A FLEXIBLE MULTI-MODEL APPROACH TO PSYCHOSOCIAL INTEGRATION IN NON PLAYER CHARACTERS IN MODERN VIDEO GAMES

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ABSTRACT
This paper introduces a novel approach to integrating various psychosocial models to facilitate the construction of flexible, expressive, and believable non player characters for modern video games. Instead of forcing game designers and developers to choose from a multitude of possible models for personality, emotion, and so on, each with their own strengths and weaknesses, our approach enables the use of multiple models simultaneously, either partially or in their entirety. In doing so, we can provide considerable flexibility and customizability in character design, leading to richer and more varied characters in video games.

Based on our approach, a prototype run-time system has been developed, using our earlier work in emergent characters as a foundation. To further support our approach in the creation of characters, tools have also been created to construct psychosocial models, as well as the characters based on these models. These prototypes have been evaluated and shown through experimentation to produce very positive results, and have great promise for continued work in the future.

Categories and Subject Descriptors
I.2.1 [**Artificial Intelligence**]: Applications and Expert Systems – *games.*

General Terms
Algorithms, Design, Human Factors

Keywords
Psychosocial modeling, personality and emotion, believability, non player character behaviour, emergent gameplay.

1. INTRODUCTION

Artificial intelligence is an increasingly important aspect of modern video games, and can be a determining factor in the overall success of a game [7,9,30,39,45]. One of the more active areas of research in game artificial intelligence is making more believable characters, also known as non player characters (NPCs) [5,15,16,17,19,20,24,36,38]. Creating believable characters, while important [10,25,45], is no easy task, requiring developers to reach beyond traditional approaches to game artificial intelligence, including finite state machines, rule based systems, and static scripting [3].

The requirements for character believability tend to be quite steep [26]. They include elements such as personality, emotion, self-motivation, social relationships, consistency, the ability to change, and the ability to maintain an "illusion of life", through having goals, reacting and responding to external stimuli, and so on [26]. While crafting a game artificial intelligence capable of achieving all of this is a daunting task indeed, one can see that at its core, a complete and integrated psychosocial model is necessary, operating in a dynamic fashion [3].

To this end, many researchers in this area have examined the use of various psychosocial models of personality, emotions, and so on in the creation of believable characters [3,5,22,24,36,38]. In the course of such work, however, an important and critical question must be inevitably answered: which psychosocial model should be used as a basis for their characters? There are numerous accepted models for elements such as personality [8,14,29,37,47], emotion [12,28,31,32,34,35,43,46], and so on, although none is regarded by the literature as perfect, complete, or all-encompassing [33,49]. In the end, each such model has its own strengths and weaknesses, and each has domains and applications to which it is particularly suited. As a result, designers and developers of believable characters are in the unfortunate position of making a very difficult choice that ultimately impacts, limits, and restricts their characters in one way or another [33,49].

To address this problem, we have created a novel approach to facilitate the integration of multiple psychosocial models together within a single character, allowing the models to be mixed and combined in a variety of ways. Doing so enables the synthesis of characters that take advantage of the richness and expressiveness of the various models available without their deficiencies. In the end, our multi-model approach to psychosocial integration eliminates the need for the difficult choice described above. Furthermore, our approach is entirely data-driven, allowing even the psychosocial models in use to be customized and tailored to the situation, giving character designers and developers considerable flexibility and freedom.

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Using our earlier work towards emergent game characters in [3] as a foundation, we constructed a prototype run-time system using our new approach to psychosocial modeling. This run-time system can be used in games, virtual worlds, and other simulations to support characters developed using multiple models of personality, emotions, and so on. To further support our approach in the creation of characters, we also built tools to enable designers and developers to more easily construct both their characters and their underlying psychosocial models. Using the prototype run-time system and character creation tools, we conducted a series of scenario-driven experiments to evaluate our approach and assess its suitability for use in believable characters for video games.

The remainder of this paper is structured as follows. Section 2 presents a discussion of related work in this area. Section 3 introduces our approach to the integration of multiple psychosocial models within believable non player characters. Section 4 describes the prototype run-time system and toolset implemented as proof of concept of this approach. Section 5 discusses our experiences to date through experimentation. Section 6 concludes this paper with a summary and discussion of possible directions for future work in this area.

2. RELATED WORK

There have been numerous attempts at implementing believable characters through exploring the formulation and application of psychosocial models of personality, emotion, and so on. There are also numerous models for defining and working with various other aspects of psychosocial behaviour, including roles, relationships, reputation, social ties, and much more, as discussed in [2,3,5,22,36,38] and elsewhere. For brevity in this paper, we have chosen to focus on aspects of personality and emotion that deal with behaviour and socialization, and address the other aspects listed above in [2,49].

Numerous models for personality have been developed over the years. One is the Myers-Briggs Type Indicator [29], which is based on four pairs of traits that are considered complementary and distinct that measure: how a person relates to others (either by Extraversion or Introversion), how a person takes in information (either by Sensing or iNtuition), how a person makes decisions (either by Thinking or Feeling), and how a person orders their life (either by Judging or Perceiving). Another popular model that has been advanced by many researchers is known as the Five Factor Model (FFM), the Big Five, or OCEAN, which assesses personality in five independent dimensions typically referred to as: Openness, Conscientiousness, Extraversion, Agreeableness and Neuroticism [47]. This work has origins that can be traced back to a sixteen factor model created by Cattell [8]. The PEN model [14], on the other hand, is comprised of just three personality dimensions, and is based on psychophysiology: Psychoticism, Extraversion, and Neuroticism. A slightly different perspective is offered in Reiss' model of basic desires [37], where personality is defined primarily by a set of tendencies and motivators that inspire or lead to action: power, curiosity, independence, status, social contact, vengeance, honor, idealism, physical exercise, romance, family, order, eating, acceptance, tranquility and saving. Other work in this area has examined linkages amongst these and other models [1,27], and while connections and correlations exist, there are still fundamental differences between these models, and no single complete over-arching model.

Similarly, several models of emotion have been formulated and studied. One of the more popular models was formulated by Ekman [12], defining six basic emotions: anger, disgust, fear, joy, sadness, and surprise. Another popular model is the OCC model, consisting of twenty-two emotions [32]. Scaled down versions of this model also exist [31]. Numerous other models exist, including Smith and Ellsworth's Emotion Appraisal Model [43], Mehrabian's PAD Emotional State Model [28], and models put forward by Tomkins [46], Plutchik [35], and Parrott [34], as discussed in [49]. Again, while there is overlap between these models, these models have many differences and were defined with different purposes in mind, such as facial expression, relation to adaptive biological processes, action readiness, and so on.

When applying these various psychosocial models to the creation of agents and game characters, researchers have followed one of two paths. In the first case, researchers have selected one of the models that they believe best suits their needs (or one each of personality and emotion), in the hopes that this will be sufficient and that their characters will not suffer from missing what is offered by the other models. This was done in work such as [2,4,6,11,13,48,50] and our own previous work in [3]. In the second case, researchers have instead constructed their own custom models, borrowing aspects from the common standard models in an ad hoc fashion, as none of these models on their own meet their needs. This was done in work such as [18,21,33,38,40,42]. Unfortunately, to date, there has been no work towards integrating the various models together or enabling their interoperability within agents or game characters, despite the potential benefits of leveraging the respective advantages of these well-studied and time-tested models all at once. Doing so is the focus of our current work in this paper.

An expanded discussion of related work can be found in [49].

3. OUR APPROACH TO MODELING

As discussed earlier, the goal of our current work is to create a flexible approach to the integration of the various psychosocial models that have been developed over the years. This goal has been met through examining vertical and horizontal scaling in modeling and applying data-driven design methodologies, as discussed in the sections below.

3.1 Vertical Scaling

The process of vertical scaling in psychosocial models refers to a hierarchical decomposition of the model into a collection of various traits, sub-traits, sub-sub-traits, and so on, typically in a tree or graph like fashion. Higher levels of the trait hierarchy would represent more abstract traits, while lower levels of the hierarchy would contain more concrete or more detailed traits. These hierarchies of traits have been suggested in the literature, but do not appear directly in most of the core models [34,41,44].

A template for vertical scaling in a model is shown in Figure 1. At the highest level of the hierarchy is the character itself. Below that would be the aspect of the character being modeled below, such as personality or emotion. Below the aspect would be the model in question, and below that would be the traits, sub-traits, and additional refinements necessary to fully and completely describe the model. Doing so allows designers and developers to explore depth, subtle nuances, and detailed elements of a particular character with respect to a given aspect and model. (As we will demonstrate in the next section, this vertical scaling also enables horizontal scaling, and the integration of multiple models with overlapping or otherwise similar features.)

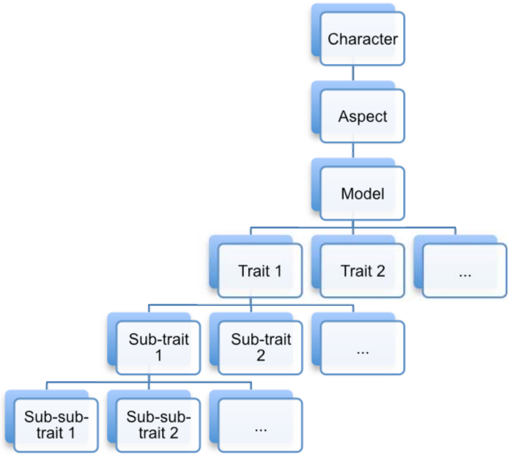

Figure 1: Template for Vertical Scaling in a Model

For example, consider the emotion model of Parrot [34] with primary, secondary, and tertiary emotions. A partial set of traits for a particular character, Alice, using only Parrot's emotion model could be visualized in Figure 2.

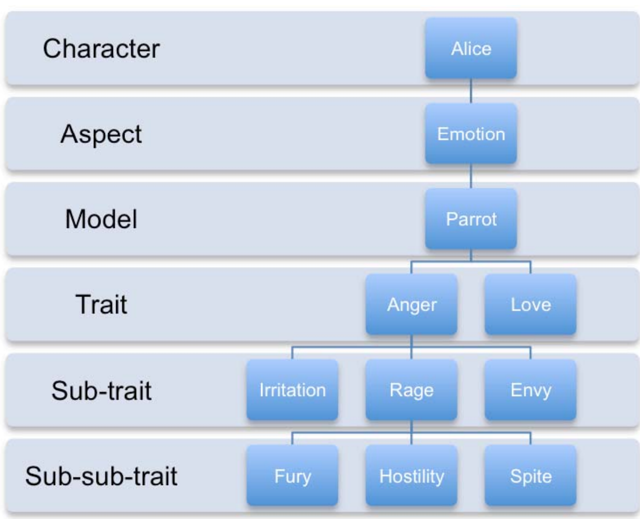

Figure 2: Partial Trait Model for Character Alice

Naturally, to define a character and drive believable behaviour from them, we need to assign values to the particular traits. (For instance, if a character is feeling anger, we must specify how angry that particular character is.) Even on this seemingly simple point, the literature in the area is fairly divided, with some researchers favoring discrete values (such as on or off, or present or not present), and others favoring a continuous scale (such as between 0.0 and 1.0 or -1.0 and 1.0). For our purposes, we have chosen to use a continuous scale between -1.0 (strongly negative) and 1.0 (strongly positive) for primitive trait values, as this would accommodate the majority of other approaches with the least difficulty. (For example, a discrete present or not present trait could be modeled by values of 1 and 0 respectively.) Some models like Reiss' [37] require compound traits with multiple values (such as a set point or target and a current value, in this case), but these approaches can typically be supported using a small set of primitive trait values [49].

To maintain consistency within the model, weights can be assigned to the linkages between a trait and its sub-traits to determine the contribution of each sub-trait towards the parent trait and the distribution from the parent trait to each sub-trait. With these weights in place, adjustments to lower-level traits made manually during production by game designers or developers, or at run-time by the game itself, can then propagate to higher-level traits, and vice-versa.

For example, consider the personality scenario in Figure 3, showing the FFM [47] trait of extraversion decomposed into just two of the possible sub-traits identified in [41]. In this example, the Outgoing trait accounts for 70% of the extraversion trait value, while Independent accounts for 30%. The character in question is very independent (0.9) and quite outgoing (0.8), so we would expect that the character would also be highly extraverted. Given these contributions and the sub-traits in Figure 3, the value for extraversion can be computed as (0.7 x 0.8) + (0.3 x 0.9) = 0.83.

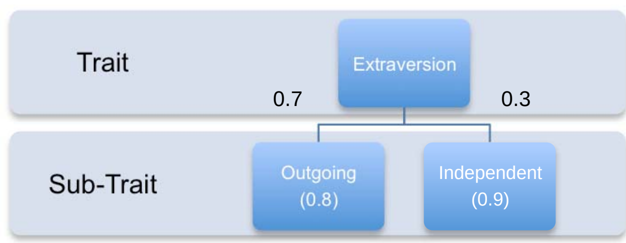

Figure 3: Applying Weights to Traits and Sub-traits

With this approach to vertically scaling psychosocial models, we can flexibly provide and automatically manage a great deal of depth and detail on the various aspects of non player characters. Through this scaling to sub-traits and sub-sub-traits, and the weightings applied in the process, we can now look to horizontal scaling to support the integration of multiple models.

3.2 Horizontal Scaling

While vertical scaling of a psychosocial model adds depth, horizontal scaling adds breadth, in this case integrating various models together and providing interoperability. Depending on designer and developer requirements, horizontal scaling can integrate entire models or only certain traits and sub-traits from models. Furthermore, additional traits from outside traditional psychosocial models can also be integrated, and other changes can be made to tailor and tune the resulting model to a great degree.

Conceptually, this is can be as simple as the template for horizontal scaling shown in Figure 4, demonstrating the integration of multiple aspects and multiple models for each aspect. When integrating multiple aspects, such as personality and emotion, with only one model per aspect, this is a relatively simple process as the aspects themselves are usually independent and do not contain conflicting traits or other potential issues.

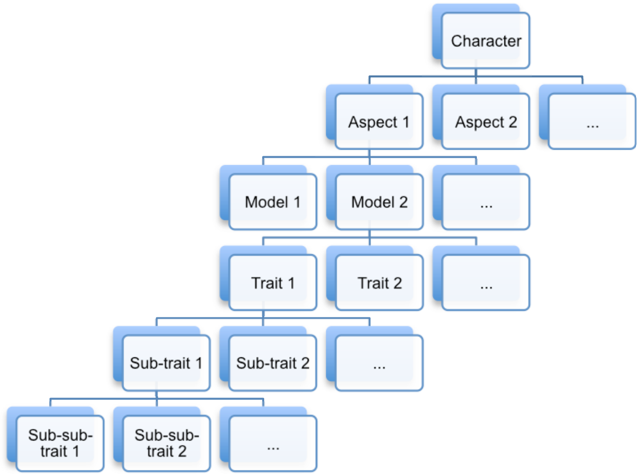

Figure 4: Template for Horizontal Scaling Across Models

For example, we can perform a relatively simple integration of personality and emotion using FFM [47] for modeling personality and Ekman's model [12] for representing emotion. A partial set of traits for a particular character, Bob, integrating these aspects and models could be visualized in Figure 5.

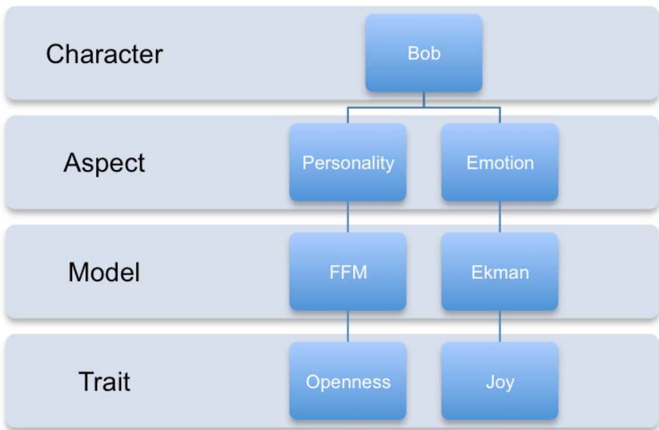

Figure 5: Partial Trait Model for Character Bob

The situation gets significantly more complicated, however, when combining multiple models under a single aspect because of the potential overlap and conflict in the models. Consider, for example, the partial set of traits for a character Charlie, whose personality we want to model to leverage elements of both MBTI [29] and FFM [47], as shown in Figure 6. This combination of models can be useful, for example, when character behaviour is guided through FFM traits, and career and professional orientation are determined through MBTI [23,29].

In the example in Figure 6, both models have traits to represent the concepts of extraversion and introversion. (There are also other sources of overlap and potential conflict between these models, as discussed in [27], but the concepts of extraversion introversion are the most highly correlated, pose the most obvious problem, and are the easiest to discuss here.) If these overlapping traits are not synchronized with one another, character behaviour could become erratic and inconsistent, thereby destroying any player immersion or suspension of disbelief [5,25], which is highly undesirable in the game. Without any linkage between traits across models, synchronization is unfortunately difficult and error-prone, as changes and updates made manually by designers and developers must occur multiple times, and those that occur at run-time during the game must occur to all affected traits in tandem. (Doing so is complicated even further when the connections and correlations between traits across models are less obvious and better hidden within the models.)

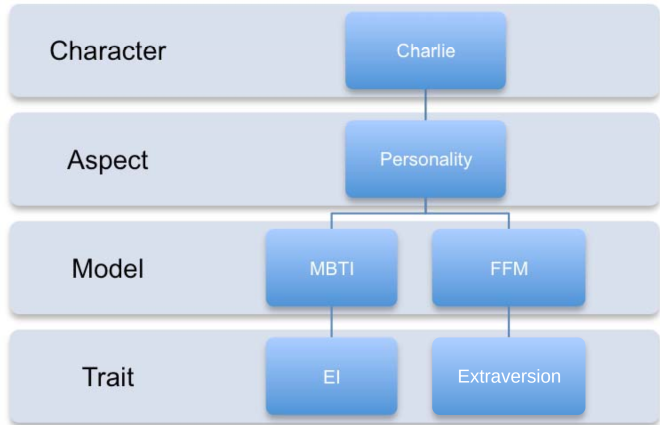

Figure 6: Partial Trait Model for Character Charlie

To solve the above problem and ensure model consistency and believable behaviour when scaling horizontally to accommodate additional psychosocial models, we can take advantage of the vertical scaling discussed in the previous section. Overlap and conflicts occur between models because of elements in common somewhere in the trait hierarchies of the models. Otherwise, the models would be independent, and there would be no problems or difficulties in the first place.

By hierarchically decomposing model traits into sub-traits, sub-sub-traits, and so on, we can uncover the common elements between the models. Instead of duplicating the common elements in each trait hierarchy, we instead use only a single element with separate links into the higher levels of the corresponding trait hierarchies. By doing things in this fashion, we can take advantage of the common elements to link the various models together and synchronize them with one another.

For example, recall the partial set of traits for the character Charlie given in Figure 6. While there is a strong correlation between the respective extraversion and introversion elements between the MBTI and FFM models used in this case [27], it is not perfect, suggesting that we cannot simply use a common extraversion trait to replace the corresponding traits in each model. Consequently, we can decompose these traits into their respective sub-traits, and potentially lower-level traits beyond that point as necessary. In the process of doing so, we can also assign weights to the linkages between the higher-level and lower-level traits in the hierarchies to indicate relative contribution and distribution, as we did in the previous section. When we do this, we end up with the expanded partial trait model shown in Figure 7. (Note that we are following the same simplified decomposition as in Figure 3 for the extraversion trait of FFM, and that decompositions and weightings were made for illustrative purposes in this example, and do not

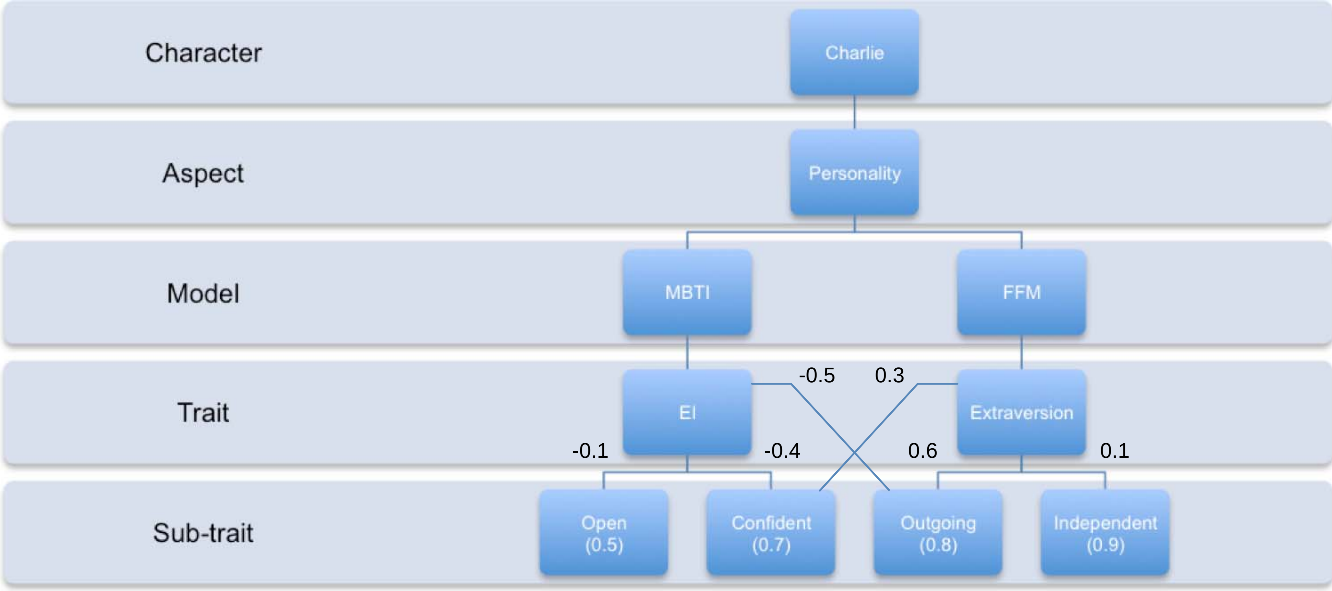

Figure 7: Expanded Partial Trait Model for Character Charlie

necessary reflect how scaling should actually be done.) In this example, we can make note of several things:

- Not every sub-trait needs to be linked to both trait hierarchies. This is only logical, since different models focus on different things. In this example, the sub-trait Open is only associated with EI of the MBTI model, and the sub-trait Independent is only associated with Extraversion in FFM.

- The weights assigned to links between the traits and sub-traits differ between the two models. Again, this makes sense since different models emphasize and consider traits differently.

- The weights assigned can be negative, as was done with sub-traits linked to the EI trait of the MBTI model. In this case, doing so makes sense, since strongly negative values of EI indicate a highly extraverted individual and strongly positive values indicate a highly introverted individual.

With trait hierarchies linked in this fashion, the models can remain synchronized and consistent. Additional models and traits can be added for further horizontal scaling, building additional linkages as necessary.

When performing horizontal and vertical scaling, it is important to base decisions in hierarchical decomposition, linkages, and weight assignment on scientific study, such as the work in [27,41,44], and the literature in this area. Even a rigorous approach, however, will not be able to handle all integration scenarios, as all the background research to do so does not exist, or has yet to be completed. In such cases, we must use our best judgment given the research results that are available, but leave flexibility and openness in our approach to allow easy changes, revisions, and additions in the future. Mechanisms to enable doing this are discussed further in the next section.

3.3 Models as Data

Instead of only viewing trait values as data, in our approach, we treat the psychosocial models as data as well, following a data-driven methodology. As noted above, these models follow a tree or graph like structure, and so it is possible to capture the models themselves as data. Doing so facilitates customization and change by designers and developers, enabling them to more easily adapt to updates or revisions in psychological theory by integrating additional models, adjusting trait decompositions, editing linkages between traits, and tuning weights assigned to linkages.

4. PROTOTYPE IMPLEMENTATION

As a proof of concept, we have developed both a run-time system for non player characters in games using our approach to psychosocial model integration, as well as management tools to assist in creating both the characters and the models that define and ultimately control their behaviour.

4.1 Run-time System

Based on our earlier work in [3], we created a run-time system for believable non player characters based on principles of emergence. (For an overview of emergence in general, and the varied use of emergence in games, the reader can consult [45].) The original system was capable of executing scenarios involving multiple characters with personalities, emotions, and social ties that were defined by simple, fixed psychosocial models. While this earlier prototype was successful, it also possessed limitations in its ability to model characters and generate behaviour.

The prototype run-time system used in our current work builds upon the emergent foundation from our earlier work, as well as the interface used in its run-time system for displaying character status and behaviour. The underlying psychosocial modeling and behaviour control systems are different, however, now using our multi-model approach, complete with vertical and horizontal scaling, and an entirely data-driven philosophy. All models, characters, and emergent interactions are now defined in XML that is read in and processed by the run-time when it is launched. Social ties are now augmented with roles, context is now available for use in making decisions, and a basic goal structure is in place to enable planning in characters. (Characters in our earlier work possessed no goals or planning capabilities and often seemed rather instinctual and reactive, as they had no mechanisms to guide their actions other than responding to environmental stimuli.) Further details on these aspects of the prototype run-time system can be found in [49].

The run-time system was developed for Microsoft Windows XP/Vista/7 using Microsoft Visual Studio 2008, and was written in C++. A combination of DirectX and OpenGL was used for interfacing with the user by providing a graphical representation of characters, their internal states, their relationships, and their behaviours. (A screen shot of this system is shown in Figure 8.) A detailed log of all activity is also recorded to the console.

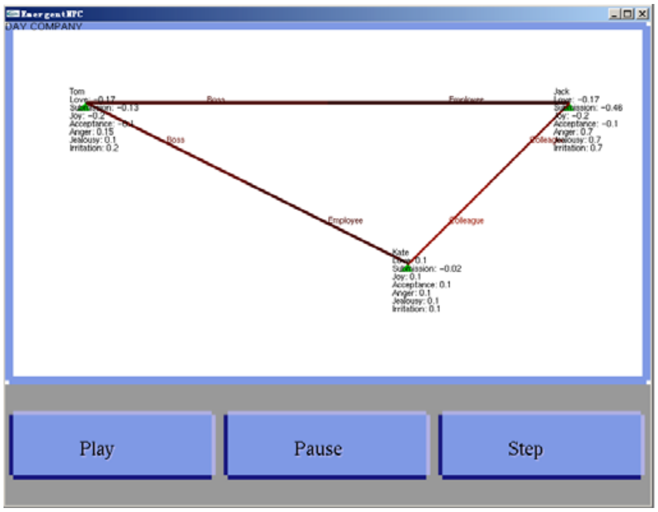

Figure 8: Emergent Run-time System

4.2 Management Tools

To assist in the creation of non player characters and the requisite psychosocial models to support them, management tools were developed, as shown in Figure 9. These tools were targeted at the same platform as the run-time system, but were developed in C#, to allow for quicker prototyping and interface development.

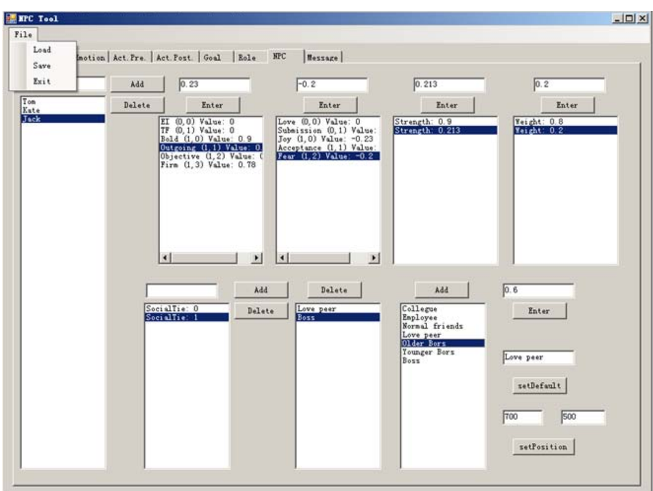

Figure 9: Management Tool for Models and Characters

These tools allowed the creation of psychosocial models, defining trait hierarchies, creating linkages between traits, and assigning weights to linkages. Multiple models could be easily integrated using the vertical and horizontal scaling techniques described earlier. With models in place, characters could be defined and assigned traits according to the models. Emergent interactions could also be defined using the tools to describe the pre-conditions and post-conditions on all interactions between all psychosocial elements, characters, and other elements of the simulated world within the run-time system. All data was stored in XML files to be used later by the run-time system.

5. EXPERIENCES TO DATE

Using the prototype implementation described in the previous section, we constructed and evaluated a number of scenarios to assess the effectiveness of our work, as discussed at length in [49]. For brevity, in this section, we present an updated version of but one of these scenarios across multiple trials and configurations.

5.1 Overview

In the scenario presented in this paper, we examine a particularly messy situation involving a love triangle. In this case, two brothers, Jack and Tom, were romantically interested in the same girl, Kate. Complicating matters further was that all three worked at the same company, with Jack working as a programmer, Kate as an administrative assistant, and Tom as their boss. Jack, as the older brother, was jealous of his younger brother, and disliked him intently. Tom, on the other hand, liked his older brother and tried to maintain a good relationship with him. Kate had romantic feelings for both brothers, but was not fond of the conflict that occurred as a result. At work, they tried to remain professional, but such restrictions were not in place outside of work.

5.2 Scenario Modeling

The above scenario is a rich, but very complicated scenario. It involved multiple psychosocial models to represent personality and emotion, multiple relationships between each pair of characters, context (in the form of setting – either at work, or outside of work), and roles with associated goals and rules to guide character behaviour, both professionally and personally.

For personality, both MBTI [29] and FFM [47] models were used. MBTI was used to define base personality traits from a professional basis, with Tom, Jack, and Kate defined as ENTJ, INTJ, and ESFP respectively to most closely match their profession in the scenario [23]. FFM was used to define other aspects of the characters useful in determining their behaviour. For emotion, Ekman's model [12] was used, although some traits were not used, and others were split and refined into lower-level emotions, to provide a suitable set of emotions for the scenario. Appropriate linkages were used to integrate the models together, as discussed earlier in this paper.

Each character had their own goals, depending on whether they were at work or not. Professionally, Tom was interested in making sure his employees were obedient and working, and that they had a good relationship. Jack and Kate as employees wished to have a good relationship with their boss and that their work was accepted. As co-workers, Jack and Kate wanted a good work relationship. Personally, Tom wanted a good relationship with his brother and wanted his brother to accept him. Jack, feeling vengeful, wanted his brother to be miserable, feeling sad and/or irritated. Each brother wanted a good relationship with Kate and wanted Kate to feel love in return. Kate felt similarly towards each brother.

Each character had several actions available to them to meet their goals and respond to the actions of the other characters. These actions included: praising, supervising, working, giving orders, scolding, flattering, obeying, snubbing, greeting, talking, kissing, hugging, holding hands, arguing, and attacking. The use of certain actions was limited by a character's goals, personality, emotional state, and relationships. For example, actions like attacking could not be carried out unless you were angry and were dealing with someone that you did not like. Further details on actions, and their relationships with goals and roles can be found in [49].

5.3 Results

The above scenario was executed under a variety of location-dependent starting conditions. Each time, the results were different, but made sense given the context.

In the first trial, this scenario was started with all characters at work. Tom was upset and did not believe his employees were working hard enough, and so he scolded them. Jack, being introverted, did nothing in response, but Kate, being extraverted, flattered Tom. This improved their relationship and made Tom happy. Being less upset, Tom stopped scolding his employees, which led them to follow his orders, and do their work. Liking this, Tom praised his employees, which improved their relationships and made them continue to work hard. The scenario reached a stable and steady state in this configuration, with everyone satisfying their professional goals.

In the second trial, the scenario was started at home, outside of work and no longer bound by professional goals. Tom would try to help or hug Jack to improve their relationship, but Jack would snub him in return because of his dislike for Tom and his goal of trying to make his brother miserable. Kate would show both brothers affection because of her feelings for them. If Kate showed her affection to one brother privately and away from the other brother, neither was aware of that situation. In this case, Jack would eventually grow happier because of Tom's actions and Kate's affection to the point where he could no longer perform actions to seek revenge and make his brother miserable. Everyone became happier and all personal goals were satisfied, except for Tom's initial goal for revenge.

On the other hand, if Kate's affection to both brothers was public and known to both brothers, the situation unfolded differently. Both brothers would become sad, jealous, and angry at each other. Tom would no longer help or hug Jack, and the two fought with each other. Kate's relationship with both brothers turned very negative at the same time. In the end, no personal goals were satisfied, except for Jack, because Tom was now miserable.

In the third trial, the scenario was executed first at work, and then moved home after a period of time. If the scenario stabilized at work with all professional goals satisfied before moving home, things unfolded much as they did in the second trial. (The difference was that Jack would come home in a submissive and somewhat happy state from being at work, and so he would not snub his brother at first.) If the scenario had not stabilized at first, things unfolded differently. Jack would come home already upset from Tom's scolding and before Tom could improve the situation, Jack attacked Tom. Despite the attacks, Tom continued to try to improve the situation with his brother. Kate, witnessing the attacks, grew increasingly sad and angry. Her relationship with Jack immediately became negative and she only showed affection to Tom. Seeing this, Jack became jealous and continued his attacks. Eventually, Kate grew so sad and upset that she could no longer show anyone any affection. With Tom's persistence, Jack eventually became happy enough that he ceased the attacks and started to like his brother. Jack, on the other hand, was still sad and upset about the earlier attacks and his feelings towards his brother were largely negative. In the end, no one had all of their goals satisfied, but Tom and Kate's relationship endured.

In just this scenario, a variety of interesting and believable behaviours could be achieved using our proof of concept. By integrating multiple psychosocial models, there is significant potential for modern video games.

6. CONCLUDING REMARKS

In this paper, we presented our approach to the integration of multiple psychosocial models for believable non player characters in games. Doing so has the potential to give game designers and developers considerable flexibility and freedom in their craft, enabling richer and more immersive experiences for their players. Our prototype systems have demonstrated the benefits of our work, and experiences to date show great promise for the future.

There are many avenues for future work in this area. The hierarchical decompositions, linkages, and weightings used in the models of our prototype were based on existing research in the literature. This research, however, is incomplete, and so further work is needed with professionals to scientifically complete this work and our models in a rigorous fashion. While our current work is already capable of supporting interesting scenarios with solid results, additional work can be done to produce even better characters through the addition of cultural aspects, physiological traits, improved socialization and more robust planning mechanisms with learning and memory. Finally, integration of our approach in a complete game engine would enable user studies to fully assess our approach to providing believable behaviour.

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