

# DUO meta-model for knowledge elicitation and bidding support in NSS: extended abstract

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## 1 Introduction

Negotiation is a complex process aimed at reaching agreement about the exchange of goods or services. Although a daily activity, few people are effective negotiators [10]. Existing Negotiation Support Systems (NSS) can improve the human performance in negotiations and increase the number of win-win outcomes if the negotiation space is well-understood [5]. However, to develop the negotiation space properly, both negotiation parties have to jointly explore their interests.

Humans and computers have complementary capabilities for negotiation. Humans are better equipped to understand context, finding new relations between concepts, and having the necessary knowledge to interpret the negotiation domain with respect to their own preferences. However, people have problems handling emotions and the complexity of outcome spaces. Computers provide computational power, data storage and search techniques to handle outcome spaces. However, they still have problems with handling huge amounts of background and context knowledge necessary to handle arbitrary conversations and problems.

We are developing a new kind of human-machine collaboration system supporting one party (or negotiator) in negotiations. To allow the human and the NSS to cooperate at the required level of competence, they need to share a model of the negotiation process, a detailed model of the particular negotiation domain (D), and the negotiators, for ease of reference called user (U) and opponent (O) in this paper. Together we call the latter 'DUO models'. To share these it is important that they reflect cognitive models of users and are based on accurate real-life data. The negotiator models (UO) can only be entirely elicited through user-system interaction during the negotiation process with the opponent and need to be revisable and adjustable. This does not mean that we have to create new models from scratch with every negotiation. Based on literature and real-life data we can implement domain-independent meta-models of the negotiators.

Negotiation literature [2, 3, 4, 7, 9] gives insight into negotiation processes and also important concepts such as issues, preferences and interests valid for any negotiation domain. The negotiation literature emphasizes that besides the above mentioned concepts the following play an important role in the process and success of a negotiation: emotions, social aspects, negotiation styles, and mental models. While

there have been attempts to persuade NSS-developers of the importance of social aspects [1, 8], to our knowledge, there are no ready-to-use formalized domain models available for NSS that cover all these concepts and that can be incorporated by system engineers and instantiated for a particular domain. Another problem developers face, is the elicitation and embedding of domain knowledge from experts and users. Our goal is to provide a meta-model that underlies both the knowledge elicitation process and the bidding support. We ground our meta-model in the negotiation literature and validate it with real-life negotiation data from expert interviews and user case studies. The resulting DUO meta-model can represent any domain involving bilateral, integrated negotiations and instantiated by feeding in expert knowledge of a particular domain.

## 2 Meta-Model

The proposed meta-model is shown below. For a bilateral negotiation we specify two negotiating parties: our system's user and the opponent. Depending on the domain, negotiators have different roles, e.g., buyer and seller in the real estate domain. An issue (also commonly called *attribute*) is a concrete, negotiable aspect such as monthly salary, number of holidays, full-time equivalent (FTE). Every issue has a set or range of possible values. The value of an issue in a given instance can be objectively determined (e.g. 2400 euro, 30 days, 0.7 FTE). Issues and their possible values typically depend on the domain. A possible outcome has a specified value for every issue. All bids made during a negotiation are possible outcomes. A negotiator's bids are determined by his strategy, which depends on his preferences and the negotiation protocol. An agreement is a bid accepted by all parties. Each negotiator has preferences. People have preferences over values within a particular issue (e.g. prefer a high over a low salary), over the issues (e.g. prefer part-time work over salary), or over complete outcomes (e.g. prefer job offer A to B). In our model all preference types are classified as sub-concepts of an abstract preference concept. Preferences are influenced by the negotiator's interests. The role of a negotiator can determine some of these interests. Other interests are individual based on the negotiator's characteristics.

We define an interest as a party's basic need, want, or motivation that is potentially at stake in a negotiation. The measure of success in a negotiation is how well your interests are met [6]. The importance of the discovery of interests during negotiations has been pointed out in the literature on interest-based negotiation [2]. By understanding one's own and the other party's reasons behind a position, people are more likely to find more creative options and by that reach a mutually acceptable agreement easily.

While an interest is not negotiable, an issue is. Chosen issues influence the degree to which interests are met, but it is not always a one-to-one relation. For example, when applying for a job, an applicant with childcare responsibilities has the interest that the children are taken care of after school. This interest, childcare, can be met by various issues, e.g. part-time work, working from home, a childcare refund, childcare facilities, salary that will cover childcare expenses. The other way around, one issue may also contribute to multiple interests. Consider, for example, the hours that you can work at home. This issue can be linked to interests such as childcare, less commuting, or liking to work in this environment.

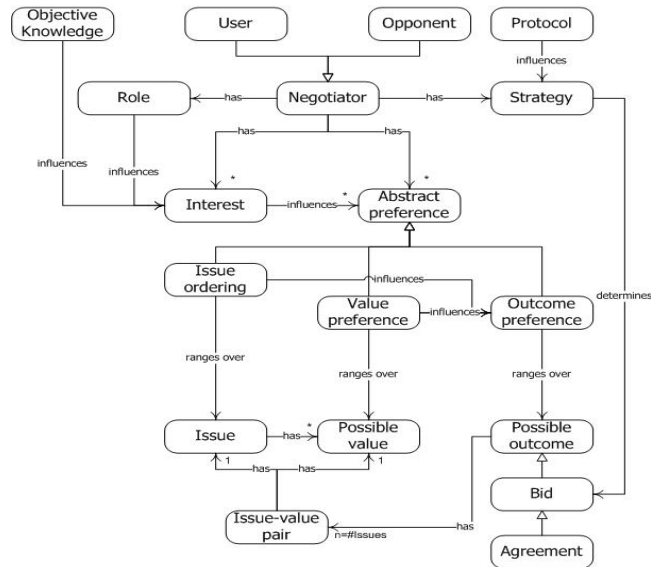


Fig. 1. DUO meta-model.

### 3 DUO Model Validation

In order to validate the DUO meta-model with real-life data we conducted five semi-structured interviews with experts (e.g. personnel recruiters), and eight user case studies (three diary studies and five detailed interviews). To interpret the gathered data, we need the four main concepts interests, issues, preference and objective domain knowledge. We analyzed the text from expert interviews and user case studies regarding: what do people negotiate about, how and why. To give an example, consider the following:

Expert\_1: "When talking to the candidate I try to find out whether the person fits the company. The candidate has to fill in a form with wishes for salary, position, lease car, reimbursement of internet costs etc. We check whether it fits the level of the candidate and is in line with our team."

This excerpt shows a differentiation between issues and interests. Issues are "salary", "position", "lease car", and the "reimbursement of costs", as these are matters to negotiate about. "Fit to the company", and "self-image" are subjective non-negotiable matters the company is concerned about. Therefore, they are interests. In this example the interests define the extent to which issues are negotiable. It is not possible to fit this relationship into an NSS model that only consists of issues. Therefore, it is important to model interests as a separate class.

## 4 Conclusion

Interests and their relation to issues are hardly taken into account in current NSS. There are at least three reasons why they should be. First, it is known that awareness of the opponent's interests stimulates the creative process of finding new options for negotiation [2]. Second, preferences over issues are based on interests. Third, addressing interests in the preference elicitation process can help identify the right issues. Due to a lack of existing models in NSS that consider interest and also default domain knowledge we designed the DUO meta-model. This model can serve as a starting point in the development of NSS and as a framework for the comparison of NSS. The model, which is grounded in negotiation literature, explicitly differentiates between negotiable issues and interests that underlie the preferences of a negotiator over issues. We have argued that such a distinction is necessary to ensure the applicability of NSS. We validated our meta-model by structuring real-life data gathered from case studies and interviews. Finally, we have shown how the model can be a basis for formal reasoning about preferences (see long paper). In the future we will extend this formal model to support the bidding process and create a formal language for handling qualitative statements of preferences using argumentation [10].

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