M.Sc. Thesis Proposal: Believable Action Selection For Non Player Characters In Video Games

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Overview

Perhaps the most interesting aspect of video games is not its fidelity of photo-realistic graphics, soundscapes or accurately modeled physics but rather how video games have utterly failed at creating meaningful emotional experiences. Traditional mediums such as film, music, and literature's greatest and most powerful works engage us at the most human and basic level: the shared human experience. Whether reducing us to tears of sadness in Spielberg's Schindler's List or making us laugh in Pixar's WALL-E, traditional mediums have and continue to tell important and powerful stories. Video games on the other hand have been unable to engage to its audience at a deeper level of meaning [1][38, 7]. Players rarely feel remorse as they kill wave upon wave of enemy soldiers. This exemplifies the fact that players often have difficulty feeling any sense of attachment to in-game characters [11]. Video game's inability to connect with players is two fold but based on one fundamental concept of humanity: choice. As video games are an interactive medium, players make choices each instant they play. However, games often rob players of any meaningful choice as the game must ensure the coherence of a linear story. The effect is that players do not choose or shape the world they play in; rather their role is akin to train conductor moving forward to a predefined final destination. Secondly, and more importantly for this paper, choice is also restricted in that the computer controlled Non Player Characters(NPCs) are not able to make meaningful choices. They cannot get angry if struck, and they are often unable to react in believable ways which have not been predefined by the designers. And so, the interactions that a player can have with NPCs are extremely limited. Video games fail to provide meaningful emotional experiences as NPCs continue to remind the player that what they are experiencing is not real.

With the problems of photo-realistic real time rendering largely solved [8] and increasingly powerful platforms available to game designers, good AI is increasingly becoming an important part of video games [25, 34, 35, 31, 36, 8]. Players expect AI that is dynamic, able to react to unexpected events and behave believably [34, 35, 36, 10]. As somewhat of a consequence to this, NPC AI is an important and active area of research [39, 25, 13, 16, 2, 14, 19, 15].

The state of the art in the creation of believable decision-making has reached out beyond computer science using models from Psychology(personality, emotions, appraisal theory) and Sociology(social appraisal variables, relationships and role theory). However, there currently exists no known NPC architecture that integrate all of these important models together to produce decisions that are believable and whose architecture is dynamic, flexible, reusable and efficient enough for the use in real-time video games. We propose a solution to this problem with an architecture based on role theory that incorporates emotional models, personality models and reasoning about consequence into utility based decision making processes.

[1]While Final Fantasy VII has been known as a watershed moment for video games in that it evoked strong emotion from its audience. These crucial moments are delivered by cutscenes, not as a result of player interaction with NPCs.

Motivation

Believable decision making of NPCs has been noted as an important quality of any video game. Some of the reasons include increased player immersion [4, 36, 31], increased likelyhood for interesting game situations [29, 2], creating a realistic environment where players feel less humiliation when losing [36] and an increased sense of empathy towards NPCs [2, 10] as well as an increase in the ways to interact with NPCs. As a result, creating better games is dependent on having NPCs that make believable decisions.

Background

Believability is a central requirement of today's NPCs and as Linvinstone writes "the requirement for modern computer games is not unbeatable AI, but believable AI" [21]. Interestingly, Believability is not realism, but is rather the façade, an illusion that allows us to suspend our disbelief [23, 21]. Believability is also largely subjective as one's culture and perspective define it [23]. As a result, designers need to be cognizant that they must not emulate human processes, rather simulate them such that they appear believable.

Loyall defines the believability of an NPC to be based on two groups of requirements. The first group of requirements takes the works of the Arts that define that believable characters need to express personality and emotion in their every action [22] They should also be self-motivated, able to undergo change and finally, have social relationships [22]. The second group of requirements is based on the fact that unlike the Arts, interactive characters do not have humans controlling their every action. As a result, processing-based requirements are what Loyall defines as the Illusion of Life [22]. These requirements include the Appearance of Goals, Concurrent Pursuit of Goals and Parallel Action, Reactive and Responsive, Situated, Resource Bounded, Exist in a Social Context, Broadly Capable and finally Well Integrated [22]. These requirements reflect a high requirement that humans have when judging NPCs. Consequently, any architecture for believable decisions must take all of these factors into consideration.

In an effort to meet the requirements of believable agents, many architectures include personality models into their decision making processes. A popular personality model is the Five Factor Model(FFM) also known as OCEAN [20]. The FFM is a set of distinct traits based on factor analysis [20]. Generally, an architecture will represent each trait as a single scalar value that can affect a number of agent processes including Goal Selection, Action Selection, Planning, Event Appraisal, and Emotional Responses [19, 10, 1, 20, 32]. Personality has been implemented using rule based processes [3] and utility based processes [19, 10]. A recent personality model provides an explanation of underlying motivations which are biological in nature [30]. Riess proposes 16 basic desires that motivate action as well as suggest the method in which they are modulated through action [30]. This perspective appears to be well suited for utility based implementations; however none are currently known to exist.

Emotions have also been synthesized in believable agents to meet the requirements of believability by affecting a number of processes including Goal Selection, Action Selection, and Attention. Many models of emotion have been synthesized including Eckman's Six Universal Expression [24, 5, 32, 40], the 22 Emotions in the OCC Model [27, 19, 2, 14, 13] and Sloman's [33] tertiary emotions. Much like personality, these are generally represented by a single scalar value. Many features of emotion have been modelled including their elicitation due to situational meaning, concern and change [14, 13, 2, 17, 37]. Concern for example has been modelled by the elicitation of emotion due to inter-goal threats in an agent's active plans [14, 13, 2]. As a result, events that force the agent to re-plan will generate emotion based on how the agent was able to cope with the change. Habituation has also been partially modelled where emotions decay over time [6, 2, 32]. More complicated systems performed calculations for emotions in response to consequences. For example, Marsella and Gratch and Aylett [2, 14, 13] performed utility calculations that considered the agents actions against how others would react. While extremely computationally expensive, this technique could be modified for application to video games.

As humans are social beings, NPCs that wish to be believable must be able to reason in regards to social relationships, culture, value and norms [14, 16, 32, 23, 9]. Some relevant research in this area is the use of social cognitive variables of Dominance and Agreeableness[18]. Bailey and Katchabaw implemented Isbister's social variables through a rule based emergent social system that allowed for the varied interaction among its agents based on their social variables, emotional state and personality factors. Another method used to describe social relationships and social structures is Role theory [16, 28]. Here a role describes one's relationship to another person(Mother, Boss, Friend) or group(position) [28] and any person may have multiple roles. Roles further describe a relationship in terms of associated Desires(goals), Beliefs(Values, Norms and Worldwiew) and Intentions [16, 28]. This provides significant advantages for designers as roles can be reused, and they are intuitively understood by non experts [16, 28]. Guyevuilleme implemented roles as a rule-based system but also extended it with a few utility calculations. Most importantly, he tied a numerical value to each role asserting its importance to the characters. This provides a simplistic but very effective method of defining the importance the goals held within the agent. Agents' values are represented as rules. An example value could be "wearing a tie at dinner". Interestingly, he suggests that these cannot be represented as utilities. However, Panzarasa suggests that values should be optional [28] which in turn suggest that their adherence could be turned into a utility calculation. For example, all monks "shall not kill". However, given certain circumstances, this may not always be the case. Consequently, social information plays an important role in the creation of believable characters.

Looking at complete architectures, decisions need to reflect the NPC's emotional state, personality traits as well as a precise knowledge and understanding of social relations as well as a care to the consequences of actions. Unfortunately, no known architecture integrates all of the components to create believable decisions for video games. While Marsella and Gratch, and Aylett [14, 13, 2] do excellent work in modelling emotions using appraisal theory, their proposed frameworks fail to consider a basic personality model in their decision making. Consequently, their planning fails to convey personality as well as suffers from low re-usability. Their approach to social knowledge also falls short in clearly defining the relationships. Also, Marsella and Gratch, and Aylett's implementation of action consequences is useful, but their approach appears to be too computationally expensive for the application in real-time video games. Johns integrated a utility function that combines both a personality model and emotions is a step in the right direction as it is efficient and allows for the characters action to reflect their personality and emotions. However, his approach does not take into consideration the consequences of actions and ignores critical social knowledge. And so while Johns' framework is highly reusabilty and flexible, it would fail many tests for believability. Finally, Guyevuilleme's role based architecture provides an intuitive and highly reusable structure for social knowledge. But it does not consider personality models and does not describe how roles can be used to aid the understanding the consequence of actions. This illustrates that the state the art in architectures for believable decision making still has much room for improvement.

Problem Statement

There is clear requirement for an NPC architecture that generates actions that meet Loyall's requirements of believability[34, 35, 36, 10]. In addition, for the use in video games, the architecture for decision making needs to be highly flexible, re-usable and have good performance.

Proposed Solution

In looking at the state of the art, it appears that there is significant room to improve upon the existing architectures. Unlike other implementations, every decision in our architecture will consider the agents' emotional state, personality traits , relevant social information as well as a care of consequence. Furthermore, our architecture will maximize flexibility, reuse with performance through the use of Roles.

To accomplish this, we propose a BDI role based architecture that uses a utility-based decision making system. Both Goal Selection and Planning will be utility-based processes that will create believable actions by making extensive use of personality and emotional models, as well as social reasoning of consequence. A sense-think-act cycle will be implemented where events are sensed and impact current emotional state of the character. The character's internal state will define which goals are currently being pursued. Furthermore, planning and the actions selected to achieve goals will use a utility function which is a reflection of the character's emotional state, personality variables as well as consequences to the actions. This work will extend the work of [16] by creating flexible roles as well as tying them to emotional memories that affect the agents current state when active. As a result, this research has many critical contributions to the state of the art in design of believable NPCs for video games.

We propose a role based architecture as seen in [16] that has significant advantages in both design and flexibility. As discussed roles are an intuitive concept for designers which make them well understood. Roles also provide an excellent way to group a number of concepts that describe behaviour. Essentially roles are self sufficient in their description of behaviour, and with the right architecture in place, simply adding a role to an agent should result in complex and believable behaviour. Furthermore, roles are highly reusable as once defined, and can be applied to any number of agents. Another advantage of a role based architecture is that roles can be given a numerical assignment that captures at a high level the importance of the relationship to the agent. This in turn provides an simple yet effective mechanism to aid the goal selection process. Finally, as many roles can be applied to an agent, this allows the agent to get in a state of *role overload* where it becomes impossible to meet the goals for each role. This translates into believable decision making, through internal conflict and believable emotional states that can be useful for dilemma based AI story directors. However as noted above, roles on their own do not provide enough information to adequately create believable decision making.

We propose to extend the role based architecture by associating additional information specific to the agent. This information should include the optional adherences to goals, values and norms that allows designers to identify the goals that are important to the individual agent. This is in contrast to Guyevuilleme's implementation that assumes mandatory adherence to all goals, values and norms. This could be efficiently accomplished by associating a single scalar with each of the goals, norms and values. Furthermore, additional information will be associated with the role to be used in consequence planning. As actions can be identified to have a negative impact on the role's goals, this provides the agent with the information required to identify the utility of an action in respect to other agents' goals. Finally, as mentioned above, calculating the utility of an action with respect to other agents can be prohibitively expensive. Roles provide a mechanism to which generalizations can be made to these calculations. For example, all enemies within an area will be harmed by actions that are in conflict with their roles goals. As they share these goals, a utility calculation for the action can be performed once for the role and then generalized to each member agent within the group. This creates a more efficient approximation of consequence then seen in [14, 13, 2]. As a result, adding and associating information to roles should result in increased believability and efficiencies.

In addition to a strengthened social reasoning system, the agent's architecture must maximize believability, flexibility, re-usability in the use of emotions and personality models. Frijda discussing emotional modelling and Ortney discussing personality, suggest the best way to achieve this is through the use of a fundamental trait models [12, 26]. A significant advantage of using these models is that they allow for efficient integration into utility functions as seen in [19]. Here actions maybe associated with having a utility for the current emotional state and personality factors. Reiss' theory of 16 basic desires seems especially well suited in these regards as goals, and the consequences of actions can be associated with each desire. No systems are known to use Reiss' theory in their utility calculations and so, our implementation will be the first to synthesis his model. Furthermore, Eckman's Six Universal Emotions have been noted to be well suited for these purposes and have the advantage of being the basis to many facial animation packages [24, 5, 32, 40].

Furthermore, as these models represent emotions and personality as simple scalars, it would be possible for AI story directors to populate a world with unique characters simply by changing these basic parameters. However, even Eckman's Emotional Model does not fully encapsulate many of the complex emotions found in humans. As a result, we are the first to propose the use of role specific emotions. A role of Wife for example, could have role specific emotions such as jealousy or love. This could be an efficient method to allow agents to maintain a greater breath of emotions that affect their decision making processes. The integration of the personality and emotional models will primarily be used to affect the decision making in utility based goal selection and planning.

A final contribution is to extend the cognitive structure of agents with emotional memories. Important events that either aid or threaten a role's goals should be translated into emotional memories for the agent. These emotional memories maybe associated with roles such that they may affect the interactions with other agents. While we have seen the cognitive state be affected by relationship variables in [14, 13] , the extension into roles provides significant advantages. This can play an important role in establishing an emotional state of mind for the character that in-turn will shape the plans created for the associated role. For example, when a goal is active for a particular role, the associated emotional memories should become active. This in turn will affect how planning occurs. Emotional memories will also need to consider their extinction as well as re-animation. Frijda suggest that specific types of emotions have a biological basis in the way they decay. Negative emotions such as fear remain constant as long the negative stimulus remains present [12]. Positive emotions on the other hand begin to decay immediately [12]. No known implementations of this type of emotional decay exists. This could be accomplished through the use of specific rules in regards to certain types of emotions. The result of emotional memories can provide an significant improvement in the believability for agents.

In conclusion, we are proposing a flexible, efficient and reusable architecture for NPC decision making that extends the state of the art by allowing the emotional state, personality factors, social knowledge and perceived consequences to affect the decision making of NPCs. Consequently, the architecture should be well suited for the use in open world video games and in combination with an AI story director.

Progress To Date And Milestones To Completion

The majority of the background research has been completed, including an outline of the architecture and its components. Further research needs to be done finalizing the design of roles, emotional memories as well as their interaction with the evaluation of consequence and affective decisions within the architecture. Once completed, an implementation of the architecture will occur including several scenarios to validate the design. Finally, the results will be summarized and the thesis completed.

Proposed Timeline:

- *Feb 15th*: Finalize Architecture Design;
- *March 6th*: Implementation of Design;
- *March 14th*: Validation and Testing;
- *April 3rd*: Complete Thesis.

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