Mechanism Design for Argumentation-based Information-seeking and Inquiry

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Abstract. Formal argumentation-based dialogue systems have attracted considerable research interest in the past. Most research in this area introduce "dialectical wrappers" over argumentation formalisms to model verbal interactions amongst agents, resulting in different dialogue models for different types of dialogues, e.g. inquiry or persuasion. In this work, we take a different approach by deploying a single dialogue model for different types of dialogues, focusing in particular on *information-seeking* and *inquiry*, yet equipping agents with different (game-theoretic) strategies and different utility functions in different dialogue types. We prove that the resulting dialogue-based mechanisms implement, in dominant strategies, appropriate social choice functions for the two types of dialogues we consider. Thus, we show the feasibility of studying agents in argumentation-based dialogues in game-theoretic, mechanism design terms.

1 Introduction

Formal argumentation-based dialogue systems have attracted considerable research interest in the past, e.g. see [11, 2, 9, 7]. Work in this area predominantly introduces dialogue protocols connecting dialectical concepts, e.g. utterances and successful dialogues, with argumentation concepts, e.g. arguments and argumentation semantics. Most such existing dialogue models are built for specific types of dialogues, e.g. [11] is built for persuasion and [2] is built for inquiry. In this work, we obtain models for two types of dialogues, i.e. *information-seeking* and *inquiry*, by adapting an existing, generic dialogue model [4, 7], based on Assumption-based Argumentation (ABA) [3, 12] as the underlying argumentation formalism. This dialogue model is generic in that it is neutral as to which type of dialogues it is applied to. We provide suitable instantiations of this generic model by studying agent strategic behaviours, in two specific types of dialogues we consider.

We view dialogues as games and utterances as actions in these games; agents in different dialogues have different utility profiles and thus choose different actions. Following Walton and Krabbe's characterisation of information-seeking and inquiry dialogues in [13], summarised in Table 1, in these dialogue types, agents can thus be understood as having different objectives, corresponding to different utility profiles, and need to determine the appropriate information to disclose within the utterances they make.

By using the dialogue model of [4, 7] we choose ABA as the underlying argumentation formalism. ABA is suitable for our proposed model of information-seeking and inquiry dialogues as it allows sub-argument level modelling of agents' knowledge: as we

Table 1. Information-seeking and inquiry dialogues (from [13]).

	Information-seeking	**Inquiry Dialogue**
Initial Situation:	Personal ignorance	General ignorance
Main Goal:	Spreading knowledge	Growth of knowledge & agreement
Participant's Aims:	Gain, show or hide knowledge	Find a "proof" or destroy one

illustrate later, agents are thus able to jointly construct arguments via dialogues. Other forms of structured argumentation, e.g. ASPIC+ [10], would also serve this purpose. We use ABA because it underpins our chosen dialogue model [4, 7]. Main building blocks of this dialogue model include *legal-move functions*, defining dialogue protocols, and *strategy-move functions*, defining agent behaviours.

The challenge of this work is twofold. Firstly, in order to study dialogues using game theoretic concepts, we need to map dialogue notions into game notions. It is expected that such a mapping is systematic in the sense that dialogues of different types share a common ground, i.e. generic dialogue models can be mapped to "generic game models". Secondly, to properly model agents in different types of dialogues, different agent utilities need to be defined. The defined utilities need to reflect agents behaviours in these dialogues. We overcome both challenges in this work.

The main contribution of this work is to prove that the game-theoretic analysis we provide results in mechanisms that implement dominant strategies, in a mechanism-design sense [8]. This means that rational agents engaged in these types of dialogues will truthfully disclose information leading to a successful outcomes of these dialogues.

2 Background & Preliminaries

In addition to the standard ABA framework definition given in [3], we use the *related* and *rule-related* notions defined in [5].

Agents have private beliefs in some internal representation. When they interact dialectically they exchange information in a shared language. We assume that this language is that of ABA, namely agents exchange rules, assumptions and their contraries, expressed in some shared underlying logical language $\mathcal{L}$. Thus, agents can be thought of as being equipped with ABA frameworks. We will often use the ABA framework an agent is equipped with to denote the agent itself. We will focus on the case of two agents, $\alpha = \langle \mathcal{L}, \mathcal{R}_1, \mathcal{A}_1, \mathcal{C}_1 \rangle$ and $\beta = \langle \mathcal{L}, \mathcal{R}_2, \mathcal{A}_2, \mathcal{C}_2 \rangle$. The *joint framework* (of α and β) is $\mathcal{F}_J = \alpha \uplus \beta = \langle \mathcal{L}, \mathcal{R}_1 \cup \mathcal{R}_2, \mathcal{A}_1 \cup \mathcal{A}_2, C_J \rangle$, where $\mathcal{C}_J(\alpha) = \mathcal{C}_1(\alpha) \cup \mathcal{C}_2(\alpha)$, for all α in $\mathcal{A}_1 \cup \mathcal{A}_2$.[1] We will assume that α, β and $\alpha \uplus \beta$ are flat, in line with [3]. Intuitively, $\mathcal{F}_J = \alpha \uplus \beta$ amounts to the beliefs that the two agents would hold collectively, if they were prepared to disclose them truthfully.

We use ABA dialogues given in [4, 7], with notions including *legal-move functions*. To generate dialogues fulfilling agents' aims, *strategy-move* functions [5] are used. A *strategy-move function* for agent x is a mapping $\phi : \mathcal{D} \times \Lambda \mapsto 2^{\mathcal{U}^x}$ ($\mathcal{D}$ denotes the set of all dialogues; Λ denotes the set of all legal-move functions; $\mathcal{U}^x$ denotes all possible utterances from x), such that, given $\lambda \in \Lambda$ and $\delta \in \mathcal{D}$: $\phi(\delta, \lambda) \subseteq \lambda(\delta)$. Given a

[1] We assume that $\mathcal{C}_i(\alpha) = \{\}$ if $\alpha \notin \mathcal{A}_i$, for $i = 1, 2$.

dialogue $\delta = \langle u_1, \ldots, u_n \rangle$ between agents x, y compatible with a legal-move function λ and a strategy-move function ϕ for x, if for all utterances u_m made by x, $u_m \in \phi(\langle u_1, \ldots, u_{m-1} \rangle, \lambda)$, then x *uses* ϕ in δ. If x and y both use ϕ, then δ is *constructed with* ϕ.

There are three particular strategy-move functions we use in this work: *thorough (ϕ_h)*, *non-attack thorough (ϕ_{nh})* and *pass (ϕ_p)* strategy-move functions [5]. Informally:

– A dialogue constructed with ϕ_h contains all information that is relevant to the topic from both agents. Dialogues constructed with ϕ_h have the desirable property that admissible arguments obtained in the dialogue are admissible in the joint ABA framework of the two agents (see Theorem 1 in [5]).
– Agents using ϕ_{nh} utter all rules, and assumptions but not contraries that are related to some utterance in the dialogue.
– Agents using ϕ_p make the claim and utter no rule, assumption or contrary in the dialogue.

We use standard *Mechanism Design* (e.g. see [8]) notions including *type, outcome, social choice function, strategy*, and *dominance*. To study agent behaviours in a framework of games, we map dialogue notions into game-theoretic notions, as follows.

Definition 1. *[6] The* types *for agents α, β are $\theta_\alpha = \alpha$ and $\theta_\beta = \beta$.*

In ABA dialogues, we view utterances as agents' actions, as follows.

Definition 2. *[6] The* action spaces *for agent $x \in \{\alpha, \beta\}$ is $2^{\mathcal{U}^x}$.*

We define the *dialogue strategy* for an agent x as the set of utterances made by x in a dialogue.

Definition 3. *[6] Given a dialogue $\mathcal{D}^{\beta}_{\alpha}(\chi) = \delta$, the* dialogue strategy s^δ_x for agent $x \in \{\alpha, \beta\}$ *with respect to δ is such that $s^\delta_x(\theta_x, \delta) = \{u | u = \langle x, \_, \_, \_, \_ \rangle \in \delta\}$.*

Since s^δ_x returns the set of utterances made by x in δ, which is determined by the strategy-move function ϕ used by x, we can thus equate a dialogue strategy used by an agent with the strategy-move function used by this agent in this dialogue.

Given a dialogue δ, the ABA framework drawn from δ captures all information disclosed by both agents in δ. Thus, we let the game-theoretic outcome be the ABA framework drawn from a dialogue, formally:

Definition 4. *[6] The* outcomes *are $\mathcal{O} = \{\mathcal{F} | \mathcal{F} \in \mathcal{AF}(\mathcal{L})$ and $\mathcal{F} = \mathcal{F}_\delta$ for some $\delta \in \mathcal{D}\}$.*

The *outcome function* maps agent actions to outcomes as follows.

Definition 5. *[6] The* outcome function *for $\sigma_1 \in \Sigma_1, \sigma_2 \in \Sigma_2$ is: $g(\sigma_1, \sigma_2) = \sigma_1 \uplus \sigma_2$.*

Note that notions given in this section are generic and do not depend on the types of dialogues agents are engaged in. These notions serve as the common ground for both information-seeking and inquiry dialogues, introduced in the next two sections.

We will illustrate notions/results in the context of the following example (used in [5]), adapted from the movie *Twelve Angry Men*, an example of argumentative reasoning [1]. We focus on the reasoning of two jurors: juror 8, played by Henry Fonda (α), and juror 9, played by Joseph Sweeney (β). These agents need to decide whether to condemn a boy, accused of murder, or acquit him, after a trial where two witnesses have provided evidence against the boy. According to the law, the jurors should acquit the boy if they do not believe that the trial has proven him guilty convincingly.

Example 1. Table 2 gives the ABA frameworks of α and β (as indicated in the rightmost column) as well as their joint framework $\mathcal{F}_J$ (given by the entire leftmost column). The components of these ABA frameworks should be self-explanatory. For example, the first rule says that the boy should be deemed to be innocent if it cannot be proven guilty. This can be assumed (as boy_not_proven_guilty $\in \mathcal{A}_1 = \mathcal{A}_2 = \mathcal{A}_J$) but can be objected to, by proving its contrary (boy_proven_guilty). The second and third rules provide ways to prove this contrary, and they rely upon assumptions in turn, etc.

Table 2. ABA frameworks for Example 1. $\mathcal{L}$ is implicit here and in all examples as it contains all sentences in rules, assumptions, and contraries.

Rules: ($\mathcal{R}_J$)	
boy_innocent $\leftarrow$ boy_not_proven_guilty	α, β
boy_proven_guilty $\leftarrow$ w1_is_believable	α, β
boy_proven_guilty $\leftarrow$ w2_is_believable	α, β
w1_not_believable $\leftarrow$ w1_contradicted_by_w2	α
w1_contradicted_by_w2 $\leftarrow$	α
w2_not_believable $\leftarrow$ w2_has_poor_eyesight	α
w2_has_poor_eyesight $\leftarrow$	β
w2_is_blond $\leftarrow$	β
w1_is_poor $\leftarrow$	β
Assumptions: ($\mathcal{A}_J$)	
boy_not_proven_guilty	α, β
w1_is_believable	α, β
w2_is_believable	α, β
Contraries: ($\mathcal{C}_J$)	
$\mathcal{C}$(boy_not_proven_guilty) = {boy_proven_guilty}	α, β
$\mathcal{C}$(w1_is_believable) = {w1_is_not_believable}	α, β
$\mathcal{C}$(w2_is_believable) = {w2_is_not_believable}	α, β

3 Information Seeking Dialogues

Following [5], we model information-seeking dialogues as engaging a *questioner* agent α posing a topic, χ, and an *answerer* agent β uttering information of relevance to χ. The purpose is to spread knowledge about arguments for χ. We assume that the questioner contributes no information, apart from initiating the dialogue; and the answerer is interested in conveying information *for* χ, but not *against*. In ABA terms, the initial situation is that some $A \vdash \chi$ in β which is not in α; and the main goal is to find δ such that all $A \vdash \chi$ in β are in $\mathcal{F}_\delta$.

Example 2. (Example 1 continued.) An information-seeking dialogue is shown in Table 3, in which the questioner queries about $w1\_not\_believable$.

Table 3. Information-seeking dialogue for the two agents in example 1.

$\langle \beta, \alpha, 0, claim(w1\_not\_believable), 1 \rangle$
$\langle \alpha, \beta, 1, rl(w1\_not\_believable \leftarrow w1\_contradicted\_by\_w2), 2 \rangle$
$\langle \alpha, \beta, 2, rl(w1\_contradicted\_by\_w2 \leftarrow), 3 \rangle$

In this example β is the questioner and α is the answerer. Note that here all rules used are known to the answerer only. The (game-theoretic) outcome of this dialogue is the framework $\mathcal{F}_\delta = \langle \mathcal{L}, \mathcal{R}_\delta, \mathcal{A}_\delta, \mathcal{C}_\delta \rangle$, in which:
$\mathcal{R}_\delta = \{w1\_not\_believable \leftarrow w1\_contradicted\_by\_w2,$
$w1\_contradicted\_by\_w2 \leftarrow\}$;
$\mathcal{A}_\delta = \{\}$; for all $a \in \mathcal{A}_\delta$, $\mathcal{C}(a) = \{\}$.

The instantiation of the mechanism design paradigm to dialogue types requires the definition of suitable utility functions, matching the motivations of agents engaged in the dialogues. In the case of information-seeking, the questioner agent can be deemed to be solely interested in posing the question, whereas the answerer agent is interested in disclosing any argument for the claim in question. This leads to the following definition of information-seeking utilities:

Definition 6. *Given an outcome* $\mathcal{F}_\delta = \langle \mathcal{L}, \mathcal{R}_\delta, \mathcal{A}_\delta, \mathcal{C}_\delta \rangle$ *drawn from* $\delta = \mathcal{D}^\alpha_\beta(\chi)$*, the* information-seeking utilities *of agents* α *and* $\beta = \langle \mathcal{L}, \mathcal{R}_\beta, \mathcal{A}_\beta, \mathcal{C}_\beta \rangle$ *are*

- $v_\alpha(\delta, \alpha) = \begin{cases} 1 & \text{if } \chi \in \mathcal{L}; \\ 0 & \text{otherwise.} \end{cases}$
- $v_\beta(\delta, \beta) = -|U_1| - |U_2|$ *where*[2]
  - $U_1 = \{u \in \mathcal{R}_\beta \cup \mathcal{A}_\beta |$ *there is some* $v \in \mathcal{R}_\delta$ *such that* u *is related to* v *or* χ *but* u *is not in* $\mathcal{F}_\delta\}$*; and*
  - $U_2 = \{u | u$ *is in* $\mathcal{F}_\delta$ *but not in* $\beta\}$.

In the remainder of this section, agents are equipped with information-seeking utilities v_α and v_β as in Definition 6.

The following theorem sanctions that for agents with information-seeking utilities, ϕ_p is the dominant strategy for the questioner agent; and ϕ_{nh} is the dominant strategy for the answerer agent.

Theorem 1. *Given* $\mathcal{D}^\alpha_\beta(\chi) = \delta$*, if* δ *is constructed with* α *using* ϕ_p *and* β *using* ϕ_{nh}*, then the dialogue strategy* s^δ *is dominant.*

We define the social choice function for Information-seeking (IS) as follows:

Definition 7. *The* IS social choice function *is:* $f_{is}(\theta_\alpha, \theta_\beta) = \langle \mathcal{L}, \mathcal{R}_f, \mathcal{A}_f, \mathcal{C}_f \rangle$*, in which:*

- $\mathcal{R}_f = \{\rho \in \theta_\beta | \rho$ *is rule-related to* χ *in* $\theta_\beta\}$*;*

[2] Given a set S, $|S|$ denotes the cardinality of S.

– $\mathcal{A}_f = \{a \in \theta_\beta | a$ *is rule-related to* χ *in* $\theta_\beta\}$*;*
– $\mathcal{C}_f(a) = \{\}$ *for all* $a \in \mathcal{A}_f$.

The intuition of Definition 7 is that the "common good" for both agents in information-seeking can be viewed as the answerer agents putting forward all arguments for the claim in question but nothing else. So truthful information is passed from the answerer agent to the questioner agent.

The next theorem sanctions that the questioner agent using ϕ_p and the answerer agent using ϕ_{nh} not only maximise their own utilities, but also meet the common good.

Theorem 2. *Given* $\mathcal{D}^\alpha_\beta(\chi) = \delta$*, if* δ *is constructed with* α *using* ϕ_p *and* β *using* ϕ_{nh}*, then the mechanism* $\mathcal{M} = (\Sigma, s^\delta)$ implements *the IS social choice function* f_{is}.

4 Inquiry Dialogues

The specification of inquiry dialogues seen in Table 1 lends itself to several argumentation-based interpretations. In [5] , we consider two such interpretations and accordingly formulate inquiry dialogue in two ways, in I-Type I dialogues, the initial situation is that it is uncertain if χ is admissible in $\mathcal{F}_J$; the main goal is that testing the admissibility of χ in $\mathcal{F}_J$; and in I-Type II dialogues; the initial situation is that there is no argument $A \vdash \chi$ in either α or β; and the main goal is that testing whether $A \vdash \chi$ is in $\mathcal{F}_J$.

Example 3. An I-Type inquiry dialogue is shown in Table 4[3]. Here, we can see that the (game theoretic) outcome $\mathcal{F}_\delta$ is the joint framework of the two agents F_J (Table 2).

Table 4. Inquiry dialogue for the two agents in example 1.

$\langle \alpha, \beta, 0, claim(boy\_innocent), 1\rangle$
$\langle \beta, \alpha, 1, rl(boy\_innocent \leftarrow boy\_not\_proven\_guilty), 2\rangle$
$\langle \alpha, \beta, 2, asm(boy\_not\_proven\_guilty), 3\rangle$
$\langle \beta, \alpha, 3, ctr(boy\_not\_proven\_guilty, guilty), 4\rangle$
$\langle \alpha, \beta, 4, rl(guilty \leftarrow W1), 5\rangle$
$\langle \beta, \alpha, 5, asm(W1), 6\rangle$
$\langle \alpha, \beta, 6, ctr(W1, not\_W1), 7\rangle$
$\langle \alpha, \beta, 7, rl(not\_W1 \leftarrow contradicted), 8\rangle$
$\langle \alpha, \beta, 8, rl(contradicted \leftarrow), 9\rangle$
$\langle \beta, \alpha, 4, rl(guilty \leftarrow W2), 10\rangle$
$\langle \alpha, \beta, 10, asm(W2), 11\rangle$
$\langle \beta, \alpha, 11, ctr(W2, not\_W2), 12\rangle$
$\langle \alpha, \beta, 12, rl(not\_W2 \leftarrow W2\_has\_poor\_eyesight), 13\rangle$
$\langle \beta, \alpha, 13, rl(W2\_has\_poor\_eyesight \leftarrow), 14\rangle$

The utility functions of agents engaged in I-TYPE I dialogues is defined as follows:

[3] Here, guilty, W1, not_W1, contradicted, W2, not_W2 are shorthand for boy_proven_guilty, w1_is_believable, w1_not_believable, w1_contradicted_by_w2, w2_is_believable, w2_not_believable, respectively.

Definition 8. *Given an outcome* $\mathcal{F}_\delta = \langle \mathcal{L}, \mathcal{R}_\delta, \mathcal{A}_\delta, \mathcal{C}_\delta \rangle$ *drawn from some* δ*, the* I-Type I utility *of agent* $x = \langle \mathcal{L}, \mathcal{R}_x, \mathcal{A}_x, \mathcal{C}_x \rangle$ *is* $v_x(\mathcal{F}_\delta, x) = -|U_1| - |U_2|$ *where*

- $U_1 = \{u \in \mathcal{R}_x \cup \mathcal{A}_x \cup \mathcal{C}_x|$ *there is some* $v \in \mathcal{R}_\delta \cup \mathcal{A}_\delta \cup \mathcal{C}_\delta$ *such that* u *is related to* v *but* u *is not in* $\mathcal{F}_\delta\}$*; and*
- $U_2 = \{u|u$ *is in* $\mathcal{F}_\delta$ *but not in* $x\}$.

In the remainder of this section, until Definition 10, agents are equipped with I-Type I utilities v_α and v_β as in Definition 8. Intuitively, this definition of I-Type I utility reflects that agents engaged in this type of dialogues are interested in finding out the acceptability of the claim in question, with respect to the joint knowledge. The following result identifies agent strategy functions that are dominant for agents with I-Type I utility functions.

Theorem 3. *Given* $\mathcal{D}^\alpha_\beta(\chi) = \delta$*, if* δ *is constructed with* ϕ_h*, then the dialogue strategy* s^δ *is dominant.*

In order to characterise the common good for agents in I-Type I dialogues, we define the following social choice function for I-Type I:

Definition 9. *Let* $\mathcal{F}_J = \theta_\alpha \uplus \theta_\beta$*. The* I-Type I social choice function *is:* $f_{i1}(\theta_\alpha, \theta_\beta) = \langle \mathcal{L}, \mathcal{R}_{i1}, \mathcal{A}_{i1}, \mathcal{C}_{i1} \rangle$*, in which:*

- $\mathcal{R}_{i1} = \{\rho \in \mathcal{F}_J | \rho$ *is related to* χ *in* $\mathcal{F}_J\}$*;*
- $\mathcal{A}_{i1} = \{a \in \mathcal{F}_J | a$ *is related to* χ *in* $\mathcal{F}_J\}$*;*
- $\mathcal{C}_{i1}(a) = \mathcal{C}_J(a)$ *for all* $a \in \mathcal{A}_{i1}$.

The intuition of Definition 9 is that we view the common good for agents in I-Type I dialogues is that the acceptability of the claim in question is thoroughly examined with respect to the joint knowledge held by both agents. Thus any information related to the claim in question in one agent's internal knowledge base must be disclosed. The following theorem sanctions that dialogues constructed with ϕ_h meet this common good.

Theorem 4. *Given* $\mathcal{D}^\alpha_\beta(\chi) = \delta$*, if* δ *is constructed with* ϕ_h*, then the mechanism* $\mathcal{M} = (\Sigma, s^\delta)$ implements *the I Type-I social choice function.*

By altering the utility functions, we can model agents' behaviour in I-Type II agents too, as follows. Since agents in I-Type II aim at jointly finding all arguments for the claim in question, there is no need for them to utter contaries that may lead to arguments attacking the claim.

Definition 10. *Given an outcome* $\mathcal{F}_\delta$ *drawn from some I-Type II dialogue* $\delta = \mathcal{D}^\alpha_\beta(\chi)$*, the* utility *of agent* $x = \langle \mathcal{L}, \mathcal{R}_x, \mathcal{A}_x, \mathcal{C}_x \rangle$ *is* $v_x(\delta, x) = -|U_1| - |U_2|$ *where*

- $U_1 = \{u|u \in \mathcal{R}_x \cup \mathcal{A}_x$ *such that* u *is rule-related to* χ *but* u *is not in* $\mathcal{F}_\delta\}$*; and*
- $U_2 = \{u|u$ *is in* $\mathcal{F}_\delta$ *but not in* $x\}$.

In the remainder of this section agents are equipped with utilities v_α and v_β as in Definition 10. Similarly to Theorem 3, the following theorem sanctions that ϕ_{nh} is a dominant strategy for both agents in I-Type II dialogues.

Theorem 5. *Given $\mathcal{D}^{\alpha}_{\beta}(\chi) = \delta$, if δ is constructed with ϕ_{nh}, then the dialogue strategy s^{δ} is dominant.*

Similarly to the case of I-Type I dialogues, we define the social choice function for I-Type II dialogues as follows. The common good for agents in I-Type II is on finding all rules and assumptions that form arguments for the claim.

Definition 11. *Let $\mathcal{F}_J = \theta_\alpha \uplus \theta_\beta = \langle \mathcal{L}, \mathcal{R}_J, \mathcal{A}_J, \mathcal{C}_J \rangle$. The* I-Type II social choice function *is: $f_{i2}(\theta_\alpha, \theta_\beta) = \langle \mathcal{L}, \mathcal{R}_{i2}, \mathcal{A}_{i2}, \mathcal{C}_{i2} \rangle$, in which:*

- $\mathcal{R}_{i2} = \{\rho \in \mathcal{R}_J | \rho$ *is rule-related to* χ *in* $\mathcal{F}_J\}$;
- $\mathcal{A}_{i2} = \{a \in \mathcal{F}_J | a$ *is rule-related to* χ *in* $\mathcal{F}_J\}$;
- $\mathcal{C}_{i2}(a) = \{\}$ *for all* $a \in \mathcal{A}_{i2}$.

Dialogues construct with ϕ_{nh} meet the common good for both agents.

Theorem 6. *Given $\mathcal{D}^{\alpha}_{\beta}(\chi) = \delta$, if δ is constructed with ϕ_{nh}, the mechanism $\mathcal{M} = (\Sigma, s^{\delta})$* implements *the I Type-II social choice function f_{i2}.*

5 Conclusions

Formal argumentation-based dialogue systems have attracted considerable research interest in the past, e.g. see [11, 2, 9, 7]. Different protocols were proposed to model agents in different types of dialogues. Less work has been devoted to understanding agents' strategic behaviours in dialogues. In this work, we study the modelling of information-seeking and inquiry dialogues with game theoretical notions. Continuing our previous work in modelling agents' interests, strategies and actions in persuasion dialogues, we show that a generic correspondence between dialectical concepts and game notions can be established. Thus, this works links argumentation-based dialogues with games. We establish a natural equivalence between agents' dialectical strategies and their game theoretical strategies.

One of the main observation of this work is that by analysing two different types of dialogues, we establish some common ground for modelling dialogues with game-theoretic notions and recognise that altering agents' utility profiles alone is sufficient for modelling different agent behaviours in different types of dialogues. With this setting, we can also look at agent behaviours in a mechanism design perspective in which certain social choices are fulfilled, naturally corresponding to the aims of the dialogues.

We believe that the utility functions we have defined are natural. In any case, in the future, we would like to explore other utility settings for information-seeking and inquiry dialogues and and study game theoretical modelling of other types of dialogues, including deliberation and negotiation.

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