Emotionally Responsive General Artificial Agent Simulation

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Abstract

Emotions are an integral part of human decision making. It follows that emotions should take part in the decision process towards the design of more realistic artificial agents. Three psychological models for emotions are examined and a corresponding algorithm is developed for each depicting its process. A generalized multi-agent model is designed to demonstrate the implementation of each of the three methods. An agent thus represents a human capable of exhibiting emotional state in response to an arbitrary emotionally charged event of varying impact.

Introduction

Emotions are complex and difficult to interpret. They involve many things side by side including feelings, behavior, and facial expression to name a few (Ortony, Clore and Collins 1988). Furthermore, psychologists do not agree on a single theory to define human emotions. Computer Science has made many efforts in recognizing emotions. Some of the fields of Artificial Intelligence (AI) have very well been able to depict emotions, especially in Robotics, and Human-Computer Interaction. Emotional intelligence has been of growing interest in the multi-agent systems community. Artificial agents can not only depict emotion but can also make decisions using emotional influence. They acquire knowledge about their environment, reflect changes in their emotional states, and perform corresponding actions. The question of interest is how to generate emotions in artificial human agents? There are many psychological theories behind arousal of emotions in humans, but can these theories work on the artificial agents? How well can the emotion process derived by psychologists generate an emotion in computer agents? In order to find out some answers to these questions we have used three different emotional theories to implement using multi-agent systems and observed the emerging behavior of these agents evaluating their emotional response.

Psychological Theories

Concepts of emotion and various theories of emotion can be found in psychology books such as Frijda (1986), Ortony, Clore and Collins (1988) known as OCC, Lazarus (1991), and Scherer (1984a). Relations between Artificial Intelligence and psychology of emotions have been very well described in the work of Sloman (1990) and Russell and Norvig (1995). A study by Adam, Herzig and Longin (2009) describes the recent work done in building emotional agents with the help of Belief, Desire and Intention (BDI) logic and formalization of emotional theories as described by OCC. Using full belief, probability, and choice, various emotions are formalized and a task is performed based on emotional reasoning.

Artificial Emotional Multi-Agent Model

The multi-agent context established in this study aims to maintain a generic implementation and does not focus on any particular application. The main components of the system are abstractions of: agents, representing the actors with the human emotion being re-created; objects that possess properties that contribute to the agent's emotional response; and events that define any given emotional stimulus. The speed and direction of the agent in the Cartesian grid world are defined randomly for each agent for the purpose of interacting with other neighboring agents and objects. Objects are initially located in various areas and maintain a fixed location. Each object possesses a predefined value defining how well an object is liked or disliked from a range of +10 to -10. We assume all the agents are homogenous, in the sense that they have a common evaluation for liking or disliking a presented object. Events can be setup to have either a constant or variable impact on all agents. Furthermore, agents can adapt to the repeated occurrence of an event or stimulus over time. Agents may be enabled to use a memory to store the last 10 events; the memory size can be changed by means of a simulation parameter.

Implementation

With the help of the OCC theory, up to 22 emotions can be generated. In every time step all agents randomly move to a position depending upon the move speed. For every agent from the agent list an emotion is randomly generated. First, an event is triggered and then checked against the history. If the event is present then same emotion and color is updated. A unique color is assigned for each emotion. Next the agent checks if there is an object at its position. If an object is found then according to its value it is recognized as liked or disliked. The agent then checks for neighbors in the surrounding area depending upon the communication distance parameter. If there are no neighbors around it then either of the wellbeing, prospect or attribution emotion is generated depending upon the event triggered. If there are neighbors, then for every neighbor agent some emotion is generated out of fortune of others or attribution emotion, depending upon the event triggered. Once the emotion's generated history is updated the color of the agent changes. Wellbeing emotion either generates a pleased or a displeased emotion. Furthermore, in prospect emotions we use the probability for an event to occur according to which hope, fear, satisfaction, fears-confirmed, disappointment and relief emotions can be generated. Attribution emotions generate approval and gratification, or disapproval and remorse for the agent's own actions. For another agent's action it can generate approval and gratitude, or disapproval and anger. Fortune of others emotions can again lead to a pleased or displeased emotion but this time due to some other agent's action.

The implementation of Frijda's and Scherer's theories are also developed but for brevity not described here.

Initially agents are randomly arranged in the two dimensional grid world. Each agent is recognized by some color reflecting its current emotion. There are some objects placed in the world and every object is given a value from -10 to +10. Number of agents, number of objects, world size, emotional theory method, communication distance and moving speed of the agent are taken as parameters in the model written in the Repast multi-agent simulation system. We assume that every agent knows what is desirable for other agents. Every time step one event occurs for every agent triggering the AgentStep(). The events are recognized as numbers varying from 0 to 49. We assume that for every agent an emotion is triggered due to some event, but more than one event can also trigger the same emotion. Every event is responsible for some kind of emotion. There are 50 events that can take place, identified with an ID from 0 to 49. In our test cases we target event 0, an arbitrary event defined to match with the pleased emotion for OCC, or pleasure in case of Frijda's, or joy in case of Scherer's. There is a set number of agents in the system and there is a 50% chance that event 0 is triggered. The remaining 49 events occur 50% of the time. Each method runs for 1000 ticks and we track how many times the event 0 occurred for each agent. Subsequently, for each event 0 occurrence we track how many times the pleased (pleasure or joy) emotion is generated. The agent can be enabled to store the last 10 events which have occurred in its memory when we enable variable event impact. It is worth noting that the OCC method yields 22 possible emotions, while Frijda has only 4 and Scherer has 7 in this implementation.

Conclusions and Future Work

Although the mean is fairly stable, the variance increases dramatically in the presence of history. Frijda's method was shown to have the most variance in the absence of history, while having the least variance of the three methods in the presence of history.

Overall the consistency of the mean in the results supports the hypothesis that any of these three implemented psychological methods could produce a promising artificial model for emotions. Frijda's method has the least number of defined emotions and they are the most general. Consistent emotional response is best exemplified by OCC but at a worst variance when emotional history is introduced. This work presents the initial port of the theoretical model unto a well defined computer model. Much work remains to be unfolded in bringing artificial agents to exhibit emotions in real world applications.

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