Adaptive Game AI and Video Game Enjoyability

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1 Introduction

In modern times nearly every person in the country is aware of video games and the majority of them have played one at least once. Because video games represent controlled environments that can be created to mimic real world environments, they are ideal testing spaces for ideas that may be difficult or dangerous when tested in reality. It is for this reason that video games are widely used to test different types of Artificial Intelligence (AI) such as Recurrence Learning Algorithms [Liu et al., 2011], Q-learning a reinforcement learning technique [Patel et al., 2011], Ambient intelligence systems [Sadri, 2011], and what is known as intelligent agent processing [Wickramasinghe and Alahakoon, 2004]. There are an almost innumerable number of different intelligence systems out there, but most have the same basic building blocks. Using a simple model laid out by Pieter Spronck, author of the 2005 book, Adaptive Game AI, I plan to test the effectiveness of an adaptive AI as compared to a non-adaptive AI [Spronck, 2005]. I wish to test how effective a behaviorally adaptive video game AI is at improving video game enjoyability according to user survey response in a simple and controlled video game environment.

Since Malone’s work the most voluminous facets of research done into the computer science of video games are how to make educational games that retain their ability to engage and entertain the user, and also building more robust and adaptive video game AI.

The two main research areas in this field are studies into what makes games enjoyable to play (how to build systems with the user’s entertainment in mind) and studies in which the goal is to build an adaptive game AI. Although these subjects are rarely connected in academic papers there is a broad base of research that has been done in both of these subject areas. One of the few studies that combined these research areas was known as PADS [Yun et al., 2010], which means Profile-based Adaptive Difficulty System. This system focuses on having a game that adapts the overall game difficulty to the user rather than having a non-playable character (NPC) whose behavior is based on the actions that the user takes. In this study, the authors used minute by minute data on user interaction and user feedback on the enjoyability of the game. Their data revealed that the game adapting itself to the player’s skill level causing each user to believe the game was at a moderate difficulty, and at this level of conquerable challenge the users appeared to be the most engaged within the game (i.e. entirely invested in the fantasy).

2 Background Info

2.1 General

In studies done in the infancy of video games, it was identified that there were main factors that went into the effectiveness of all video games [Malone, 1980]. Some of the most important early research into what makes a computer game fun to play was done by Thomas Malone at the famous Xerox Palo Alto Research Center. [Malone, 1982, Malone, 1980] Malone lays out three main components that together make up the features defining how enjoyable any particular
game is to play. The game must be challenging, this means that the outcome is not predetermined and there is some goal the player must satisfy that takes skill. The game should engage the user’s self-esteem by engaging the user in intrinsic rather than extrinsic fantasies. This means that the main goals of the game are of a morally rewarding nature rather than games where you fight for fame or fortune. This is why in many games, the main goal of the game is to save either the world or humanity from some genocidal threat. The last component that Malone describes is the importance of engaging the user’s curiosity.

"Curiosity is the motivation to learn, independent of any goal-seeking or fantasy-fulfillment. Computer games can evoke a learner’s curiosity by providing environments that have an ‘optimal level of informational complexity.’ In other words, the environments should be neither too complicated nor too simple with respect to the learner’s existing knowledge. They should be novel and surprising, but not completely incomprehensible.” [Malone, 1980]

Examples of later studies on what makes video games enjoyable have revealed other motivations that may be responsible for the entertainment of video games. A 2002 study on general design tactics for creating and testing the fun of video games outlines two more direct general causes for enjoyment in video games. [Federoff and Federoff, 2002] The first cause being that video games provide an escape from reality that is more compelling than other forms of entertainment because of the participatory nature of video games. This escape from reality is noted in the study by psychologists as something that is essential to human mental health from time to time, and the effectiveness of video games at creating this escape is part of what makes them so popular. The second form of enjoyment from games is the chance to learn a skill in order to accomplish some sort of challenging goal. This is enjoyable for the user because it satisfies their need for intrinsic stimulation and intellectual growth.

### 2.3 Adaptive Game AI

The amount of work that has been done in the field of adaptive game AI is staggering. There are a number of techniques used to mimic what we perceive as intelligence. The most common of these is an adaptive machine learning algorithm that is generally tailored around some goal. There are three main types of adaptive video game AI. [Charles et al., 2005] The first of these, which is the most common and the most simple type of adaptive AI is one that increases or decreases difficulty of the game based on how much of a challenge the user is experiencing. This means that if the player is struggling, the game will get a little easier, and if the player is just pushing through with no challenge then the game will increase the difficulty without the player having to change any settings. The second type of game AI which has become popular in modern Role Playing Games (RPGs) such as the 2004 game Fable is an environmentally adaptive AI. This means that the environment and the game world will change based on the actions that the player takes. For instance if a player decides to take an evil action the world may get darker and if the player decides to be a hero the people may seem friendlier. The final type of adaptive game AI is by far the least common and the hardest to build; behaviorally adaptive game AI. This means that the NPC in the game will change it’s behavior based upon how the user plays the game. This means specifically the NPC will be correcting it’s mistakes and creating new behaviors designed specifically to defeat the user currently playing the game. This is the hardest because it involves a large amount of data and processing, which is why it is used mainly in RPGs. These are inherently iterative games and that is why it has been successfully implemented in games such as Baldur’s Gate and Neverwinter Nights, which are two of the most popular RPGs of the past decade. [Spronck et al., 2003] While these techniques may vary among each other they all share one basic principle, the use of machine learning in an iterative fashion. The different researchers who use this technique have to deal with the contemporary problems of heavy machine learning which are run time, data storage, and the ever present problem of making sure the results are relevant. Machine learning is a process where based on one set of data and how the edges are weighted between nodes, it takes a graph with no weights and applies them based on the pat-
tern it previously recognized. This iterative process takes a long time to analyze the large mass of data that is required for machine learning. There also has to be enough storage space for the large amount of data which is compounded upon during every loop of the game where machine learning is applied. Finally there also has to be some sort of indication that your algorithm is finding relevant patterns among the data rather than just coincidental patterns, which is very difficult to do. These problems are solved by each researcher in their own way, from using dynamic programming [Liu et al., 2011], to using incremental data streams which arrive over time and slightly alter the main algorithm every cycle [Vallim et al., 2010].

The direction of creating an adaptive AI based on iterative machine learning techniques is a popular area of research in the game AI community. This is because they involve reasoning, planning and learning within a controlled environment, which is the best way to test an AI for the real world. Recently there has been a large amount of interest in creating an Adaptive Game AI, which is an AI in computer games that has the ability to adapt to changing circumstances within the game world environment [Vallim et al., 2010]. Arguably the most important recent work in this field has been done by Professor Pieter Spronck, the author of Adaptive game AI. Spronck identified the core development pieces and structures required to make an adaptive game AI in a recent paper A Model for Reliable Adaptive Game Intelligence. [Spronck, 2005] Spronck said that adaptive game AI has two main objectives, namely to enhance the agents with the ability to learn from their mistakes, to avoid such mistakes in future play (self-correction), and to enhance the agents with the ability to devise new behavior in response to previously unconsidered situations, such as new tactics used by the human player (creativity). The core problem with the system’s ability to learn however is finding a balance between its exploration and exploitation behaviors. Exploitation is when the adaptive game AI does not learn, but uses its learned knowledge. Exploration is when the adaptive game AI attempts to learn new behaviors. When brought down to the lowest level though, Spronck says that adaptive game AIs are necessarily based on two concepts. The first concept is domain knowledge of the game environment. The reasoning behind this concept is that, to meet the four computational requirements, adaptive game AI must be of high performance. The two main factors of importance when attempting to achieve high performance for a machine learning algorithm are the exclusion of randomness and the addition of domain specific knowledge. Since randomness is inherent in most games, it cannot be completely excluded. Therefore, it is imperative that the learning process is based on domain-specific knowledge. The second concept is an opponent model. The task of an opponent model is to understand and mimic the opponents behavior, to assist the game AI in choosing successful actions against this opponent. Without an opponent model, the game AI is unable to adapt adequately to human player behavior. [Spronck, 2005]

Using these concepts and the processes outlined in Spronck’s work, it should be possible for any interested researcher to be able to build their own adaptive game AI. It seems likely that this use of adaptive AI will be effective at improving the games enjoyability because it has already been shown in recent studies that games which are less predictable are more enjoyable. In 2011 at the University of Derby there was a study done using recent award winning games such as Borderlands, which used item randomization to make the game a slightly different experience each time you played it. [Snowdon and Oikonomou, 2011] In the study, it was seen that re-playability and initial enjoyment of the game was improved when the player did not know what was coming next.

3  Research Question and Evaluation

How much does an adaptive game AI improve the users survey response regarding their enjoyment of game-play in a simple and controlled video game environment? This question will be answered using this simple game type: a two dimensional version of vollyball, in which there are two teams of one and each individual is a semi-circle with one eye. This is a classic game type known as slime volleyball or one slime
within the online community. This game was chosen because of its availability as open source code and because it represents a very simple environment with a relatively small range of behaviors that can be taken. A simple game of this type is ideal for testing the effectiveness of adaptive AI because there is a lower range of data that has to be learned and because there are few variables to potentially influence the results. In the study, users will be randomly assigned to play either the open source game AI or an adaptive game AI. Before play the users will then be asked to remember the words Apple Table Penny which are a widely used memory test for cognitive impairment (Folstein Mini Mental Status Test). In this study, however the words are used to test user engagement in the game play with the idea that the more engaged the user is, the less chance they will have of remembering the words. At the end of the game they will be asked to fill out a form which both asks them for user feedback on how much they enjoyed or found pleasure in the game as well as a list of the words they remembered being told. The survey will be done using a number of seven point likert scales (strongly disagree, disagree, somewhat disagree, neutral, somewhat agree, agree, strongly agree) so that the feedback can be easily transferred to numeric data. This method is effective because it gets several different aspects of how well the video game accomplishes it’s goals, and because it will be relatively easy to obtain data for the study.

4 Conclusion

The results will be measured based on how the users answer the feedback questions for both the regular AI and the adaptive game AI systems. The comparison will hopefully prove a large and significant difference in the playability of general versus adaptive AI games. If the adaptive game AI proves effective that is important because it supports the allocation of more funding and research into adaptive AI for video games. Adaptive game AI can serve as a testing ground for more socially important AI applications. Once actually built these adaptive AI methods could be scaled up to help in important real world applications such as organizing health records or even adapting street lights to improve the movement of traffic. There is no limit to where these kinds of AI can go, but there aren’t many places where they can start out. That is why the research into video games is more important than most people realize.

References


