Modeling Memes, A Memetic View of Affordance Learning

Benjamin D. Nye (benjamid@seas.upenn.edu)
School of Engineering and Applied Science
Department of Electrical and Systems Engineering
3320 Smith Walk
Hayden Hall, Room 120B, ACASA Lab
Philadelphia, PA 19104

Keywords: Memes; Information Theory; Social Psychology; Social Learning Theory; Systems Theory; Affordance Theory; Agent Based Modeling; Cognitive Agents

Overview

The purpose of this doctoral research is to apply a systems approach to defining and understanding memes. A meme is a piece of social information which transmits and replicates within a society (Heylighen, 1998). Memetics allow insight into the evolution of ideas and behavior, a fundamental question pertinent to all fields of social science. Three mechanisms guide the evolution of memes: reproduction, variation, and selection (Dennett, 1995). These mechanisms have to be understood in terms of empirical research on individual, social, and environmental factors that influence transmission and change of ideas. However, the body of relevant empirical study and theory is vast. This raises the basic research question: What synthesis of theories usefully explains meme behavior? The thesis of this research addresses this question using a three step process:

1. Synthesis of Theories - A conceptual model is synthesized which connects social science research to the mechanisms guiding meme transmission and evolution.
2. Computational Model - A cognitive agent simulation model is coded which operationalizes insights and theory captured by the conceptual model.
3. Testing the Model - Experiments conducted using the model examine the validity, flexibility, and types of insight the computational model provides.

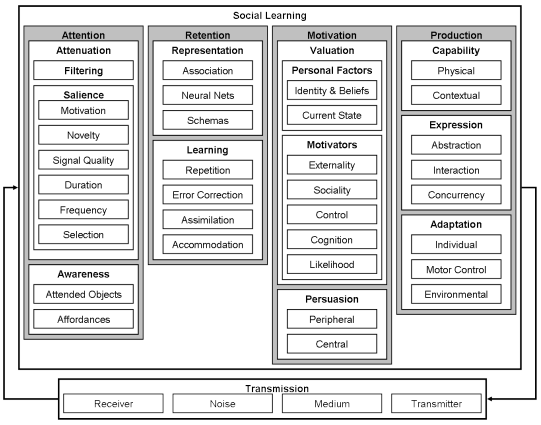
Hypotheses

This process is being used to test three hypotheses. The first hypothesis is that the theoretical relationships used to build the computational model will be statistically significant in the data collected from simulation runs. This hypothesis is intended to show internal validity. For example, the halo effect states a positive correlation of the likeability of a source with their persuasiveness. For this to hold true, a meme should be more likely to be repeated when received from a likable source. Relationships will be reported from the collected data by running logistic regression and statistical tests are being used to test significance.

The second hypothesis is that this model will provide a effective framework for representing and analyzing individual and situational characteristics that influence meme fitness. This hypothesis will be tested by applying classification techniques to detecting agents that receptive or resistant to different memes. The differences between classes will be examined statistically. These classifications will be compared against a human analysis of the scenario, as part of basic Turing test.

The third hypothesis is that memes can improve its correspondence with empirically collected behavioral data. This test involves building a scenario based on empirical data by tuning the scenario based upon personality factors and behavioral frequencies. The behavior of most interest is the first time an agent takes an action that express a meme. The order that agents first express memes can then be statistically compared against the real world observed ordering. The independent variable in this hypothesis is the set of agents who are initially aware of the meme. For this hypothesis to hold true, the trials with meme transmission must match the real-world ordering better than the trials where no social learning occurs (due to agents starting with full information). This tests if the propagation pattern improves the match of behavior to the ground truth.

Figure 1: Conceptual Model for Meme Transmission

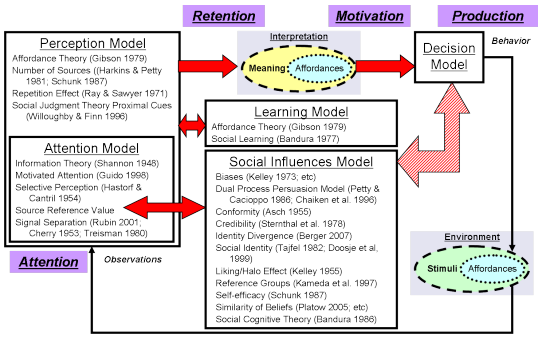


Experimental Design

As part of the thesis proposal, Shannon Information Theory and Bandura Social Learning Theory were synthesized to form an end-to-end model for retransmission of memes (Bandura, 1986; Shannon, 1948). Information theory considers the effects of noise and environmental influences on a physical transmission. Social learning theory considers the

processes that affect an agent's likelihood of repeating a transmission to which it is physically exposed. Social learning has a concept of observational learning that consists of 4 steps: attention, retention, motivation, and production. The synthesis of information theory and social learning theory provides a conceptual framework for connecting empirical findings together into a single process. Findings from perception, social psychology, learning, marketing, and other fields have been connected within this conceptual framework as noted in Figure 1. The thesis proposal for this project provides a significant mapping of theories into this framework, along with their implications for the mechanisms of meme evolution.

Figure 2: PMFServ Implementation of Meme Transmission



Based upon this synthesis of literature into a unified model, a simulation consisting of cognitive agents has been built using the PMFServ socio-cognitive agent architecture (Silverman, 2004). Figure 2 shows the key elements of the conceptual model that implemented as cognitive components for PMFServ agents. These agents are simulated within a shared environment, with meme transmission occurring when agents learn about affordances from each other's behavior. This implementation will concentrates on the cognitive factors that affect memes. The agents used within this model consider not only the intrinsic information of a meme, but also the appeal of the source, and the influence of the environment. Computational models for social influence, attention, and learning have been implemented according to empirically based findings and theory. The halo effect (Kelley, 1955), selective attention (Simons & Chabris, 1999), and conformity (Asch, 1963) are examples of over a dozen constituent theories used to build cognitive components.

The computational model is being used to simulate two scenarios: a reproduction of the Stanford Prison Experiment and an archetypal Iraqi village of Hamariyah based on US Marine Corps human terrain data. The Stanford Prison experiment is an infamous landmark field study in which seemingly normal participants were assigned roles as guards or prisoners in a simulated prison (Haney, Banks, & Zimbardo, 1973). The Stanford Prison experiment scenario has been calibrated and tested using de-identified Comrey Personality inventories and hourly coded behavioral logs. The potential memes in the Stanford Prison Experiment are the practice of throwing prisoners in "the hole" and the spread of prisoner resistance. All three hypotheses will be examined using the Stanford Prison Experiment simulation.

The Iraqi village scenario is being used to examine a pair of competing memes, one for informing to the US group and one for helping to plant an IED. Since there is no ground-truth data, only the first two hypotheses can be examined. However, the Iraqi village will be better suited to classification due to its larger number of agents and actions.

Contribution

The main goal of this research topic is to present a useful conceptual model for the transmission of memes, accompanied by a working and useful implementation. The theoretical contribution of the work has been to synthesize established models to help explain meme dynamics. It has also identified gaps in social science literature where the interaction of different theories is not well understood. The cognitive architecture implementation provides insight into the conceptual model's value for operationalizing and analyzing memes. The end result should help advance the capabilities of simulated societies to analyze real societies.

Acknowledgments

Many thanks to my advisor Dr. Barry Silverman, as well as my esteemed committee members Dr. Tony Smith, Dr. Kathleen Carley, and Dr. Joseph Bordogna.

References

Asch, S. E. (1963). Opinions and Social Pressure. *People and Productivity*.

Bandura, A. (1986). *Social Foundations of Thought and Action. A Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice-Hall.

Dennett, D. C. (1995). *Darwin's Dangerous Idea: Evolution and the Meanings of Life*. Simon & Schuster.

Haney, C., Banks, W. C., & Zimbardo, P. G. (1973). Interpersonal Dynamics in a Simulated Prison. *International Journal of Criminology and Penology*, *1*, 69–97.

Heylighen, F. (1998). What makes a meme successful? Selection criteria for cultural evolution. In *16th international congress on cybernetics* (pp. 418–423). Namur, Belgium: Association internationale de cybernétique.

Kelley, G. A. (1955). The psychology of personal constructs (Vols. 1 & 2).

Shannon, C. E. (1948). A Mathematical Theory of Communication. *Key Papers in the Development of Information Theory*. Available from `http://cm.bell-labs.com/cm/ms/what/shannonday/shannon1948.pdf`

Silverman, B. G. (2004). Toward Realism in Human Performance Simulation. In J. W. Ness, V. Tepe, & D. R. Ritzer (Eds.), (Vol. 5, pp. 469–498). JAI Press.

Simons, D. J., & Chabris, C. F. (1999). Gorillas in our midst: sustained inattentional blindness for dynamic events. *Perception*, *28*, 1059–1074.