

Dimensions in Dialogue Act Annotation

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Abstract

This paper is concerned with the fundamentals of multidimensional dialogue act annotation, i.e. with what it means to annotate dialogues with information about the communicative acts that are performed with the utterances, taking various ‘dimensions’ into account. Two ideas seem to be prevalent in the literature concerning the notion of dimension: (1) dimensions correspond to different types of information; and (2) a dimension is formed by a set of mutually exclusive tags. In DAMSL, for instance, the terms ‘dimension’ and ‘layer’ are used sometimes in the sense of (1) and sometimes in that of (2). We argue that being mutually exclusive is not a good criterion for a set of dialogue act types to constitute a dimension, even though the description of an object in a multidimensional space should never assign more than one value per dimension. We define a dimension of dialogue act annotation as an aspect of participating in a dialogue that can be addressed independently by means of dialogue acts. We show that DAMSL dimensions such as Info-request, Statement, and Answer do not qualify as proper dimensions, and that the communicative functions in these categories do not fall in any specific dimension, but should be considered as ‘general-purpose’ in the sense that they can be used in any dimension. We argue that using the notion of dimension that we propose, a multidimensional taxonomy of dialogue acts emerges that optimally supports multidimensional dialogue act annotation.

1. INTRODUCTION

Communication is a complex, multi-faceted activity. In natural dialogue there is often a certain activity or task which one or both of the participants want to perform through the dialogue; moreover, dialogue participants also constantly monitor the communicative process, provide and receive communicative feedback, and deal with social obligations such as greeting and thanking. Since dialogue participants perform the various activities more or less at the same time, it is not surprising that dialogue utterances are often multifunctional, serving multiple purposes at once. For example, an utterance may answer a question, provide positive feedback about the understanding of the question, and pass the turn to the dialogue partner, as in the case of the second utterance in the following dialogue fragment:

- (1) 1. U: Can you tell me what time is the first train to the airport on Sunday morning?
2. S: On Sunday morning the first train to the airport is at 5.32.
3. U: Thank you.

Note that utterance 3 is also multifunctional, as it expresses thanks but also provides positive feedback about the speaker’s processing in this case: perception, understanding, and acceptance of the propositional content) of the previous answer.

Another source of the multiple functionality of a dialogue utterance is the possible indirectness of dialogue acts. Consider for example the following

opening fragment of a dialogue between a user (U) and an interactive help manual for a fax machine (S):

- (2) 1. U: What can I do with this machine?
2. S: Do you have a more specific question?
3. U: Can I send a fax to multiple addressees?

The opening question is too general; utterance 2 indicates this in the form of an indirect request to formulate a more specific question. Utterance 3 is besides a question also an indirect reaction to that indirect request. (And it is in fact also an indirect answer to the question of utterance 2.) Note that the kind of multifunctionality that we observed in example (1) is also present here, adding to the overall multifunctionality of the utterances 2 and 3.

The fact that utterances in dialogue are very often multifunctional implies that accurate annotation of utterances with dialogue act information calls for the assignment of more than one tag to an utterance. This is often referred to as *multidimensional annotation*. Dialogue act annotation schemes, i.e. collections of dialogue act tags in themselves may be neutral with respect to whether annotators should or should not assign multiple tags to an utterance, though the simpler schemes, such as the HCRC Maptask scheme (Carletta et al., 1996) and the LINLIN scheme (Ahrenberg et al., 1995) are intended for one-dimensional annotation, since the various tags are meant to be mutually exclusive. The DAMSL scheme (Dialogue Act Markup using Several Layers, Allen & Core, 1997) was designed for multidimensional annotation. In a study of the use of multiple DAMSL tags in annotating meeting recordings, Clark and

Popescu-Belis (2004) found that only a very small percentage of the possible combinations of tags were in fact used by annotators (220 out of approx. 4 million). This is due to the fact that many tags are supposed to be mutually exclusive; moreover, sometimes the assignment of one tag forces the assignment of another one. In DAMSL some of the dependencies between dialogue act tags are captured in the annotation scheme, and some are captured in the annotation tool, while others are not captured at all.

In this paper we argue that it is possible to design truly multidimensional annotation schemes that support not only the assignment of multiple dialogue act tags to dialogue utterances, but do so in a principled way, based on a well-defined notion of dimension in dialogue. We discuss the fundamental principles for the design of such schemes.

The work described in this paper is inspired by efforts to develop a widely shared set of tools and concepts for semantic annotation in the EU project LIRICS (see Bunt & Schiffrin, 2006) and in ISO TC 37/SC 4/TDG 3 (see <http://let.uvt.nl/research/ti/t dg3>). As Soria & Pirrelli (2003) note, in a comparative study of dialogue act annotation schemes: “No single mono-dimensional hierarchy is likely to capture the complex bundle of mutual relations holding between tags of different tag sets.”

2. DIMENSIONS IN DIALOGUE

A multidimensional annotation scheme should ideally guide annotators in not considering impossible tag combinations. We suggest that such guidance should be based primarily on conceptual clarity of the ingredients of an annotation scheme, rather than on frequency statistics of dialogue act type co-occurrences; in particular on a conceptually clear notion of *dimension*. To locate an entity in a multidimensional space is to assign the entity a value for each dimension, and never more than one value. Lack of a value in a dimension, or an imprecise values in one or more dimensions, may correspond to underspecification. The dimensions defining a multidimensional space should moreover be orthogonal, i.e. the assignment of a value to an entity in one dimension is independent of that in other dimensions (see Bunt & Girard, 2005 for formal definitions of ‘dimension’ and ‘layer’). DAMSL being the most widely used annotation scheme for multidimensional dialogue act annotation, let us examine to what extent DAMSL approaches this ideal.

2.1 MULTIDIMENSIONALITY IN DAMSL

DAMSL makes a top-level distinction of four types of information, called “layers”: Forward-looking functions; Backward-looking functions; Information Level, and Information Status. Of these, the latter serves to annotate an utterance which is in fact impossible or irrelevant to annotate, as *inaudible*, *retracted*, or *self-talk*. Annotations in the Information Level layer indicate whether a dialogue act is about the task, about the management of the task, or about the communication. The layers of Forward- and Backward-looking functions, also called ‘dimensions’, contain DAMSL’s communicative functions. The

assumption behind this dichotomy is that all utterances can have both backward- and forward-looking functions (BLFs and FLFs). The FLFs are subdivided into the following 8 ‘dimensions’ (definitions taken from Allen & Core, 1997):

1. Statement: Asserts and other acts where the speaker makes a claim about the world (modified in Core et al., 1998 to also allow statements to be claims about the communication).
2. Info-request: Speaker requests Hearer (by just asking or in another, indirect way) to provide information.
3. Influencing-addressee-future-action: Speaker is suggesting potential action to Hearer, beyond answering a request for information.
4. Committing-speaker-future-action: Speaker is potentially committing himself to perform a future action.
5. Conventional: Opening or Closing, i.e. Speaker summons Hearer and/or starts the interaction, or Speaker closes the dialogue or is dismissing Hearer.
6. Explicit-performative: Speaker is performing an action by virtue of making the utterance.
7. Exclamation (no explicit definition given)
8. Other-forward-looking-function: No definition given; supposedly any FLF that does not fit into the categories 1-7.

The backward-looking functions are subdivided into the following 4 dimensions:

1. Agreement: Speaker is addressing a previous proposal, request, or claim, with the possibility of accepting or rejecting all or part of the proposal, request or claim; of withholding his attitude towards the proposal, request, or claim; or stating his attitude while being non-committal to the proposal, request, or claim.
2. Understanding: Utterances concerning the understanding between Speaker and Hearer, ranging from merely hearing the words to fully identifying intention.
3. Answer: Standard reaction of Speaker to an Info-request action by Hearer.
4. Information-relation: Tag which should capture how the content of this utterance relates to the content of its antecedent (still subject of further study).

These classes consist of mutually exclusive functions. One, rather naive notion of dimensions that is found in the literature, is that of a set of mutually exclusive values. The following examples show that such a notion of dimension is unsatisfactory. First, consider dialogue fragment (3).

- (3) 1. A: Well, I hope you’ll have a good time there.
 2a. B: Yeah, thanks.
 2b. You’ll be visiting the family in Denmark.
 3. A: That’s right.

Utterance 2b looks like a statement, but is actually a declarative question, i.e. a question in the form of a declarative sentence (see Beun, 1989). The DAMSL scheme and annotation tool would support tagging the utterance both as Assert and as Info-request (DAMSL's tag for all types of question). But this is conceptually wrong: a speaker cannot at the same time assert the truth of a proposition and question its truth. DAMSL supports this possibility as a consequence of putting questions and statements in different dimensions, with the assumption that dimensions are independent.

The same goes for the tags Info-request and Answer: since these are different dimensions, an utterance may be tagged as being both, even though it is conceptually impossible to ask a question and answer it at the same time. (Of course, sometimes one sees the answer to a question immediate after having asked it, and one may express that, but in such a case the answer comes after the question, not simultaneous with it.)

One might, alternatively, think that Info-request and Answer, being mutually exclusive, belong to the same dimension. But that would be wrong as well, as example (4) shows.

- (4) 1. S: Do you have a question about image quality?
 2. U: How can I change the contrast?

Utterance 2 is a question as well as an answer to the previous question. This is possible since it is a question about something else than it is an answer. It asks a specific question about the task domain, and by doing so it (indirectly) answers the question whether U wants to know something about image quality. So clearly, an utterance can have both a question and an answer function, hence these cannot be alternatives within one dimension.

The problems that we see here are caused by the use of an informal, sloppy notion of dimension. The following example shows the heart of the problem.

- (5) 1. S: And what possibilities do you have on Thursday?
 2. U: Did you say Thursday?

Utterance 2 expresses a problem in U's understanding of the previous utterance, and as such has a function in the Understanding dimension. This dimension in DAMSL has two possible values: Signal-understanding and Signal-non-understanding. The latter tag would clearly be too crude, since S only expresses an understanding problem concerning only a small part of the previous utterance. Something like 'Partial-signal-non-understanding' would be closer, if it existed, but would still not be accurate. An accurate description would be: *S wants to make sure that he correctly understood the designated element in the previous utterance.* But *S wants to make sure that...* is the essence of the communicative function known as Check, a function in the Info-request dimension (introduced in DAMSL at the 1998 DAMSL revision meeting; see Core et al., 1998). So an accurate

characterization of the utterance in the Understanding dimension amounts to characterizing it in the Info-request dimension! Similarly, an accurate characterization of "*I did not quite hear whether you said 'Thursday'*" in the Understanding dimension would result in a characterization in the Statement dimension.

The point of these examples is that questions, assertions, checks and answers can be not just about the task at hand, but can also be about understanding; in fact, questions, assertions, and answers can be about *any* aspect of the communication. For example, "*Are you there?*" is a question about the presence or attention of the dialogue partner, and "*I think we're done*" is an assertion of the opinion that the dialogue can soon be ended. Questions, assertions, and answers are therefore functions that do not constitute separate dimensions, and that do not belong to any particular dimension, and so the DAMSL categories Info-request, Statement, and Answer do not constitute proper dimensions. Discarding these dimensions incidentally offers a way out for the awkward fact that statements and answers in DAMSL belong to entirely different dimensions, whereas they are in fact semantically very similar.

A similar analysis applies to requests, offers, instructions, suggestions, and other directive and commissive acts; like questions, statements and answers, dialogue acts with these functions can also be about any aspect of the dialogue, as is illustrated by examples such as those in (6).

- (6) a. Please repeat that.
 b. Would you like me to repeat that?
 c. Wait a minute please.

For this reason the DAMSL categories 'Committing-speaker-future-action' and 'Influencing-addressee-future-action', likewise, do not qualify as proper dimensions.

2.2 PROPER DIMENSIONS AND COMMUNICATIVE FUNCTIONS

In order to design a dialogue act annotation schema that is truly multidimensional, we start not just from possible combinations of dialogue acts but from the conceptual view that a participant in a dialogue has a number of things to manage. Besides trying to perform the underlying task or activity, that motivates the dialogue, he has to monitor mutual attention and correctness of understanding; he furthermore has to manage a variety of aspects of the interaction, including the distribution of sender and receiver roles ('turn management'), the continuation of the interaction under time constraints ('time management'), and the introduction and closing of topics ('topic management'); and he also has to deal with social obligations such as introducing oneself, apologising, thanking and greeting. Each of these conceptually distinct aspects of participating in a dialogue may qualify as a proper dimension of

dialogue act annotation if the two conditions in (7) are satisfied:

- (7) 1. This aspect of participating in a dialogue can be addressed by means of dialogue acts that have a communicative function specific for this purpose;
2. This aspect of participating in a dialogue can be addressed independently of other aspects, i.e., dialogue utterances can have a communicative function for this aspect, independent of its functions in other dimensions.

The first of these criteria means that we are considering an aspect of communication that cannot just be distinguished according to some abstract conceptual analysis, but that corresponds to empirically observable dialogue phenomena. The second condition requires the orthogonality of the system of dimensions that we are designing. (Any inherent dependencies (implications or constraints) between functions in different dimensions would have to be regarded as empirical facts about communication, rather than as properties of the system of dimensions.)

<i>Dimension</i>	<i>Dimension-specific communicative functions</i>	<i>Typical expressions</i>
Task/Activity	OpenMeeting; CloseMeeting; Appoint; Hire	domain-specific fixed expressions
Auto-Feedback	PerceptionNegative EvaluationPositive OverallPositive	<i>Huh?</i> <i>True.</i> <i>OK.</i>
Allo-Feedback	InterpretationNegative EvaluationElicitation	<i>THIS Thursday.</i> <i>OK?</i>
Turn Management	TurnKeeping TurnGrabbing TurnGiving	final intonational rise hold sign with hand <i>Yes.</i>
Time Management	Stalling Pausing	slowing down speech; fillers <i>Just a minute</i>
Contact Management	ContactChecking	<i>Hello?</i>
Own Comm. Man.	SelfCorrection	<i>I mean...</i>
Partner Comm. Man.	PartnerCompletion	completion of utterance
Topic Management	TopicShiftAnnouncement	<i>Something else.</i>
Dialogue Structuring	DialogueActAnnouncement	<i>Question.</i>
Social Obligations	Apology Greeting Thanking	<i>I'm sorry</i> <i>Hello! Good morning.</i> <i>Thanks</i>

Table 1: Examples of dimension-specific communicative functions and typical expressions per dimension.

Each of the above mentioned activities of a dialogue participant forms a potential dimension: (1) task performance; (2) contact and attention monitoring; (3) feedback on understanding and other aspects of processing dialogue utterances; (4) turn management; (5) time management; (6) topic management; and (7) social obligations management. Whether these indeed qualify as dimensions can be determined by checking the criteria (7).

Take the category of time management. Utterances that address time management include those where the speaker wants to gain a little time in order to determine how to continue the dialogue; this function is called Stalling. Speakers indicate this by slowing down in their speech and/or by using fillers, as in *ehm, well, you know,....* The observation that dialogue participants do exhibit this behaviour means that the category of time management functions satisfies the first criterion of (7). Moreover, the devices used to indicate the Stalling function can be applied to virtually *any* utterance, which can have any other function in any other dimension. Time management therefore satisfies the second criterion

as well, and hence qualifies as a proper dimension.

A similar analysis can be applied to the other candidate dimensions mentioned above. Of these, the feedback category should be divided into two, depending on whether a speaker gives feedback on his own processing, or whether he gives or elicits feedback on the addressee's processing; we call these dimensions 'Auto-feedback' and 'Allo-feedback', respectively (cf. Bunt, 1995). Table 1 gives some examples of communicative functions within each of these dimensions, with typical utterance forms in English. Note that in natural dialogue many of these functions are often indicated not or not only linguistically, but also through nonverbal means such as facial expressions, head movements, direction of gaze, and hand gestures. Nonverbal expressions corresponding to many dialogue acts in the various dimensions mentioned here have been identified by Petukhova (2005) in a multidimensional analysis of recorded conversations in meetings, as part of the EU project AMI (<http://www.ami.org/>).

We have identified three other dimensions that correspond to conceptually distinct aspects of communication and that satisfy the two criteria in (7): (a) own communication management¹, which is the category of functions a speaker may use to indicate something about his editing or creating a contribution to the dialogue; (b) partner communication management, which occurs when a speaker is assisting or correcting the dialogue partner in producing a dialogue contribution (such as completing an utterance which the dialogue partner is struggling to complete); and (c) discourse structuring, which is the explicit opening or closing of a (sub-)dialogue, or saying something about a discourse plan. These dimensions are conceptually clear and different enough from the seven dimensions listed above to be distinguished, and empirical evidence shows that they satisfy the criteria (7); examples of communicative functions in these dimensions are also shown in Table 1.

Altogether, this leads us to distinguishing the following 11 dimensions:

1. Task/Activity: dialogue acts whose performance contributes to performing the task or activity underlying the dialogue;
2. Auto-Feedback: dialogue acts that provide information about the speaker's processing (perception, interpretation, evaluation, or application) of the previous utterance or some particular previous utterance(s);
3. Allo-Feedback: dialogue acts used by the speaker to express opinions about the addressee's processing (perception, interpretation, evaluation, or application) of the previous utterance or some particular previous utterance(s), or that solicit information about that processing;
4. Turn Management: dialogue acts concerned with grabbing, keeping, giving, or accepting the speaker role;
5. Time Management: dialogue acts signalling that the speaker needs a little bit of time to formulate his contribution to the dialogue, or that his preparation for producing a contribution requires so much time that a pause is necessary;
6. Contact Management: establishing whether the dialogue partner is present and paying attention; also indicating the speaker's presence and attention;
7. Own Communication Management: dialogue acts to indicate that the speaker is editing the contribution to the dialogue that he is currently producing;
8. Partner Communication Management: the agent who performs these dialogue acts has the addressee rather than the speaker role, and assists the dialogue partner in his formulation of a contribution to the dialogue;
9. Topic Management: dialogue acts whose function is to explicitly start or close a topic, or negotiate a topic shift;
10. Dialogue Structuring: dialogue acts for explicit opening or closing a (sub-) dialogue or announcing that the speaker is going to perform certain dialogue acts, possibly conditional to the addressee's consent that he do so;
11. Social Obligations Management: dialogue acts that take care of social conventions such as welcome greetings, apologies in case of mistakes or inability to help the dialogue partner, and farewell greetings.

Note that the total set of communicative functions that is available for constructing dialogue acts in this multidimensional system, consists of the dimension-specific functions of which some examples are mentioned above and listed in Table 1, plus all the general-purpose functions, which include:

1. Information-seeking functions: all sorts of questions (WH-questions, yes/no-questions, multiple-choice questions, checks, etc.)
2. Information-providing functions:
 - informs, agreements, disagreements, corrections, etc., but also informs with additional rhetorical functions such as explanation, justification, exemplification, etc.
 - answers, i.e. information-providing dialogue acts in response to an information need signaled by the dialogue partner, including also confirmations, disconfirmations.
3. Commissive functions, where the speaker commits himself to performing some action(s), possibly conditional on the addressee's consent that he do so, such as offers, promises, and acceptance of requests or other directive functions;
4. Directive functions, where the speaker wants the addressee to consider some action(s) to perform, potentially putting pressure on the addressee to do so, such as instructions, requests, and suggestions.

3. CONCLUSIONS AND FUTURE WORK

By taking the notion of a dimension seriously, as an aspect of participating in a dialogue that can be addressed independently by dialogue acts, we have arrived at a set of dimensions that is very different from that of DAMSL. Having a clear conceptual basis, and using empirically testable criteria for distinguishing a dimension, we have arrived at the 11 dimensions proposed in this paper. By placing the communicative functions of dialogue acts in these dimensions, we are able to capture the constraints on multiple dialogue act tagging in a natural and principled way.

¹ This concept as well as the term have been borrowed from Allwood et al. (1994).

The methodology we have followed also makes it clear in what ways one could extend the proposed set of dimensions, if needed. A crucial point in designing this set of dimensions was that a number of important communicative functions, such as questions, answers, requests and statements, do not belong to any specific dimension at all, but are general-purpose functions that can be used in any dimension, depending on their semantic content.

Limitations of space prevented us from going in detail into the sets of communicative functions that populate these dimensions; see Bunt & Girard (2005) for a proposed set of dialogue control functions, and <http://ls0143.uvt.nl/dit/> for a more complete proposal. At the moment, the set of dimensions proposed in this paper is being used in the design of a multi-agent dialogue management engine for use in interactive multimodal information extraction (see Akker et al., 2005 and Bunt & Keizer, 2006). and in an annotation effort to investigate its usability for multidimensional dialogue act markup (Geertzen & Bunt, in prep.).

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