# Confronting Conversational Game Theory and the Poesio-Traum-Theory in the Trindi-Kit

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## 1 Introduction

The TRINDI-kit offers a framework for formalizing, implementing and testing dialogue theories. Its Information-State (IS) approach enables the implementation of theories stemming from rather different traditions in one dialogue management architecture.
In [DT99] implementations of various dialogue theories are presented, but a more detailed discussion - considering and comparing these implementations - does not take place.
We will try to do this here with two theories and their implementations:

(i) the theory developed by Poesion and Traum in [PT97] and [PT98], for which we will use the term PTT (Poesio and Traum Theory) and its implementation EDIS

(ii) the theory in the tradition of Conversational Game Theory (henceforth CGT) as developed by - and its implementation, the SRI Autoroute Demonstrator (SRIAD).

Both implementations focus on different aspects of dialogue: EDIS primarily on Grounding and Obligations, SRIAD on formalizing CGT. We will examine these implementations and their underlying theories with respect to some important aspects of dialogue-management, particularly concentrating onto how a theory deals with the foci of the other. Beside a better understanding of the advantages and disadvantages of the approaches we aim at providing a basis for discussing an integration of (aspects of) both implementations.
After a presentation of the relevant aspects of the architecture of TRINDI we will very briefly present the main features of both theories and their implementations. In the main part we will evaluate different aspects of dialogue in both theories, before discussing perspectives for integrating them in the final section.

## 2 The TRINDI-Kit

The TRINDI-kit[1] is a toolkit for implementing and testing dialogue theories, based on the Information-State-approach. In this approach an Information State (IS) is assumed to be a data structure containing all the relevant information about the current state of the dialogue.

[1]developed in Sicstus prolog, website: http://www.ling.gu.se/research/projects/trindi

Whenever the state of the dialogue changes - which is up to the dialogue theory using the IS-approach[2] - the IS is updated according to specified rules: **UPDATE-rules**. If the theory is active in the dialogue so-called **SELECTION-rules** may - on the basis of the information in the IS - select the next action.
Pic. 1 shows the architecture of the TRINDI-kit implementing the IS-approach. The interesting parts/modules for us are:

- the **Information State (IS)** as the central blackboard containing the information about the current state of the dialogue.
- the **Update module** which updates the IS on basis of the input.
- the **Selection module** which selects the next action of the system.
- the **Control module** controlling the other modules.

to be finished.

# 3 The Conversational Game Theory

tbd.

# 4 Poesio's and Traum's Theory

tbd.

# 5 Confronting PTT and CGT

In this section we will compare the way both theories treat aspects of dialogue and dialogue-management. We start from the objectives and more theory-oriented aspects like dialogue structure or the modelling of context going towards more implementation-specific issues like dialogue processing or portability.

## 5.1 Objectives

The differences start already at the level of the aims of the theories and their implementations. Whereas PTT focuses on modeling two aspects of dialogue - Grounding and Obligations - "CGT is intended to provide a fully general account of conversation and dialogue ..."(p.64) This is reflected in the implementations EDIS and SRIAD. The former concentrates on the two aspects of dialogue and leaves other issues aside - an opportunity supported by the TRINDI-kit. The latter takes topics concerning the whole of the dialogue into account: analysis and re-analysis, preferences, reconfiguration, etc. . Beside that SRIAD also aims at formalizing CGT: defining a syntax and a semantics for contributing to further development of the theory.
Having these objectives in mind supports the understanding and the search for an integration of both implementations.

## 5.2 Plans, networks or ...?

The techniques applied for updating the IS in EDIS and SRIAD illustrate some of their pros and cons. SRIAD emulates plan- and recursive-transition-network-based methods in the IS-framework, EDIS applies a set of rules directly on the

[2]Usually the utterances of the dialogue participants are seen as ..., but new incoming information, a change in the environment, time could have an impact as well.

IS.
In this way EDIS can avoid disadvantages of plan-based (like the need for expensive reasoning) and RTN-approaches (e.g. the reliance on static networks), but loses the opportunity to use the experiences collected with both. Thus being rather unrestricted EDIS is very flexible to apply any suitable rule, allowing even highly interacting rule-systems. Which can - on the other hand - cause problems of complexity, making the reconfiguration of larger system difficult.
SRIAD's basic idea is the use of plans for the processing at a higher-level and RTNs for small components. Thus restricting the load of expensive reasoning but keeping a certain flexibility a compromise is achieved.

## 5.3 Dialogue Structure and Dialogue Acts

In both theories the dialogue participants (DP) are considered to perform a kind of Dialogue Act (DA) with their utterances. Starting from these DAs - as a representation of the language-input to the system - the IS is updated. The set of DAs employed in both theories differ: PTT tries to follow DRI(1997), CGT takes the taxonomy of Carletta(1997) as a starting point. Whereas the DAs in PTT form a loose (but highly interacting) set, which - if used for reflecting the structure of the dialogue - would result in a rather flat structure, the DAs[3] in CGT are stuck together in Conversational Games forming a hierarchical dialogue structure.
Hierarchical structures are of use in a range of discourse theories, supporting the applied for referring can be of use Depending on the Advantages/Disadvantages.
Another difference is that PTT enables the almost arbitrary mapping of various DAs to one utterance. CGT is more restrictive in this respect: possible mappings must be prescribed and hard-coded in the game-networks making arbitrary mappings impossible.

## 5.4 Context and Beliefs

CGT's and PTT's approaches to dialogue make them use rather different models of context.
PTT specifies the context for both dialogue participants in an explicit and declarative way. It is divided into grounded and non-grounded information about obligations, performed DAs and socially commited propositions. Basic components are Discourse Units (DU), containing information contributed by an utterance. In contrast to PTT EDIS takes only the current and previous DU into account.
The context model applied in SRIAD reflects the use of plan- and RTN-based techniques. For the *Rational Agent* the context consists of the plan with its goals and the current set of beliefs about the world. The *Conversational Game Player* - traversing the recursive transition network - uses the information about the current node withing the network. Obligations or ungrounded information - explicitly stated in EDIS - has to be inferred from the network. These networks can be considered as belonging to the static part of the IS, which is then divided into a dynamic and static part.

## 5.5 Grounding: How does CGT/SRIAD cope with Grounding?

Grounding in EDIS is realized with the help of obligations: forward-looking acts like **assert**, **check**, **info-request** and **direct** impose the obligation to per-

[3]We consider MOVES as the actual dialogue acts- moves as the basic building blocks

form an acknowledge-act onto the hearer. During processing the next utterance update rules on the basis for background-grounding acts like **acknowledge** are triggered first and merge the acknowledged information into the common ground.
In SRIAD **acknowledge**-moves are part of conversational games. They are the final transitions in the inform- and question-answer-game, thus imposing the obligation to perform the **acknowledge** move in order to finish these games.

### 5.6 Obligations: How does CGT cope with Obligations?

The other focus of PTT/EDIS, Obligations, is implicit in the transitions of the RTN of CGT/SRIAD. As mentioned above with the acknowledge move (non-recursive) transitions leading to the final node in a conversational game form - once the game has started - an obligation to be performed in order to end the game. Conditional obligation are (it is lost that after each: inf-move an obligation to ack is imposed. Obligations across the limits of a conversational game cannot be modelled in SRIAD, but the

### 5.7 Monitoring a Dialogue

A feature stressed by the developers of SRIAD is the possibility to use it for monitoring a dialogue, without taking part in it. This was not possible with the pre-TRINDI version. Due to the different modules for processing the input (ending in the update rules) and generating a response (starting from the selection rules) EDIS should be capable of monitoring as well.

### 5.8 EDIS and SRIAD processing a dialogue: preferences and re-analysis

tbd.

### 5.9 Reconfigurability

tbd.

## 6 Discussion

As one should expect the comparison illustrates the impact of the different foci and perspectives of the implementations. PTT is very close to the utterances, models obligations in a declarative way and explicitly differentiates grounded and ungrounded information. CGT looks at the dialogue from a higher level, assigning a hierarchical structure to it and applying methods known from parsing for analysis and re-analysis.
One main advantage of EDIS towards SRIAD is its flexibility that enables it e.g. to process several DAs arbitrarily linked to one utterance. SRIAD would have to hard-code these DAs in its games, being forced to predict all possible linkings. Being explicit with respect to obligations and Grounding is another pro for EDIS. This could at least partly be modelled in CGT, where sequences of moves introducing an obligation (e.g. to be acknowledged) and moves fulfilling this obligation (e.g. acknowledge-acts) occur together. This could be stated as a restriction for these sequences as obligation-fulfiller-pairs and the idea of Grounding and Obligation would be partially explicit.
With its flexibility the approach of EDIS is very suited for SRIAD's more important benefits consist of (i) its parsing capabilities due to the network structure of the conversational games allowing the application of preference mechanisms

and techniques of re-analysis - both known from the parsing of natural language with a range of experiences and developed techniques - and (ii) the hierarchical structure that can be obtained from the processing of a dialogue with conversational games. Both could be realized in EDIS as well - with additional and costly efforts.
For an integration of both theories/implementations the alignment of EDIS-ideas into SRIAD seems to be a natural idea, the latter providing the global view of the dialogue. Modelling the features of PTT in a CGT-framework with its more restricted oppurtunities is certainly a challenging task contributing to the further development of CGT. Of course one could try to run EDIS and SRIAD in parallel - a technique applied in parsing natural language - necessary information could be taken from the respective relevant system. The TRINDI-kit should at least ease the realization of this idea.

# References

[DT99] Johan Bos et al. David Traum. A model of dialogue moves and information state revision. deliverable d2.1, 1999.

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[PT98] Massimo Poesio and David Traum. Towards an axiomatization of dialogue acts. In J. Hulstijn and A. Nijholt, editors, *Proceedings of TWENDIAL, the Twente Workshop on the Formal Semantics and Pragmatics of Dialogues*, pages 207–222, Enschede, May 1998.