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A Computational Model of Argumentation in Everyday Conversation: A Problem-Centred Approach

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1. Introduction: Spontaneous Argumentation

Human beings are all expert in argument generation. Modelling natural argumentation, as it occurs in spontaneous conversation, is important for two reasons at least. First, it is a source of inspiration for argumentation system design, which can choose to imitate it to some extent. Second, as automatically generated arguments are intended to human hearers or readers, it is important to understand the way the latter generate relevant utterances for each other. This paper offers a new model of spontaneous argument generation.

It is important to measure the importance of argumentation in spontaneous speech. Quantitative data about conversational typology are unfortunately lacking.[1] We performed our own measures. Table 1 shows a distribution of conversational genres, with figures assessed through a sampling method. The corpus we used is composed of 17 hours of conversations, recorded during meals at family gatherings between 1978 and 1988 among educated individuals belonging to a French middle class family. The corpus has been digitalized, and 150 excerpts of 120 s have been automatically extracted at random positions. For each excerpt, the central utterance (occurring at time 60 s) has been assigned a category (Table 1). The small relative size of the 'empty' category reveals that in this family meal context, language is used 89% of the time. Conversation proper, which excludes utilitarian (more or less ritualized) speech, occupies more than 70% of the time (as most of inaudible utterances, due to superimposed noise or simultaneous conversations, count as conversational). Argumentation amounts to 74% of conversation time.

[1] Eggins and Slade (1997) provide estimates for their corpus, but argumentative discussion is distributed over several categories.

Table 1: Distribution of conversational genres in a corpus of family conversations

Conversation	60 %	Argumentative discussions	74 %
		Narratives	19 %
		Immediate events	7 %
Inaudible	13 %		
Other (child screaming, songs)	5 %		
Utilitarian (mainly negotiation about food offer)	11 %		
Empty	11 %		

There are a few fundamental differences to keep in mind between naturally occurring argumentation and typical argument generation systems. Argumentative dialogues, as they occur in everyday casual conversation, are mostly non-routine activities. Individuals discuss topics in which they have no special expertise, such as the next elections or the preceding football match. They do this using their sole knowledge, without access to any external oracle that would help them establish the truth value of propositions. They do it also with limited computational capabilities, as they have to produce relevant arguments in the real time of conversation.

2. The Rules of the Modelling Game

Artificial argumentation systems can rely on various resources that are unlikely to be available in spontaneous human argumentation. Systems may have access to pre-computed sets of plans (Bratman *et al.* 1988), and may perform global operations on these sets, such as checking consistency among plans (Amgoud *et al.* 2003). They may use a planner, for instance a means-end analyser, that proposes several plans which must then be filtered to be compatible with the current intentions (Bratman *et al.* 1988). They may have access to pre-computed static relations between conversational arguments, and they may perform global operations on the resulting graph, like finding circuits or independent paths (Dung 1995). They may use a catalogue of argument patterns, embedded in a single set of epistemic and behavioural rules or in several dialogue games (Airenti *et al.* 1993; Hulstijn 2000; Maudet 2001). Some complex rules may be used to ascribe beliefs to other participants of the dialogue (Lee & Wilks 1996). Argumentation systems may use social expertise, performing computation on objects like social commitments (Bentahar *et al.* 2003). In some cases, domain expertise and social expertise are not separated, as the same planning procedures are supposed to operate on both. Systems may also use an external perspective, allowing access to external truth. In such case, model-theoretic semantics can be used, for instance, to delineate and evaluate the agents' beliefs (Shapiro *et al.* 2000) and the progression of agents towards truth and consensus through dialogue (Tallon *et al.* 2003).

Most of these capabilities cannot be taken as granted when the problem is to account for spontaneous argumentative behaviour. The 'rules' we choose for the modelling task are listed below.

2.1. No Routine Activity

Conversational argumentation can potentially deal with any issue. Contrary to many verbal tasks of daily life, like ordering a taxi, there is no pre-definite script for such interactions. Arguments cannot be retrieved from previous mastery of dialogue games (Airenti *et al.* 1993) and must be computed anew. Moreover, the knowledge required to deal with conversational discussions cannot be on principle circumscribed. We must consider it as unbounded.[2] If, for convenience, a superset of the relevant knowledge is made available to the model as a list of rules, we impose the list to be not scannable. In other words, queries for rules must have at least one term instantiated. This means in particular that the model can neither check the consistency of the knowledge base, nor use general-purpose theorem provers that would derive new propositions from known facts and axioms.

The same restriction applies to the set of beliefs and desires that is provided to the model. Such a set should be thought as inherently unbounded. Most artificial systems are embedded in task-oriented contexts, in which beliefs, desires and goals can be imported mostly from the task to be fulfilled. When there is no such task, or when participants have to pre-existing expert knowledge of how it could be solved, there is no set of goals that can be scanned to see whether some of them can be achieved. Individuals in everyday conversations do not come with a list of goals to reach. Goals are generated on the fly in the course of the discussion.

Similarly, the set of potential arguments should be considered unbounded. We renounce to the possibility of scanning a set of potential arguments to see which one would best fit the situation.

2.2. Cognitive Plausibility

Since the model is expected to have some cognitive plausibility, it should have no access to any external perspective that would enable it to decide on the truth value of propositions. Another requirement is that the model make sequential choices. Contrary to planning programmes that can easily take the best option among one hundred alternatives in a single move, human beings in a novel situation are bound to compare pairs of eventualities. Also, we should avoid presupposing in the first place that individuals engage in complex computations of plans or of nested belief structures to make the content of their next utterance optimal. A model of natural argumentation cannot consist in deriving arguments from complex axioms using a theorem prover that has the power of a Turing machine. It should be procedural, and the procedure involved should be kept minimal.

[2] This statement may seem excessive. However, we may not think of knowledge as a static finite set of rules, but as a mechanism that produces on demand logical or causal constraints from the observation or simulation of qualitative and analogue models (Ghadakpour 2003).

2.3. Simplifications

The purpose of cognitive modelling is not to create a complete model of human cognition. On the contrary, it is to isolate a particular aspect of cognitive performance, here argument generation, and to propose plausible mechanisms for it. We make certain simplifying assumptions. First, we grant the model full access to relevant knowledge, though only 'on demand'. For instance, if the procedure needs to know a possible cause for a given state of affairs, it is returned to the procedure.

Another simplifying assumption is the absence of complex 'theory of mind'. By default, the model supposes that its knowledge is shared with other participants. Only relevant differences may be noticed and taken into account. This means that the model avoids any complex epistemic computation.

The model is intended to investigate how relevant arguments are produced during conversational discussions. We try to isolate this problem, as far as possible, from social issues, such as face preservation (Muntigl & Turnbull 1998), cooperative attitudes or politeness. In other words, the generation of relevant arguments is seen as an *autonomous mechanism* that can be used for the sake of managing social relationships.

This simplifying attitude is an effort toward seeking simple utterance generation procedures that may have some cognitive plausibility. There is, of course, no guaranty that fully adequate procedures can be easily discovered. The study presented here is meant as a first step in that direction. Although we are still a long way from realistic utterance generation, this model may hopefully provide new insight into the way beliefs and desires are handled in spontaneous dialogue.

The paper is organised as follows. In section 3, we give a few basic concepts underlying the model: cognitive conflict, strength, recursive abduction. In section 4, we detail the basic procedure of the model, and in section 5 we illustrate its functioning through the trace of a computer implementation running on a simple example. In section 6, we discuss the strong points of the model, and also its current limits. We conclude by showing the interest of embedding the model in full-fledged argument generation systems.

3. Cognitive Conflicts

It has long been recognised that aspects of argumentation have to do with incompatible beliefs and desires, and with belief revision. "Practical reasoning is a matter of weighing conflicting considerations for and against competing options, where the relevant considerations are provided by what the agent desires about and what the agent believes" (Bratman 1990). The planning procedure described here essentially consists in (1) detecting some local incompatibility in the participants' current beliefs and desires, and (2) attempt to resolve this incompatibility.

Beliefs and desires are not supposed to be binary by nature. My belief that the earth is round is stronger than my belief that my bank account is currently positive. My wish to avoid loosing my credit car is lower than my wish to avoid loosing an arm. It is possible to conceive of psychological protocols, using bets and insurances, to assess individuals' belief and desire intensities. It is thus a reasonable assumption to grant such values to the model. Notice that direct perception and hearsay are also gradual sources of belief.

Beliefs and desires are psychologically highly different attitudes. However, and this is a strong point of our model, these attitudes can be processed similarly as far as their propagation or their consistency is concerned. We may even perform comparisons between belief and desire intensities, when the algorithm must decide which is the weaker. For instance, I may wish that my bank account balance be positive, but my belief in the contrary may be stronger.

We call *strength* of a state of affairs the intensity with which this state of affairs is believed or wished by participants. Strengths are negative in case of disbelief or avoidance. At each step t of the planning procedure, a function $\nu_t(T)$ is supposed to provide the strength of any proposition T on demand. When the strength of T is neither given nor inferred, $\nu_t(T) = 0$ (we may omit subscripts t to improve readability).

Strengths are supposed to propagate through causal links. An effect may inherit the strength of its weakest known cause: If $(C_1 \& C_2 \& \ldots C_n) \rightarrow E$ is a causal relation that has been made available to the procedure, then $\nu(E)$ and $min_i\ \nu(C_i)$ must be equal. The knowledge currently used in our implementation of the model is a set of such causal links.[3] It may also include a few incompatibility relations, like the fact that a same object cannot be present at two different locations at a time.

A *cognitive conflict* is a situation in which a same proposition is given two opposite strengths: $\nu_{t'}(T) \cdot \nu_t(T) < 0$. The conflict, noted $(T, n_1) \uparrow (T, n_2)$, has an intensity, given by the product $I = -n_1 n_2$. Note that cognitive conflicts are internal to the agent; they are not supposed to be objective. More important, *cognitive conflicts do not oppose persons*, but representations.

The argument generation procedure starts with the detection of a cognitive conflict, and stops when this conflict, or the subsequent ones that may come out during the resolution process, have disappeared, or when no solution can be found. Resolution involves two mechanisms: abduction and strength revision.

Abduction is central to problem-solving (Magnani 2001), to diagnosis reasoning (Reiter 1987) and more generally to human intelligence (Hobbs *et al.* 1993). It is also essential to the argumentative procedure proposed here. For the sake of simplicity, causal links are supposed to be explicitly given to the model, and abduction is performed by using causal links backwards. Abduction from E using the causal clause $(C_1 \& C_2 \& \ldots C_n) \rightarrow E$ returns the weakest cause in the clause, *i.e. Argmin* $\nu(C_i)$. This is, of course, a gross simplification. Further developments of the model could involve procedures to perform Bayesian abduction or sub-symbolic simulations to make the abduction part more plausible. We distinguish *diagnostic abduction* from *creative abduction*. The former returns only actual (*i.e.* observed) causes, whereas the latter may return any cause from the chosen clause.

Strength revision is the possibility given to the algorithm, when it reaches a dead end, to modify strength values. Notice that the model makes a distinction between actions and states of affairs. The difference is that the strength of an action is erased after the action has been performed.

[3] A difference between implication and causality is to be observed in a statement like "There is no smoke without fire". Here, $\neg$(*smoke* & $\neg$*fire*) translates into *smoke* $\supset$ *fire*, showing that implication and causality may go in opposite ways.

4. Resolving Cognitive Conflicts

We show now, step by step, how cognitive conflicts are processed in the model. The procedure is inherently problem-based: It is launched as soon as the current proposition T creates a conflict (we may consider T as the last event observed or the last input in working memory).

(a) Conflict: Consider the conflict $(T, -n_1) \uparrow (T, n_2)$, with $n_1 > 0$ and $n_2 > 0$. There may be a certain threshold I_0, depending on the context, below which the conflict is ignored. If $I = n_1 n_2 > I_0$, the resolving procedure goes as follows.

(b) Propagation: Perform diagnostic abduction from T (T is unwanted with strength n_1). If it succeeds, it returns an actual cause C_i of T. If $0 < \nu(C_i) < n_1$, the cognitive conflicts propagates to its cause: Make $\nu(C_i) = -n_1$, and go through step (b) anew with the cognitive conflict $(C_i, -n_1) \uparrow (C_i, \nu(C_i))$. However, if $\nu(C_i) \leq 0$, the conflict is solved by suggesting $\neg C_i$.

In the following conversation, adapted from (Crystal & Davy 1975:52), we see how cognitive conflict propagation leads participants to produce arguments.

C- How did you get – I mean how did you find that side of it, because...
A- Marvellous
C- You know some people say that... that driving a car across a ferry is the devil of a job [. . .] *well I'll tell you the sort of thing I've heard, I mean every summer, you see stories of tremendous queues at the...*
D- But they're people who haven't booked

The initial cognitive conflict is about driving a car across the Channel, which is presented as 'marvellous' by A and D and 'the devil of a job' by C. At some point, C propagates the conflict onto its actual cause: the mention of 'tremendous queues'. D did not have to wait in these queues, so he propagates the new conflict onto an actual cause for being in such queues: not having booked, which happens to have a negative strength in A and D's case. The conflict thus vanishes, as the strength inherited from 'marvellous' is negative too. We can see how the content of the three arguments ('driving a car across the ferry is the devil of a job', 'you see stories of tremendous queues', 'but they're people who haven't booked') results from conflict detection and propagation.

(c) Reparation: If propagation fails, perform creative abduction from $\neg T$ ($\neg T$ is wanted (*i.e.* believed or desired) with strength n_1). If successful, it returns a (possible) cause C_i of $\neg T$. If $-n_1 < \nu(C_i) < 0$, make $\nu(C_i) = n_1$ and go to step (b) with the cognitive conflict $(\neg C_i, -n_1) \uparrow (\neg C_i, -\nu(C_i))$. If $\nu(C_i) \geq 0$, suggest C_i; if C_i is an action and is feasible, simulate its execution by making its consequences actual and reset $\nu(C_i)$ to 0; then observe the resulting situation and restart the whole procedure.

Consider the following conversation (original in French). R, S and their friends want to project slides on a white door, as they have no screen.

[The projector would be ideally placed on the shelves, but it is unstable]
R- Can't you put the projector there [on the desk]*?*
S- […] *it will project on the handle. That will be nice!*

R- Put books underneath. But can’t you tilt it?
S- It will distort the image

R initial suggestion (put the projector on the desk) is motivated by the instability of the projector, which creates a cognitive conflict. The conflict propagates to its cause. Then reparation occurs: the problematic term (projector on shelves) is negated, and an action is found that realises this counterfactual: remove the projector from the shelves. The procedure goes on, with an alternation of conflict detection, propagation and reparation (Table 3).

Table 2: Covert and overt argumentative moves

projector unstable	*Conflict detection*
projector on the shelves	*Propagation*
remove the projector from the shelves	*Repair*
image no longer on the door	*Conflict detection*
Can't you put the projector there? [on the desk]	*Repair*
I'll project on the handle.	*Conflict detection*
the projector is horizontal	*Propagation*
Put books underneath. But can't you tilt it?	*Repair* *Repair*
It will distort the image.	*Conflict detection*

(d) Failure: When reparation fails, make $\nu(T) = n_1$ (T is thus marked as resisting resolution with strength n_1) and redo the whole procedure.

At the end of the preceding dialogue, the strength n_1 of the image distortion (D) is inherited from the strength of tilting the projector (through (c)), which is itself inherited from the strength of not having the image projected on the handle. When D is observed, it conflicts with the desire n_2 of having a non-distorted image. The conflict reads: $(D, -n_2) \uparrow (D, n_1)$. If $n_1 > n_2$, there is no actual cause weaker than n_2 for D, and propagation fails. If there is no weak enough cause that could produce $\neg D$, reparation fails as well. One proceeds through step (d) and D is stored with the new strength n_2. Note that this leaves the situation with the unresolved conflict $(D, -n_2) \uparrow (D, n_2)$.

(e) Revision: When the system is blocked with an unresolved conflict $(T, -n_1) \uparrow (T, n_2)$, revise n_1. If the new value of n_1 is such that $n_1 n_2 \le I_0$, the systems considers the conflict tolerable; if $n_1 > n_2$ resolving procedure takes a new start.

Thanks to the possibility of revision, we may model the fact that in our last example, participants may find after a while that the image distortion is intolerable after all.

(f) Giving up: The system exits the resolution procedure when it is blocked and revision does not change strength values.

Figure 1 summarizes the whole argumentation generation procedure.

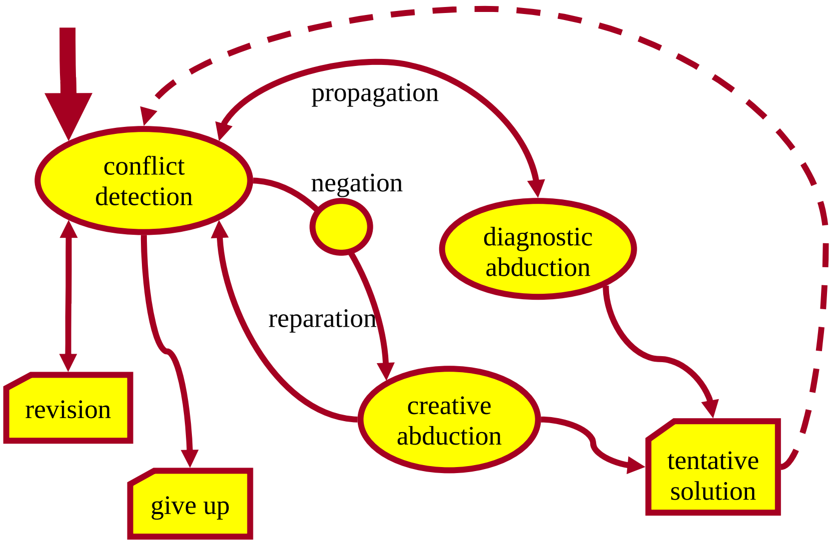

Figure 1: *The argument generation procedure*

5. Implementation

We implemented the model in a Prolog programme. For such an implementation to remain plausible, the size of the programme must be kept minimal. The above procedure is realized with less than 130 Prolog goals (15 clauses), excluding display, domain knowledge and state transitions when an action is performed. As usual in this kind of simulation, the same domain knowledge is used by commodity for two independent purposes: reasoning and simulation. Ideally, the simulation of actions should be achieved though an independent finer grained device, such as qualitative or analogue systems.

The domain knowledge used to reconstruct conversations contains causal relations, such as:

on(*projector*, *desk*) + *horizontal*(*projector*) → *on*(*image*, *handle*)

Some predicates which appear in causal relations, such as *move*(*Object*,*Place*), are marked as being actions, so their strength is cancelled when they are performed. Such domain knowledge is, ideally, independent from the particular argumentation that we want to reproduce. It should be derived from expert knowledge on the subject, and from 'common sense'. Note that capturing domain knowledge through explicit rules is technically convenient but unnatural, especially for common sense knowledge. Our model is fully compatible with a more plausible setting in which the domain knowledge would be provided by a lower level simulation, using constraint programming or qualitative physics, as long as such simulation of the situation is able to supply causal links or, more specifically, is able to perform abduction.

In addition to the domain knowledge, the initial situation is given to the programme as a set of facts, such as:

initial_situation(*on*(*projector*, *shelves*)).

Lastly, initial strengths are given through preferences like:

preference(*stable*(*projector*), 20)
preference(*distorted*(*image*), –10)
preference(*on*(*image*, *handle*), –20)
preference(*on*(*image*, *door*), 30)

Actual values initially given to preferences are not relevant. Only the hierarchy is used in the programme. Table 3 shows the trace of the program in the simple dialogue about the projector.

Table 3: Trace of execution for the projector example

Step	**Operation**	**proposition**	**strength**
(a)	problem with	-stable(projector)	-20
(b)	abducting from	-stable(projector)	-20
(b)	abducting from	on(projector, shelves)	-20
(c)	abducting from	-on(projector, shelves)	20
(c)	------> Action:	remove(projector, shelves)	
(a)	problem with	-on(image, door)	-30
(b)	abducting from	-on(image, door)	-30
(c)	abducting from	on(image, door)	30
(b)	abducting from	-on(projector, desk)	30
(c)	abducting from	on(projector, desk)	30
(c)	------> Action:	move(projector, desk)	
(a)	problem with	on(image, handle)	-20
(b)	abducting from	on(image, handle)	-20
(b)	abducting from	horizontal(projector)	-20
(c)	abducting from	-horizontal(projector)	20
(c)	------> Action:	underneath(books, projector)	
(a)	problem with	distorted(image)	-10
(b)	abducting from	distorted(image)	-10
(c)	abducting from	-distorted(image)	10
(d)	failure:	-distorted(image)	-10
(f)	Giving up		

Each phase in Table 3 is labelled according to the corresponding step of the planning procedure (left column). Note that the quality of the resulting reasoning process depends on the adequacy of the knowledge base. In this example, the predicate *on* depends on whether it applies to physical objects like projectors or books, or to non-physical entities like images, as otherwise the programme spends some time trying to physically move the image onto the door or off the handle!

A current limitation of the implementation (and of the model) is that it is unable to decide whether a given conflict or a given tentative solution should be made explicit as an argument or should remain covert (Table 2, where covert moves are in italics). When too many moves are kept silent, the programme's output seems elliptical, whereas uttering too much gives an expression of clumsiness, despite the fact that all moves are understood as relevant.

The programme is able to produce the same arguments as those observed in a variety of real dialogues, using a small number of steps. This performance should not be underestimated. Usually, planning procedures consider many useless possibilities, and unlike humans, base their choice on multiple evaluations. The challenge of the approach is not only to produce the correct argumentation, but also to produce it in a reasonable number of steps and with a minimally complex procedure.

6. Discussion

Let us list some strong points of the approach.

- The model does not mix domain knowledge and dialogic expertise. In particular, the model does not use argument patterns. The only contingent knowledge is domain knowledge. Nothing like the relative strength of an argument in presence of another is needed. Such relations are computed. Dialogic expertise lies entirely in the resolution procedure.[4]
- The procedure as a whole can be understood as a planning procedure, though it is not designed to generate plans, but arguments. The programme may output what resembles a plan, as in the projector example, but this plan emerges from the argument generation procedure. Planning is thus a side-effect of argument generation, and not the reverse (Hulstijn & van der Torre 2004).
- The model does not include any "concealed" operation, which would be necessary to design utterances while having to remain absolutely hidden from interlocutors. For example, the programme does not generate global plans that would then have to be filtered on the basis of their compatibility with current intentions. The programme does not even use any proving mechanism. The argumentation procedure, as it goes, generates plans, perform evaluations and checks for consistency with current preferences. The resulting architecture is thus significantly simpler than most classical architectures, chosen for their efficiency, like the IRMA architecture (Bratman *et al.* 1988).
- The program does not carry out complex epistemic calculations on interlocutors' beliefs and goals. Obviously, such mental operations are involved in certain dialogues. What the model suggests is that complex epistemic calculus is dispensable for the management of the most basic argumentative dialogues. Moreover, it also suggests that epistemic knowledge could be used, when required, as domain knowledge, as it would not significantly alter the planning procedure itself.
- All decisions made by the argumentation procedure are *sequential* and *local*. At each step, the procedure holds a term and takes decisions like 'do it', 'abduct from it' or 'revise its strength'. There is no global optimisation.
- The procedure adopts an internal perspective. There is no access to external truth. The state of the local world is supposed to be merely perceived, and all strength values are purely internal.

[4] Note that this dialogic expertise excludes the way arguments, once conceived, are expressed.

- The procedure is insensitive to the distinction between beliefs and desires. It is remarkable that the same computation applies both in epistemic reasoning (as in diagnosis) and in task-oriented planning. Of course, it remains crucial to draw a fundamental distinction between beliefs and desires. The processing of beliefs and of desires may strongly diverge when it comes to expressing the corresponding propositions and to performing actions (one does not attempt to change the state of the world in epistemic dialogues). The model simply suggests that the distinction is not necessary in the core of the argument generation system.

In its present state, the programme is able to handle situations for which adequate expert knowledge is available, *e.g.* as a set of causal rules. Its output, at each step, is an argument in predicative form and its logical relation to the context (cognitive conflict, invalidation, reparation). From this point, rich natural language generation is possible, using various logical paraphrases.

The main limit of the procedure is that it ceases to function properly whenever the domain knowledge is locally faulty or incomplete. The origin of such malfunction is the difficulty, well-known in all knowledge-based systems, to capture common sense with rules, especially when spatial relations are involved. One positive aspect of this problem is that the difficulty is encapsulated in the abduction procedure, and does not concern argument generation. One perspective is to interface the abduction procedure with causal reasoning through simulation.

As it stands, the argumentation generation procedure is conceived as a module that is easy to interface with NLP and dialogue systems. It may be embedded into a wider dialogue system in which rescue procedures can take control whenever both abductive phases fail.

The model is conceived to offer a tentative plausible image of cognitive processes underlying argument generation. It does not aim at technical efficiency. If used to process specific task-driven dialogues, it could prove as inefficient as would be a novice in comparison with an expert. However, the model may prove technically helpful when limited knowledge is available to utter arguments that will nevertheless appear relevant. It may be also useful to understand the relevance of users' arguments.

We consider our approach as a promising step toward better understanding of human spontaneous argumentation. The current limitations of the model are due to the extreme simplification of the knowledge made available to the system, which consists of explicit causal rules. The good side of it is that the argument generation procedure is general, simple and systematic, and offers a plausible, though still partial, image of the human spontaneous argumentative ability.

References

Airenti, G., Bara, B. G. & Colombetti, M. (1993). Conversation and behavior games in the pragmatics of dialogue. *Cognitive Science, 17*, 197-256.

Amgoud, L., Herzig, A. & Mercier, D. (2003). Calcul des intentions d'agent à partir de ses désirs. In Chaib-Draa & Herzig (2003),

Bentahar, J., Moulin, B. & Chaib-Draa, B. (2003). Vers une approche pour la modélisation du dialogue basée sur les engagements et les arguments. In Chaib-Draa & Herzig (2003),

Bratman, M. E. (1990). What is intention?. In P. R. Cohen, J. L. Morgan & M. E. Pollack (Eds.), *Intentions in communication*, 15-32. Cambridge, MA: MIT press.

Bratman, M. E., Israel, D. J. & Pollack, M. E. (1988). Plans and resource-bounded practical reasoning. *Computational Intelligence, 4* (4), 349-355.

Chaib-Draa, B. & Herzig, A. (2003). *Actes des journées francophones 'Modèles formels de l'interaction' (MFI-03)*. Toulouse: Cépaduès Editions.

Crystal, D. & Davy, D. (1975). *Advanced Conversational English.* Londres: Longman.

Dung, P. M. (1995). On the acceptability of arguments and its fundamental role in nonmonotonic reasoning, logic programming and n-person games. *Artificial Intelligence*, *77,* 321-357.

Eggins, S. & Slade, D. (1997). *Analysing casual conversation.* London: Equinox.

Ghadakpour, L. (2003). *Le système conceptuel, à l'interface entre le langage, le raisonnement et l'espace qualitatif: vers un modèle de représentations éphémères.* Paris: Thèse de doctorat, Ecole Polytechnique.

Hobbs, J. R., Stickel, M. & Martin, P. (1993). Interpretation as abduction. *Artificial Intelligence, 63,* 69-142.

Hulstijn, J. (2000). Dialogue games are recipe for joint action. In *Proccedings of the 4th Workshop on Formal Semantics and Pragmatics of Dialogue (Gotalog-00),* 99-106. Göteborg: Gothenburg Papers in Computational Linguistics 00-5.

Hulstijn, J. & van der Torre, L. (2004). Combining goal generation and planning in an argumentation framework. In *International workshop on non-monotonic reasoning*. Whistler BC, Canada: Pacific Institute for the Mathematical Sciences.

Lee, M. & Wilks, Y. (1996). *Speech acts on demand.* Mexico City: Proceedings of the 5th International Pragmatics Conference.

Magnani, L. (2001). *Abduction, reason and science - Processes of discovery and explanation.* New York: Kluwer Academic.

Maudet, N. (2001). *Modéliser l'aspect conventionnel des interactions langagières : la contribution des jeux de dialogue.* Thèse de doctorat en informatique, Université P. Sabatier, Toulouse.

Muntigl, P. & Turnbull, W. (1998). Conversational structure and facework in arguing. *Journal of Pragmatics*, *29* (3), 225-256.

Reiter, R. (1987). A theory of diagnosis from first principles. *Artificial Intelligence*, *32*, 57-95.

Shapiro, S., Pagnuco, M. & Lespérance, Y. (2000). Iterated belief change in the situation calculus. In *Proc. of the 7th Conference on Principles on Knowledge Representation and Reasoning (KR2000).* Morgan Kaufman Publishers.

Tallon, J-M., Vergnaud, J-C. & Zamir, S. (2003). Contradicting beliefs and communication: the static case. In Chaib-Draa & Herzig (2003),