Quantification Annotation in ISO 24617-12, Second Draft

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Abstract

This paper describes the continuation of a project that aims at establishing an interoperable annotation scheme for quantification phenomena as part of the ISO suite of standards for semantic annotation, known as the Semantic Annotation Framework. After a break, caused by the Covid-19 pandemic, the project was relaunched in early 2022 with a second working draft, which deals with certain issues in the annotation of quantification in a more satisfactory way than the original first working draft.

Keywords: semantic annotation, quantification, interoperability, annotation schema, ISO standard

1. Introduction

In 2019 the ISO organisation initiated a project that aims to define an annotation schema for quantification phenomena, as part of the suite of semantic annotation standards known as the Semantic Annotation Framework (SemAF). The project was kicked off with a first draft of an annotation schema called QuantML (ISO WD 24617-12). Due to the Covid pandemic, project activities in 2020 were postponed to 2021. The Quantification Annotation Challenge at the IWCS 2021 conference, together with feedback from ISO experts, resulted in a second draft of the QuantML annotation scheme (ISO WD 24617-12, Second Draft, November 2021) and a formal restart of the project.

This paper discusses some issues in the annotation of quantification that did not have a satisfactory treatment in the original first working draft ('FD', 2019), and how these issues are addressed in the second draft ('SD', 2021). These issues concern primarily the coverage and expressive adequacy of QuantML annotations, in particular relating to the distinction between restrictive and non-restrictive NP head modification, to quantificational aspects of relative clauses and prepositional phrases, and to generic quantification, but they also concern the conceptual clarity and transparency of the annotation scheme and the use of alternative representation formats and annotation tools.

This paper is organised as follows. Section 2 briefly summarizes the approach and the analytical framework for the annotation of quantification phenomena used in the project (for more detail see Bunt et al. (2018) and Bunt (2020)). Section 3 discusses the main issues that were addressed in the Second Draft. Section 4 is concerned with the usability of the QuantML scheme, in relation to its conceptual clarity and transparency, and support of intuitive representation formats. Section 5 wraps up with concluding remarks and suggestions for future work.

2. QuantML

2.1. Analytical Framework

2.1.1. ISO Semantic Annotation Framework

The QuantML scheme is designed according to the ISO principles of semantic annotation (ISO standard 24617-6, 'SemAF Principles', see also Bunt (2015) and Pustejovsky et al. (2017). This means that the scheme is defined by a metamodel and a markup language which has a three-part definition consisting of (1) an abstract syntax that specifies the possible *annotation structures* at a conceptual level in the form of set-theoretical constructs; like pairs and triples (2) a semantics that specifies the meaning of the annotation structures defined by the abstract syntax; (3) a concrete syntax that specifies a representation format for annotation structures. Defining the semantics at the level of the abstract syntax puts the focus of an annotation standard at the conceptual level rather than at the level of representation formats, and makes annotations interoperable across representation formats. Annotators and consumers of annotations have to deal only with concrete representations, but they can rely on the existence of an underlying abstract syntax layer and its semantics for precise specifications of the meaning of annotations.
The abstract syntax can be seen as a formalization of the metamodel (with slightly more detail and greater precision), specifying a store of basic concepts, called the 'conceptual inventory', and decribing how the elements of the inventory can be used to build well-formed annotation structures. Two types of structure are distinguished: *entity structures* and *link structures*. An entity structure contains semantic information about a segment of primary data and is formally a pair $\langle m, s\rangle$ consisting of a markable, which refers to a segment of primary data, and certain semantic information. A link structure contains information about the way two or more entity structures are semantically related. The most important entity structures in QuantML are those that describe events and their participants; link struc-

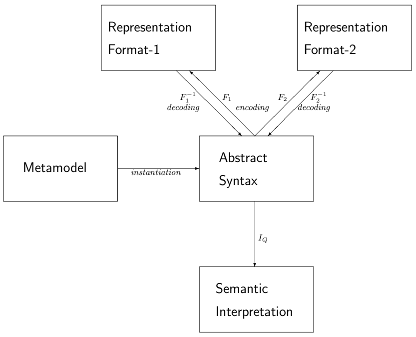

Figure 1: Architecture of QuantML.

tures relate participants to events and specify quantifier scopings.

The annotation structures defined by the abstract syntax can be represented in a variety of ways (see Fig. 1); XML is a popular representation format, and various forms of graphical representation are also used (Ide and Bunt, 2010; Abzianidze et al., 2020).

A concrete syntax specifies a vocabulary and a class of syntactic structures, which together define the class of well-formed representations, and an encoding function that assigns such a representation to every well-formed annotation structure defined by the abstract syntax.

The QuantML semantics has the form of an interpretation-by-translation into semantic representations; the recursive interpretation function I_Q maps annotation structures to Discourse Representation Structures (DRSs) in a compositional way: the interpretation of an annotation structure is a function of the interpretations of its component entity structures and link structures. This particular form of semantics is a choice of convenience rather than one of principle, inspired by the fact that DRSs have also been used in several other SemAF schemes. Other choices, such as Minimal Recursion Semantics (Copestake et al., 2005) could work equally well, and although the compositionality of the semantics seems a desirable feature, not all existing proposals for interpreting quantifiers are compositional (e.g., Robaldo, 2011). Most importantly, the semantics shows what an annotation exactly means.

2.1.2. Generalised Quantifier Theory

Quantification is linguistically, logically, and computationally extremely complex, and has been studied for centuries by logicians, linguists, formal semanticists, and computational linguists. The universal and the existential quantifier, familiar from predicate logic, can be viewed as expressing properties of sets of individual objects (Mostowski, 1957; Lindström, 1966): the universal quantifier expresses the property of containing all the elements of a given domain; the existential quantifier of containing at least one such element. This approach opened the way to generalise the notion of a quantifier to other properties of sets, such as the property of containing more than three elements, or of containing most of the elements of the reference domain. The concepts in this broader class of quantifiers are called ’generalised quantifiers’.

The study of how generalised quantifiers are used and expressed in natural language has led to generalised quantifier theory (GQT, Barwise and Cooper, 1981). An important point in this theory is that there is a fundamental difference between quantification in natural language and quantification in logic. Words like *“all”* and *“some”* in English, as well as their equivalents in other languages, might seem to be the counterparts of the universal and existential quantifiers of formal logic, and so-called ‘cardinal quantifiers and ‘proportional quantifiers’ like *“three”*, and *“most”*, may seem to be the counterparts of certain generalised quantifiers, but they are not. In formal logic, if p is a formula that denotes a proposition then the expressions ‘$\forall x.p$’ and ‘$\exists y.p$’ are quantifications, saying that p is true of all individual objects and that p is true of at least one such object, respectively. Such quantifications, which range over all individual objects in a universe of discourse, are not found in natural languages. Quantifying expressions in natural languages, instead, like *“all students”, “quelques gens”*, and *“mais que cinco melodias”*, include the indication of a restricted domain. This is reflected in the view that quantifiers in natural language are not determiners like *“all”* and *“some”*; instead, noun phrases are quantifiers (Barwise and Cooper, 1981). (In addition, quantifiers are often expressed by adverbs.)

The QuantML scheme takes an approach which combines GQT with neo-Davidsonian event semantics.

2.1.3. Neo-Davidsonian event semantics

Abzianidze & Bos (2019) note that neo-Davidsonian event semantics is adopted in most if not all semantically annotated corpora. Davidson (1989) introduced events as individual objects into semantic representations, notably as an extra argument of predicates that correspond to verbs, as in ‘read(e, x, y)’. In the neo-Davidsonian’ variation of this approach ‘(Dowty, 1989; Parsons, 1990), instead of increasing the number of arguments, one-place predicates are applied to existentially quantified event variables, and semantic roles are used to relate participants to events.

The combination of GQT with neo-Davidsonian event semantics has two advantages: (1) it allows a treatment of adverbial temporal and spatial quantifiers such as *“twice”*, *“more than three times”*, *“twice an hour”, “everywhere”, “nowhere”*, and (2) this approach is also taken in other parts of SemAF.

The neo-Davidsonian approach implies the use of an inventory of semantic roles. For reasons of intra-SemAF compatibility and in line with the recommendation by Abzianidze & Bos (2019) to use an existing role inventory, QuantML uses the set of roles defined in Part 4 of semAF, ISO 24617-4, which is based on the LIRICS and VerbNet inventories (see Bunt & Palmer, 2013; Bonial et al. 2011; Petukhova & Bunt, 2008).

3. QuantML Second Draft

3.1. Restrictive and Additive Modification

FD claims to provide a treatment of restrictive modification of NP heads by adjectives, nouns, PPs, relative clauses and possessive phrases, but as noted by Perrier (2021), the treatment in FD is unable to distinguish between restrictive and non-restrictive modification. This is illustrated by example (1), which FD would annotate as shown in Fig. 2.

(1) The man who walked in the park whistled.

The semantics of this annotation would be represented by the DRS $[x|$man$_0$(x), walk-in-park(x), whistle(x)]], which would also represent the sentence *"The man walked in the park and whistled*". This is incorrect, since the latter sentence carries the presupposition that there is a single contextually distinguished man (singled out by the predicate man$_0$), who walked and whistled, while sentence (1) does not have that presupposition. The problem is that the semantics in FD only applies to definite descriptions consisting of a bare noun, To overcome this limitation, SD proposes a treatment which is best illustrated with example (2)

(2) Two of the six men who posted a letter whistled.

The entity structure for the NP *"Two of the six men who posted a letter"* has the reference domain determined by the men who posted a letter, the involvement 2, the definiteness "determinate", and the reference domain size 6. The semantic interpretation in SD introduces two set-type discourse referents (X and X'), corresponding to the participant set and the reference domain, respectively:

(3) $I_Q(\langle\langle$man,count$\rangle$, I_Q(who posted a letter)$\rangle$, 2, det, 6) = $[X, X'|X \subseteq X', |X| = 2, |X'| = 6, x' \in X' \leftrightarrow$ [man'(x'), (who posted a letter)'(x')]]

The explicit introduction in the semantics of both the reference domain and the participant set is unsurprising, as the embedded NP *"the six men who posted a letter"* introduces a set of men, and the *"Two of"* introduces a subset of that set.

The definite singular case *"The man who posted a letter whistled"* is interpreted as saying that the reference domain is a singleton set consisting of one man who posted a letter, and all the members of that domain whistled:

(4) $I_Q(\langle\langle$man,count$\rangle$, I_Q(who posted a letter)$\rangle$, all, det, 1) = $[X, X'|X \subseteq X', X' \subseteq X, |X'| = 1, x' \in X' \leftrightarrow$ [man'(x'), (who posted a letter)'(x')]]

(The condition $X' \subseteq X$ interprets the proportional involvement "all".) This leads to the sentence annotation being interpreted schematically as the DRS (5a), which can be simplified to (5b).

(5) a. $[X, X'|X \subseteq X', X' \subseteq X, |X'| = 1, x' \in X' \leftrightarrow$ [man'(x'), (who posted a letter)'(x')], $x \in X \rightarrow$ whistle(x)]

b. $[X||X| = 1, x \in X \leftrightarrow$ [man(x), (who posted a letter)'(x)], $x \in X \rightarrow$ whistle'(x)]

If the modifier is non-restrictive, as in *"The man, who posted a letter, whistled"*, then the quantification is interpreted as saying that the reference domain is a singleton set consisting of one (contextually distinguished) man, and all the members of that domain posted a letter and whistled. Schematically:

(6) $[X, X'|X \subseteq X', |X'| = 1, x' \in X' \leftrightarrow$man$_0$'(x'), $x \in X \rightarrow$ [(posted a letter)'(x), whistle'(x)]]

Being a non-empty subset of the singleton set X', X must be identical to X', so (6) can be simplified to:

(7) $[X||X| = 1, x \in X \leftrightarrow$ man'(x), $x \in X \rightarrow$ [(posted a letter)'(x), whistle'(x)]]

So in the restrictive case there is a single man who posted a letter, and that man whistled; in the non-restrictive case a definite single (contextually distinguished) man whistled (and posted a letter). A new attribute ('restrictiveness') with values "restrictive" and "additive" is introduced to mark the distinction.

Consistent with this approach, SD treats singular proper names as quantifying over a singleton reference domain.

3.2. Relative Clauses

Compared to FD, SD provides a simpler semantics of the annotations of relative clauses modifying NP heads. As the semantic representations in (4) - (7) show, a relative clause should be interpreted as a monadic predicate. This predicate is constructed from the components of a relative clause annotation as follows.

First a relative clause (RC) is semantically just like a main clause, except that one of the verb's arguments is missing; its semantic role is played by the modified NP head. The semantic information in a relative clause is formed by the semantic role R_H associated with the head and the annotation structure A_{RC} of the events and participants in the RC. The interpretation of such an annotation structure, if it is fully scoped, has a most deeply nested sub-DRS embedded within the scope of all the quantifiers in the clause, in which the participants are linked to events in their respective semantic roles. This sub-DRS is called the 'nucleus' of the DRS. To construct the interpretation of the RC as a one-place predicate, the condition $R_H(e, z)$ that links the 'missing' participant to the event in the semantic role R_H is inserted in the nucleus, and this participant variable is abstracted over. This is expressed schematically in (8), where 'IN(K,C)' designates the operation of inserting condition C in the nucleus of K, 'evv(K)' designates the event variable of K, and A' abbreviates $I_Q(A_{RC})$.

(8) $\mathrm{I}_Q(R_a, A_{RC}) = \lambda z.\mathrm{IN}(A', R_H(\mathrm{evv}(A'), z))$

Markables:
m1=The man who walks in the park, m2=man who walks in the park, m3=man, m4=who walks in the park, m5=walks, m6=the park, m7=park, m8=whistles

QuantML annotation using XML-based concrete syntax:

```
<entity xml:id=”x1” target=”#m2” domain=”#x2” involvement=”some” definiteness=”det”/>
<qDomain xml:id=”x2” target=”#m8 source=”#x3” restrictions’#r1”/>
<sourceDomain xml:id=”x3” target=”#m3” individuation=”count” pred=”man”/>
<relClause xml:id=”r1” target=”#m4” semRole=”agent” clause=”#e1” distr=”individual” linking=”linear”/>
<event xml:id=”e1” target=”#m5” pred=”walk”/>
<participation event=”#e1” participant=”#x1” semRole=”agent” distr=”individual” evScope=”narrow />
<entity xml:id=”x4” target=”#m6” domain=”#x5” involvement=”a” definiteness=”det”/>
<sourceDomain xml:id=”x5” target=”#m7” individuation=”count” pred=”park”/>
<participation event=”#e1” participant=”#x4” semRole=”location” distr=”individual” evScope=”narrow />
<event xml:id=”e2” target=”#m6” pred=”whistle”/>
```

Abstract syntax:
A = $\langle \epsilon_E, \{\epsilon_{P1}\}, \{L_1\}, \emptyset \rangle$ with
ϵ_E = ⟨ m8, whistle ⟩, ϵ_{P1} = ⟨ m1, ⟨⟨⟨m3,man⟩, count⟩, ⟨m4,⟨‘rel. clause’, Agent, individual⟩⟩⟩, some, det⟩.

Figure 2: Example QuantML annotation (version FD).

3.3. Inverse PP Linking

A PP modifier can have a complex internal structure, since the NP that it contains can have internal modifiers of its head, such as a relative clause. The abstract syntax of a PP annotation structure is a pair $\langle R_{PP}, \epsilon_{PP} \rangle$, with ϵ_{PP} schematically as in (9), where C1 is a set of conditions and K1 is a sub-DRS; the discourse referent X corresponds to the participant set of a quantification, X’ to the reference domain.

(9) a. $[X|C1, x \in X \leftrightarrow K1]$

b. $[X, X'|C1, x \in X \leftrightarrow K1]$

The semantic interpretation of a PP-annotation is obtained by inserting the PP’s relation R_{PP}, which relates the modified NP head to the NP in the PP, in the sub-DRS K_1:

(10) $I_Q(R_{PP}, \epsilon_{PP}) = \lambda z.[\ \mathrm{X}|\mathrm{C}_1, x\ \in\mathrm{X}\rightarrow\ (K_1 \cup [|R_{PP}`(x,z)])\ ]$ if $I_Q(\epsilon_{PP})$ has the form (9a), else $= \lambda z.[X, X'|X \subseteq X', C_1, x \in X \rightarrow (K_1 \cup [|R_{PP}`(x,z)])]$

The resulting one-place predicates can be used to form the DRS that interprets a linearly linked PP-modification.

PP modifiers are often inversely linked to an NP head, meaning that the NP in the PP is a quantifier that outscopes the quantification of the head. In such a case, the two PP annotation components, P_{RP} and ϵ_{PP}, are used in the construction of the semantic interpretation of the (restrictively) modified head as follows:

(11) $I_Q(\langle\langle\langle D, v\rangle, \langle\langle R_{PP}, \epsilon_{PP}\rangle,$ individual, inverse, restrictive$\rangle\rangle, q_a,$ indet$\rangle) =$
$= I_Q(\epsilon_{PP}) \cup [X \subseteq D, Y|y \in Y \rightarrow [X' \subseteq X|q_a`(X'), x \in X' \rightarrow I_Q(R_{PP})(y,x)]]$

This is illustrated in (12) for the NPs *“A woman from every borough”* and *“Three students from all eight universities”*.

(12) a. A woman from every borough [spoke.]
$I_Q(\langle\langle\langle\langle$ woman, count $\rangle, \langle\langle$ from, $\langle\langle$ borough, count$\rangle$, all, det$\rangle\rangle$, individual, inverse, restrictive$\rangle\rangle$, some, indet$\rangle)$
= $[X \subseteq$woman, B=borough$_0|$ b $\in$ B $\rightarrow [X' \subseteq X|x' \in$ X’ $\rightarrow$ from$(b', x')]]$

b. Three students from all eight universities [participated in the talks.]
= $[X \subseteq student,$ U=university$_0||U| = 8, u \in U \rightarrow [X' \subseteq X||X'| = 3, x' \in X' \rightarrow$ from(u, x')

3.4. Quantification and Negation

Amblard et al. (2021) draw attention to the complexity of the interaction between quantification and negation, *“in particular when the polarity induced by a negation on an event differs between participants in the event”*. An example is (13), if B is understood as saying that she closed some of the windows but not all.

(13) A: It’s hot here. Did you close the windows?
B: I did not close *all* the windows.

QuantML is flexible in this respect, since polarity is not annotated as a property of events (as in ISO-TimeML), but rather as a property of the participation relation, making it possible to express polarity separately for each participant set. So for example (13), besides the reading *there is no set of close-events such that all the windows were involved as theme and I as agent*, also the reading *there is a set of close-events with I as the agent such that not all the windows were involved as theme* can be distinguished by a QuantML annotation.

3.5. Generic quantification

In FD, generic quantification is left out of consideration because of the lack of a satisfactory, widely accepted semantic treatment of generics. Generic quantification is quite common, however (see e.g. Dönicke, 2021), which would make it convenient to be able to at least signal the occurrence of generic quantifications even if such annotation would not have a proper semantic interpretation.

Although QuantML adheres to the principle that annotations should have a semantic interpretation, the three-layered structure of the annotation scheme does allow for certain distinctions to be made in the concrete syntax that do not correspond to a semantic distinction. It has been observed (Bunt, 2019) that three types of optionality may occur due to the layered structure, viz. (1) semantic optionality, i.e.the phenomenon that annotations may but do not have to contain a certain component, both in the abstract and in the concrete syntax, such as the size of the reference domain; (2) syntactic optionality, i.e. the case that a certain element need not be specified in the concrete syntax since it has a default value; if it is not specified, the default value is supplied by the decoding function and used by the semantics; (3) uninterpreted optionality, i.e. when a component may be specified in the concrete syntax, but is not considered in the abstract syntax (i.e., by the decoding function) and hence has no semantic impact. An example is the use of the attribute '@pos' in ISO-TimeML, with values like "verb" and "noun".

So in the concrete QuantML syntax, an attribute '@genericity', with values like "generic" and "non-generic", can be used to label a quantification as generic without semantic consequences.

4. Conceptual Clarity and Transparency

4.1. Events as Participants

The QuantML metamodel (see Fig. 5) suggests, as Amblard et al. (2021) note, that events and participants are disjoint categories. This is not intended (the Quantification Challenge test suite includes examples of events as participants, namely *"Anne needed to sneeze twice"*,and "*'More than for hundred ships are waiting to pass through the Suez Canal"*).

It may be noted that events can play the role of a participant in another event in a variety of ways. Some nouns such as *concert, meeting, accident, party,...* denote events, and as an NP head they indicate quantified participants. Also, as infinitival clauses in constructions like *need to sneeze, like to say, help to clean,...* they can play the same role as non-event participants (*need more money, like french fries, help my friend,...*) This aspect of the metamodel should be made explicit, even though it is not easily expressed in the visualisation.

4.2. Determinacy (and Definiteness)

FD draws a clear distinction between determinacy and definiteness, saying, with reference to Coppock & Beaver (2015): *"Definiteness is a morphological category with a language-dependent marking; in English and in other European languages it is marked by the use of a definite article or a nominal suffix"*, such as "the book" in English, and "bogen" in Danish. Other expressions that are considered to be definite include NPs with a demonstrative pronoun ("those shoes") or a 'universal' determiner ("every man"), and singular NPs with a possessive pronoun ("my house") or a genitive construction ("Mary's car"). Proper names and personal pronouns also counted as definite. Determinacy, by contrast, is the semantic property of referring to some particular and determinate entity or collection of entities (Peters and Westerståhl, 2013). Although definite expressions often have this property, the relation between definiteness and determinacy is far from straightforward.

While the distinction between the two may seem clear enough, the annotations in FD make use of an attribute called 'definiteness', with values"det" and"indet". This is confusing. In SD this attribute was therefore changed to 'determinacy' and it is made more clear that whether a NP is determinate depends entirely on the context, as Bos (2021a) emphasizes.

A fundamental issue concerns the existence of determinacy in article-less languages. Cheng & Sybesma (1999), in a much quoted survey paper, say that *"In Mandarin, bare nouns in preverbal position can be interpreted as definite or as generic, but not as indefinite. In Cantonese, bare nouns cannot be interpreted as definite; Cantonese instead uses [CL + N] classifier constructions, which can in addition receive an indefinite reading, but not a generic one. In Mandarin, [CL + N] phrases are restricted to an indefinite interpretation."* Chen (2004) writes that *"definiteness as a grammatical category defined in the narrow sense has not been fully developed in Chinese. Of the major determiners in Chinese, demonstratives are developing uses of a definite article, and yi 'one' plus classifier has developed uses of an indefinite article."* According to Jenks (2018), *"Mandarin demonstratives play a central role in the expression of definiteness. Mandarin subjects are often topics, and therefore definite."* Lee (1982) makes a similar observation about Korean. Simik & Demian (2020), who performed experimental studies of definiteness in German and Russian, find that *"Uniqueness/maximality prove to be relevant for articleless languages, although less clearly than for languages with articles."*

The upshot of this appears to be that in article-less languages, determinacy is not an obligatory aspect of quantification annotation, but it should be annotated in those cases where determinacy is marked overtly or is obvious in the given context.

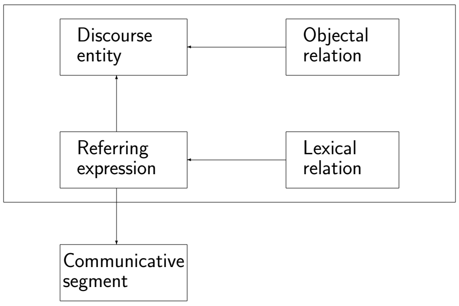

Figure 3: Metamodel for coreference annotation (ISO 24617-9).

Markables: m1 = one of the fifty-two students, m2 = the fifty-two students, m3 = students, m4 = protested.
Annotation in QuantML/XML:

```
<entity xml:id=”x1” target=”#m1” domain=”#x2”
  involvement=”one” determinacy=”det” size=”52”/>
<refDomain xml:id=”x2” target=”#m2” source=”#x3”
  restrs=””/>
<sourceDomain xml:id=”x3” target=”m3”
  individuation=”count” pred=”student”/>
<event xml:id=”e1” target=”m4” pred=”protest”/>
<participation event=”e1” participant=”x1”
  semRole=”agent” distr=”individual” polarity=”positive”/>
```

Figure 4: Segmentation and QuantML annotation in XML.

4.3. Transparency and Representation Formats

A transparent annotation scheme has a metamodel which is conceptually clear and informative. Figure 3, for example, shows the metamodel for reference annotation used in ISO 24617-9 (2019). This metamodel indicates that (1) referring expressions are anchored to s‘communicative egments’ in the primary data; (2) such expressions refer to entities that play a role in a discourse (‘discourse entities’); and (3) that referring expressions are involved in ‘lexical relations’, and discourse entities in ‘objectal relations’. While exemplary for its simplicity, this metamodel provides little information about the annotations that it supports. (For further discussion see Bunt, 2022).

A fully transparent annotation scheme allows an annotation to be viewed as an *instantiation* of the metamodel, a notion that is introduced and formalised in Bunt (2022). With a few small adustments, this is possible for the QuantML annotation scheme, as illustrated by the metamodel shown in Fig. 5 and the example annotation shown in Fig. 6. (omitting optional components and default values, like positive polarity, narrow event scope, and repetitiveness at least 1). The QuantML annotation, represented in XML format is shown in Fig. 4; this annotation has a straightforward mapping to a representation in terms of components of the SD metamodel. Boxed entities in the latter representation correspond to XML elements, and strings associated with boxes correspond to unstructure values of attributes within such elements; arrows from boxes to boxes indicate attributes with structured values. Arrows with multiple heads indicate the possibility of multiple linking (like for the participation in events) or an attribute having multiple values (like for the reference domain of a quantification being defined by a source domain and multiple modifiers). An annotation representation in this form is on the one hand a direct application of the metamodel, and can on the other hand be viewed as a graphical rendering of the XML representation.

The Nancy semantics group (‘NSG’) has used another graphical representation for XML annotations, which we refer to as ‘NSG graphs’, illustrated in Fig. 9 for the annotation of the sentence *“Not all the students passed the exam”*. This format seems more convenient for human consumption and inspection than XML. A representation in this format can also be viewed as an instantiation of the metamodel, with boxes at the edges corresponding to entity structures, arcs labelled with attribute-value pairs corresponding to link structures (participation or scoping), and other labelled arcs indicating complex values. In fact, the conversion between NSG graphs and metamodel-instantiation graphs is straightforward, and the NSG graph format can be seen very well as an alternative to the pivot XML format specified as part of ISO WD 24617-12.

Two other representation formats have been suggested by the designers of the Groningen Meaning Bank and the Parallel Meaning Bank, viz. a graphical rendering of DRSs, called Discourse Representation Graphs (DRGs, Abzianidze et al., 2020), and a string notation called Simplified Box Notation (SBN, Bos, 2021b). The SBN notation uses positional indices, indicating a distance in the primary data, instead of names of discourse entities. Figure 7 shows an example.

Positional indices make SBN representations easier to align with textual elements, which brings computational advantages for sequence-based machine learning systems. The use of these indices is thus a strength of these representations, but it is also a limitation. As Bos (2021b) mentions, universal quantification is a troublemaker since it involves the movement of textual material in order to get the scoping right. The same is true for other semantic phenomena where the order of the textual elements differs significantly from the structural position of the corresponding material in semantic representations, such as inverse linking of a PP modifier (as in *“A representative of every company visited us.”*), cross-serial dependencies, or cumulative (branching) quantification; in such cases the QuantML/XML annotation uses a feature whose value indicates the phenomenon (like linking=“inverse”, or scoping=“dual’), and the interpretation function computes the right DRS.

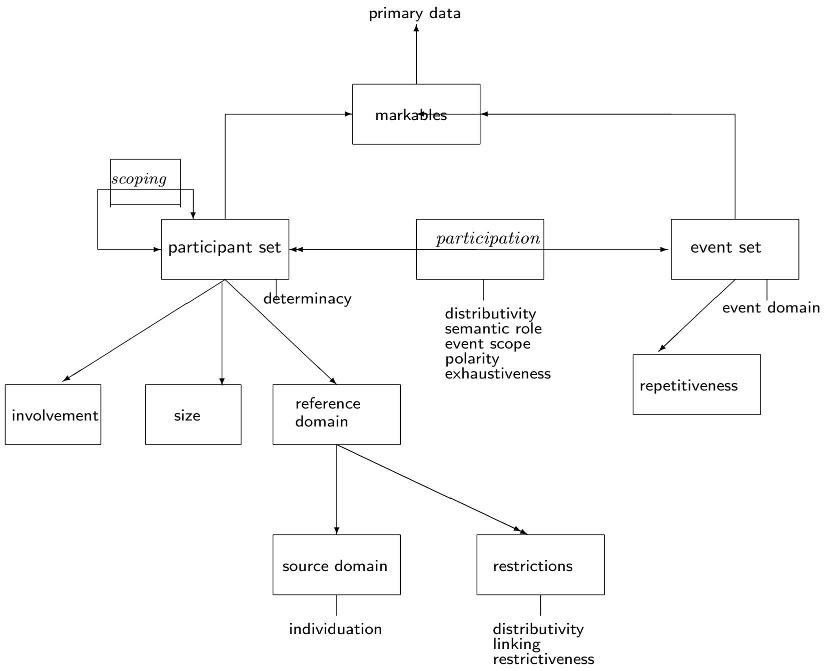

Figure 5: QuantML metamodel.

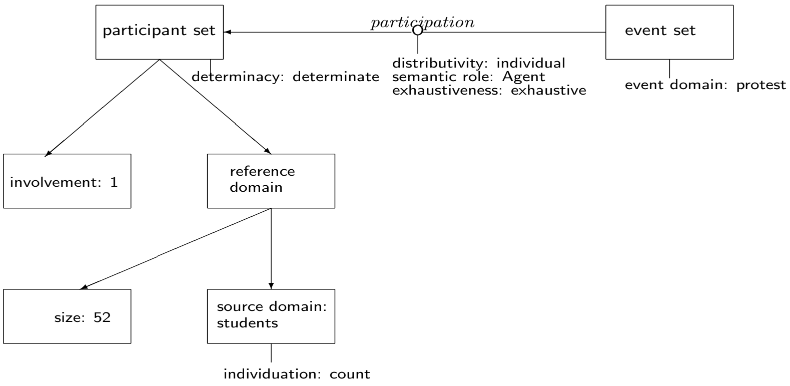

Figure 6: QuantML annotation represented as instantiation of the QuantML metamodel .

```
             NEGATION -1   % Not
             NEGATION -1   % all
student.n.01               % the
                           % students
             NEGATION -1   %
pass.v.14    Agent -1      % passed
             Theme +1      %
exam.n.01                  % the exam.
```

Figure 7: Example SBN representation

SBN + DRG forms a proposal for general meaning representation, rather than for an annotation schema, as it does not come with a specification of categories of information to be captured in annotations. Semantic *annotation* and semantic *representation* are of course close relatives, with differences in emphasis and in practice. Where a semantic *representation* of certain primary data expresses a semantic interpretation of those data, a semantic *annotation* is rather the association with the data of certain information that forms constraints on their interpretation.

Due to its notational simplicity the SBN format may be expected to be easier to use than the standard DRS format, making it more feasible for human annotators to create meaning representations, so when the purpose is to annotate text with fully-fledged meaning representations, as in the case of the Parallel Meaning Bank, then SBN seems a powerful tool. Moreover, DRGs, to which SBN representations can be automatically converted (and which are simpler than the graphical representations considered in Abzianidze et al. 2020), are a pretty graphical format that can be useful for supporting human inspection and correction of DRSs.

Primary data: *“Not all the students passed the exam.”*

Markables: m1 = all the students, m2 = students, m3 =passed, m4 = the exam, m5 = exam.

QuantML Annotation in XML:

```
<entity xml:id=”x1” target=”#m1” domain=”#x2”
  involvement=”all” determinacy=”det”/>
<sourceDomain xml:id=”x2” target=”m2”
  individuation=”count” pred=”student”/>
<event xml:id=”e1” target=”m4” pred=”pass”/>
<participation event=”e1” participant=”x1”
  semRole=”agent” distr=”individual”
  polarity=”neg-wide”/>
<entity xml:id=”x3” target=”m4” domain=”x4”
  involvement=”one” determinacy=”det”/>
<sourceDomain xml:id=”x4” target=”m5”
  individuation=”count” pred=”exam”/>
<participation event=”e1” participant=”x3”
  semRole=”theme” distr=”individual”/>
<scoping arg1=”x3” arg2=”x1”
  scopeRel=”unscoped”/>
```

Figure 8: Segmentation and QuantML annotation in XML.

QuantML Annotation as NSG Graph:

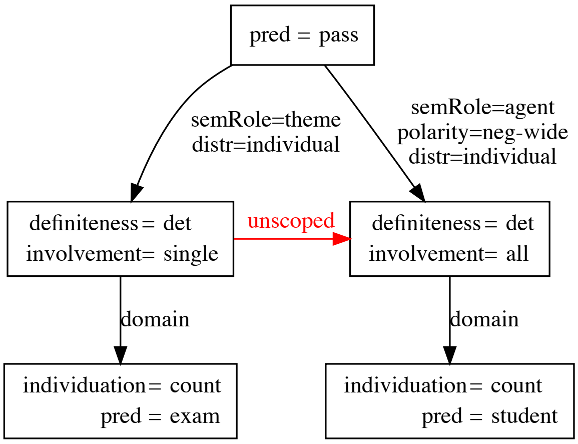

Figure 9: NSG Graph representation of *Not all the students passed the exam.*

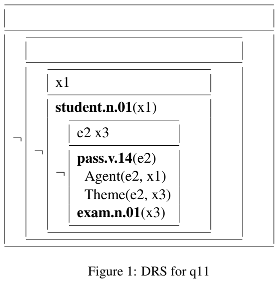

Figure 10: DRS for *Not all the students passed the exam.*

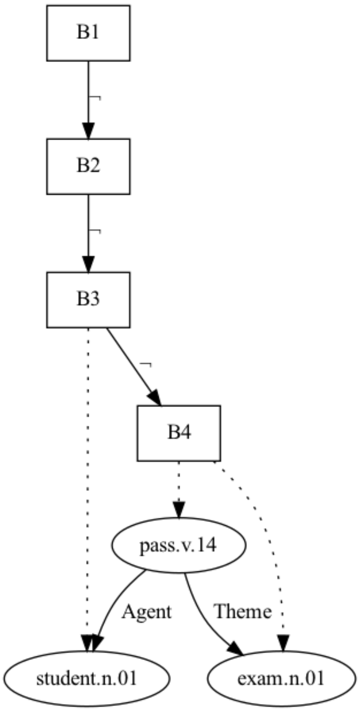

Figure 11: DRG for *Not all the students passed the exam.*

5. Conclusions

The ISO project on quantification annotation has benefited significantly from the Quantification Annotation Challenge in the ISA-17 workshop at IWCS 2021. Technical improvements and simplifications have resulted in the second draft of the QuantML annotation scheme, corroberating the idea that quantification in natural language can be semantically characterised by a relatively small number of features. Alternative representation formats have emerged, like NSG graphs and metamodel-instantiation graphs, and ideas for annotation tools, which promise to be very useful.

For semantic annotation with the aim to provide fully-fledged meaning representations as annotations, SBN representations have the advantage of relating directly to the primary data, without intermediate steps. The layered structure of QuantML, on the other hand, has the advantages of flexible alignment with the primary data through the use of markables, and hiding from the annotator the semantic intricacies of certain phenomena like quantification with mixed distributive/collective distributivity, inverse linking, exhaustive quantification, and cumulative quantification.
Future work includes the streamlining of the QuantML metamodel, to make it optimally transparent in the sense that annotations can in all cases be represented as instantiations of the metamodel, and building a comprehensive set of annotated examples in various languages - the QuantML Bank.

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