durch die technische Normung beeinflußt wurde, standen die hierarchischen Begriffsbeziehungen, die eine eher statische Sprachbetrachtung widerspiegeln, zunächst im Mittelpunkt". Still, the increasing complexity of the subject fields that terminology has to tackle nowadays shows the need for further research on non-hierarchical relations. This is especially true if we consider the growing importance that terminology is gaining in the field of knowledge management and in knowledge representation systems, where the needs of translation management have led not only to the use of specific terminology management tools, but also to an increasing integration between terminology and complex knowledge representation systems. Indeed, a domain terminology, considered as an organized concept system including concept designations and relations, is a good starting point for the development of a KRS. We are especially referring to formal ontologies, as they share a number of features with terminology. Terminology provides the conceptual structure of a domain, a formal ontology, defined as "an explicit specification of a conceptualization" (Gruber 1993), represents this knowledge formally, thus providing an operationalisation of the terminology. The main components of formal ontologies are: classes, relations, functions, formal axioms and instances. Terminology shares the first two components with ontology, classes (which correspond to concepts) and relations, but it still lacks the power to represent all kind of relations. Indeed, hierarchical relations are clearly represented in both terminology and ontology ; on the the other hand, a standard for non-hierarchical and thematic relations has not yet been defined in terminology. From this point of view, formal ontologies seem to be the most natural output for terminologies; this idea arises not only from the integration between conceptualization and specification, but also from the common background of terminology and ontology. Indeed, both terminology and ontology are based on an epistemological theory, i.e., they represent a world model – or, in other words, they both have an ontological commitment.

This paper is not meant to propose any definitive solution, but it is aimed at contributing to the research in field of dynamic concept relations by highlighting some issues that are worth being dealt with in future work. Starting from the distinction between static and dynamic situation proposed by (Jouis 2007), we shall focus on dynamic relations and outline a definition proposal. This paper introduces then a representation of dynamic concept relations by means of conceptual graphs (CGs). A similar approach was first introduced by (Gerzymisch-Arbogast 1996) ; the notation adopted in this paper, however, is based mainly on a purely logical approach (Sowa 1976, 1999) and features a higher degree of formality. We indeed consider CGs as a "formal notation that serves as an intermediary between the human and the computer" (Sowa 1976). Conceptual graphs can be expressed in a quite clear and intuitive display form that can be easily used in every-day terminology practice or translated to other logical notations, thus offering the possibility to operationalise terminology while preserving user-friendliness for terminologists and formalization possibilities for engineers.

A case study shows how conceptual graphs are used to represent dynamic relations between terms belonging to law field. In this case study, we shall use some of the concepts collected at the University of Genoa within the last edition of our Specialization degree course and University Master degree course in Legal Translation and their Italian and English designations.

2. Dynamic Concept Relations

As a beginning of this section, we shall introduce a short overview of the standards and some previous work about non-hierarchical concept relations, in order to give an insight into the current situation and into the issues that have to be clarified.

According to the standard ISO 704, "an associative relation exists when a thematic connection can be established between concepts by virtue of experience. […] Some associative relations exist when dependence is established between concepts with respect to their proximity in space or time. […] Some relations involve events in time such as a process dependent on time or sequence, others relate cause and effect" (ISO 704

2000). Space and time proximity are also considered in the German standards (DIN 2330 1993) and (DIN 2342-1 1992), which define non-hierarchical concept relations as the relations existing when spatial, temporal or causal connections are considered. The DIN standards divide non-hierarchical relations into sequential and pragmatic relations, providing a short classification: causal relations (cause-effect), genetic relations (producer-product), stages of a process, and transmission relations between sender and receiver belong to sequential relations, while thematic relations, which are nor hierarchic nor sequential, belong to pragmatic relations.

The classification proposed by (Felber 1984) is derived from Wüster's ideas. In Felber's view, ontological relations are essentially relations "characterized by contiguity (juxtaposition) in space or time or by the connection cause-effect". Felber divides concept relations into logical relationships, ontological relationships and relationships of effect. He ranks partitive relations, relations of succession and relations of material – product under ontological relations ; while causality, tooling and descent (with the subtypes genealogic descent, ontogenetic descent and descent between stages of substances) are ranked under the relations of effect. In this classification, thematic relations are not considered. This schema is quite different from the one proposed by ISO, which ranks partitive relations among hierarchical relations. Causal relations have been deeper analysed by Nuopponen (Nuopponen 1994a, 1994b). Nuopponen's categories are based essentially on Wüster's previous work (Wüster 1974), which she extends with a more detailed classification of causal relations and of the concepts involved.

A different meta-terminology is used in (Cabré 1999). Cabré distinguishes between logical and ontological concept relations. The latter are divided into coordination relationships ("(part-whole relationships), which describe two types of relationships : those established between a whole and its parts […], and those among the various parts of a single whole […]. These relationships are based on the contiguity of objects in space, and are thus produced simultaneously") and "chain relationships, which are based on the succession of objects in time (cause-effect relationships), which are thus sequential". Thus, this classification is based mainly on time variation issues, as it distinguishes between relations that happen at the same time and relations produced over a certain lenght of time. (Cabré 1999) further specifies that "ontological relationships can also exist between the formatives or words that make up complex terms". The dynamic of term formation is beyond the scope of this paper ; for insights in this topic (Kageura, 1997, 2002) can be referred to.

(Arntz *et al.* 2004) essentially follow the division of the standard DIN 2330 between sequential and pragmatic relations. To the sequential relations proposed by the DIN standard, Arntz et al. add "chronologische Beziehung", "Herstellungsbeziehung", "instrumentelle Beziehung" and "funktionelle Beziehung". Furthermore, they rank the relation concerning the stages of a process as a subordinate relation of the chronological relation.

A totally different account of dynamic concept relations is given in (Kageura 1997). The subject is dealt from an operational point of view and the categories proposed for concept system classifications are closer to the components of a formal ontology than to the traditional terminological classifications. Indeed, the categories introduced are entities, activities, and quality and relations; a further division mirrors an ontological commitment. This approach integrates terminology issues with ontological categories.

Finally, with regard to dynamic concepts we would like to mention (Pilke 2000).

If we try to sum up what we know about non-hierarchical concept relations from the previous work and the standards mentioned, we are first of all faced with a terminological question: how are we to name relations which are other than hierarchical relations ? As candidate terms we have "associative relations" (ISO 704 2000), "nichthierarchische Begriffsbeziehungen" (non-hierarchical relations) (DIN 2330 1993 ; DIN 2342-1 1992), "ontological relationships" (Cabré 1999) and "relationships of effect" (Felber 1984). Furthermore, previous literature does not clarify thematic relations in details. According to the standard ISO 704, they correspond to associative relations, therefore as a candidate term for naming this kind of relations we also have "thematic relations".

The brief overview outlined above shows clearly that there is absolutely no full consensus about the classification of non-hierarchical relations, nor on their definition. In some cases, the same relations are mentioned, but they are ranked in a different way by the various authors. Thematic relations mentioned in the DIN standards are neither further analyzed nor mentioned by other authors. Indeed, they are highly domain-dependent, which prevents general classification. Still, as they are at the core of most domain terminologies, thematic relations need to be dealt with, especially as far as their representation is concerned. In addition to the disagreement on theoretical issues concerning dynamic relations, it is not always easy to decide at which point of the classification a relation should be located exactly. For example, some relations are sequential both in space and time and, at the same time, they may produce an effect. This aspect is described in (Kageura 1997) as follows : "Within the classificatory organization of concept systems, we have to distinguish two different kinds of multidimensionality : multidimensionality introduced by the co-existence of different means of concept classification, i.e., generic/specific, part/whole, and type/value ; multidimensionality introduced by the application of different types of characteristics or facets at the same level in the generic/specific structure. Generic/specific and part/whole classifications have been widely accepted in terminological studies, as these relations are clearly recognizable among entity concepts, while type/value relations have not been given much attention as a means for classificatory organization of concepts". If we were to include all relation categories resulting from such combinations in a taxonomy, the classification of non-hierarchical relations would grow exponentially, assuring the granularity of the classification but preventing flexibility and clarity. Thus, an approach is needed which on one side relies on a solid theoretical foundation, and, on the other side, assures a certain degree of flexibility in the representation of specific domains.

In this paper we take up the classification proposed by (Jouis 2007) into "situation statique ("état de choses") et situation dynamique (modification et changement dans le domaine)" (Jouis 2007). If we look carefully at the classifications above, we may notice that, even if under different designations, they all describe relations that modify the subject field in some way and to same extent. According to such classifications, concepts belonging to the same subject field may have a temporal or spatial succession or they can affect each other in a causal, functional or more generic way. The division between static and dynamic relations allows us to comprise thematic relations in the classification, since the definition of dynamic situations of (Jouis 2007) is broad enough to include domain-dependent relations. From a terminological point of view, the definition of dynamic relations as relations modifying the subject field faces us with two important issues. First of all, concepts succeeding and affecting each other determine a multidimensional concept system, which has to be represented accordingly : "Since the characteristics of a concept are frequently specified from different points of view or facets (function, material, shape, weight, etc.) a set of characteristics that constitutes a concept is normally multidimensional. From this point alone, we can expect a concept system to be multidimensional" (Kageura 1997). Secondly, the question arises whether and how the characteristics of concept influencing each other are affected. Indeed, concept relations determine the intension of the concepts taking part in the relation and therefore their definition : "The intensional definition should be based on the concept relations determined during analysis. A definition based on a generic relation shall state the generic concept sharing the same dimension, either immediately above or at some higher level, followed by the essential characteristics that differentiate the given concept from coordinate concepts in a generic concept system" (ISO 704, 2000). According to the standard (DIN 2330), "Kann eine Definition nicht über hierarchische Beziehungen erstellt werden, ist es ausnahmensweise zulässig, nichthierarchische Begriffsbeziehungen zur Formulierung heranzuziehen. So könnte z.B. ein Produkt über seine genetische Beziehung zum Produzenten definiert werden. BEISPIEL : Gammastrahlung entsteht durch eine Isotopenkollision" (DIN 2330). This standard states the possibility that non-hierarchical relations are used in definitions, but still it does not state precisely how. According to (Arntz et al., 2004), "dynamische Begriffe (Pilke 2000 : 179ff) sind jedoch vielfach Teil eines Beziehungsgeflechts, das sich nur in der flexibleren Form eines nichthierarchischen Begriffssystems darstellen läßt. Bei der Strukturierung und Darstellung solcher Systeme wird grundsätzlich die gleiche Methodik angewandt wie bei den hierarchischen Systemen, diese wird jedoch von Fall zu Fall an die speziellen Gegebenheiten des konkreten Falles angepasst". If we are to modify the method used for hierarchical relations so as to apply it to non-hierarchical relations and to the concept involved, we have first of all to determine how non-hierarchical relations can affect the intension of concepts and how multidimensionality can be addressed in terminological definitions. Still in question is whether definitions deriving from dynamic relations can be written according to general patterns or to domain-dependent patterns.

To sum up what is outlined above, we can state that dynamic relations describe changes in the subject field and mostly imply multidimensionality ; that they cannot be represented with a hierarchical concept system, and that their description requires the standard method to be adjusted according to the specific case. Thus, we can maintain that dynamic relations can be both domain-independent (such as, for example, causal relations) and highly domain-dependent, given that they also include many domain-specific thematic relations. Therefore, we may summarise the above stating that dynamic relations are relations describing the way concepts belonging to the same subject field affect each other at any level of specification.

If we consider such definition a starting point to work with dynamic relations, we may use the ISO recommendation for intensional definitions as a basis for writing definitions according to the requirements of dynamic relations: a definition based on a dynamic relation shall state the concept taking part in the relation, followed by the way it is affected by the related concepts. In defining the concepts affected by a dynamic relation this way, two elements are to be highlighted : the cardinality of the relation, i.e., the number of concepts involved (to say it formally, the relation arguments), and the context of the concept, i.e., the situation to which the relation belongs to. Both elements can be represented formally by conceptual graphs and translated respectively into predicates and contexts in other forms of logics. Such a definition could be a trade-off between the traditional intensional definition and the recent operationalisation needs.

3. Representation of dynamic concept relations

Using conceptual graphs as a representation tool for dynamic concept relations has several advantages. As outlined above, they are an intermediary notation between highly informal and highly formal representation systems; they can be expressed in a quite intuitive display form or translated to predicate calculus and other forms of logic. However, it is important that conceptual graphs are well built ; otherwise they can cause serious problems if translated or implemented into a knowledge representation system. For this reason, a short tutorial may be necessary for terminologists who would like to work with conceptual graphs. Their difficulty degree is still much lower than that of other knowledge representation systems.

Conceptual graphs (CGs) are a "network of concepts and conceptual relations that describe the domain roles" (Sowa 1976). They are an intensional formalism as the meaning of the relation they express is called the intension, while the surrogates corresponding to the concepts involved are called the extension. We may notice a similarity with intension and class in terminology, being intension the set of characteristics of a concepts and the class the set of objects the concept refers to. Terminologies deal with the concepts of a subject field and their designations, defining the concept with their relation to the other concept belonging to the subject field ; CGs offer a representation for the concept network based on *roles*. CGs derive from Peirce's existential graphs, but, "beside Peirce's primitives, conceptual graphs provide means of representing *case relations*, *generalized quantifiers*, *indexicals* and other aspects of natural language" (Sowa 1999).

3.1. Brief overview on CGs

A more formal definition of CGs is supplied in (Sowa 1999) : "A *conceptual graph* g is a bipartite graph that has two kinds of nodes called, *concepts* and *conceptual relations*". Concepts are represented by boxes, while relations are represented by circles, for example :

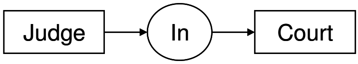

Figure 1. Conceptual graph for the sentence "A judge is in a court"

The default quantifier used in CGs is the existential quantifier ∃. The arrows between the boxes and the circle are called *arcs* and they are said to belong to the relation, not to the concept ; every arc links the concepts of the graph to the relation. The number of arcs determines the *valence* of the relation, i.e., a nonnegative integer number representing the number of the relation arguments. A relation with only one arc is said monadic, a relation with two arcs dyadic, a relation with three arcs triadic, and so on. CGs having concepts and relations can be linked together, if they feature one identical concept, by overlaying the identical concepts :

Figure 2. Conceptual graph for the sentence "An old judge is in a court"

Concepts feature a type and a referent. Types are surrogates for classes, while referents are surrogates for individuals (instances). With a "terminological terminology", we could say that types are the proper concepts, while referents are the objects referred to by the concept. The designation coincides in this case with the concept graphically, as it is written in the box. Concept types may be designated either by a type label or by a lambda expression. Usually, types precede referents and are followed by a colon. If no referent is indicated, the existential quantifier ∃ is supposed to rule. CGs thus allow to represent concepts (or classes) and referents (or instances). Types can be defined for relations, too ; furthermore, relations may have a *signature*, i.e., a constraint on the concepts that can take part in the relation.

By means of concept and relation types it is also possible to express hierarchies. To this aim it is necessary to introduce the lambda expression *e*, which may be defined as "a conceptual graph, called the body of *e*, in which *n* concepts have been designated as formal parameters of *e*" (Sowa 1999). The lambda expression is usually indicated with the Greek letter λ and, if more formal parameters have been established, a number. Hierarchies are created with subtype relations, where the symbol ≤ indicates subtype, the symbol < indicated proper subtype, the symbol ≥ indicates supertype and the symbol > indicates proper supertype. The same rules and notations are applied to hierarchies of relation types. "The definitional mechanism introduces new type labels, whose place in the hierarchy is determined by their definitions […]. The formal parameter is always a supertype of the newly defined type : Farmer ≥ MaineFarmer. As an alternate notation, type labels can be defined with the keyword type and a variable" (Sowa 1999). Finally, CGs can also represent contexts : "A context $\mathscr{C}$ is a concept whose designator is a nonblank conceptual graph *g*" (Sowa 1999). In the context $\mathscr{C}$, it is possible to nest other conceptual graphs, as in the following example :

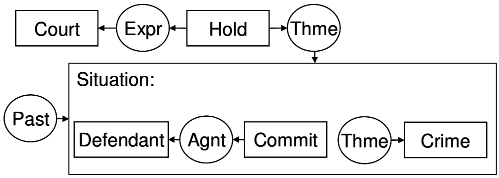

Figure 3. CG for "A court holds that a defendant committed a crime"

Identity between concepts outside the context and concepts nested in the context can be established with the so-called co-reference link, which is represented by a dotted line in the display form and by a x* in the linear form :

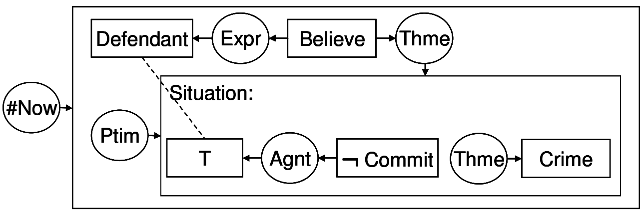

Figure 4. CG for "A defendant believes that he did not commit a crime"

In this example, the symbol ¬ indicates negation. The dotted line indicates the linked concepts are the same. This example illustrates in addiction that time can be represented in CGs. Many different notations have been proposed for time representation; an overview is given in (Schärfe 2003).

In conclusion, we can state that CGs can represent concepts, relations, and referents; concepts and relations can be arranged in hierarchies by means of their type labels ; last but not least, CGs can also represent contexts and time dimension.

3.2. Case study

In the following section, conceptual graphs are used to represent dynamic concept relations in the law field. For this case study, we chose three particularly interesting terms from the terminology collected during the last edition of the Specialization degree course and University Master degree course in Legal Translation of the University of Genoa. The course was divided into thematic units corresponding to the different branches of the law ; for every thematic unit (e.g. "criminal law") students were taught lessons of translation, law and terminology. At the end of every thematic unit, students had to produce a glossary including a number of multilingual terminology records. For this case study, we are analyzing some Italian terms featuring subtle differences from each other, which cannot be expressed in terms of characteristics deriving from hierarchic relations. The subtlety of the term differences caused the students a lot of troubles in identifying the right English equivalents. Beside proposing a way of representing dynamic concept relations, this case study is aimed to illustrate how CGs can make the terminological analysis easier.

3.3. Diffamazione

The first term analyzed is *diffamazione*. According to the Italian Penal Code, *diffamazione* is a crime and is defined as follows: "Chiunque, fuori dei casi indicati nell'articolo precedente, comunicando con piu' persone, offende l'altrui reputazione, e' punito con la reclusione fino a un anno o con la multa fino a lire due milioni […]". It is clear that this article cannot be considered a terminological definition, as it conveys a lot of information which is not essential and, at the same time, does not explicitly states other essential information. For example, the noun phrase *l'altrui reputazione* has the implicit meaning that the person offended is not present at the time of the offence. This is an essential characteristic of the concept underlying the term *diffamazione*, as it turns out to be one of the characteristics differentiating it from other terms of the same domain. Such information has to be stated in an explicit way in any knowledge representation system. At this point, we would like to recall the above mentioned definition of ontology as "an explicit specification of a conceptualization" (Gruber 1993). Thus, it is important that CGs, as an intermediate notation between plain text and formal knowledge representation systems, represent such information in an adequate way. The extraction of the relevant concepts from the above shows how implicit is the information we have. The only concepts we may obtain from text mining are [Offendere] and [Reputazione]. This means that a CG should make explicit the underlying information, as shown in the following graph :

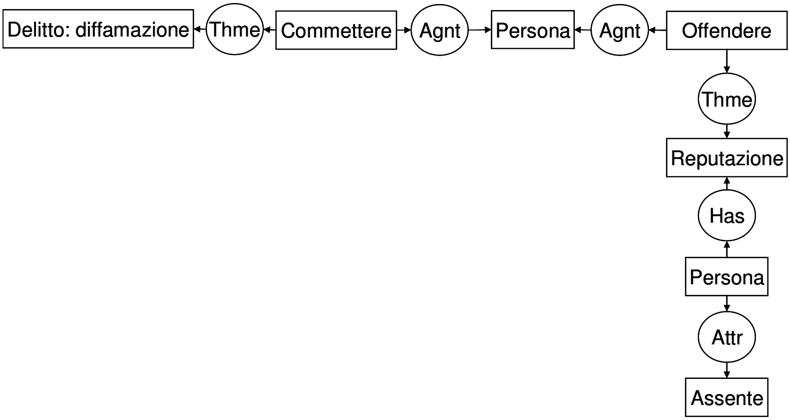

Figure 5. CG for "Diffamazione è il delitto che commette chi offende la reputazione di una persona assente"

This graph conveys the essential information for the terminological definition in an explicit way, representing both static and dynamic relations: the indication of a hierarchy at the beginning of the graph belongs to the first kind of relation; the colon allows indeed to state that *diffamazione* is a subtype of *delitto*. Thus, this CG represents both the static and the dynamic dimension of the concept intension, thus adding information to the classical intensional definition as "generic concept sharing the same dimension, either immediately above or at some higher level, followed by the essential characteristics that differentiate the given concept from the coordinate concept in a generic concept system" (ISO 704 2000). The essential characteristics differentiating the concept behind the term *diffamazione* derive from dynamic relations, which are represented in the CG by means of relation nodes. Relation nodes state the concepts of the intension and the way they interact in an explicit way. The presence of an apparently identical concept [Persona] does not represent a problem in CGs, as the identity of two concepts carrying the same name must be expressed with the coreference link. Thus, CGs allow managing concepts independently from their names, a feature that, however, should be taken into consideration when translating CGs into systems featuring unique name convention.

As an equivalent for *diffamazione*, some students proposed the English term *libel*, defining it as follows: "a written or oral defamatory statement that conveys an unjustly unfavourable impression". If we design a CG according to this definition, we may notice some differences in the intension:

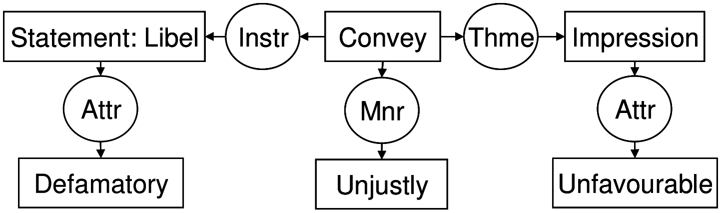

Figure 6. CG for "Libel is a defamatory statement that conveys an unjustly unfavourable impression"

First of all, it should be highlighted that this CG represents *libel* as an instrument to convey an unfavourable impression and not as an agent as *libel* is not an animate being, thus expliciting the relations in the intension and avoiding attributing intentionality to *libel* itself, which could cause serious problems in the translation to a KR system.

If we consider the content itself, we may notice that the concepts of offence, reputation and absence of the person being offended do not belong to the intension. Furthermore, a libel is defined as a *statement*, not even as a *crime*. This should led us to a reflection about the adequacy of the equivalent proposed, of the definition outlined, or, at least, about the differences of the two law systems involved. Thus, CGs provide a good feedback to check whether the conceptual analysis and the resulting definition are adequate, complete and efficient.

3.4. Ingiuria

The second term analyzed is *ingiuria*. According to the Italian Penal Code, *ingiuria* is a crime described as follows : "Chiunque offende l'onore o il decoro di una persona presente è punito con la reclusione fino a sei mesi o con la multa fino a lire un milione. […]". If we proceed as in the case of *diffamazione*, we obtain the following graph :

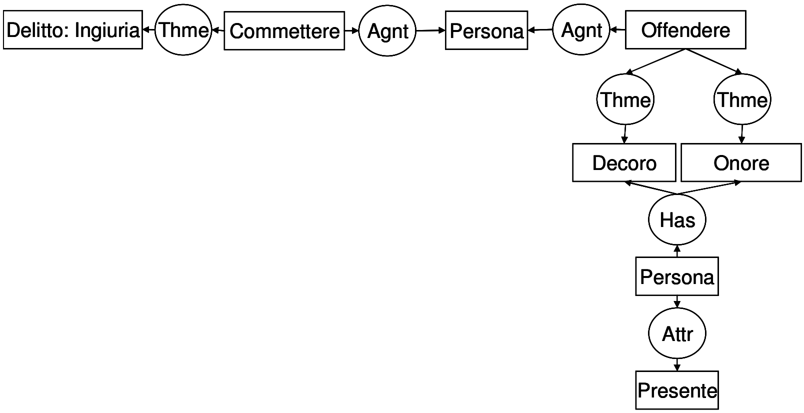

Figure 7. CG for "Ingiuria è il delitto che commette chi offende l'onore e il decoro di una persona presente"

This CG illustrates clearly the differences between the intensions of *diffamazione* and *ingiuria*, i.e., theme and attribute. Both graphs feature the same relations, but the relation values are different. Thus far the graph allows us to analyze not only the kind of relation underlying the essential characteristics of a concept, but also which values they assume. In this case, for example, the dynamic relation between [Offendere] and what is being offended is of the same type agent-theme, but the values are different: in the case of *diffamazione*, *reputazione* is theme of the action; in the case of *ingiuria*, *onore* and *decoro*. This is a crucial point for a further analysis of the specification level of thematic relations. We may notice that CGs frame dynamic relations within general relation types, to which more specific information is added in the boxes. On one side, such a representation enables to manage different specification levels at the same time depending on the focus of the analysis. On the other side, this division allows to represent the relation types in a language independent way (granted that English has been used as a basis for representing the relation nodes), while the boxes contain language-specific information, thus allowing interesting comparative analysis. From this point of view, a conceptual structure expressed in CGs is a clear output where relations, concepts and roles are stated in an explicit way, thus being an ideal basis for terminological analysis and comparison between possible equivalents. Such a bipartite structure gives terminologists an insight into the conceptual super-structure into which the domain-specific information can be mapped, thus allowing contrastive analysis focusing either on language or on the structure itself, even if we grant for the sake of argument that the CGs are designed in a consequent way with regard to both notation and *ratio*.

The equivalent for *ingiuria* proposed by the students is *insult*, which was defined as "expression, statement or behavior that is considered offensive, rude or degrading. An insult is an act that offends a person's sense of pride or dignity. Insults may be intentional or accidental".

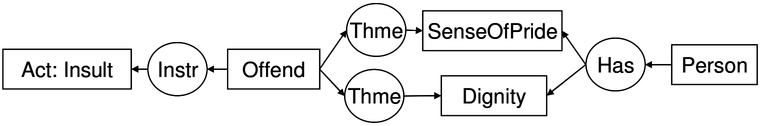

Figure 8. CG for "An insult is an act that offends a person's sense of pride or dignity"

The CG only represents the terminologically relevant information. The relations are quite close to the relations defined in the CG for *ingiuria* ; still, some concepts are missing or simply not defined (e.g. we have no information about the presence of the person being offended).

3.5. Calunnia

The last term of this case study is *calunnia*, which can be defined as follows on the basis of the Italian Penal Code : "Delitto commesso da chi, con i mezzi previsti dalla legge, accusi falsamente qualcuno di un reato, ovvero ne simuli a suo carico le tracce".

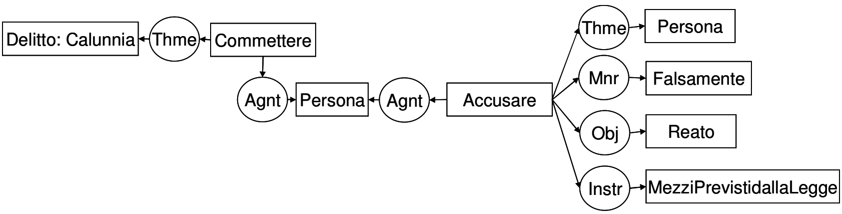

Figure 9. CG for "Calunnia è il delitto commesso da chi, con i mezzi previsti dalla legge, accusi falsamente qualcuno di un reato"

So far, we notice that the intension of *calunnia* is quite complex, as it features a 5-adic relation with an agent, a theme, a manner, an instrument and an objective (*reato*). The latter is the most controversial argument of the relation, as it describes the object of the charge, not the patient or the theme. Actually, this objective entails a whole situation, and could therefore be represented as a context.

The English equivalent proposed during the course is calumny, which was defined as follows : "A false charge or imputation".

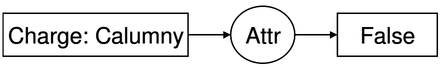

Figure 10. CG for "A calumny is a false charge"

This graph seems to represent a simpler intension if compared with *calunnia*; however, this is due to the fact that great part of the intension is entailed in the concept expressed by the term charge, which has to be made explicit accordingly :

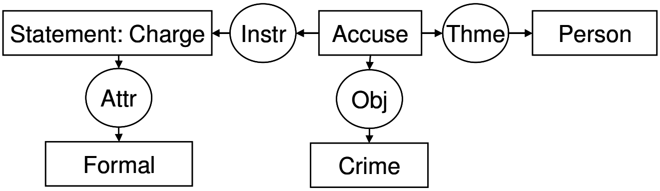

Figure 11. CG for "A charge is a formal statement to accuse a person of a crime"

At this stage we can restrict and join the graphs as follows :

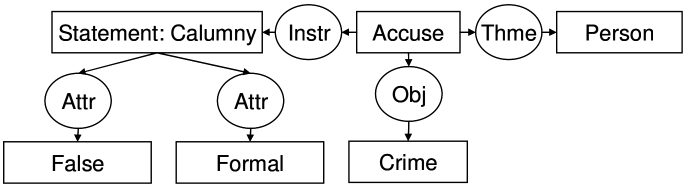

Figure 12. CG for "A calumny is a false, formal statement to accuse a person of a crime"

This graph allows a comparison in order to evaluate the equivalent proposed.

So far we have used CGs to represent the conceptual structure underlying terms which were already defined; still, from the observations we have made, it is clear that CGs are an extremely useful instrument to represent conceptual structures during the analysis of conceptual systems, with regard to both monolingual and multilingual terminology. Thus far, two methods of using CGs can be outlined. In the first place, CGs are used as a means for representing the conceptual structure, and in particular the dynamic concept relations, during the concept system analysis. This is the proper use of CGs as a representation means. This method allows terminologists to work with dynamic concept relations and complex subject fields to manage both hierarchies and thematic relations, thus encoding both static and dynamic aspects of the terminology they are working on. During terminological concept analysis, the rules outlined in (Sowa 1976) for designing and merging CGs may also apply. Firstly, the relevant concepts should be chosen and represented with the boxes (the criteria for the choice of the concepts are beyond the scope of this article ; nevertheless, we would like to mention the role that an ontological approach to terminology can play in this phase); secondly, the relations among them are made clear and represented with the corresponding nodes. If any restriction has to be imposed, signatures and lambda expressions can be added. Finally, the conceptual structure obtained this way can be modified by joining, copying, etc. Upon comparison between the graphs representing different concepts, definitions can be written according to the intension outlined in the graphs – i.e., definitions should describe clearly the relations involved and highlight the relations differentiating concepts from each other according to the predicate representation sketched by means of CGs. In this way, during the conceptual analysis itself it is possible to develop a quite formal and semantic consistent representation of the conceptual structure underlying the analyzed subject field; dynamic concept relations are represented in a bipartite way, by means of a generic relation node and of a concept box which specifies the node. It may be noticed that the relation nodes, e.g. "Agnt", "Ptnt", etc. correspond to what is called thematic roles in semantics: "Linguists often talk of thematic roles or roles […], which have to do with the participants in the events or states the sentence describe" (Chierchia *et al.* 2000). If applied to CGs, θ-roles, as they are often called, help mapping thematic information to a more general structure having a quite solid theoretical basis. Indeed, "thematic roles can be thought of as kinds of specific roles, so we could define them formally as properties common to sets of specific roles" (Chierchia *et al.* 2000). θ-roles convey both syntactic and semantic information, as they illustrate syntactic positions and, at the same time, semantic argument structure, thus acting as an interface between syntax and semantics. We are not dealing with the interactions between syntax and semantics, which is far beyond the scope of this paper; nevertheless, we would like to highlight how using thematic roles for CGs relation nodes allows different levels of analysis. Indeed, CGs represent at the same time the conceptual structure of the subject field, the relations defining a concept, and some syntactic information about the terms chosen to express the concept.

In second place, CGs can be used as a check means, too, as showed in the examples above; indeed, if designed in a consequent way, they allow to compare intensions both in monolingual and in multilingual terminology. Still, in our opinion the first approach, i.e. using CGs during the conceptual analysis, permits saving a considerable amount of time, which is a quite important factor if we consider that terminology work is an extremely time-intensive task.

4. Conclusions and future work

In the introduction we outlined a brief overview of the previous work, which highlighted the lack of a systematic definition and classification of non-hierarchical concept relations, in particular thematic relations.

Starting from the division between static and dynamic relations proposed by (Jouis 2007), we defined dynamic relations as relations describing the way concepts belonging to the same subject field affect each other at any level of specification.

In the third section, we proposed a way of representing dynamic concept relations by means of conceptual graphs, being CGs an intermediate notation between plain text terminologies and formal knowledge representation systems. We outlined a brief introduction to CGs and highlighted how relation nodes can be expressed by thematic roles, which allows a mapping of domain-dependent relations into more general relations. Thus far, we underlined the possibilities offered by thematic roles in terms of syntactic and semantic analysis.

Finally, we presented a short case study that illustrates the representation of some dynamic concept relations in law field; in the reflections on the case study we outlined two methods of using CGs in terminology work, i.e. as a proper representation means during conceptual analysis and as a check tool of definitions and concept structure.

Thus far, some issues have been tackled which need further and deeper analysis.

In the first place, it must be investigated how to represent entailments by means of CGs in a way that can be also managed in terminology work. The procedure we adopted in the case of *calunnia* may not always apply ; as it is not possible (and not even reasonable) to repeat the characteristics of every super-ordinate concept. A way of representing inheritance and inference rules should be outlined, which also takes the needs of terminologists in consideration.

In the second place, future work may also deal with the problem of distinguishing concepts and their designations, as they overlap in the graphic representation proposed so far. Still, in our opinion this is a fundamental issue, as it is connected with the more general problem of language dependency of instruments which are supposed to be language-independent.

Another interesting research topic connected with this paper is the investigation of how terminological representations by means of CGs could be extended with Petri Nets to represent processes. Indeed, tackling processes in terminology is a quite difficult task, as concepts are defined through different transitions and stages.

Finally, we would like to remark the necessity of continuing the theoretical research on dynamic concepts and non-hierarchical relations, in order to pin down what has been stated so far – and which steps still have to be taken to reach, if possible, a standard, shared approach to the topic.

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