

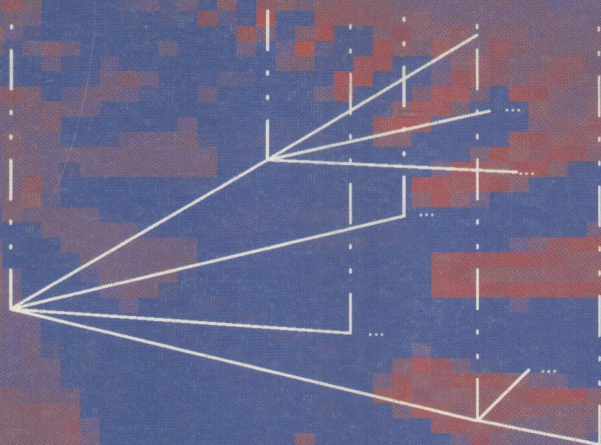
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LNAI 2922

Frank Dignum (Ed.)

# Advances in Agent Communication

International Workshop  
on Agent Communication Languages, ACL 2003  
Melbourne, Australia, July 2003  
Revised and Invited Papers



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# Preface

In this book we present a collection of papers around the topic of Agent Communication. The communication between agents has been one of the major topics of research in multi-agent systems. The current work can therefore build on a number of previous workshops, the proceedings of which have been published in earlier volumes in this series. The basis of this collection is the accepted submissions of the workshop on Agent Communication Languages which was held in conjunction with the AAMAS conference in July 2003 in Melbourne. The workshop received 15 submissions of which 12 were selected for publication in this volume. Although the number of submissions was less than expected for an important area like Agent Communication there is no reason to worry that this area does not get enough attention from the agent community. First of all, the 12 selected papers are all of high quality. The high acceptance rate is only due to this high quality and not to the necessity to select a certain number of papers. Besides the high-quality workshop papers, we noticed that many papers on Agent Communication found their way to the main conference. We decided therefore to invite a number of authors to revise and extend their papers from this conference and to combine them with the workshop papers. We believe that the current collection comprises a very good and quite complete overview of the state of the art in this area of research and gives a good indication of the topics that are of major interest at the moment.

The papers can roughly be divided over the following four topics:

- Fundamentals of agent communication
- Agent communication and commitments
- Communication within groups of agents
- Dialogues

Although the topics are of course not mutually exclusive they indicate some main directions of research. We therefore have arranged the papers in the book according to the topics indicated above.

The first six papers focus on some fundamental issues in agent communication. The paper of *A. Jones and X. Parent* explains how the semantics of messages can be given in terms of the institutional context in which they are sent. *M. Rovatsos, M. Nickles and G. Weiss* go one step further and pose the thesis that the interaction itself provides the meaning of the messages. The use of cognitive coherence theory is explored in the paper of *P. Pasquier, N. Andrillon, B. Chaib-draa and M.-A. Labrie*. This theory is used to explain why certain utterances are used and why some effects are achieved. In the paper of *R. Kremer, R. Flores and C. La Fournie* the performatives that are used in the messages are discussed and a hierarchy of performative types is proposed. The last two papers in this section deal with the verification of agent communication. In the paper of *M.-P. Huget and M. Wooldridge* model checking is used as

a method to check the compliance of agent communication to some properties. *U. Endriss, N. Maudet, F. Sadri and F. Toni* propose a logical formalism to describe communication protocols. The use of this formalism makes it possible to verify the communication protocols against some properties such as guaranteed termination, answers when you expect them, etc.

The concept of “commitment” is used by a growing number of researchers in agent communication and therefore is given a separate section in this book. The first paper of this section is by *N. Fornara and M. Colombetti* and discusses how protocols can be specified when the ACL is based on a semantics of commitments. A logical model to describe the commitments themselves as a basis for agent communication is discussed in the paper of *M. Verdicchio and M. Colombetti*. *J. Bentahar, B. Moulin and B. Chaib-draa* argue that commitments can be combined into a commitment and argument network to formalize agent communication. When commitments are used to model agent communication some issues arise in how to create and dissolve them. In the paper of *A.U. Mallya, P. Yolum and M. Singh* some of the issues around resolving commitments are discussed. In the paper of *A. Chopra and M. Singh* especially some nonmonotonic properties of commitments are handled.

A relatively new topic that arose at this year’s workshop is that of multi-party dialogues. Many issues come up in this setting that do not play a role in dialogues between only two agents. The main issues are discussed in the first two papers of this section. The paper of *D. Traum* focuses on the complete setting of the dialogues, including the focus of attention, etc. The second paper of *F. Dignum and G. Vreeswijk* discusses the issues from the dialogue perspective. The latter paper also gives a first attempt to create a test bed in which one can check the properties of multi-party dialogues. This is of particular interest because it will be hard to formally prove some of these properties given the complex settings and many parameters that play a role.

In the papers of *P. Busetta, M. Merzi, S. Rossi and F. Legras* and of *F. Legras and C. Tessier* some practical applications and implications of multi-party dialogues are discussed. Finally, in the paper of *J. Yen, X. Fan and R.A. Volz* the importance of proactive communication in teamwork is discussed.

The last section of the book is centered around the concept of dialogues in agent communication. The first two papers discuss some fundamental issues concerning dialogues while the other three papers describe some applications of dialogue theory in negotiation and resolving discrepancies. The paper of *P.E. Dunne and P. McBurney* handles some issues around the selection of optimal utterances within a dialogue. In the paper of *S. Parsons, P. McBurney and M. Wooldridge* the mechanics of the dialogues themselves are discussed.

In the paper of *R.J. Beun and R.M. van Eijk* we see the application of dialogue games in resolving discrepancies between the ontologies of the agents. A topic that will certainly become more and more relevant in open agent systems!

The paper of *P. McBurney and S. Parsons* describes how the idea of “posit spaces” can be exploited to describe protocols for negotiation between agents. In the final paper by *I. Rahwan, L. Sonenberg and F. Dignum* a first attempt is

made to describe how negotiation dialogues can be modeled using the interests of the agents as a basis.

We want to conclude this preface by extending our thanks to the members of the program committee of the ACL workshop who were willing to review the papers in a very short time span, and also of course to the authors who were willing to submit their papers to our workshop and the authors who revised their papers for this book.

October 2003

Frank Dignum  
Utrecht, The Netherlands



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# Conventional Signalling Acts and Conversation

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**Abstract.** This article aims to provide foundations for a new approach to Agent Communication Languages (ACLs). First, we outline the theory of signalling acts. In contrast to current approaches to communication, this account is neither intention-based nor commitment-based, but convention-based. Next, we outline one way of embedding that theory within an account of conversation. We move here from an account of the basic types of communicative act (the statics of communication) to an account of their role in sequences of exchanges in communicative interaction (the dynamics of communication). Finally, we apply the framework to the analysis of a conversational protocol.

## 1 Introduction

Current approaches to conversation can be divided into two basic categories:

- those that are intention-based or mentalistic. Inspired by Grice [14], these approaches focus on the effects communicative acts have on participants' mental states (see e.g. [30, 20]);
- those that are commitment-based, in that they assign a key role to the notion of commitment (see e.g. [36, 29, 9]).

What the relative merits are of intention-based and convention-based approaches to communication is a question that has been much debated within the Philosophy of Language [14, 22, 26, 3]. We cannot here enter into the details of this debate. Suffice it to say that it has become increasingly clear that the role played by the Gricean recognition-of-intention mechanism is not as important as one might think. Indeed, as far as literal speech acts are concerned, it is necessary to assume such a mechanism only for those cases where communicative acts are performed in the absence of established conventional rules. On the other hand, as some researchers working on Agent Communication Language (ACL) have also observed, the intention-based account takes for granted a rather controversial assumption, according to which agents' mental states are verifiable. This last observation is in fact one of the starting points of the commitment-based account as proposed by Singh [29] and Colombetti [9]. However, there are also some strong reasons to believe that that account too is fundamentally problematic. The most obvious reason has to do with the fact that it is not entirely clear what it means for speaker  $j$  to commit himself to an assertion of  $p$ . Should not

the propositional content of a commitment be a future act of the speaker? If so, to what action is  $j$  preparing to commit himself, when asserting  $p$ ? A natural reaction is to say that, in asserting  $p$ , speaker  $j$  in fact commits himself to defend  $p$  if  $p$  is challenged by  $k$ . This is the view defended by Walton and Krabbe [36], and by Brandom [4, 5]. However, in line with Levi [21], we believe that this defence does not stand up to close scrutiny. What counts as an assertion in a language-game may correlate very poorly with  $j$ 's beliefs. For instance,  $j$  can say that  $p$  without being able to defend  $p$ <sup>1</sup>. Does that mean that  $j$  is not making an assertion? If not, what is he doing? As we shall see, to focus exclusively on agents' commitments amounts, ultimately, to confusing two kinds of norms, which have been called "preservative" and "constitutive". The first are the kind that control antecedently existing activities, e.g. traffic regulation, while the second are the kind that create or constitute the activity itself, e.g. the rules of the game.

Objections of these kinds, we believe, indicate the need for an account of signalling acts based not on *intentions*, or *commitments*, but on *public conventions*.

The paper is structured as follows. Section 2 outlines the basic assumptions and intuitions which motivate the theory of conventional signalling acts. Section 3 outlines one way of embedding that theory within an account of conversation. We move here from an account of the basic types of communicative act (the statics of communication) to an account of their role in sequences of exchanges in communicative interaction (the dynamics of communication). The proposed framework is applied to the analysis of a conversational protocol.

## 2 Conventional Signalling Acts

The account of signalling acts outlined in this section bases the characterisation of communicative action neither on the intentions of communicators, nor on their commitments, but rather on the publically accessible conventions the use of which makes possible the performance of meaningful signalling acts. Consideration, first, of the communicative act of asserting will serve as a means of presenting the basic assumptions and intuitions which guide this approach.

### 2.1 Indicative Signalling Systems

The term 'indicative signalling system' is here used to refer to a signalling system in which acts of asserting can be performed. Such systems are constituted by conventions which grant that the performance, in particular circumstances, of instances of a given class of act-types *count as* assertions, and which also specify what the assertions mean. For example, the utterance with a particular intonation pattern of a token of the sentence "The ship is carrying explosives" will count, in an ordinary communication situation, as an assertion that the ship is carrying explosives. The raising, on board the ship, of a specific sequence of flags, will also count as an assertion that the ship is carrying explosives. In the

<sup>1</sup> For instance, Levi gives the example of a teacher explaining a thesis to a group of students.

first case the signal takes the form of a linguistic utterance, and in the second it takes the form of an act of showing flags. These are just two of a number of different types of media employed in signalling systems. For present purposes, it is irrelevant which medium of communication is employed. But for both of these signalling systems there are conventions determining that particular acts count as assertions with particular meanings.

According to Searle [26], if the performance by agent  $j$  of a given communicative act counts as an assertion of the truth of  $A$ , then  $j$ 's performance *counts as an undertaking to the effect that  $A$  is true*. What lies behind that claim, surely, is that when  $j$  asserts that  $A$  what he says *ought* to be true, in some sense or other of 'ought'. The problem is to specify what sense of 'ought' this is. (Cf. Steenius [31].) The view adopted here is that the relevant sense of 'ought' pertains to the specification of the conditions under which an indicative signalling system is in an optimal state: given that the prime function of an indicative signalling system is to facilitate the transmission of reliable information, the system is in a less than optimal state, relative to that function, when a false signal is transmitted. The relevant sense of 'ought' is like that employed in "The meat ought to be ready by now, since it has been in the oven for 90 minutes". The system, in this case the oven with meat in it, is in a sub-optimal state if the meat is not ready – things are not then as they ought to be, something has gone wrong. The fact that the principles on which the functioning of the oven depends are physical laws, whereas the principles on which the signalling system depends are man-made conventions, is beside the point: in both cases the optimal functioning of the system will be defined relative to the main purpose the system is meant to achieve, and thus in both cases failure to satisfy the main purpose will represent a less-than-optimal situation.

Suppose that agents  $j$  and  $k$  are users of an indicative signalling system  $s$ , and that they are mutually aware that, according to the signalling conventions governing  $s$ , the performance by one of them of the act of seeing to it that  $C$  is meant to indicate that the state of affairs described by  $A$  obtains. The question of just what kind of act 'seeing to it that  $C$ ' is will be left quite open. All that matters is that, by convention (in  $s$ ), seeing to it that  $C$  counts as a means of indicating that  $A$  obtains. The content of the convention which specifies the meaning, in  $s$ , of  $j$ 's seeing to it that  $C$  will be expressed using a relativised 'counts as' conditional (see, for a detailed formal account, [19]), relativised to  $s$ , with the sentence  $E_j C$  as its antecedent, where  $E_j C$  is read ' $j$  sees to it that  $C$ ' or ' $j$  brings it about that  $C$ '.<sup>2</sup> How, then, is the form of the consequent to be represented? The communicative act is an act of asserting that  $A$ , and thus counts as an undertaking to the effect that the state of affairs described by  $A$  obtains. As proposed in the previous paragraph, this is interpreted as meaning that, when the communicative act  $E_j C$  is performed,  $s$ 's being in an optimal state would require that the sentence  $A$  be true. So the form of the signalling convention according to which, in  $s$ ,  $j$ 's seeing to it that  $C$  counts as an undertaking to the effect that  $A$ , is given by

<sup>2</sup> The logic of the relativised action operator is given in [19] and [17]. The best available introduction to this kind of approach to the logic of agency is to be found in [11].



$$(\text{sc-assert}) \quad E_j C \Rightarrow_s I_s^* A \quad (1)$$

where  $I_s^*$  is a relativised optimality, or ideality, operator (a normative operator of the evaluative kind<sup>3</sup>),  $I_s^* A$  expresses the proposition that, were  $s$  to be in an optimal state relative to the function  $s$  is meant to fulfil,  $A$  would have to be true, and  $\Rightarrow_s$  is the relativised ‘counts as’ conditional.

We state informally some assumptions we associate with (sc-assert). First, signalling system  $s$  is likely to contain a number of other conventions of the same form, according to which  $j$ ’s seeing to it that  $C'$  counts as an undertaking to the effect that  $A'$ ,  $j$ ’s seeing to it that  $C''$  counts as an undertaking to the effect that  $A''$ , ... and so on. So the conventions expressed by conditionals of form (sc-assert) may be said to contain the *code* associated with indicative signalling system  $s$  – the code that shows what particular kinds of assertive signalling acts in  $s$  are meant to indicate. We might then also say that  $s$  itself is *constituted* by this code. Secondly, we assume that the (sc-assert) conditionals constituting  $s$  hold true for *any* agent  $j$  in the group  $U$  of agents who use  $s$ ; that is, each agent in  $U$  may play the role of communicator. Thirdly, we assume that the members of  $U$  are all mutually aware of the (sc-assert) conditionals associated with  $s$ <sup>4</sup>.

## 2.2 Communicator and Audience

Suppose that  $j$  and  $k$  are both users of signalling system  $s$ , and that (sc-assert) is any of the signalling conventions in  $s$ . Then we adopt the following schema:

$$((E_j C \Rightarrow_s I_s^* A) \wedge B_k E_j C) \rightarrow B_k I_s^* A \quad (2)$$

The import of the schema is essentially this: if  $k$  (the audience) believes that  $j$  performs the communicative act specified in the antecedent of (sc-assert), then  $k$  will accept that the consequent of (sc-assert) holds. He believes, then, that were signalling system  $s$  to be in an optimal state,  $A$  would be true. Another way of expressing the main point here is as follows: since  $k$  is familiar with the signalling conventions governing  $s$ , he is aware of what  $j$ ’s doing  $C$  is meant to indicate, and so, when  $k$  believes that  $j$  has performed this act,  $k$  is also aware of what would then have to be the case if the reliability of  $j$ ’s assertion could be *trusted*. This is not of course to say that  $k$  will necessarily trust  $j$ ’s reliability, but *if* he does so he will then also go on to form the belief that  $A$ . In summary, assuming (sc-assert) and (2), and supposing that

$$B_k E_j C \quad (3)$$

it now follows that

$$B_k I_s^* A \quad (4)$$

<sup>3</sup> On the distinction between *evaluative* and *directive* normative modalities, see [17]. For the logic of the  $I_s^*$  operator we adopt a (relativised) classical modal system of type EMCN. As is shown in [8], a classical system of this type is identical to the smallest normal system K. For details, see [17].

<sup>4</sup> See [17] for some remarks on the analysis of mutual belief.