Argument Comparison Criteria Analysis

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1. Introduction

In this work we show a possible form of classification of comparison methods in argumentation systems [AG95,BV,Dung93,PRAK,Sim92]. The main idea in these systems is that any proposition will be accepted as true if there exists an argument that supports it, and this argument is acceptable according to an analysis between it and its counterarguments. This analysis requires a process of comparison of conflicting arguments, in order to decide which one is preferable. After this dialectical analysis in the set of arguments of the system, some of them will be *acceptable* or *justified* arguments, while others not. In this classification, the argument comparison method plays a very important role.

2. Comparison methods

Arguments support conclusions with different strength. The target of any comparison method is to determine the difference of conclusive force in conflicting arguments. It determines an order of conclusive force between arguments, which is partial, because some pairs of arguments may be incomparable.

There exists a lot of methods for comparing arguments, such as the principle of *specificity*, introduced by Poole in 1985, *directness* by Loui, *preemption* by Horty et. al., *combined defeat* by Prakken, and *accumulation of numerical strength*, by Pollock. On the other hand, some authors do not commit to a specific method to compare arguments [Vree97,DungLP]. This attitude saves them from the responsibility of telling how and why a particular argument should overrule any other argument.

When two arguments A and B are in conflict, they are compared so the strongest argument is identified, say A and it is noted B<A. Then, a defeat relation is established between A and B. In this case, the argument A defeats the argument B, because it is stronger according to the comparison method.

However, it is possible for two conflicting arguments to be incomparable, according to the selected comparison criterion. In this case, the conflict can not be solved, and it is usually translated to reciprocal defeat relations: A defeats B and viceversa. This situation is not good, because the status of A and B as *accepted* or *rejected* can not be determined. Therefore, it is said that A and B are *undecided* arguments [DCM2k].

The outcome of a system with a set of arguments *Arg* depends on the set of all defeat relations defined in *Arg*. The defeat relation is based on the outcome of the comparison method that is being used, so it is clear the importance of this method in the system. Changing the method will probably change the outcome, so the chosen criterion will always have a strong influence in argument classification.

The worst case is to have a comparison criterion that makes all the arguments incomparable, so the system fall in a general indecision state.

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However, it is not possible to construct a complete argument hierarchy. And this is not a real disadvantage, because there exists by nature incomparable arguments in the real world. Any criterion that always adopt a preference for any pair of arguments tends to be fictitious, because of the arbitrary conflict resolution, and it hides de possibility of indecision in the system.

2.1 Levels of strength

A comparison criterion can be analyzed in function of its *indecision*. The indecision appears when two arguments are incomparable (the information available is not enough to find the strongest argument) or they have the same conclusive force (the information available can not distinguish any relative difference in strength). The partial order induces a relation of equivalence between arguments. We say that two arguments A and B are *equivalent in strength* if $A \leq B$ and $A \geq B$. The relation $R_{\equiv}$ ="A is equivalent in strength to B" is a relation of equivalence, because it is a reflexive, symmetrical and transitive and therefore it determines a partition of the set of arguments. For any set of arguments *Arg* and any argument *A*, we define

$$A_{\equiv} =_{df} \{ X : X \in Arg \text{ , } X \text{ is equivalent to } A\}$$

which leads to the quotient set $Arg/R_{\equiv}$.

If two arguments A_1 and A_2 are in different partition sets, then A_1 is stronger than A_2 , or A_2 is stronger than A_1 or they are incomparable. If an argument of a set C_1 is stonger than an argument of the set C_2, then we say that C_1 is preferable to C_2.

For this reason, a hierarchy between partition sets can be established, in the following manner:

- Sets not preferable to any other sets are in level 0.
- Any set *C* is in level *n*, if it is preferable to at least one set C_1 of level *n-1*, and there is no other set *C'* such that *C* is preferable to *C'* and *C'* is preferable to C_1

An argument *A* is an argument of level *k*, if *A* belongs to a set in level *k*. Two arguments have *equal relative force* if the are in the same level. Arguments of the same level, but in different sets are *incomparable*.

This structure of partition sets can be used to make a classification of methods. For example, a comparison criterion is *determinant* if there is only one partition set in each level. It is not *strictly ranked*, if all the strict arguments are in the same level.

The best scenario is a structure that contains a lot of levels, with only one partition set in each level (so the method should be *determinant*) and only one argument in each set, which corresponds to a complete order between arguments. If unary sets of arguments is not possible then the method should produce the highest possible number of sets. The main question arises: is it possible to build a comparison method with this structure? If not, then the criterion should produce at least small partition sets and levels with few sets. We should focus us in the precision of the methods, and its refinements. The structure of levels leads us to a definition of *accuracy* between methods.

Definition [Accuracy of methods]. A comparison criterion θ_1 is *more accurate* than θ_2, if it induces more strength levels than θ_2 under the same scenario of arguments. □

A method θ_1 is a refinement of θ_2 if at least one set C of θ_2 is equal to the union of sets of arguments $C_1, C_2, \ldots C_n$ of θ_1 . That is to say, if θ_1 has almost the same sets as θ_2, but it establish a hierarchy between arguments in at least one set of θ_2 . Any refinement of a method is better because reduces the amount of incomparable arguments and therefore is more accurate.

In order to minimize the possibility of indecision in the system, the following considerations must be taken into account:

- The partition sets should not contain a lot of arguments, in order to minimize the possibility of finding conflicts between arguments of equal strength, because these conflicts can not be solved.

- Few partition sets in each level, in order to reduce the amount of incomparable arguments in the system, and therefore maximizing the capability of solving conflicts.
- The method should induce a high number of levels so it is easy to find a difference of conclusive force between arguments.

In order to fulfill these requirements, the following it should be noted that:

- The criterion must be very specific, and not based only in general aspects of the structure of arguments. For example, the criterion based in the number of defeasible rules of the arguments does not obey this rule, because it is very easy to find two arguments structurally equal. A refinement of the criterion could provoke a shrink in the size of the sets.
- For each level, there is a trade-off between producing arguments of equal force and producing incomparable arguments. Of these two possibilities, the former is preferable. If there are a lot of sets in each level, then the criterion is not very specific, and it is based on properties not existent in every argument. A refinement is needed.
- To produce a lot of levels the criterion should be based in different properties of arguments, not only structural properties, in order to make easy the task of finding a difference of conclusive force. This is the best way of avoiding indecision.

3. Actual work and next step.

It is possible to identify more properties of methods based on the structure of levels of strength. These properties are being gathered in order to build a good and complete taxonomy of the comparison criteria. We can therefore "compare" these comparison methods, so we can define the concept of "better methods", use them, and therefore improve the performance of the system.

In the future, a very important target is the construction of a criterion based, not only in the composition of the arguments but also in the structure of the dialogue in which the arguments take part. In this way, the criterion could obtain different results in argument comparison, so we can avoid indecision when it is due to structural equality of the pair of arguments being compared.

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