Agents and the Algebra of Emotion

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ABSTRACT

Using NAMS (Negotiating Agents and Marital Stability), a couple who is considering marriage is aided in evaluating their compatibility. Using a vector of fundamental emotions, our algebra of emotion allows us to model self-generating emotions (such an interest or anger), have history-sensitive interactions, and accommodate gender differences.

Categories and Subject Descriptors

J.4 [**Computer Applications**]: Social and Behavioral Science—*Psychology,Sociology*; D.m [**Software**]: Miscellaneous—*Software psychology*

General Terms

Human Factors

Keywords

Agents, Negotiation, Personality, Emotion

1. INTRODUCTION

Can software agents be programmed to mimic human behavior so well that humans benefit from observing the automated behavior? This is exactly the goal of NAMS (Negotiating Agents and Marital Stability). Research in the area of marital stability indicates that it is not so much how a couple (Bob and Alice) differs that is important, as there will always be differences. The key issue is in how they deal with those differences [6]. From a counseling viewpoint, the goals of NAMS are (a) to help individuals make appropriate marital decisions, and (b) to motivate an individual to change destructive habits. These stakes are great indeed. As with Computational Organization Theory [1], the costs of modeling and researching relationships before a commitment is made using NAMS are far less than counseling real participants after poor decisions have been made.

From a computer science viewpoint, there are several benefits to considering emotions. First, human machine interactions with agents are benefited. Second, emotions are an abstraction of a complex internal state than can efficiently be communicated. Third, emotions can limit the search space of appropriate responses.

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2. PREDICTING MARITAL STABILITY

Of first marriages, roughly 40-50% will end in divorce under current trends. Thus, divorce affects a significant portion of society. Marital problems are associated with lower work productivity. Adults and children are at risk for greater mental and physical problems [2].

Studies indicate that, with high degrees of accuracy, researchers can predict which marriages will end in failure from information gathered before the couple marries [3]. Thus, a tool like NAMS is particularly important not only because it serves as a diagnostic aid for the counselor, but that interaction behavior can be demonstrated and modified so the individuals can draw their own conclusions. Many of the studies in place are designed to measure problems of an existing marriage, but NAMS is used for couples considering marriage to help them avoid problems that have caused other marriages to fail [6].

It is reported that couples argue most about money and children, but some researchers believe that the specific topic of the argument is not nearly as important as how they argue [10]. Through NAMS, couples see that some patterns of interaction always lead to failure. Women are more likely to start conflict discussions and therefore can often control the argument by not escalating from neutral to a negative conversation [7]. Wedding marital research with emotional agents is beneficial due to the rich body of interaction literature that is utilized. The negotiation will be guided by current research in the area such as social exchange theory and interdependence theory which help to identify goals and interaction strategies.

3. THE EMOTION SYSTEM

Building from earlier systems [8, 11], emotions are triggered by achievement of goals (written in Prolog) or as the likelihood of achieving a goal changes. The data base consists of goals and subgoals, each of which triggers emotion. Thus, when a goal is achieved, the resultant emotion is a composite of individual subgoal emotions and the emotions for the containing goal. Personality and couple interaction style questionnaires are used to select and parameterize specific goals with both triggered emotions and goal importance [5, 3]. As goals are evaluated, a deficiency list of subgoals which need to be achieved (along with their importance) is passed to the action generator. The action generator ranks the possible actions based on their relationship to the deficiency list, the importance, the emotional state of the agent, and appropriateness to the agent personality.

Not only are emotions complex, but they are also dy-

namic, varying both episodically and longitudinally. A negative event can trigger an emotional response that may dissipate within a short time. Other emotions evolve slowly due to maturity, experience, or cumulative history. Some emotions are actually self-generating, e.g., a person may become angry, with cause, but then remain angry because anger feeds on itself. Some emotions fade quickly, while others persist long after the original cause is forgotten.

Izard defines emotional state as "a particular emotion process of a limited duration" and an emotional trait as a "tendency of the individual to experience a particular emotion with frequency in his or her day-to-day life" [9].

Fundamental emotions are interdependent and are interrelated in dynamic and relatively stable ways [9]. Some emotions are organized in a kind of hierarchical relationship (e.g., attention may graduate to surprise), while there is an apparent polarity between other emotions like joy and sadness. Still other sets of emotions have fairly regular relationships [9]. Our model represents these fundamental emotions as discrete and independent components. While this does restrict the model to an extent, most of the inter-relationships observed can be modeled (in the short term) as linear transformations on the emotion vector. The elegant expression of the transformations via matrix algebra is the strength of this model.

Interactions between the agents are affected not only by emotions and personality, but are tailored to express particular concerns raised by the couple questionnaires.

The Transformations

Gmytrasiewicz and Lisetti [4] use a set of transformations on tuples, which they call *emotional transformations*. We use emotional transformations, based on the Gmytrasiewicz work, to effect the following transformations:

Addition of emotions: Basic emotions are created as the weighted sum of the memory vector (emotions due to past events), the response emotion vector, and the personality emotion vector (emotion tendencies due to personality traits).

Combining of emotions: If Bob successfully suppresses fear arising out of past experiences, that is expressed via premultiplication of Bob's emotion vector, E^b, by a combining matrix, C. Note that the superscript b indicates the owner of the matrix. Thus, $E^{b'} = CE^b$

Filtering is similar but involves disabling (or manipulating) certain emotions due to personal beliefs. For example, if an agent believes that women are not allowed to be angry or men are not allowed to show fear, the agent may block those emotions from their response. Filtering may also take place due to the social setting, e.g., not yelling out in public or suppressing anger due to perceived differences in power.

Degradation: The intensity of the emotion degrades over time, though not all emotions degrade at the same rate. The degradation vector is subtracted from the emotion vector after each interaction unit.

Attribution: Emotions are also affected by the attribution modifier, a multiplier matrix which adjust the emotions based on who the agents blames for the situation: self, others, or fate.

Comparing: Comparison is done by vector subtraction in order to model emotions that have not been acted upon (e.g., pent up emotions). These emotions are prime candidates for a later "blow up". For example, when Bob totally

ignores some emotions when he responds to a percept, that ignored emotion is carried over to later conversations.

This model of emotion allows other analysis. When Alice models Bob's emotions with a reduced matrix, there will be times when she is surprised at what he does. This "jump" in what she expected him to do and what he does is caused, partially, because she is working with a reduced model of him. In the future, we will explore the problems caused because we are working with a simplified model. Thus, we may learn that Alice needs some sensitivity training in understanding components of Bob's emotions.

4. CONCLUSIONS

When agents are asked to mimic human behavior, emotions and personality must be modeled. An emotion vector is computed from volatile and trait component matrices which are updated separately. Using matrix algebra, these matrices are utilized to create a variety of effects.

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