A Context-based Argumentation Framework with Values [⋆]

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Abstract. This paper proposes a context-based argumentation system based on *ASPIC*$^{+}$ frameworks. It considers the changeability of contexts in conversations. Moreover, this system encodes the participants' preferences by giving priority orderings over the set of all the values associated with contexts and norms respectively. People argue for reaching agreements, this paper defines a concept called *consensus* to represent the agreements reached among the participants.

Keywords: argumentation frameworks· contexts · values · norms · preferences

1 Introduction

Formal argumentation systems have been considered as useful tools for resolving disputes [5, 11, 12]. In the literature, some studies extend argumentation frameworks by combining them with normative systems and values [1–3, 6, 7]. However, there are very few works pay attention to the changeability of contexts in argumentation.

Consider the following example from the *Aesop's Fables*.

Example 1 (The Fox and the Crow). [1] A hungry Fox was walking through the woods looking for something to eat. Suddenly he found a crow sitting on a branch high up in a tree, with a big piece of cheese in her beak. The Fox decided to get that piece of cheese for himself. He said hello to the Crow and tried to make her talk. However, the Crow suspected that the Fox was after her cheese, so she didn't return his greeting.

Just before the Crow was about to swallow the cheese, the Fox tries flattery instead: "Oh, crow, how your feathers shine! What a beautiful form and what splendid wings! Such a wonderful bird should have a very lovely voice, since everything else about you is so perfect. Could you sing just one song, I know I should hail you Queen of Birds."

Pleased with the flattery, the crow forgot her suspicion and also her breakfast. She was so eager to show off her voice, so she opened her beak wide to utter her loudest caw. The cheese dropped down and the Fox gobbled it up immediately.

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[1] Several versions of this story can be found on the webpage https://fablesofaesop.com/the-fox-and-the-crow.html

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In the story, the Crow was certainly not going to open her beak at first because she won't give her own food to the Fox. But the Fox then sneakily shifted the context of their conversation. Eventually, the Crow decided to show off her singing voice and lost her food for the sake of vanity.

While the change of context is achieved implicitly by tricking in Example 1, in other conversations, such change can also be brought up explicitly. Different contexts of conversations may stand for different culture background, and lead to different social norms and priorities over values. Due to the disagreement between participants, in order to persuade the others, it is common that some participants try to switch the context by proposing new arguments. If they succeed in changing the context, new values may be added and every participant has to reconsider his/her priority orderings over all the values. Consequently, changes in priorities might lead to some consensus. A key problem lies in whether the audiences will adopt the proposed new context.

The current paper argues that the contextual factors are important for obtaining preferences over arguments in argumentation theory, and the alternative contexts should also be compared based on priories. Such comparison can be achieved by associating values with norms and contexts. What's more, since people argue for reaching agreements, I define a concept called *consensus* to represent the agreements achieved between participants with different priorities on values.

The remaining of this paper is structured as follows. Section 2 proposes an argumentation system that combines $ASPIC^+$ framework with contexts, values and social norms, then defines the concept of consensus. Section 3 presents some related work, while section 4 briefly concludes this paper and points out the future work.

2 An Argumentation System based on Contexts and Values

In this section I try to encode the factors influence the participants' preference orderings over the set of arguments into a formal argumentation system.

2.1 The Definition of Contexts

Within different contexts, people may have different priority orderings on values. In Example 1, when the Crow remembered she was hungry, the value of food[2] was the most important. However, she was then convinced by the Fox and shifted the context of arguments from 'hunger' to 'longing for compliments'. As a consequence, the Crow forgot the value of her food and lost the cheese for the value of vanity. In other words, in the second context, the value of food was no longer the Crow's top priority. Suppose that the Crow was wiser, she might think that vanity is far less important than satisfying her hunger and won't be shifted the context as easily as in the story.

We can see that during a dispute, a participant may implicitly or explicitly propose a new context, then the audience needs to choose whether to shift the main context of

[2] The readers may find that in this paper the concept *value* is used rather generalized. Values are like some crucial factors such as goals or desires related to particular contexts or norms, based on which the participants of a debate can give their priority orderings.

arguments based on priorities (may be an unconscious process). When the context is changed, participants' priorities over values are probably changed concurrently.

To capture these features, the current paper associates values not only to the norms applied in the argumentation, but also to the contexts of arguments. Whether a participant decides to shift the context depends on his priority orderings over values. Moreover, in each context, there is a series of norms. Each norm associated with at least one value[3]. Each side of participants hold their own priority orderings over the set of all the values in every context. The difference in priority orderings may lead to disagreement on the conclusions.

More specifically, the contexts that appear in a conversation are arranged in the order of their appearance. Each context is consisted of a particular name, a set of norms, a set of values that associated with the norms and the contexts, and a set of participants' priority orderings over the values. I use 'N' to denote the set of norms, 'V' to denote the set of values, 'P' to denote the set of different orderings over values, C_i to denote a certain context where the subscript number indicates the particular order of a context. A context is defined as follows.

Definition 1 (Context). *Let $C_i = \langle \alpha(v_\beta), N_i, V_i, P_i \rangle$ $(i = 1, 2, \ldots, n)$ be a context, where*

- *α is the notation for the name of a certain context, and v_β denotes the value β corresponding to α; each name of a context is associated with at least one value.*
- *$N_i = \{n_1(v_p), n_2(v_q), n_3(v_r), \ldots, n_k(v_x)\}$ is a set of norms, where n_j $(j = 1, 2, \ldots, k)$ is a norm, $v_p, v_q, v_r, \ldots, n_k(v_x)$ are values corresponding to the norms; each of the norms associated with at least one value. The forms of norms are: $\varphi_1, \ldots, \varphi_n \xrightarrow{v_u}$ / $\xRightarrow{v_u} \varphi$ ($\xrightarrow{v_u}$ and $\xRightarrow{v_u}$ refer to certain inferences and uncertain inferences respectively; φ_i and φ are elements in the logical language of an argumentation theory); if $i > 1$, then always let $N_{i-1} \subseteq N_i$.*
- *$V_i = \{v_\beta, v_p, v_q, v_r, \ldots, v_x\}$ is a set of all the values that appear in C_i.*
- *$P_i = \{\gtrsim_1, \gtrsim_2, \ldots, \gtrsim_n\}$ is a set of orderings over V_i in context C_i, where $\gtrsim_1, \gtrsim_2, \ldots, \gtrsim_n$ $(n \geqslant 1)$[4] are preorderings on V_i, such that: 1. $v_n \gtrsim v_m$, iff v_n is at least as preferred as v_m; 2. $v_n > v_m$, iff $v_n \gtrsim v_m$ and not $v_m \gtrsim v_n$; 3. $v_n \approx v_m$, iff $v_n \gtrsim v_m$ and $v_m \gtrsim v_n$.*

Note that according to this definition, the set of norms in a context C_i is always a union set of N_1 to N_i $(i \geqslant 1)$, so that when the context be shifted, we won't lost the norms contained in the previous contexts, as well as their associated values. Accordingly, for the set V_i, if $i > 1$, then $V_{i-1} \subseteq V_i$.

In Example 1, there are two main contexts. In the first context, the Crow and the Fox both were hungry and desiring for eating some food. For the Crow, her food is superior to the Fox's food. So when she possessed a piece of cheese, she won't open her mouth and drop it to the Fox. For the Fox, on the contrary, food for himself is superior to food for the Crow. I use '*hun*' to denote 'hungry', '*eat*' to denote 'eating', 'fc' to denote 'food of the Crow', 'ff' to denote 'food of the Fox', '*cheese*' to denote 'a piece of cheese (in the Crow's mouth)', '*open*' to denote 'open (the Crow's) mouth', the first context in the story can be modelled as follows based on Definition 1.

[3] While it's normal that some values are associated with more than one norms or contexts.

[4] n is less than or equal to the number of different sides of the participants.

Example 2 (The Fox and the Crow: Context 1).
$C_1 = \langle hun(v_{eat}), N_1, V_1, P_1\rangle$, where $N_1 = \{n_1(v_{fc}), n_2(v_{ff})\}$,
$(n_1(v_{fc}) = hun(v_{eat}), cheese \overset{v_{fc}}{\Longrightarrow} \neg open,\ n_2(v_{ff}) = hun(v_{eat}), cheese \overset{v_{ff}}{\Longrightarrow} open)$
$V_1 = \{v_{eat}, v_{fc}, v_{ff}\}$, $P_1 = \{\gtrsim_1, \gtrsim_2\}$,
the Crow's ordering 1 (according to $\gtrsim_1$) : $v_{eat} \gtrsim v_{fc} > v_{ff}$
the Fox's ordering 1 (according to $\gtrsim_2$) : $v_{eat} \gtrsim v_{ff} > v_{fc}$

2.2 A Context-based Argumentation System

The idea behind the Context-based Argumentation System (*CAS*) is that the preferences on the set of arguments can be obtained based on the orderings over the set of values. I build the argumentation system on the basis of $ASPIC^+$ framework since some principles for obtaining preference relations have already been given in its design [8]. Adopted from [8], a *CAS* can be defined as follows.

Definition 2 **(*CAS*).** *An argumentation system based on contexts is a tuple* $CAS = (\mathscr{L}, \bar{\ }, \mathscr{R}, \mathscr{C}, n)$*, where:*

- $\mathscr{L}$ *is a logical language.*
- $\bar{\ }$ *is a function from* $\mathscr{L}$ *to* $2^{\mathscr{L}}$*, such that: 1.* φ *is a contrary of* ψ *if* $\varphi \in \overline{\psi}$ *and* $\psi \notin \overline{\varphi}$*; 2.* φ *is a contradictory of* ψ *(denoted by '*$\varphi = -\psi$*'), if* $\varphi \in \overline{\psi}$ *and* $\psi \in \overline{\varphi}$ [5]*; 3. each* $\varphi \in \mathscr{L}$ *has at least one contradictory.*
- $\mathscr{R} = \mathscr{R}_s \cup \mathscr{R}_d$ *is a set of strict (*$\mathscr{R}_s$*) and defeasible (*$\mathscr{R}_d$*) inference rules of the form* $\varphi_1, \ldots, \varphi_n \overset{(v_u)}{\longrightarrow} / \overset{(v_u)}{\Longrightarrow} \varphi$ *(*$\overset{(v_u)}{\longrightarrow}$ *and* $\overset{(v_u)}{\Longrightarrow}$ *refer to strict inference rules and defeasible inference rules respectively;* φ_i, φ *are elements in* $\mathscr{L}$*);* $\mathscr{R}_s \cap \mathscr{R}_d = \emptyset$*.*
- $\mathscr{C} = \{C_1, C_2, \ldots, C_n\}$ *is a set of contexts, where* $C_i = \langle \alpha(v_\beta), N_i, V_i, P_i\rangle$ $(i = 1, 2, \ldots, n)$*, such that: 1.* $\{x(v_y) | \langle x(v_y), N_i, V_i, P_i\rangle \in \mathscr{C}\} \subseteq \mathscr{L}$ *and if* $\forall \alpha(v_\beta) \in \{x(v_y) | \langle x(v_y), N_i, V_i, P_i\rangle \in \mathscr{C}\}$*,* $\exists \alpha' \neq \alpha$ *such that* $\alpha'(v_{\beta'}) \in \{x(v_y) | \langle x(v_y), N_i, V_i, P_i\rangle \in \mathscr{C}\}$*, then* $\alpha(v_\beta) = -\alpha'(v_{\beta'})$*; 2.* $\mathscr{N}_i \subseteq \mathscr{R}_s \cup \mathscr{R}_d$*; 3.* $V_i \subseteq \mathscr{L}$*.*
- *n is a naming function such that n:* $\mathscr{R}_d \rightarrow \mathscr{L}$*.*

The definition of $\mathscr{C}$ shows that different contexts in an argumentation system are conflicting with each other. In other words, each side of the participants can only choose one main context among all the alternatives based on their priority orderings over the set of values.

As in $ASPIC^+$, arguments can be constructed from a set of premises, namely a knowledge base $\mathscr{K} \subseteq \mathscr{L}$. A tuple of an argumentation system and a knowledge base $\mathscr{K}$ is called an argumentation theory (AT) [8]. $\mathscr{K}$ is consisted of two disjoint subsets: the set of axioms ($\mathscr{K}_n$) and the set of the ordinary premises ($\mathscr{K}_p$). Let the set of the names of contexts $\{x(v_y) | \langle x(v_y), N_i, V_i, P_i\rangle \in \mathscr{C}\}$ be a subset of $\mathscr{K}_p$. Adopted from [8], I use $Prem(A)$ to denote the set of all the formulas of $\mathscr{K}$ used to build an argument A, $Conc(A)$ to denote the conclusion of A, $Sub(A)$ to denote the set of all the sub-arguments of A, $DefRule(A)$ to denote the set of all the defeasible rules of A, and $TopRule(A)$ to denote the last rule of A. An argument in a *CAS* is defined as follows.

[5] For all $\varphi \in \mathscr{L}$, we have $\neg - \varphi \in \overline{\varphi}$ and for all $\neg\varphi \in \mathscr{L}$, we have $\varphi \in \overline{\neg\varphi}$.

Definition 3 (Arguments). *An argument A on the basis of a CAS $= (\mathscr{L}, \bar{\ }, \mathscr{R}, \mathscr{C}, n)$ and a knowledge base $\mathscr{K} = \mathscr{K}_n \cup \mathscr{K}_p$ has one of the following forms:*

1. *φ, if $\varphi \in \mathscr{K}$ with: $Prem(A) = \{\varphi\}$, $Conc(A) = \varphi$, $Sub(A) = \{\varphi\}$, $DefRules(A) = \emptyset$, $TopRule(A) = undefined$.*
2. *$A_1, \ldots, A_n \xrightarrow{(v_u)} / \xRightarrow{(v_u)} \psi$, if $A_1, \ldots, A_n$ $(n \geq 1)$ are arguments, such that there exists a strict/defeasible rule $Conc(A_1), \ldots, Conc(A_n) \xrightarrow{(v_u)} / \xRightarrow{(v_u)} \psi$ in $\mathscr{R}$ with: $Prem(A) = Prem(A_1) \cup \ldots \cup Prem(A_n)$; $Conc(A) = \psi$; $Sub(A) = Sub(A_1) \cup \ldots \cup Sub(A_n) \cup \{A\}$; $DefRules(A) = DefRules(A_1) \cup \ldots \cup DefRules(A_n)$ $(\cup\{Conc(A_1), \ldots, Conc(A_n) \xRightarrow{(v_u)} \psi\})$; $TopRule(A) = Conc(A_1) \ldots Conc(A_n) \xrightarrow{(v_u)} / \xRightarrow{(v_u)} \psi$.*

Based on Definition 3, the following arguments can be constructed in the argumentation theory. Here I use a subscript '0' to indicate the argument constructed only by the specific names of contexts.

Example 3 (Example 2 continued).

$A_0 : hun(v_{eat})$	$A_1 : cheese$
$A_2 : A_0, A_1 \xRightarrow{v_{fc}} \neg open$	$A_3 : A_0, A_1 \xRightarrow{v_{ff}} open$

In *ASPIC*$^+$, three kinds of attack relations between arguments are allowed: attack on the conclusion of defeasible rules (rebutting), attack on the defeasible rules (undercutting) and attack on the ordinary premises (undermining). Based on [8], the attack relation is defined as follows.

Definition 4 (Attack).
*An argument A attacks argument B, iff A undercuts, rebuts or undermines B, where: 1. A **undercuts** B on B', iff $B' \in Sub(B)$ such that $TopRule(B') = r \in \mathscr{R}_d$ and $Conc(A) \in \overline{n(r)}$ ('$n(r)$' means that rule r is applicable); 2. A **rebuts** B on B', iff $Conc(A) \in \overline{\varphi}$ for some $B' \in Sub(B)$ of the form $B''_1, \ldots, B''_n \Rightarrow \varphi$; A contrary-rebuts B iff $Conc(A)$ is a contrary of φ. 3. A **undermines** B on B', iff $B' = \varphi$ and $\varphi \in Prem(B) \cap \mathscr{K}_p$, such that $Conc(A) \in \overline{\varphi}$; A contrary-undermines B iff $Conc(A)$ is a contrary of φ.*

According to [8], the undercutting, contrary-rebutting and contrary-undermining attacks are 'preference-independent' since these conflicts are always asymmetric. For the other kinds of attacks, whether they are succeeds as defeats depends on the preferences between arguments. Formally, it is decided by a preordering $\succeq$ on the set of all the constructed arguments in an AT: $A \succeq B$ if and only if A is at least as preferred as B; $A \succ B$ if and only if $A \succeq B$ and $B \not\succeq A$; $A \approx B$ if and only if $A \succeq B$ and $B \succeq A$. Adopted from [8], the defeat relation between arguments can be defined as follows.

Definition 5 (Defeat). *Let A, B be arguments, $B' \in Sub(B)$. A defeats B iff A preference-independently attacks B on B', or A preference-dependently attacks B on B' and $B' \not\succ A$.*

ASPIC$^+$ offers two principle (i.e. *the last link principle* and *the weakest link principle*) for 'lifting' the preference ordering $\succeq$ over arguments, which are based on the priority orderings over the sets $\mathscr{R}_d$ and $\mathscr{K}_p$. Due to space restriction, the introduction of these two principles are omitted. For further details, please refer to [8, 9]. This paper aims to obtain priority orderings over the set of premises and the set of norms based on the orderings over the set of values. For this purpose, I define a preordering $\geqslant$ based on $\gtrsim$ defined in Definition 1 as follows.

Definition 6 (Priority Ordering). *Given a* $CAS = (\mathscr{L}, \bar{\ }, \mathscr{R}, \mathscr{C}, n)$, $C_i = \langle \alpha(v_\beta), N_i, V_i, P_i \rangle$ $(i = 1, 2, \ldots, n)$ *is a context in* $\mathscr{C}$. *According to an ordering* $\gtrsim \in P_i$ *on* V_i*, such that*

- $\geqslant$ *is a preordering on* N_i*, for* $n_a(v_p), n_b(v_q) \in N_i$*: 1.* $n_a(v_p) \geqslant n_b(v_q)$*, iff* $n_a(v_p) \in \mathscr{R}_s$ *or* $v_p \gtrsim v_q$*; 2.* $n_a(v_p) > n_b(v_q)$*, iff* $n_b(v_q) \notin \mathscr{R}_s$ *and* $v_p > v_q$*; 3.* $n_a(v_p) \approx n_b(v_q)$*, iff* $v_p \approx v_q$.
- $\geqslant$ *is a preordering on* $\{x(v_y) | \langle x(v_y), N_i, V_i, P_i \rangle \in \mathscr{C}\}$*, for* $g(v_p), h(v_q) \in \{x(v_y) | \langle x(v_y), N_i, V_i, P_i \rangle \in \mathscr{C}\}$*: 1.* $g(v_p) \geqslant h(v_q)$*, iff* $g(v_p) \in \mathscr{K}_n$ *or* $v_p \gtrsim v_q$*; 2.* $g(v_p) > h(v_q)$*, iff* $h(v_q) \notin \mathscr{K}_n$ *and* $v_p > v_q$*; 3.* $g(v_p) \approx h(v_q)$*, iff* $v_p \approx v_q$.

For the evaluation of arguments, we need to construct abstract argumentation frameworks (AFs) based on the set of all the arguments constructed in the argumentation system and the set of defeat relations between arguments. According to the definitions of contexts and *CAS*, it is possible to obtain more then one AF within a context since different participants may have different orderings on the set of values[6]. Using '*CO*' to denote the set of attack (or conflict) relations, '*D*' to denote the set of defeat relations and '$\mathscr{D}$' to denote the set of *D*s in a context, an abstract argumentation framework in *CAS* can be defined as follows.

Definition 7 (Argumentation Frameworks). *Let* $CAT = (CAS, \mathscr{K})$ *be an argumentation theory in CAS, such that:*

1. *a structured argumentation framework* SAF_{C_i} *in the context* $C_i = \langle \alpha(v_\beta), N_i, V_i, P_i \rangle$ *is a tuple* $\langle \mathscr{A}_i, CO_i, \mathscr{P}_i \rangle$*, where*
   - $\mathscr{A}_i$ *is a set of arguments constructed from* $\mathscr{K}$ *based on* CAT *and* C_i*;*
   - CO_i *is the conflict relations between elements in* $\mathscr{A}_i$*;* $(A, B) \in CO_i$ *iff A attacks B according to Definition 4;*
   - $\mathscr{P}_i = \{\succcurlyeq_1, \succcurlyeq_2, \ldots, \succcurlyeq_n\}$*, where* $\succcurlyeq_j$ $(i = 1, 2, \ldots, n)$ *is a preordering on* $\mathscr{A}_i$ *lifted from the corresponding ordering* $\gtrsim_j$ *in* P_i*;*
2. *given an* $SAF_{C_i} = \langle \mathscr{A}_i, CO_i, \mathscr{P}_i \rangle$ *based on the context* C_i*, let* $\mathscr{D}_i = \{D_1, D_2, \ldots, D_n\}$*, such that* $D_1, D_2, \ldots, D_n$ *are sets of defeat relations according to* $\succcurlyeq_1, \succcurlyeq_2, \ldots, \succcurlyeq_n \in \mathscr{P}_i$ *and Definition 5.* $\mathscr{F}_{C_i} = \langle \mathscr{A}_i, \mathscr{D}_i \rangle$ *is a sequence of AFs in context* C_i*, where* $F_{C_{i-j}} = \langle \mathscr{A}_i, D_j \rangle (1 \leq j \leq n)$ *is an AF in the sequence* $\mathscr{F}_{C_i}$.

According to the above definition, how many AFs that can be obtained in a context C_i depends on how many different orderings over the set of V_i are given.

Consider Example 3, argument A_2 and A_3 are conflicting with each other according to Definition 4. Based on the Crow's ordering $\gtrsim_1$, A_2 is strictly preferred to A_3 (i.e. $A_2 \succ A_3$), while based on the Fox's ordering $\gtrsim_2$, A_3 is strictly preferred to A_2.

Fig. 1 shows the AFs based on the Crow's priority order (on the left) and the AF based on the Fox's priority order (on the right). For the sake of illustration, I label the values contained in an argument alongside it.

[6] Therefore, they may have different preferences on arguments, which will lead to different defeat relations.

$$\begin{tikzcd}
A_0(v_{eat}) & A_2(v_{eat}, v_{fc}) \arrow[d] \\
A_1 & A_3(v_{eat}, v_{ff})
\end{tikzcd}
\qquad
\begin{tikzcd}
A_0(v_{eat}) & A_2(v_{eat}, v_{fc}) \\
A_1 & A_3(v_{eat}, v_{ff}) \arrow[u]
\end{tikzcd}$$

Fig. 1. AFs for Context 1 of the running example

Arguments in an AF are evaluated based on *argumentation semantics* [4]. Several classical argumentation semantics has been given in [4], the current paper takes the preferred extensions as an example, since the preferred semantics enables us to get the maximal credulously acceptable set of arguments. A set of arguments that can be collectively accepted under certain argumentation semantics is called an extension.

Given an argumentation framework $F = \langle \mathscr{A}, D \rangle$, for $E \subseteq \mathscr{A}$, we say: E is *conflict-free* if and only if $\nexists A, B \in E$ such that $(A, B) \in D$; $A \in \mathscr{A}$ is defended by E if and only if $\forall B \in \mathscr{A}$ if $(B, A) \in D$, there $\exists C \in E$ such that $(C, B) \in D$; E is *admissible* if and only if E is conflict-free, and each argument in $E \subseteq \mathscr{A}$ is defended by E; E is a *preferred extension* if and only if E is the maximal (w.r.t. set-inclusion) admissible set [4].

According to Fig. 1, we can get one preferred extension $\{A_0, A_1, A_2\}$ based on the AF on the left side, which reflects the Crow's preferences over arguments; we can get another preferred extension extension $\{A_0, A_1, A_3\}$ based on the AF on the right side, which reflects the Fox's preferences over arguments. It can be seen that in the running example, the reason the Fox and the Crow can not reach an agreement in the first context is that they have different priority orderings on the set of values, which causes different preferences on arguments and eventually leads to different extensions of arguments and conclusions.

2.3 The Consensus

In this subsection I define the concept *consensus* and illustrate the ideas behind it through the running example. According to Example 1, in the second context proposed by the Fox, the Crow was longing for compliments because of vanity, so she chose to open her mouth for showing off her singing voice and forgot her desire for eating. Meanwhile, the Fox still thought eating is the most important. Let '*lc*' denotes '(the Crow is) longing for compliments', '*van*' denotes 'vanity', '*so*' denotes 'showing off', '*voi*' denotes '(the Crow's) singing voice', '*sing*' denotes 'singing for the Fox', the second context in the story can be modelled as follows.

Example 4 (The Fox and the Crow: Context 2).
$C_2 = \langle lc(v_{van}), N_2, V_2, P_2 \rangle$, where $N_2 = \{n_1(v_{fc}), n_2(v_{ff}), n_3(v_{so})\}$,
$(n_1(v_{fc}) = hun(v_{eat}), cheese \overset{v_{fc}}{\Longrightarrow} \neg open$, $n_2(v_{ff}) = hun(v_{eat}), cheese \overset{v_{ff}}{\Longrightarrow} open$,
$n_3(v_{so}) = lc(v_{van}), voi \overset{v_{so}}{\Longrightarrow} sing)$
$V_2 = \{v_{eat}, v_{fc}, v_{ff}, v_{van}, v_{so}\}$, $P_2 = \{\gtrsim'_1, \gtrsim'_2\}$
the Crow's ordering 2 (according to $\gtrsim'_1$) : $v_{van} \gtrsim v_{so} > v_{eat} \gtrsim v_{fc} > v_{ff}$
the Fox's ordering 2 (according to $\gtrsim'_2$) : $v_{van} \approx v_{so} \approx v_{eat} \gtrsim v_{ff} > v_{fc}$

Moreover, a strict rule '$sing \rightarrow open$' and a transposition[7] of this rule '$\neg open \rightarrow \neg sing$' are added into the argumentation theory. Thus with respect to context 2 of the story, the following arguments can be constructed.

$A_0 : hun(v_{eat})$	$A_1 : cheese$	$A_2 : A_0, A_1 \overset{v_{fc}}{\Longrightarrow} \neg open$
$A_3 : A_0, A_1 \overset{v_{ff}}{\Longrightarrow} open$	$B_0 : lc(v_{van})$	$B_1 : voi$
$B_2 : B_0, B_1 \overset{v_{so}}{\Longrightarrow} sing$	$B_3 : B_2 \rightarrow open$	$B_4 : A_2 \rightarrow \neg sing$

According to Example 4, we can obtain an AF based on the Crow's preferences as showed in Fig. 2, and an AF based on the Fox's preferences as showed in Fig. 3.

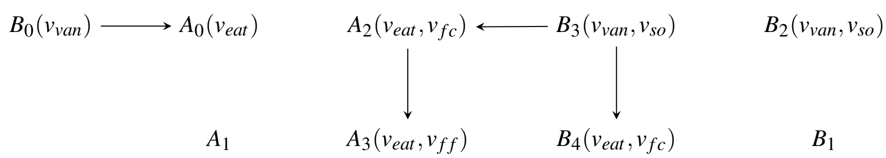

Fig. 2. AF for the Crow in Context 2 of the running example

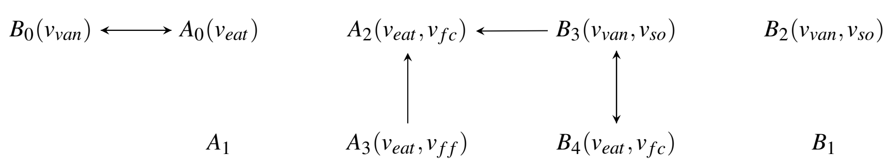

Fig. 3. AF for the Fox in Context 2 of the running example

Based on the AF in Fig. 2, we can get one preferred extension $\{A_1, A_3, B_0, B_1, B_2, B_3\}$, while based on the AF in Fig. 3, we can get the following four preferred extensions: $\{A_1, A_3, B_0, B_1, B_2, B_3\}$, $\{A_1, A_3, B_0, B_1, B_2, B_4\}$, $\{A_0, A_1, A_3, B_1, B_2, B_3\}$, $\{A_0, A_1, A_3, B_1, B_2, B_4\}$. It can be observed that now the Crow and the Fox have got one identical preferred extension $\{A_1, A_3, B_0, B_1, B_2, B_3\}$, and the corresponding conclusions are 'a piece of cheese in the Crow's mouth', 'open the Crow's mouth', 'the Crow is longing for compliments', 'the Crow's singing voice', 'singing for the Fox'. These conclusions together can be seen as an agreement the Crow and the Fox had reached in the story, which lasted until the Crow found that she was fooled.

I define a concept called *consensus* to indicate the agreements in a *CAS*. The intuition behind this concept is that in a multi-participant argumentation, if there is an extension of arguments in a context that can be accepted by at least two sides of participants with different priorities on values, then this extension can be regarded as a

[7] In $ASPIC^+$, the set of strict rules should be closed under transposition/contraposition.

consensus among these participants. Based on this intuition, a consensus is defined on the basis of argumentation semantics. Let $\mathscr{E}_{\mathscr{S}}$ denotes a set of extensions under certain argumentation semantics $\mathscr{S}$, a consensus based on $\mathscr{S}$ is defined as follows.

Definition 8 ($\mathscr{S}$-consensus). *Given a CAT, $\mathscr{A}_i$ is all the arguments that can be constructed in a context $C_i = \langle \alpha(v_\beta), N_i, V_i, P_i \rangle$, while $\mathscr{F}_{C_i} = \langle \mathscr{A}_i, \mathscr{D}_i \rangle$ is a corresponding sequence of AFs. Let $F_{C_{i-j}}$ and $F_{C_{i-k}}$ be two AFs in the sequence, if $\exists E_1, E_2 \subseteq \mathscr{A}_i$, $E_1 \in \mathscr{E}_{\mathscr{S} i-j}$ and $E_2 \in \mathscr{E}_{\mathscr{S} i-k}$, such that either $E_1 \subseteq E_2$ or $E_2 \subseteq E_1$, then both E_1 and E_2 are $\mathscr{S}$-consensus among participants who give the ordering $\gtrsim_j$ and $\gtrsim_k$.*

3 Related Works

There are some works considered contexts based on other structured argumentation systems. For example, based on the Assumption-based Argumentation frameworks (ABA), Zeng et al. presented an approach for making context-based and explainable decisions in paper [15]. Besides, based on Defeasible Logic Programming (DeLP), Teze and Gottifredi et al. [14] provided an approach to specify a context-adaptable selection mechanism that allows to select and use the most appropriate argument comparison criterion based on user's preferences. Moreover, in paper [13] Teze and Godo et al. present a framework that allows the design of recommender systems capable of handling queries that can include contextual information. However, in these work values are not involved.

In paper [3] Bench-Capon proposed a Value Based Argumentation Frameworks (VAF), which extended the abstract AFs by relating arguments to the values they promotes, and allowing these values to be ranked reflecting the preferences of the audiences. It defined objective acceptable and subjective acceptable arguments according to value relevance. What's more, this work points out that a dispute is resoluble (i.e. a consensus can be constructed) only if there is an unique preferred extension.

Compared with the current paper, except for the different technical tools applied, none of the above mentioned works focuses on the changeability of contexts in disputes.

As for the notion of consensus, paper [10] designed a mechanism to calculate the consensus for decision making using argumentation, which took the strength of arguments into account, while the current paper proposes a qualitative definition of consensus based on the existing argumentation semantics.

4 Conclusions and Future work

In this paper I propose a context-based argumentation system called *CAS*, which takes the changeability of contexts in conversations into account. The system encodes the participants' preferences by giving orderings over the set of all the values associated with contexts and norms respectively. What's more, this paper defines a concept called *consensus* based on the existing argumentation semantics to reflect the agreements reached among different participants.

CAS is built based on *ASPIC*$^+$ frameworks. One main reason is that *ASPIC*$^+$ has offered some principles for preferences lifting. Moreover, *ASPIC*$^+$ provides more flexible choices for modelling nature language argumentation, since it allows users to model more types of attack relations and supports both credulous and skeptical reasoning.

Due to space constraints, the properties of the proposed argumentation system are not discussed. I'd like to explore and summarize the features associated with the *CAS* in future research.

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