A View on Dialogue Move Taxonomies for Tutorial Dialogues

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Abstract

In this paper, we look into extending standard dialogue move taxonomies for the genre of tutorial dialogues. We suggest a way of investigating tutorial dialogue phenomena robustly. We keep a view towards reusable general dialogue management and the easy reconfigurable genre and domain dependent phenomena.

1 Introduction

We developed a dialogue move taxonomy[1] based on a preliminary analysis of our empirical data on tutoring elementary set theory in German (Wolska et al., 2004). The taxonomy draws on DAMSL (Allen and Core, 1997), which is an attempt to provide a standard top-level structure for annotating dialogues aiming at enhancing reusability of annotation schemes. We make use of the DAMSL multiple-level structure, which allows catering for the various functions an utterance may have in dialogue.

We modified and extended the dialogue moves in DAMSL with moves from the BE&E (Basic Electricity & Electronics) annotation scheme (Core et al., 2002), which was developed for the tutorial dialogue genre. The BE&E annotation scheme is based on DAMSL, however without distinguishing all levels that DAMSL provides for. It, furthermore, provides additional dialogue moves, derived from a tutorial dialogue corpus. We adopt some of these moves, but in order to cater for more tutorial dialogue genre specific and domain specific phenomena, we define new dialogue moves and group them in a separate task level, following DAMSL. The need for such separation in dialogue systems has been also advocated by (Allen et al, 2001) who use a modular architecture for dialogue and task planning for the domain of route planning, and (Zinn et al., 2002), who argues for its advantages in the tutorial dialogue genre.

[1] Taxonomy here means a set of dialogue moves, which can assume different uses, e.g, an annotation scheme use.

2 General Description of the Taxonomy

Our taxonomy features six dimensions, one for every different function that an utterance might have at the same time. The actual detailed description of what the utterance does in the dialogue at hand corresponds to one of the categories of dialogue moves defined in the dimensions themselves. In every dimension, there are different levels of description of the dialogue moves. These are structured in classes and subclasses, up to three different levels deep. The current function of an utterance is represented on the deepest level of subclasses, which inherit the properties of the respective super-classes. The six dimensions in the taxonomy are: 1) Forward Looking, 2) Backward Looking, 3) Task, 4) Conventional task-management, 5) Conventional dialogue-management, and 6) Communicative status.

3 Task Dimension Motivation

Extending DAMSL, we propose an expanded task dimension for our multi-dimensional dialogue move taxonomy. We define dialogue moves in it in a top-down manner using empirical data that we have collected (cf. (Wolska et al., 2004)). We are additionally guided by tutorial dialogue specific moves defined in (Core et al., 2002), as well as by psychological considerations regarding teaching (Wilson and Cole, 1996; Lim and Moore, 2002; Weiner, 1992). We claim that adding the task dimension helps separating generic dialogue management, on the one hand, and manipulating genre and domain specific phenomena, involved in modelling different teaching models and domains, on the other hand. The latter we view as only a sub-part of the dialogue manager.

More specifically the expanded task dimension allows clearly separating out and defining the genre and domain specific characteristics of dialogue, which further facilitates the original idea of the DAMSL attempt for reusability and reconfigurability. That is, it provides a better framework for capturing what is generic in dialogue management and, hence, reusable between genres, and, contrary, what is specific to the genre or even the different domains. The latter also makes modelling the genre, and the different domains in it, more straight forward, providing guidelines for what needs to be considered.

In such a framework, tutorial systems can make use of the advantages of natural language capabilities in tutoring, which have been discussed in (Moore, 1993), independently from their preferred teaching strategies. Teaching models which presuppose dialogue interaction have already been demonstrated to be a beneficial ingredient of tutoring (Chi et al., 1994; Rosé et al., 2001). Additionally, however, the modelling of such dialogue based teaching strategies can manipulate psychological aspects of learning, such as help the student build a deeper understanding of the domain, eliminate cognitive load, and promote schema acquisition (Wilson and Cole, 1996; Lim and Moore, 2002).

3.1 Task Dimension Description

In order to effect the above mentioned aims, we define a `task` dimension, which captures functions that are particular to the task at hand and its manipulation, and hence to the genre. It comprises mostly newly defined moves. These moves require special treatment in the tutorial genre or acquire their specific function only due to the genre. They can also only be planned by use of special modules that deal with domain knowledge (cf. (Benzmüller et al., 2003)) or after consulting information on the current student progress. Moves in this dimension are also quite often indirect ones.

The task dimension is divided into two subdimensions in order to distinguish between the two parallel tasks that are performed while tutoring, namely the proof task and tutoring task. In the `proof task` we define the dialogue move *domain_contribution*, which is concerned with resolving the domain task for the session. In our domain the task is finding a mathematical proof to a problem. Example (1) is a *domain_contribution*, where the student tries to perform a step in the proof which they are expected to complete.

(1) S: $K((a \cup B) \cap (C \cup D)) = K(a \cup B) \cup K\ (C \cup D)$

The dialogue moves in the `tutoring task` subdimension are: *Hint*, *domain_contribution_ evaluation* (comprises teaching model specific sub-classes), *check_origin_of_problem*, *request_evaluation*, *resign*, *prompt*, *encourage*, *request_assistance*, and *align*. These moves pertain to the tutoring, as they do not try to resolve the task directly, but rather aim at helping the student resolve it. This sub-dimension constitutes the framework for manipulating different teaching strategies.

3.2 Task Dimension Use

The careful expansion of the task dimension can prove extremely beneficial in a difficult genre as tutorial dialogues. The task level moves can be more clearly defined for use in tutorial dialogues. Such definitions facilitate our understanding of the phenomena in tutorial dialogues and their implementation separately from the general dialogue management moves, and in parallel to them.

Let us have a closer look into how the clear separation of the task level has allowed us the formalisation of specific tutorial phenomena.

Before any reasonable feedback can be given to the student, the student's input needs to be evaluated. There are, however, two categories of student input that are relevant to tutoring. There is input that does not contribute to the task but carries tutoring relevant information, such as motivation levels. This aspect of the input is useful for the genre irrespective of the teaching model implemented. For example, it is useful to represent the move *resign*, i.e., the student stating that they do not wish to continue with the task. The way this move will be treated, can be decided according to the pedagogical model of choice. *Resign* is realised, for instance, by the utterance in Example (2).

(2) S3: Gebe auf.
'I give up.'

On the other hand, there is task related input with which the student tries specifically to handle the task, one way or another. It is characteristic of this kind of input that it is, first, domain specific and, second, that it needs to be evaluated with respect to its success in bringing the task forward. Again the specific way in which the evaluation will take place is up to the implementor and dependent on the teaching model assumed and the domain. Nonetheless, the task dimension expansion which we are proposing and the dialogue moves which we define in it provide a framework and point to a possible way for the further formalisation. More specifically, the dialogue move *domain_contribution* must be available in order to represent an attempt to bring the task

forward. Once this is represented, it is up to the implementor to decide on categories for the evaluation of this attempt, that is the *domain_contributions* relevant to the tutoring purposes. This decision is both domain dependent (different domains might require divergent evaluation methods) and teaching strategy dependent (the information useful for tutoring may vary between models). Hence, it lies beyond the scope of dialogue management. We are currently formalising such categories and incorporating them in feedback managing algorithms, either as domain specific or not, where possible (Tsovaltzi and Fiedler, 2003). These algorithms are external resources for the dialogue manager.

Yet a third dialogue move related to the previous two, is the move *domain_contribution_evaluation*. This super-class comprises dialogue moves which signal the domain evaluation of *domain_contributions*, and correspond to the above mentioned evaluation categories. The managing of such dialogue moves, e.g. generating them or not, and the tutoring situations which determine such manipulation decisions are very relevant for pedagogical reasons and differ for various teaching models. The need for representing them is , however, common in the genre of tutorial dialogues. The utterance in Example (3) has a *signal_irrelevant* function at task level, while 'irrelevant' constitutes an interesting *domain_contribution* category in the proving domain.

(3) Das ist zwar richtig, aber im Augenblick uninteressant.
'That is correct, but at the moment not interesting.'

We have further been able to better formalise the task dimension move *hint*, which bares a particular importance for the socratic teaching method that we are modelling. More specifically, we were able to formalise the very complicated socratic tutoring strategy, which is most appropriate for tutoring proving, and with it the hinting process that implements it and focuses on eliciting information and active learning (Fiedler and Tsovaltzi, 2003). Thus, we defined hint categories in a hint taxonomy based on the needs in the domain. Our hint taxonomy captures the underlying function of hints. The latter is mainly responsible for the educational effect of hints. The structure of the hint taxonomy also reflects the function of the hints with respect to the domain information that the hint addresses or is meant to trigger.

In order to capture the different underlying functions of a hint in our hint taxonomy we have defined hint categories across different dimensions. The same underlying function can be common for different surface realisations. Part of the surface realisation is captured by the forward and backward-looking dimensions and the direct dialogue moves represented there. In other words, the hint categories are defined in a taxonomy within the top level dialogue move taxonomy. This makes it possible to investigate the underlying function of hints, which is itself a very complicated issue, separately from their surface realisation, whose function can be captured in the spirit of the more standard dialogue moves. Example (4) is a *hint* in the task dimension and it realises a passive relevant-concept hint function, based on our hint taxonomy and according to the needs as they arise from the the current student level. The particular realisation is an *open_option* in the forward-looking dimension. Given a different dialogue context, however, the same underlying hint function could just as well be an *action_directive* without altering the hint function at the cognitive level, but serving the dialogue context better. This approach is contrary to what has been done before in modelling tutorial dialogues, which do not distinguish between the cognitive and dialogue function of hints and have, thus, provided no clear account of the status of hints in the proposed dialogue move taxonomies (Person and Graesser, 2003; Core et al., 2002). The hint categories in the hint taxonomy constitute output of a hinting algorithm which is called upon by the dialogue manager (Fiedler and Tsovaltzi, 2003).

(4) T: Sie müssen als erstes die wenn-dann-Beziehung betrachten.
'First you have to consider the if-then-relation.'

As mentioned before, another advantage of the expansion of the task dimension which we are proposing is that it facilitates reusability and easy reconfigurability. The latter is a counter effect of the robust definitions of the functions at that level. This makes it possible to define the manipulation of the information captured at the task level for serving the purposes of any teaching model preferred. At the same time the definition of the task level function as separate from the function at the most standard forward and backward-looking levels clarifies exactly what needs to be manipulated for the tutoring and task (domain) purposes, as opposed to what can be reused intact since it pertains to the general dialogue management attributes. The required manipulation of the latter is not expected to differ between genres.

Clear distinctions with regard to dialogue move functions, as we have deliberated, offers itself as a valuable basis for specifying interfaces between the dialogue manager and other modules in a system. Examples of such modules in our genre may be a task manager, the pedagogical knowledge, the teaching

model, a user model (cf. (Benzmüller et al., 2003)). For example, the recognition of the student input that constitutes a *domain_contribution* at the task level, that is it tries to advance the task, also means that it must be evaluated for the domain knowledge that it demonstrates. Thus, it has to be sent to the task manager and the evaluation module. On the contrary, other kinds of student input do not need to involve the task manager for their manipulation. Early realisation of this fact allows valuable speed.

In terms of the inter-relations between this dimension and moves in other dimensions, it allows us to capture the special status that moves have for the tutorial dialogue genre, which are commonly indirect speech acts, highly unlikely to serve the same purpose in other genres. We can, for instance, recognise a *signal_non_understanding* backward-looking function and read this as the student asking for assistance, that is, as a *request_assistance* at the task dimension. This representation facilitates its treatment according to the teaching model each time. It is, thus, necessary to represent and recognise the move, albeit not restrictive as to its treatment. Representing such indirect dialogue moves, in general, allows their easy manipulation according to the desired teaching model, without restricting its choice.

4 Conclusion and Future Work

We have presented a dialogue move taxonomy, which attempts to clearly separate the general dialogue management attributes of utterances from the genre and domain specific ones. We claim that such a separation facilitates a deeper understanding for the appropriate manipulation of the genre specific phenomena and allows their formalisation. That in turn, enables building a reusable and easily reconfigurable dialogue manager, based on such principles.

We are currently testing the taxonomy and our hypotheses about valuable inter-relations of dialogue moves through an annotation programme. The results of the annotations will give us better grounds for asserting the hypotheses or altering and amending the taxonomy. We can then extract an advanced dialogue model and specify it for the dialogue management and the manipulation of the complex tutorial dialogue phenomena, as well as for the genre independent dialogue phenomena.

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