CS 685 Final Report:

The Use of Personality in Intelligent Agents

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1 Introduction

Software agents are practical inventions. When given knowledge pertaining to a task to be done, artificially intelligent agents can perceive the current state of the world and perform the needed task independently and expertly. This allows agents to be used in many situations where a human presence is generally needed, since the agent can be implemented with the person's knowledge and abilities, thus allowing the agent to perform the task in the same capacities as the human operator.

However, one major obstacle to creating agents that attempt to emulate human behaviour is the personality aspect of human beings. For basic tasks, such as ones where the agent only interacts with other computer systems, the lack of personality in agents is not an issue. However, for tasks where the agent needs to interact and effectively communicate with a user, not exhibiting emotions or personality can make the user feel detached from the agent and from the whole interaction experience.

Several groups, both commercial and academic, have made progress in endowing agents with personality and emotional capabilities. The Oz group at CMU is developing believable personalities to make its virtual reality and interactive fiction applications more realistic [1,2,7]. Extempo is a software company that is investigating the use of convincing personalities to enhance its web-based software products [5]. Cañamero [3] and the company CyberLife [4] are two of several groups creating intelligent creature agents whose personalities react to the user's attempts to play with and care for them. Finally, there are companies such as BDI [6] who use personalities to create more realistic human characters in computer generated simulations [8,9]. Although this list is not exhaustive by any means, these are key application areas in the field of personality-imbued agents, and are the main focus of the remainder of the report.

The goal of this report is to show the motivations behind integrating personalities with software agents, and how this research area has progressed in recent years. This exploration is linked to the practical side of software agents by showing how the research is applied to applications in and out of industry. Finally, this report looks at the future direction of agents with personalities, as well as some proposals for possible applications of this new technology.

2 Motivations

The main impetus behind integrating personality into software agents is to facilitate the interaction with the user. The form this takes will vary, depending on the intention of the system. For some systems, the goal is for the user to feel as though the characters represented by the agents are as real as possible, and for others it is to make the user feel more comfortable, to encourage the user to interact more readily with the system. In some cases, the application is simply a toy program for the user's amusement, but even in this case, a personality is integrated to encourage enthusiasm and interest in the user.

2.1 Realism

When realism is the goal, the user should be compelled suspend disbelief that the environment is not real, and should not encounter events that disrupt this belief. Instead of demanding agents to be fully capable and human-like, the modified requirements are to create agents that do not disrupt the user's acceptance of the scenario as being real. A characterization of this is called the "Eliza effect". Eliza is a psychiatric program made in the 1960s that provided psychological therapy to the user by rewording the problems the user enters into the computer. This was thought of to be helpful in most cases, simply because the user was willing to overlook the fact that the feedback was given by a computer, and thus was able to accept what the system had to offer. Bates describes this effect as being a situation "in which people see subtlety, understanding and emotion in an agent as long as the agent does not actively destroy the illusion" [1, p.2].

The Oz project relies on this effect to convince users to suspend disbelief when using its virtual reality system, to accept the illusion that the characters in their micro-world are realistic, and not just computer-generated [7]. This group believes that the success of storytelling media is based greatly on the emotional power brought out by the characters and the story, and that the Oz project's interactive media should also try to have the same impact on the user as TV and movies have on the viewer [1]. Although visual appeal and authenticity is also important, they feel that to focus on rendering and creating images that appear more realistic is like focussing on paper when writing literature, or on cellulose when making cinema. Realism is conveyed not only through appearance, but also through content elements such as characters, story and style [1].

2.2 Comfort

The Turing test dictates that a system is passable if it behaves in a way that can be mistaken for human behaviour. Hayes-Roth proposes the Extempo test, which states that a system is passable if the user willingly suspends belief that he or she is interacting with a human being. "The human user might well know that the character is not a human being and say so if asked. But the user would not care and would not intentionally or significantly alter his or her own behaviour on that account within the context of the interaction" [5, p104].

Applications of believable agents occur in many interactive tasks such as education, assistance, public relations and entertainment. In the Extempo case, the Imp characters apply humanlike skills to converse with customers, recording the content of the discussions for future reference. This is in order to understand their customers better and to be more effective in serving them in the future. They believe that agents with interactive characters make it easier for users to communicate with the system through natural conversation, expressions and gestures. Their approach also tries to design characters specifically to appeal to the customers they serve, in order to build relationships with customers based on familiarity, affection and trust [5].

2.3 Expertise

Agents with personalities are not just viewed as being superior to agents without them, they are also viewed as being potentially superior to dealing with humans in certain situations. For example, Web-based agents are superior to human assistants in that they not only have access to the resources of the web, but they also have the ability to use it effectively and thoroughly to achieve the user's goals. They are also available at any time, any day of the week, and can be scaled flexibly to give immediate, one-on-one attention to every customer of the system. Finally, these assistants deliver consistent behaviour, and remember important features of past interactions, making the user feel valued and significant [5].

2.4 Amusement

People respond to machines endowed with personality-like characteristics as if they had actual human personalities. So emotions are instilled into agents, but in order to be convincing to the user, the actor's behaviour must be believable and consistent without being completely predictable to the user [9]. The goal is not only to create an agent that is able to function well in a virtual world, but also one that can register emotional competencies, like playing, finding events to be pleasant or noxious, learning from the environment, and "enjoying life" in general [3]. If an agent is "real" enough, the user will find it pleasurable to go along with the illusion that he or she is interacting with a real person.

In the case of the Creatures project, the goal was to create synthetic, biological agents with behaviour that is suitably lifelike to entertain the general public. So even though their efforts have resulted in a remarkable example of artificial life, their success is measured by how entertaining and immersive the experience of "playing" with these creatures can be [4].

3 Implementation

Currently, there is no consensus available on the definition of a personality or on its components. Most definitions emphasize the "unique or distinctive qualities of individuals" when describing personality, but usually it implies the ability for agents not only to achieve their task, but also to exhibit consistent extraneous behaviours that indicate an underlying motivation [8]. Because of this uncertain definition, researchers not only have to produce agents with personality, but they have to define what an agent with personality really is. The following sections describe the attempts by current researchers to impose some sort of personality structure into the agents, both in how it converses and how it acts with the user.

Important characteristics that seem to be stressed in the different approaches are:

- competence in the world
- reactivity to change
- goal-directed behaviour
- appropriate emotional interpretations and responses
- individual personalities
- social skills
- language skills
- an ability to interact/interfere with surroundings.

Some of the approaches only address one or two of these characteristics, while others like the Oz project attempt to embrace a broader perspective (called "broad agents"), to enhance the realism of the system [7].

One interesting thing to note is that the expectations for the agents in some scenarios is lowered because most users lower their own level of communication when operating in those same scenarios. This is because when dealing with agents with personalities attached, the users themselves become actors, changing their behaviours and taking on a role so that they might more easily interact with the system. In this way, the expectations on the agent's abilities to emulate human behaviour are reduced, since humans naturally experience more limited interactions when dealing with an assistant than when dealing with a companion or somebody else socially [8].

3.1 Adding Personality to Speech

The nature of the relationship between the speaking agent and the other agent in the dialogue affects how the speaking agent will act in a conversation. The three factors of the other agents that influence the speaker's phrasing are the social distance between the agents, the relative power held by the other agent, and how imposing the act being discussed would be. When phrasing a request, the speaking agent will be more direct when asking for something small from agents who are familiar and of equal or lesser status. So to convey one kind of speech act, many different forms can be used, each of which has a tone that implies a different emotional disposition of the user. For example, if an agent requests that the user perform an action, the request may be presented with varying degrees of assertiveness, such as in the following ways:

-Do *action*.

-Can you do *action*?

-I can't do *action*.

-I want *action*.

The acoustic delivery (i.e. happy, nervous, shy) of the utterances is mainly affected by the emotional disposition of the agent, which is implemented before the interaction. For a system to have convincing linguistic interactions it must convey emotions not only through the content of the utterances, but through syntactic form and acoustic delivery. How a sentence is delivered conveys as much meaning as what the sentence is saying [10].

3.2 Adding Personality to Behaviour

When adding personality to the behaviour of an agent, the techniques that are used seem to vary from application to application. The types of behaviour that an agent has will depend on its environment, its expected contact with the user, and the kind of task to be performed, among other factors. The techniques that have been encountered so far are divided into four sections, in decreasing order of user involvement. The first section describes avatar systems, where an avatar is an agent in a virtual environment that is controlled directly by the user of the system to interact with other agents. The second section describes social agents, where the user interacts with the system by communicating directly to a social agent. The third category consists of environments where the user has more of an observing role, and can interfere only in very minor ways. The final section is a completely different approach to personality implementation, using biological methods to model a human physiology into the agent as much as possible.

3.2.1 Avatar Systems

With avatar systems, agents are given the ability to improvise their behaviour in a similar manner as human improvisational actors, by giving them basic personalities and directions, and by following cues from the situation and from other agents. The components of the agent's social model for this system are broken down into *personality traits*, *moods* and *attitudes*. Personality traits are persistent characteristics, and correspond to general patterns of behaviour and modes of thinking. Moods correspond to current emotions or sensations that arise from the current situation, and are very variable over time. Moods can also be general feelings, or specific to certain objects or agents. Finally, attitudes characterize an interpersonal relationship and how the agent is disposed to act towards another (i.e. trust, sympathy, status) [9].

The personality model in the avatar cases is modeled after trait theories and social learning theories. Trait theories state that behaviours result from basic personality traits of the agent, while social learning theories state that behaviours are learned from the outcomes of actions in similar situations in the past. The personalities, moods and attitudes are represented by scaled variables, which have correlation functions that determine how known moods and attitudes affect the emotions of the agent in general. These characteristics are affected by the current environment, the number of agents present, the persistent personality traits and the current mood of the agent. Actions are then chosen, based on what is most appropriate given the above elements of the situation [9].

The resulting processes performed by the agents are: perceiving, reasoning, learning, deciding, acting, interacting, revealing and feeling emotions (added to produce personality influences on behaviour). Each of these processes then has a value that quantifies how well or badly the agent is at performing these tasks, thus characterizing the agent's personality traits. The agent's behaviours will influence its mood and attitudes, which in turn affect its behaviour. The avatar's actions can then be directed with little interference from the user, and the agent will perform the actions with behaviours that are consistent with its personality [8].

3.2.2 Social Agents (Extempo System)

Extempo's Improvisational (Imp) characters consist of an underlying personality, a role, and task-specific knowledge. The personality of a virtual character is composed of its background, appearance, movements, gesturing, voice, opinions, and social dynamics. These characteristics are reflected in how the virtual character moves, speaks and behaves when interacting with the user. Task-specific knowledge gives the agent more knowledge about the domain, possible actions, and value-added commentary that could be contributed. By combining different character traits, new characters can be built easily to suit various situations [5].

3.2.3 Independent Agents (Oz System)

Em is the subsystem of the Oz project that is responsible for handling the emotional and social aspects of the agent's behaviour. It also handles social relationships between agents, how these relationships change over time and how they use emotions in the agents' behaviours [7].

Sensory data is taken in by the main architecture of the system, and the emotional state of the agent is generated by Em, given the inputs and current emotional state. Actions are then chosen based on the perception of the situation, the system's goals and the current emotions, to different degrees depending on importance of the event. This approach is based on the Ortony, Collins and Clore (OCC) cognitive model of emotion, which groups emotions together into emotional clusters, where emotions in each cluster share similar causes (e.g. distress and fear) [7].

Em features the following emotions: joy, distress, hope, fear, pride, shame, admiration, reproach, anger, gratitude, gratification and remorse. Each emotion falls under one of four categories:

- *Goal-achievement:* emotions evoked depending on how events achieve goals (joy, distress)
- *Agent Standards:* emotions evoked based on how self or others measure up to standards of behaviour or performance (admiration, shame)
- *Object Effects:* emotions evoked from positive or negative reactions to objects, including other agents (love, hate).
- *Combinations:* simultaneous emotions from single event.

The agent's attitudes towards other agents, objects and the user can change over time as the evoked emotions encourage or discourage certain behaviours. Em's emotions, while not presuming to be comparable to human emotions, claim to reflect the emotions encountered in "universal human social settings". According to Reilly and Bates, the system tends to produce "enough" emotions for the individuals who develop or use the system to find its behaviour to be believable [7].

3.2.4 Biological Approaches

Instead of being programmed with all of the personality traits, biological approaches implement basic traits and build upon these traits as the agent learns through interacting more with its environment. The agent's motivations in this case are more physiological in nature, resulting in behaviours that direct the agent towards or away from a goal, increase the agent's alertness to a situation, or organize the agent's actions together towards one goal. In the case of the Creatures, personal goals and physiological goals are kept separate, so that each can be influenced by events to produce motivations and emotions that similar to human reactions to these events [3].

These approaches use stronger AI techniques through the use of neural networks for motor control and learning, and the use of biology to devise artificial biochemistries for simulating hormonal responses and other internal stimuli [4]. The user's role in these cases is to encourage/discourage behaviours, and to interact with the Creatures and the environment to encourage certain behaviours in the agents. The biological aspect has been implemented to such a degree that reproduction is possible, as are expressive reactions to positive or negative stimuli, so that the effect of creating an agent with pet-like characteristics is as convincing as possible [4].

The difficulty with this approach is that emotions are more difficult to quantify, since they are unseen reactions or impressions resulting from a given event, and instead of manifesting themselves directly, only enhance the current motivational states.

4 Applications

The techniques mentioned above have all been applied to create actual systems that interact with the user either as a simulation, an assistant, or as entertainment. The applications of these techniques are as follows:

- *Lyotard the Cat*: This product of the Oz project is a cat that wanders through the virtual environment, behaving towards its environment and the user based on its internal likes and dislikes. Lyotard's feeling change over time, and can go from initially disliking the user to becoming fond of the user (usually after feedings). To create suspension of belief, empirical data and empirical experiments are made. In the case of the main product Lyotard, cat owners were brought in to observe the agent's behaviour[7].
- *The CyberCafé*: This virtual environment allows the user to control an avatar, or a virtual agent, and engage in interactions with other agents that have been given certain goals and personalities. The nature of the action sequences and the dialogue change depending on the characteristics of the avatar and those of the other agents[9].
- Extempo's Improvisational (Imp) characters consist of an underlying personality, a role, and task-specific knowledge[5]. These are used for various web-oriented public-relations tasks, such as Max (web page guide), Merlin (virtual tour guide) and Jennifer James (web site spokesperson). The most recent is a "virtual Santa", who chats with the user and recommends certain gifts that the user might like[5].
- *Interactive fiction and task-oriented dialogue modeling*: Agents can be given personalities, moods, goals and attitudes, and told to act out a script based on these initial feelings. Each agent will then modify it views according to how the script evolves, and if left to improvise, will devise completely unexpected dialogues. The example used was a segment of Casablanca, where the basic actions were recorded, and then replayed by the agents with completely different personalities[10].
- *DI-Guy*: An agent in a virtual environment, this is used for simulations where human characters with realistic movements and behaviours are needed. Usually the application of these agents are in military situations such as emergency rescue, hostage situations, military formations and chemical cleanup, but can also be applied to flight deck training, sports simulations and disco dancing[6].

- *Creatures*: As mentioned above, these creatures are close to exhibiting characteristics of strong artificial life. As software toys though, they are amusing in their own right, playing in their environment, exploring the scenery and the objects to be played with, and interacting with the user and each other.

Other biological applications include El-Fish (tropical fish agents), Petz (virtual dogs, cats and other virtual pets), Fin-Fin (bird/dolphin hybrid in virtual environment) and Galapagos (six-legged agent in maze-like environment) [4].

5 Conclusions

In general, the performances of personality-imbued agents seemed believable to the subjects who used them, since the agents in this system performed actions that were consistent and recognizable based of the personalities they were given. Where possible, variability was introduced to make the system seem more lifelike. For example, in the Cybercafé, the personality trait values were allowed to vary according to a normal distribution, thus producing responses that were slightly different each time, but centered around the principal personality traits of the agent[9]. The Imp characters also seemed effective at applying humanlike skills to converse with customers, recording the content of the discussions for future reference. This is in order to understand their customers better, to be more effective in serving them in the future[5]. Unfortunately, this is a case where emotions may work at a disadvantage, for agents have difficulty sensing when its presence is obtrusive and should be withdrawn (an unfortunate flaw in many human system as well).

The main drawback mentioned in the research on Creatures, but which applies to the agents' personalities in general is that behaviours are hard to interpret. It is hard to tell if the behaviours of a Creature agent are a result of internal motivations, or whether it is a tendency for users to anthropomorphise the agents' actions. However, going by the standard that the agent is successful if the user is willing to suspend disbelief in the reality of the agent's world, the Creatures are treated as alive by most of the test users, so much so that they have been considered to be a potential example of "strong" artificial life[4].

6 Future Directions

Since so much of the personality-endowed agents seemed to be applied to areas involving scripts and acting out roles, it seems natural that these technologies will be applied to the area of entertainment. However, instead of being limited to toy desktop applications, these agents should take on real acting roles, either in computer-generated or live-action movies.

Using lifelike agents to emulate humans in limited domains is already being explored in a limited fashion. Movies are exploiting computer-generated images and entities more and more, especially in movies that require a great deal of special effects. However, these entities are still controlled completely by human operators, and do not have any of the autonomy that agents could supply. Also, limited agent-based technologies are being introduced into some movies, such as the large crowd or stampede scenes in the animated Disney features *Lion King*, *Hunchback of Notre Dame* and *Mulan*. The presence of agent-based technology in these roles is only because of the scalability of preparing one agent, and then duplicating it hundreds of times to create the crowd-like behaviour. Nothing yet combines the computer generated models with intelligent, personality-enhanced agents as supporting actors.

The major obstacle to this thought is that such roles could not yet be speaking roles, since speech-producing technology is still rather limited. DECtalk is currently one of the most widely-used speech generation tools, despite its voice box-like sound quality. However, the computer graphics and the AI agent technology is available, so if this can be extended and combined so that the personalities and emotional states of the agents can be modeled by convincingly rendered characters, then virtual actors can be added seamlessly to computer-generated or live-action movies. In computer generated or animated movies, this would reduce production time and to enhance the believability of the "actors" involved. In live-action movies, personality-added agents could serve the role of extras or stunt doubles, since they would be consistent, believable, would scale up in large scenes, can be added after the scene is shot, and are inexpensive to implement.

In accordance with this suggestion, I plan on approaching Disney, Pixar and Industrial Light and Magic with the idea, to learn whether such ideas have been suggested or considered as a possible entertainment breakthrough. If this has already been considered, then it will be enlightening to learn what issues they have encountered. If not, I will investigate the possibility of copyrighting this idea, hopefully with the end result of becoming substantially wealthy from the royalties this idea will undoubtedly produce. In either case, the results of this report have not only been enlightening from an academic standpoint, but look to have several future benefits as well.

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