MODELING OF ARGUMENTATION DISPUTES

CORNEL POPA

Argumentation is a daily activity; we all engage, like the prose of Mr. Jourdain, in natural languages, all day long, without knowing it.

We argue when we talk to our friends over a cup of coffee; we argue in our scientific debates and articles; we argue in our public lectures or conferences, in our doctoral theses, in our applications to the authorities. Lawyers argue in court, when pleading for a client; the judge argues when presenting the grounds for a court decree; Parliament members argue when they propose, support or reject a bill; diplomats argue in international organizations; journalists argue in their editorials; managers argue when they negotiate a deal.

Argumentation is done in a natural language but, unfortunately, one cannot also check its validity in a natural language. A spontaneous discourse applied to a given issue is one thing, and a critical reflection on the structure, stages, effectiveness and validity of a course is another.

The argumentation discourse lies at the level of the object language; its critical consideration lies at the level of metalanguage.

The theory of argumentation was studied by rhetoric in the ancient times and it has been for half a century the subject of neorhetoric. Over the last few decades, it has concerned increasingly philosophers and logicians, managers, politicians and jurists. It is of interest to engineers and computer scientists, to expert system developers and to specialists in the theory of communications.

1. A LIST OF EXIGENCIES FOR AN ARGUMENTATION THEORY

Ten years ago I formulated a list of exigencies which ought to be accomplished by a good argumentation theory.

1. The theory should be adequate to current use of argumentative discourse. At the same time the theory must *keep certain features from the classical logic of argumentation*, such as the idea of looking for reasons (rational basis) for a thesis, and should keep and explain certain argumentation structures, such as, for instance, the *enthymeme* and merge them in an adequate framework.

2. It should transcend the limitations of classical Aristotelian logic and remove the deficiencies and shortcomings of syllogistic canons.

3. The theory should be able to *distinguish between valid and invalid arguments.* The theory must make use of logical *laws and principles* and find

support for argued thesis in a set of previously accepted sentences. This set of sentences must contain factual data and hypothetical universal sentences describing rules *or statutes* of institutions or organizations. Even if argumentation aims at convincing the interlocutors and winning a dispute, it should not be reduced to quibbling and sophistry.

4. The theory of argumentation should be built on the skeleton of *formal logical languages* capable of describing real-world situations and arguments should be reduced, in one way or another, to sets of formulas solved by making use of computer programs.

5. It should take advantage of the theory of models and of the semantics of first-order predicate logic; it should use modern decision methods, standard forms and structures (normal prenex forms, Skolem normal forms, Horn clauses) capable of being processed by computer. Validity check for certain arguments can be done using decision trees or derivation trees, AND-OR graphs, by natural or sequential calculus, by the method of resolution, by the Davis-Putnam method, by the method of conservative extension of partial interpretations.

6. The theory of argumentation should *relate* explicitly to the *theory of demonstration* and to the theory of deduction, compared with and differentiated from these theories, as it should be compared with and *distinguished* from emotional and affective *motivation and justification*.

7. The theory of argumentation *should be correlated with the problem-solving techniques and methods* based on relational knowledge data. Argumentation becomes in this case a justification of a problem's solutions.

8. The theory of argumentation should *assimilate the pragmatic dimension of language*, use certain actionalist (praxiological) concepts such as *actional situation, agents as arguer, addresser, supervisor, audience, conflicting parties, adversary or previous speaker, argued thesis, support or founding data, claims, acceptance, doubt, rejection, conviction.*

9. It should be correlated with epistemic and doxastic logic, with the logic of acceptance and rejection, with the theory of understanding and conviction.

10. A modern theory of argumentation should account for the main types of argumentation species: a) argumentation of factual data; b) argumentation of a universal statement; c) argumentation for the justness of a *claim* defended by a party to a trial; d) argumentation or justification of a trial *decision*; e) motivation of a goal (*teleo-argumentation*); f) argumentation of a *program*, procedure or method of achieving a goal; g) arguing the *feasibility* of a goal; h) argumentation of *effectiveness or efficacy* of a procedure or technology; i) argumentation of *lawfulness or unlawfulness* of a conduct; j) it should describe the causal explanation; k) nomological explanations; l) teleological explanations.

11. A modern theory of argumentation should be able to describe the individual languages of the participants in the argumentation, their interrelations,

their common knowledge base, its structure, and the differences between such individual languages.

12. The modern version of the theory of argumentation should be capable of describing the dialogue between the participants in the argumentation, its cycles, the direction shifts of the message and the status of emitter (speaker) and receiver (listener), the questions and answers to questions, the dynamics of the acceptance or rejection states of sentences from their knowledge bases. Obviously, this latter requirement exceeds the power of classic mathematical logic and engages us in the use of non-monotonic logics that will enable us to describe the change in time of the knowledge base or opinions of participants in the argumentation dispute. We should be able to describe how a participant's knowledge base is expanded, how knowledge is revised and how a participant will abandon certain theses.

13. The theory should describe the rules that must be observed by the participants in the argumentation dispute, the success and failure conditions of a participant arguing in favor of a thesis and the success conditions of the interlocutor, the person to whom the argumentation is addressed, having the right to respond with an argument.

14. The new theory should deal with the main problems and defects of the argumentative discourse, with its pathology, with the means and ways to prevent deviations from the correct and dignified conduct in an argumentation dispute.

15. The theory of argumentation should be extended with the theory of conflicts and negotiation between two opponents, businesses, diplomats, etc.

We have listed above many – and difficult – requirements that a good theory of argumentation should meet. In our 1994 formulation, we spoke of ten such requirements that the developer of a good theory of argumentation should meet. They have now multiplied to 15. It would take a Hercules of intellectual work to bring all these tasks and works to completion in a short time.

All these requirements, extremely difficult to meet in a single paper, are *strategic goals* and a *research program* for our group.

Beyond these chapters is where our adventure on the tempest-ridden waters of the theory of argumentation is heading at the beginning of the third millennium.

2. DIMENSIONS OF THE ARGUMENTATION ENDEAVOR

– The theory of argumentation is not limited to the phases and art of delivering a discourse or to rhetoric and stylistic flourishes.

– The theory of argumentation is not limited to the analysis of the syntax and semantic of the language in which a discourse is written. Argumentation is linked to an *actional situation*, to *agents* and their intentions, goals and agendas.

– The theory of argumentation cannot be described solely within the confines of Aristotelian logic.

Argumentation is a multidimensional social human activity:

1. *form of communication* between an emitter or arguer and listeners, and a means to influence the convictions of our fellow humans;
2. *rational discourse* and a logic form of knowledge organization;
3. way to provide *grounds or supports for* assertions, decisions, plans and programs;
4. means to *justify* or motivate *past conducts* and to *prepare future ones*;
5. form of *opinion conflict* and *inter-human competition* at a spiritual level;
6. *logic applied to an actional situation*.

Argumentation is a form of inter-human communication mediated by natural languages in which an individual tries to convince, at a given moment, the direct addressee and the public of the truth, justness or usefulness of his thesis or opinion. We are arguing in face with unsolved question, in relation with an issue under discussion, in a given action situation, by bringing to its support factual statements and conditional statements or clauses that describe principles, laws or rules accepted by all discussion participants.

Argumentation takes place in the natural languages, but the assessment of its correctness requires using logical techniques and methods. Quite often we need to formalize in an adequate logical language statements spoken or written in a natural language, to remove ambiguity, giving them a single, ambiguity-free meaning. This way, natural language statements are linked to well-formed formulas in such formal languages. On the other hand, argumentation is intimately linked to an action situation, to the state and intentions of humans, of speakers and actors (or agents) participating in the dispute.

The main moments of our endeavor will concern: the relationship between valid reasoning and argumentation, enthymeme as a traditional species of argumentation, the structure of an argumentation system, certain notions of formal language theory, reduction and deduction, norm system and justification of court decrees, the correlation between argumentation, conviction and understanding; the theory of argumentation, derivation trees and problem solving; procedural justification as a species of argumentation, explanation as a species of argumentation. Argumentation in which principles and rules are associated with various degrees of certainty and where the factual basis itself is uncertain will remain outside the scope of our study. This first attempt that we make at a theory of argumentation will stress more the analysis of argument structure and of argumentation endeavor, the definition of a formal argumentation system and less the study of argument construction methods for a given thesis. Recently, I have found an elegant method for argumentation tree construction by making use of conjunctive normal forms of the accepted knowledge bases of the disputing agents.

3. SYNTAX OF ARGUMENTATION LANGUAGE. ARGUMENTATION OPERATORS

The starting point in rethinking the theory of argumentation was the identification in natural language of several argumentation operators, rendered by means of the conjunctions (“because”, “as”, “for”, “in order to…”, “so that…”, “by reason of…”), particles that link a thesis to be argued for to a set of factual statements and to certain rules or laws expressed as conditional sentences or general clauses.

Let L be any language, then an elementary argumentation d can be seen as a relationship:

1. $d \subset L \times L^m = d(C, [F, R])$, where $| [F, R] | = m+1$ and $| C | = 1$

where C is the argumentation thesis, L a language and L^m is a set of m clauses functioning as grounds or premises. F is the set o factual statements, and R is the rule or generic clause described by an elementary tree.

For an elementary argument to be valid, it must meet certain requirements.

2. $v(C)=1$, if $v([F, R])=1$

The argumentation thesis C is true if its factual premises or data are true and if its generic clause and associated inference scheme connecting the premises and the rule are also true.

3. $F \subseteq M$

The factual basis F of the elementary argument must be a part of the set M of instantiated atoms or literals describing the actional situation.

4. $F \wedge R \vdash C$

The argumentation thesis must be an immediate logical consequence of the factual basis and of the rule R.

5. $((PI \wedge \ldots \wedge Pm) \supset C)=R$, $R \in KR$, $Pi_{1<i<m} \in KF$

The rule R must be a conditional statement or a generic clause and its antecedent, the “premises” must be a subset of the elements of model M describing the model of the actional situation to which the argumentation refers. Argumentation is in our vision logic applied to an actional situation.

The above show that the argumentation relationship is defined on a Cartesian product and well-formed formulas of the first-order predicate logic, having as a first element the thesis for argumentation and as a second element a set of formulas describing the premises or the grounds of the thesis.

The thesis is true if its reason is true, and the reason T is true if all its factual statements F of the rule antecedent are true and if the rule R is true.

The second important moment was identifying several *species of argumentation operators*, such as "by reason of…", "in order to…", "for…", "because…", "since…" for which there are several species of *elementary arguments* that may be connected with the theory of inference schemes. At the same time we defined a number of prerequisites, attributes and requirements for elementary arguments and represented them by a species of labeled arc, a sort of palm leaf with a long stem. We placed at the lower end of the stem, at the root, the thesis for argumentation C and at the upper end, "on the leaves", the arguments, all together forming the reason.

Let there be the generic statement clause $-p \vee -q \vee r$. This comes from $(p \wedge q) \supset r$, describing, say, a relationship of dependence in the domain D. Let us represent this clause as:

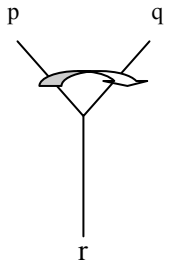

Fig. 1. – An elementary tree with two branches.

This is the formal structure of a generic clause or conditional statement read from consequent to antecedent or premises. But the reason of the thesis for argumentation also implies unifying substitutions, extending the substitution applied in the consequent with the substitution applied in the antecedent, respectively in the atoms labeling the leaves of the elementary tree and, finally, checking if all these have become instantiated atoms coinciding with the atoms of the actional situation model.

At the next step we developed a theory of composition of complex arguments from species of elementary arguments formulating conditions and forms of argument assembly.

A particularly remarkable aspect is the following: *For any finite knowledge base or finite set of statements admitted by the two actors, arguer and addressee and for any thesis for argumentation assumed by the emitter or arguer we can determine, using a semantic/syntactic method whether it can use the statements in the knowledge base as rational basis.*

The method envisaged by us consists roughly of the following steps: 1. formalizing the common knowledge base in predicate logic language; 2. bringing it to its normal prenex form; 3. transposing the normal prenex form into a Skolem normal conjunctive form; 4. identifying a subset from the elements of the

interpretation domain and of model M of the actional situation described by a list of instantiated atoms forming the initial factual basis of the argumentation endeavor; 5. constructing the justification (derivation) tree using algorithms or methods developed by us; 6. processing this tree from the bottom up so that any leaf labeled by a predicate is unified with the root of another elementary tree. The reduction and unification process is repeated until we reach the leaves of the complex tree. If they are all labeled by instantiated atoms or factual data included in the model M, then the argument is valid and it corresponds to a valid demonstration, from the top down, by modus *ponens* from the leaves to the thesis for argumentation. If, on the contrary, there is at least one predicate not instantiated in the element from the model M, then the argument is not valid and we can discover why it is not valid. More precisely, we can discover a counter-model for it.

Furthermore, the method we are proposing also suggests certain changes that should be brought to the knowledge base so that it may found a rational basis for the argumentation thesis.

The composed argumentation tree has three types of relevant nodes: 1. roots; interior nodes or resolution nodes and terminal nodes or leaves. The roots and interior node labels are the set of all arguable theses from the initial knowledge base.

We correlated, in a first stage, the theory of argumentation with the theory of demonstration and showed that any valid argument corresponds to a valid reasoning.

Argumentation cannot be fully reduced to the theory of demonstration though; this is possible only to the extent where we deal with declarative statements of descriptive type for which we have an appropriate semantic and syntax defined.

4. AN ARGUMENTATION SYSTEM

An argumentation system will contain, first of all, an arguer, or emitting agent, an addressee or main receiving agent, a listener (a collective passive agent), a control agent or supervisor and an actional situation; all these form the pragmatic dimension of argumentation.

The system will also include a formal language L, strong enough to include first-order predicate logic, some lexical and linguistic components, alphabets or vocabularies, individual languages or idiolects, capable to describe a set of consistent opinions, a scientific theory or a fragment of a natural language in which the argumentation is to be carried out.

The language of first-order predicate logic will be enriched with modal, epistemic or doxastic operators, with deontic or teleological operators and with certain syntactic and semantic symbols currently used in mathematical logic or

artificial intelligence, among which the symbols ⊢, ⊨, M, Tr and d, designating respectively, the syntactic logical consequence, the semantic logical consequence, a semantic model, an argumentation tree and the direct basis relationship ("because").

The language will contain a symbol C for the argumentation thesis, which is the epistemic goal, an alphabet of elementary atoms or predicates, a list of instantiated atoms or factual statements (KF) and a list of rules or generic clauses (KR), as well as other derived predicates to help us describe the structure and the dynamics of the argumentation endeavor.

SA = [h1, h2, h3, h4, sit, W, L, Lh1, Lh2, C, At, KF, KR, accept, d, M, Tr]

where:

1. h1, h2, h3, h4 are the participants in the argumentation, respectively: the arguer, the receiver or addressee of the argumentation, the public or passive receiver and the supervisor or moderator of the communication process.
2. sit is the actional situation in which the argumentation is made. The actional situation is described by a model M, which is a list of literals. Literals are instantiated predicative atoms or unary clauses from conjunctive normal form of the common knowledge basis, with or without negation sign in front of them, describing the characteristics of the actional situation. For example, the actional situation in the argumentation Bridge was described by the model M = [q, r, v, z], which, in natural language, meant: q = the Bridge over the river was made of wood; r = the Bridge was old, etc..
3. W is a set of opinion states, corresponding in an epistemic automaton to states of the automaton describable by sets of formulas;
4. At is a list of predicative atoms.
5. L is a logical language, usually predicate logic, in which we can describe the statements of the argumentation discourse from the natural language;
6. Lh1, Lh2 are individual languages or idiolects of the two main participants in the argumentation, the arguer and the addressee called antagonist by certain authors. They satisfy the conditions:

a) $(Lh1 \cup Lh2) \subset L$

Idiolects are sublanguages of the languages of the argumentation discourse and of the formal logical language in which the real discourse is described.

b) $Lh1 \cap Lh2 \neq \varnothing$

The intersection between the personal language of the arguer and that of the addressee must be non-void. The condition is still weak enough: the overlapping

and coincidence area of the two personal languages must be substantial. This intersection describes the common knowledge base accepted by both the emitter and the receiver.

7. C is the argumentation thesis:

a) C ∈ Lh1 and is a non-primitive, derived predicative atom

The argumentation thesis C belong to arguer's idiolect, to his personal language, denoted by Lh1. The arguer accepts C, but C did not belong to the addressee's idiolect. The addressee *does not accept C. He rejects it* or is indifferent, "neutral" towards it. The two disputants are in a conflict of opinion, or doxastic conflict.

b) C ∉ Lh2

8. At is a set of primitive or derived predicative atoms. The atoms are the simplest well-formed formulas in predicate logic that may be true or false:

a) At ⊂ (Lh1 ∪ Lh2)

9. KF is a set of literals instantiated from At (or the *factual basis*) describing the actional situation and satisfying the conditions:

a) KF ⊂ At

b) KF ⊂ M

The factual basis, KF, consists of atoms and is included in the model M of the actional situation *sit*.

10. KR stands for the rules or generic clauses describing natural or social dependencies:

a) K = KF∧KR represents the *initial knowledge base* of the argumentation

11. accept is a value judgement operator, accept(X, F) = "agent X accepts formulas F" analyzed in our logic of acceptance [42, 43]

In particular:

Arguer h1 constrains logically the argumentation addressee h2 to accept conclusion C if and only if:

(i) accept (h1, K)
(ii) accept (h2, K)
(iii) accept (h2, E): – accept(h2,K), element(E,K)
(iv) accept (h2, C): – accept(h2, B), deduced-from(B, C)

12. *d* is the elementary argumentation operator, and d* is the iterated argumentation operator obtained by composing several elementary arguments.
13. *Tr* is the knowledge basis tree, *i.e.* the demonstration tree for the argumentation thesis. It allows visualization of the structure of complex arguments, and is obtained by iterated compositions of the elementary arguments, where at least one of the direct grounds of C, say Ti, becomes, in its turn, an argumentation thesis. Tr satisfies the following conditions:

a) Tr has as its root C, the argumentation thesis;
b) Tr leaves are labeled with atoms instantiated from the model M of the actional situation M;
c) each elementary argument described by the relation d from Tr corresponds to a rule or a generic clause in KR;
d) any element X from the factual basis KF of an elementary argument is a terminal node (*i.e.* "leave") or becomes argumentation thesis in a subsequent argumentation step;
e) any tree of a compound argument is finite.

An agent's opinions are sets of clauses he accepts. We can describe an agent's opinion as a set of formulas that describe the clauses he accepts. We postulate requirements for these opinions of an agent: 1. If an agent accepts a set of clauses, he must accept the consequences derived from such clauses. 2. Clauses accepted by an agent at a given moment must by mutually consistent, *i.e.* have a model satisfying them.

The argumentation system accounts for the agents participating in the argumentation dispute, for their languages, opinions or knowledge. These are expressed in a first stage by a discourse in a natural language and then, in a later stage in a formal logical language, bring about in conjunctive normal forms or sets of clauses

We should mention that both the factual basis KF and the set of generic clauses or rules KR that describe dependence relations at an objective level, causal relations, goal-means relationships, practical directives, know-how relationships, are captured by means of semantic mechanisms of the logical systems.

This way we can study every argued thesis in a detached, subjectivism-free manner. Each one can be supported or founded on explicit well-established facts and explicit rules accepted by participants.

Furthermore, we can check whether the belligerents' assertions are internally consistent, whether a speaker does not contradict himself and, of course, we can check their agreement and disagreement areas.

In addition to that, we can distinguish between goal disagreements or teleological conflicts, we can define conflicts between assumed goals and agent's abilities or capabilities, conflicts between norms and actual conducts of agents.

For each valid argument there is a valid derivation or proof. This way we can verify argument's validity by means of decision procedures as decision trees, sequential calculus, Davis-Putnam method, method of successive semantic interpretations, method of resolution, logical programming ans. The argumentation thesis C is derivable from the knowledge base K, more precisely from KF, factual basis and from KR, rule basis.

5. LOGIC OF ACCEPTANCE AND THE THEORY OF ARGUMENTATION

It has been claimed for more than 2000 years that argumentation concerns exclusively true declarative statements. However, in our opinion, argumentation is not concerned mainly with declarative statements, but with value judgments, decisions or options of the conflicting parties, their acceptances, rejections and doubts, the solution of inter-human tensions, solving conflict situations.

The theory of argumentation may be seen as a component of the logic of action. Argumentation took place during the preparatory stages of the action in the process of decision making, more rarely during the stage of the execution, and always after the action was accomplished. We must find support for our value judgement of the results and for our critical remarks of the observed shortcoming.

The theory of argumentation is governed rather by the logic of acceptance than by the logic of declarative propositions. It is not an error or a deviation to relate the argumentation to true or false statements, as good faith interlocutors usually accept what is true and reject what is false. Logic of acceptance will include however as a particular case acceptance based on epistemic or veridical grounds. But people accept, also, what is profitable for them and what they think is right and what seems credible or plausible. We also accept proposals, offers, excuses, pleas, and programs.

I had to stop my rethinking task of a new theory of argumentation in order to outline the elements of a logic of value judgments, which I called logic of acceptance. My addressee or opponent in a dispute is the one that must accept the theses I defend, the way that I myself have to accept some of his theses based on legal or moral norms, on objective data or plausible arguments.

I have recently (May 5, 2001) presented a report on acceptance logic at the Faculty of Mathematics of the University of Bucharest and I published in Noesis, XXV, 2000 *An Axiomatic System for the Logic of Acceptance Pp 57-72*. Another study "Logic of Acceptance, Opinions and Argumentation" is pending publication in the Series *Philosophy Studies of the Annals of the "Spiru Haret" University* for 2000.

The logic of acceptance appears as a promising area for research, as it accounts for the mechanism of value judgments and is intimately connected to decision acts. Furthermore, it appears as a generalization of the systems of epistemic and doxastic logic created by Jakko Hintikka or the teleological systems proposed by us.

6. VERIFYING THE ALREADY BUILT ARGUMENTS AND SEARCHING FOR ARGUMENTS FOR A GIVEN THESIS IN AN ADMITTED KNOWLEDGE BASE

Many arguments in natural language are elliptic, with implied grounds or premises. A major requirement for a theory of argumentation is creating a procedure for verifying the validity of any argument.

But this is not an easy requirement; currently arguments are made in natural languages, and verifications are done in formalized logical languages. We must "translate" the argumentation from the natural language to the logical one. And all translations are more or less "betrayals" of the initial text. Nevertheless, the world keeps making translations. So we too will continue to submit arguments to formalization. Once formalization was performed, we apply logical decision methods. These are varied, and over the years we have presented them in several manuals of logic (*Predicate Logic*, Hyperion, 1992, *Symbolic Logic and Knowledge Bases*, "Politehnica" University, 1998 and 1999, *Logic and Metalogic*, Foundation "Romania de Mâine", Bucharest, 2000).

In the 1990s we introduced the notion of ideolelect or individual language in the theory of argumentation and raised the issue of compatibility of knowledge bases associated with the actors of the argumentative dispute and their common knowledge. Furthermore, we have used logic programming to check the validity of an argument.

The argumentation process coincides largely with the PROLOG demonstrations. An interested reader would find approximately 100 pages on our achievements in the theory of argumentation and the applications of the theory of argumentation to cases or "causes" of criminal law or family law. We also investigated several other applications of the theory of argumentation.

The theory developed around 1997–1998 was limited to arguments that had already been formulated and did not raise a more complicated problem of the following form: given a knowledge base K admitted by the actors, find all theses Q for which arguer h1 can construct valid arguments. The problem has a solution at the level of normal conjunctive form theory, at the level of natural calculus theory and at the level of logical programming.

The first part of our theory gave a logical model within classic mathematical logic satisfying monotonicity requirements. No thesis that was previously demonstrated will be changed at a later moment.

Problems get more complicated if we admit that the knowledge bases of the participants in the argumentation process are *dynamic*, *i.e*. they change from one moment to another, that the argumentation actually made by a side can change the attitude and value judgments of the addressee. The latter may abandon a thesis he used to support a moment ago and erase it from his knowledge base or even admit its opposite.

The questions or counter-arguments of the opponent can no longer be modeled within a monotonic logic, as we will need to extend or revise the initial knowledge base and continuously update it.

Recently I have presented at the Faculty of Mathematics (May 5, 2001) a method founded on conjunctive normal form model and development of a method to allow identification of the set of all assertions that the arguer can validly support from a commonly accepted knowledge basis by two agents of an argumentation dispute.

We can ask a few additional questions:

What is the role of questions in an argumentation dispute and how does their answer contribute to the extension of one's own knowledge basis?
What role do lexical and stipulative definitions play in the argumentation dispute?
What is the role of hypotheses and assumptions and how do they influence the extension of knowledge basis?
What happens when the arguer accepts a counter-argument of the opposing party?
What role does the logic of acceptance and rejection play in the argumentation process?

Given two knowledge bases, of the arguer and of the addressee, one must be able to solve the following types of problems:

1. Check whether they are mutually consistent, *i.e*. has a common model.
2. Identify points of conflict or doxastic disagreement.
3. Be able to identify the set of assertions jointly admitted by both agents of the disputes (We could of course consider also the knowledge basis of the supervisor and especially the regulations or norms admitted for public disputes of this type).

We will state, as a conclusion, a few characteristics of the model or series of models that we proposed during the last years for the theory of argumentation:

a As a form of inter-human communication, argumentation must have a *systemic-cybernetic* perspective. It can be described by means of input and output systems, by feedback relationships. In a first chapter of our book that is being prepared we analyzed several such systems, such as

the one proposed by Shannon-Weaver, Newcomb, Schramm, Thayer, Campbell, as well as models proposed by Frans H. van Eeemeren, Rob Grootendorst and Tjark Kruiger.

b The theory of argumentation, in its current stage, must use models of agents with different idiolects, having primitive atoms and derived atoms or specifically defined and common, so that derived concepts and relationships may be introduced, capable of being demonstrated by an inferential machine, regardless of its concrete implementation.

c The formal language used must be able to describe the agents' specific knowledge bases, their factual data, their goals and abilities, as well as their common knowledge base, the questions they ask themselves or their epistemic goals, and in particular these must be defined logically, structurally and procedurally.

d It should describe discourse communication between two agents, an emitter and a receiver, under the immediate or ulterior control of a moderator or supervisor that makes sure that the rules of correct communication in an argumentation dispute are observed. The message may be transmitted from the arguer to his direct addressee, but also from the addressee or receiver, who may have objections to one or more of the arguments invoked by the first emitter. We should, among others, limit the number of argument and counter-argument cycles and the number of attempts that a party may have at defending a thesis or a point of view.

e The model will facilitate a *semiotic perspective*, as it must account for the syntax, semantic and pragmatics of an argumentation discourse. Argumentation takes place in natural languages, but logic validity checking will be done in a logical language, usually first-order predicate logic language. The syntax of the language will be the syntax of predicate logic. The semantic will be, of course, the semantic of first-order predicate logic. The pragmatics of the language will be materialized in describing the actional situation of the two agents, the arguer and his addressee. The *actional situation* will have a logical model consisting of a set of instantiated atoms, *i.e.* a set of factual data. This set of factual data is supplemented by a number of rules or generic clauses that describe natural dependencies or physical laws, causal dependencies, instructions or practical directives, legal, technical, moral, or sanitary regulations.

f The model will have an *informational* nature, as it will introduce initial knowledge basis accepted by the two disputants, arguer and addressee (perhaps for the supervisor, too). The model will be able to check their mutual consistency. It should be able to describe the dynamics of the initial basis; its updating by inserting new data or by repeated acts of

acceptance or rejection of arguments proposed by the arguer and by the counter-arguer.

g The model also has a *teleological* nature, as the arguers have their own interests and goals, outside and inside the discourse. A goal inside the discourse is, of course, an argumentation thesis assumed by a participant in a dispute.

h The model should be *dynamic* and *temporal*, to allow the knowledge basis to be revised or updated when it expands.

i The model should take into account goal-means relations, instructions or practical directives, competence and abilities of participating agents and, as a consequence, it will have an *actionalist or praxeological* nature. It will use certain elements of the logic of action proposed by the author during the last years, especially in modeling human activities using the theory of output-less automata or the theory of temporal, teleological, normative and performative acceptors and PROLOG programs for these theories of action.

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