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Value-based argumentation framework built from prioritized qualitative choice logic ☆

Karima Sedki [a,b,*]

[a] LIMICS (INSERM UMRS 1142), Université Paris 13, Sorbonne Paris Cité, 93017 Bobigny, France
[b] UPMC Université Paris 6, Sorbonne Universités, Paris, France

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ABSTRACT

The notion of preference is crucial in many fields. This justifies the development of many formalisms for preferences representation such as CP-nets, qualitative choice logic and its extensions. Preferences help to choose the best option in decision making, to compare between arguments in argumentation theory, etc. In this paper, we establish a link between a preference formalism, called Prioritized Qualitative Choice Logic (*PQCL*) and argumentation theory. We show that for any set of preferences expressed using *PQCL* (called *PQCL* theory), a Value-based Argumentation Framework (*VAF*) can be built. However, we point out some problems related to the evaluation of arguments which does not guarantee the correspondence between elements of *PQCL* theory and those of its associated *VAF*. We show that the major problem is due to the evaluation of arguments defined in existing argumentation frameworks, where an absolute status is assigned to each argument: objectively (or skeptically) accepted if it belongs to every extension, subjectively (or credulously) accepted if it is in some extensions and not in others and rejected if it does not belong to any extension. To deal with this problem, we propose to revise the evaluation of arguments in the corresponding *VAF*. As a result, there is a direct relationship between preferred extensions of the corresponding *VAF* and preferred models of a set of preferences expressed using *PQCL*. In addition, rank ordering the set of arguments is possible. The relationship between the two formalisms is interesting since on the one hand, it points out that one should be careful in using argumentation theory for decision making purposes or in formalizing a given problem as an argumentation framework and on the other hand, it makes it possible to use an argumentation framework for preference elicitation.

1. Introduction

Prioritized Qualitative Choice Logic (*PQCL*) [9,10] extends Qualitative Choice Logic [13] for representing prioritized preferences that do not have the same level of importance. It allows the expression of simple and complex user preferences and the integration of some knowledge represented as propositional formulas. For instance, an agent who provides two preferences: *I prefer healthy recipes to full-fat recipes*, and *I prefer still water to gaseous drinks*, may consider that the first preference

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* Corresponding author at: LIMICS (INSERM UMRS 1142), Université Paris 13, Sorbonne Paris Cité, 93017 Bobigny, France.
E-mail address: karima.sedki@univ-paris13.fr.

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statement is more important than the second preference statement. This logic is appropriate for many applications. For instance, it is applied for alert correlation in [11]. However, preference elicitation in *PQCL* logic is not an easy task, especially when there are many options and different users who express their preferences.

Most often, a user prefers one option to another on the basis of some arguments justifying each choice. For example, the user reasons as follows for choosing between two recipes:

> *Recipe x is easy to prepare but requires lengthy cooking time, recipe y is healthier, it requires less cooking time, but it is somewhat expensive. However, although y is somewhat expensive, x is also expensive because it consumes a lot of energy for cooking.*

It is clear that intuitively arguments and counter-arguments in favor or against the available options are constructed during the process of providing preferences. So, can argumentation theory be used for *PQCL* preference elicitation? Argumentation theory is known to be a powerful framework based on constructing arguments and counter-arguments in favor or against some statements, comparing arguments, etc. One of the most popular argumentation frameworks (*AF*) was proposed by Dung [20]. It is composed of a set of abstract arguments and a binary attack relation between these arguments. Many instantiations of this framework are proposed such as preference-based argumentation frameworks (*PAF*) [44,15,5,37,7], value-based argumentation frameworks (*VAF*) [8,28,33], metalevel argumentation [35], weighted augmentation frameworks [23], etc. In *VAFs*, arguments can promote values in which a preference ordering over arguments is defined from a preference ordering over the promoted values as presented in [8], from both minimal and maximal specificity principles as presented in [28], or from information sources for the promoted values as presented in [33] in which conflicting preferences between arguments are resolvable through hierarchical argumentation over this preference information.

To answer our question about the usefulness of argumentation theory for *PQCL* preference elicitation, we think that it is firstly appropriate to study the relationship between a given *PQCL* theory (i.e., a set of knowledge and preferences expressed using *PQCL* logic) and argumentation theory. Namely, our aim in this paper is to determine if there is an associated argumentation system for a given *PQCL* theory. The problem of preference elicitation using *PQCL* (i.e., existence of a *PQCL* theory that corresponds to a given argumentation framework) will be studied in future work. Thus, in this paper, we establish a link between *PQCL* and argumentation theory, particularly with *VAF*.[1] We show that any *PQCL* theory can be encoded as a *VAF*. Compared to the *VAF* presented in [28] which is a generalization of Bench-Capon's *VAF* [8] and based on minimal and maximal principles for deriving the preference relation among arguments, the *VAF* presented in our paper is different in the sense that arguments are constructed from a given *PQCL* theory and a preference relation among arguments is derived from the *PQCL* inference relation. In addition, an audience in our framework corresponds to a *PQCL* formula and each argument promotes multiple values, namely one value w.r.t. each audience.

Our findings are interesting since they show that instead of starting only from propositional formulas to construct an argumentation system, it is also possible to consider simple preferences or other preference forms such as prioritized and conditional ones. In addition, as a given set of preferences can be encoded as a *VAF*, this means that preferences elicitation is possible using an argumentation framework which is our aim for future work. Another contribution of this paper is the fact that the established relationship points out some problems regarding the status of arguments when applying the evaluation of arguments defined in different argumentation frameworks [20,8]. Thus, to deal with this problem, we propose to revise the evaluation of arguments in the corresponding *VAF*. Indeed, a direct relationship is established between preferred extensions of the corresponding *VAF* and preferred models of the *PQCL* theory in question. As a result, one should be careful in using argumentation theory for decision making purposes or in formalizing a given problem as an argumentation framework because in argumentative approaches, the objective is to define the status of arguments which can be accepted, rejected, or undecided, while in decision making approaches such as in *PQCL*, the aim is to select the best option and if possible rank order the set of options.

In the rest of this paper, we firstly recall some concepts of *PQCL* in Section 2 and some basics on *AF* and *VAF* in Section 3. In Section 4, we present a mapping from *PQCL* theory to a *VAF*. In Section 5, we discuss the results of this paper and some related works. Section 6 concludes the paper.

2. *PQCL* logic

Prioritized Qualitative Choice Logic (*PQCL*) [9,10] extends Qualitative Choice Logic [13] to represent users' knowledge and prioritized preferences. A new logical connective $\vec{\times}$, called *ordered disjunction* is used. Intuitively, if a and b are two options then $a \vec{\times} b$ means: "if possible a, but if a is impossible then at least b". The language of *PQCL* is composed of three types of formulas:

1. **Propositional formulas:** Allow the expression of knowledge. $\mathcal{O}$ denotes the set of options (represented as propositional atoms) and $PROP_{\mathcal{O}}$ the language of propositional formulas.

[1] The choice of *VAF* is justified by the fact that in this framework, arguments promote values that help to compare them. In *PQCL*, interpretations promote satisfaction degrees that help to determine which interpretations can be a model. Thus, the link between the two formalisms can be naturally established.