Determining Preferences Through Argumentation

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Abstract. Arguments concerning what an agent should do cannot be considered in isolation: they occur in the context of debates where 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. Where the position concerns practical reasoning, defence may be made by making a choice justified in terms of the values of an agent. 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 position which is coherent both with respect to the attack relations between arguments and any value choices made. 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. A key contribution is that the value choices are made as part of the argumentation process, and need not be determined in advance.

1 Introduction

In this paper we will be concerned with *practical reasoning* - reasoning about the action to perform 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 [19], [2], as there are always alternatives, and often reasons to refrain from the action as well as reasons to perform it. 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 attacking arguments in the debate. We call such a coherent

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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. [9,4]. These debates can also be seen as representing the relevant presumptive arguments and the critical questions [19] 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 [7], [11] and [3].

Second, 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 by Searle in [17]:

> 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 [16][1] and what is acceptable to one audience may be unacceptable to another. Disagreements are represented in argumentation frameworks such as that of Dung [9] by the presence within a debate of multiple acceptable positions. In [4], Bench-Capon advances an extended argumentation framework which explicitly relates arguments to values and explicitly represents audiences in terms of their preferences over values.

While a framework such as that of [4] 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. A third feature of practical reasoning (as indicated by Searle in [17]) is that we cannot presuppose that people bring to a debate a knowledge of their value preferences. It means that the value preferences should emerge from the construction of a position instead of being taken as an input.

Finally, practical reasoners may not be equally open to all arguments: they may have certain arguments that they wish to include in their position, certain arguments that they wish to exclude, and they may be 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. Such

[1] The term “audience” is also used in Hunter [14], although he distinguishes between audiences only in terms of beliefs, whereas [4] distinguishes them in terms of values, while also accommodating differences in beliefs.

a distinction between arguments has been taken into account in the construction of positions for Dung's framework [9] by [6]. This treatment, however, does not relate arguments to values, and so cannot use these reasons for action in order to explain choices. Moreover, it is in consequence not possible to require these choices to show a consistent motivation: in order to do this we need to use an extension of [9] such as provided by [4].

Providing an account of how we can explain disagreements in terms of a consistent ranking of values is the objective of our work. In particular, we provide a means for explaining how the ordering of values emerges from the construction of a position.

Section 2 recapitulates the argumentation frameworks which provide our formal starting point, Section 3 describes the dialogical framework introduced in [8] for developing a position and Section 4 points to some related work, draws some conclusions and identifies directions for further exploration.

2 Value-Based Argumentation Framework

We start with a review of Dung's argument system [9] upon which the value-based argumentation framework proposed by Bench-Capon in [3,4] relies.

Definition 1. *[9] An* argument system *is a pair $\mathcal{H} = \langle \mathcal{X}, \mathcal{A} \rangle$, in which $\mathcal{X}$ is a finite set of* arguments *and $\mathcal{A} \subseteq \mathcal{X} \times \mathcal{X}$ 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'. A set $S \subseteq \mathcal{X}$ is* conflict-free *if no argument in S attacks an argument in S.*

Definition 2. *[4] 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 3. *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 $\langle v_2, v_1 \rangle \in \alpha$.*

An audience is an ordering of values that does not need to be total. In [3,4], an audience corresponds to what we call here a 'specific audience'. The following definitions are slightly adapted versions of those from [3,4].

Definition 4. *Let $\langle \mathcal{X}, \mathcal{A}, \mathcal{V}, \eta \rangle$ be a VAF, ϑ be an audience, and x and y be two arguments of $\mathcal{X}$. 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 $\langle \eta(x), \eta(y) \rangle \in \vartheta$. The arguments x and y are* in conflict *with* *respect to* ϑ *if* x *successfully attacks* y *with respect to* ϑ or y *successfully attacks* x *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. *The argument* y *is a* defender *of* x with respect to 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.

For $S \subseteq \mathcal{X}$, 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; 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.

Motivating examples showing the advantages of VAFs are given in [3,12].

To accomodate the fourth feature of practical reasoning, that is, to take into account that reasoners may have certain arguments they wish to include in a position, others they wish to exclude and that they are indifferent to the rest, we extend the definition of a VAF as follows:

Definition 5. *A VAF* $\langle \mathcal{X}, \mathcal{A}, \mathcal{V}, \eta \rangle$ *is* DOR-partitioned *if* $\mathcal{X} = D \cup O \cup R$ *for 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. *A* DOR*-partitioned VAF is called a* DOR-VAF.

An admissible set which can be adopted as a position in a DOR-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 a position via:

Definition 6. *Given a* DOR-*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 a* position *if and only if there exists at least one audience* ϑ *w.r.t. which* S *is admissible and* $\forall y \in Y$, $\exists x \in \mathrm{Des}(\mathcal{X})$ *such that* y *is a defender of* x. *An audience w.r.t. which* S *is a position is said to be a* corresponding audience *of* S.

This new notion of a position accomodates the third feature of practical reasoning: the preferences between values are not given as an input on the basis of which the position is constructed, but are a result of constructing the position.

3 Development of a Position

In order to build a position, one may start by considering the set of desired arguments. This set must be first tested to demonstrate that there is at least one audience w.r.t. which it is conflict-free. It may be that this condition can only be satisfied by imposing some value preferences. If we can satisfy this test we must next ensure that any defeated argument in the set has a defender in the set w.r.t. at least one audience. To this end, some optional arguments may be added to the set as defenders of defeated arguments and/or some additional constraints on the ordering of values may be imposed. We would like such extensions of the position under development to be kept to a minimum. If the process succeeds, then the set developed is a position and the set of constraints determined by the construction can be extended into a corresponding audience of this position, by taking its transitive closure. Otherwise, the user has to reconsider the partition of the set of arguments; such issues are the subject of ongoing research.

This construction can be presented in the form of a *dialogue* between two players. One, the *opponent*, outlines why the set under development is not yet a position by identifying arguments which defeat members of the set. The other, the *proponent*, tries to make the set under development a position by extending it with some optional arguments and/or some constraints between values. If the opponent has been left with no legal move available then the set of arguments played by the proponent is a position and the set of constraints advanced can be extended into a corresponding audience. If the proponent has no legal move available the set of desired arguments cannot be extended into a position.

This presentation in a dialogue form has the main advantage of making clear why some constraints between values must be imposed and why some optional arguments must belong to the position. Moreover, it is highly appropriate to the dialectical nature of practical reasoning identified above.

In Section 3.1, we present a formal dialogue framework that we instantiate in Section 3.2 in order to check if a set of desired arguments is conflict-free for at least one audience. We instantiate the dialogue framework in Section 3.3 to check if a conflict-free set of desired arguments can be made acceptable. Finally, in Section 3.4 we combine these two instantiations to construct positions and we give an example of such a construction.

3.1 Dialogue Framework

A dialogue framework to prove the acceptability of arguments in Dung's argument system has been developed by [15] and refined in [7]. We extend this last framework to deal with the development of positions in a DOR-VAF.

Informally, a dialogue framework provides a definition of the players, the moves, the rules and conditions under which the dialogue terminates, i.e. those situations wherein the current player has no legal move in the dialogue. In order to capture the construction of positions, the dialogue framework we define comprises two players, PRO and OPP. The rules are expressed in a so-called 'legal-move function'. Regarding the definition of a move, since playing an argument may be possible only if some preferences between values hold, a move must comprise an argument and a set of value preferences. In particular, a player may propose some ordering of values, i.e without any specific argument being involved (for example, when he wants to make a set of desired arguments conflict-free for at least one audience). To this end, it is convenient to extend the arguments of a DOR-VAF $\langle \mathcal{X}, \mathcal{A}, \mathcal{V}, \eta \rangle$ with an 'empty argument' denoted $\_$. This argument can be used if the proponent's move is only to advance a value ordering. We denote by $\mathcal{X}^-$ the set $\mathcal{X} \cup \{\_\}$.

Definition 7. *Let* $\langle \mathcal{X}^-, \mathcal{A}, \mathcal{V}, \eta \rangle$ *be a* DOR-VAF*. A* move *in* $\mathcal{X}^-$ *is described via a pair* $[P, \langle X, V \rangle]$ *where* $P \in \{\text{PRO}, \text{OPP}\}$*,* $X \in \mathcal{X}^-$*, and* $V \subseteq \mathcal{V} \times \mathcal{V}$*.* PRO *denotes the* proponent *and* OPP *denotes the* opponent*.*

For a move $\mu = [P, \langle X, V \rangle]$*, we use* $\text{pl}(\mu)$ *to denote* P*,* $\text{arg}(\mu)$ *to denote* X*, and* $\text{val}(\mu)$ *to denote* V*. The set of moves is denoted by* $\mathcal{M}$ *with* $\mathcal{M}^*$ *being the set of finite sequences of moves.*

Let $\phi : \mathcal{M}^* \rightarrow 2^{\mathcal{X}^- \times 2^{\mathcal{V} \times \mathcal{V}}}$ *be a* legal-move function*. A* dialogue *(or* ϕ*-dialogue)* d *about* $S = \{a_1, a_2, \ldots, a_n\} \subseteq \mathcal{X}$ *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 the following conditions hold:*

1. $\text{pl}(\mu_{0_k}) = \text{PRO}$*,* $\text{arg}(\mu_{0_k}) = a_k$*, and* $\text{val}(\mu_{0_k}) = \emptyset$ *for* $1 \leq k \leq n$
2. $\text{pl}(\mu_1) = \text{OPP}$ *and* $\text{pl}(\mu_i) \neq \text{pl}(\mu_{i+1})$*, for* $i \geq 1$
3. $\langle \text{arg}(\mu_{i+1}), \text{val}(\mu_{i+1}) \rangle \in \phi(\mu_{0_1}\mu_{0_2}\ldots\mu_{0_n}\mu_1\ldots\mu_i)$*.*

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 (*1.*). Subsequent moves are played alternately by OPP and PRO (*2.*). The legal-move function defines at every step what moves can be used to continue the dialogue (*3.*). We do not require $\text{arg}(\mu_{i+1})$ to attack $\text{arg}(\mu_i)$, because we want a dialogue to be sequential, so we need to let OPP try all possible answers to any of PRO's arguments, but only one at a time.

Let $\langle \mathcal{X}^-, \mathcal{A}, \mathcal{V}, \eta \rangle$ be a DOR-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. We denote μ_i by $\text{last}(d)$ and write $\phi(d)$ for $\phi(\mu_{0_1}\ldots\mu_{0_n}\mu_1\mu_2\ldots\mu_i)$. In addition, $\text{argPRO}(d)$ (resp. $\text{valPRO}(d)$) will denote the set of arguments (resp. values) played by PRO in d.

Now that we have a way to define a dialogue and the rules of a dialogue, let us define when a dialogue terminates (i.e. cannot be continued).

Definition 8. *Let* $\langle \mathcal{X}^-, \mathcal{A}, \mathcal{V}, \eta \rangle$ *be a DOR-VAF,* ϕ *be a legal-move function, and* d *be a finite* ϕ*-dialogue.* d cannot be continued *if* $\phi(d) = \emptyset$*.* d *is said to be* won by PRO *if and only if* d *cannot be continued, and* $\text{pl}(\text{last}(d)) = \text{PRO}$*.*

We introduce additional notation to instantiate the dialogue framework to develop positions. Given a DOR-VAF $\langle \mathcal{X}^-, \mathcal{A}, \mathcal{V}, \eta \rangle$ and a set $V \subseteq \mathcal{V} \times \mathcal{V}$, $\text{TC}(V)$ denotes the transitive closure of V. Given an audience ϑ and $x \in \mathcal{X}^-$, we use,

- $\mathcal{A}_\vartheta^+(x)$ for the set of arguments successfully attacked by x,
- $\mathcal{A}_\vartheta^{++}(x)$ for the set of arguments definitely attacked by x,
- $\mathcal{A}_\vartheta^-(x)$ for the set of arguments that successfully attack x,
- $\mathcal{A}_\vartheta^{--}(x)$ for the set of arguments that definitely attack x,
- $\mathcal{A}_\vartheta^\pm(x)$ for 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 $\varepsilon \in \{+, -, \pm, ++, --\}$, $\mathcal{A}_\vartheta^\varepsilon(S) = \bigcup_{x \in S} \mathcal{A}_\vartheta^\varepsilon(x)$.

3.2 Checking Conflict-Freeness

Let $\langle \mathcal{X}^-, \mathcal{A}, \mathcal{V}, \eta \rangle$ be a DOR-VAF and ϑ be an audience. $\text{Des}(\mathcal{X})$ is not conflict-free w.r.t. ϑ if there are two desired arguments x and y 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 Des($\mathcal{X}$) 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.

Consider a dialogue d about Des($\mathcal{X}$), based on a legal-move function where OPP plays moves using arguments such as y and the value ordering is empty, and where PRO only exhibits constraints on the value of these arguments. Then the set of arguments played by PRO in d (i.e. argPRO(d)) is Des($\mathcal{X}$), possibly along with $\{\_\}$. The transitive closure of the value orderings played by PRO in d (i.e. TC(valPRO(d))) 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* DOR-VAF*,* d *be a dialogue about* Des($\mathcal{X}$)*, and* $\vartheta = \mathrm{TC}(\mathrm{valPRO}(d))$*.* $\phi_1 : \mathcal{M}^* \rightarrow 2^{\mathcal{X}^- \times 2^{\mathcal{V}\times\mathcal{V}}}$ *is defined by:*

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

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

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

$$\phi_1(d) = \begin{cases} \{\langle \_\, , V\rangle\} & \text{if } \mathrm{TC}(\mathrm{valPRO}(d) \cup V) \text{ is an audience,} \\ \emptyset & \text{otherwise.} \end{cases}$$

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 the set of desired arguments is conflict-free:

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

3.3 Making the Arguments Acceptable

Given a DOR-VAF $\langle \mathcal{X}, \mathcal{A}, \mathcal{V}, \eta\rangle$, let us assume that the set Des($\mathcal{X}$) is conflict-free in the most restricted sense, i.e. there are no arguments x and y in Des($\mathcal{X}$) such that $\langle x, y\rangle \in \mathcal{A}$. For an audience, ϑ, we call the set containing the desired arguments which aims at being a position 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, i.e. there is (at least one) argument x in the position under development such that some argument y successfully attacks x w.r.t. ϑ and no argument z in the position successfully attacks y w.r.t. ϑ.

Let us consider a dialogue d about the conflict-free set Des($\mathcal{X}$), based on a legal-move function where OPP plays moves involving some argument y and the value ordering is empty, and where PRO uses one of (W1)–(W4) below. The arguments in the position under development are those played by PRO. The transitive closure of the value orderings played by PRO (i.e. TC(valPRO(d))) must be the audience w.r.t. which the moves are made.

We identify four ways to make an argument 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.

Our next definition gives formal translations of (W1) through (W3) as dialogue moves. We omit the rather lengthier specification (W4) for space reasons.

Definition 10. *Let* $\langle \mathcal{X}^-, \mathcal{A}, \mathcal{V}, \eta \rangle$ *be a* DOR-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* $\mathrm{pl}(\mathrm{last}(d)) = \mathrm{PRO}$ *(next move is by* OPP*), let* $Y = \mathcal{A}^-_\vartheta(\mathrm{argPRO}(d)) \setminus \mathcal{A}^+_\vartheta(\mathrm{argPRO}(d))$*,*

$$\phi_2(d) = \bigcup_{y \in Y} \{\langle y, \emptyset \rangle\};$$

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

(W1) *let* $Z_1 = (\mathrm{Opt}(\mathcal{X}) \cap \mathcal{A}^{--}_\vartheta(y)) \setminus \mathcal{A}^\pm_\vartheta(\mathrm{argPRO}(d))$*; 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* $Z_3 = (\mathrm{Opt}(\mathcal{X}) \cap \mathcal{A}^-_\vartheta(y)) \setminus \mathcal{A}^\pm_\vartheta(\mathrm{argPRO}(d))$*; if* $Z_3 \neq \emptyset$*, then*

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

else if (W4) is played $\phi_2(d)$ *contains the corresponding moves; else* $\phi_2(d) = \emptyset$*.*

Each of these four ways would 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 set of 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.

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-*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 position such that $\mathrm{TC}(\mathrm{valPRO}(d))$ is a corresponding audience. If $\mathrm{Des}(\mathcal{X}) \neq \emptyset$ is contained in a position, then a ϕ_2-dialogue about $\mathrm{Des}(\mathcal{X})$ won by PRO exists.

3.4 Development of Positions

Let us consider the following legal-move function:

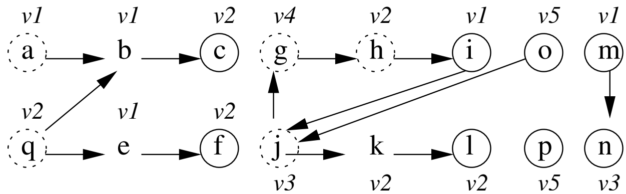
Definition 11. *Let* $\langle \mathcal{X}^-, \mathcal{A}, \mathcal{V}, \eta \rangle$ *be a* DOR-*VAF, d be a dialogue about* $\mathrm{Des}(\mathcal{X})$, *and* $\vartheta = \mathrm{TC}(\mathrm{valPRO}(d))$. $\phi_3 : \mathcal{M}^* \to 2^{\mathcal{X}^- \times 2^{\mathcal{V} \times \mathcal{V}}}$ *is defined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

• *if* $\mathrm{pl}(\mathrm{last}(d)) = \mathrm{PRO}$ *(next move is by* OPP*: if* $\phi_1(d) \neq \emptyset$ *then* $\phi_3(d) = \phi_1(d)$ *else* $\phi_3(d) = \phi_2(d)$*;*

• *if* $\mathrm{pl}(\mathrm{last}(d)) = \mathrm{OPP}$ *(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-VAF. If d is a ϕ_3-dialogue about $\mathrm{Des}(\mathcal{X})$ won by PRO, then $\mathrm{argPRO}(d) \setminus \{\_\}$ is a position such that $\mathrm{TC}(\mathrm{valPRO}(d))$ is a corresponding audience. If $\mathrm{Des}(\mathcal{X}) \neq \emptyset$ is contained in a position, 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 Des($\mathcal{X}$). The first moves of d contain the desired arguments, i.e. $\mu_{0_1}\mu_{0_2}\mu_{0_3}\mu_{0_4}\mu_{0_5}\mu_{0_6}\mu_{0_7}\mu_{0_8} = [\text{PRO}, \langle c, \emptyset \rangle][\text{PRO}, \langle f, \emptyset \rangle][\text{PRO}, \langle i, \emptyset \rangle]$ $[\text{PRO}, \langle l, \emptyset \rangle][\text{PRO}, \langle m, \emptyset \rangle][\text{PRO}, \langle n, \emptyset \rangle][\text{PRO}, \langle o, \emptyset \rangle][\text{PRO}, \langle p, \emptyset \rangle]$. Then, to ensure the conflict-freeness of Des($\mathcal{X}$) w.r.t. one audience:

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

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

$\mu_3 = [\text{OPP}, \langle b, \emptyset \rangle]$
$\mu_4 = [\text{PRO}, \langle a, \emptyset \rangle]$ **(W1)**
$\mu_5 = [\text{OPP}, \langle e, \emptyset \rangle]$
$\mu_6 = [\text{PRO}, \langle \_ , \{\langle v2, v1 \rangle\} \rangle]$ **(W2)**
$\mu_7 = [\text{OPP}, \langle h, \emptyset \rangle]$
$\mu_8 = [\text{PRO}, \langle g, \{\langle v4, v2 \rangle\} \rangle]$ **(W3)**
$\mu_9 = [\text{OPP}, \langle j, \emptyset \rangle]$
$\mu_{10} = [\text{PRO}, \langle \_ , \{\langle v4, v3 \rangle\} \rangle]$ **(W2)**
$\mu_{11} = [\text{OPP}, \langle k, \emptyset \rangle]$
$\mu_{12} = [\text{PRO}, \langle j, \{\langle v3, v2 \rangle, \langle v3, v5 \rangle\} \rangle]$ **(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 argPRO(d) = Des($\mathcal{X}$) $\cup \{a, g, j\}$ is a position, and the transitive closure of valPRO(d) $= \{\langle v4, v3 \rangle, \langle v3, v2 \rangle, \langle v4, v2 \rangle, \langle v2, v1 \rangle, \langle v3, v1 \rangle, \langle v3, v5 \rangle\}$ is one of its corresponding audiences.

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 $v2$, q. 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. For a discussion of how preferences over values emerge in a particular domain, see [5], which gives an account of how the decisions made in a body of case law reveal the social priorities of the jurisdiction in which they are made.

4 Related Work and Conclusion

The basis for our consideration of positions within sets of arguments is the abstract framework of [9]. This, 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[2] has motivated approaches in addition to the VAF formalism [3] underpinning the present work. Thus, [1] introduce "preference-based argument" wherein the attack $\langle x, y \rangle$ is a *successful attack* 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 [12, pp. 368–69].

The dialogue mechanism for position construction uses the expressive formalism presented in [15] which also forms the basis of schemes described in [1,7]. Use is made of a partitioned argumentation framework to introduce restricted notions of admissibility to Dung's framework in [6]. A related approach – the TPI-dispute protocol introduced in [18] – has been analysed extensively in [11] with respect to its computational efficiency. In view of the intractability of deciding whether a position exists (cf. [12]), it would be interesting to obtain a characterisation of rules W1-4 as a proof-theoretic technique as was done in [11] 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 where choice in terms of the values of the audience is important such as case law in and political debate as in [13]. Both of these areas are receiving increasing attention as the notion of e-democracy becomes widespread.

[2] See e.g. [10, pp. 188-89] for a discussion of these.

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