Paraconsistent Argumentation Frameworks

Walter Carnielli

CLE and Department of Philosophy
Universidade Estadual de Campinas
walter.carnielli@cle.unicamp.br
Argumentation Frameworks

• Aims: to connect the area of argumentation frameworks, a relevant aspect of automatizing argumentation, with the Logics of Formal Inconsistency

• Why? Because this offers a better solution, not yet explored in the literature

• The logics of this paraconsistency variety, in particular the Basic Logic of Consistency, BCL, are endowed with all the good properties that would help in problems in argumentation frameworks.

• BCL satisfies the conditions of crash resistance, non-interference and backwards compatibility (required for a good theory about argumentation frameworks)
Great Problems in Argumentation Frameworks

• The theory of argumentation is perhaps one of the most socially important activity connected to logic

• Disputes in areas like medicine and law may lead to torrid debates, which may be due to contradictory information or in irreconcilable positions

• A final position in such debates is sometimes unreachable
..and Effects of such Problems

• Network effects: all this may have great influence on issues such as e-government, social discussion systems and opinion pools

• The network of arguments and subarguments sometimes get too complex to be followed while maintaining “calm” rationality

• Even simple cases may give rise to complex argumentation involving chains of statements, where the conclusion of an argument may be used as a premise of another

E.g. : global warming
Higher Complexity

• From the point of view of computer usage, by automatizing the relation between claims and data in the famous Toulmin scheme, argumentation patterns can be seen as reusable solutions to recurring questions in the design of arguments.

• This requires a robust architecture, such as the argumentation frameworks, introduced by Dung which are graph-style representations of what may be viewed as a dispute.

Toulmin’s Approach

• S. Toulmin originated in 1958 the so-called ``informal argumentation'' in philosophy, thought to be a common underlying basis for arguments in every field (or at least in most fields) of human activity, as legal, scientific, and conversational arguments.

• In Toulmin's theory, evidence and rules (called warrants) support claims:

• Claims may also be qualified (for instance, by adding constraints or by indicating uncertainty). A rebuttal is an attack against an argument.

• Data are supported by warrants which have backings, showing that a ``a claim holds with qualifiers regarding the situation, unless there is a rebuttal"".
Toulmin criticized

- There are many criticisms against Toulmin's model, as for instance the view that people actually do not think in terms of Toulmin's warrants

- Dung's argumentation frameworks provide a robust graphical model of argumentation which have been widely used in computational representation of argumentation.

Toulmin, S. The Uses of Argument. Cambridge University Press, 1958
Argumentation Frameworks Formalized

• An argumentation framework is composed by a set of elements called arguments and by a binary elation over arguments called attack.

• Formally, an argumentation framework is a pair $AF = <AR, \text{attacks}>$ where $AR$ is a set of arguments, and $\text{attacks}$ is a binary relation on $AR$, i.e.

$$\text{attacks} \subseteq AR \times AR$$

• There are at least a dozen of different models for capturing argument structure.
Argumentation Frameworks Formalized

• In the most general form a logical formalism to accommodate argumentation theory is a triple

\[ <\text{Atoms}, \text{Formulas}, Cn> \]

where \textit{Atoms} is a countably (finite or infinite) set of atoms, Formulas is the set of all well-formed formulas that can be constructed using Atoms, and

\[ Cn : \mathcal{P}(\text{Formulas}) \rightarrow \mathcal{P}(\mathcal{P}(\text{Formulas})) \] is a consequence function

• It is to be noted that the consequence function in this case takes as input a set of formulas and as an output a collection of sets of formulas
Argumentation Frameworks Formalized

• A combinatorial (graph-theoretical) problem connected to those frameworks is to find sets of arguments that do not attack each other (these are called conflict-free), and to find arguments that are not defeated by a given set of arguments (these are called acceptable)

• A conflict-free set of arguments is then considered to be admissible if each argument is acceptable with respect to the set.
• A maximal admissible set is said to be a preferred extension
• In certain cases, it is not possible to define an instantiation of Dung's theory satisfying the conditions of crash resistance, non-interference and backwards compatibility
**Argumentation Frameworks revisited**

- Problems of this sort in argumentation theory may simply be dissolved, if we were working with a suitable paraconsistent logic.
- Nothing prevents $Cn$ to be taken as a paraconsistent consequence function.
- This move would require minimal adjustments on the underlying concepts and definitions.
- The notions of crash resistance, non-interference and backwards compatibility are essential for argumentation frameworks.
- Starting to move: semi-stable semantics satisfy several properties usually attributed to paraconsistency

Classical logic is too heavy

• It is clear that classical logic violates crash resistance, since every contradictory set of formulas is contaminating.

• A logic of formal inconsistency (LFI) that uses the same logical language as classical logic satisfies the conditions of crash resistance, non-interference and backwards compatibility.

• Moreover, it also satisfies the condition of backward compatibility with classical logic (in the sense that for each set of formulas that is consistent under classical logic, the LFI in question entails the same consequences as classical logic).
The role of contradictions

• We have defended elsewhere the view that contradictions may have an epistemological rather than an ontological character:

  Carnielli, W. A and Rodrigues, A. The Basic Logic of Consistency: syntax, semantics and philosophical motivations

• The Logics of Formal Inconsistency (LFIs) are a family of paraconsistent logics that have resources to express the notion of consistency within the object language, and thus recover the full power of classical logic for consistent sentences.

• LFIs are able not only to distinguish triviality from contradiction, but also non contradiction from consistency (cf. Carnielli, W. A., Coniglio, M. E. and Marcos, J. Logics of formal inconsistency)
The logic BCL

• I argue here that a particular LFI, the Basic Logic of Consistency (BLC), would be a seemly partner for argumentation frameworks.

• BLC is defined by adding to introduction and elimination rules for \(\land\), \(\lor\) and \(\rightarrow\) and an explosion rule restricted to consistent sentences (EXP), namely:

\[ oA, A, \neg A / B \] (where \(oA\) denotes the operator of "consistency")

• BLC also adds excluded middle as an axiom (EM) \(A \lor \neg A\)

• A sound and complete valuation semantics can be easily obtained for BLC
Axioms for BCL

Ax1. $\alpha \rightarrow (\beta \rightarrow \alpha)$
Ax2. $(\alpha \rightarrow \beta) \rightarrow ((\alpha \rightarrow (\beta \rightarrow \gamma)) \rightarrow (\alpha \rightarrow \gamma))$
Ax3. $\alpha \rightarrow (\beta \rightarrow (\alpha \& \beta))$
Ax4. $(\alpha \& \beta) \rightarrow \alpha$
Ax5. $(\alpha \& \beta) \rightarrow \beta$
Ax6. $\alpha \rightarrow (\alpha \lor \beta)$
Ax7. $\beta \rightarrow (\alpha \lor \beta)$
Ax8. $(\alpha \rightarrow \gamma) \rightarrow ((\beta \rightarrow \gamma) \rightarrow ((\alpha \lor \beta) \rightarrow \gamma))$
Ax9. $\alpha \lor \neg \alpha$
Ax10. $\diamond \alpha \rightarrow (\alpha \rightarrow (\neg \alpha \rightarrow \beta))$

Inference Rule:

MP $\alpha, \alpha \rightarrow \beta / \beta$
**Negation in BCL**

- BLC fits the idea that contradictions have epistemological, rather than ontological character.

- The values 1 and 0, attributed to a formula $A$, may be interpreted, respectively, as *there is some evidence that* $A$ is the case and *there is some evidence that* $A$ is not the case.

- Thus, a contradiction $A \& \neg A$ means only that there is some evidence that $A$ is the case and not $A$ is the case, a situation not uncommon in argumentation.
Adequateness of BCL for argumentation frameworks

- Consistency is primitive and not defined in terms of negation. A may be understood as the truth-value of A has been conclusively established.

- According to this view, we may have $A \& \neg A$ without $\neg A$ for example, in a circumstance such that there is evidence only for A but the truth-value of A has not been decided yet.

- Such features of BCL make it to deserve more attention as a suitable formal logic behind argumentation frameworks.
References


• Toulmin, S. The Uses of Argument. Cambridge University Press, 1958