Measuring the Strength of Instrumental Arguments*

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Abstract. During the first step of practical reasoning, i.e. deliberation, an intelligent agent generates a set of desires and then selects which of them he commits to achieve, that is, which of them will become intentions. An intelligent agent may in general generate multiple desires, which may be conflicting. The conflicts among desires is defined based on the conflicts among their plans, which can be represented by instrumental arguments. Thus, it is relevant to measure the strength of these kinds of arguments in order to compare them and determine which desires that will become intentions. This work presents three ways of measuring the strength of instrumental arguments.

1 Introduction

Instrumental arguments are employed in the domain of intelligent agents in order to represent their plans and argue over them (see [1][5][8]). This means that, since plans are seen as arguments, argumentation techniques can be used for determining non-conflicting plans, which in turn allows agents to decide which desires can become an intention (from a BDI[3] model perspective).

Instrumental arguments' claim is a desire and their premises are mainly composed of desires and resources. Furthermore, other kinds of mental states can also be part of it, such as beliefs and actions. For example, let A be an instrumental argument that represents a plan of a robot to get fixed, the claim is be_fixed and the premise is $has\_refill) \wedge \neg be\_oper \wedge in\_wshop$. Note that the desire is to be fixed, the beliefs are to be in the workshop, not to be operative, and to have the refill. Figure 1 shows this instrumental argument and its sub-arguments namely B and C. Besides, given that during deliberation there is uncertain perceptions, we consider that both beliefs and actions are pervaded with uncertainty. In Figure 1, we can notice that action go_wshop (of argument C) has a certainty degree expressed by the interval $[0.9, 1]$ and belief has_refill and action $turn\_off$(both of argument B) have $[0.7, 1]$ and $[0.8, 1]$ as certainty degrees, respectively.

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[3] BDI is the acronym for Belief-Desire-Intention model [9].

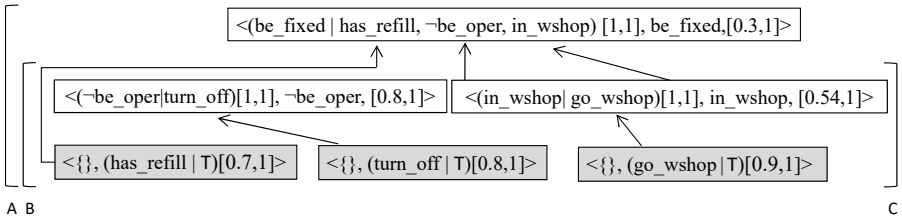

Fig. 1. Tree of instrumental arguments A, B, and C. Gray-filled rectangles represent the leaves of the tree.

Against this background, our goal is to study and propose a way of measuring the strength of instrumental arguments. Thus, the research questions that are addressed in this work are:

- How to measure the strength of an instrumental argument considering that its premise have uncertain elements?
- Given that an instrumental argument has elements in its premise of different nature, is there only one way of measuring its strength?

Next section presents the proposal for measuring the strength of instrumental arguments and Section 3 presents the conclusions of this work.

2 Proposal

In addressing the first question, we propose to use a coherence-based probability logic approach (see [7]) for dealing with uncertainty, which will be expressed in form of intervals that are assigned and/or calculated for each uncertain element of the argument[4]. Thus, after the final calculation the argument has an associated interval that is calculated based on the uncertainty of its premises. Lastly, the argument's strength is calculated based on this interval. We use the approach of Pfeifer [6] to calculate the strength of instrumental arguments from this interval. This approach is based on two criteria: the precision of the interval and the location of it such that the higher the precision of the interval is and the closer to 1 the location of the interval is, the stronger the argument is. We call this one **logical strength**.

Thus, given an argument A whose associated probabilistic interval is $[l, u]$. We represent the logical strength value of A by means of a three-dimensional vector: $\langle \texttt{COMBINATION}(A), \texttt{PRECISION}(A), \texttt{LOCATION}(A) \rangle$, where:

- $\texttt{PRECISION}(A) = 1 - (u - l)$
- $\texttt{LOCATION}(A) = \frac{l+u}{2}$
- $\texttt{COMBINATION}(A) = \texttt{PRECISION}(A) \times \texttt{LOCATION}(A)$

[4] The values of the probabilistic intervals are between zero and one ($[0, 1]$), where 0 stands for the minimum value and 1 for the maximum one.

With respect to the second question, let us recall that the other elements of an instrumental argument are desires and resources, which does not have attached a probabilistic interval, but they may have a preference value and a cost value, respectively. We can use these values in order to measure an instrumental argument from other perspectives. The first one is not a novel idea since it was already proposed in [8] and considers the cost of performing the plan represented by the instrumental argument. We can call this one **utility strength** and it is calculated adding up all the desires' preference values and subtracting the total cost of performing the plan.

We have also identified another perspective to measure the strength of an instrumental argument, it is related to how achievable each desire of the premise of the instrumental argument is. With achievable, we refer to how close a desire is to become an intention. Thus, when a given desire is difficult to be achieved (that is, it does not advance in the intention formation process), it obviously has influence on achieving the desire in the claim of the instrumental argument, because it means that the desire in the claim will also be difficult to reach. We call this one **achieving strength** and we propose to use the model of Castelfranchi and Paglieri [3] called Belief-based Goal Processing (BBGP). This model is an extension of the BDI and unlike it, has four stages and four different statuses. Thus, in BDI there are two statuses, namely desires and intentions whereas in BBGP there are four statuses, namely active, pursuable, chosen, and executive. Figure 2 show the comparison of both models.

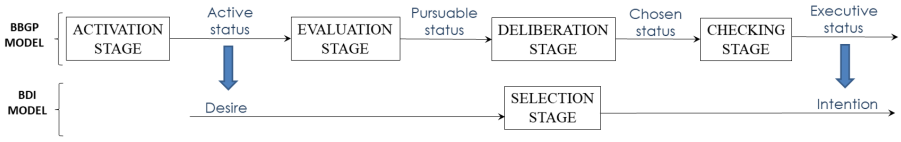

Fig. 2. Intention formation process for BBGP and BDI models.

3 Final Remarks

We have identified three ways for measuring the strength of instrumental arguments. We are still analysing and studying if other kinds of measures can be determined and also the properties of these three measures. We would also like to study other approaches of probabilistic logic in order to obtain tighter intervals, if possible.

This approach can be applied in real engineering problems. As one can see in the example, this kind of approach can be used in robotic applications in order to endow a robot when he has de necessity to recognize and decide about the intentions he should pursue. Another application is in the spatial planning problem, which aims to rearrange the spatial environment in order to meet the needs

of a society [4]. As space is a limited resource, it causes that the planner finds conflicts in the desires and expectations about the spatial environment. These desires and expectation can be modeled as a set of restrictions and conditions (e.g., suitability, dependency, and compatibility), which can be seen as desires. Thus, the planner can be seen as a software agent that has to decide among a set of conflicting desires. It could also be applied during a design process, in which inconsistencies among design desires may arise and this results in design conflicts [2].

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