Introduction

One constant issue in development of video games is the tremendous effect that game agents have on the quality of the player's experience. In many modern games, a single player or even multiple players are given an opportunity to have bots as opponents or as team-mates. In addition, some games involve players interacting with friendly non-player characters (NPCs) who are not companions. Interactions with such characters vary based on the game genre and the implementation of the individual game. However, one common goal among most game genres and character types, is to have effective artificial intelligence (AI) that keeps the player involved and enthusiastic. This means that in games involving combat or sports, team-mates must be responsive and must not hinder accomplishment of a goal and opponents must be non-predictable. In more cinematic role-playing games (RPGs), both friendly and enemy characters require dimension and a realistic forum in which to interact with the player for the experience to be satisfying. Work has been done in researching the believability of characters in video games, along with several recent approaches to implementing team-based AI. There are also many ways to model characters, in addition to algorithms which allow game agents to be less predictable and thus, more enjoyable to play with. Studies conducted on the quality and methodology of game agent implementation continue to aid the video game industry in enriching the experience for all types of players.

What makes a character believable?

"When the player's expectations match their experience, a character is fully believable." This is part of a definition given for believability of an agent in a video game [1]. Studies and surveys that have been completed have attempted to better enumerate what a player's expectations are regarding the behavior of game agents. In a study performed in [1], NPCs were chosen from different video games. Subjects involved in the study were tasked to rate each NPC based on five attributes contributing to believability. These attributes are emotion, personality, appearance, goal or motivation, and social relation. The goals of this study were to find how much each of these five attributes contribute to the general believability of a character, as well as if the friendliness or hostility will affect the believability and enjoyment of the interaction.

The NPCs used for the study were chosen from games rated by a popular game rating website. Lee and Heeter [1], chose four games that were either rated high or low. They avoided middle rated games to pursue more diverse results. From each game, they chose two characters: a hostile character and a friendly character. They studied the characters based on how the game was rated and whether the character was hostile or friendly. The authors then recorded eight video clips of each character which displayed all of each characters' behavior patterns. This method was chosen over having subjects play the game to maximize attention paid to the character. The subjects were then tasked to complete surveys rating each character based on how each character embodied the five attributes which contribute to believability. The survey used a five-level Likert scale where five represented strong agreement and one represented strong disagreement. There was also a final general question regarding each character's overall likability on the survey as well.
Each believability question was analyzed using a Pearson correlation to relate specific believability to general believability. From the study [1], Lee and Heeter were able to formulate two hypotheses. First, they noticed that players who frequently played RPGs will rate the NPCs higher than players who had not played many RPGs. Furthermore, they noticed that characters in games with higher ratings will be more believable and enjoyable than characters who did not come from high rated games. Moreover, it was found that the believability of the characters was dependent more on the specific believability factors than the general factors. The specific believability attributes personality, emotion, goal and appearance or behavior significantly contributed to the overall believability of each character. In addition, they found that friendly characters were reported to be much more believable than hostile characters. It has been assessed that this is a result of the player often having longer and more significant verbal interaction time with friendly characters versus hostile NPCs.

What makes a character effective?

A rating of the functionality of a game agent is dependent primarily on its role in a game, along with the genre of the game. However, in most genres, the effectiveness of a game agent is related to its role in a team-mate environment of some kind. In [2], real-time team-mate AI is defined as involving NPCs that coordinate with players on the same team and participate in decision making. A real-time team-mate must also be relevant to game-related goals and prioritize player participation.

The genres explored by McGee and Abraham's survey [2], were team sports, action games, real-time strategy (RTS) games and RPGs. Within each genre, there is some specification regarding what sort of role an ally or opponent team-mate may take on. In general, friendly team-mates should coordinate in such a way that they do not hinder the player's action or that of his or her team. They support friendly team-mates when needed, and they take some form of action against the player's opponent. An example of this from an action game would be engaging an enemy agent or healing wounded team-mates. Generalizing the role of opposing team-mates includes coordinating movement in such a way to prevent the player's team from advancing, to attack or score against the player's team, and to aid in the opponent team gaining the upper hand against the player's team and any other teams involved.

McGee and Abraham [2], also noted contributions to real-time team-mate AI, relative to several categories. Classification includes observing player behavior and assigning a style to the user's type of play. Another category, prediction, involves anticipating player actions, such as whether a player will block or attack. A third category, action selection dictates the action that a team-mate takes. Finally, adaptation and learning involves real-time updates for an agent to evolve and be able to better strategize for future events. Each category has had progress in the development of real-time algorithms, some more than others. Classification, action-selection and prediction have had more work done than the other areas. Although, as mentioned in [2], there is much more that can be done in each of these areas. This could aid in the comparison and ultimate evolution of different methods or approaches with the goal of finding better implementations of real-time team-mate AI.

What are some ways to improve believability and effectiveness in game agents?

Player Behavioral Modeling

In [3], player behavioral modeling is described as being a way to assess a player's in-game behavior and to use that behavior to tailor the experience to each unique player. Player behavioral
modeling aims to create an AI that is interesting or effective when considering these player models and to offer ways for game developers to implement it creatively. Player behavioral modeling has some history in classic games like chess. However, it has a very rapidly growing significance in video games.

Bakkes, et al. [3], discuss specific roles of NPCs in video games and the differences of roles between different types characters and the variations in the implementation. An NPC that acts as a companion or ally must assess the player's behavior in a way that ensures that the agent does not take an action that would interfere the player's progress in the game. In short, the NPC must display situational awareness. For example, in a soccer game, a player's NPC team-mate would not score a point in its own goal. There are also NPCs that may take on a coaching role. These NPCs must be able to assess a player's behavior to a degree that they are able to guide the player in a certain direction efficiently without misleading the player. Opposing NPCs also have a specific role in video games. An opponent must challenge the player without being at such a level of difficulty to cause frustration, possibly provoking the player to want to quit. There are further roles that an NPC can play that do not embody one of the above mentioned roles. For example, a shop keeper in an RPG may not necessarily fall into a role of companion, coach, or opponent. However, as these types of NPCs have less meaningful, linear interactions with a player. Thus, it is not necessary to explicitly consider these types of NPCs. The three roles considered by Bakkes, et al. [3], provide a firm foundation on which to use player behavioral modeling to better customize gameplay to the individual player.

Player behavioral modeling can be implemented and approached in several ways as described in [3]. Modeling based on player action may be considered undemanding because it simply requires considering a list of game states and possible actions with a likelihood of that action being picked by the player. Though, due to incomplete information, difficulty generalizing new situations, and the possibility of rather large state-spaces, player action can be a less appealing option in some situations. Using player tactics to implement behavioral modeling involves observing a player's behavior and combining that with analysis of in-game goals that may motivate a player to act in a certain way. Tactics modeling offers a potentially much smaller state-space and easier generalization than other types of modeling but prove difficult to generalize. This approach can be effective in more linear or simple games, while it may not be very effective alone in more complex games. Strategic modeling includes analyzing player tactics to infer what course of action a player may take in reaching a major objective in a game. While it is possible that this approach may require more observation than other approaches, it is more easily abstracted. Finally, profiling the player offers an abundance of information to improve the experience along with the ability to generalize the player profile in different locations. These models provide an insight to the reasons behind a player's behavior. However, since the profiles are unique to each player, it can be discouraging to use this approach as new profiles require the same degree of observation as previous profiles.

As illustrated, implementations using player actions, tactics, strategies, or profiling are better suited in different combinations depending on the type of game that they are being used with. Factors like generalization and state-space size dictate what types of player behavioral modeling approaches are best to take. When implemented in the proper way, player behavioral models have a high potential to enhance the gaming experience by using observations of a player's behavior to learn how to react to him or her.

**Improving Emotional Intelligence in Game Agents**

In some video games, friendly or opposing NPCs include characters who are at the mercy of their own emotions and motivations. Acampora, et al. [4], propose a novel cross-platform architecture meant to model the emotions of NPCs in such a way that attributes such as action selection and personality can be improved and thus the character be more believable and effective. The ideas behind this architecture
merge theories from psychology with a computational intelligent technique, Timed Automata Based Fuzzy Controllers (TAFCs).

A standard model for emotions was developed by Ortony, Clore, and Collins, is referred to as the OCC model. The model is based on the notion that three kinds of stimuli: consequences of events, actions of agents and attractions of objects, dictate an agent's emotion based on the reaction that said stimuli provokes. A model for human personality, the Five Factor Model, asserts that it is based on five dimensions abbreviated with the acronym OCEAN. The dimensions considered are openness, conscientiousness, extraversion, agreeableness, and neuroticism. The TAFC, then, is made up of two components. During the first phase of a system's existence, a traditional fuzzy controller models the system's control behavior. In order to have a way to account for time related events, a timed automaton, which can be thought of as a finite-state automaton with a finite set of real-valued clocks. The automaton has the task of describing the dynamic evolution of a system [4]. These models can be combined to form a framework for better simulating emotional intelligence.

The ultimate framework introduced by Acampora, et al. [4], was called Timed and Emotional Artificial Mind for NPCs (TEAM). It attempts to model NPC behaviors by simultaneously taking into account emotions and time. The OCC and OCEAN models are used to assess attributes of an agent like emotions, personality, and physical condition. The TAFCs are then responsible for the actual decision making. From this combination, TEAM is a framework that is made up of components that allow communication, input, output, and emotional and timed decisional models. From the input interface, important attributes of the environment are passed to the emotional and timed decisional models. Each component analyzes the information separately. Considering this information, the respective components to update the emotional state of the bot and make decisions on further actions. Once TEAM was fully implemented, several tests were conducted to test the quality of the bot.

In [4], a case study was performed first, using the game *Unreal Tournament 2004*, specifically the game type "Capture the Flag." This was done by interchanging the implemented AI within the game's engine with the proposed TEAM bots. Preliminary experiments were conducted by comparing the two different bots. The preliminary experiments focused on achieving a desired level of "human likeness." This scale was based on two characteristics. The first aspect being average score, where score is the number of friendly flags captured by the opponent in a capture the flag simulation. The second factor for human likeness scale was duration of the match played. In total, there were four experimental contexts, two with the TEAM bot and two without. The performances with the highest human-likeness scores were the TEAM bots.

Eventually, a relatively nontraditional Turing test was performed on the TEAM bot. In [4], this test is described as a series short videos of gameplay that were prepared. Some videos had a human playing the *Unreal Tournament 2004* game mode, "Capture the Flag," and some with a bot playing the same mode. The videos were then shown to student judges to evaluate the performance. In total, ten judges were chosen who each viewed four videos that were selected randomly, two from the bot selection and two from the human selection. In this test, the human videos were scored with higher levels of human likeness. However, the TEAM bot did receive about seventy percent of ratings above three on a seven-point Likert scale out of all rounds. From the results of the preliminary test, along with these Turing results, it can be said that the TEAM framework is a formidable example of a functional and portable implementation of emotional intelligence that can be used in game agent decision making which can add to effectiveness and believability of an agent.
Game Agent Learning With Fictitious Play

Patel, et al. [5], proposed the use of a game theoretic based learning rule known as fictitious play with the goal of making game bots less predictable. Efforts have been made to improve game AI with Finite State Machines (FSMs) and reinforcement learning. However, it is argued that FSMs have proven to still be very predictable and reinforcement learning can be difficult to implement. The community of game AI treatment that the authors focus on is analytical and efficiency oriented rather than combat oriented or non-combat oriented. The learning algorithm that has been proposed, fictitious play, executes actions based on observations and with the assumption that the opponent is playing a fixed strategy. In fictitious play, beliefs based on previous moves of an opponent are reviewed and the best response, based on those beliefs, is selected.

Experimentation with the algorithm is described in [5] as being approached using a scaled down version of the game Counter Strike with simulated bots that use fictitious play to aid in decision making. The game agents which used fictitious play were able to dynamically change their strategy. In the game Counter Strike, terrorists and counter terrorists make up the two teams that oppose one another. This experiment focuses on a mode of the game called diffusion, in which the terrorists plant bombs and the counter terrorists must secure bomb sites and diffuse the bombs. The team which is always controlled randomly was assigned to the counter terrorist team. In different phases of the experiment, the counter terrorist team is given different fixed strategic probabilities of visiting either bomb site. Several rounds of experiments were conducted. Some rounds with of the terrorists playing randomly and some playing with fictitious play. It was found that when the terrorist bots used fictitious play, they were less predictable and as a result, won more rounds than when being controlled randomly.

In future implementations, Patel, et al.[5], describe the desire to evolve this algorithm to consider groups of opponent bots rather than a single agent. They also introduce the possibility of experimenting with a bot's ability to adapt to changing styles of play rather than fixed strategies. Like the Emotional Intelligence implementation, this fictitious play algorithm is portable. It is also expandable and can be used in a variety of situations involving NPCs apart from one-on-one combat. Besides combat, allied and opposing agents can use the fictitious play algorithm to learn player behavior in dialogue and other aspects requiring user decision making to allow the agents to better understand the player and offer him or her a more noteworthy gaming experience.

Conclusion

In many ways, the believability of a character in a game can directly affect the level of enjoyment that a player gets from playing a game. In the study performed by Lee and Heeter [1], it was shown that games with more believable NPCs were rated higher. In many genres, the effectiveness of an NPC, relative to their function in a game, can effect the quality of the experience that a person has in playing a game. It is important that an NPC's behavior keeps the player engaged and does not impede the player's progress. There are also many new novel approaches to improving the quality of team-mate agents in video games [2]. Concepts like various types of player behavioral modeling [3], a framework based on emotional intelligence [4], and agent learning based on fictitious play [5]. With the growing capability of hardware and many new ideas to explore in improving AI in NPCs, there is certain to be expansion in the effectiveness and believability of characters in video games. Studies, like the ones addressed, can help to aid in the evolution of game AI.
References


