Dialectical construction of argument positions

Knowledge representation, argumentation, practical reason, dialectics

Abstract

Arguments concerning what an agent should do cannot be considered in isolation: they occur in the context of debates in which sets of arguments attacking and defending each other are advanced. This is recognised by the use of argumentation frameworks which determine the status of an argument by reference to its presence in a coherent position: a subset of the arguments advanced which is collectively able to defend itself against all attackers. Participants in the debate, however, are typically not neutral in their attitude towards the arguments: there will be arguments they wish to accept and others they wish to reject. In this paper we model how a participant in a debate can develop a coherent position guided by their preferences as to which arguments they wish to accept. We define a framework for representing a set of arguments constituting the debate, and describe how a position including the desired arguments can be developed through a dialogue with an opponent.

1 Introduction

In this paper we will be concerned with *practical reasoning* - reasoning about which action should be performed in a given situation. We will begin by drawing attention to a number of features of such reasoning which any account must respect.

First arguments justifying actions must be considered in the context of other related arguments. Arguments justifying actions are typically presumptive in nature [Walton, 1996], [Atkinson *et al.*, 2004], as there are always alternatives, and often pros as well as cons. Even a universal and deep seated norm such as *thou shalt not kill* is acknowledged to admit exceptions in circumstances of self-defence and war. Such presumptive justifications can only be accepted if due consideration to arguments attacking and defending them is given. In a set of arguments relating to an issue - which we call a *debate* - the acceptability of an argument relies on it forming part of a coherent subset of such arguments able to defend itself against the attacking arguments in the debate We call such a coherent subset a *position*. The notion of the acceptability of an argument deriving from its membership of a defensible position in a debate has been explored in AI through the use of argumentation frameworks, e.g. [Dung, 1995], [Bench-Capon, 2003]. These debates can also be seen as representing the relevant presumptive arguments and the critical questions [Walton, 1996] that may be posed against them. Such reasoning is naturally modelled as dialectical and can be explored through the use of a dialogue in which a claim is attacked and defended. Dialogues to identify positions in debates represented as argumentation frameworks have been explored in [Cayrol *et al.*, 2003], [Dunne and Bench-Capon, 2003] and [Bench-Capon, 2002].

Next, debates about which action is best to perform must permit rational disagreement. Whereas the truth of facts may be demonstrated and compel rational acceptance, with regard to actions there is an element of choice: we cannot choose what is the case, but we can choose what we attempt to bring about, and different people may rationally make different choices. This is well summarised in [Searle, 2001]

> Assume universally valid and accepted standards of rationality, assume perfectly rational agents operating with perfect information, and you will find that rational disagreement will still occur; because, for example, the rational agents are likely to have different and inconsistent values and interests, each of which may be rationally acceptable.

Such differences in values and interests mean that arguments will have different *audiences*, to use the terminology of [Perelman and Olbrechts-Tyteca, 1969] and what is acceptable to one audience may be unacceptable to another. Disagreements are represented in argumentation frameworks such as that of [Dung, 1995] by the presence within a debate of multiple acceptable positions. In [Bench-Capon, 2003] an extended argumentation framework which explicitly relates arguments to values and explicitly represents audiences in terms of their preferences over values has been advanced.

While a framework such as that of [Bench-Capon, 2003] can be used to explain disagreements between different audiences in terms of their different ranking of values, it does not explain how these value rankings are formed. The third feature of practical reasoning means that we cannot presuppose that people bring to a debate a knowledge of their value preferences. [Searle, 2001] states

> This answer [that we can rank values in advance] while acceptable as far as it goes [as an *ex post* ex-

planation], mistakenly implies that the preferences are given *prior* to practical reasoning, whereas, it seems to me, they are typically the product of practical reasoning. And since ordered preferences are typically products of practical reason, they cannot be treated as its universal presupposition.

It is an account of this phenomenon which is the primary objective of this paper. We will provide a means for explaining how the ordering of values emerges from the construction of a position. Instead of taking a value ordering as input, we assume that the reasoners have certain arguments that they will wish to include in their position, certain arguments that they will wish to exclude, and are indifferent to the status of the remainder. For example a politician forming a political programme may recognise that raising taxation is electorally inexpedient and so must exclude any arguments with the conclusion that taxes should be raised from the manifesto, while ensuring that arguments justifying actions bringing about core objectives are present: other arguments are acceptable if they enable this. In developing such a position, should it be possible, a value ordering will be formed.

Section 2 recapitulates the argumentation frameworks which provide our formal starting point, section 3 provides a dialogical framework for developing a position and section 4 points to some related work, draws some conclusions and identifies direction for further exploration.

2 Value-based Argumentation Framework

We start with the presentation of Dung's argument system introduced in [Dung, 1995] upon which the value-based argumentation framework proposed in [Bench-Capon, 2003; 2002] relies.

Definition 1 *An* argument system *is a pair $\mathcal{H} = \langle \mathcal{X}, \mathcal{A} \rangle$, in which $\mathcal{X}$ is a finite set of* argument *and $\mathcal{A} \subset \mathcal{X} \times \mathcal{X}$ is the* attack relationship *for $\mathcal{H}$. A pair $\langle x, y \rangle \in \mathcal{A}$ is referred to as 'y* is attacked by *x' or 'x* attacks *y'. For R, S subsets of $\mathcal{X}$, we say that $s \in S$ is attacked by R if there is some $r \in R$ such that $\langle r, s \rangle \in \mathcal{A}$.*

Definition 2 *Let $\langle \mathcal{X}, \mathcal{A} \rangle$ be an argument system. Let S be a subset of arguments of $\mathcal{X}$. An argument $x \in \mathcal{X}$ is* acceptable to *S if for every $y \in \mathcal{X}$ that attacks x there is some $z \in S$ that attacks y. S is* conflict-free *if no argument in S attacks an argument in S. A conflict-free set S is* admissible *if every argument in S is acceptable to S. S is a* preferred extension *if it is a maximal (with respect to $\subseteq$) admissible set.*

The value-based argumentation framework proposed in [Bench-Capon, 2003; 2002] is defined as follows:

Definition 3 *A* value-based argumentation framework *(VAF) is defined as $\langle \mathcal{X}, \mathcal{A}, \mathcal{V}, \eta \rangle$, where $\langle \mathcal{X}, \mathcal{A} \rangle$ is an argument system, $\mathcal{V} = \{v_1, v_2, \ldots, v_k\}$ is a set of k* values, *and $\eta : \mathcal{X} \to \mathcal{V}$ is a mapping that associates a value $\eta(x) \in \mathcal{V}$ with each argument $x \in \mathcal{X}$.*

Definition 4 *An* audience *ϑ for a VAF $\langle \mathcal{X}, \mathcal{A}, \mathcal{V}, \eta \rangle$ is a binary relation on $\mathcal{V}$, such that (i) there is no $v \in \mathcal{V}$ such that $\langle v, v \rangle \in \vartheta$ (ϑ is irreflexive) and (ii) for any v_1, v_2, and v_3 in $\mathcal{V}$, if $\langle v_1, v_2 \rangle \in \vartheta$ and $\langle v_2, v_3 \rangle \in \vartheta$, then $\langle v_1, v_3 \rangle \in \vartheta$ (ϑ is transitive). A pair $\langle v_i, v_j \rangle$ in ϑ is referred to as 'v_i* is preferred to *v_j' with respect to ϑ.*

A specific audience *α is an audience such that all the values are comparable with respect to it, i.e. for two distinct values v_1 and v_2 in $\mathcal{V}$, either $\langle v_1, v_2 \rangle \in \alpha$ or $\langle v_2, v_1 \rangle \in \alpha$.*

Ideas analogous to those of admissible sets in Dung's argument system are defined in the following way. Note that all these notions are now relative to some audience.

Definition 5 *Let $\langle \mathcal{X}, \mathcal{A}, \mathcal{V}, \eta \rangle$ be a VAF and ϑ be an audience. Let x and y be two arguments of $\mathcal{X}$. Let $S \subseteq \mathcal{X}$.*

x successfully attacks *y with respect to ϑ if: $\langle x, y \rangle \in \mathcal{A}$ and $\langle \eta(y), \eta(x) \rangle \notin \vartheta$.*

x definitely attacks *y with respect to ϑ if: $\langle x, y \rangle \in \mathcal{A}$, and $\eta(x) = \eta(y)$ or $\langle \eta(x), \eta(y) \rangle \in \vartheta$.*

y is an individual defender *of x* with respect to the audience *ϑ if and only if there is a finite sequence $a_0, \ldots, a_{2n}$ such that $x = a_0, y = a_{2n}$, and $\forall i, 0 \leq i \leq (2n-1)$, a_{i+1} successfully attacks a_i w.r.t. ϑ.*

x is acceptable to *S* with respect to *ϑ if: for every $y \in \mathcal{X}$ that successfully attacks x with respect to ϑ, there is some $z \in S$ that successfully attacks y with respect to ϑ.*

We say x and y are in conflict *with respect to ϑ if either successfully attacks the other with respect to ϑ.*

S is conflict-free with respect to *ϑ if there are no arguments in S in conflict with respect to ϑ.*

S is admissible with respect to *ϑ if: S is conflict-free with respect to ϑ and every $x \in S$ is acceptable to S with respect to ϑ.*

S is a preferred extension for *ϑ if: S is a maximal admissible set with respect to ϑ.*

Motivating examples which show the advantages of using VAFs can be found in e.g. [Dunne and Bench-Capon, 2004a] and [Bench-Capon, 2003].

A VAF whose set of arguments is partitioned according to the intuition whereby an agent desires some actions to be accepted, others to be rejected and is indifferent to the rest, can be defined as follows:

Definition 6 *A VAF $\langle \mathcal{X}, \mathcal{A}, \mathcal{V}, \eta \rangle$ is* DOR-partitioned *if $\mathcal{X} = D \cup O \cup R$ for three disjoint sets D, O and R, which denote respectively a set of* desired *arguments, a set of* optional *arguments and a set of* rejected *arguments. We use $\mathrm{Des}(\mathcal{X})$ to denote D, $\mathrm{Opt}(\mathcal{X})$ to denote O and $\mathrm{Rej}(\mathcal{X})$ to denote R.*

An admissible set which can be adopted as a position in a DOR-partitioned VAF, is a set that contains the desired arguments and possibly some optional arguments, whose role is to help a desired argument to be acceptable to the position. We formally define this new notion of admissibility:

Definition 7 *Given a DOR-partitioned VAF $\langle \mathcal{X}, \mathcal{A}, \mathcal{V}, \eta \rangle$, a set $S = \mathrm{Des}(\mathcal{X}) \cup Y$ where $Y \subseteq \mathrm{Opt}(\mathcal{X})$ is* restrictedly admissible w.r.t. an audience *ϑ if and only if S is admissible w.r.t. ϑ and $\forall y \in Y$, $\exists x \in \mathrm{Des}(\mathcal{X})$ such that y is an individual defender of x w.r.t. ϑ.*

In order to build a position (i.e. a restrictedly admissible set), one may start with considering the set of desired arguments. This set must be first tested to demonstrate that it is conflict-free for at least one audience. If this is not the case, then the set of desired arguments must be re-examined and the source of conflict excluded. Otherwise, the set must be tested to determine whether it is admissible for at least one audience. If it is not, some optional arguments may be used or some constraints on the ordering of values imposed to make acceptable the desired arguments preventing the set being admissible. The position under development then contains not only the desired arguments but perhaps also some optional arguments along with some constraints between values. We want such extensions of the position under development to be kept to a minimum.

As it has been argued, preferences should not be used to generate a position, but only to explain it. However, the construction of a position implies some constraints on the preferences between values. First, to ensure that the set of desired arguments is conflict-free for at least one audience, an ordering of some values may have to be considered. Second, if the set of desired arguments is conflict-free but not admissible for any audience, then the set may be extended with some optional arguments or some ordering of values, which constrain the preferences between them. This order must be consistent with the fact that an audience is irreflexive, which is checked by producing the transitive closure. An example will be given in section 3.4 after we have introduced our formal machinery.

3 Development of a position

We would like the construction of a position to explain why some constraints between values must be taken into account, and why some optional arguments must belong to the position. A convenient way to do so is to present the construction of the position in the form of a dialogue between two players: one, the *opponent*, outlines why the position under development is not admissible for any audience; the other, the *proponent*, tries to make the position under development admissible for at least one audience by extending it with some optional arguments or some constraints between values. The dialogue has two possible terminations: either PRO has the last word and then the set of arguments played by PRO is a restrictedly admissible set for at least one audience; or OPP has the last word, which means that the set of desired arguments cannot be extended into a restrictedly admissible set for at least one audience. In this last case, the user has to re-consider the partition of the set of arguments.

In Section 3.1, we present a formal dialogue framework, that we instantiate in Section 3.2 in order to check if a set is conflict-free for at least one audience. We instantiate the dialogue framework in Section 3.3 to build a restrictedly admissible set containing a conflict-free set of desired arguments. Finally, in Section 3.4 we combine these two instantiations of the dialogue framework to construct restrictedly admissible sets.

3.1 Dialogue framework

A dialogue framework to prove the acceptability of arguments in Dung's argument system has been developed by [Jakobovits and Vermeir, 1999] and refined in [Cayrol *et al.*, 2003]. We extend this last framework to deal with the development of positions in a value-based argumentation system.

Definition 8 *Let $\langle \mathcal{X}, \mathcal{A}, \mathcal{V}, \eta \rangle$ be a* DOR*-partitioned VAF and _ be a special additional argument called the* empty argument. *$\mathcal{X}^-$ denotes the set $\mathcal{X} \cup \{\_\}$.*

A move *in $\mathcal{X}^-$ is a pair $[P, \langle X, V \rangle]$ where $P \in \{\mathrm{PRO}, \mathrm{OPP}\}$, $X \in \mathcal{X}^-$, and $V \subseteq \mathcal{V} \times \mathcal{V}$. PRO denotes the* proponent *and OPP denotes the* opponent. *V is a set of orderings of values the player P is committed to. For a move $\mu = [P, \langle X, V \rangle]$, we use $\mathrm{pl}(\mu)$ to denote P, $\arg(\mu)$ to denote X, and $\mathrm{val}(\mu)$ to denote V. The set of moves is denoted by $\mathcal{M}$. $\mathcal{M}^*$ denotes the set of finite sequences of moves.*

A function $\phi : \mathcal{M}^* \to 2^{\mathcal{X}^- \times 2^{\mathcal{V} \times \mathcal{V}}}$, called the legal-move function, *governs the dialogue.*

A dialogue *(or ϕ-dialogue) d for a finite set $S = \{a_1, a_2, \ldots, a_n\} \subseteq \mathcal{X}$ is a countable sequence $\mu_{0_1}\mu_{0_2}\ldots\mu_{0_n}\mu_1\mu_2\ldots$ of moves in $\mathcal{X}^-$ such that:*

1. $\mathrm{pl}(\mu_{0_k}) = \mathrm{PRO}$, $\arg(\mu_{0_k}) = a_k$, *and* $\mathrm{val}(\mu_{0_k}) = \emptyset$ *for* $1 \le k \le n$
2. $\mathrm{pl}(\mu_1) = \mathrm{OPP}$ *and* $\mathrm{pl}(\mu_i) \neq \mathrm{pl}(\mu_{i+1})$, *for* $i \ge 1$
3. $\langle \arg(\mu_{i+1}), \mathrm{val}(\mu_{i+1}) \rangle \in \phi(\mu_{0_1}\ldots\mu_{0_n}\mu_1\ldots\mu_i)$

We say that d is about *S.*

A dialogue $d = \mu_{0_1}\mu_{0_2}\ldots\mu_{0_n}\mu_1\mu_2\ldots\mu_i$ is won by PRO *if and only if d is finite, cannot be continued (that is $\phi(d) = \emptyset$) and $\mathrm{pl}(\mu_i) = \mathrm{PRO}$.*

Hence, in a dialogue about a set of arguments, the first n moves are played by PRO to put forward the elements of the set, without any constraint on the value of these arguments, and the subsequent moves are played alternatively by OPP and PRO. Playing an argument may be possible only if some preferences between values hold. This is why a move comprises an argument and a set of value preferences. Moreover, if a player wants to put forward only some ordering of values, then he can do so by playing this ordering along with the empty argument. The legal-move function defines at every step what moves can be used to continue the dialogue. When the set returned by the legal-move function is empty, the dialogue cannot be continued.

We introduce some notation that will be useful to instantiate the dialogue framework to develop positions.

Let $\langle \mathcal{X}, \mathcal{A}, \mathcal{V}, \eta \rangle$ be a VAF, $S \subseteq \mathcal{X}$ and $d = \mu_{0_1}\ldots\mu_{0_n}\mu_1\mu_2\ldots\mu_i$ be a finite ϕ-dialogue about S. μ_i is denoted by $\mathrm{last}(d)$. $\phi(d)$ denotes $\phi(\mu_{0_1}\mu_{0_2}\ldots\mu_{0_n}\mu_1\mu_2\ldots\mu_i)$ and $\mathrm{argPRO}(d)$ (resp. $\mathrm{valPRO}(d)$) the set of arguments (resp. values) played by PRO in d.

Given an audience ϑ and $x \in \mathcal{X}$, we denote by:

- $\mathcal{A}^{+}_{\vartheta}(x)$ the set of arguments successfully attacked by x,
- $\mathcal{A}^{++}_{\vartheta}(x)$ the set of arguments definitely attacked by x,
- $\mathcal{A}^{-}_{\vartheta}(x)$ the set of arguments that successfully attack x,
- $\mathcal{A}^{--}_{\vartheta}(x)$ the set of arguments that definitely attack x,
- $\mathcal{A}^{\pm}_{\vartheta}(x)$ the set $\mathcal{A}^{+}_{\vartheta}(x) \cup \mathcal{A}^{-}_{\vartheta}(x)$.

Note that $\mathcal{A}^{+}_{\vartheta}(\_) = \mathcal{A}^{-}_{\vartheta}(\_) = \mathcal{A}^{--}_{\vartheta}(\_) = \mathcal{A}^{++}_{\vartheta}(\_) = \emptyset$. Moreover, given a set $S \subseteq \mathcal{X}$ and $\varepsilon \in \{+, -, \pm, ++, --\}$, $\mathcal{A}^{\varepsilon}_{\vartheta}(S) = \bigcup_{x \in S} \mathcal{A}^{\varepsilon}_{\vartheta}(x)$.

Given a set $V \subseteq \mathcal{V} \times \mathcal{V}$, $\mathrm{TC}(V)$ denotes the transitive closure of V.

3.2 Checking conflict-freeness

Given a VAF $\langle \mathcal{X}, \mathcal{A}, \mathcal{V}, \eta \rangle$, let $S \subseteq \mathcal{X}$. Let ϑ be an audience. S is not conflict-free w.r.t. ϑ if there are two arguments x and y in S such that y successfully attacks x, that is, $\langle y, x \rangle \in \mathcal{A}$ and $\langle \eta(x), \eta(y) \rangle \notin \vartheta$. In order to make S conflict-free, the value of x should be made preferred to the value of y, that is, $\langle \eta(x), \eta(y) \rangle$ added to ϑ. This is possible only if under the new set of constraints the transitive closure of $\vartheta \cup \{\langle \eta(x), \eta(y) \rangle\}$ remains an audience.

Let us consider a dialogue d about the set S, based on a legal-move function where OPP plays moves using arguments such asf y and the value ordering is empty, and where PRO only exhibits constraints on the value of these arguments. Then the arguments played by PRO in d are the arguments of S along with the empty argument. The transitive closure of the value orderings played by PRO must be the audience w.r.t. which moves are made. Formally:

Definition 9 *Let $\langle \mathcal{X}, \mathcal{A}, \mathcal{V}, \eta \rangle$ be a VAF, d be a dialogue about a set $S \subseteq \mathcal{X}$, and $\vartheta = \mathrm{TC}(\mathrm{valPRO}(d))$. $\phi_1 : \mathcal{M}^* \to 2^{\mathcal{X}^- \times 2^{\mathcal{V} \times \mathcal{V}}}$ is defined by:*

- *if the last move of d is by PRO (next move is by OPP),*

$$\phi_1(d) = \bigcup_{y \in \mathcal{A}^-_\vartheta(\mathrm{argPRO}(d)) \cap \mathrm{argPRO}(d)} \{\langle y, \emptyset \rangle\};$$

- *if the last move of d is by OPP (next move is by PRO), let $y = \arg(\mathrm{last}(d))$, $V = \bigcup_{x \in \mathcal{A}^+_\vartheta(y)} \{\langle \eta(x), \eta(y) \rangle\}$. $\phi(d)$ is*

$$\begin{cases} \{\langle \_, V \rangle\} & \text{if } \mathrm{TC}(\mathrm{valPRO}(d) \cup V) \text{ is an audience} \\ \emptyset & \text{otherwise} \end{cases}$$

The dialogue framework instantiated with the legal-move function ϕ_1, is correct and complete w.r.t. the determination of an audience w.r.t. which a set of arguments is conflict-free:

Property 1 *Let $\langle \mathcal{X}, \mathcal{A}, \mathcal{V}, \eta \rangle$ be a VAF. Let $S \subseteq \mathcal{X}$. If d is a ϕ_1-dialogue about S won by PRO, then S is conflict-free for the audience $\mathrm{TC}(\mathrm{valPRO}(d))$. If S is conflict-free for at least one audience, then there exists a ϕ_1-dialogue about S won by PRO.*

This instance of the dialogue framework can indeed be used to check if the set of desired arguments of a DOR-partitioned VAF is conflict-free for at least one audience, and if so, to give such an audience.

3.3 Making the arguments acceptable

Given a DOR-partitioned VAF $\langle \mathcal{X}, \mathcal{A}, \mathcal{V}, \eta \rangle$, let us assume that the set $\mathrm{Des}(\mathcal{X})$ is conflict-free in the most restricted sense, that is, there are no arguments x and y in $\mathrm{Des}(\mathcal{X})$ such that x attacks y. Let ϑ be an audience. Let us call the set containing the desired arguments which aims at being a restrictedly admissible set the 'position under development'. The reason why the position under development would not be admissible w.r.t. ϑ is that some arguments in it would not be acceptable to it w.r.t. ϑ, that is, there would be one or more argument(s) x in the position under development, such that an argument y would successfully attack them w.r.t. ϑ and no argument z in the position would successfully attack y w.r.t. ϑ. We have identified four ways to make the argument(s) x acceptable to the position under development:

(W1) Add to the position under development an optional argument z which definitely attacks y and which is not in conflict with any argument of the position under development.

(W2) Make the value of the arguments successfully but not definitely attacked by y preferred to the value of y, if the addition of these preferences to the current audience ϑ can be extended into an audience.

(W3) Add to the position under development an optional argument z which successfully but not definitely attacks y and which is not in conflict with any argument of the position under development.

(W4) Add to the position under development an optional argument z which successfully attacks y, and which might be successfully but not definitely attacked by the position under development or which might successfully but not definitely attack the position under development; the addition of value preferences to the current audience in order for the addition of z to the position to be correct must form an audience.

Each of these four ways will be tried in turn. In responding to an attack, the proponent will wish to maintain as much flexibility to respond to further attacks as possible. The order in which the four ways are tried is thus determined by the desire to make the least committal move at any stage. Flexibility is limited in two ways. If the position is extended by including an additional argument, as in W1, W3 and W4, the potential attackers of the position is increased since this argument must now also be defended by the position. If a commitment to a value ordering is made, as in W2, W3 and W4, this must be subsequently respected, which restricts the scope to make such moves in future responses. We regard this second line of defence as more committal that the first. Therefore W1 is tried first since it imposes no constraints on the audience, although it does extend the position. W2 is selected next because, although it does constrain the audience to adopt certain value preferences, it does not introduce any additional arguments to the position, and so does not give rise to any additional attackers. If W3 is resorted to, both the position is extended and a value ordering commitment is made, but the argument introduced is compatible with the existing position. W4 is the final resort because it extends the position, constrains the audience, and requires further constraints to be imposed to enable it to cohere with the existing position.

Let us consider a dialogue d about the conflict-free set $\mathrm{Des}(\mathcal{X})$, based on a legal-move function where OPP plays moves where the argument is of the kind of y and the value ordering is empty, and where PRO plays in one of the four ways above. The arguments of the position under development are those played by PRO. The transitive closure of the value orderings played by PRO must be the audience w.r.t. which the moves are made. Formally:

Definition 10 *Let $\langle \mathcal{X}, \mathcal{A}, \mathcal{V}, \eta \rangle$ be a DOR-partitioned VAF, d be a dialogue about $\mathrm{Des}(\mathcal{X})$, $\vartheta = \mathrm{TC}(\mathrm{valPRO}(d))$. $\phi_2 : \mathcal{M}^* \to 2^{\mathcal{X}^- \times 2^{\mathcal{V} \times \mathcal{V}}}$ is defined by:*

- *if the last move of d is by PRO (next move is by OPP),*

$$\phi_2(d) = \mathcal{A}^-_\vartheta(\mathrm{argPRO}(d)) \setminus \mathcal{A}^+_\vartheta(\mathrm{argPRO}(d));$$

• *if the last move of d is by* OPP *(next move is by* PRO*), let* $y = \mathrm{arg}(\mathrm{last}(d))$*, and:*

(W1) *let* $Z_1 = (\mathrm{Opt}(\mathcal{X}) \cap \mathcal{A}_\vartheta^{--}(y)) \setminus \mathcal{A}_\vartheta^{\pm}(\mathrm{argPRO}(d))$*; if* $Z_1 \neq \emptyset$*, then*

$$\phi_2(d) = \bigcup_{z \in Z_1} \{\langle z, \emptyset \rangle\}$$

(W2) *else, let* $Z_2 = \mathrm{argPRO}(d) \cap (\mathcal{A}_\vartheta^{+}(y) \setminus \mathcal{A}_\vartheta^{++}(y))$*; if* $Z_2 \neq \emptyset$ *then*

$$\phi_2(d) = \langle \_\, , \bigcup_{x \in Z_2} \{\langle \eta(x), \eta(y) \rangle\} \rangle$$

(W3) *else, let* $Z_3 = (\mathrm{Opt}(\mathcal{X}) \cap \mathcal{A}_\vartheta^{-}(y)) \setminus \mathcal{A}_\vartheta^{\pm}(\mathrm{argPRO}(d))$*; if* $Z_3 \neq \emptyset$*, then*

$$\phi_2(d) = \bigcup_{z \in Z_3} \{\langle z, \{\langle \eta(z), \eta(y) \rangle\} \rangle\}$$

(W4) *else, let* $Z_4 = \mathrm{Opt}(\mathcal{X}) \cap \mathcal{A}_\vartheta^{-}(y) \cap ((\mathcal{A}_\vartheta^{+}(\mathrm{argPRO}(d)) \setminus \mathcal{A}_\vartheta^{++}(\mathrm{argPRO}(d))) \cup (\mathcal{A}_\vartheta^{-}(\mathrm{argPRO}(d)) \setminus \mathcal{A}_\vartheta^{--}(\mathrm{argPRO}(d))))$. *Given* $z \in Z_4$*, let* $X(z) = \mathrm{argPRO}(d) \cap (\mathcal{A}_\vartheta^{-}(z) \setminus \mathcal{A}_\vartheta^{--}(z))$, $Y(z) = \mathrm{argPRO}(d) \cap (\mathcal{A}_\vartheta^{+}(z) \setminus \mathcal{A}_\vartheta^{++}(z))$, $V_{X(z)} = \bigcup_{x \in X(z)} \{\langle \eta(z), \eta(x) \rangle\}$ *and* $V_{Y(z)} = \bigcup_{y \in Y(z)} \{\langle \eta(y), \eta(z) \rangle\}$. *Let* $Z_4' = \{z \in Z_4 \mid \eta(z) \neq \eta(y)$ and $\mathrm{TC}(\vartheta \cup V_{X(z)} \cup V_{Y(z)} \cup \{\langle \eta(z), \eta(y) \rangle\})$ is an audience$\}$. *Let* $Z_4'' = \{z \in Z_4 \mid \eta(z) = \eta(y)$ or $\langle \eta(z), \eta(y) \rangle \in \vartheta,$ and $\mathrm{TC}(\vartheta \cup V_{X(z)} \cup V_{Y(z)})$ is an audience$\}$.

$$\phi_2(d) = \bigcup_{z \in Z_4'} \{\langle z, V_{X(z)} \cup V_{Y(z)} \cup \{\langle \eta(z), \eta(y) \rangle\} \rangle\} \cup \bigcup_{z \in Z_4''} \{\langle z, V_{X(z)} \cup V_{Y(z)} \rangle\}.$$

The dialogue framework instantiated with the legal-move function ϕ_2, is correct and complete w.r.t. the determination of an audience for which the conflict-free set of desired arguments is admissible for at least one audience:

Property 2 *Let* $\langle \mathcal{X}, \mathcal{A}, \mathcal{V}, \eta \rangle$ *be a* DOR*-partitioned VAF. Assume that* $\mathrm{Des}(\mathcal{X})$ *is conflict-free. If d is a ϕ_2-dialogue about* $\mathrm{Des}(\mathcal{X})$ *won by* PRO*, then* $\mathrm{argPRO}(d) \setminus \{\_\}$ *is a restrictedly admissible set w.r.t.* $\mathrm{TC}(\mathrm{valPRO}(d))$*. If* $\mathrm{Des}(\mathcal{X})$ *is contained in a restrictedly admissible set w.r.t. at least one audience, then there exists a ϕ_2-dialogue about* $\mathrm{Des}(\mathcal{X})$ *won by* PRO.

3.4 Development of positions

Let us consider the following legal-move function:

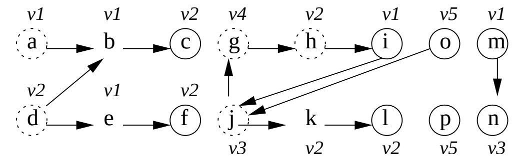
Definition 11 *Let* $\langle \mathcal{X}, \mathcal{A}, \mathcal{V}, \eta \rangle$ *be a* DOR*-partitioned VAF, d be a dialogue about* $\mathrm{Des}(\mathcal{X})$*, and* $\vartheta = \mathrm{TC}(\mathrm{valPRO}(d))$*.* $\phi_3 : \mathcal{M}^* \rightarrow 2^{\mathcal{X}^- \times 2^{\mathcal{V} \times \mathcal{V}}}$ *is defined by:*

• *if the last move of d is by* PRO *(next move is by* OPP*), then, if* $\phi_1(d) \neq \emptyset$*, then* $\phi_3(d) = \phi_1(d)$ *else* $\phi_3(d) = \phi_2(d)$*;*

• *if the last move of d is by* OPP *(next move is by* PRO*), if* $\mathrm{arg}(\mathrm{last}(d)) \in \mathrm{Des}(\mathcal{X})$ *then* $\phi_3(d) = \phi_1(d)$*, else* $\phi_3(d) = \phi_2(d)$.

Property 3 *Let* $\langle \mathcal{X}, \mathcal{A}, \mathcal{V}, \eta \rangle$ *be a* DOR*-partitioned VAF. If d is a ϕ_3-dialogue about* $\mathrm{Des}(\mathcal{X})$ *won by* PRO*, then* $\mathrm{argPRO}(d) \setminus \{\_\}$ *is a restrictedly admissible set w.r.t.* $\mathrm{TC}(\mathrm{valPRO}(d))$*. If* $\mathrm{Des}(\mathcal{X})$ *is contained in a restrictedly admissible w.r.t. at least one audience, then there exists a ϕ_3-dialogue about* $\mathrm{Des}(\mathcal{X})$ *won by* PRO.

Example Consider the following VAF $\langle \mathcal{X}, \mathcal{A}, \mathcal{V}, \eta \rangle$:



The arguments are the vertices of the graph and the edges represent the elements of the attack relation. The set of values is $\mathcal{V} = \{v1, v2, v3, v4, v5\}$. The value associated to an argument is indicated just below or just above the argument. The desired arguments are plain-circled, the optional arguments are dot-circled, and the rejected arguments are not circled. Let us develop a position. We start a ϕ_3-dialogue d about $\mathrm{Des}(\mathcal{X})$. The first moves of d contain the desired arguments, i.e. $\mu_{0_1}\mu_{0_2}\mu_{0_3}\mu_{0_4}\mu_{0_5}\mu_{0_6}\mu_{0_7}\mu_{0_8} = [\mathrm{PRO}, \langle c, \emptyset \rangle]\ [\mathrm{PRO}, \langle f, \emptyset \rangle][\mathrm{PRO}, \langle i, \emptyset \rangle][\mathrm{PRO}, \langle l, \emptyset \rangle][\mathrm{PRO}, \langle m, \emptyset \rangle][\mathrm{PRO}, \langle n, \emptyset \rangle][\mathrm{PRO}, \langle o, \emptyset \rangle][\mathrm{PRO}, \langle p, \emptyset \rangle]$. Then, to ensure the conflict-freeness of $\mathrm{Des}(\mathcal{X})$ w.r.t. one audience:

$\mu_1 = [\mathrm{OPP}, \langle m, \emptyset \rangle]$
$\mu_2 = [\mathrm{PRO}, \langle \_\, , \{\langle v3, v1 \rangle\} \rangle]$

Now, to make the arguments of $\mathrm{Des}(\mathcal{X})$ acceptable:

$\mu_3 = [\mathrm{OPP}, \langle b, \emptyset \rangle]$
$\mu_4 = [\mathrm{PRO}, \langle a, \emptyset \rangle]$ **(W1)**
$\mu_5 = [\mathrm{OPP}, \langle e, \emptyset \rangle]$
$\mu_6 = [\mathrm{PRO}, \langle \_\, , \{\langle v2, v1 \rangle\} \rangle]$ **(W2)**
$\mu_7 = [\mathrm{OPP}, \langle h, \emptyset \rangle]$
$\mu_8 = [\mathrm{PRO}, \langle g, \{\langle v4, v2 \rangle\} \rangle]$ **(W3)**
$\mu_9 = [\mathrm{OPP}, \langle j, \emptyset \rangle]$
$\mu10 = [\mathrm{PRO}, \langle \_\, , \{\langle v4, v3 \rangle\} \rangle]$ **(W2)**
$\mu11 = [\mathrm{OPP}, \langle k, \emptyset \rangle]$
$\mu12 = [\mathrm{PRO}, \langle j, \{\langle v3, v2 \rangle, \langle v3, v5 \rangle\} \rangle]$ **(W4)**

$d = \mu_{0_1} \ldots \mu_{0_8}\mu_1\mu_2\mu_3\mu_4\mu_5\mu_6\mu_7\mu_8\mu_9\mu_{10}\mu_{11}\mu_{12}$ is a ϕ_3-dialogue won by PRO. The set $\mathrm{argPRO}(d) = \mathrm{Des}(\mathcal{X}) \cup \{a, g, j\}$ is restrictedly admissible w.r.t. the transitive closure of $\mathrm{valPRO}(d) = \{\langle v4, v3 \rangle, \langle v3, v2 \rangle, \langle v4, v2 \rangle, \langle v2, v1 \rangle, \langle v3, v1 \rangle, \langle v3, v5 \rangle\}$.

At certain points we may be presented with a choice of arguments to use with W1-4. For example b may be attacked by a or, if $v1$ is not preferred to $v2$, d. Similarly there are choices when we declare value preferences: in the example we can either prevent the attack of j on g succeeding, or choose preferences which lead to i or o defeating j. Such choices may, if badly made, lead to backtracking. Some heuristics seem possible to guide choices: it is better to attack an undesired argument with an argument of its own value where possible, as with a and b above, as this attack will succeed even if the value order changes. Also, when a value preference is required, a choice which keeps an optional argument available is better than one which defeats it, as the argument may be required to defeat a future attack, as in the example where j is required to defeat k.

4 Related work and conclusion

[Dung, 1995] provides the starting point for consideration of positions within sets of arguments. His abstract framework, however, does not distinguish between an attack and an attack which succeeds. Refining the concept of "successful attack" together with the computational problems associated with Dung's schema[1] have motivated approaches in addition to the VAF formalism [Bench-Capon, 2002] underpinning the present work. Thus, [Amgoud and Cayrol, 2002] introduce "preference-based argument" wherein the attack $\langle x, y\rangle$ is a *successful attacks* by x on y in the event that the *argument* y is "not preferred" to x. A comparison of the preference and value-based approaches may be found in [Dunne and Bench-Capon, 2004a, pp. 368–69].

The dialogue mechanism for position construction uses the expressive formalism presented in [Jakobovits and Vermeir, 1999] which also form the basis of schemes described in [Amgoud and Cayrol, 2002; Cayrol *et al.*, 2003]. Use is made of a partitioned argumentation framework to introduce restricted notions of admissibility to Dung's framework in [Cayrol *et al.*, 2002]. A related approach – the TPI-dispute protocol introduced in [Vreeswijk and Prakken, 2000] – has been analysed extensively in [Dunne and Bench-Capon, 2003] with respect to its computational efficiency. In view of the intractability of deciding whether a position exists (cf. [Dunne and Bench-Capon, 2004a]), it would be interesting to obtain a characterisation of rules W1-4 as a proof-theoretic technique aw was done in [Dunne and Bench-Capon, 2003] for TPI-disputes w.r.t. the CUT-free Sequent calculus.

In this paper we have described an approach to practical reasoning which respects four important phenomena of such reasoning. It addresses the need to consider arguments in context, so that alternatives are properly considered, and so that actions are chosen with reference to what else must be done: it is a position comprising a set of actions rather than a single argument that is adopted. It permits of a dialogical construction which corresponds to the presumption and critique structure of practical reasoning. It accommodates different value preferences to explain rational disagreement as to the proper course of action. Finally and this is a key contribution of this paper it permits the ordering of value preferences to emerge from the debate rather than requiring the unrealistic assumption that agents are able fully to determine their rankings in advance. We believe that this approach will have significant application in the analysis and modelling of argumentation in areas such as case law in and political debate as in [Dunne and Bench-Capon, 2004b], both of which are receiving increasing attention as the notion of e-democracy becomes widespread.

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[1] see e.g. [Dunne and Bench-Capon, 2002, pp. 188-89] for a discussion of these.