

Annotating Interactive Spoken Language Using ISO Standards



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Spoken Language: Discourse and Dialogue

Studies of Discourse and Dialogue, like virtually all modern studies of language and nearly all research in NLP, are based more and more on corpora of recorded language use.



outline

Introduction

- 1 Discourse and dialogue corpora
- 2 Annotation of discourse structure (ISO 24617-8)
- 3 Characteristics of interactive spoken language and the design of the (ISO 24617-2) dialogue annotation scheme
 - a. Dimensions of dialogue act annotation
 - b. Segmentation of spoken and multimodal dialogue
 - c. ISO 24617-2: How well does it work?
 - d. The DialogBank
- 4 Combining annotations of dialogue acts and discourse structure

Concluding remarks



1. Discourse and Dialogue Corpora

Studies of Discourse and Dialogue, like virtually all modern studies of language and nearly all research in NLP, are based more and more on corpora of recorded language use.

Some corpora annotated with representation of discourse structure:

- Penn Discourse Treebank (PDTB)
 - RST Treebank
 - Annodis
 - Potsdamer Commentary Corpus
-
- Use of different approaches (PDTB 'discourse relations' rhetorical structure theory, Segmented Discourse Representation Theory...).
 - Text-based.



Discourse and Dialogue Corpora

Annotated corpora of interactive spoken language and multimodal communicative behaviour:

- HCRC Map Task
 - AMI Corpus
 - Switchboard
 - TRAINS
 - ICSI-MRDA
-
- Generally only shallow annotations of communicative functions of dialogue segments, of feedback phenomena, of disfluencies
 - Corpus-specific ways of analyzing and annotating → lack of domain-independence, lack of theoretical underpinning, lack of generality, lack of inter-operability across approaches and domains.



Discourse and Dialogue Corpora

Annotated corpora of interactive spoken language and multimodal communicative behaviour:

- HCRC Map Task
 - AMI Corpus
 - Switchboard
 - TRAINS
 - ICSI-MRDA
- lack of domain-independence, lack of theoretical underpinning, lack of generality, lack of inter-operability across approaches and domains.
- **ISO: Support for annotating corpus data in a way that is domain-independent, theoretically based, and interoperable.**

Part 2 Annotation of Discourse Structure

ISO DR-Core (ISO24617-8:2017): Core Concepts for the Annotation of Discourse Relations

Harry Bunt and Rashmi Prasad

(Tilburg University

University of Wisconsin)

ISA-12

Portoroz (Slovenia), May 28, 2016

ISO 24617-8: Basic Approach

Discourse relations

- Relations between abstract semantic objects that are talked about in discourse (text or spoken dialogue), such as events, states, facts, conditions,... (“*situations*”, including negated events etc.) or beliefs or dialogue acts.
- Discourse relations have two and only two arguments

Definitions and argument roles

Scope of ISO 24617-8:

- Strictly semantic criteria are used: Each relation definition specifies how each of the two arguments contributes to the semantic interpretation.
- E.g., Cause: one argument is “Reason”; other is “Result”

Motivation: Syntactic criteria used in some frameworks do not carry over to languages that do not exhibit similar syntactic configurations of the arguments.

Semantic argument roles

Example (from the PDTB):

“Sears is negotiating to refinance the Sears Tower since they were unable to find a buyer for the building.”



```
<drArg xml:id="e1" target="m1" type="event"/>
```

```
<drArg xml:id="e2" target="m3" type="event"/>
```

```
<dRel xml:id="r1" target="m2" rel="cause"/>
```

```
<drLink rel="#r1" reason="e2" result="e1"/>
```

Semantic Argument Roles

“Sears was unable to find a buyer for the building, so they are negotiating to refinance the Sears Tower.”

```
<drArg xml:id="e1" target="m1" type="event"/>
```

```
<drArg xml:id="e2" target="m3" type="event"/>
```

```
<dRel xml:id="r1" target="m2" rel="cause"/>
```

```
<drLink rel="#r1" reason="e1" result="e2"/>
```

Meaning of Discourse Relations

- **Semantic content:**

→ John bought the book because he liked it.

(reason for why the event of buying the book occurred)

- **Dialogue act:**

→ Are you hungry? Because there is some food in the cupboard

(reason for why the speaker asked the question)

→ John has left his house, because the lights are off.

(reason for the speaker's belief about John having left)

Meaning of Discourse Relations: Semantics and Pragmatics

Scope of ISO project:

- Included are interpretations that involve:
 - The **semantic content** of the arguments (“semantic” interpretation)
 - The **dialogue acts** expressed by the arguments (“pragmatic” interpretation)
- “Pragmatic” interpretations in principle allowed for all discourse relations, but marked up for arguments rather than for relations.

Motivation: Difference between “semantic” and “pragmatic” interpretations is not a matter of different *relations* but of different inferences due to different *argument types*.

ISO 24617-8 'Core' Discourse Relations

Cause

Condition

Negative Condition

Concession

Contrast

Conjunction

Disjunction

Elaboration

Exception

Exemplification

Expansion

Manner

Purpose

Restatement

Similarity

Substitution

Synchrony

Asynchrony

DReIML annotation language

Principled distinction (ISO Linguistic Annotation Framework):

Annotations vs Representations:

- An *annotation* is the linguistic information that is added to primary data, independent of any representation format.
- A *representation* is the rendering of an annotation in a particular format.
- ISO standards apply at the level of annotations, rather than representations.

DReIML annotation language

ISO Principles for Semantic Annotation (ISO 24617-6):

Abstract syntax, concrete syntax, and semantics:

- An abstract syntax specifies well-formed annotations as set-theoretical constructs (“annotation structures”).
- A concrete syntax specifies a format for the representations of annotation structures.
- A semantics assigns meanings to annotation structures.



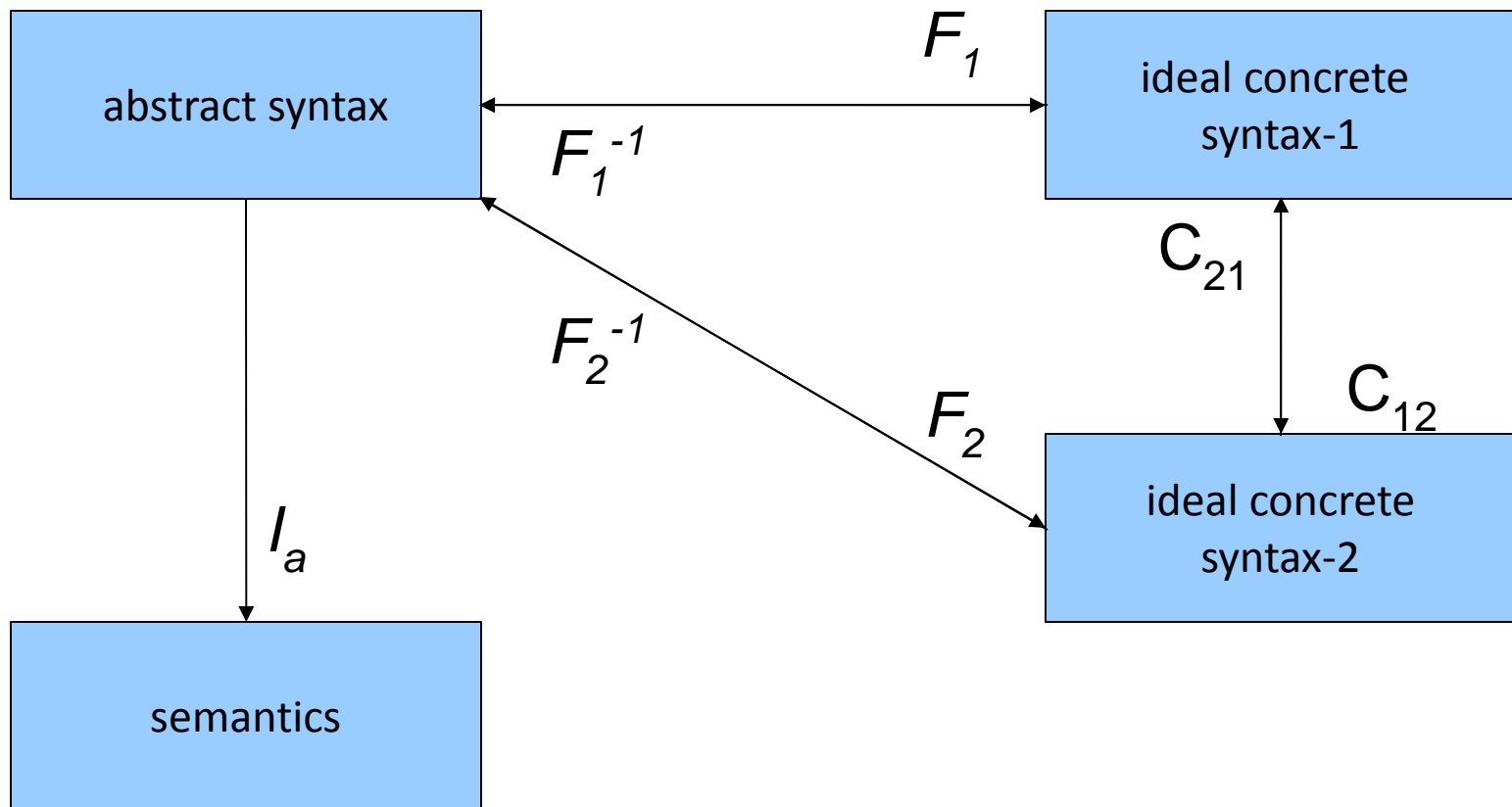
DRelML annotation language

Ideal representation format (Bunt, 2010):

- Representation format for a given abstract syntax specified by a concrete syntax that is:
 - **Complete**: every annotation structure defined by the abstract syntax has a representation;
 - **Unambiguous**: every representation encodes one and only one annotation structure defined by the abstract syntax

Every ideal representation format has a meaning-preserving conversion to any other ideal representation format.

Alternative ideal representations



DRelML annotation language

Example: “Bill fell because Carl pushed him.”

Abstract annotation:

{<m₁,s>, <m₂,s>,<<m₁,s>, <m₂,s>, cause_{rel}>}

Concrete representation:

```
<dRel id="r1" target="#m2" rel="cause"/>
```

```
<drArg id="e1" target="#m1" argType="event"/>
```

```
<drArg id="e2" target="#m3" argType="event"/>
```

```
<drLink rel="#r1" reason="#e2" result="#e1"/>
```



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Concluding remarks



Spoken Communication (versus Text)

- Interactivity:
 - turn management devices
 - sub-sentence units
 - feedback
- Time pressure:
 - time management devices
 - completions
- Disfluencies
 - speech editing devices (false starts, repairs,..; completions)
- Social activity:
 - greetings
 - apologies
 - thankings
 - ...

→→ Basis for the design of ISO 24617-2 for dialogue annotation



(3a. Dimensions of dialogue act annotation)

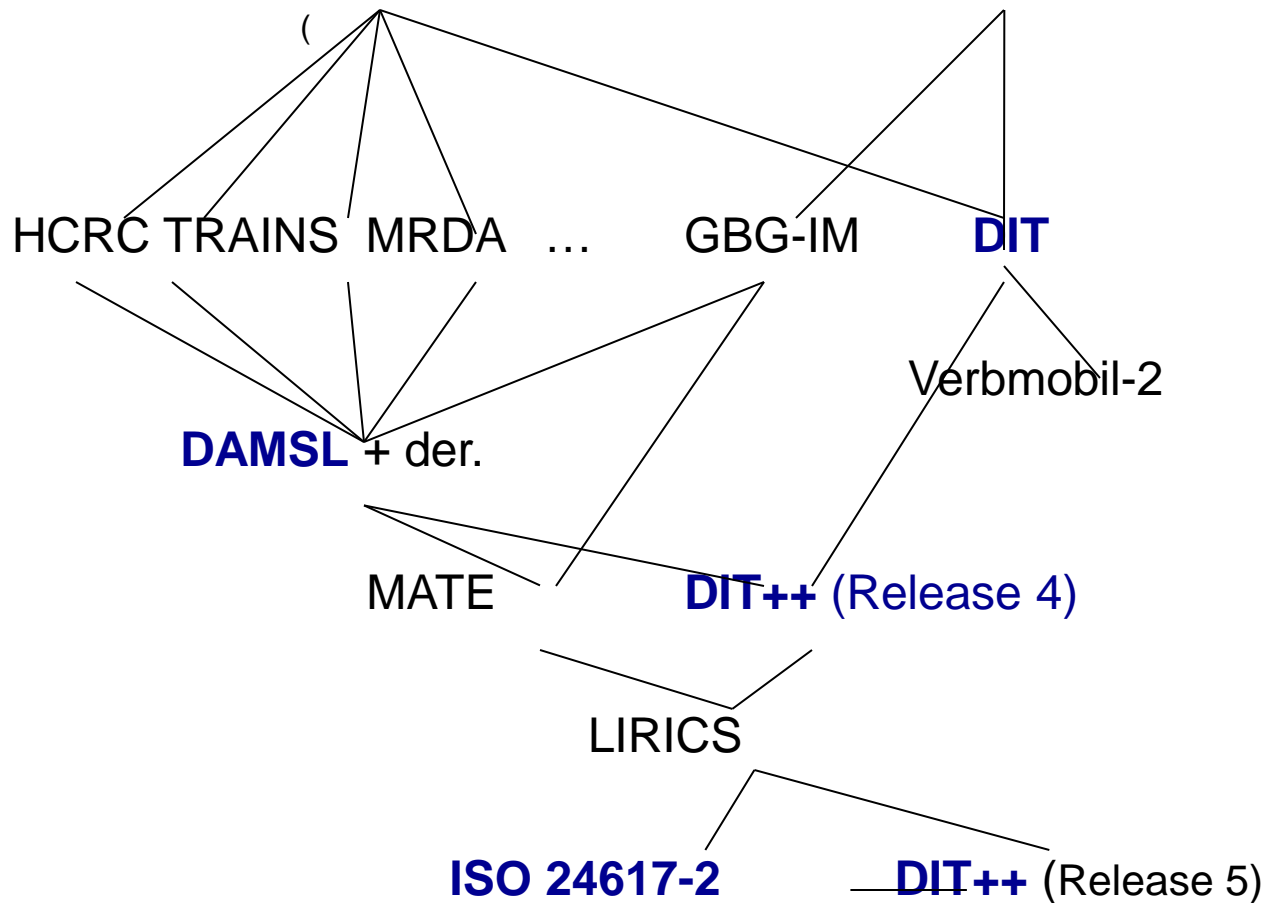
ISO/DIT++ dimensions

1. **Task**: dialogue acts moving the underlying task forward
2. **Auto-Feedback**: providing information about speaker's processing of previous utterances
3. **Allo-Feedback**: providing or eliciting information about addressee's processing of previous utterances
4. **Turn Management**: allocation of speaker role
5. **Time Management**: managing use of time
6. **Discourse Structuring**: explicitly structuring the dialogue
7. **Own Communication Management**: editing one's own speech
8. **Partner Communication Man**: editing addressee's speech
9. **Social Obligations Management**: dealing with social conventions (greeting, thanking, apologizing,..)

Dialogue act analysis frameworks

Speech Act Theory
(Austin, Searle)

Communication as Cooperation (Grice)
Communicative Activity Analysis (Allwood)



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ISO 24617-2 dialogue annotation standard

- Comprehensive, domain-independent taxonomy of dialogue acts
- Dialogue acts defined semantically as ***update operators*** applied to participants' ***information states***
- Dialogue utterances may be ***multifunctional***, due to multiplicity of tasks in communicating
- Dialogue annotation is ***multidimensional***, assigning multiple dialogue acts to segments of dialogue in multiple 'dimensions'
- Taxonomy is organized according to DIT++ ***dimensions*** of communication
- ***Qualifiers***, e.g. for sentiment or certainty, for making fine-grained distinctions.



Other features of ISO 24617-2

- ♥ **Functional dependence relations** (e.g. Answer → Question, Confirm → Check Question) between DAs
- ♥ **Feedback dependence relations** between a feedback act and its ‘antecedent’ DA
- ♥ **Rhetorical relations** between DAs or their semantic content
- ♥ Annotation language **DiAML** (**D**ialogue **A**ct **M**arkup **L**anguage) with:
 - ★ **abstract syntax** and concrete syntax
 - ★ **semantics** in terms of information-state update operators defined for *abstract* syntax
 - ★ **concrete syntax** defining XML representations

Sequential and simultaneous multifunctionality

Example:

A: Ehm, okay that's fine with me.
Stalling *Feedback* *Inform*
Take Turn

- **sequential** multifunctionality
- **simultaneous** multifunctionality

(Allwood, 1994)



Forms of multifunctionality

Discontinuous multifunctionality:

U: Can you tell me what time is the first train to the airport on Sunday?

S: **The first train to the airport on Sunday is at ... let me see... 5.32.**

U: Thank you.

Overlapping multifunctionality:

U: Can you tell me what time is **the first train to the airport on Sunday?**

S: **The first train to the airport on Sunday** is at ... let me see... 5.32.

U: Thank you.

Interleaved multifunctionality:

I think 25 euros for a remote -- is that locally something like 10 pounds *is too much money to buy an extra or a replacement one* -- or is it even more?

So, how to segment a dialogue?

The units that carry communicative functions can be:

- very small, not necessary linguistically well-formed, possibly nonverbal or multimodal
- part of or overlapping with another unit
- discontinuous
- interleaved with another unit



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Functional segments

Definition:

Functional segments are minimal stretches of communicative behaviour that have one a communicative function and a semantic content.

- Minimal: no material that does not contribute to the expression of a communicative function or semantic content.
- They have *at least one* communicative function, and possibly more than one.



(3d ISO 24617-2: How well does it work?)

Annotator agreement on segmentation

| <u>Dimension</u> | <u>K</u> |
|-------------------------------|----------|
| Task | 0.52 |
| Auto-Feedback | 0.32 |
| Allo-Feedback | 0.53 |
| Turn Management | 0.90 |
| Time Management | 0.91 |
| Own Communication Management | 1.00 |
| Partner Comm. Management | 1.00 |
| Dialogue structuring | 0.87 |
| Social Obligations Management | 1.00 |



Communicative functions

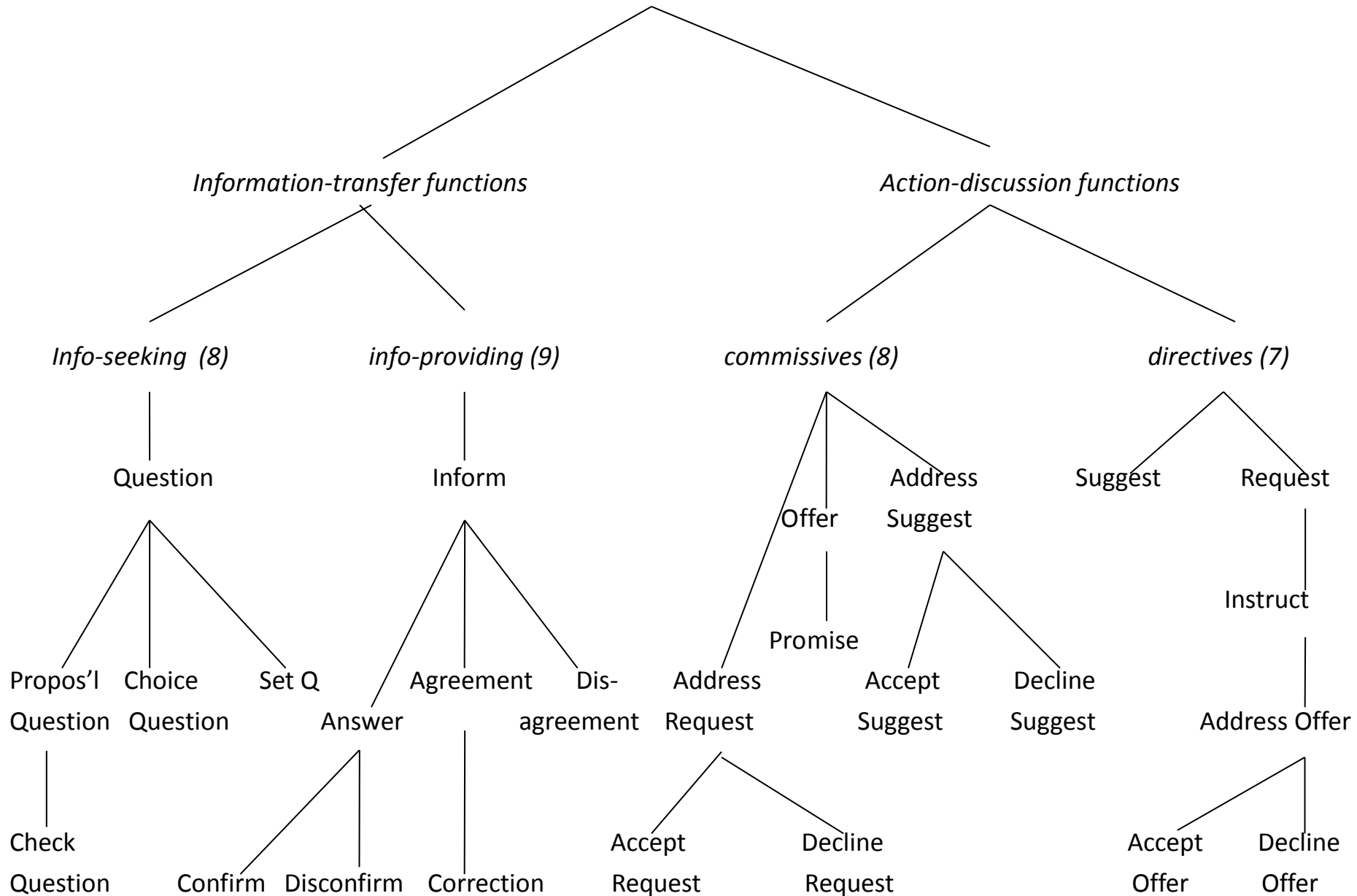
Dimension-specific communicative functions, e.g.:

- *Turn Release* (Turn Management)
- *Stalling* (Time Management)
- *Self-Correction* (Own Communication Management)
- *Completion* (Partner Communication Management)
- *Dialogue opening* (Discourse Structuring)
- *Thanking* (Social Obligations Management)

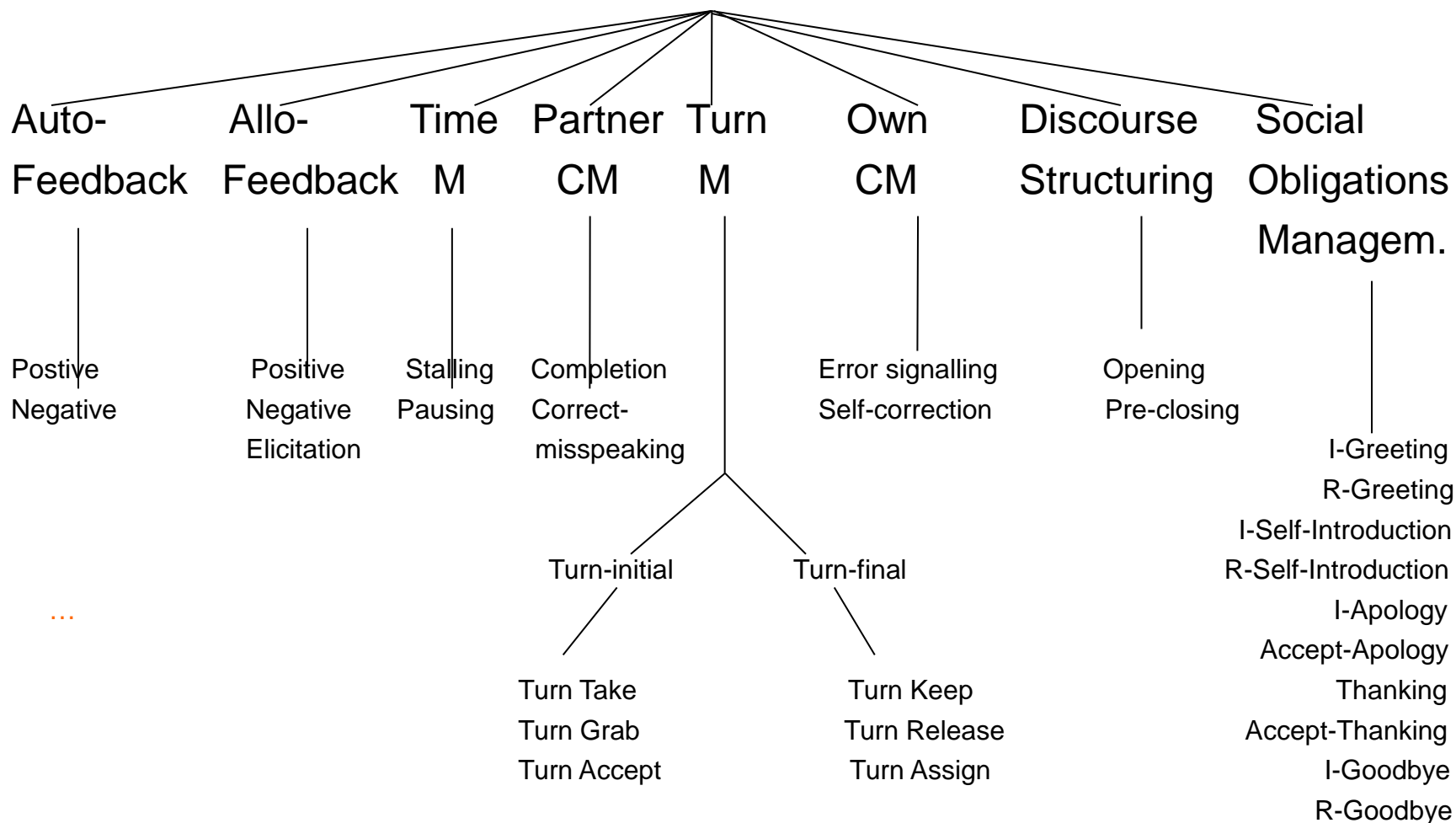
General-purpose functions, applicable in any dimension, e.g.:

- Information-seeking functions: *Propositional Question, Set Question, Check Question, Choice Question*
- Information-providing functions: *Inform, Agreement, Disagreement, Correction*
- Commissive functions: *Promise, Offer, Accept Suggestion, Decline Suggestion,...*
- Directive functions: *Request, Instruct, Suggestion, Accept Offer, Decline Offer*

ISO 24617-2 and DIT++ General-Purpose Communicative Functions



Dimension-specific communicative functions in ISO 24617-2





Communicative functions

51 core communicative functions

- 21 general-purpose functions:
 - 4 information-seeking functions
 - 6 information-providing functions
 - 6 commissive functions
 - 5 directive functions
- 30 core dimension-specific functions
 - 2 auto-feedback functions
 - 3 allo-feedback functions
 - 6 turn management functions
 - 2 time management functions
 - 3 discourse structuring functions
 - 2 own communication management functions
 - 2 partner communication management functions
 - 10 social obligation management functions



Dialogue Act Markup Language (DiAML)

P1: What time is the first train on Sunday to the Airport?

P2: The first train is at 6.15, I believe.

```
<diaml xmlns:"http://www.iso.org/diaml/">
<dialogueAct xml:id="da1" target="#fs1"
  sender="#p1" addressee="#p2"
  communicativeFunction="setQuestion" dimension="task" />
<dialogueAct xml:id="da2" target="#fs2.1"
  sender="#p2" addressee="#p1"
  communicativeFunction="answer" dimension="task"
  certainty="uncertain" functionalDependence="#da1"/>
<dialogueAct xml:id="da3" target="#fs2.2" sender="#p2"
  addressee="#p1" communicativeFunction="autoPositive"
  dimension="autoFeedback" feedbackDependence="#fs1"/>
</diaml>
```



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Dimension recognition by annotators

| Dimension | Agreement | | | Accuracy |
|----------------------|-----------|-----|------|----------|
| | Po | Pe | K | K |
| Task | 0.85 | 0.1 | 0.83 | 0.81 |
| Auto-Feedback | 0.91 | 0.1 | 0.90 | 0.92 |
| Allo-Feedback | 0.93 | 0.1 | 0.92 | 0.91 |
| Turn Management | 0.93 | 0.1 | 0.92 | 0.92 |
| Time Management | 0.99 | 0.1 | 0.99 | 0.90 |
| Own Communication M. | 0.99 | 0.1 | 0.99 | 0.89 |
| Partner Comm. Man. | 0.99 | 0.1 | 0.99 | 1.00 |
| Dialogue structuring | 0.99 | 0.1 | 0.99 | 0.87 |
| Social Oblig. Man. | 0.99 | 0.1 | 0.99 | 0.95 |

Automatic dimension recognition

| Dimension | DIAMOND | | AMI | | OVIS | |
|-----------------------|---------|--------|------|--------|------|--------|
| | BL | Accur. | BL | Accur. | BL | Accur. |
| Task | 0.65 | 0.71 | 0.67 | 0.72 | 0.61 | 0.74 |
| Auto-Feedback | 0.72 | 0.85 | 0.78 | 0.90 | 0.66 | 0.76 |
| Allo-Feedback | 0.87 | 0.97 | 0.97 | 0.99 | 0.53 | 0.80 |
| Turn Management | 0.70 | 0.90 | 0.59 | 0.93 | 0.89 | 0.99 |
| Time Management | 0.66 | 0.82 | 0.70 | 0.99 | 0.96 | 0.99 |
| Own Communication M. | 0.77 | 0.83 | 0.90 | 0.94 | 0.99 | 0.99 |
| Partner Comm. Man. | 0.45 | 0.63 | 0.99 | 0.99 | 0.99 | 0.99 |
| Discourse structuring | 0.59 | 0.68 | 0.98 | 0.93 | 0.76 | 0.89 |
| Social Oblig. Man. | 0.80 | 0.92 | 0.99 | 0.99 | 0.96 | 0.98 |

Communicative function recognition

Correct recognition is not a black-and-white matter, consider:

| | <u>Annotator 1</u> | <u>Annotator 2</u> |
|---------------------------------|------------------------|--------------------|
| A: You checked the room number? | Propositional Question | Check Question |
| B: Yep. | Answer | Confirm |

Annotators 1 and 2 do not fully agree (inter-annotator agreement 1),
and do not fully disagree (inter-annotator agreement 0).

Commonly used agreement scores, such as the standard kappa coefficient (κ),
only allow agreements values 0 and 1.

‘Taxonomically weighted kappa’ (Geertzen & Bunt, 2008) takes the structure of
the taxonomy of tags into account.

Human communicative function recognition

for DIT++ 3.2 (2008) tags (in the DIAMOND corpus)

| Dimension | standard kappa | | | weighted kappa | | |
|----------------------|----------------|------|-------------|----------------|------|---------------|
| | Po | Pe | κ | Po | Pe | κ_{tw} |
| Task | 0.52 | 0.09 | 0.47 | 0.76 | 0.17 | 0.71 |
| Auto-Feedback | 0.32 | 0.14 | 0.21 | 0.87 | 0.69 | 0.57 |
| Allo-Feedback | 0.53 | 0.19 | 0.42 | 0.79 | 0.50 | 0.58 |
| Turn Management | 0.90 | 0.42 | 0.82 | 0.90 | 0.42 | 0.82 |
| Time Management | 0.91 | 0.79 | 0.58 | 0.91 | 0.79 | 0.58 |
| Own Communication M. | 1.00 | 0.50 | 1.00 | 1.00 | 0.95 | 1.00 |
| Partner Comm. Man. | 1.00 | 1.00 | – | 1.00 | 1.00 | – |
| Dialogue structuring | 0.87 | 0.48 | 0.74 | 0.87 | 0.48 | 0.74 |
| Social Oblig. Man. | 1.00 | 0.19 | 1.00 | 1.00 | 0.19 | 1.00 |

Human communicative function recognition

for DIT++ 3.2 and ISO 24617-2 tags (in the DIAMOND corpus)

| Dimension | standard kappa | | | weighted kappa | | |
|-----------------------------|----------------|-------------|-------------|----------------|-------------|---------------|
| | Po | Pe | κ | Po | Pe | κ_{tw} |
| Task | 0.52 | 0.09 | 0.47 | 0.76 | 0.17 | 0.71 |
| Auto-Feedback | 0.32 | 0.14 | 0.21 | 0.87 | 0.69 | 0.57 |
| Auto-Feedback | 0.99 | 0.50 | 0.98 | 0.99 | 0.50 | 0.98 |
| Allo-Feedback | 0.53 | 0.19 | 0.42 | 0.79 | 0.50 | 0.58 |
| Allo-Feedback | 0.98 | 0.33 | 0.97 | 0.98 | 0.33 | 0.97 |
| Turn Management | 0.90 | 0.42 | 0.82 | 0.90 | 0.42 | 0.82 |
| Time Management | 0.88 | 0.79 | 0.57 | 0.91 | 0.79 | 0.58 |
| Time Management | 0.88 | 0.50 | 0.82 | 0.88 | 0.50 | 0.82 |
| Dialogue structuring | 0.87 | 0.48 | 0.74 | 0.87 | 0.48 | 0.74 |
| Dialogue structuring | 0.98 | 0.50 | 0.96 | 0.98 | 0.50 | 0.96 |



Automatic comm. function recognition

Petukhova & Bunt (2014): Accuracy of machine-learned recognition of communicative functions in spoken dialogues (AMI corpus):

| Dimension | Bayes Net | Ripper |
|----------------------------|-------------|-------------|
| Task | 82.6 | 86.1 |
| Auto-Feedback | 96.9 | 98.1 |
| Allo-Feedback | 96.3 | 95.7 |
| Turn Management | 90.9 | 91.2 |
| Time Management | 90.4 | 93.4 |
| Discourse Structuring | 82.1 | 78.3 |
| Own Communication Man. | 78.4 | 81.6 |
| Partner Communication Man. | 71.7 | 70.0 |
| Social Obligations Man. | 98.6 | 98.6 |



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3d. The DialogBank

New language resource built at Tilburg University

(preliminary release December 2015; Release 1, May 2016; Release 2, December 2016)

Annotated dialogues:

- Using ISO 24617-2
- Gold standard
- Re-annotated dialogues from existing corpora
 - Some with original annotations
 - Some with annotations of previous DIT++ versions
- Newly annotated dialogues
 - from existing corpora without annotation
 - From newly collected corpora

The DialogBank

| <i>Origin</i> | <i>Lang</i> | <i>Original and previous representations</i> | <i>Original annotation</i> | <i>Previous annotation</i> |
|------------------|-------------|--|--|--------------------------------|
| HCRC Map Task | EN | NITE XML DiAML-Anvil | HCRC Map Task communicative functions; | DIT++4.0 |
| Switchboard | EN | 3-column tabular | SWBD-DAMSL communicative functions | ISO 24617-2 comm. functions |
| TRAINS | EN | DiAML-Anvil | DAMSL communicative functions | DIT4.0 |
| DBOX | EN | DiAML-XML | full ISO 24617-2 annotation | no previous annotation |
| DIAMOND | NL | 13-column tabular | DIT++3.0 communicative functions and dimensions | DIT\$++3.0 |
| Dutch Map Task | NL | plain text | no dialogue act annotation | no dialogue act annotation |
| OVIS | NL | plain text | DIT++ communicative functions and dimensions | DIT++3.0 |
| Schiphol Airport | NL | plain text | DIT++ communicative functions and dimensions | DIT++3.0 |



DialogBank contents

- ◆ Annotations include: Dimension, Communicative Function, Sender, Addressee, (Other Participants), Functional Dependence Relations, Feedback Dependence Relations, Qualifiers, Rhetorical Relations (from ISO 24617-8, DR-Core).
- ◆ ISO 24617-2 annotations represented in 3 formats: DiAML-XML, DiAML-MultiTab, and DiAML-TabSW
- ◆ Conversion between formats possible
- ◆ Abstract annotation structure
- ◆ Comparison with original annotations



Alternative representations of DiAML annotations

Which representation do you like best?

Look at DialogBank: go to <https://dialogbank.uvt.nl>

Click on ‘annotated dialogues’, choose ‘Switchboard’ and compare annotations of one of the dialogues, first as represented in DiAML-XML format, and then as represented in DiAML-TabSW, and DiAML-MultiTab format.

Notice in the DiAML-XML format the large parts concerned with dialogue tokenization and segmentation!



ISO 24617-2 Limitations

- ◆ Accurate annotation of feedback dependence relations (also for speech self-editing or partner editing)
- ◆ Annotation of argument roles for rhetorical relations
- ◆ Distinction between ‘semantic’ and ‘pragmatic’ interpretations of rhetorical relations



Nonfunctional segments

A: What time would there be a flight on Tuesday in the evening?

B: There's no direct evening flight on Thursday in the evening.

A: On Tuesday

Negative allo-feedback referring to "Tuesday", which is

- Not a dialogue act
- No a functional segment.

Similarly for own speech editing:

A: I'm a, uhm, I'm *pretty much a new junkie*

└────────── Self-correction

Inform



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Rhetorical relation in DiAML, example

1. A: Where would you position the buttons?
2. A: I think that has an impact on many things.

```
<diaml xmlns: http://www.iso.org/diaml/>  
  <dialogueAct xml:id="da1" target="#fs1" sender="#p1" addressee="#p2"  
    communicativeFunction="setQuestion" dimension="task"/>  
  <dialogueAct xml:id="da2" target="#fs2" sender="#p2" addressee="#p1"  
    communicativeFunction="answer" dimension="task"/>  
  <rhetoricalLink dact="#da2" rhetoRelatum="#da1" rhetoRel="cause"/>  
</diaml>
```

DRelML annotation

Example: “Bill fell because Carl pushed him.”

Abstract annotation:

{<m₁,s>, <m₂,s>,<<m₁,s>, <m₂,s>, cause_{rel}>}

Concrete representation:

<dRel id=“r1” target=“#m2” rel=“cause”/>

<drArg id=“e1” target=“#m1” argType=“event”/>

<drArg id=“e2” target=“#m3” argType=“event”/>

<drLink rel=“#r1” reason=“#e2” result=“#e1”/>

Compare with the limited DiAML annotation of a Cause relation using a <rhetoricalLink> element.



Discourse relations in dialogue

Can the expressiveness of the DiAML and DRelML annotations be combined?



Discourse relations in dialogue

Can we combine the expressiveness of the DiAML and DReIML annotations?

Yes we can!

Both DiAML and DReIML are compact notations for XML expressions.



Concluding remarks

- ISO 24617-2 offers rich possibilities for the accurate annotation of dialogue act information, at different possible levels of detail due to the hierarchical structure of the inventory of communicative functions, the use of orthogonal dimensions, and the optional use of qualifiers and rhetorical relations.



Concluding remarks

- ISO 24617-2 offers rich possibilities for the accurate annotation of dialogue act information, at different possible levels of detail due to the hierarchical structure of the inventory of communicative functions, the use of orthogonal dimensions, and the optional use of qualifiers and rhetorical relations.
- The ISO 24617-2 annotation scheme and markup language DiAML have been used successfully for this, as witnessed by the DialogBank.



Concluding remarks

- ISO 24617-2 offers rich possibilities for the accurate annotation of dialogue act information, at different possible levels of detail, due to the hierarchical structure of the inventory of communicative functions, the use of orthogonal dimensions, and the optional use of qualifiers and rhetorical relations.
- The ISO 24617-2 annotation scheme and markup language DiAML have been used successfully for this purpose, as witnessed by the DialogBank.
- Building the DialogBank has revealed some limitations, some of which can be resolved by combining DA annotations with the annotations of other semantic information, as according to DR-Core, ISO-TimeML, and other schemes.