

# Interoperability of Dialogue Corpora through ISO 24617-2-based Querying

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## Abstract

The paper presents an approach to achieving interoperability of dialogue act annotations through developing a query format for accessing existing annotated corpora. The interpretation of expressions in the query format implements a mapping from ISO 24617-2 concepts to those of several existing annotation schemes. This approach is tested on two important types of existing dialogue corpora: spoken two-person dialogue corpora collected and annotated within the HCRC Map Task paradigm, and multiparty face-to-face dialogues of the AMI corpus. Additionally, we provide a mapping between ISO 24617-2 concepts and DAMSL-based taxonomies. We present the results and evaluate them with respect to accuracy and completeness through statistical comparisons between retrieved and manually constructed reference annotations.

**Keywords:** semantic interoperability, international standards, dialogue act annotation

## 1. Introduction

ISO standards for linguistic annotation aim to contribute to the interoperability of language resources. ISO 24617-2 “Semantic annotation framework, Part 2: Dialogue acts”, in particular aims to contribute to the interoperability of annotated dialogue corpora.

An obvious way of achieving interoperability is to make sure that, whenever a new corpus is constructed, an annotation schema is used that is compatible with the one defined in the standard, e.g. using a subset of the annotation concepts defined in the standard, or using concepts with a well-defined relation to those of the standard. The ISO dialogue act annotation scheme is quite well known and already employed in some dialogue projects, e.g. in the ToMA project (Blache et al., 2009) where the Corpus of Interactional Data (CID) was labeled according ISO 24617-2; and a new corpus of DBOX dialogue gaming data (Petukhova et al., 2014) discussed in these proceedings.

Another way is to convert the annotations in existing corpora to annotations that are compatible with the ISO standard; this approach has been applied to the SWBD-DAMSL annotations in the Switchboard corpus (Fang et al., 2012; Bunt et al., 2013).

This paper explores a third way of achieving interoperability: developing a query format for accessing existing annotated corpora whose expressions make use of the annotation language defined by the standard, where the interpretation of expressions in the query implements a mapping from ISO 24617-2 concepts to those of the annotation scheme used in the corpus. We explore this approach for two important types of existing dialogue corpora: spoken two-person dialogue corpora collected and annotated for a variety of languages according to the HCRC Map Task paradigm, and multiparty face-to-face dialogues of the AMI corpus.

The paper is structured as follows. Section 2 introduces the AMI and MapTask corpora. Section 3 discusses the mapping between dialogue act concepts defined in the AMI and Map Task schemes and those in the ISO standard. Section 4 introduces the Dialogue Act Markup Language (DiAML) defined in the ISO standard, on which the query format is

based and discusses the querying of annotated corpora using DiAML. Section 5 presents the results and evaluates them with respect to accuracy and completeness through statistical comparisons between retrieved and manually annotated corpus data. Conclusions and indications for future work make up the final Section 6.

## 2. Annotated dialogue corpora

Recent years have witnessed a growing interest in annotating linguistic data at the semantic level including annotation of dialogue corpus data with dialogue act information. Over the years a number of dialogue act annotation schemes has been developed, such as those of the TRAINS project in the US (Allen et al., 1994), the MapTask studies in the UK (Carletta et al., 1996), the Verbmobil project in Germany (Alexandersson et al., 1998). Within these and many other projects several annotated dialogue corpora are constructed that are widely used for analysing and modelling human dialogue behaviour and designing of human-machine natural language based dialogue systems. However, such corpora are not easy to re-use for purposes and domains other than they were originally developed for.

One of the best known and most widely used dialogue act annotation schemes is DAMSL. There are several variants of this scheme, such as Switchboard-DAMSL (Jurafsky, 1997) and Coconut (Di Eugenio et al., 1998). Several dialogue corpora have been annotated using DAMSL scheme and are available for research purposes. First of all, the **Monroe** corpus<sup>1</sup>, a collection of task-oriented spoken dialogues. The tasks involved are complex and include a variety of types of problem-solving tasks. The corpus consists of 20 dialogues with 4794 speaker turns in total. Annotations of the Monroe corpus are available in the Standard Generalized Markup Language (SGML; ISO 8879:1986). Second, the dialogue act annotated **Switchboard** corpus consists of telephone conversations between speakers of American English and contains 650

<sup>1</sup><http://www.cs.rochester.edu/research/speech/monroe/>

fully spontaneous conversations. This corpus and the Switchboard-DAMSL annotations are now available in NXT format (see (Calhoun et al., 2010)). Third, the **Coconut** dialogue corpus<sup>2</sup> is a collection of two-party negotiation typed computer-mediated dialogues. The corpus consists of 35 dialogues annotated with Coconut-DRI (DAMSL variant) dialogue act annotation scheme. Dialogue act annotations are inline annotations of the format: `< Tag_Number > Text < /Tag_Number > or < Tag_Number = "Identifier" > Text < /Tag_Number >`. Another big collection of dialogues constitutes the **HCRC MapTask**<sup>3</sup> corpus, consisting of 128 dialogues where one participant plays the role of an instruction-giver while the other participant, the instruction-follower, navigates through the map. The dialogues are transcribed and annotated for a wide range of behaviours, e.g. prosodic and syntactic units, gaze direction, conversational moves, etc. The HCRC MapTask annotated corpus is available in NXT format. Moreover, MapTask's underlying idea was so successful that dialogues for a comparable task (map-searching) has been collected in many languages other than English: German MapTask (Hamburg MapTask corpus<sup>4</sup>, French MapTask corpus<sup>5</sup> (MAPTASK-AIX) , Italian MapTask (Grice and Savino, 2003), and many others. The **AMI** corpus<sup>6</sup>, collected in a large-scale EU project, contains 100 hours of transcribed and annotated meeting conversations (in English) where the participants (usually four) play different roles in a fictitious design team. The annotated corpus is also available in NXT format. The above mentioned dialogue corpora differ in (1) underlying task (instructing a map search, decision making, selling-buying negotiations and a collaborative design task); (2) number of dialogue participants (two- or multi-party); (3) communication channels and modalities (computer-mediated typed, face-to-face spoken interactions, and spoken interaction without visual contact); and (4) annotated phenomena and annotation scheme used.

### 3. Mapping

Analysing annotation schemes and data representations, and their compatibility with ISO 24617-2, at least four very important issues need to be taken into consideration: (1) the multifunctionality of dialogue utterances; (2) the way a dialogue is segmented into meaningful units; (3) the relations between segments; and (4) the qualification of communicative functions. Existing annotation schemes take different points of view on these issues. For the purpose of querying we largely ignore differences in segmentation, and use the segmentation used in the corpus.

Previous mapping initiatives, such as the MATE project (Klein et al., 1998), noticed that the use of hierarchies or multidimensional meta-schemes makes mappings better

feasible and more accurate. The ISO-compatibility of an annotation scheme can be considered at many levels (Bunt et al., 2013). One possibility is to take the communicative function tags used in a given annotated corpus and replace them by ISO tags. Since there is no one-to-one correspondence between tags, this is mostly not a simple matter, but in fact requires the re-expression of the information that is captured by the corpus annotations in terms of concepts defined in the ISO standard. Table 1 shows how the functional tags for information-giving and information-seeking acts in the DAMSL, SWBD-DAMSL, AMI, HCRC Map Task, and ISO 24617-2 annotation schemes are related.

We systematically compared the MapTask, AMI and ISO 24617-2 annotation schemes by inspecting the definitions as well as examples in annotation guidelines and annotated corpus data. Additionally, four AMI dialogues (3,897 utterances) and eight MapTask dialogues (1,728 utterances) were re-annotated according to ISO 24617-2.

#### 3.1. Multifunctionality and multidimensionality

The ISO 24617-2 annotation scheme is highly multidimensional, supporting multifunctional analysis by allowing the assignment of multiple dialogue act tags to a dialogue segment. In this respect it is comparable to DAMSL, and it includes the most important insights behind it.<sup>7</sup> The ISO 24617-2 taxonomy of communicative functions distinguishes 9 dimensions, taken from the DIT<sup>++</sup> taxonomy (Bunt, 2009), in which dialogue acts address information about a certain task (the *Task* dimension); the processing of utterances by the speaker (*Auto-feedback*) or by the addressee (*Allo-feedback*); the management of difficulties in the speaker's production of contributions (*Own-Communication Management*) or that of the addressee (*Partner Communication Management*); the speaker's need for time to continue the dialogue (*Time Management*); the allocation of the speaker role (*Turn Management*); the structuring of the dialogue (*Dialogue Structuring*); and the management of social obligations (*Social Obligations Management*). There are 41 dimension-specific and 26 general-purpose communicative functions.

Other schemes propose tagsets which as a rule are fairly simple, and are mostly used to code dialogue utterances with a single tag. HCRC MapTask defines such a one-dimensional scheme with 12 mutually exclusive dialogue act tags (Carletta et al., 1996).

Again other schemes, while allowing a single dialogue act label to be assigned to each dialogue segment, have additional tags that can be added to the main label in order to describe the meaning more accurately. AMI is one such scheme which has additional layers and relational tags. For instance, an additional layer of so-called 'reflexive' acts allows labelling the type of semantic content by specifying whether a dialogue contribution is about the meeting task or about managing the task. Further, the AMI annotation scheme has relational tags to indicate relations between dialogue units. For example, INFORM which can be combined with 4 relation tags: POSitive, NEGative, PARTial and UNCertain. This allows to annotate several types of

<sup>2</sup><http://www.pitt.edu/~coconut/coconut-corpus.html>

<sup>3</sup><http://www.hcrc.ed.ac.uk/maptask/>

<sup>4</sup><http://www1.uni-hamburg.de/exmaralda/files/z2-hamatac/public/index.html>

<sup>5</sup>[http://crdo.up.univ-aix.fr/voir\\_depot.php?lang=en&id=732&prefix=sldr](http://crdo.up.univ-aix.fr/voir_depot.php?lang=en&id=732&prefix=sldr)

<sup>6</sup><http://www.amiproject.org/>

<sup>7</sup>The ISO 24617-2 scheme is based on an analysis of 18 existing annotation schemes.

ISO(Qualifier or Relation)	DAMSL	SWBD-DAMSL	AMI.Relational tag	HCRC MapTask
Inform Inform( <i>Uncertain</i> ) Inform( <i>Certain</i> ) Inform(Explanation) Inform( <i>Clarification</i> )	(Re)Assert Other Statement (Re)Assert	Statement: Statement-opinion Statement-non-opinion	Inform Inform.Uncertain Inform	Statement  Explain Clarify
Agreement	Agreement:Accept Accept-part	Agree Accept Accept-part	Inform.Positive -	Reply-y -
Agreement( <i>Uncertain</i> )	Maybe	Maybe	Inform.Uncertain	-
Disagreement	Reject	Reject Dispreferred responses	Inform.Negative	Reply-n
Disagreement( <i>Uncertain</i> )	Maybe Reject-part	Maybe Partial Reject	Inform.Uncertain -	- -
Correction		-	Inform.Negative	-
Set answer	Answer	Answer	Inform	Reply-w
Prop. answer	Answer Answer	Yes-answer No-answer	Inform	Reply-y; Reply-n
Prop. answer( <i>Negative</i> )	Answer	Negative non-no answer	Inform.Negative	
Confirm	Answer	Yes-answer	Inform.Positive	Reply-y
Disconfirm	Answer	No-answer Dispreferred responses	Inform.Negative	Reply-n
Set question	Info-Request	WH-question	Elicit Inform	Query-w
Propos. Question	Info-Request	YN-question	Elicit Inform	Query-yn
Check-Question	Info-Request+Assert	Declarative YN-question Declarative WH-question Tag-Question	Elicit Inform	Check
Choice question	Info-Request	OR-question Or-clause	Elicit Inform	Query-w
Question	Info-Request	Open Questions	Elicit Inform	
Question	Forward-Looking	Rhetorical questions	Elicit Inform	

Table 1: Information transfer (providing and seeking) communicative functions in the ISO24617-2, DAMSL, SWBD-DAMSL, AMI and HCRC MapTask annotation schemes.

answers, e.g. positive or negative answer, or positive uncertain answer, etc. It does not allow, however, to differentiate between, for example, a confirm, an agreement and a positive propositional answer, or between those of accept request, accept suggestion and accept offer, which are not concerned with the exchange of information in propositional form, but address the performance of actions.

### 3.2. Relations between dialogue units

ISO 24617-2 distinguishes three types of relations between dialogue units: functional relations (like question-answer), feedback relations and rhetorical relations, as described in Section 4. In AMI, annotators should consider whether a unit expresses a response to something, and so, indicate that by adding a link. For instance, an answer is linked to a question (as ‘source’ of the link; the answer as ‘target’). As for rhetorical relations, AMI has a separate scheme to capture argumentation structure, however, not relating dialogue acts but segments.

HCRC MapTask does not explicitly mark any relations between dialogue units. The functional labels *Explain* and *Clarify* are defined to say that the current speech act explains or clarifies something.

### 3.3. Communicative function qualifiers

ISO 24617-2 defines a set of qualifiers to enable more precise description of the speaker’s intention with respect to certainty, conditionality and sentiment. Some dialogue act taxonomies pay attention to these phenomena. For instance, DAMSL and DAMSL-based schemes distinguish such functions as Maybe, Reject-Part or Accept-Part. AMI uses the relational tags POSitive, NEGative, PARTial, or UNCertain to classify the type of a relationship. Emotions are also annotated in AMI, however these labels are as-

signed directly to the (verbal or nonverbal) behaviour of a participant and are not tied with dialogue act annotation. HCRC MapTask does not capture these phenomena.

### 3.4. Tag correspondences

In this section we present the mappings, based on both theoretical and empirical considerations, between the AMI, HCRC Map Task, and ISO 24617-2 annotation schemes.

A first observation is that there are very few one-to-one correspondences between function tags. ‘Instruct’ in HCRC MapTask and ISO 24617-2 is an example. There are even fewer many-to-one functional tag correspondences from AMI or MapTask to ISO 24617-2, also if we chose a more general ISO tag. For example, AMI’s Elicit-Inform, Elicit-Assessment, Elicit-Comment-Understanding and Elicit-Offer-or-Suggestion may be mapped to ISO’s general Question tag. Upon analysis and re-annotation it turns out that of the dialogue acts with these functions, Elicit-Inform and Elicit-Offer-or-Suggestion mostly address the Task dimension, while Elicit-Assessment and Elicit-Comment-Understanding are mostly concerned with feedback elicitation. The remaining Elicit-Offer-or-Suggestion maps in about 50% of the cases to the ISO tag ‘Question’ and in 50% to ‘Request’.

In view the highly multidimensional and detailed nature of the ISO annotation scheme, the most common mapping to that scheme is one-to-many. This is the source of most of the problems for automatically mapping between the annotations in the AMI and MapTask corpora and ISO equivalents. For example, Inform in the AMI corpus may correspond to Inform, Answer, Agreement, Disagreement, and several kind of Accept and Reject tags defined in the ISO standard. To be able to differentiate between these we take the functional tag of the preceding segment and the AMI

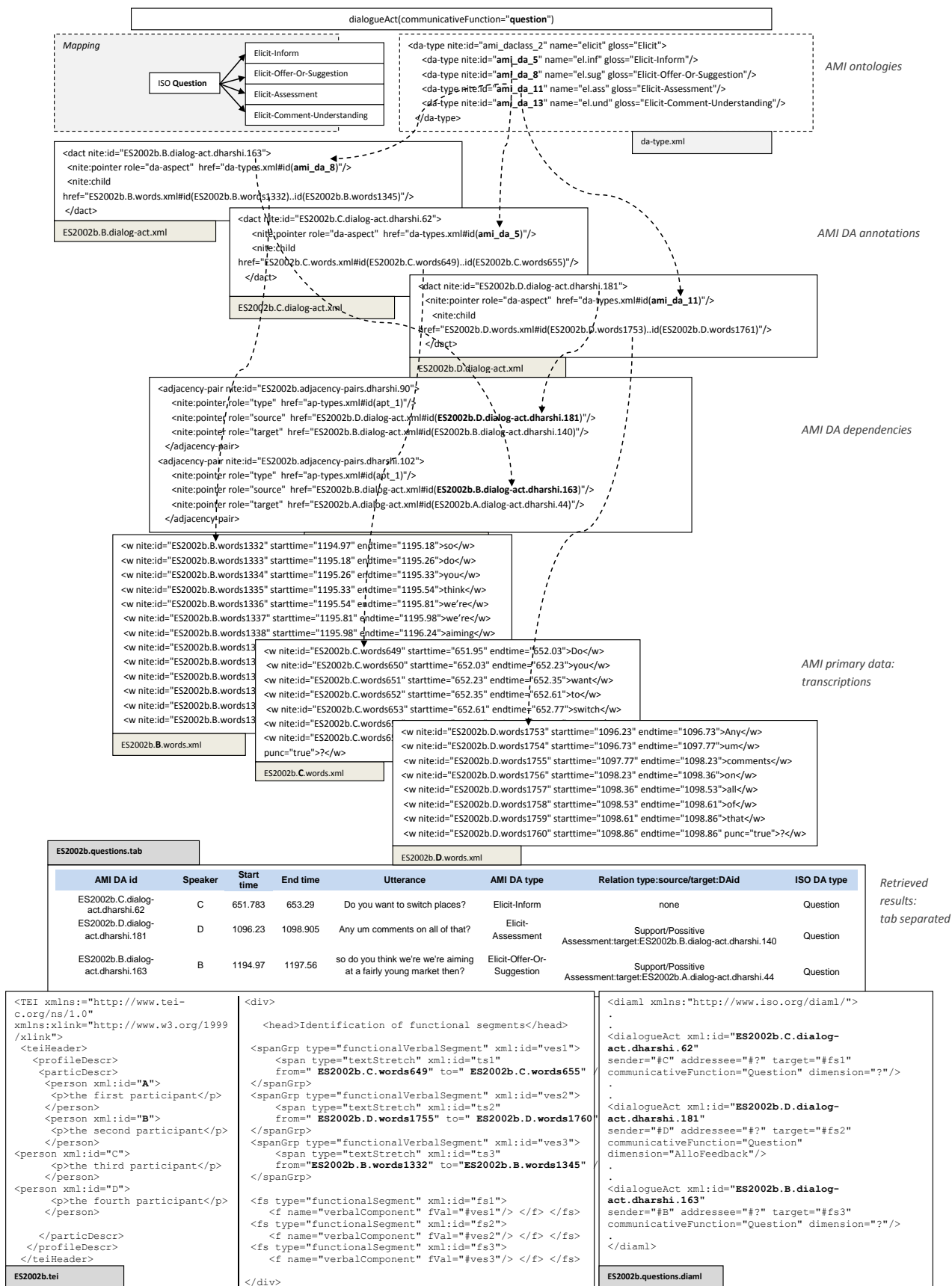


Figure 1: Example of Questions retrieval from the AMI meeting corpus and representing them in DiAML.

AMI	Previous AMI tag	AMI relational tag	ISO functional tag
Inform	Elicit Inform	POSitive or NEGative	Answer
	Inform	POSitive	Agreement
		NEGative	Disagreement
	Elicit-offer-or-suggestion	POSitive	Accept Request
			Answer
		NEGative	Decline Request
			Answer
		-	Address Request
		Answer	
	Elicit-Comment-Understanding	POSitive NEGative	Positive AutoFeedback Negative AutoFeedback
Elicit-Assessment	POSitive NEGative	Positive AutoFeedback Negative AutoFeedback	

Table 2: One-to-many mapping between AMI Inform and corresponding ISO functional tags.

relational tag into account. If the previous tag was Elicit Inform, then the AMI Inform is mapped to Answer, if the AMI preceding tag was Inform, we map to Agreement if a POSitive relation tag was assigned, and to Disagreement if a NEGative tag was assigned (see Table 2).

## 4. Querying corpora through DiAML

### 4.1. Annotation representations in ISO 24617-2

The representation of annotations in the ISO Dialogue Act Markup Language (DiAML) relies on a three-level architecture:

1. a primary source, which may correspond to a speech recording, textual transcription or any low-level annotation thereof, e.g. a tokenisation;
2. the marking of functional segments from the primary source;
3. the actual dialogue act annotation associated with a functional segment.

The representation of a dialogue act annotation makes use of the XML element `<dialogueAct>`. This element has the following attributes:

- `@target`, whose value is a functional segment identified at the second level;
- `@sender`, `@addressee`, `@otherParticipant`;
- `@communicativeFunction`, `@dimension`;
- `@certainty`, `@conditionality`, and `@sentiment` qualifiers;
- `@functionalDependence` and `@feedback` Dependence, which have `<dialogueAct>` elements and functional segments as values.

Additionally, rhetorical relations among dialogue acts are represented by means of `<rhetoLink>` elements. Figure 1 contains a concrete example of the use of DiAML.

### 4.2. Dialogue act information retrieval

AMI, HCRC MapTask and ISO 24617-2 annotations are in stand-off form, i.e. the representations are stored in separate files, linked to the primary data, typically using separate files per dialogue and per speaker. If a specific dialogue act (or type of dialogue act) is to be retrieved, we go through multiple annotation files and collect the relevant information. For example, to extract all instances of Question acts in AMI corpus data, the query will be searching for matches for the tags Elicit Inform, Elicit-Assessment, Elicit-Comment-Understanding and Elicit-Offer-or-Suggestion. Figure 1 illustrates the query

processing and the retrieval workflow. The dialogue act types `da-type` are specified in AMI ontology files (`da-type.xml` for dialogue acts) where the unique identifier that is the value of `@nite:id` is assigned to each of them, e.g. `ami_da_5` for Elicit-Inform, `ami_da_8` for Elicit-Offer-or-Suggestion, etc. Having this information, we search the dialogue act annotation files, e.g. `ES2002b.B.dialogue-act.xml`, where ES2002 is a meeting id, b means that it was the second dialogue with these participants, B stands for the speaker who plays the project leader role). Each dialogue act has a unique `@nite:id` identifier as well, which helps to find all other information in AMI data that points to this dialogue act, e.g. adjacency pairs. We collect the primary data that the annotation is attached to. Each identified `<dact>` element is linked to words produced by the corresponding speaker. The start and end words are indicated, for example, as `href="ES2002b.D.words.xml#id(ES2002b.D.words1753)..id(ES2002b.D.words1761)"`. Since we know that AMI does not allow dialogue segments to be discontinuous, we compile the wording of the corresponding utterance by taking every word between start and end token including the former and the later ones, e.g. ‘Any um comments on all of that?’ for the example in Fig. 1. Each word element `<w>` in the transcription files has `@starttime` and `@endtime` as attributes. The start time of the first token and the end time of the last token of the corresponding dialogue act are then used to compute the utterance time stamps. The figure also shows how the metadata and the primary data can be represented in TEI format and the dialogue act annotation in DiAML.

Some annotations in AMI bypass dialogue act annotations, e.g. rhetorical relation for argumentation structure, disfluencies, etc., and are attached directly to the primary data. To retrieve this information, the workflow would be slightly different. For instance, we need to start with those annotation files, e.g. `ES2002a.A.argumentstructs.xml` with a word span as `@nite:child`. Subsequently, we check whether the same word segments are marked for dialogue acts, and compute rhetorical relations between the identified dialogue acts.

Other AMI annotations that are not part of dialogue act annotations, but are relevant to determine, are those for emotions. Emotion tags are assigned in AMI to multimodal data, e.g. words, focus of attention signals, head movements and gestures. In order to relate this information to dialogue acts, time stamps need to be taken into account to identify a multimodal utterance.

DiAML query for	Percentage of instances retrieved per query	
	HCRC MapTask	AMI
SetQuestion	2.9	2.3
PropositionalQuestion	7.1	5.8
CheckQuestions	7.1	3.3
SetAnswer	2.4	3.9
PropositionalAnswer	4.3	9.8
Inform	7.8	11.7
Instruct	26.8	0.3
Suggest	0.0	10.1
PositiveAutoFeedback	15.7	20.5
FeedbackElicitation	4.7	0.7

Table 3: Retrieval performance on HCRC MapTask data.

There are at least two possible ways of query existing annotated corpora using DiAML. One way is to transform corpora which are in XML format into DiAML compliant format, and subsequently query these data using XQuery or XPath designed to query XML data. For example, the XPath query to retrieve all Questions from the AMI data would be:

```
(1) /AMI-data/*.diaml/
    dialogueAct/
    [communicativeFunction="question"]
```

or XQuery

```
(2) for $x in doc("*.diaml")/AMI-data
    where
    $x/communicativeFunction="question"
    order by $x/starttime
    return $x/dialogueAct
```

To define a query in the ways shown above, knowledge of the corpus specific annotation scheme and its translation into ISO 24671-2, as well as of DiAML structure is required.

The second approach is to define a DiAML query format and provided a good (100% can not be achieved) mapping to ISO 24617-2 exists can be directly used to retrieve desired information from annotated data. Both approaches are valid. The first one presents a standard way of querying XML data. The second approach is a more straightforward and flexible way of DiAML oriented querying of dialogue act annotated data. Since it closely relates to DiAML specification, there is no need to know details of different annotation schemes and their annotation formats. For the DiAML-oriented querying we designed an interface presented in Figure 2.

## 5. Results and their validation

Table 3 presents the retrieval results when querying HCRC MapTask and AMI corpora (per ISO functional tag) in terms of relative frequency in the given corpus data.

The results have been evaluated in terms of precision and recall. While precision is the fraction of retrieved instances (i.e. utterances with the queried tag) that are relevant to the query and indicates the correctness of the retrieved results, recall is the fraction of the instances that are relevant to the query that are successfully retrieved and indicates the completeness of the retrieved results (i.e. the lower recall the more relevant instances are missed by the query). For this, we compared the retrieved results for each dialogue act

Query for	HCRC MapTask		AMI	
	Precision	Recall	Precision	Recall
SetQuestions	87.8	92.0	88.5	91.3
PropositionalQuestions	81.1	65.8	75.8	68.5
CheckQuestions	75.2	67.6	73.2	56.4
SetAnswer	65.0	59.5	77.5	54.2
PropositionalAnswer	73.2	69.1	77.8	66.8
Confirm	71.4	62.5	71.7	47.3
Inform	83.5	64.4	80.5	79.8
Inform Elaborate	na	na	79.4	72.1
Inform Explain	81.3	72.6	66.7	63.1
Inform Clarify	74.8	29.6	73.7	47.8
Request/Instruct	80.8	92.1	75.8	93.7
Suggest	na	na	65.6	60.5
PositiveAutoFeedback	72.1	68.3	95.1	89.3
FeedbackElicitation	52.2	21.8	78.8	57.1

Table 4: Retrieval performance for HCRC MapTask and AMI data per query.

type with manually produced reference annotations. Table 4 presents the evaluation results for HCRC MapTask and AMI data for each ISO dialogue act type occurring in the corpus data.

The results show reasonably high precision and recall for all types of dialogue acts, except for Feedback Elicitation utterances in case of HCRC MapTask corpus which cannot be easily mapped. Such utterances correspond to most of HCRC MapTask ‘aligns’ and ‘ready’ utterances, and sometimes to ‘query-w’ and ‘query-yn’ utterances, where no clear-cut distinction can be made without taking more complex dialogue properties into account (e.g. larger dialogue history in combination with the wording of dialogue contributions from the left context, where the latter was ignored in the experiments reported here).

## 6. Conclusions and Outlook

In this paper we briefly discussed three approaches to interoperability of annotated dialogue corpora (1) creation of new annotated corpora using ISO 24617-2; (2) conversion of existing annotated data into annotations that are compatible with the ISO standard; and (3) development of a query format for accessing existing annotated corpora through mapping to annotation language defined by the standard. We applied the third approach to two different dialogue corpora, annotated with different dialogue act annotation schemes. This demonstrates the portability of the approach. The used query format based on DiAML provides an attractive solution, since it can be applied to query many different annotated dialogue resources provided a good mapping between tagsets is achieved.

There are other annotated dialogue resources that are interesting to be added to the collection of interoperable resources. 18 existing dialogue act annotation schemes have been mapped to ISO 24617-2 (see informative Appendix F of the standard). For the most widely used schemes corpus data exists and new annotations based on variations of such schemes may be produced in the future. For instance, DAMSL with all its existing variants such as Coconut-DAMSL, SWBD-DAMSL and MRDA should be added to this pool. Moreover, dialogue resources for other languages than English should be explored.

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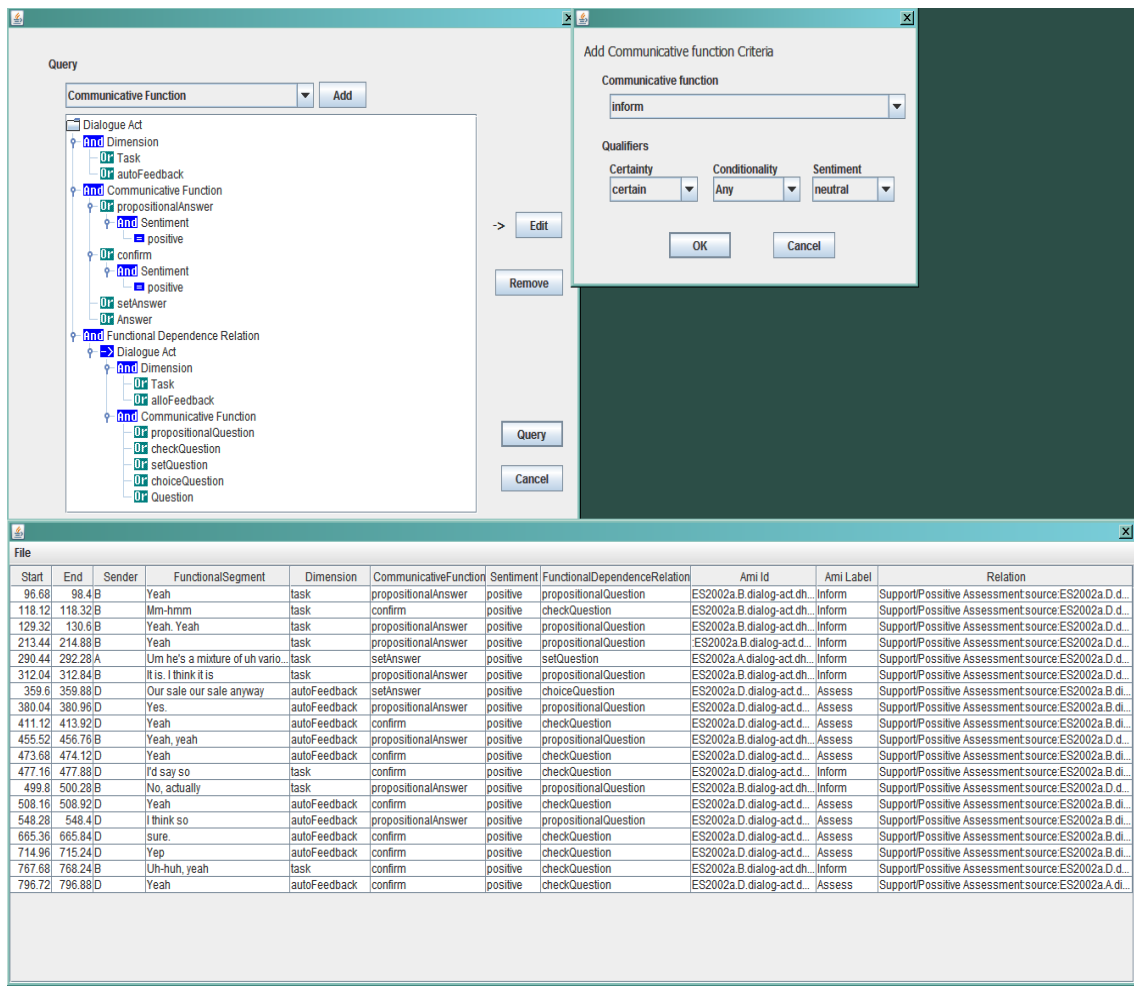


Figure 2: Interface for DiAML-based querying of annotated dialogue corpus (example on AMI data).

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