# ISSA Proceedings 1998 – Validity Of Distributed Inference; Towards A Formal Specification Of Validity Criteria In Argumentative Models

*1. Introduction*

Many disciplines, including gametheory, the theory of social choice, conversation analysis, social psychology and organization theory are in some way or another concerned with distributed inference. Roughly put, this notion refers to those patterns of reasoning, arguing or deciding where more than one agent affects (the outcome of) the process of reasoning, arguing or deciding. These agents may fulfill different roles, they may have distinct knowledge, preferences and even conflicting interests, but they are interdependent as well. They are aware that moves and choices of other agents may influence their own interests and they may even adopt their choices and preferences to the expected choices of the others.

However, in order to act in a rational way and to achieve individual or collective goals, this idea of "mutual awareness" usually is not enough. Quite often, agents are urged to commit themselves to some form of joint activity or cooperation. We are aware that this very generic description of distributed inference includes many divergent and hardly related models in the field of reasoning. Indeed, also much work in modern argumentation theory can be qualified as such (Barth 1991). However, for our purposes this description suffices.

Without adhering to a radical argumentativism like Ducrot and Anscombre (all language-use is argumentative) we believe there is a raising conviction that important types of distributed inference are primarily argumentative and consequently should be modeled as such. In (Starmans 1996b) the role of argumentation theory in Artificial Intelligence was reviewed and some relations between both fields were explored. Furthermore, many formal approaches to commonsense reasoning, including (Loui 1991) (Vreeswijk 1993) (Hage 1993) (Starmans 1996a) and (Verheij 1996) adopt argumentative insights, concepts and methods. But also in organization theory, business communication and qualitative marketing research various diagnostic and evaluative instruments or tools have been developed, that can be considered as argumentative: they can be analyzed as a verbal and social goal-oriented activity, a process of constructing, weighing and combining arguments and counterarguments. They include Porter's 5-forces model (Porter 1980) and the so called MABA-analysis (Market-Attractiveness Business-Assessment), a well-known method in portfolio analysis. What's more, some of these models can be reconstructed rather easily as a critical discussion. (Starmans, forthcoming).

In our doctoral dissertation (Starmans 1996a) it was argued that formal models of distributed inference should be based on a suitable, integrated theory of argumentation. A mere eclecticism of concepts and ideas taken from argumentation theory does by no means provide a solid foundation for developing such models. In this paper we focus on one related and significant problem, that seems to be a bottleneck in the before mentioned models as well; the validity of distributive argumentative models. How can these inferences be validated and what concept of validity do we require?
Unfortunately, the term validity is not unproblematic. It has many uses, meanings and dimensions in logic, argumentation theory and social science, and none of these fields possesses a monopoly of its use.
Avoiding the extensive literature on the topic, in this paper we will focus on one aspect of the problem of validity in distributive argumentative models, that is closely related to the idea of intersubjective validity. Since this notion deals with the conformity between the model's components and the "values, standards and objectives actual arguers find acceptable" (Barth 1982), an important question is: what role, does the initial knowledge of different agents play in the ultimately accepted arguments and conclusions.

How can these "initial commitments" be combined, integrated, adopted or aggregated? Debates may proceed in different ways, but one cannot validate specific moves or rather the entire procedure without representing requirements regarding these initial commitments. It is argued that in order to validate the process of argumentation, these validity criteria have to be represented in a declarative, i.e. non-procedural way. It is shown that this can be achieved by defining an aggregation function and by specifying formal properties of it.

*Towards a concept of validity*
The notion of validity is crucial in AT. "The general objective of the study of

argumentation is to develop criteria for determining the validity of argumentation in view of its points of departure and presentational layout and to implement the application of these criteria in the production, analysis and evaluation of argumentative discourse." (Eemeren 1996; 22). And since the process takes place "before a rational judge" it is the task of argumentation theorists to indicate the "validity criteria to be applied by a rational judge in carrying out a reasonable evaluation of argumentation". In these endeavors, the term valid "acquires a pragmatic meaning which accords with the interests of argumentation theorists". Therefore, "soundness criteria are validity criteria in a pragmatic sense, relating to all elements that are part of the argumentative discourse, from the premises, whether explicit or implicit, and other constituents of the point of departure of argumentation, to the argumentation structures and the argumentation schemes employed in its presentational layout." (Eemeren 1996; 21)
However, argumentation theorists differ in the meanings they assign to the term valid.
Usually, these differences relate to the various conceptions of rationality or reasonableness. As a result, "every theoretical contribution to the study of argumentation provides us with a definition of (particular aspects of) pragmatic validity" (Eemeren 1996; 23). According to many argumentation theorists modern logicians restrict themselves to a concept of validity that neglects "the actual reasoning processes and the contextual surroundings in which they take place; a great many verbal, contextual, situational, and other pragmatic factors that play a part in the communication process are not taken into account, so that the problems of argumentative discourse cannot be adequately dealt with."
Several attempts to develop alternative concepts of validity can be found in literature. Toulmin's attacks on the concept of validity as adopted by logicians and Barth's introduction of problem-solving validity and intersubjective validity are the most well-known. Although we cannnot discuss all these important issues here, we will further elaborate on this idea of intersubjective validity.

Validity criteria that are to be applied by a rational judge, whether they are described formally or informally, must be independent of the moves, the actual proceeding of the debate. The basic idea underlying this paper is that one important aspect of validity concerns the role that the initial knowledge of the individual agents plays -in some way or another- in the ultimate outcome.
Ideas on dominance, equality, autonomy, unanimity and so on – depending on the specific dialectical situation- must be represented. These ideas can be made

somewhat more precise in the following way. Let an information-state or theory represent the initial knowledge of an agent. Then, as debate proceeds, this agent will perform speechacts, raise arguments and make commitments, based on this initial knowledge. Other agents will do the same and the ultimate result is that some arguments and conclusions are accepted by the group. These arguments and conclusions are based on knowledge that is “accepted” as well and it can be represented in an information state too, a so called aggregated information-state. In a way, this is a declarative representation of the actual procedure of the debate.
Among other things, validating a debate or an argumentative procedure demands a representation of the construction of this aggregated theory, based on the individual information-states of the actors. So we need an aggregation-function which maps the individual information-states into an aggregated information-state. In the following sections such an aggregation function is defined in a straightforward way and it is shown how the theory of social choice can be useful in describing formal properties of this aggregation function.

*Preliminary definitions*
Assume that the knowledge of an agent is represented in well-formed formulas of some language L and that ( is a set of these formulas. Usually this set is assumed to be consistent, but we will not take this aspect into account here.

Let $N$ = {a1, ..., an} be a non empty set, the elements of which are called actors or agents. N is called a *group* and each M ⊆ N is called a *subgroup* of N. Next ($\Sigma_1$denotes the information-state associated with actor $a_1$ and *Th*(L) denotes the set of all information-states.
Then, a profile of $N$ is a mapping : NTh(L), which assigns to each member of N an information-state. A profile p is a combination of individual information-states and will usually be denoted as a tuple p = ((1, ..., (n). So for each profile p based on N we have p e Th(L)n, where Th(L)n denotes the set of all n-tuples of information-states. Now, we can define an aggregation function that maps each profile of each subgroup of a group N = {a1, ..., an} into a new information-state. It is an operator U such that

$\theta : \cup \{Th(L)^{K} | \; k < n\}$ $Th(L)$

Roughly spoken, it maps each combination of individual information-states into a collective information-state. So, given a group N = {a1, ..., an}and a profile p =

((1, …, (n) of N also U((1), U((2) or, for example, U((1, …, (n-1) should be defined. Theories which are the result of such an aggregation procedure are called aggregated theories. More formally:
Let *N* = {a1, …, an} be a group and p = ((1, …, (n) a profile of N and U an aggregation procedure. Then G = ((1, …, (n) (is called an aggregated theory based on p.

The fact that U is also defined for subgroups of N, enables us to model specific behavior of small groups of participants and some of the dynamics of a debate. For example, in some "ideal" circumstances division of tasks might even be possible by creating two debates performed by subgroups if the following equation holds:
θ (($\Sigma_1$, …, ($\Sigma_1$, (Σ

Given our considerations on the relation between and , the following functions are preferable, though unrealistic as well:
U((1, …, (n) = U((1) È … È U((n)
U((1, …, (n) = U((1) Ç … Ç U((n)

In order to make a more profound use of these functions, three classes of more useful properties are introduced.

*Principles of preservation*
Debates can be characterized according to the degree in which characteristics of the individual information-states are preserved in the ultimate aggregated theory. Sometimes this can be highly desirable, sometimes it is virtually impossible. In all examples we assume a group N = {a1, …, an}. A natural, but at the same time trivial situation where preservation seems reasonable, arises if a profile ((1, …, (n) e Th(L)n shows full unanimity, i.e. (1 = (2 = … = (n =G. Although this will occur infrequently, it goes without saying that any notion of intersubjective validity will demand that the aggregated theory at least comprises G. Preservation of Unanimity (for groups): an aggregation procedure U represents preservation of unanimity if for each tuple ((1, …, (n) e Th(L)n we have:
if (1 = (2 = … = (n = G then G Í U ((1, …, (n)

Preservation of unanimity in this form requires a full consensus in the entire group. Since U should also be defined over subgroups of N, unanimity among members of a subgroup of N should also be "rewarded", by generalizing the above definition.

Preservation of Unanimity (for subgroups): an aggregation procedure U represents preservation of unanimity if for each profile ((1, …, (m) e Th(L)m with 1 < m < n based on any subgroup M of N we have:
if (1 = (2 = … = (m = G then G Í U ((1, …, (m)

Of course, this does not entail G Í U ((1, …, (n). It does not say anything about the relation between G Í U ((1, …, (m) and G Í U ((1, …, (n). Although it will be more common that unanimity appears in a subgroup M, than that it appears in the entire N, this property is neither very realistic, nor desirable. A more important property deals with unanimity for subtheories and this will be called the Pareto-principle, which resembles the well known Pareto-principle in the theory of social choice. Again
intersubjective validity seems to require it.

Pareto-principle: an aggregation procedure U satisfies the Paretoprinciple if for each profile ((1, …, (n) e Th(L)n we have
G Í (1 and … and G Í (n then G Í U((1, …, (n)

This principle states that information once accepted by the entire group cannot be ignored in the aggregated theory. The principle can be generalized as well by taking profiles ((1, …, (m) e Th(L)m with 1 < m < n into account. But of course other types of preservation can play a role as well. U may preserve “lack of information” or ignorance as well.

Preservation of Ignorance: an aggregation procedure satisfies preservation of ignorance under unanimity if for each profile ((1, …, (n) e Th(L)n we have: if D Í (1 and … and D Ë (n then D Ë U((1, …, (n)

The principle can be generalized as well by taking profiles with 1 < m < n into account. Obviously the combination of preservation of unanimity and preservation of ignorance does result in a full determination of the aggregated theory by the individual informationstates. There is no influence of external sources at all, if all actors agree about the available information. So:
if (1 = (2 = … = (n = G then G = U ((1, …, (n)

In some cases this seems a most rational and -from a democratic point of view- desirable property. On the other hand many situations simply forbid this principle. A well governed and decent society simply requires external standards or laws that have to be obeyed by all members, whether or not these standards and laws are part of their individual information-states or not.

*Autonomy*

Principles of autonomy deal with the relation between the group and external norms and sources of information. To what extent is the ultimate outcome determined by the members of the group only? And how are the initial commitments constrained by external norms? Obviously, these principles are related to the previous ones.

Autonomy demands certain principles of preservation, though we usually will not demand the strong unanimity preservation (whether for groups or for subgroups) we gave in all previous examples of preservation. The degree to which a group is able to preserve information in the aggregated theory is an indication of the influence of the members themselves. Full autonomy is stronger as it demands exterior information to be fully irrelevant, also when there is no unanimity in the group! Again, usually this seems more realistic and desirable.

An extreme and total absence of autonomy can be found in the following situation. In all examples we assume a group N = {a1, …,an}.

A traditional group: an aggregation procedure U represents a traditional group if there is a fixed theory G such that for each profile ((1, …, (m) e Th(L)m with 1 < m < n we have: U ((1, …, (m) = G

Clearly, this leaves no room for real debate, the individual knowledge and preferences of the members are completely neglected; the outcome of the reasoning process is determined by some external source. The requirement to prevent this traditional society to arise is usually called the property of non-imposition. A more important aspect of autonomy is the following well-known principle.

Principle of Universal Domain: an aggregation procedure is said to satisfy the principle of universal domain if:

U : È {Th(L)k | k < n} Õ Th(L) is a total function

Every theory based on L is allowed and each n-fold profile of these theories as well. There are no external standards or constraints, limiting the commitments of the individual members. The following principle resembles this feature of

Universal Domain.

Principle of Universal Scope: an aggregation procedure satisfies the principle of universal scope if: for each theory G there is a profile p = ((1, …, (n) such that U((1, …, (n) = G
Or, put differently, for each theory G there is an input ((1, …, (n) such that G is the aggregated theory. Having developed these traditional principles of aggregation, let us now take a more essential type of autonomy into account.
Strong autonomy: an aggregation procedure is said to satisfy strong autonomy if for each profile ((1, …, (m) e Th(L)m with 1 < m < n and with M = {a1, …, am}, we have U((1, …, (m) Í È {(j | j e M}

So there are no facts in the aggregated theory which are not believed by at least a subgroup.

*Dominance and Equality*
Even more important are the relations between the members of a group; their individual influence, their roles in coalitions. To what extent can individuals influence the aggregated theory. Some preliminary definitions are required first. In the following examples we presume a fixed subgroup M Í N with |M| = m and m < n. For the sake of convenience, we assume that M = {a1, …, am} but every arbitrary subgroup suits.

Decisive Group: a subgroup M Í N with and is called decisive if U((1, …, (n) = U((1, …, (m)

The aggregated theory is completely determined by a subgroup of N. In fact the members of N\M appear to function as “dummies”. If M Ì N this means that at least one agent has no influence at all. If |M| = 1, a kind of dictatorship arises, a property that will be discussed in this section as well.

Semi-Decisive Group: a subgroup M Ì N with |M| = m and m < n is called semi-decisive if
U((1, …, (m) Í U((1, …, (n)

Here the dominance of the subgroup is less, since it does not determine the aggregated theory completely.

Minimal Decisive Group: a decisive group M is called minimal decisive, if each

subgroup H Ì N is not decisive.
It goes without saying that a debate does not permit very small decisive groups. Nevertheless, it would be too easy to stipulate that the modelling requires the entire N to be the minimal decisive group. It can be quite reasonable that a specific source does not in fluence the outcome.

Another principle deals with the ability of subgroups to prevent information from being adopted into the aggregated theory.

Veto-power: a subgroup M Ì N with |M| = m and m < n possesses veto-power if:
if G Ë U((1, …, (m) then G Ë U((1, …, (n)

Here the dominance concerns the absence, rather than the presence of information. Now, clearly aggregation procedures can be characterized according to the way they allow specific subgroups (decisive or with veto-power) to dominate the other members of the group. Related notions are based on them.

Strong Dictatorship: an aggregation procedure allows for strong dictatorship if there is a minimal decisive group of only one individual, i.e.,
if U((1, …, (n) Í (i

Weaker versions of dictatorship correspond with the notions of semi-decisive group and veto-power.

Weak Dictatorship: an aggregation procedure allows for weak dictatorship if:

if G Í (i then G Í U((1, …, (n)

One-person veto power: an aggregation procedure allows for one-person veto power if:

if G Ë (i then G Ë U((1, …, (n)

In fact, strong dictatorship is the most extreme type of dominance in debate. If a1wants all his initial commitments to be adopted, i.e. (i = U(()i than the operator U is just a projection-function: the aggregated theory coincides with a (sub)theory of one particular actor.
The others are basically dummy’s and do not contribute to the debate. In a way it satisfies a (rigid) interpretation of problemsolving validity, but it neglects intersubjective validity.

A usually undesirable, but rather opposite property deals with suppression.

Suppression: an aggregation procedure allows for suppression if U there is a ai e N = {a1, …, an} such that for each profile ((1, …, (m) e Th(L)m with 1 < m < n in which ai participates and for each theory D we have:

if D Í (1 then D Ë U((1, …, (m)

Accordingly, non-suppression demands that there is no individual whose knowledge will be systematically neglected. One person veto power is a strong type of dominance as well, since one individual may obstruct information from being adopted in the aggregated theory. However, unlike a dictator this actor is not able to determine the aggregated theory.

Until now, we only discussed extreme types of dominance. The opposite situation occurs when only the whole group is decisive. i.e., there is no real subgroup M Ì Nwith M = {1, …m} such that U{(1, …, (m) Í U{(1, …, (n) .

An attempt to fully prohibit dominance of one specific subgroup needs the following property of anonymity.

Anonymity: an aggregation procedure fulfills the requirement of anonymity if all members have equal power. Let N = {a1, …, an} be a group and p be a permutation on the index-set of N. Then U has the property of anonymity if
U((1, …, (n) = U((p(1), …, (p(n))

All contributors are of equal importance. It does not matter which agent makes the commitment. For notational convenience, we restricted ourselves to the entire but obviously it can be extended to each profilet U{(1, …, (m) e Th(L) with 1<m<n.

*Conclusion*
In this paper only one, though important aspect of distributive validity was scrutinized. We have presented our ideas on aggregation in debate in a straightforward way, since we primarily wanted to sketch the basic principles of one aspect of validation, that is closely related to intersubjective validity. First and foremost, it seems obvious that at least some preservation principles and some notion of autonomy and equality are required in fairly all kinds of debate. Furthermore, anyone concerned with intersubjective equality should at least

preserve unanimity and follow the Pareto-principle. Taking autonomy seriously, will imply a rejection of the idea of traditional groups and adherence to at least universal domain and universal scope. Finally, some ideas of dominance and equality imply a rejection of dictatorship and very small decisive groups as well. However, full equality (anonymity and neutrality) is not always desirable in a debate as well.

Whether, or rather to what extent, the enumerated principles –that are well-known in the theory of social choice- are desirable or not, may depend on the type of debate, the dialectical situation and the adopted theory of argumentation.

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