A Model for a Motivational System Grounded on Value Based Abstract Argumentation Frameworks

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Abstract. Digital interventions for promoting behavioural changes have become more and more prevalent, due to the ubiquitous role played by the Web 2.0. Not many of these programmes are however grounded on well established theories, both from a psychological and from a dialogue perspective. We present in this paper a model for incorporating a general framework for abstract argumentation, into a motivational intervention based on the Transtheoretical Model of Behaviour Change. A preliminary implementation of the model as a proof of concept has been carried out on the domain of healthy eating.

Keywords: Motivation, health promotion, argumentation systems.

1 Introduction

Digital interventions to promote healthy lifestyles are more and more ubiquitous. [13] offers a detailed overview of Internet based interventions, and conclude that, as their effect can vary substantially, it is important to identify the parameters that can contribute to their success. Their analysis seems to suggest that more successful interventions are strongly grounded on theory, especially if the theory deals with planned behaviour, and that using a variety of techniques which could impact different stages of the changing process is crucial, as well as the use of different styles of interactions. In this paper we show how insights from a relatively new research field, Argument and Computation [10], can be utilised to augment the design of a motivational system, based on the Transtheoretical Model of Change. A small prototype has been implemented, in the domain of healthy eating. This paper, after introducing some relevant background literature, will discuss the design of the system, and show a walked-through example to demonstrate the way we envisage this system to work.

2 Background

The Transtheoretical model of Change [9] is a widely accepted theory that attempts to model how people modify their behaviour. The model suggests that

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people progress through "stages of change", from a first *precontemplation* stage, when people see no problem with their current behaviour, up to a *maintenance* stage, where the new behavior is continued on a regular basis. In each of the stages, an advisor can use various strategies to foster movement to the next stage. In particular, when people have to move from precontemplation to *contemplation*, a stage where it is clear that there is a problem to address, information alone is not sufficient, and it has been argued that appeal to persuasion or argumentation could be beneficial [3,11]. Therefore it makes sense to explore what research fields like persuasive technologies or argument and computation can contribute to the problem specification. In particular, we were interested in those theories which explicitly model extra-rational factors in the argumentation process, such as perspectives and values. A recent work [12] in particular attempts a systematic definition of the concept of "value" and the way this can be used in pragmatic argumentation to reason about goals, augmenting the "Value-Based Argumentation Framework" as defined in [2]. The system presented in this paper is based on this work, and uses the definitions of values and perspectives as described in the paper. This section gives a brief overview of these notions, but we refer to the paper for a more extensive description.

Perspectives

A state of affair can be evaluated from different points of view, or perspectives. This allows to express concepts like: from the "health" perspective t is preferable to s, while from a "travel comfort" perspective, the opposite is true. A **perspective** is defined by [12] as a pre-order on states in a certain domain, and is denoted with $\leq p$. We use p,q,r to denote perspectives. When $s \leq_p t$ (where s and t are states), we say that t is at least as preferred as s from perspective p.

The same state of affair can be evaluated from different perspectives. In some cases it is not known which of two states is preferred from a given perspective, but one can assume that one perspective is influenced by another. For example one can assume that perspective $p =$ *"Being successful"* **positive influences** perspective $q =$ *"Happiness"* thus if a state is preferred from p, it will be preferred from q too. We denote that a perspective p positively influences the perspective q with notation $p \uparrow q$ and similarly we use $p \downarrow q$ for a negative influence.

Perspectives influencing each other may create **influence chains**. These chains can be represented with a directed graph (Fig. 1) where the dashed arrows indicate a negative influence, while the solid ones a positive influence. The left graph denotes how perspective p positively influences q, which in turn negatively influences r. It follows that p negatively influences r (right graph).

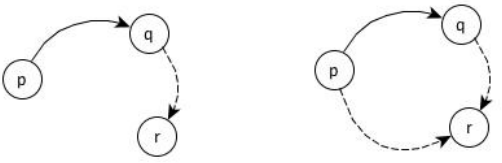

Fig. 1. Perspective Influence Chain

Values

Perspectives are subjective points of view and are not necessarily shared by every agent in the dialogue. The way in which an agent reasons with perspectives is based on the agent's set of values and preferences. An **agent preference** is a pre-order on states denoted with $<_\alpha$. When $s <_\alpha t$ we say that agent α prefers state t to state s. Therefore agent preferences are perspectives which an agent considers valid. If one or more preferences maximise a particular perspective, this perspective is considered a value for that agent. A **value** is therefore a perspective maximised from one or more agent's preferences. Starting from an agent's values, it is possible to infer other agent's preferences, kept implicit in the user model, by finding those which maximise his values.

Values can also be in an order relationship, to allow for situations in which, for example, a user may prefer the value Health to Happiness, and thus will choose a state transition that maximises Health over one that maximises Happiness. A **Value System** is a pre-order on values, and is denoted with $\prec_\alpha$. When $W \prec_\alpha V$ we say that agent α prefers to promote the value set V over the value set W. Transitions may promote or demote a particular value set:

- **pro:** function $pro : S \times S \rightarrow V$ determines the values promoted by a transition from a state to another. This function is defined as: $pro(s,t) = \{v \in V_\alpha \mid t <_v s\}$. When $pro(s,t) = V$ we say that the transition from s to t promotes V.
- **dem:** function $dem : S \times S \rightarrow V$ determines the values demoted by a transition from a state to another. This function is defined as: $dem(s,t) = pro(t,s) = \{v \in V_\alpha \mid t <_v s\}$. When $dem(s,t) = V$ we say that the transition from s to t demotes V.
- **Neutral transition:** when a transition from s to t neither promotes nor demotes a value ($v \notin (dem(s,t) \cup pro(s,t))$ we say that that transition is neutral for that value.

By means of the value ordering and the functions *pro* and *dem*, it is possible to derive α preferences.

3 System Description

The system's architecture is shown in Fig. 2. The jVS dialogue manages the interaction with the user. It is build on top of an ASPIC type dialogue [1], which is an implementation of a dialogue game based on an abstract argumentation

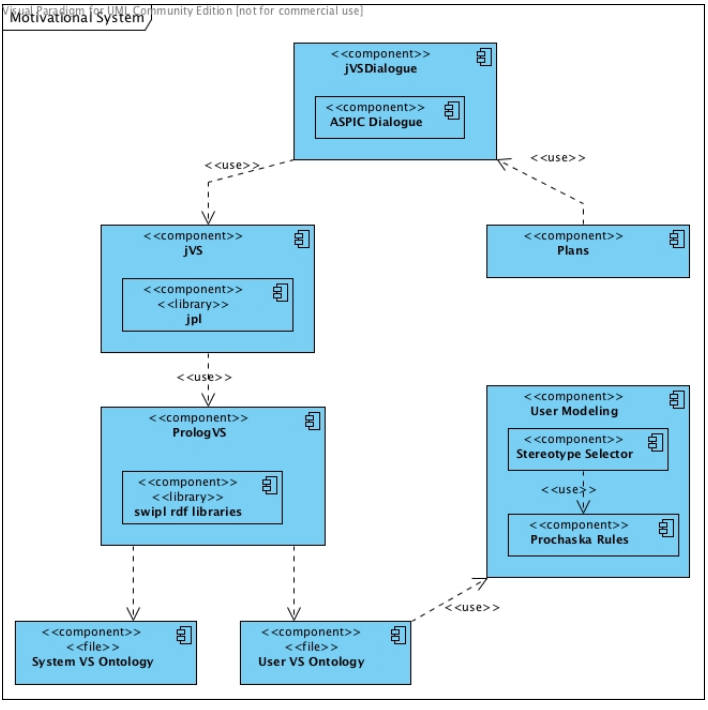

Fig. 2. System Architecture

framework. The jVS interfaces the dialogue component with the reasoning engine, a set of prolog libraries which reason about the value systems according to the theory at [12]. The libraries use information from a set of ontologies describing the stereotypical model of a user in each of the 6 stages of change, according to the Transtheoretical model, as well as the set of values and perspectives which can be applied to a state of the world. The system maintains one belief model, in form of an ontology, for each user of the system, as well as the system's own. Aside from domain related notions, the model of values and preferences in the ontology is shown in Fig. 3. The User Modelling component chooses the appropriate stereotype for the user, from information retrieved during the interactions, on the basis of a widely used Transtheoretical model questionnaire. The Plans component manages the plans used by the system to build the interaction with the user in each stage.

The interaction is driven by discourse plans describing the evolution of the motivational strategy. A plan consists of domain knowledge, eliciting questions to build the user model of their values, suggestions to the user depending on which stage the user is in, and motivational expressions to operate some positive reinforcement when the user succeeds in achieving a goal. The plan content depends on the stage of change of focus at any one time, as to each stage corresponds a different set of goals. For instance in the precontemplation stage one goal might be raising awareness of the problem the user is facing.

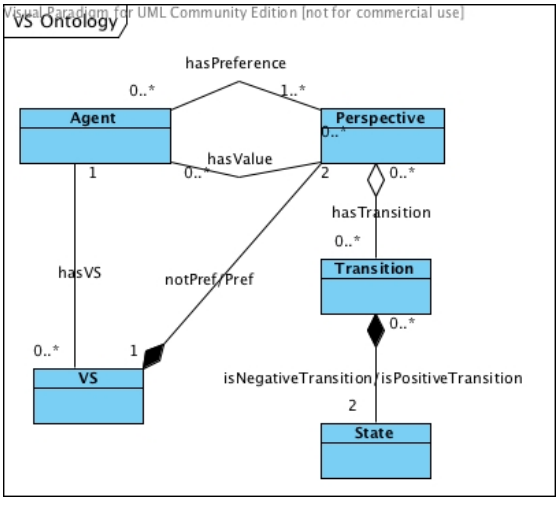

Fig. 3. Value/Preference Ontology

The main drive for deciding what to say is the user's stage of change. The discourse plan, on the basis of the different stages of change, identifies appropriate argumentation paths in the VS. One of the paths is chosen on the basis of the user model (taking into account what the user already said and whether the user had already 'accepted' some argumentations beforehand). The use of a VS path allows to detect inconsistencies in the user's system of values. In this paper we show the value systems using a very simple, preliminary, formalisation, not comprising the stage of change user profile, that has mainly the purpose of better explain how the system manipulates values and how they are connected together. In the remainder of the section, an example will help understand this mechanism.

3.1 A Walked through Example

Let us suppose the system contains the states: (i) Eating junk food less than 4 times a month; (ii)Eating junk food between 4 and 8 times a month; (iii) Eating junk food more than 8 times a month, while the perspectives to evaluate the states are Healthy eating; Fitness; Health; Social life. Let us also suppose that the following pre-order applies in, respectively, the system's set of beliefs (left) and the user's set of beliefs (right):

System's VS	User's VS
Healthy Eating $\uparrow$ Fitness	-
Fitness $\uparrow$ Social life	Fitness $\uparrow$ Social life
Fitness $\uparrow$ Health	-
Social life $\prec$ Health	Social life $\prec$ Health

At the start of the interaction, the user makes no connection between healthy eating and health, therefore the user justifies some behaviours, like eating too much junk food, without loss of coherence in his system. Also, the user values

health and social life, with the former preferred over the latter, therefore if the system succeeds in showing that some behaviour is negatively affecting health, the user might agree that it is a behaviour that should be modified. Let us suppose the dialogue is concerned with the transition:

A = Eating junk food more than 8 times a month is preferred to Eating junk food less than 4 times a month

The user has a preference for the transition, while the system considers A a transition the user should avoid, as the perspectives that A demotes are more than those which A promotes. But in the user's model, the user is not "aware" of all A's negative impacts. The situation is therefore:

System's VS	User's VS
Perspectives that the transition A promotes	
Social Life	Social Life User's preferences
Perspectives that the transition A demotes	
Healthy Eating Fitness Health Social Life	

The argumentation the system may attempt with the user is therefore:

> *Eating junk food more than 8 times a week, instead of less than 4 times a week, is not advisable because your Health would be penalised, because A penalises healthy eating, which in turn promotes fitness, which in turn promotes health.*

The system hopes that by integrating these new connections, the user would be persuaded that the transition is negative. The VS focuses on the health perspective, because the user has indicated this is preferred over other perspectives. If the user accepts the line of reasoning above, the image of the user's VS will be modified as in Fig. 4. A screenshot of the system corresponding to one phase in this dialogue is shown in Fig. 5.

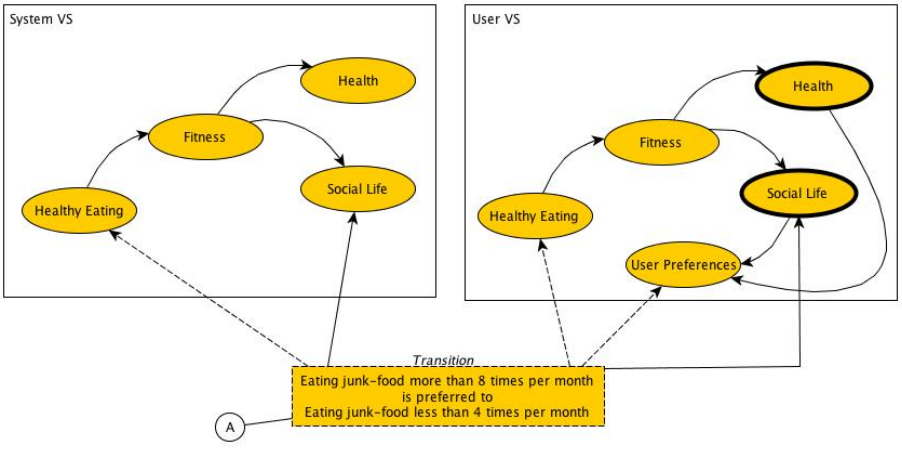

Fig. 4. User and System's VS after the interaction in the example

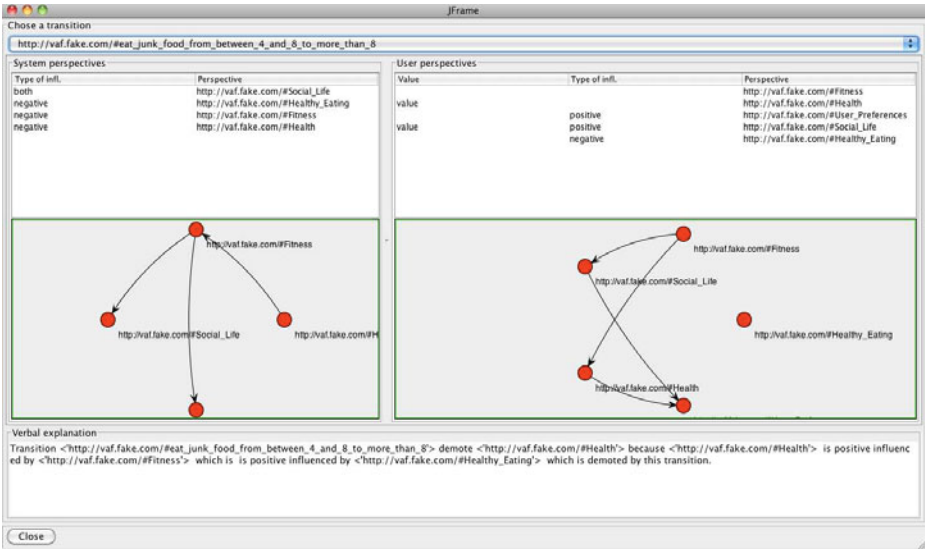

Fig. 5. Screenshot of the system for the example

4 Conclusion

This paper provides a practical, although prototypical, demonstration of a motivational system that uses the Transtheoretical Model [9] and the Value System [12] to adapt the interaction on the basis of the user's state of change and on his personal values.

Other work has been done on digital intervention for motivation, using similar theories and ideas. [5] presents a motivational system to stop smoking that interacts with the user via phone text. The system texts users periodically with messages that encourage to persevere, and that focus on their success so far. Users can also text the system in case they crave for cigarettes, receiving messages that help them to carry on with the quitting attempt. The paper proves that this way to interact with the user considerably increases the rate of success of the smoke cessation intervention. In [7] the Transtheoretical Model and various motivational techniques are used for motivating people to save energy. They successfully apply well known theories to new contexts, paying much attention to the system's capability of understanding which changing stage the user is in. The system is however still at a theoretical stage. [6] presents a software aimed at behavioural researchers, where they can build platforms to test their interventions on real users and process the results. Researchers are provided with an end-user development environment where they can build their own interfaces and facilities that will be used by their test subjects, giving them tailored advice. Similar tools are intended to be used for the system in this paper.

The system presented in this paper has been implemented as a prototype. The argumentation component is fully implemented, while the strategic component

is still at a design stage. The role of natural dialogue for interacting with the system has been left for the moment outside the scope of this work. Testing of the system showed that it is able to provide very simple argumentation, and it is envisaged that with more complex ontologies and with an interface with a NL dialogue system it will be possible to obtain more complex and convincing natural dialogue with the user. A small evaluation is being designed as a Wizard of Oz experiment [8], and plans are under way to adapt the system so that it can be interfaced with an embodied conversational agent developed at the first author's research lab [4].

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