Reducing Diffusion Time in Attitude Diffusion Models Through Agenda Setting*

(Extended Abstract)

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ABSTRACT

Attitude diffusion is when "attitudes" (general, relatively enduring evaluative responses to a topic) spread through a population. Attitudes play an incredibly important role in human decision making and are a critical part of social psychology. However, existing models of diffusion do not account for key differentiating aspects of attitudes. We develop the "Multi-Agent, Multi-Attitude" (MAMA) model which incorporates several of these key factors: (1) multiple, interacting attitudes; (2) social influence between individuals; and (3) media influence. All three components have strong support from the social science community. Using the MAMA model, we study influence maximization in a attitude diffusion setting where media influence is possible – we show that strategic manipulation of the media can lead to statistically significant decreases in diffusion of attitudes.

Categories and Subject Descriptors

J.4 [**Computer Applications**]: Social and Behavioral Sciences

Keywords

social simulation, attitude dynamics, cognitive consistency, mass-media, social network, diffusion

1. INTRODUCTION

Attitudes are "general and relatively enduring evaluative responses to objects" where objects can be "a person, a group, an issue or a concept" [5, Page 1]. Attitudes form a cornerstone of social psychology and are incredibly important to the decisions and behaviors of humans. In the past 50 years, numerous studies and meta-reviews have shown that attitudes impact behaviors in a variety of domains (see [2] for a review), such as product purchasing (like purchasing energy efficient products), or health related behaviors (such as vaccination).

Given that attitudes inform important behavior and that attitudes can change due to social influence, we feel it is important to study attitude diffusion using multi-agent social simulation which allows us to capture non-linear, emergent phenomenon. However, current diffusion models do not capture the key characteristics of attitude change and attitude diffusion.

Our objective in this paper is to propose a simple computational model that captures the effect of multiple, interacting attitudes and media influence and thus lead to developing more sophisticated models focused on the important problem of attitude diffusion. We call our model the "Multi-Agent, Multi-Attitude" (MAMA) model.

Theoretical Background The MAMA model is based on strongly supported theories from the social sciences.

Cognitive consistency is a hypothesized drive for individuals to have attitudes that are "consistent" with each other. Cognitive consistency is an important factor in attitude change [4]. For instance, according to these theories, an individual holding a strong positive attitude towards environmentalism should also hold a strong positive attitude towards recycling; if they do not, the attitudes are inconsistent with each other and could cause an uncomfortable feeling (i.e. *cognitive dissonance*) which tends to result in either attitude or behavior change [2]. We operationalize two factors: (1) Attitudes that are inconsistent with other related attitudes are more *likely* to change; (2) Attitudes that are related to many other attitudes *resist* change (embededness)[2, Chap. 12].

Agenda setting is when the media's focus on certain stories increases their importance in the minds of the viewers [6]. Agenda setting and interpersonal communication interact to influence individuals. In the early "two-step" model, media was thought to influence "opinion leaders" who then interacted and influenced others [3]. While the two-step model has lost support, the general idea of media influencing the agenda, which in turn spurs discussion and interpersonal influence, has some support [6].

2. MAMA MODEL

The Multi-Agent, Multi-Attitude (MAMA) model contains two levels. The *social* level captures interpersonal interaction between agents (Figure 1) through a social network.

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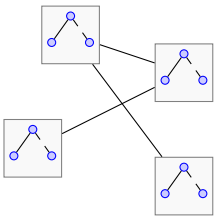

Figure 1: Social network.

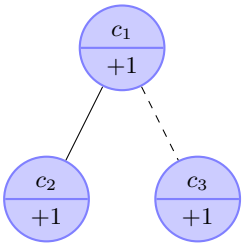

Figure 2: Cognitive network.

The *cognitive* level (Figure 2) captures the interaction of attitudes *within* an agent. We represent the cognitive network as a *bi-valued, binary constraint satisfaction network* [1]. In Figure 2 dashed lines are negative relationships and solid lines are positive relationships. Each node is a "cognition" (some topic, like "environmentalism") and the value at the bottom is the attitude toward the cognition (positive or negative).

Attitude change

In our model, attitude change is initiated by interpersonal interaction, but mediated by the state of the cognitive network. Given no cognitive influence, there is a baseline probability that an agent changes their attitude.

Drive for cognitive consistency

In Figure 2, cognition c_1 is in an inconsistent state with cognition c_3 – the link between them is negative, so they should be opposite, however there are positive attitudes towards both cognitions. Based on cognitive consistency theory, we should expect c_1 to be more likely to change. On the other hand, cognitions that are highly consistent should be less likely to change.

We represent this drive for consistency as a multiplicative weight on the baseline probability.

Embededness

In Figure 2, cognition c_1 is connected to two other cognitions vs. c_2, which is only connected to 1 other cognition. Thus, we would expect c_1 to have more resistance to change than c_2 or c_3 due to it's embededness.

We represent this resistance to change as a multiplicative weight on P_{base}.

Agenda Setting We define agenda setting in terms of the choice of attitude to focus on. In each timestep of the system a pair of agents interact and one of the agents changes it's attitude towards the topic cognition with probability proportional to the product of the baseline probability and the factors mentions above.

An agenda defines the current topic. There are two types of agendas, a uniform agenda (choosing a topic cognition uniformly randomly) and a time varying agenda (TVA) where we choose topics in a sequential manner.

Experiment Figure 3 shows results of an experiment testing a uniform agenda vs. a TVA. The TVA focused on cognition c_2 with probability p until the boundary value, then switched to a uniform agenda. The x-axis is the boundary value, y-axis is mean diffusion time, and the lines are different p. The uniform agenda is a TVA with boundary value 0 or $p = .3$ (the red line).

We can see that the TVA does significantly better than the other options, but only up to a certain boundary point.

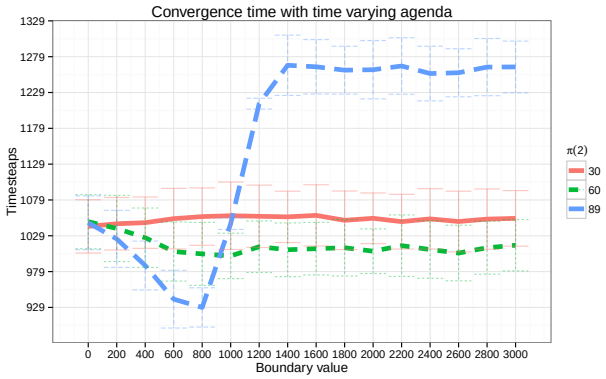

Figure 3: Mean diffusion time (to 90%) over 100 runs with a time varying agenda. Regular graph, $k = 2, n = 1000$. Cognitive network for each agent was the same as Figure 2.

3. CONCLUSION

Agent-based simulation is an important tool that allows empirical study of complex interactions, in our case between interpersonal influence and attitudes. In this work, we developed a novel agent based model that captures social and cognitive factors that affect decision making (the MAMA model). We used agent-based simulation to study the impact of agenda setting on diffusion time within the MAMA model. We found that merely setting the order of topic cognitions can dramatically decrease the time to diffusion.

What do these results suggest for a hypothetical influencer who has access to the media? First, it is important to understand the underlying attitudes and their interaction towards a decision. The links between attitudes can have large effect on their diffusion.

Second, these results suggest a multi-stage ad campaign is better than a single campaign focused on all the attitudes going into a decision.

REFERENCES

[1] R. Dechter. From local to global consistency. *Artificial Intelligence*, 55(1):87–107, May 1992.

[2] A. H. Eagly and S. Chaiken. *The Psychology of Attitudes*. Wadsworth Cengage Learning, 1993.

[3] E. M. Rogers. *Diffusion of Innovations*. Free Press, fifth edition, 2003.

[4] J. E. Russo, K. A. Carlson, M. G. Meloy, and K. Yong. The goal of consistency as a cause of information distortion. *Journal of Experimental Psychology: General*, 2008.

[5] P. S. Visser and L. M. Clark. Attitudes. In A. Kuper and J. Kuper, editors, *Social Science Encyclopedia*. Routledge, 2003.

[6] H. N. N. Vu and V. Gehrau. Agenda diffusion: An integrated model of agenda setting and interpersonal communication. *Journalism & Mass Communication Quarterly*, 87(1):100–116, Mar. 2010.