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Deliverable 2.1
Technical report on new models dealing with the properties of interest in a PIC context

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Abstract
This document presents the main results of the Work Package 2 of the PRIN 2022 project EPICA. In particular, it reports on the new models that have been defined to deal with the properties of interest in a PIC context and it presents the scientific publications where the models have been proposed.

1 Introduction

This document is the Deliverable 2.1 *Technical report and scientific publications describing new models dealing with the properties of interest in a PIC context*[1] of the PRIN 2022 project Empowering Public Interest Communica-

[1]This deliverable is subject to changes in the event that errors or omissions are detected after its release.

tion with Argumentation (EPICA), funded by European Union – Next Generation EU - Mission 4 “Education and Research” component C2 - investment 1.1 (CUP D53D23008860006).

This deliverable is the main outcome of the Work Package 2 “Formal modelling” of the EPICA project and reports on the research activity we performed aiming at achieving theoretical and methodological advancements in CA. In particular, we defined original models and properties useful to capture and analyze crucial aspects of institutional PIC, focusing on characterizing the concept of *strenght* of arguments and sets of arguments.

In fact, since the introduction of the Abstract Argumentation Framework (AAF) [3], several efforts have been made in the past in the direction of taking into account the ‘strength’ of the arguments of the dispute. In particular, in *Preference-based argumentation framework* (PAF) [2], the fact that some arguments are perceived as stronger than others by the audience to which the arguments are addressed is encoded with a set of preferences, whose effect on the reasoning is the deactivation of any attack where the attacked is preferred to the attacker. Then, in Bench-Capon’s value-based approach (*Value-based Argumentation Frameworks* - VAFs) [1], the difference in strength between the arguments is modeled as a consequence of the fact that the arguments may promote different social values, and the audience has preferences between these social values.

Starting from Bench-Capon’s value-based approach, two challenges have been addressed:

— first, the *single audience* scenario has been addressed, and a new concept of ”robustness” has been defined. Specifically, the robustness of arguments and sets of arguments is considered from the point of view of the resistance of the *accepted* and of the *extension* status of arguments and sets of arguments, respectively, to changes in the audience preferences.

— then, the scenario of *diverse audiences* has been considered. The focus in this context has been on developing a mathematical model to quantify and analyse how different inferential and epistemic standards, as well as the influence of non-inferential components like promoted values, affect the assessment of public interest communication among varied target audiences.

The document is organized as follows. Section 2 presents the definition of the *robustness* property over arguments and sets of arguments, in the context

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of Single-Audience Value-Based Abstract Argumentation Framework (AVAF). Furthermore, it discusses the complexity analysis of the problems of checking whether arguments and sets of arguments are robust w.r.t. changes in the modelling of the scenario. Section 3 addresses the case of diverse audiences, describing the impact measure adopted, the notion of convincing argument and also a generalisation to lists of arguments included in a campaign.

2 Robustness in Value-based Abstract Argumentation

In *(single-Audience) Value-based Argumentation Frameworks* (AVAFs) [1], the difference in strength between the arguments is modeled as a consequence of the fact that the arguments may promote different social values, and the audience has preferences between these social values.

AVAFs have proved effective in several scenarios, such as promotional campaigns and trials: they allow the analyst to simulate the subjective views of the people to which the arguments are addressed (e.g. the target population, in the case of promotional campaigns, or the jury, in the case of trials) and then to reason on how the audience will perceive the status of the arguments.

However, the outcome of the reasoning performed over an AVAF could be affected by reliability issues, since:
1) the audience profile may not be accurate, as the beliefs and social convictions of the involved individuals are not always easy to predict; so, some preferences put in the audience profile by the analyst may be wrong and/or some preferences actually characterizing the audience may be missing;
2) even if, initially, the audience profile is accurately modeled, the audience may change their opinions over time and, therefore, the importance they attribute to values.

A possible way for assessing the reliability of the result of the reasoning is studying its "*robustness*": once the status of a set of arguments (is it an extension or not?) or of a single argument (is it accepted or not?) has been determined over an AVAF, its "**robustness degree**" is the maximum number of changes to the audience profile that are tolerated, in the sense that no modification of the status would be observed if any set of changes of this cardinality were performed.

Intuitively, the higher the degree of robustness, the greater the reliability of the result of the reasoning: if many changes to the profile are required to alter

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the outcome, it means that, even if there were errors in defining the profile or changes occurred since it was defined, it is unlikely that such errors and changes would be numerous enough to affect the result.

In the context of AVAF, then we introduced a new paradigm for reasoning on the robustness of the status of (sets of) arguments, which is a relevant issue since it can effectively help assess the reliability of the outcome of the reasoning over AVAFs. In particular, we introduced the decision problems underlying the computation of the degree of robustness, and thoroughly investigated their computational complexity. The novelty of the contribution lies in the fact that robustness has never been studied in the literature of abstract argumentation with regard to audience profiling, but only, indirectly, within the framework of enforcement. In this context, however, the level of values and preferences was not considered. The focus has been solely on how to turn sets of arguments into extensions through direct modifications of the structure of the argumentation graph, without addressing the opposite problem (which is relevant in the context of robustness) of how to turn what is an extension or accepted into a non-extension or not accepted.

In next subsections we give some preliminary notions and then define the computational problems relevant to robustness. We then present the complexity analysis of the defined problems.

2.1 Preliminaries

A *preference* between two elements x_1, x_2 of a set X is an expression "$x_1 > x_2$" which is read as "x_1 is preferred to x_2". A (strict) preference relation on a set X is a partial, transitive, asymmetric, irreflexive relation $P \subset X \times X$. Each $(x_1, x_2) \in P$ is interpreted as a preference $x_1 > x_2$. If $(x_1, x_2) \notin P$, we write $x_1 \not> x_2$.

A *preference-based argumentation framework* (*PAF* [2]) is a triplet *PF* $= \langle A, D, P \rangle$, where $\langle A, D \rangle$ is an AAF and P is a (strict) preference relation on A. The effect of preferences is the *inactivation* of any attack (a, b) where $b > a$. Thus, the extensions and the accepted arguments of *PF* $= \langle A, D, P \rangle$ are those of the "*implied*" AAF *F* $= \langle A, D' \rangle$, where D' is the subset of D containing only its *active* attacks, i.e. the attacks (a, b) with $b \not> a$.

Formally, given a set of values V, an *(audience) profile* (or *preference specification*) π over V is a set of *preferences* of the form $v_1 > v_2$, with $v_1, v_2 \in V$. In graph terms, π is represented by the digraph, called *preference graph*, having V and $\{(v_1, v_2) | v_1 > v_2\}$ as sets of nodes and arcs. We denote as π^* the transitive closure of π. A profile π is said to be *consistent* iff it is acyclic, meaning that π^* is a (strict) preference relation over V. For instance, the profile $\{v_1 > v_2, v_2 > v_3, v_3 > v_1\}$ is not consistent: observe that its transitive closure is not a strict preference relation, since it contains the preferences $v_1 > v_3$ and $v_3 > v_1$ (thus violating the asymmetry).

A *Single-Audience Value-based Argumentation Framework* (AVAF) is a tuple $\mathit{VF} = \langle A, D, V, \mathit{val}, \pi \rangle$, where $\langle A, D \rangle$ is an AAF, V a set of values, π a consistent preference specification over V, and $\mathit{val} : A \to V$ a total function associating arguments with values. The semantics of an AVAF $\mathit{VF} = \langle A, D, V, \mathit{val}, \pi \rangle$ is given by the PAF $\mathit{PF} = \langle A, D, P(\pi) \rangle$, where $P(\pi)$ is the strict preference relation implied by π, i.e. $P(\pi) = \{(a, b) | (\mathit{val}(a) > \mathit{val}(b)) \in \pi^*\}$. Thus, the extensions and the accepted arguments of *VF* are those of *PF*, or, equivalently, of the AAF implied by *PF*, that are called the PAF and the AAF “implied" by *VF*, respectively.

In order to formalize the problems, we introduce the following notions and notations. Given a preference specification π over a set of values V, we consider two primitive update operations over π: the insertion $\mathit{ins}(v_1 > v_2)$ and the deletion $\mathit{del}(v_1 > v_2)$, which inserts and removes the preference $v_1 > v_2$ into and from π, respectively.

In turn, we call “*preference update*" any set U of primitive update operations, and define the application of U to π as $U(\pi) = \pi \cup \{v_1 > v_2 | \mathit{ins}(v_1 > v_2) \in U\} \setminus \{v_1 > v_2 | \mathit{del}(v_1 > v_2) \in U\}$. In turn, we define the application of a preference update U to an AVAF $\mathit{VF} = \langle A, D, V, \mathit{val}, \pi \rangle$ as the AVAF $U(\mathit{VF}) = \langle A, D, V, \mathit{val}, U(\pi) \rangle$.

A preference update U over π is said to be *consistent* if $U(\pi)$ is consistent. U is said to be “del-only" (resp., “ins-only") if it contains only deletions (resp., insertions). Obviously, a del-only preference update over a consistent profile is always consistent.

2.2 The robustness problems and their complexity

We now introduce the fundamental problems that support the reasoning on the “robustness" of the outcome of the reasoning performed over an AVAF. With “robustness" we mean the number of changes to the audience profile that are allowed (as a consequence of changes in mind of the audience or of the need of fixing inaccuracies of the profile w.r.t. the actual subjective view of the audience) with no impact on the status of a set of arguments or of a single argument, in terms of being or not an extension or an accepted argument,

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respectively.

Definition 1 (k-robustness problems)**.** RE$^\sigma$(*VF*$, S, k$) *(resp.,* RNE$^\sigma$(*VF*$, S, k$)*) is the problem of checking if the set S, that is (resp., is not) an extension of the AVAF VF under σ, is still (resp., is still not) an extension of U(VF) under σ for every consistent preference update U with $|U| \leq k$.*

RA$^\sigma$(*VF*$, a, X, k$) *(resp.,* RNA$^\sigma$(*VF*$, a, X, k$)*), where $X \in \{$Cr, Sk$\}$, is the problem of checking if the argument a, that is (resp., is not) X-accepted for the AVAF VF under σ, is still (resp., is still not) X-accepted for U(VF) under σ for every consistent preference update U with $|U| \leq k$.*

The suffixes -IO and -DO will denote the variants of the robustness problems restricted to ins-only and del-only preference updates. Restricting to ins-only (resp., del-only) updates means assessing the robustness in the case where the audience profile may be strictly more specific (resp., strictly more general) than what initially specified by the analyst.

We carried out the characterization of the computational complexity of the k-robustness problems. The results are summarized in Table 1, which also reports the complexity of the classical verification and acceptance problems over AAFs, PAFs, and AVAFs (obviously, the semantics `cf` is not considered for the acceptance and the related robustness problems, and `ad` is not considered for the skeptical acceptance and the related robustness problems, since these cases are trivial).

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Verification Problem

σ	Ver	RE	RE -IO	RE -DO	RNE	RNE -IO	RNE -DO
cf	P	P	trivial	P	coNP	coNP	trivial
ad	P	coNP	coNP	P	coNP	coNP	coNP
st	P	coNP	coNP	P	coNP	coNP	coNP
co, gr	P	coNP	coNP	coNP	coNP	coNP	coNP
pr	coNP	coNP	coNP	coNP	Π_2^p	Π_2^p	Π_2^p

Credulous acceptance

σ	Acc	RA	RA -IO	RA -DO	RNA	RNA -IO	RNA -DO
ad	NP	Π_2^p	Π_2^p	Π_2^p	coNP	coNP	coNP
st	NP	Π_2^p	Π_2^p	Π_2^p	coNP	coNP	coNP
co	NP	Π_2^p	Π_2^p	Π_2^p	coNP	coNP	coNP
gr	P	coNP	coNP	coNP	coNP	coNP	coNP
pr	NP	Π_2^p	Π_2^p	Π_2^p	coNP	coNP	coNP

Skeptical acceptance

σ	Acc	RA	RA -IO	RA -DO	RNA	RNA -IO	RNA -DO
st	coNP	coNP	coNP	coNP	Π_2^p	Π_2^p	Π_2^p
co	P	coNP	coNP	coNP	coNP	coNP	coNP
gr	P	coNP	coNP	coNP	coNP	coNP	coNP
pr	Π_p^2	Π_2^p	Π_2^p	Π_2^p	Π_3^p	Π_3^p	Π_3^p

Table 1: Complexity of the verification and acceptance problems over AAFs/PAFs/AVAFs and of the k-robustness problems over AVAFs. When a class beyond P is reported, it means that the problem is complete for the class

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3 Vector-Based Extension of Value-Based Argumentation for Public Interest Communication

We now focus on the context of *multiple audiences* and describe a Value-based Argumentation Framework extending the approach in [1].

In particular, we consider a triple $\langle A, \rightarrow, A^{\text{pos}} \rangle$ where $\langle A, \rightarrow \rangle$ is an *argumentation framework*—i.e. A is a set of arguments and $\rightarrow$ is a binary relation $\rightarrow \subseteq A \times A$—and $A^{\text{pos}} \subseteq A$. We read $a \rightarrow b$ as "a attacks b." The set A^{pos} will be the set of arguments expressing the goals of the considered communication campaign. In practical applications, one starts by identifying A^{pos} and then constructs A by adding possible chains of attacks to elements of A^{pos}.

By extension, we also say that a set of arguments "$S \subseteq A$ attacks b" (in symbols $S \rightarrow b$) if there is $a \in S$ such that $a \rightarrow b$. The framework $\langle A, \rightarrow \rangle$ is conveniently represented as a directed graph in which the arguments are vertices and edges represent attacks between arguments.

The key question is whether a given argument $a \in A^{\text{pos}}$ will convince the public of a campaign. In order to propose some ways to answer this question, we endow $\langle A, \rightarrow, A^{\text{pos}} \rangle$ with some additional structure.

The *set of audiences* is a set of the form $I = \{1, 2, 3, ..., k\}$, of *cardinality* k. To each audience $i \leq k$ we associate a *weight* p_i. Weights satisfy the following conditions:

$$\forall_{i \leq k}\, p_i \geq 0, \qquad\qquad \sum_{i=1}^{k} p_i = 1.$$

This takes into account the fact that each i may not represent an individual listener, but a portion of the whole population that has similar values.

Let us suppose that we have a fixed (and ordered) set of values (e.g. equality, individual health, collective health, etc.) of cardinality n.

We do not argue for a specific set of values, as this is beyond the scope of the present analysis. Various solutions can be found in the literature, such as in [4, 5, 6, 7].

In [1], each argument is associated with an individual value. We believe that this can be refined, since an argument can rely on several values, each with a different degree. To this purpose, we define

— the *space of values* as $V = [0, 1]^n$, each dimension of which is associated with the corresponding value;

— the *value function val*: $A \to V$, which assigns each $a \in A$ to its *vector of values*.

It may be possible to refine the model by imposing certain restrictions on the vectors resulting from *val*. Such restrictions should be motivated by further considerations or empirical evidence.

Each audience $i \leq k$ will have their own preferences among values. We want to represent this by introducing the *audience specific value function* $\mathrm{asv}\colon I \to V$, which assigns to each audience i a vector whose jth entry represents the importance that audience i gives to value j. As above, further considerations or empirical evidence may require imposing some restrictions on the vectors resulting from asv.

We want to answer the question from above: given an argument $a \in A^{\mathrm{pos}}$, will a convince the audience?

To this purpose, we introduce in next section an impact measure which aims to capture how much each argument is effective for a given audience. In Section 3.2 we focus on the issue of formally expressing the goals corresponding to the question from above, and, finally, in Section 3.3 we generalize to a list of arguments.

3.1 The impact measure

For each audience $i \leq k$ we introduce their *impact measure* as a function

$$\|\cdot\|_i\colon A \to [0,1].$$

We want it to assign to each argument a the impact that a has on i, by evaluating the values on which a relies and the importance that these values have for i. In particular, we want to ensure that if an argument a relies on a value that is important to i, then a will have a high impact on i. To this end, we require that this can be written as a composition

$$\|\cdot\|_i\colon \quad A \xrightarrow{\textit{val}} V \subseteq \mathbb{R}^n \xrightarrow{\mathrm{s}_i} \mathbb{R}$$

In words, given an argument a, its impact on audience i is determined on the basis of its value of vectors *val*(a) which is then synthesised into a single real number, measuring the impact, through an audience specific function s_i.

The function s_i is required to satisfy the following properties:

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- It is a seminorm, i.e. for any $\vec{x}, \vec{y} \in \mathbb{R}^n$ and $\lambda \in \mathbb{R}$ we have[2]

$$\mathrm{s}_i(\vec{x} + \vec{y}) \leq \mathrm{s}_i(\vec{x}) + \mathrm{s}_i(\vec{y}), \qquad \text{(Subadditivity)}$$
$$\mathrm{s}_i(\lambda \cdot \vec{x}) = |\lambda| \cdot \mathrm{s}_i(\vec{x}). \qquad \text{(Absolute homogeneity)}$$

- It satisfies *monotonicity*: Consider $\vec{x} = \langle x_1, ..., x_n \rangle, \vec{y} = \langle y_1, ..., y_n \rangle$. If $|x_1| \leq |y_1|, ..., |x_n| \leq |y_n|$, then $\mathrm{s}_i(\vec{x}) \leq \mathrm{s}_i(\vec{y})$.
- The restriction $\mathrm{s}_i\,|_V$ has codomain contained in $[0, 1]$.

In particular, monotonicity ensures that if an argument a relies on values which are of higher importance to i, then a will have a higher impact on i.

Seminorms satisfy some very nice properties. For instance:

Proposition 1. *Let* $\mathrm{s}_i \colon \mathbb{R}^n \to \mathbb{R}$ *be a seminorm. Then:*

1. $\mathrm{s}_i(\vec{0}) = 0$.
2. Nonnegativity*: For every* $\vec{x} \in \mathbb{R}^n$*, we have* $\mathrm{s}_i(\vec{x}) \geq 0$.

In this paper we consider the following definition for the impact measure:

$$\begin{aligned} \|\cdot\|_i \colon A &\to [0, 1], \\ a &\mapsto \sqrt{\frac{1}{n} \sum_{j=1}^{n} (\mathrm{asv}(i)_j \cdot \mathit{val}(a)_j)^2}. \end{aligned}$$

If we use $\|\cdot\|$ to denote the Euclidean norm and $\odot$ to denote the Hadamard product (i.e. the component-wise product), then we can write

$$\|a\|_i = \frac{1}{\sqrt{n}} \|\,\mathrm{asv}(i) \odot \mathit{val}(a)\|.$$

We want to show that this function indeed satisfies the desired properties:

Proposition 2. *The function*

$$\begin{aligned} \mathrm{s}_i \colon \mathbb{R}^n &\to \mathbb{R} \\ \vec{x} &\mapsto \frac{1}{\sqrt{n}} \|\,\mathrm{asv}(i) \odot \vec{x}\| \end{aligned}$$

is a monotonic seminorm, and the restriction $\mathrm{s}_i\,|_V$ *has codomain contained in* $[0, 1]$.

[2] $|\cdot|$ denotes the absolute value.

Beside the one proposed here, there are several possible ways to define an impact function, and empirical evidence will be necessary to evaluate and compare these different definitions. In particular, one possibility is to consider additional features of arguments besides values, for instance their presentation form, their emotional aspects an so on. A simple way to capture these additional features would be including in the computation a multiplicative factor given by a function $E\colon I \times A \to [0,1]$:

$$\|\cdot\|_i\colon A \to [0,1], \qquad a \mapsto E(i,a) \cdot \sqrt{\frac{1}{n}\sum_{j=1}^{n} (\mathrm{asv}(i)_j \cdot \textit{val}(a)_j)^2}.$$

Further investigation in this direction is left to future work.

3.2 Convincing arguments

In this section we explore the issue of expressing in formal terms the goals corresponding to the question: "Will the argument $b \in A$ convince the audience?"

A first simple goal that one can identify is to maximise overall effectiveness:

Goal 1 Find the argument $a \in A^{\text{pos}}$ for which the following quantity is maximal:

$$\sum_{i=1}^{k} p_i \cdot \|a\|_i.$$

Another possible goal is to maximise the number of people convinced by an argument $a \in A^{\text{pos}}$, that is:

Goal 2 Find the argument $a \in A^{\text{pos}}$ for which the following quantity is maximal:

$$\sum_{i=1}^{k} p_i \cdot \chi(\mathrm{con}_i(a)),$$

where

$$\chi(\varphi) = \begin{cases} 1 & \text{if } \varphi \text{ is true,} \\ 0 & \text{if } \varphi \text{ is false.} \end{cases}$$

and $\mathrm{con}_i(a)$ is true iff a is able to convince the audience i.

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But what does it mean for an argument to convince an audience? In other words, how do we define con_i?

One reasonable view is that an argument b convinces the audience i if and only if every attack a on it is rejected by some condition (that may depend on b and i):

$$\mathrm{con}_i(b) \iff \forall_{a \to b} \text{ argument } a \text{ is rejected.}$$

How do we determine whether an argument a is rejected?

For a first tentative answer to this question, we define the following relation:

$$a \twoheadrightarrow_i b \iff (a \to b \,\&\, \|a\|_i \geq \|b\|_i)\,.$$

We read $a \twoheadrightarrow_i b$ as "argument a *defeats* argument b according to audience i." We also write $a \not\twoheadrightarrow_i b$ for $\neg(a \twoheadrightarrow_i b)$. The idea, in line with the spirit of Bench-Capon's approach, is that an argument a can succesfully attack another argument b according to a given audience i only if b is not preferred by i to a on the basis of the promoted values.

Accordingly, the notion of convincing argument can be formalized as follows::

$$\mathrm{con}_i(b) \iff \forall_{a \to b}\, a \not\twoheadrightarrow_i b \iff \forall_{a \to b}\, \|a\|_i < \|b\|_i.$$

This formalisation is rather simple and corresponds to a strong notion of convincing argument: the argument is regarded as unquestionable by the audience as it does not receive any effective attack. This strong notion may however turn out to be inadequate in some cases.

As a solution, we propose to define con_i using the grounded semantics [3], which corresponds to a recursive notion of strong defence. We recall here the basic notions of grounded semantics for the benefit of readers not already familiar with Dung's theory of argumentation frameworks. According to grounded semantics, convincing arguments can be identified as follows. We start with arguments that are not defeated by any other argument, making them unquestionable. Subsequently, arguments that are defended by these unquestionable arguments (i.e. arguments whose attackers are in turn attacked by unquestionable arguments) are also recursively considered unquestionable. More precisely, we propose the following algorithm:

1. Consider $\langle A, \twoheadrightarrow_i \rangle$ as an argumentation framework.
2. Add undefeated arguments to the grounded extension $\mathcal{E}_{GR}(A)$.
3. Remove from the framework A the arguments defeated by elements of $\mathcal{E}_{GR}(A)$.

4. If in the modified framework there are undefeated arguments, then go back to Step 2, else exit.

5. Define
$$\text{con}_i(a) \iff a \in \mathcal{E}_{GR}(A).$$

In addressing these considerations, future research may explore refinements or extensions of the notion of convincing argument. In particular, one could consider the application of Bayesian reasoning, machine learning techniques, or other methodologies to datasets concerning past Public Interest Communication campaigns in order to better characterize the notion of convincing argument in different contexts.

3.3 Possible generalisation: list-of-arguments campaigns

In several cases, campaigns consist of a list of arguments, often presented as a "top ten" or similar format. This approach aims to distil complex ideas or positions into a concise and easy to remember set of key points. This strategy aims to ensure clarity and resonance with the audience, making the message more impactful. By strategically selecting these arguments, campaigns can effectively align with the values and concerns of their audience, thereby increasing their persuasive influence. The order of these arguments can be crucial. In some contexts, the first argument holds significant weight as it captures initial attention and sets the tone for the entire message. Alternatively, the last argument can leave a lasting impression, often considered the most impactful as it resonates as the final thought with the audience. Understanding how the sequence influences perception and engagement is vital for crafting compelling campaigns that effectively communicate their intended message. Moreover, audience preferences vary regarding the length of argument lists. Some audiences may prefer a shorter list that highlights key points succinctly, allowing for easy recall and immediate impact. In contrast, others may favour a longer list that provides comprehensive coverage of different aspects of the issue, appealing to those who seek detailed information and thorough analysis.

Under these considerations, if a list $\ell \in A^*$ is given[3], we have to consider several factors, including its *length* and its *order*. These factors can be taken care of by functions $O_i \colon A^* \to [0,1]^*$ that satisfy $length(O_i(\ell)) = length(\ell)$.

[3]Given a set S, we denote the collection of lists of elements of S by S^*. In this respect a real interval is treated as the set of all numbers included between its endpoints.

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The j-th element of O_i represents the effect of being in position j on the overall impact of an argument.

There are several other properties that we might want to consider, but we don't address them in this report. These include the *consistency* and *cohesion* of the list. Consistency refers to whether the arguments within the list attack each other, potentially leading to internal conflicts that undermine the overall persuasiveness of the list. Cohesion, on the other hand, pertains to the relationships between the arguments in the list. Cohesive arguments are those that support and reinforce each other, creating a unified and convincing narrative. Taking into account both the consistency and cohesion of the arguments can help ensure that the list is both logically sound and effectively persuasive.

For each audience $i \leq k$, we extend $\|\cdot\|_i$ to lists. We propose:

$$\|\cdot\|_i\colon \qquad A^* \to [0,1], \quad \langle a_1, ..., a_m\rangle \mapsto \sqrt{\sum_{j=1}^{m} (O_i(\langle a_1, ..., a_m\rangle)_j \cdot \|a_j\|_i)^2}.$$

Then, as above, a first goal can be

Goal 1 Find ℓ among lists of A^{pos} of a bounded (or fixed) length, such that the following quantity is maximal:

$$\sum_{i=1}^{k} p_i \cdot \|\ell\|_i.$$

Again, another possible goal is to maximise the number of people convinced

Goal 2 Find ℓ among lists of A^{pos} of a bounded (or fixed) length, such that the following quantity is maximal:

$$\sum_{i=1}^{k} p_i \cdot \chi(\text{con}_i(\ell)).$$

The question is then to define a notion of convincing list.

An option is to say that a list ℓ convinces i if and only if at least one argument of ℓ convinces i. Accordingly, taking also into account the impact of the order, a possible preliminary definition is:

$$\text{con}_i(\langle b_1, ..., b_m\rangle) \iff \bigvee_{j \leq m} \forall_{a \to b_j} \|a\|_i < O_i(\langle b_1, ..., b_m\rangle)_j \cdot \|b_j\|_i.$$

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4 Conclusions

In this document we first addressed the single audience scenario, defining a new concept of robustness. Specifically, the robustness of arguments and sets of arguments has been considered from the point of view of the resistance of the accepted and of the extension status of arguments and sets of arguments, respectively, to changes in the audience preferences.

Then, we addressed the scenario concerning diverse audiences, developing a mathematical model to quantify and analyse how different inferential and epistemic standards, as well as the influence of non-inferential components like promoted values, affect the assessment of public interest communication among varied target audiences.

Further details on the two frameworks can be found in the two research papers [8, 9] attached to this document, respectively.

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