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Symmetric Multi-Aspect Evaluation of Comments
Extended Abstract

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1 Introduction

As we explained in [3], most online systems for the Social Web, such as social media, online discussion forums, news sites and product review sites, offer limited support in identifying the helpful comments among the credible ones. We thus proposed the *multi-Dimensional Comment Evaluation* (mDiCE) framework, which relies on methodologies from the field of Computational Argumentation to clearly distinguish between the acceptance (credibility) and the quality (helpfulness) of arguments.

In this paper, we extend this framework and introduce the *symmetric multi-Dimensional Comment Evaluation* (s-mDiCE) framework, which has a more intuitive behavior and a wider scope, aiming to cover also the goal-oriented debates found in decision support systems or in debate portals, e.g., in active citizenship portals. s-mDiCE combines features, such as voting on arguments, expert rating, supporting and attacking arguments, in a unified and adaptable framework that can guarantee intuitive behavior for the user or the moderator who wish to spot important opinions or to rank them for easier processing.

2 Formalization of the s-mDiCE Framework

Our proposal is a generic formal framework that enables the evaluation of thestrength of arguments considering one or more aspects.

Definition 1. *An s-mDiCE (symmetric multi-Dimensional Comment Evaluation) framework is an (N+1)-tuple* $\langle \mathcal{A}, \mathcal{D}^*_{d1}, \ldots, \mathcal{D}^*_{dN} \rangle$*, where* $\mathcal{A}$ *is a finite set of arguments and* $\mathcal{D}^*_{d1}, \ldots, \mathcal{D}^*_{dN}$ *are aspects (dimensions), under which an argument is evaluated.*

Depending on the domain of interest, different aspects can be defined, such as relevancy, reliability, objectivity etc. The ultimate objective of the s-mDiCE framework is the calculation of the quality and acceptance score of each argument (we use the interval $\mathbb{I} = [0, 1]$ as the range of these functions), using the different aspects as different "dimensions" for calculating said scores.

Definition 2. *An aspect* $\mathcal{D}^*_x$ *corresponding to an argument set* $\mathcal{A}$ *is a 5-tuple* $\langle \mathcal{R}^{supp}_x, \mathcal{R}^{att}_x, BS_x, V^+_x, V^-_x \rangle$*, where* $\mathcal{R}^{supp}_x \subseteq \mathcal{A} \times \mathcal{A}$ *is a binary acyclic support relation on* $\mathcal{A}$*,* $\mathcal{R}^{att}_x \subseteq \mathcal{A} \times \mathcal{A}$ *is a binary acyclic attack relation on* $\mathcal{A}$*, and* $BS_x : \mathcal{A} \to \mathbb{I}$*,* $V^+_x : \mathcal{A} \to \mathbb{N}^0$ *and* $V^-_x : \mathcal{A} \to \mathbb{N}^0$ *are total functions mapping each argument to a basic score, a number of positive and a number of negative votes relative to this aspect, respectively.*

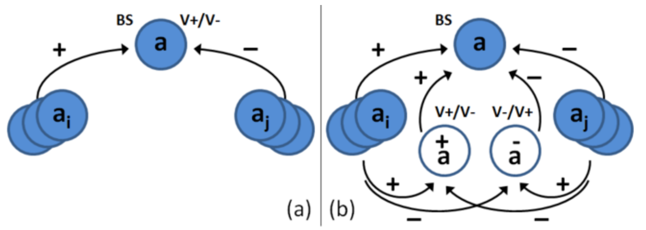

Figure 1. (a) A debate graph with votes, base score and user-generated supporting and attacking arguments, (b) its transformation with black nodes.

The current definition generalizes the one introduced in [3], incorporating also the notion of a *base score* (or intrinsic strength) BS_x, which is often used in decision-making systems (e.g., in [1, 4]) to capture an expert's initial rating over an opinion, before any debate has taken place. This parameter offers an one-time estimation for an argument; other users may then affect the final score of the opinion positively or negatively through their arguments or votes. In other systems, the base score may obtain a more personalized flavor, representing for instance the trust that a user attributes to the user who issues an argument regardless of its content.

Discussion forums and review sites on the Web, on the other hand, rely on a different rating scheme, enabling their users to express their (unjustified) stance towards comments through various voting mechanisms, such as positive/negative votes, like/dislike counters, star-based rating mechanisms etc. Many methods have been suggested to aggregate such ratings having different degrees of confidence.

Some systems treat votes as a base score, yet the conceptual difference between the two is important. Our proposed framework distinguishes between static base scores and dynamic ratings. It also considers the credibility that votes carry, given their the interplay of the underlying supporting or attacking arguments.

In s-mDiCE, we reduce votes to the argument level and convert them to arguments by assuming that they express an opinion in favor or against the target argument. As these opinions carry no content on their own, we call them *supporting* and *attacking blank arguments*. We can estimate the credibility of these opinions more accurately by adding additional attacks (supports) from arguments that support (resp. attack) the target argument to its attacking blank argument, and additional supports (resp. attacks) to its supporting blank argument. Fig. 1 presents the simple argumentation graph that shows these interactions.

Before formally defining blank arguments, some convenient notation is needed. We let $\bar{\mathcal{A}}$ denote the set of user-generated arguments and use $\mathring{\mathcal{A}}$ to refer to the set of blank arguments of an s-

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mDiCE framework $\mathcal{F}$, such that $\mathcal{A} = \mathring{\mathcal{A}} \cup \widetilde{\mathcal{A}}$. Moreover, given an aspect $\mathcal{D}^*_x = \langle \mathcal{R}^{supp}_x, \mathcal{R}^{att}_x, BS_x, V^+_x, V^-_x \rangle$, we define the set of direct supporters of an argument $a \in \mathcal{A}$ as $\mathcal{R}^+_x(a) = \{a_i : (a_i, a) \in \mathcal{R}^{supp}_x\}$. Similarly, the set of direct attackers of a is defined as $\mathcal{R}^-_x(a) = \{a_i : (a_i, a) \in \mathcal{R}^{att}_x\}$.

Definition 3. *Let $\mathcal{F}$ be an s-mDiCE framework and $\mathcal{D}^*_x = \langle \mathcal{R}^{supp}_x, \mathcal{R}^{att}_x, BS_x, V^+_x, V^-_x \rangle$ be an aspect of $\mathcal{F}$. For each argument $a \in \widetilde{\mathcal{A}}$, we define two new arguments $\overset{+}{a}$ and $\bar{a}$, called the supporting and attacking blank argument of a respectively, such that*

- $(\overset{+}{a}, a) \in \mathcal{R}^{supp}_x$,
- $V^+_x(\overset{+}{a}) = V^+_x(a)$, $V^-_x(\overset{+}{a}) = V^-_x(a)$,
- *for all* $(a_i, a) \in \mathcal{R}^{supp}_x$ *it also holds that* $(a_i, \overset{+}{a}) \in \mathcal{R}^{supp}_x$,
- *for all* $(a_j, a) \in \mathcal{R}^{att}_x$ *it also holds that* $(a_j, \overset{+}{a}) \in \mathcal{R}^{att}_x$, *and similarly*
- $(\bar{a}, a) \in \mathcal{R}^{att}_x$,
- $V^+_x(\bar{a}) = V^-_x(a)$, $V^-_x(\bar{a}) = V^+_x(a)$,
- *for all* $(a_i, a) \in \mathcal{R}^{supp}_x$ *it also holds that* $(a_i, \bar{a}) \in \mathcal{R}^{att}_x$,
- *for all* $(a_j, a) \in \mathcal{R}^{att}_x$ *it also holds that* $(a_j, \bar{a}) \in \mathcal{R}^{supp}_x$.

There is a inherent symmetry in the model, which is the main differentiation to mDiCE, where the blank argument is only used as a means to express the positive stance of votes towards an argument (e.g., its social support [2]). We next introduce a set of generic functions that help assess the different quantities affecting the strength of an argument.

Definition 4. *The generic score function $g^{vot} : \mathbb{N}^0 \times \mathbb{N}^0 \rightarrow \mathbb{I}$ aggregates the positive and negative votes into a single strength score.*

Definition 5. *The generic score function $g^{set} : (\mathbb{N}^0)^{\mathbb{I}} \rightarrow \mathbb{I}$ aggregates the strength of a set of supporting or attacking arguments into a single strength score.*

We apply these functions, in order to estimate both the acceptance and the quality score of an argument. For the former, we need to define $s^{dlg}_x()$, which reflects the credibility of an argument by combining the strength of its supporting and attacking arguments, i.e., the outcome of the dialogue that it generated on a given aspect. For the latter, we define $s^{cng}_x()$ to characterize the congruence strength, i.e., the degree of people's compliance with an argument with respect to its clarity and justification.

Definition 6. *Let $\mathcal{F} = \langle \mathcal{A}, \mathcal{D}^*_{d1}, ..., \mathcal{D}^*_{dN} \rangle$ be an s-mDiCE framework and $\mathcal{D}^*_x = \langle \mathcal{R}^{supp}_x, \mathcal{R}^{att}_x, BS_x, V^+_x, V^-_x \rangle$ be an aspect of $\mathcal{F}$. The dialogue strength $s^{dlg}_x : \mathcal{A} \rightarrow \mathbb{I}$ of an argument $a \in \mathcal{A}$ over aspect $\mathcal{D}^*_x$ is given by*

$$s^{dlg}_x(a) = g^{dlg}(G^x_1(a), g^{set}(\{s^{dlg}_x(a_i) : a_i \in \mathcal{R}^+_x(a)\}), g^{set}(\{s^{dlg}_x(a_j) : a_j \in \mathcal{R}^-_x(a)\})) \quad (1)$$

where

$$G^x_1(a) = \begin{cases} BS_x(a) & , \textit{if } a \in \widetilde{\mathcal{A}} \\ g^{vot}(V^+_x(a), V^-_x(a)) & , \textit{if } a \in \mathring{\mathcal{A}} \end{cases}$$

and function $g^{dlg} : \mathbb{I} \times \mathbb{I} \times \mathbb{I} \rightarrow \mathbb{I}$ is a generic score function valuating the dialogue strength of an argument for a given aspect, considering the aggregation of the strength of the votes or base score, the supporting and the attacking arguments.

Definition 7. *Let $\mathcal{F} = \langle \mathcal{A}, \mathcal{D}^*_{d1}, ..., \mathcal{D}^*_{dN} \rangle$ be an s-mDiCE framework and $\mathcal{D}^*_x = \langle \mathcal{R}^{supp}_x, \mathcal{R}^{att}_x, BS_x, V^+_x, V^-_x \rangle$ be an aspect of $\mathcal{F}$. The congruence strength $s^{cng}_x : \mathcal{A} \rightarrow \mathbb{I}$ of an argument $a \in \mathcal{A}$ over aspect $\mathcal{D}^*_x$ is given by*

$$s^{cng}_x(a) = g^{cng}(G^x_2(BS_x(a), g^{vot}(V^+_x(a), V^-_x(a))), g^{set}(\{s^{dlg}_x(a_i) : a_i \in \mathcal{R}^+_x(a) \cap \widetilde{\mathcal{A}}\}), g^{set}(\{s^{dlg}_x(a_j) : a_j \in \mathcal{R}^-_x(a) \cap \widetilde{\mathcal{A}}\})) \quad (2)$$

where $G^x_2 : \mathbb{I} \times \mathbb{I} \rightarrow \mathbb{I}$ is a generic function combining the strength of the base score of an argument and its votes, and $g^{cng} : \mathbb{I} \times \mathbb{I} \times \mathbb{I} \rightarrow \mathbb{I}$ is a generic score function valuating the congruence score of an argument, considering the aggregation of the strength of the votes, the supporting and the attacking arguments.

Notice that $g^{cng}()$ only considers the strength of user-generated arguments; in a sense, it calculates the strength of the supporting blank argument, even though one may choose to instantiate it in a different way. For example, typically, $g^{cng}(x_v, x_s, x_a)$ should lay more emphasis on x_v and x_a, increasing on x_v and decreasing on x_a, as, arguably, the "ideal" comment would attract only positive votes and no supporting arguments. That is, in an ideal setting, supporting arguments are only asserted to add information or to explain better the opinion stated, thus denoting a sense of dissatisfaction related to the quality of the target argument. However, we keep the function generic to allow its instantiation to vary from system to system.

Finally, by considering the strength of all aspects defined within a particular s-mDiCE framework, the main scores (quality, acceptance) of an argument can be determined.

Definition 8. *Let $\mathcal{F} = \langle \mathcal{A}, \mathcal{D}^*_{d1}, ..., \mathcal{D}^*_{dtN} \rangle$ be an s-mDiCE framework. The quality and acceptance scores of an argument $a \in \mathcal{A}$ is given by the functions $\mathcal{QUA} : \mathcal{A} \rightarrow \mathbb{I}$ and $\mathcal{ACC} : \mathcal{A} \rightarrow \mathbb{I}$, respectively, which aggregate the strength of its aspects, such that*

$$\mathcal{QUA}(a) = g^{\mathcal{QUA}}(s^{cng}_{d1}(a), ..., s^{cng}_{dN}(a)) \quad (3)$$

$$\mathcal{ACC}(a) = g^{\mathcal{ACC}}(s^{dlg}_{d1}(a), ..., s^{dlg}_{dN}(a)) \quad (4)$$

with $g^{\mathcal{QUA}}, g^{\mathcal{ACC}} : \mathbb{I}^N \rightarrow \mathbb{I}$.

As is obvious from the above, our framework is generic enough to allow many different types of functions to be defined. It is therefore important to define adequate properties for such functions, which would guarantee a "reasonable" behaviour for the task at hand. Defining and proving these properties for specific instantiations of the model is part of our future work.

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