ISO DR-Core (ISO 24617-8): Core Concepts for the Annotation of Discourse Relations

Harry Bunt* and Rashmi Prasad**
*Tilburg Center for Cognition and Communication (TiCC), Tilburg University, Tilburg, Netherlands
**Department of Health Informatics and Administration,
University of Wisconsin-Milwaukee, Milwaukee, USA
harry.bunt@uvt.nl;prasadr@uwm.edu

Abstract

This paper summarizes ISO 24617-8 (ISO DR-Core), a new part of the ISO SemAF framework for semantic annotation. Within this framework a range of standards is developed to support the interoperable annotation of semantic phenomena. The effort to develop a standard for the annotation of semantic relations in discourse is split into two parts, of which ISO 24617-8 concerns the first part, formulating desiderata for the annotation of discourse relations and providing clear definitions for a set of 'core' discourse relations, based on an analysis of a range of theoretical approaches and annotation efforts. Following the ISO principles for semantic annotation, an abstract syntax as well as a concrete XML-based syntax for annotations were defined, together with a formal semantics. Mappings are provided between the ISO core relations and various other annotation schemes.

Keywords: discourse relation annotation, ISO standard, interoperability

1. Introduction

In a discourse, which comes into play when communication involves a sequence of clauses or sentences in a text, or utterances in a dialogue, a major aspect of the understanding comes from how the events, states, facts, and propositions mentioned in the discourse are related to each other. Understanding such relations, such as *Cause, Contrast*, and *Condition*, contribute to what is called the 'coherence' of the discourse. They can be realized explicitly, by means of certain words and phrases (often called 'discourse connectives'), or they can be implicit and have to be inferred on the basis of the discourse context and world knowledge.

Existing annotation frameworks exhibit two major differences in their underlying assumptions: the representation of discourse structure, and the semantic classification of discourse relations. Notwithstanding these differences, there are also strong compatibilities. Based on an analysis of differences and commonalities, ISO DR-Core (ISO 247617-8: 2016) forms the first part of an effort to develop an international standard for the annotation of discourse relations.[1] This first part aims to: (1) establish desiderata for the interoperable annotation of discourse relations; (2) specify a way of annotating discourse relations that is compatible with existing and emerging ISO standard annotation schemes of semantic information; and (3) provide clear and mutually consistent definitions of a set of 'core' discourse relations which are commonly found in some form in existing approaches to discourse relations and their annotation. Together, (2) and (3) form a 'core annotation scheme' for discourse relations.

ISO DR-Core does not aim at providing a fixed and exhaustive set of discourse relations, but rather at providing an open, extensible set of relations. It also discusses certain issues that it leaves open, as they require further study in collaboration with other efforts, in particular with the European COST action TextLink.

Drawing on the commonalities found across existing frameworks, ISO DR-Core defines 20 core discourse relations and provides mappings of these relations to other annotation schemes. With respect to discourse structure, ISO DR-Core provides specifications for a low-level annotation of discourse relations, with the idea that (a) the description at this low level is what is well understood and can be unequivocally defined; (b) extensions to represent higher-level discourse structure will be possible where desired; and (c) it will allow for annotations to be compatible across frameworks, even when they are based on different theories of discourse structure.

The ISO 24617-8 core annotation scheme can be used in three different situations:

- for annotating discourse relations in natural language corpora;
- for defining mappings between annotations made using different frameworks or annotation schemes;
- as a target representation of automatic methods for shallow discourse parsing, for summarization, and for other NLP applications.

2. Basic concepts

This section provides a very brief 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 theories of discourse coherence developed by Hobbs (Hobbs, 1990) and Kehler (1995); Rhetorical Structure Theory (Mann

[1] This paper may be regarded as an update and complement of Prasad and Bunt (2015), henceforth PB'15, which describes the state of developing ISO 24617-8 in early 2015.

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). The section ends with a summary of the main assumptions that underlie ISO DR-Core.

2.1. Representation of discourse structure

One difference between existing frameworks for representing discourse relations concerns the representation of structure. For example, the RST Bank (Carlson et al., 2003) 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 allows for general graphs that allow multiple parents and crossing, while the DISCOR corpus (Reese et al., 2007) and the ANNODIS corpus (Afantenos et al., 2012), based on SDRT (Asher and Lascarides, 2003), use directed acyclic graphs that allow for multiple parents, but not for crossing. Some frameworks are theory-neutral with respect to discourse structure, including the PDTB (Prasad et al., 2008) and DiscAn (Sanders and Scholman, 2012), both of which annotate individual relations and their arguments without combining these to form a structure that encompasses the entire text. *ISO DR-Core takes a theory-neutral stance, annotating only low-level discourse relations that can then be annotated further to project a higher-level tree or graph structure, depending on one's theoretical preferences*. (Note, however, that no constraints are assumed that would prevent selecting larger spans of text as realizations of arguments, including single- or multi-paragraph long text, or subdialogues – see Section 2.7.) From the point of view of interoperability, low-level annotation can serve as a pivot representation when comparing annotations based on different theories.

2.2. 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 ISO DR-Core, 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 are provided in Section 3.

2.3. 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 (1), 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 believe that John is not at work.

(1) John is not at work today, because he sent me a message to say he was sick.

This distinction is known in the literature as the 'semantic-pragmatic' distinction (Sanders et al. (1992)); as the 'ideational-pragmatic' distinction in Redeker (1990); and as the 'content-metatalk' distinction in SDRT. Some frameworks, such as that of Sanders et al., allow this distinction for all relation types; others, like the PDTB and RST only admit it for some. Since we believe that the choice should in the end be determined by what is observed in corpus data *ISO DR-Core allows this distinction for all relation types. However, ISO DR-Core does not encode this distinction on the relation, but on the arguments of the relation*, because in all cases 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. In the semantic representation of (1), for example, the two arguments related by a *Cause* relation are a belief (namely that John is not at work today) and an event, where the inferred belief concerns the first argument, not the relation between the arguments. The annotation scheme thus conforms to the *semantic* representation of the relation and its arguments.

2.4. 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. Reconciliation of groupings across frameworks is difficult, since they arise from differences in what is taken to count as semantic closeness. *The solution adopted in ISO DR-Core is to initially provide a 'flat' set of core relations*. In some cases, an ISO relation can turn out to be a more general case of more fine-grained relations in some other framework. As noted in Prasad and Bunt (2015), an advantage of a flat set is that it can serve as a pivot representation between frameworks, especially between those that groups relations differently. A disadvantage, especially for the ISO 24617-8 set of core relations, is that in some cases a relation may turn out to be a more general case of more fine-grained relations in some framework. However, note that the ISO core relation set is part of an ongoing effort and we envisage further extensions to the relation set. Furthermore, an extensions to the core annotation scheme with a well-motivated taxonomical structure is planned to be elaborated in concertation with the TextLink project.

2.5. Representation of (a)symmetry of relations

Virtually all existing frameworks embody a representation of whether a discourse relation is symmetric or asymmetric; for example, the Contrast relation is symmetric whereas the Cause relation is asymmetric. Most annotation schemes encode asymmetry in terms of the textual 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. In the PDTB, argument spans are named Arg1 and Arg2 according to syntactic criteria, including linear order.

In ISO DR-Core, annotations abstract over the linear ordering for argument realizations, since this is not a semantic distinction. Asymmetry is represented by specifying the argument roles in the definition of each relation, arguments bearing relation-specific semantic roles. For example, in the Cause relation, defined as 'Arg1 provides a reason for Arg2' (see Table 1), the text span named Arg1 is the one that provides the reason in the Cause relation, irrespective of linear order or any other syntactic consideration, and Arg2 corresponds to what constitutes the result in the relation. This representation can be effectively mapped to other schemes for representing asymmetry, and in no way obfuscates the differences in linear ordering of the arguments, which is easily determined by pairing the argument role annotations with the text span annotations, as in the examples (2) - (5) in Section 4.3. 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 discourse that follows (Asher et al., 2007).

2.6. 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'. *In ISO DR-Core, 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.

2.7. 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. *In ISO DR-Core, 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 the realizations should be adjacent in the discourse. *ISO DR-Core remains neutral on both these issues and does not specify any constraints on the extent or adjacency of argument realizations*.[2]

2.8. Summary: Assumptions of ISO DR-Core

In summary, the following basic concepts and assumptions underlie ISO DR-Core.

- A discourse relation is a relation expressed in discourse (written, spoken, or multimodal) 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. 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 arguments are represented as a property of arguments, rather than of discourse relations.
- Discourse relations are categorized as a flat set of relations.
- Annotations are at a low level; ISO DR-Core 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.

[2]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.

	ISO DRel	Symmetry	Relation and Argument-Role Definitions
1.	Cause	Asymmetric	Arg1 provides a reason for Arg2 to come about or occur.
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 enables Arg2.
5.	Manner	Asymmetric	Arg1 is a way in which 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 doesn't.
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 Arg2 being the favored or chosen alternative.
11.	Conjunction	Symmetric	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 describes a set of situations; Arg2 is an element of that set.
14.	Elaboration	Asymmetric	Arg1 and Arg2 are the same situation, but Arg2 contains more detail.
15.	Restatement	Symmetric	Arg1 and Arg2 are the same situation, but described 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. The Arg1 and Arg2 situations are distinct.
19.	Functional dependence	Asymmetric	Arg2 is a dialogue act with a responsive communicative function; Arg1 is the dialogue act(s) that Arg2 responds to.
20.	Feedback dependence	Asymmetric	Arg2 is a feedback act that provides or elicits information about the understanding or evaluation by one of the dialogue participants of Arg1, a communicative event that occurred earlier in the discourse.

Table 1: ISO set of core discourse relations

3. ISO Core Discourse Relations

Table 1 presents the 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 2.5., the semantic roles of the arguments are built into the definition of each relation; labels for the semantic roles are listed in Table 2.

The set of ISO core discourse relations takes into account the work of annotating relations in (spoken) dialogue that has resulted in ISO standard 24617-2 for dialogue act annotation. The coherence relations that are found in written text are also found in spoken dialogue, both within speaker turns (where they contribute to the coherence of what is said in a turn) and between speaker turns (Petukhova et al., 2011; Riccardi et al., 2016; Tonnelli et al., 2010).[3] But more important for the coherence of spoken dialogue is that the participants respond to each other. Many dialogue acts are inherently 'responsive' (or 'backward-looking'), such as *Answer, Confirmation, Disconfirmation, Agreement, Disagreement, Correction, Accept Offer, Reject Suggestion, Address Request, Accept Apology*, and many others. Dialogue acts with such a function can only be understood in relation to what it is that they respond to. ISO 24617-2 therefore annotates such dialogue acts not only as having a certain communicative function, but also as having a 'functional dependence' relation with one or more previous dialogue acts. Similarly for feedback acts, which do not only have a feedback function but also a 'feedback dependence' relation to what it is that they provide or elicit information about (see Petukhova et al., 2011).

The annotation of coherence relations in (spoken) dialogue that have their basis in the use of 'responsive' dialogue acts is defined in the annotation scheme of ISO

[3]ISO DR-Core has been applied in the annotation of discourse relations in dialogues in the DialogBank; see Bunt et al., 2016).

24617-2. For example, the question-answer relation, which is sometimes considered as a discourse relation, is annotated as shown in (2), where speaker P2 answers a question by speaker P1. In (2b), which is represented in the XML-based format of the ISO 24617-2 Dialogue Act Markup Language (DiAML), the markables #s1 and #s3 identify the stretches of speech corresponding to P1's question and P2's answer, respectively. (See example (6) in Section 4.4 for the annotation of P1's second utterance.) The characterization of P2's contribution as being an answer in combination with the specification of the functional dependence relation with P1's question captures this coherence relation.

(2) a. P1: Is it safe to put my camera through here?
It's a very expensive camera you know.
P2: Yes, that's perfectly safe.

b. <dialogAct id="a1" target="#s1" sender="#p1"
addressee="#p2" dimension="task"
communicativeFunction="question" />
<dialogAct id="a3" target="#s3" sender="#p1"
addressee="#p2" dimension="task" />
communicativeFunction="answer"
functionalDependence="#a1"/>

Tables (3) - (5) show equivalences between the ISO DR-Core relations and seven well-known taxonomies for discourse relations: RST and the RST Treebank; SDRT and the DISCOR and ANNODIS schemes; the PDTB taxonomy and the classification of Sanders et al.. 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, and on other attempts to construct mappings between annotation schemes (Benamara and Taboada, 2015; Lapshinova et al., 2015).
The correspondences shown are based on a comparison of the relation definitions provided in the various frameworks. From RST, we have also included a few of the presentational relations since they cover the same kinds of examples, although we note that the presentational type of meaning is described in RST to capture speaker intentions (i.e., speaker's belief of the intended effect on the hearer), so the correspondence with these presentational relations in RST is not strict. On the other hand, it may be possible to view this subset of the presentational relations as also subject-matter relations.

4. Annotation of Discourse Relations in XML

4.1. Overview

The annotations of discourse relations in ISO DR-Core are designed in accordance with ISO 24617-6, Principles of semantic annotation[4], 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' as set-theoretical constructs, independent of any particular representation format, in accordance with a conceptual view as expressed in a 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 *ideal*. An important point of this approach is that *any ideal representation format is convertible through a meaning-preserving mapping to any other ideal representation format*.
Figure 1 presents the metamodel that expresses the conceptual view underlying ISO DR-Core and outline its abstract and concrete syntax. The semantics of ISO DR-Core annotations, which is defined through a translation into discourse representation structures (DRSs), is outlined in the appendix of PB'15.
Note that annotators only have to deal with the *concrete* DRelML syntax; the abstract syntax mainly has a theoretical significance for proving the convertibility of the DRelML scheme to other annotation schemes and representations and vice versa; see ISO 24617-2 and Bunt (2015). The semantics of the annotations, which is defined for the abstract syntax and is inherited by its concrete representations, is relevant for the extraction of content from DRelML annotated resources and for inferencing with DRelML annotations.

4.2. 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. ISO

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

	Discourse relation	Argument role labels
1	Cause	Reason, Result
2	Concession	Expectation-raiser, Expectation-denier
3	Elaboration	Broad, Specific
4	Restatement	n.a.
5	Condition	Antecedent, Consequent
6	Negative Condition	Negated-Antecedent, Consequent
7	Contrast	n.a.
8	Similarity	n.a.
9	Expansion	Foreground, Entity-description
10	Purpose	Goal, Enablement
11	Manner	Means, Achievement
12	Exception	Regular, Exclusion
13	Substitution	Disfavoured-alternative, Favoured-alternative
14	Conjunction	n.a.
15	Disjunction	n.a.
16	Exemplification	Set, Instance
17	Synchrony	n.a.
18	Asynchrony	Before, After
19	Functional dependence	Antecedent-act, Dependent-act
20	Feedback dependence	Feedback-scope, Feedback-act

Table 2: Role labels for arguments of ISO DR-Core discourse relations

ISO DR-Core	RST	RST Treebank
Cause	Vol. cause, Non-vol. cause, Vol. result, Non-vol. result, Evidence, Justify	Cause, Consequence, Result Evidence, Explanation-argumentation, Reason
Condition	Condition	Condition, Contingency, Hypothetical
Negative Condition	Otherwise	Otherwise
Purpose	Purpose	Purpose
Manner	–	Manner, Means
Concession	Concession	Concession, Antithesis, Preference
Contrast	Contrast	Comparison
Exception	–	–
Similarity	–	Analogy, Proportion
Substitution	Antithesis	–
Conjunction	Joint	List
Disjunction	Joint	Disjunction
Exemplification	Elaboration (set-member)	Elaboration set-member, Example
Elaboration	Elaboration (general-specific, whole-part, Elaboration (abstract-instance, process-step)	Conclusion, Elaboration-general-specific, Conclusion, Elaboration-general-specific, Elaboration-part-whole, Elaboration-process-step, summary
Restatement	Restatement	–
Synchrony	–	Temporal-same-time
Asynchrony	Sequence	Temporal-before, Temporal-after, Sequence, Inverted-sequence
Expansion	Elaboration (object-attribute)	Elaboration object-attribute, Elaboration additional

Table 3: Mapping between discourse relations in ISO DR-Core, RST, and RST Treebank

DR-Core 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"*) (cf. Ginzburg, 2011).

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.

4.3. Abstract and concrete syntax

The abstract syntax of ISO DR-Core annotations consists of (a) a specification of the concepts from which

ISO DR-Core	SDRT	DISCOR	ANNODIS
Cause	Explanation, Result	Explanation, Result	Explanation, Result
Condition	Consequence	Consequence	Conditional
Negative Condition	Consequence	Consequence	Conditional
Purpose	Explanation	Explanation	Goal
Manner	Elaboration	Elaboration	Elaboration
Concession	Contrast	Contrast	Contrast
Contrast	Contrast	Contrast	Contrast
Exception	–	–	–
Similarity	Parallel	Parallel	Parallel
Substitution	–	–	–
Conjunction	Continuation	Continuation	Continuation
Disjunction	Alternation	Alternation	Alternation
Exemplification	Elaboration	Elaboration	Elaboration
Elaboration	Elaboration	Elaboration	Elaboration
Restatement	Elaboration	Elaboration	Elaboration
Synchrony	–	–	–
Asynchrony	Narration	Narration, Precondition	Narration, Flashback
Expansion	Background, Elaboration	Background, Elaboration	Background, Entity-Elaboration
		Commentary	Comment
–		Attribution, Source	Attribution, Frame, Temporal-location

Table 4: Correspondences between ISO DR-Core, SDRT, DISCOR and ANNODIS

ISO DR-Core	PDTB	Sanders et al/DiscAn
Cause	Reason, Result,	Causal-Semantic-Basic-Positive
	Justification	Causal-Semantic-NonBasic-Positive
		Causal-Pragmatic-Basic-Positive
		Causal-Pragmatic-NonBasic-Positive
Condition	Hypothetical, General,	Causal-Semantic-Basic-Positive
	UnrealPast, UnrealPresent,	Causal-Semantic-NonBasic-Positive
	FactualPast,	Causal-Pragmatic-Basic-Positive
	FactualPresent	Causal-Pragmatic-NonBasic-Positive
Negative Condition	Condition	–
Purpose	Result	Causal-Pragmatic-Basic-Positive
		Causal-Pragmatic-NonBasic-Positive
Manner	–	AdditiveSemantic-Basic-Positive
	–	AdditiveSemantic-NonBasic-Positive
Concession	Expectation,	Causal-Semantic-Basic-Positive ,
	Contra-Expectation	Additive-Semantic-Negative
Contrast	Juxtaposition, Opposition	Additive-Semantic-Negative
Exception	Exception	Additive-Semantic-Negative
Similarity	Conjunction	Additive-Semantic-Positive
Substitution	Chosen Alternative	Additive-Semantic-Negative
Conjunction	Conjunction, List	Additive-Semantic-Positive
Disjunction	Disjunctive, Conjunctive	Additive-Semantic-Negative
Exemplification	Instantiation	Additive-Semantic-Positive
Elaboration	Generalization, Specification	Additive-Semantic-Positive
Restatement	Equivalence	–
Synchrony	Synchronous	–
Asynchrony	Precedence, Succession	–
Expansion	EntRel	Additive-Semantic-Positive

Table 5: Correspondences between ISO DR-Core, the PDTB, and Sanders et al./DiscAn

annotations are built up, and (b) a specification of the possible ways of combining these elements into 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

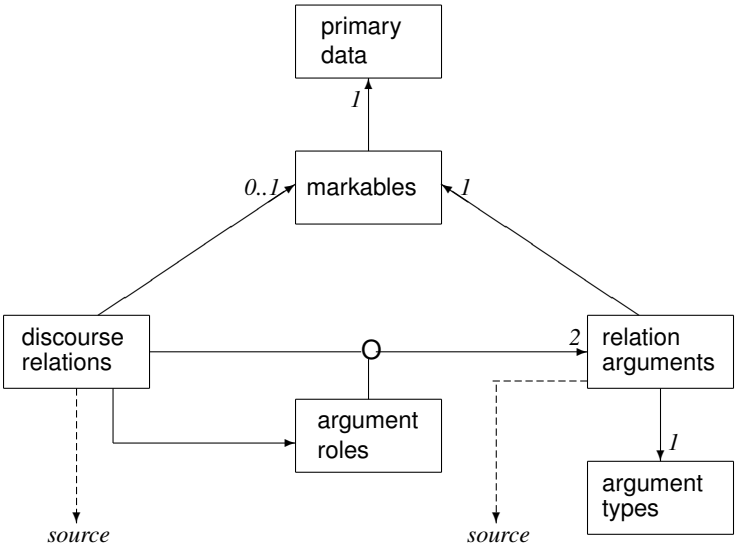

Figure 1: Metamodel for the annotation of discourse relations.

captures the information that two arguments participates in a discourse relation in a certain roles, such as a triple $\langle \rho_{cause}, \varepsilon_1, \varepsilon_2 \rangle$ consisting of a relation entity structure $\rho_{cause} = \langle m, cause \rangle$ and two argument entity structures, participating in the argument roles $\alpha(cause) = (reason, result)$ as defined by the argument role assignment function α which is specified in the abstract syntax (see Table 2 for this specification).

DRelML representation

The DRelML concrete syntax uses four special XML elements in order to allow compact representations:

1. the elements dRel and drArg are defined for representing discourse connectives and their arguments, respectively;
2. the elements explDRLink and implDRLink are defined for representing explicit and implicit discourse relations, respectively.

The examples (3) and (4) illustrate the use of DRelML to represent the annotation of an explicit and an implicit *Cause* relation, respectively. The markables m1 and m3 correspond to the clauses *"John fell"* and *"Bill pushed him"*; the markable m2 corresponds to the discourse connective *"because"* in (3). Sequences like "arg1="#e1" arg1Role="result" support an annotation like (3) to be semantically interpreted as the DRS ⟨r,x,y, cause(r), reason(r,x), result(r,y)⟩. For clarity the argument type 'event' is specified in these examples (a subtype of 'situation'), but this value may be left unspecified, which is interpreted as not requiring an inferred belief (in contrast with example (1)).

(3) John fell because Bill pushed him.
<drArg xml:id="e1" target="#m1" type="event"/>
<dRel xml:id="r1" target="#m2" rel="cause"/>
<drArg xml:id="e2" target="#m3" type="event"/>
<explDRLink rel="#r1" result="#e1" reason="#e2"/>

(4) John fell. Bill pushed him.
<drArg xml:id="e1" target="#m1" type="event">
<drArg xml:id="e2" target="#m3" type="event"/>
<implDRLink rel="cause" result="#e1"
reason="#e2"/>

Note that the representations using this DRelML form are just an abbreviation of a standard XML expression, such as the following representation of (3):

(5) John fell because Bill pushed him.
<fs xml:id="e1">
<f name="target"><value="#m1"/></f>
<f name="type"><value="event"/></f>
</fs>
<fs xml:id="r1">
<f name="target"><value="#m2"/></*f* >
<f name="rel"><value="cause"/></f4¿4
</fs>
<fs xml:id="e2">
<f name="target"><value="#m3"/></f>
<f name="type"><value="event"/></f>
</fs>
<fs xml:id="dr1">
<f name="result"><value="#e1"/></f>
<f name="reason"><value="#e2"/></f>
<f name="rel"><value="#r1"/></f>
</fs>

4.4. Annotation of discourse relations in dialogue

The discourse relations defined in ISO DR-Core are not only relevant within the ISO DR-Core annotation scheme, but can also be used to annotate rhetorical relations in spoken or multimodal dialogue according to the ISO 24617-2 annotation scheme for dialogue act annotation (using the DiAML markup language). The following example illustrates this.[5] The speaker

[5]For more examples see the DialogBank resource at `https://dialogbank.uvt.nl`

in (6a) first asks whether it is safe to put his camera through the X-ray machine at an airport security check and subsequently motivates his question by telling that his camera is a very expensive one. Following ISO 24617-2 this can be annotated as in (6b), where #p1 and #p2 indicate the two participants, and the markables #s1 and #s2 identify the functional segments "Is it safe to put my camera through here" and "It's a very expensive camera you know", respectively. A <rethoricalLink> element relates the *Inform* act to the *Question* act as its 'antecedent' through a *Cause* relation, indicating moreover that the *Inform* act is the *reason* argument of that relation. If the order of the two dialogue acts would be the other way round, as in "I have a very expensive camera. Is it safe to put that through here?", then the rhetorical relation would be annotated as "cause_result".

(6) a. Is it safe to put my camera through here? It's a very expensive camera you know.

b. <dialogAct id="a1" target="#s1" sender="#p1" addressee="#p2" dimension="task" communicativeFunction="question" />
<dialogAct id="a2" target="#s2" sender="#p1" addressee="#p2" dimension="task" />
communicativeFunction="inform" />
<rhetoricalLink dact="#a2" rhetoAntecedent= "#a1" rhetoRel="cause_reason" />

Note that DiAML representations like the one shown here are a compact form of XML, abbreviating more lengthy standard XML expressions, just like a DRelML representation such as (3) abbreviates (5).
The representation in (6) illustrates the DiAML-representation of a'pragmatic' *Cause* relation among dialogue acts. Dialogue acts are related though a 'semantic' *Cause* relation if there is a causal relation between their respective semantic contents. The DiAML representation with 'rhetorical links' cannot distinguish between 'pragmatic' and 'semantic' variants of a discourse relations. By combining the annotation schemes of ISO 24617-2 and ISO DR-Core, in particular of their unabbreviated representations (like (5)), we can both distinguish 'pragmatic' and 'semantic' variants as well as 'mixed' variants of a discourse relations without needing specifications like 'argType="dialogueAct"'. To avoid a length XML expression, we illustrate this by combining in (7b) the abbreviations of DRelML and DiAML to compactly represent a 'mixed' cause relation in the sense of the fact they "they don't have a fixed place" is why P1 says that he can never find them (where markable s3 identifies the word "because" and s4 the stretch "they don't have a fixed place").

(7) a. P1: I can never find my remote control.
P2: That's because they don't have a fixed place.

b. <dialogAct id="a1" target="#s1" sender="#p1" addressee="#p2" dimension="task" communicativeFunction="inform" />
<dialogAct id="a2" target="#s2" sender="#p2" addressee="#p1" dimension="task" />
communicativeFunction="inform" />
<dRel xml:id="r1" target="#s2" rel="cause"/>
<drArg xml:id="e2" target="#s4" />
<explDRLink rel="#r1" result="#da1" reason="#e2"/>

5. Concluding Remarks

In this paper we have summarized ISO 24617-8 ('ISO DR-Core'), the first part of an effort to establish an interoperable annotation scheme for 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 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 annotations and representations for discourse relations. Future work will aim to remove some of the limitations, in particular aiming to develop a well-motivated taxonomy of discourse relations in collaboration with the TextLink project.

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