Semantic Relations in Discourse: The Current State of ISO 24617-8

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Abstract

This paper describes some of the research conducted with the aim to develop a proposal for an ISO standard for the annotation of semantic relations in discourse. A range of theoretical approaches and annotation efforts were analysed for their commonalities and their differences, in order to define a clear delineation of the scope of the ISO effort and to give it a solid theoretical and empirical basis. A set of 20 *core* discourse relations was identified as indispensible for an annotation standard, and these relations were provided with clear definitions and illustrative examples from existing corpora. The ISO principles for linguistic annotation in general and semantic annotation in particular were applied to design a markup language (DRelML) for discourse relation annotation.

1 Introduction

The last decade has seen a proliferation of linguistically annotated corpora coding many phenomena in support of empirical natural language research – both computational and theoretical. In the realm of discourse (which for the purposes of this paper is taken to include dialogue as well), a surge of interest in discourse processing has led to the development of several corpora annotated for discourse relations, for example, causal, contrastive and temporal relations. Discourse relations, also called 'coherence relations' or 'rhetorical relations', may be expressed explicitly or implicitly, and they convey meaning that is key to an understanding of the discourse, beyond the meaning conveyed by individual clauses and sentences. The types of abstract semantic objects connected by discourse relations include events, states, conditions and dialogue acts, that are typically expressed as sentences, but they can also be smaller or larger units (clauses, paragraphs, dialogue segments), and they may also occur between abstract objects not explicitly realized but inferrable from semantic content. Discourse relations and discourse structure are key ingredients for NLP tasks such as summarization (Marcu, 2000; Louis et al., 2010), complex question answering (Verberne et al., 2007), and natural language generation (McKeown, 1985; Hovy, 1993; Prasad et al., 2005) and there are now several international and collaborative efforts to create annotated resources of discourse relations, across languages as well as across genres, to support the development of such applications.

This paper describes some of the research conducted with the aim to develop a proposal for an ISO standard for the annotation of semantic relations in discourse. A range of theoretical approaches and annotation efforts were analysed for their commonalities and their differences, in order to define a clear delineation of the scope of the ISO effort and to give it a solid theoretical and empirical basis. A set of 20 *core* discourse relations was identified as indispensible for an annotation standard, and these relations were provided with clear definitions and illustrative examples from existing corpora. The ISO principles for linguistic annotation in general and semantic annotation in particular were applied to design a markup language (DRelML) for discourse relation annotation. The proposed standard is restricted to the annotation of 'local' discourse relations between two abstract objects, in that these relations are annotated

independently of other relations in the same text or dialogue. The standard does not consider higher-level discourse structure representations which would involve linking relations between units whose local relations are annotated, and would form a linking structure for an entire discourse. The standard is moreover restricted to strictly informational relations, to the exclusion of, for example, presentational relations, which concern the way in which a text is presented to its readers or the way in which speakers structure their contributions in spoken dialogue. In this paper, we present the key aspects of the proposed standard.

2 Basic concepts

2.1 Discourse relations and their realization

A major aspect of understanding a text comes from understanding how the events, states, conditions, beliefs, dialogue acts and other types of abstract objects mentioned in the discourse are related to each other by relations such as Cause, Contrast, and Condition. Examples (1-3), taken from the Wall Street Journal corpus, illustrate the Cause relation realized in different ways (shown underlined) in a text – as an explicit subordinating conjunction in (1), as an explicit expression not belonging to any well-defined syntactic class in (2), and as an implicit relation in (3). In each case, the two abstract object arguments of the discourse relation are highighlighted, in italics and boldface, respectively.

(1) Mr. Taft, who is also president of Taft Broadcasting Co., said *he bought the shares* because **he keeps a utility account at the brokerage firm of Salomon Brothers Inc., which had recommended the stock as a good buy**.

(2) *But a strong level of investor withdrawal is much more unlikely this time around*, fund managers said. A major reason is **that investors already have sharply scaled back their purchases of stock funds since Black Monday**.

(3) *Some have raised their cash positions to record levels*. (Implicit (because)) **High cash positions help buffer a fund when the market falls**.

Existing frameworks for representing discourse relations differ along several lines. This section provides a comparison of the most important frameworks, focusing on those that have been used as the basis for annotating discourse relations in corpora, in particular, the theory of discourse coherence developed by Hobbs (Hobbs, 1990), Rhetorical Structure Theory (Mann and Thompson, 1988), the cognitive account of coherence relations by Sanders et al (Sanders et al., 1992), Segmented Discourse Representation Theory (Asher and Lascarides, 2003), and the annotation framework of the Penn Discourse Treebank (Prasad et al., 2008, 2014), which is loosely based on DLTAG (Webber et al., 2003). The comparison highlights and discusses the differences that are considered relevant for developing a pivot representation in ISO SemAF-DRel. For each issue, the discussion is followed by the position adopted in the ISO standard. The section ends with a summary of the key concepts used in the ISO SemAF-DRel specification, and the ISO SemAF-DRel metamodel.

2.2 Representation of discourse structure

One difference between frameworks concerns the representation of structure. For example, the RST Bank (Carlson et al., 2003), based on Rhetorical Structure Theory (Mann and Thompson, 1988), assumes a tree representation to subsume the complete text of the discourse. The Discourse Graphbank (Wolf and Gibson, 2005), based on Hobbs' theory of discourse (Hobbs, 1990), allows for general graphs that allow multiple parents and crossing, and the DISCOR corpus (Reese et al., 2007) and ANNODIS corpus (Afantenos et al., 2012), based on Segmented Discourse Representation Theory (SDRT) (Asher and Lascarides, 2003), allow directed acyclic graphs that allow for multiple parents, but not for crossing. There are also frameworks that are pre-theoretical or theory-neutral with respect to discourse structure, including the PDTB (Prasad et al., 2008), based loosely on DLTAG (Webber et al., 2003), and DiscAn

(Sanders and Scholman, 2012), based on (Sanders et al., 1992). In both of these, individual relations along with their arguments are annotated without being combined to form a structure that encompasses the entire text. *The ISO standard takes a pre-theoretical stance involving low-level annotation of discourse; individual relations can then be annotated further to project a higher-level tree or graph structure, depending on one's theoretical preferences*. From the point of view of interoperability, low-level annotation can serve as a pivot representation when comparing annotations based on different theories.

2.3 Semantic description of discourse relations

Some frameworks, such as SDRT, Hobb's theory, PDTB, and Sanders et al's theory, describe the meaning of discourse relations in 'informational' terms, i.e., in terms of the content of the arguments; RST, on the other hand, provides definitions in terms of the intended effects on the hearer/reader. In many cases it is possible to cast one type of definition into the other. *In the ISO standard, discourse relation meaning is described in informational terms*, with the idea that a mapping can be created from the ISO core relations to those present in various existing classifications, including those that define relations in intentional terms. These mappings will be provided in the ISO document for the standard.

2.4 Pragmatic variants of discourse relations

With the exception of Hobbs (1990), all frameworks distinguish relations when one or both of the arguments involve an implicit belief or a dialogue act that takes scope over the semantic content of the argument. This is motivated by examples like (4), where John's sending of the message did not cause him to be absent from work, but rather that it caused the speaker/writer to say that John is not at work. Similarly, in (5), an explanation is provided not for the content of the question but for the questioning act itself.

(4) John is not at work today, because he sent me a message to say he was sick.
(5) What are you doing tonight? Because there's a good movie on.

This distinction is known in the literature as the 'semantic-pragmatic' distinction in Van Dijk (1979), Sanders et al. (1992), and Miltsakaki et al. (2008); as the 'internal-external' distinction in Halliday and Hasan (1976) and Martin (1992); as the 'ideational-pragmatic' distinction in Redeker (1990); and as the 'content-metatalk' distinction in SDRT (Asher and Lascarides, 2003). Some frameworks, such as that of Sanders et al. (1992), allow this distinction for all relation types; others, like the PDTB and RST only admit it for some. In the absence of *a priori* reasons for a restriction to only some relation types, we believe that the choice should in the end be determined by what is observed in corpus data. *In the ISO scheme, therefore, the 'semantic-pragmatic' distinction is allowed for all relation types*, in accordance with the general aim of not being overly restrictive in the absence of well-defined criteria. *However, the ISO scheme does not encode this distinction on the relation, but on the arguments of the relation*, because in all cases involving the inference of an implicit belief or dialogue act, what is different is not the relation itself, but rather that the arguments require an inference of a belief or dialogue act that is *implicit* in the text and that, when factored into the interpretation, changes the status of the abstract objects between which the relation holds.

2.5 Hierarchical classification of discourse relations

All existing frameworks group discourse relations together to a greater or lesser degree, but they differ in how the groupings are made. For example, while PDTB groups Concession together with Contrast under the broader Comparison class, Sanders et al. place Concession under the Negative Causal relation group but Contrast under the Negative Additive group. Reconciliation of these groupings across the frameworks is difficult, since they arise from differences in what is taken to count as semantic closeness. *The solution adopted in the ISO scheme is to initially provide a 'flat' set of core relations*. A major advantage of a flat set is that it can serve as a pivot representation between frameworks, especially

between those that groups relations differently. In the full ISO-DRel standard document, we have provided mappings between ISO-Drel relations and each of the different annotations frameworks taken into consideration here. A disadvantage, especially for the specific set of relations developed here, is that in some cases, an ISO relation can turn out to be a more general case of more fine-grained relations in some framework. However, we note that the ISO core relation set is part of an ongoing effort and we envisage further extensions to the relation set. Furthermore, an extension to the scheme that provides a well-motivated taxonomical structure is planned to be elaborated in concertation with the multilingual European TextLink project (`http://textlinkcost.wix.com/textlink`).

2.6 Representation of (a)symmetry of relations

Virtually all existing frameworks embody a representation of whether a discourse relation is symmetric or asymmetric, that is, for a given relation REL and its arguments A and B, whether (REL, A, B) is equivalent to (REL, B, A). For example, the Contrast relation is symmetric whereas the Cause relation is asymmetric. Frameworks differ in how this distinction is represented in their annotation scheme. Most classifications encode asymmetry in terms of the textual linear ordering and/or syntax of the argument realizations. Thus, in Sanders et al's classification, where the argument span ordering is one of the 'cognitive' primitives underlying the scheme, the relation Cause-Consequence captures the 'basic' order for the semantic causal relation, with the cause appearing before the effect, whereas the relation Consequence-Cause is used for the reversed order of the arguments. In the PDTB, argument spans are named Arg1 and Arg2 according to syntactic criteria, including linear order, and the asymmetrical relations are defined in terms of the Arg1 and Arg2 labels (for example, the relation Cause:Reason has Arg2 as the cause and Arg1 as the effect, while the relation Cause:Result has Arg1 as the cause and Arg2 as the effect.

In the ISO scheme, annotations abstract over the linear ordering for argument realizations, since this is not a semantic distinction. Instead, asymmetry is represented by specifying the argument roles in the definition of each relation. Arguments are named Arg1 and Arg2, but they bear relation-specific semantic roles. For example, in the Cause relation defined as 'Arg1 serves as an explanation for Arg2' (see Table 1), the text span named Arg1 will be the one that provides the reason in the Cause relation, irrespective of linear order or any other syntactic consideration. Similarly, Arg2 will always correspond to what constitutes the result in the relation. This representation can be effectively mapped to other schemes for representing asymmetry. It is important to note that this representation in no way obfuscates the differences in linear ordering of the arguments, which can be easily determined by pairing the argument role annotations with the text span annotations. Linear ordering has a bearing for claims that different versions of an asymmetric relation may not have the same linguistic constraints, for example, in terms of linguistic predictions for the following discourse (Asher et al., 2007).

2.7 Relative importance of arguments for text meaning/structure

Some frameworks, namely RST, Hobbs' theory, and SDRT distinguish relations or arguments in terms of their 'relative importance' for the meaning or structure of the text as a whole. In RST, one argument of an asymmetric relation is labeled the 'nucleus', whereas the other is labeled 'satellite' (Mann and Thompson (1988), Pg. 266). Hobbs (1990) has a similar approach, using the term 'dominance', with the goal of deriving a single assertion from a discourse relation that connects two segments, and distinguishing relations in terms of how this single assertion should be derived. In subordinating relations, in particular, the assertion associated with the relation is obtained from the 'dominant' segment, as specified in the relation definitions. SDRT, on the other hand, classifies a relation as 'subordinating' or 'coordinating' depending on what structural configuration the arguments create in the discourse graph (Asher and Vieu, 2005). *In the ISO scheme, the relative role of arguments for the text (meaning or structure) as a whole is not represented directly*, but because of the explicit identification of the roles of the arguments in each relation definition, such a layer of representation can be derived using the relation-specific argument roles. For example, for the Cause relation, a mapping from ISO categories to RST categories would

label the Arg1 (corresponding to the reason) argument as the satellite and the Arg2 (corresponding to the result) argument as the nucleus.

2.8 Syntactic form, extent and (non-)adjacency of arguments

Concerning the kinds of syntactic forms the realization of an argument can have, all frameworks agree that the typical realization of an argument is as a clause, but some allow for certain non-clausal phrases as well. This issue gets very complicated when a wide range of languages is considered. *In the ISO standard, constraints are placed on the semantic nature of arguments rather than on their syntactic form. That is, an argument of a discourse relation must denote a certain type of abstract object*.

Two related issues have to do with how complex the realizations of arguments can be syntactically, and whether arguments need to be adjacent in the discourse. With respect to complexity, all frameworks allow for argument realizations to be arbitrarily complex, composed of multiple clauses in coordination or subordinate relations, as well as multiple sentences, as long as they are required for interpreting the relation in which they participate. In some cases, such as the PDTB, further stipulations are made to the effect that argument realizations must contain the 'minimal' amount of information needed to interpret the relation. With respect to adjacency, some frameworks, such as RST, require the related arguments to be realized by textually adjacent phrases, whereas others, such as the PDTB, impose this constraint only for implicit discourse relations. To a large extent, these differences arise because of differences in assumptions about the global structure of a text, which are, then, naturally reflected in the annotation. As with syntactic form, it is difficult to reconcile these differences. *The ISO scheme remains neutral on this issue and does not specify any constraints on the extent or adjacency of argument realizations*.[1]

2.9 Summary: Assumptions of ISO standard under development

In summary, the following provides the basic concepts underlying the ISO standard under development for representing and annotating discourse relations.

- A discourse relation is a relation expressed in text/dialogue between abstract objects, such as events, states, conditions, and dialogue acts.
- Discourse relations can be expressed explicitly in text/speech or can be implicit. The annotation of implicit relations may optionally include the specification of a connective that could express the inferred relation.
- A discourse relation takes two and only two arguments. But arguments can be shared by different relations.
- The meaning of discourse relations is described in informational terms.
- Pragmatic aspects of meaning involving beliefs and dialogue acts as one or both of the arguments are represented as a property of arguments, rather than of discourse relations, and come into play only when the belief or dialogue act is implicit.
- Discourse relations are categorized as a flat set of relations.
- Annotations are at a low level; the ISO scheme is agnostic towards the nature of the global structure of a text or dialogue.
- Asymmetrical relations are represented with relation-specific argument role labels.
- The relative importance of a relation's arguments with respect to the text as a whole is not represented as such.
- No a priori assumptions are made concerning constraints on syntactic form, syntactic complexity, or textual adjacency of expressions that may realize the arguments of a discourse relation.

These choices are reflected in the metamodel of the ISO annotation scheme shown in Figure 1.

[1] Despite the flexibility for these argument features in the current ISO model, we note that for a fully interoperable annotation scheme, it is important for a consensus to be established for well-defined constraints on arguments.

3 The Annotation of Discourse Relations in DRelML

3.1 Overview

The Discourse Relations Markup Language DRelML is designed in accordance with ISO 24617-6, Principles of semantic annotation[2], which implements the distinction between annotations and representations that is made in the Linguistic Annotation Framework (ISO 24612). Accordingly, the definition of an annotation language consists of three parts:

1. an abstract syntax, which specifies a class of annotation structures in accordance with a certain conceptual view, expressed in a given metamodel;
2. a formal semantics, describing the meaning of the annotation structures defined by the abstract syntax;
3. a concrete syntax, specifying a reference format for representing the annotation structures defined by the abstract syntax.

Abstract and concrete syntax are related through the requirements that the concrete syntax is *complete* and *unambiguous* relative to the abstract syntax. Completeness means that the concrete syntax defines a representation for every structure defined by the abstract syntax; unambiguity means that every expression defined by the concrete syntax represents one and only one structure defined by the abstract syntax. A representation format defined by a concrete syntax which has these two properties is called an *ideal* representation format. An important aspect of this approach is that *any ideal representation format is convertible through a meaning-preserving mapping to any other ideal representation format* (including the GrAF format defined by Ide and Suderman (2007), as shown in (Ide and Bunt, 2010)).

In this section we present the metamodel that expresses the conceptual view underlying DRelML and outline its abstract and concrete syntax. The semantics of DRelML annotations, which is defined through a translation into discourse representation structures (DRSs), is outlined in the appendix.

Note that annotators only have to deal with the *concrete* DRelML syntax; the underlying abstract syntax is relevant mainly for establishing possible mappings between DRelML and other annotation schemes; the semantics is relevant for the extraction of content from DRelML annotated resources.

3.2 Metamodel

Of central importance in the annotation of discourse relations are evidently the relations and their arguments, and they take central stage in the metamodel shown in Figure 1. Discourse relations are linked to relation arguments through argument roles. The arguments themselves can be of various types, as indicated by the link from relation arguments to argument types. This standard assumes that two types of arguments have to be distinguished (possibly with subtypes): 'situations', which include eventualities (events, states, processes,...), facts, conditions, as well as negated eventualities (as in *"Mary smiled at John, but the didn't smile back"*), and dialogue acts involved in 'pragmatic' interpretations of discourse relations (as in *"Carl is a fool; he beats his wife"*).

The assumption made in the present standard that all discourse relations are binary is represented in the metamodel by the number '2' at the tip of the arrow from discourse relations to arguments.

The arguments of a discourse relation are always realized explicitly in the primary data; this is reflected by the fact that each argument is related to a markable, which in turn is associated with a segment of primary data. The fact that a discourse relation can be explicit or implicit is reflected in the indication '0..1' at the tip of the arrow from discourse relations to markables.

The dotted arrows at the bottom indicate possible links to another layer of annotation, concerned with the identification of the source to which a discourse relation or (one or both of) its arguments may be attributed.

[2] See Bunt (2015) for a summary description of ISO 24617-6.

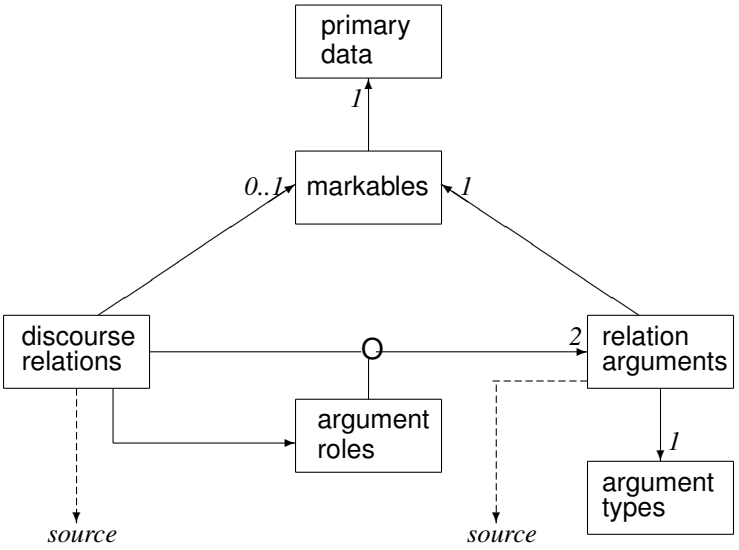

Figure 1: Metamodel for the annotation of discourse relations.

3.3 Abstract syntax

The abstract syntax of DRelML consists of (a) a 'conceptual inventory', i.e. a specification of the concepts from which annotations are built up, and (b) a specification of the possible ways of combining these elements into conceptual structures, called 'annotation structures'.

Conceptual inventory The conceptual inventory of DRelML contains the concepts that form the ingredients for building annotation structures:

1. D, a set of discourse relations.
2. R, a set of argument roles for discourse relations.
3. A function σ from R to $D \times D$ which assigns two argument roles to every discourse relation;
4. M, a set of markables that identify the segments of primary data to be marked up in a given annotation task. Different from the other ingredients of the conceptual inventory, this set is specific for an annotation task.
5. T, a set of argument types, including the types 'situation' and 'dialogue act'.

Annotation structures An annotation structure is a set of entity structures, which contain semantic information about a region of primary data, and link structures, which describe a semantic relation between two such regions.

An entity structure is either (1) a relation entity structure, which is a pair $\langle m_i, r_j \rangle$ consisting of a markable m_i, and a discourse relation r_j, or (2) an argument entity structure, which is a pair $\langle m_k, t \rangle$ consisting of a markable and an argument type.

A link structure captures the information that an argument participates in a discourse relation in a certain role, such as a triple $\langle \rho_{cause}, \varepsilon, \alpha \rangle$ consisting of a relation entity structure, an argument entity structure, and an argument role.

3.4 Concrete syntax

An XML-based representation format can be defined by introducing XML elements, attributes and values corresponding to the components of the abstract syntax. This means the specification of a vocabulary corresponding to the conceptual inventory and the definition of representation structures for the entity structures and link structures of the abstract syntax.

Vocabulary In an XML-based concrete syntax, the n-tuples of concepts that form annotation structures are represented by lists of attribute-value pairs that make up XML elements. In an XML element the meaning of a component is indicated by the name of an attribute (rather than by the position in a conceptal n-tuple), The vocabulary of DRelML therefore contains names of attributes that represent the meaning

of a position in an annotation structure, and values that name the corresponding concepts. In addition, DRelML exploits the possibility of using semantically insignificant optional parts in its representations in allowing the insertion of connective expressions in the representation of implicit discourse relations (as in PDTB annotations).

Representation structures The representation of an annotation structure is a list of the representations of its entity structures and link structures. These representation are defined as follows:

1. A relation entity structure is represented by an XML element called dRel, with the following attributes:
   - xml:id, whose value specifies a unique identifier (unique within the annotation structure);
   - target, whose value represents a markable that identifies a location in the text where a discourse relation is mentioned;
   - rel, whose value names a discourse relation.
2. An argument entity structure is represented by an XML element 'drArg', with the following attributes:
   - xml:id, whose value specifies a unique identifier;
   - target, whose value represents a markable that identifies a location in the text where a discourse relation is mentioned;
   - argType, whose value specifies an argument type.
3. A link structure containing an implicit discourse relation is represented by an XML element called implRel, which has the following attributes:
   - xml:id, whose value specifies a unique identifier;
   - rel, whose value names a discourse relation;
   - markables, whose value is a sequence of two markables, identifying the arguments of an occurrence of the implicit discourse relation;
   - disConn, whose value represents a connective, that could be inserted for an implicit discourse relation (optional).
4. A link structure containing an explicit discourse relation is represented by an XML element called drLink, which has the following attributes:
   - rel, whose value represents a relation entity structure;
   - arg, whose value is a drArg element representing an argument of a discourse relation;
   - role, whose value represents a semantic role in a discourse relation.

The following example shows the DRelML annotation representation constructed by this concrete syntax as well as the corresponding semantics. Note that both arguments of the Cause relation in this example are characterised as 'situation', rather than 'dialogue act' (or 'belief') in order to indicate the 'semantic' interpretation of the relation. The treatment of a 'pragmatic' Cause relation is considered in the appendix, which also provides more details on the derivation of the semantics from the annotation structures underlying the representations considered here.

(6) a. Carl is crazy, because he got his father's bad genes.

b. [r1] <dRel xml:id="r1" target="#m2" rel="cause"/>
[a1] <drArg xml:id="s2" target="#m3" argType="situation"/>
[a2] <drArg xml:id="s1" target="#m1" argType="situation"/>
[L1] <drLink rel="#r1" arg="s2" role="arg1"/>
[L2] <drLink rel="#r1" arg="s1" role="arg2"/>

c.

r, e1, e2
cause(r) situation(e1) result(r,e1) situation(e2) reason(r,e2)

4 ISO Core Discourse Relations

The ISO set of core discourse relations is at a level of granularity that is neither too broad nor too fine-grained. Semantic equivalences are established with five well-known semantic taxonomies for discourse relations: PDTB (Miltsakaki et al., 2008); Kehler's theory of discourse coherence (Kehler, 1995), which is itself largely based on Hobbs' work (Hobbs, 1990), Rhetorical Structure Theory (Mann and Thompson, 1988), SDRT (Asher and Lascarides, 2003) and the taxonomy of Sanders et al. (1992). It also draws on the experiences with discourse relation annotation in multiple languages and genres (Carlson et al., 2003; Wolf and Gibson, 2005; Prasad et al., 2008; Oza et al., 2009; Prasad et al., 2011; Zufferey et al., 2012; Zhou and Xue, 2012; Mladová et al., 2008; Afantenos et al., 2012; Sanders and Scholman, 2012), among others.

	ISO DRel	**Symmetry**	**Relation and Argument-Role Definitions**
1.	Cause	Asymmetric	Arg1 serves as an explanation for Arg2.
2.	Condition	Asymmetric	Arg1 is an unrealized situation which, when realized, would lead to Arg2.
3.	Negative Condition	Asymmetric	Arg1 is an unrealized situation which, when not realized, would lead to Arg2.
4.	Purpose	Asymmetric	Arg1 serves to enable Arg2.
5.	Manner	Asymmetric	Arg1 describes how Arg2 comes about or occurs
6.	Concession	Asymmetric	An expected causal relation between Arg1 and Arg2, where Arg1 is expected to cause Arg2, is cancelled or denied by Arg2.
7.	Contrast	Symmetric	One or more differences between Arg1 and Arg2 are highlighted with respect to what each predicates as a whole or to some entities they mention.
8.	Exception	Asymmetric	Arg1 evokes a set of circumstances in which the described situation holds, while Arg2 indicates one or more instances where it doesnt.
9.	Similarity	Symmetric	One or more similarities between Arg1 and Arg2 are highlighted with respect to what each predicates as a whole or to some entities they mention.
10.	Substitution	Asymmetric	Arg1 and Arg2 are alternatives, with B being the favored or chosen alternative.
11.	Conjunction	Symmetric	Both Arg1 and Arg2 bear the same relation to some other situation evoked in the discourse. Their conjunction indicates that they are doing the same thing with respect to that situation, or are doing it together.
12.	Disjunction	Symmetric	Arg1 and Arg2 are alternatives, with either one or both holding
13.	Exemplification	Asymmetric	Arg1 evokes a set of circumstances in which the described situation holds, and Arg2 instantiates an instance of the set.
14.	Elaboration	Asymmetric	Both Arg1 and Arg2 describe the same situation, but in more or less detail.
15.	Restatement	Symmetric	Both Arg1 and Arg2 describe the same situation, but from different perspectives.
16.	Synchrony	Symmetric	Some degree of temporal overlap exists between Arg1 and Arg2. All forms of overlap are included.
17.	Asynchrony	Asymmetric	Arg1 temporally precedes Arg2.
18.	Expansion	Asymmetric	Arg2 provides further description about some entity or entities in Arg1, expanding the narrative forward of which Arg1 is a part, or expanding on the setting relevant for interpreting Arg1.
19.	Functional dependence	Asymmetric	Arg2 is a dialogue act whose semantic content is, due to the dialogue act type, dependent on that of the dialogue act Arg1, that occurred earlier in the discourse.
20.	Feedback dependence	Asymmetric	Arg2 is a feedback act that provides or elicits information about the processing of Arg1, which occurred earlier in the discourse, by one of the dialogue participants.

Table 1: ISO set of core discourse relations

Table 1 presents the proposed set of core ISO discourse relations. The level of granularity is motivated by the consideration that these relations cover what has been more or less successfully implemented in various annotation efforts to date. However, this set is by no means fixed and can be augmented if necessary. As discussed in Section 2.6, the semantic roles of the two arguments are built into the definition of each relation. For lack of space, examples of only a few relations are given below. For examples of other relations, the reader is referred to the ISO document.

1. Cause: **Arg1** serves as an explanation for *Arg2*.

   a) Perhaps because **they won**, *Mr. Bork's attackers come through more vividly than his defenders*.

   b) *Sears is negotiating to refinance its Sears Tower for close to $850 million*, sources said. (Implicit=because) **The retailer was unable to find a buyer for the building**.

   c) **Now, though, enormous costs for earthquake relief will pile on top of outstanding costs for hurricane relief**. "That obviously means *that we won't have enough for all of the emergencies that are now facing us, and we will have to consider appropriate requests for follow-on funding,"* Mr. Fitzwater said.

   d) *The nations of southern Africa know a lot about managing elephants*; (Implicit=as) **their herds are thriving**.

2. Condition: **Arg1** is an unrealized situation which, when realized, would lead to *Arg2*.

   a) But some bond market analysts said *that could quickly change* if **property casualty insurance companies scramble to sell portions of their municipal portfolios to raise cash to pay damage claims**.

   b) If **anyone has difficulty imagining a world in which history went merrily on without us**, *Mr. Gould sketches several*.

3. Functional dependence: **Arg2** is a dialogue act whose semantic content is, due to its communicative function, on that of another dialogue act, *Arg1*, that occurred earlier in the discourse.

   a) *A: What newspapers do you read?* [Question]
   B: I read uh the local newspaper, and I also try and read one of the uh major dailies like the Chicago Tribune, or the New York Times or something like that [Answer]

   b) *B: I really like NPR a lot* [Inform]
   A: Yeah that?s pretty good [Agreement]

4. Feedback dependence: **Arg2** is a feedback act, i.e. a dialogue act that provides or elicits information about the processing of something said earlier by one of the dialogue participants; *Arg1* is the (sequence of) dialogue acts – or their semantic content, or their realisation – whose processing is considered.

   a) *A: go south and you'll pass some cliffs on your right*
   B: okay
   A: and keep going down south
   B: mmhmm

   b) *A: we are going to go due south straight south and then we're going to turn straight back round and head north past an old mill on the right hand side*
   B: due south and then back up again

5 Conclusions

In this paper we have summarized some of the research conducted with the aim to formulate a proposal for an ISO standard for the annotation of semantic relations in discourse. On the basis of an analysis of a range of theoretical approaches and annotation efforts a clear delineation of the scope of the ISO effort was made, restricting the effort for example to local, low-level relations with a solid theoretical and empirical basis. The ISO principles for linguistic annotation in general and semantic annotation in particular were applied to design the markup language DRelML for discourse relation annotation. Future work will aim to remove some of the restrictions adopted so far, in particular aiming to develop a well-motivated taxonomy of discourse relations in collaboration with the European TextLink project.

Although the proposal is based on existing practices and experiences such as the PDTB, the ISO scheme will need to be validated by converting existing annotations to those of the ISO scheme, as well as applying the scheme in annotation campaigns.

Acknowledgement

This work was partially supported by NSF grant IIS-1421067.

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Appendix: Semantics of Annotation Structures

Following the approach to the semantic interpretation of annotation structures outlined in ISO 24617-6 (Principles of semantic annotation), a semantic interpretation of the annotation structures defined by the abstract syntax can be obtained by compositionally interpreting annotation structures through their translation into Discourse Representation Structures (DRSs). The following rules define a translation from entity structures and link structures to DRSs. Discourse referents for the arguments of a discourse relation are paired with the markables of their textual realizations, as proposed by Bunt (2014), in order to make sure that the correct arguments are linked to the discourse relations in which they participate; this is necessary when an annotation structure is interpreted for a text fragment with multiple occurrences of the same discourse relation. The markables can be eliminated when the arguments of a discourse relation have been identified (e.g. merging with clause-internal semantics). In the rules below, a' is the vocabulary item naming the concept a of the conceptual inventory.

1. Relation entity structures: $I(\langle m_i, r_j \rangle) =$ $\begin{array}{|c|}\hline \langle m'_i, r \rangle \\ \hline r'_j(r) \\ \hline \end{array}$
2. Argument entity structures: $I(\langle m_k, t \rangle =$ $\begin{array}{|c|}\hline \langle m'_k, e \rangle \\ \hline t'_j(e) \\ \hline \end{array}$
3. Link structures with explicit discourse relation: $I(\langle \rho, \varepsilon, \alpha \rangle) =$ $\begin{array}{|c|}\hline \langle m'_\rho, r \rangle, \langle m'_\varepsilon, x \rangle \\ \hline \alpha'(r,x) \\ \hline \end{array}$
4. Link structures for implicit discourse relation: $I(\langle r_j, \langle m_1, m_2 \rangle) = \langle \{r, \langle m'_1, x \rangle, \langle m'_2, y \rangle\}, \{r'_j(r),$ $(\sigma(r_j))'_1(r,x), (\sigma(r_j))'_2(r,y)\}\rangle$ or in box notation: $\begin{array}{|c|}\hline r, \langle m'_1, x \rangle, \langle m'_2, y \rangle \\ \hline r'_j(r) \\ (\sigma(r_j))'_1(r,x) \\ (\sigma(r_j))'_2(r,y) \\ \hline \end{array}$

The following examples illustrate this for (a) an explicit 'semantic' Cause relation and (b) an implicit 'pragmatic' Cause relation.

(7) a. Carl is crazy, because he got his father's bad genes.
b. Carl is crazy; he beats his wife.

(8) Entity structures and link structures for (7) according to DRelML abstract syntax:
a. $\langle \{ \langle m_1, situation \rangle, \langle m_3, situation \rangle, \langle m_2, r_{cause} \rangle \} \}\rangle$
$\langle \langle m_1, situation \rangle, \langle m_2, r_{cause} \rangle, r_{cause-arg2} \rangle$
$\langle \langle m_3, situation \rangle, \langle m_2, r_{cause} \rangle, r_{cause-arg1} \rangle$
b. $\langle \{ \langle m_1, \langle dialog\text{-}act \rangle, \langle m_2, situation \rangle \} \rangle$
$\langle r_{cause}, \langle m_1, m_2 \rangle \rangle$

Annotation representations for (8) according to DRelML concrete syntax:

(9) a. See (6b)

b. [a1] <drArg xml:id="a1" target="#m1" argType="dialogAct"/>
[a2] <drArg xml:id="s2" target="#m2" argType="situation"/>
[L1] <implRel xml:id="r1" rel="cause" markables="#m2 #m1" disConn="because"/>

Discourse Representation Structures for (8), after elimination of marbles paired with discourse referents:

(10) a. See (6c)

b. a1 U a2 U L1 =

r, e1, e2
cause(r)
dialogue-act(e1)
result(r,e1)
situation(e2)
reason(r,e2)