MAP: A Computational Model for Adaptive Persuasion (Extended Abstract)

Yilin Kang
School of Computer Engineering
Nanyang Technological University
Singapore 639798
kang0028@ntu.edu.sg

Ah-Hwee Tan
School of Computer Engineering
Nanyang Technological University
Singapore 639798
asahtan@ntu.edu.sg

ABSTRACT

While a variety of persuasion agents have been created and applied in different domains such as marketing, military training and health industry, there is a lack of a model which provides a unified framework for different persuasion strategies. Specifically, persuasion is not adaptable to the individuals' personal states in different situations. Grounded in the Elaboration Likelihood Model (ELM), this paper presents a computational model called Model for Adaptive Persuasion (MAP) for virtual agents. MAP is a semi-connected network model which enables an agent to adapt its persuasion strategies through feedback. We have implemented and evaluated a MAP-based virtual nurse agent who takes care and recommends healthy lifestyle habits to the elderly. Our user study show that MAP-based agents are able to change others' attitudes and behaviors intentionally, interpret individual differences between users, and adapt to user's behavior for effective persuasion.

Categories and Subject Descriptors

H.4 [**Information Systems Applications**]: Miscellaneous

General Terms

Human Factors, Model

Keywords

Agent, Adaptive, Persuasion, Social behavior

1. INTRODUCTION

Although persuasion has been heavily researched in the fields of psychology and social science for many years, a number of aspects remain poorly understood, especially how persuasion can really be persuasive at an individual level [3, 2]. In this paper, we focus on making the persuasion more adaptive to different individuals' personal states through the right strategy.

We propose a unified framework for personalized persuasion based on the Elaboration Likelihood Model (ELM) [1]. ELM is a theory of the thinking processes that might occur when we attempt to change a person's attitude through communication. Where people fall along this continuum is determined by their motivation and ability to process the message presented to them. When motivation and ability to think are high, individuals are inclined to go down a "central route to persuasion", but when motivation is low or ability to process is hindered, people are more likely to go down a "peripheral route to persuasion". Central route processes are those that require a great deal of thought, and are therefore likely to predominate under conditions that promote high elaboration. Some of the main strategies under central routes are *Logic, Reasoning, Example, Evidence and Facts*. The tactics for the peripheral route can be overwhelming. Theorists have varied in how they individuate influence strategies. Some of the most acceptable strategies includes *Reciprocity, Liking, Social proofing, Consistency, Authority and Scarcity.*

Based on ELM, we present a computational model called Model for Adaptive Persuasion (MAP) for virtual agents. It is a semi-connected network model which enables an agent to adapt its persuasion strategies through feedback. By incorporating MAP, an agent will be able to identify which route of thinking may be involved and learn the user's personal state from the user's feedback. We have developed a virtual nurse agent, called Sophie, based on MAP in a 3-D virtual home environment. A pilot user study has shown that compared with the single best persuasion strategy method, the MAP-based virtual agent achieved a significantly higher rate of successful persuasion.

2. MODEL AND DYNAMICS

Following the theory of ELM, Fig 1 shows the general architecture of the Model for Adaptive Persuasion (MAP). It is a semi-connected network model which employs three layers, namely an internal layer, a route of thinking layer and a strategy layer. The internal layer comprises two nodes, namely the motivation node and the ability node. The route of thinking layer consists of two nodes: the central route node and the peripheral route node. The strategy layer includes eleven strategy nodes. The first five nodes ($S_1 - S_5$) are strategies under the central route, and the rest ($S_6 - S_{11}$) are strategies under the peripheral route.

Internal State: Let $\mathbf{X} = (x_m, x_a)$ denote the activation vector of a user's internal state that will influence that user's route of thinking, where x_m is the activation value of the user's motivation and x_a is the activation value of the user's ability.

Route of thinking: Let $\mathbf{Y} = (y_c, y_p)$ denote the activation vector of the user's route of thinking, where y_c is the activation value of the central route and y_p is the activation value of the peripheral route.

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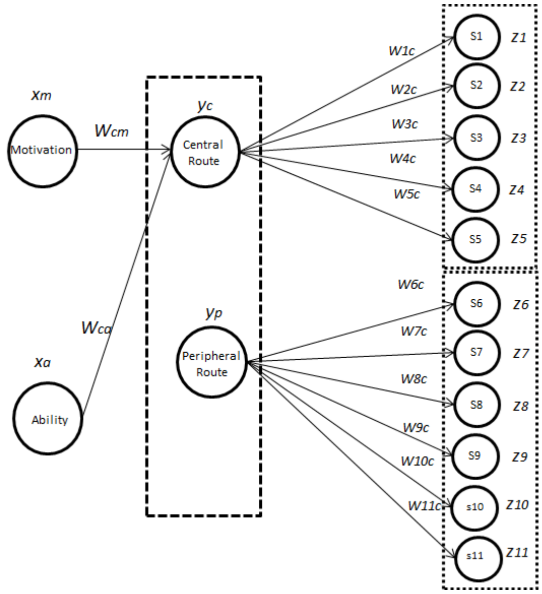

Figure 1: Model for Adaptive Persuasion (MAP).

Strategy: Let $\mathbf{Z} = (z_1, z_2, ..., z_n)$ denote the activation vector for the strategies, where z_j indicates the activation value of strategy j, for $j = 1, ..., n$.
Eligibility vectors: Let $\mathbf{E} = (e_1, e_2, ..., e_n)$ denote the eligibility vector of strategy, where e_j indicates the eligibility value of the different strategies j, for $j = 1, ..., n$. Initially, e_j are all 1's. Once a strategy j is selected for use, the eligibility value e_j is set to 0.
Weight vectors for central route: Let $\mathbf{W_r} = (w_{cm}, w_{ca})$ denote the weight vector for the central route, where w_{cm} indicates the weight value from node *Motivation* to node *Central route*, and w_{ca} indicates the weight value from node *Ability* to node *Central route*.
Weight vectors for strategies: Let $\mathbf{W_s}$ indicate the weight vector of strategy. Initially, the weight of strategy j $w_{jk} = \delta$, where $j = 1, ..., n$, $\delta \in [0, 1]$, $k \in \{c, p\}$.

The dynamics of the MAP model is summarized in Algorithm 1.

3. CASE STUDY

We developed two versions of virtual nurse agents who specialize in healthcare advice and recommendation. The first virtual nurse (E1), named Abby, persuades using the best strategy (chosen by user) and provides the baseline control condition. The second virtual nurse Sophie (E2) provides the treatment condition, wherein MAP is embodied.

The scenario given to the subjects was one wherein the virtual nurse tries to persuade the user to do exercises and eat healthy food. 26 subjects aged from 56 to 75 were recruited. Subjects were provided with a set of detailed instructions on the experimental procedures. Before the experiment began, the experimenter conducted a short tutorial session to familiarize the subjects with the basics of the environment and how to interact with the virtual nurse. After the tutorial, the subjects completed a pre-study questionnaire which included demographics information and preferred persuasion strategy. After a subject finished interacting with the virtual nurse, another questionnaire was administered. The results show that 17 people out of 26 (65%) have been successfully persuaded by the MAP-based agent Sophie, whereas only 9 out of 26 (35%) have been persuaded by the single strategy based agent Abby.

Algorithm 1: Dynamics of the MAP model

Initialize the network;
Given the internal state vector $\mathbf{X}$ and the weight vector $\mathbf{W_r}$, the value of the route of thinking is determined by $y_c = \sum_{i=m,a} w_{ci} x_i$. If $y_c > 0.5$, the central route will be activated, otherwise, the peripheral route will be activated;
while *persuasion has not succeeded* **do**
    Given the activation values of the route of thinking vector $\mathbf{Y}$, the weight vectors for strategies $\mathbf{W_s}$, and the eligibility vectors $\mathbf{E}$, the activation value of z_j is computed by $z_j = \sum_{k=c,p} y_k w_{jk} e_j$;
    All the nodes for strategies undergo a code competition process, $z_J = \max\{z_j : \text{for all } j = [1, ...n]\}$;
    Adopt the winning node J's strategy and update the eligibility value so that $e_J = 0$;
    Perform the strategy J, observe the received reward r (if any) from the environment;
    if r *exists* **then**
        Adjust the weight vector $\mathbf{W_s}$: $\Delta w_{Jk} = \alpha(1 - w_{Jk})r - \delta_{w_{Jk}}$; $w_{Jk}(t + 1) = w_{Jk}(t) + \Delta w_{Jk}$;
    else
        Reapply the strategy in a different way;
    Update y_c and y_p ;

4. CONCLUSION

This paper has examined the gaps between the theories of persuasion under the domains of psychology and social science and agent technology, specifically, the lack of computational methods which can adapt to different individuals' preferences based on these theories. To this end, we have proposed MAP which can be embodied into agents to enable adaptive persuasion. Experiments on real users have validated our approach and model.

5. ACKNOWLEDGMENTS

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