EDTree: Emotional Dialogue Trees for Game Based Training

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Abstract. Immersion and interactivity are a major focus when creating gaming applications, as technology has improved and enabled the creation of larger and more detailed virtual environments the need for more engaging NPCs (non-playable characters) is also required. Many games utilise a form of dialogue tree when conversing with characters within a gaming application, allowing the user to choose their questions/responses. While this method does provide a dynamic conversation system, it is quite a one-sided level of interactivity with the NPC simply responding to the current question without it affecting the conversation on a whole. We present a novel dialogue system that explores the emotional state of the NPC to provide a more complex form of dialogue tree, termed EDTree (Emotional Dialogue Tree). Based on user actions, the interactions between the user and the NPC are enriched by the emotional state of the NPC. Utilising this system will provide an immersive experience based around improved believability of virtual characters. To demonstrate the effectiveness of our approach, we show an example of a training system that explores the use of gaming technology and the proposed EDTree.

1 Introduction

The use of dialogue trees within gaming environments has been around for several decades. Since the early 2000s it has seen major commercial use by large gaming companies such as Bethesda [1] and Bioware [2]. While the complexity of applications has been improved constantly with new technologies, the dialogue tree system remains the most advanced form of conversational interactivity between users and NPCs however has not seen much improvement since its inception. This is reflected in the lack of formal publication that has been placed on dialogue systems and as a result the systems currently in use remain conceptual and are not based on any scientific research. This paper aims to tackle some of the limitations observed in the current standard of dialogue methods whilst formally presenting a new system which advances current commonly used techniques.

Emotional response is one of the key factors in decision making and interactions between individuals [3, 4], if realistic characters wish to be created the

inclusion of emotions to dictate their actions would benefit their believability. One of the major issues presented with a dialogue tree is the lack of dynamic response from a virtual character, while the character will respond to any questions given by the user there is a lack of consistency during the conversation and the overall flow will remain static and unchanged regardless of actions being taken by the user. The goal of our proposed EDTree (Emotional Dialogue Tree) is to remove these limitations and improve the user experience by adding a more realistic form of interaction that taps into the emotional states of characters.

Due to the growing use of gaming applications in training simulations [5, 6] there is a need to create realistic and intelligent virtual characters in systems that focus on human interaction. In this paper, we present the use of EDTree in a game-based training application. The objective is for professional training within the public sector, where engaging with conversations and dialogues are the norm. We have created a virtual training platform that realistically simulates interaction with the general public in order to train professionals in the police force. One of the primary requirements of the training applications was to teach users how to deal with potentially dangerous individuals in a safe environment where their decisions would emulate real life situations. The major challenges in creating such an application is to simulate realistically any actions taken by the user of the application, as a result, it should have a noticeable effect on the NPC, hence, the simulated effects will teach trainees how to appropriately handle a given situation.

2 Conversational Interactions

Conversational interactions between the player and an NPC are very important for an immersive virtual environment in order to engage the user with an application, a dialogue tree is the most commonly used technique to achieve this goal [7].

Dialogue trees are hierarchical data structures that allow the traversal of a conversational scene based on user inputs. Typically, users are presented with multiple conversational options for a question or response to engage with an NPC. After an option has been chosen, the NPC will respond in an appropriate manner. According to the users' conversational choices, the traversal of the dialogue tree will provide the responses, and new options for conversation become available. There are primarily two methods of implementing such dialogue trees, namely Hub and Spoke model and the Waterfall model [8].

2.1 Hub and Spoke Dialogue System

A Hub and Spoke system as shown in Figure 1 features a central hub that will branch into different conversation options to facilitate dialogue interactions, each option leads to a set of NPC responses. After all options have been exhausted, the dialogue tree will return to the central hub and another option can be selected. The primary purpose of a Hub and Spoke system is to provide expositional

information to the user, typically it only ends when a desired option has been selected or when the user has decided to end the conversation. This method of dialogue tree results in a very formulaic form of conversation where users are presented with repeated dialogue that does not emulate the real life interactions between two individuals.
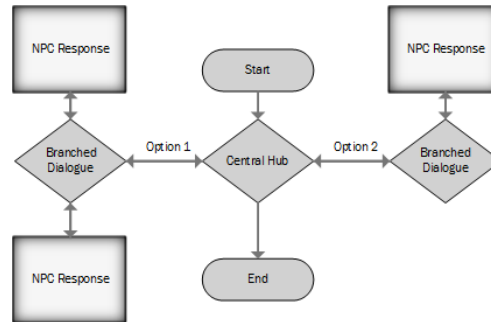

Fig. 1. Example of Hub and Spoke dialogue tree.

2.2 Waterfall Dialogue Tree

Figure 2 illustrates a waterfall dialogue tree that presents users with a series of choices that flow into new options and do not allow them to return to pick previous unchosen choices. A particular selection may be expanded to provide several dialogue options, but the overall flow remains the same, hence, there is a constant stream of new information.

While a dialogue tree that follows the waterfall technique provides a more realistic method of conversation than a Hub and Spoke system, it can be much more restrictive for the narrative of a game. For example, many applications require a very specific outcome to an interaction between the user and an NPC. As a result, many gaming applications that feature a waterfall style dialogue tree often end interactions with the same required outcome or response regardless of how the user has traversed the tree. Depending on the options the user has picked this can often lead to a very disjointed conversation where the response of an NPC doesnt seem to match the questions the user has asked, or responds in a way that can feel forced or irrelevant.

Due to the restrictions presented in both models, many modern applications choose a hybrid of both Waterfall and Hub and Spoke dialogue trees [8], allowing for the freedom of the Hub and Spoke style whilst maintaining the realism of the Waterfall method. While a combination of these methods provide a realistic interaction between the player and the NPC, there is little consistency between the previous conversation choices of the player and how the NPC responds. A player can often choose insulting conversation options and the NPC will not be
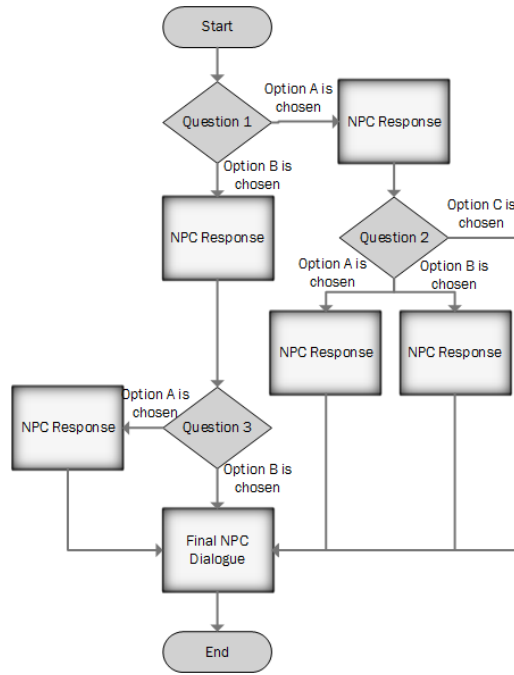
Fig. 2. Example of Waterfall dialogue tree.

affected by those choices in further conversations. As described by [1] dialogue trees often feature hard coded responses even when user input is present. In order to achieve a higher level of realism, we propose a new method to incorporate emotional states of NPCs into the dialogue tree structures.

3 Emotional Dialogue Tree

In order to maintain consistency between user actions and NPC dialogue, a series of variables can be used to monitor the interaction with a given NPC. These values can encode various emotional states ranging from fondness, sympathy, respect or any arbitrary value based on the needs of the designer. Depending on the current emotional values of an NPC, they can be placed in a particular state and depending on the state the NPC will respond to the user based on their previous interactions.

As shown in Figure 3, our EDTree structure can be added to any conventional dialogue tree as an extended component. While the EDTree is a powerful technique to enhance the interactions between users and NPCs, it should be noted that it is an addition to the current methods of dialogue tree design to add more importance to the actions and choices made by a user. Therefore, our proposed method can be easily used within an existing application system, without the need of redesign the core conversational system.

3.1 EDTree Applications

We tested our EDTree technique primarily in a game-based training application. The application itself is aimed towards public sector staff learning different pro-
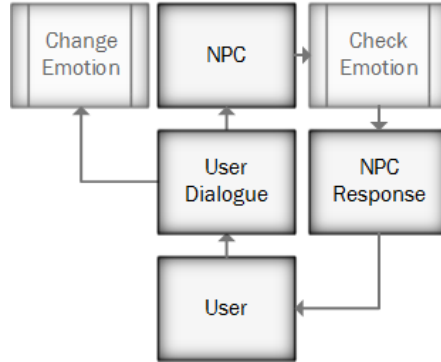
Fig. 3. Top level emotional dialogue tree structure and interaction loop.

cedures to engage the general public with. Such applications also require realistic NPCs that will react in accordance to the decisions of the trainee. One important application is, for example, a police officer questioning a crime suspect as inappropriate actions could lead to dangerous outcomes. Within the application, the user is placed into a virtual environment and can interact with members of the public via conversational dialogues. As shown in Figure 4, the emotional state of the NPC changes while being questioned from non-cooperative to co-operative.

To implement the EDTree each NPC were given variables for both nervousness and respect towards the player, as the user interacts with the NPC these values are modified based on the users actions, for example if the user performs a police background check on the NPC their nervousness value will be increased whereas engaging in general conversation such as asking how the NPC is feeling will increase respect. Each NPC is also given a multiplier to each emotion variable so that each action will have a potentially stronger result based on its "personality", for example a guilty suspect is much more likely to become nervous when performing a background check than an innocent one so this is reflected in the nervousness multiplier.

A directed graph traversal scheme for an emotional dialogue tree is shown in the following algorithm. This scheme constructs the emotional state into a graph. The *directed graph* G is a set of emotional states V and a set of state transfer E. The state transfers are of the form (i, j) where $i, j \in V$. A state of a graph G is a mapping $c : V \longrightarrow 1, 2, ..., s$ such that $e(i) \neq e(j)$ for all state transfers $(i, j) \in E$. $e(i)$ is referred to as the emotional value of the state that are displayed by the node i. Given a well structured set of states and links of each state, our proposed EDTree structure is able to propagate updates through the conversation dialogue efficiently.

The EDTree works by sequentially traversing algorithm the conversation dialogue graph as following:

There are two important computation processes in the EDTree system. Firstly, setting the dialogue options from the user is important, which displays a series of questions/responses for the user to choose that will interact with the NPC.

Data: EDTree Algorithm
Result: Directed dialogue graph traversal
n = $|V|$;
Choose a start conversation dialogue state $d(1), ..., d(n)$ of numbers $1, ..., n$
  $U := V$ **for** $i = 1$ to n **do**
    | $v := d(i)$ $E := EmotionalState$ $e(v) := EmotionalValue$
    | $U : the set of emotional values.$
end

Algorithm 1: Sequential dialogue graph algorithm

Secondly, each NPC has a text file that contains its entire dialogue. Based on the current conversation state, NPC's emotional state and what the user has selected the file can be read for the appropriate response.

3.2 Gamification of Training Scenario

The training system is developed based on the gamification of the training objectives and learning outcomes. Once the user engages in conversation with the NPC a group of options are presented to the user to exchange dialogues, each of these options would lead to different outcomes or steered towards a single outcome. Our training system utilises the EDTree and certain choices which will result in the NPC becoming more comfortable conversing with the trainee or more agitated by their actions. Primarily there are two variables in the proposed EMTree that dictate the state of the NPC, a nervousness value and a respect value, depending on these values, a NPC will be more cooperative towards the trainee. It is left to the discretion of the user how to deal with the NPC in order to achieve their goals and based upon how well a trainee can deal with the individual, he or she is scored appropriately at the end of the training session.

4 Results and Discussions

We tested our training system with the EDTree, which provides realistic interactions between users and NPCs. Each NPC was initially placed in one of four states being nervous-respectful, nervous-disrespectful, happy-respectful and happy-disrespectful, as the user interacted with a given NPC the nervousness and respect variables were modified based on player action changing the states of the NPC. As states were modified different dialogue scripts were read to produce different conversation options and outputs which reflected the NPC's emotional state resulting in a dynamic conversation system based on user action. With our system, users can be see how their actions and approach to a situation will affect an individual. The dynamic responses produced by our training system helps trainees to learn basic interaction skills and how to improve in the future.

Given that one of the main requirements of the application is teaching trainees how to deal with the public, this level of realism is a beneficial inclusion to the

simulation and also allows supervisors to monitor the progress of their trainees by checking the emotional state of a particular NPC when the application is finished.

Fig. 4. Test scene: The NPC states of emotion changes during the conversation dialogues, from a state of disrespect (top left) to nervous (top right) to cooperative/happy (bottom left). The bottom right image shows a street scene.

Another benefit of the EDTree is the ability to give each NPC more personality that is reflected in their interactions with the player. Attributes such as shyness, pride, jealousy etc are also shown much more clearly and not just left to the narrative of the story.

5 Conclusion

We proposed a novel EDTree structure which adds many qualities to a virtual character within an application including personality, interactive immersion and engagement, all of which would greatly benefit an application that focuses strongly on character driven stories/narratives. Therefore, our EDTree enhanced gaming system is applicable to many applications that are built on conversations and dialogues.

While the benefits of the EDTree are clear, it requires a lot more work to implement than traditional methods of dialogue tree, because there are many states an NPC can have, there are many more conversational responses needed. In a purely textual based application this may not be an issue as it only requires more dialogue scripting which can be a relatively cheap resource to include. However, in more complex applications like those that require actors to voice NPCs, the proposed EDTree may not be practical.

In summary, our EDTree can be implemented into an application or in simulations similar to the one discussed in this paper that require accurate feedback based on user actions.

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