A Culture Model for Non-Player Characters' Behaviors in Role-Playing Games

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***Abstract*—Video game players often seek more profound experiences with non-player characters (also known as NPCs). Believable game characters should then react emotionally, reveal personality traits, and exhibit social behavior. With these challenges in mind, we propose a different strategy for modeling game character behaviors. In our new approach, character behavior modeling is not only based on the emotions and personality traits but also on the culture of the region in which the NPC lives in the game world. We propose a pragmatic model to simulate game characters' cultural behavior closely aligned with well-known emotion and personality models. Our goal is to reproduce cultural behavior based on six different dimensions: time, wealth, dignity, politeness, collectivism, and rationality. We propose the integration of these dimensions with the concepts of trust (or confidence) level, prejudice, personality, and emotion. Also, we tested the proposed model by developing an experimental Role Playing Game.**

***Index Terms*—NPC behavior, Culture model, Game AI, Cultural behavior, Emotion and Personality Models, Proxemics**

I. Introduction

The game industry is increasingly growing year by year [1], moving lots of money and calling investors' attention for this market [2]. In particular, Brazil is one of the best emergent countries to invest in game development because it is the 13th most significant video game market globally [3]. This so appealing global market calls for a challenging balance: from one side, there are many opportunities for a continuously and growing production of games; on the other hand, there is fierce competition, and some game genres experience market saturation [4]. In this competitive environment, game designers must bring a unique and different experience to the player if they want their new games to stand out among so many. [5].

The industry always thought of ways to make the gameplay different from its competitors and expand the game's lifetime by increasing the game's replayability (i.e., the video game's potential for continued play after its first completion). The most known strategy to achieve content variability is to give open-world experience to the players [6], showing the world and tools for the players to create their own game. In this context, one of the earliest successful example was the game Elite (1984), which started the *space sim* genre [7]. This sense of variability is even more significant when we talk about Procedural Content Generation (PCG), which makes games like *Minecraft* (Mojang, 2009) and *No Man's Sky* (Hello Games, 2016) stand out as examples of millions of interactions during gameplay, causing PCG to take over the game industry.

The strategies above mentioned usually focus on map creation, not giving attention to the way NPCs react to player actions throughout the game. To start solving this issue, we adopt the strategy in which the NPCs' actions are based on behavior models that can relate to emotions and personality in lots of different ways. In this paper, we focus on two well-known models used in the study of human behavior: Plutchik's Wheel of Emotions [8], to help us simulate emotions; and the OCEAN personality model [9] (also known as the Big Five model), to help us simulate personality traits.

Although several games create countries and societies (e.g., Civilization series of games, Empire Earth games, Rise of Nations, SimCountry), few simulate behaviors based on cultural background (i.e., on cultural elements). In this paper, we propose a model to create game characters immersed in a specific culture. Yet, more importantly, we make them behave accordingly to the player's actions.

In our model, we do not limit ourselves from creating NPCs belonging to specific cultural groups but make their activities depend on their culture, personality, and current emotions. Also, the NPCs' actions depend on two more individual factors: prejudice, which is related to discrimination towards others, and confidence or trust, being how much the NPC trusts the leading player. Some games already use this last factor, like *Binary Domain* (SEGA, 2012). In this game, the way the players protect their allies during the battle, the things they say, the actions they do, influence each character's confidence level differently and bring future consequences to the narrative [10].

In this paper, we also developed an experimental RPG, called *Future Falls*, to test the proposed model. We focused on RPGs for many reasons. Firstly they value the behavior of the characters deeply. Secondly, game designers are continually creating RPGs. Thirdly, the general public highly accepts this game genre [11]. In *Future Falls*, the player is a character from the Human race (here, "race" is a synonym for culture)

who tries to end human slavery and make peace with other cultures. To complete this task, the player must interact with different races, in different regions, and gain their trust by doing specific missions for each NPC, or interacting with them buying or selling items, or performing other actions.

This paper is organized as follows. The section *Related Works* presents the works that influenced the present paper and other works using cultural dimensions in simulations. The section *Basic models* explains the basic models for personality, emotions, interpersonal distances, and cultural dimensions. *The basis of the proposed game* presents how the emotion, personality, and culture models fit into the RPG gameplay. Also, this section presents game design elements. In *Combining Personality, Emotions and Culture* we explain how we use each basic model, and how they influence player's emotions and behavior. *Conclusion* and *Future Work* are a closure of our paper presenting final considerations and future research directions.

II. Related Works

The work by Baffa *et al.* (2017) [12] strongly motivated the present proposal. Their work presents an experimental game in which emotion and personality models (namely, Plutchik's Wheel of Emotions and OCEAN models) influence the way NPCs behave towards player actions. That research work has shown good results compared to other approaches, while its implementation is kept simpler and concise.

Böloni *et al.* (2018) [13] was the most influential work on our culture model. Their paper presents a model for simulating social interaction, which can be used not just to simulate the interaction between a virtual agent and a human user, but also to predict human behavior. They decribe a computational model of social norms based on values that cultures find desirable, such as wealth and dignity. Moreover, the model assumes that numerical metrics can be assigned to these values. The authors above mentioned considered four social metrics: time, wealth, dignity, and politeness.

The seminal work by Geert Hofstede, a Dutch social psychologist, influenced most of the work on culture studies with his theory of cultural dimensions [14] [43]. Böloni *et al.* [13] explicitly recognize that their social metrics can be associated with one or more of Hofstede's cultural dimensions. For example, "dignity" is associated with the dimensions of "power distance" (which is the acceptance of unequal distribution of power in a group or country) and "masculinity *vs* femininity" (which measures the balance between assertiveness and competitiveness versus a focus on cooperation, human relations and quality of life).

Our model proposes six cultural metrics (time, wealth, dignity, politeness, collectivism, and rationality), which four of them are adapted from the social metrics proposed by Böloni *et al.* [13], one is adapted from the Hofstede's cultural dimension of "individualism *vs* collectivism", and one is completely new (rationality). Moreover, most importantly, our adaptation considers the context of games.

To the best of our knowledge, there is no other work in the literature that models cultural behaviors in Role-Playing Games. There are works that generate virtual humans in crowds using the Hofstede's dimensions [15] [16], but they are not models to create RPGs.

III. Basic Models

In this section, we present the models related to Emotion, Personality, Culture, and Proxemics (Interpersonal Distances), which compose our complete model.

A. The emotion model

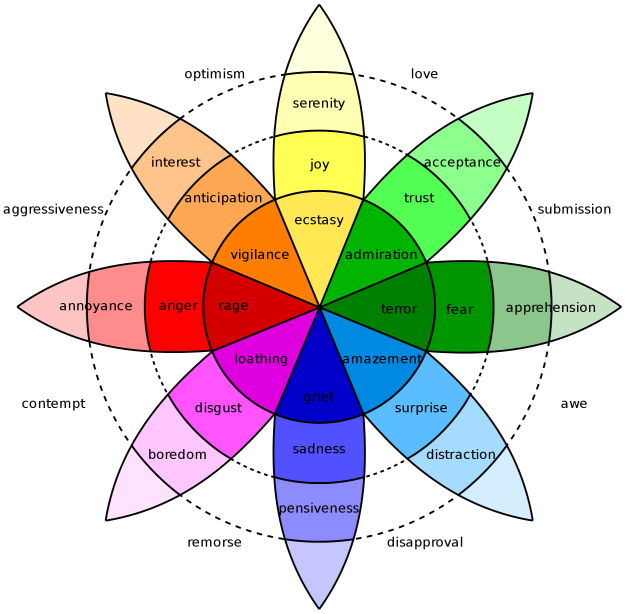

Fig. 1. Plutchik's Wheel of Emotions (reproduced from [8]).

Emotion is defined as a state that occurs within the nervous system [17] [18], brought on by chemical changes related to thoughts, feelings, behavioral responses, and mental experiences with a high intensity and high hedonic content [19]. Nevertheless, there is still no consensus on its definition, mixing constantly with personality, mood and temperament concepts. This helped lots of theories to emerge trying to explain its concept, varying from an evolutionary perspective to a simply relation with facial expression [20].

Between these approaches, the one that fits the best with our project proposal, and the most known, is the James-Lange theory, which suggests emotions occur as a result of physiological reactions to events [19]. Moreover, Paul Ekman defines emotions as discrete, measurable, and psychologically distinct [21], defining six main emotions: anger, disgust, fear, happiness, sadness and surprise [22].

In 1980, Robert Plutchik expanded Ekman's classification, creating the Wheel of Emotions [8]. In this theory, there are eight emotion sectors (representing eight primary emotion

dimensions) with three intensity levels for each emotion, as seen in Fig. 1. For example, the yellow axis has *serenity* as the lowest intensity value, *joy* as the central one and *ecstasy* as the highest value.

There are also the *dyads*, which represent combinations between emotions in four levels: primary (often perceived), secondary (sometimes perceived), tertiary (rarely perceived) and opposite (never perceived). An example of primary dyad is the combination of joy and trust, resulting in *love*, while a secondary dyad is the combination of joy and fear, resulting in *excitement*, and a tertiary dyad being the combination of joy and surprise, resulting in *delight*.

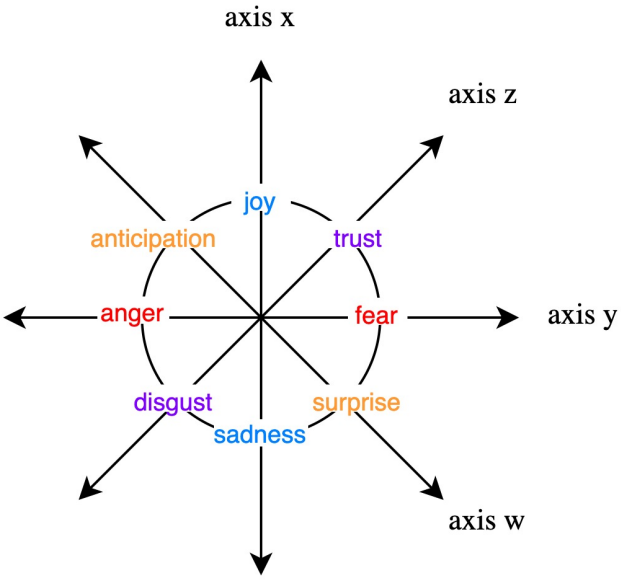

Fig. 2. 4-axis structure of basic emotions (reproduced from [12]).

TABLE I
MAIN EMOTIONS AND ITS VALUES.

Mild emotion (0.2)	**Basic emotion (0.5)**	Intense emotion (1.0)
Serenity	**Joy**	Ecstasy
Acceptance	**Trust**	Admiration
Apprehension	**Fear**	Terror
Distraction	**Surprise**	Amazement

Baffa *et al.* [12] adapted the Plutchik's model to propose a 4-axis structure of basic emotions which only considers primary emotions at normal levels, as shown in Fig. 2. In the present work, we adapted the 4-axis structure of Baffa *et al.* (*op. cit.*) to consider variations between mild and intense emotions.

In our emotion model, each axis has *main emotions* on its positive part and *opposite emotions* on its negative side. Therefore, these axes are identified by pairs of *main* x *opposite* emotions: Fear x Anger (F-A), Joy x Sadness (J-S), Surprise x Anticipation (S-A), and Trust x Disgust (T-D). The values in each axis vary from -1 to 1, and some notable values are

TABLE II
MAIN OPPOSITE EMOTIONS AND ITS VALUES.

Intense opposite (-1.0)	**Basic opposite (-0.5)**	Mild opposite (-0.2)
Grief	**Sadness**	Pensiveness
Boredom	**Disgust**	Loathing
Annoyance	**Anger**	Rage
Interest	**Anticipation**	Vigilance

associate with well-known emotions, as shown in tables I and II. For example, on the positive part of the J-S axis, we have the following main emotions: *joy* as a basic emotion at 0.5, *serenity* as a mild emotion at 0.2, and *ecstasy* as an intense emotion at 1.0. On the negative part of the J-S axis, we have *sadness* as a basic opposite emotion at -0.5, *pensiveness* as a mild opposite emotion at -0.2, and *grief* as an intense opposite emotion at -1.0.

B. Personality Model

In Psychology, there are many models to map and define the personality traits of an individual. One of the most used model is called Big Five or Five Factor Model [23]. This model is also known by the acronym O.C.E.A.N., which refers to the names of the five personality traits. In the present work, we adopted the OCEAN model with no modifications, except that a personality trait has a value in the interval [0,1]. Each personality trait is described as follows (reproduced here with the same words found in [9]):

1) Openness to experience: "The openness reflects how much an individual likes and seeks for new experiences. Individuals high in openness are motivated to seek new experiences and to engage in self-examination. In a different way, closed individuals are more comfortable with familiar and traditional experiences. They generally do not depart from the comfort zone." (*op. cit.*).

2) Conscientiousness (Scrupulosity): "Conscientiousness reflects how much careful and organized is an individual. Individuals high on conscientiousness are generally hard working and reliable. When taken to the extreme, they can demonstrate "workaholic", compulsive or perfectionist behaviors. Individuals low on conscientiousness are unable to motivate themselves to perform a task that they would like to accomplish. They tend to be more relaxed, less oriented to fulfill or achieve goals and less driven by success." (*op. cit.*).

3) Extraversion: "Extraversion reflects how an individual is oriented to the external world and get satisfaction from interacting with other people. Individuals high on extraversion tend to enjoy human interactions, are assertive and energized when around other people. Introverts tend to feel worn by socialization and spent more time alone. Because of this behavior, extroverts are generally good at social interactions due to the large amount of experience, while introverts tend to be socially awkward." (*op. cit.*).

4) Agreeableness (Sociability): "Agreeableness reflects how much an individual like and try to please others. Individuals high on agreeableness are perceived as kind, warm

and cooperative. They tend to demonstrate higher empathy levels and believe that most people are decent, honest and reliable. On the other hand, individuals low on agreeableness are generally less concerned with others' well-being and demonstrate less empathy. They tend to be manipulative in their social relationships and more likely to compete than to cooperate." (*op. cit.*).

5) Neuroticism (emotional instability): "Neuroticism is the tendency to experience negative emotions. Individuals high on neuroticism generally experience feelings such as anxiety, anger, jealousy, guilt or depression. They have difficulty dealing with stressful events and overreact in ordinary situations. Generally, higher scores on neuroticism indicates problems to control impulses and delay rewards." (*op. cit.*).

C. Proxemics

Proxemics is the scientific area which studies human's use of space and the effects that population density has on behavior, communication, and social interaction. Edward T. Hall, a cultural anthropologist, created this term in 1963, defining proxemics as "the interrelated observations and theories of humans use of space as a specialized elaboration of culture" [25]. In his foundational work on proxemics, The Hidden Dimension, Hall emphasized the impact of proxemic behavior (the use of space) on interpersonal communication. According to Hall, the study of proxemics is valuable in evaluating not only the way people interact with others in daily life, but also "the organization of space in [their] houses and buildings, and ultimately the layout of [their] towns" [24].

This definition fits in our cultural behavior context, as interpersonal distances are directly related to the dignity level (which we incorporate in our culture model), or how ashamed a NPC feels when approached by a stranger. Also, other game situations are closely related with proxemics, such as: the way the towns are built in the game; and how the game characters react to other's proximity, mainly when approaching their own personal or intimate spaces.

D. Hofstede's Cultural Dimensions

Geert Hofstede defines culture as a collective phenomenon: "culture is the collective programming of the mind that distinguishes the members of one group or category of people from others" [26]. As we needed specific dimensions to be computed and represent a specific culture, we based ourselves on the *Cultural Dimension Theory* proposed by Geert Hofstede [14]. The six cultural dimensions of this theory are as follows (reproduced here with the same words found in [14] and [26]):

1) Power Distance: "Power distance stands for the extent to which the less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally." (*op. cit.*).

2) Individualism and Collectivism: "Individualism stands for a society in which the ties between individuals are loose: one is expected to look after oneself and one's immediate family. Collectivism, meanwhile, stands for a society in which people from birth onward are integrated into strong, cohesive in-groups, which throughout people's lifetime continue to protect them in exchange for unquestioning loyalty." (*op. cit.*).

3) Masculinity and Femininity: "Masculinity stands for a society in which emotional gender roles are clearly distinct: men are supposed to be assertive, tough, and focused on material success, whereas women are supposed to be more modest, tender, and concerned with the quality of life. Femininity, meanwhile, stands for a society in which emotional gender roles overlap: both men and women are supposed to be modest, tender, and concerned with the quality of life." (*op. cit.*).

4) Uncertainty Avoidance: "Uncertainty avoidance is the extent to which the members of a culture feel threatened by ambiguous or unknown situations. Societies that score a high degree in this index opt for stiff codes of behavior, guidelines, laws, and generally rely on absolute truth, or the belief that one lone truth dictates everything and people know what it is. A lower degree in this index shows more acceptance of differing thoughts or ideas. Society tends to impose fewer regulations, ambiguity is more accustomed to, and the environment is more free-flowing."(*op. cit.*).

5) Long-term and Short-term Orientations: "Long-term orientation stands for the fostering of virtues oriented towards future rewards, in particular perseverance and thrift. Short-term orientation stands for the fostering of virtues related to the past and present—in particular, respect for tradition, preservation of 'face', and fulfilling social obligations." (*op. cit.*).

6) Indulgence and Restraint: "This dimension refers to the degree of freedom that societal norms give to citizens in fulfilling their human desires. Indulgence is defined as "a society that allows relatively free gratification of basic and natural human desires related to enjoying life and having fun." Its counterpart, restraint, is defined as "a society that controls gratification of needs and regulates it by means of strict social norms." (*op. cit.*)

E. The proposed culture model

Böloni *et al.* [13] adopted four social metrics for their computational model of social norms: time, wealth, dignity, and politeness. Although these metrics were sufficient for their case study ("The Spanish Steps Flower Selling Scam"), they are not satisfactory for our gaming context. Therefore, firstly we consider the social metrics as cultural dimensions that can be associated with the player's actions. Then we add one more dimension based on the collectivism dimension of Hofstede's Theory. Also, we introduce a new dimension called "rationality", which can take emotions in account.

Even most of these concepts can be mapped using Fuzzy Logic, like what was done in [27], we decided that each NPC would have previously determined culture, i.e. the six dimensions would have its values varying from 0 to 1 (with limits included), as a percentage. For instance, if time dimension was equal to 0.8, this value will multiply the time limit of the current event (between player and NPC), resulting in the maximum time the NPC will spend interacting with the player during this event.

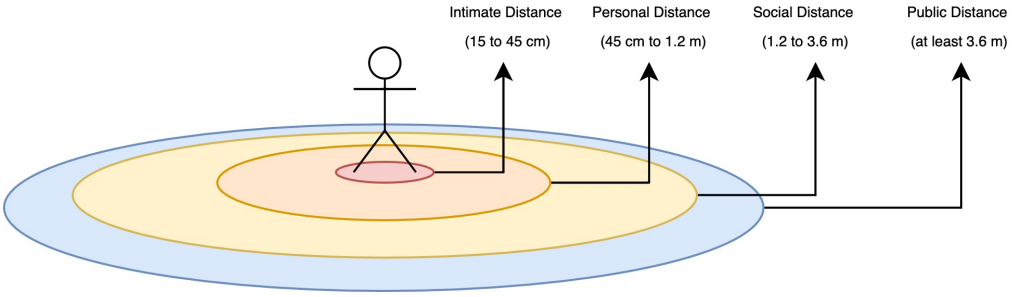

Fig. 3. Proxemics - Interpersonal distances proposed by Hall [24].

Still, we decided to use an even simpler approach with specific cultural dimensions influencing which emotion the player would have based on the last player's action. If one NPC's dignity value was 0.9, for example, and the player reached his/her personal space, this would result in a high intensity emotion. If the value was 0.2, this would result in an emotion with a minor intensity. Therefore, in the list below, we show how each dimension reflects on the game's content.

- Time: Influences how fast the NPC will move, multiplying his velocity value;
- Wealth: Represents how much the player will care about player actions like: money give away, money theft, item give away or item theft. So, if its value is 0.7, this NPC is highly affected by this cited actions.
- Dignity: As stated before, is related to situations in which the player invades NPC's social, personal or intimate spaces. It also influences how the NPC will be emotionally affected, after he is shot or harmed.
- Politeness: Represents how much a NPC is affected by a non-polite player approach or conversation;
- Collectivism: Represents how much a NPC cares about others, when they are inside their public space;
- Rationality: Its value affects how intense the resultant emotion will be (further explained throughout this report).

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IV. The basis of the proposed game

This section explains how the *Future Falls* works and how the emotion, personality and culture models fit into the RPG gameplay. Also, this section presents the following subsections: Game Mechanics; Modeled cultures; Playing as a human character; and Non Playable Characters Behavior. The game was developed using the *Unity* game engine, as it is one of the most used in market [28].

A. Game Mechanics

We decided to develop *Future Falls* mechanics following the base Role Playing Game genre features: *experience points*, that exist to help each character to level up and upgrade his abilities; *dungeons*, that are places in which the player fight enemies and level up faster, also obtaining new items; *narrative choices*, that allow the player to build its own story and interact different ways with NPCs.

Bringing RPG features to the *Future Fall's* context, makes it possible for the player to have its own experience level, which can influence the following general items: the clothes he/she can wear, that is, the armor level; the weapons he/she is able to use; the abilities and the energy he/she has.

As the game is based on players actions towards NPCs, he/she has the freedom to choose the best way to make an approach or talk to them, using his previous relations to guide him through this adventure. However, not all attitudes are considered positive for every NPC, depending on their cultural dimensions' values. Videos showing the possible outcomes of these actions, listed below, are available at *g2g.to/ICYF*.

- Walk in the four directions: If the player surpasses no social space from any NPC, he/she won't have any type of reaction;
- Shoot with a gun in the mouse/analog direction: If the player tries to kill someone, the NPC which is near (public space) will react to it in a positive or negative way, depending on his collectivism value. Moreover, if the gun hits the own NPC, he/she only reacts negatively;
- Push/Touch a NPC: Positive or negative, depending on NPC's dignity level;
- Talk to someone (politely or not): Positive or negative, depending on NPC's politeness level;
- Give/Steal item from NPC: Always influence a negative reaction, varying its intensity depending on NPC's wealth value;
- Give/Steal money from NPC: Influence a positive or negative reaction, depending on NPC's dignity value.
- Approach the NPC (proxemics): Influence a positive or negative reaction, depending on NPC's dignity level.

Each enemy has a trust level ($tLvl$), which is influenced by any of the above cited player actions. The positive or negative reaction we talked about means that each action can make the NPCs trust level lower or increase, depending on the positive or negative reaction. Thus, as seen in table III, each NPC mental state (resulted from the emotional reaction to player's behavior) influences positively (+1) or negatively (-1) the current NPC's trust level (mentalFactor). We can also notice, by checking (1), that this factor is multiplied by the prejudice level ($pLvl$), a percentage that determines the total value of this influence. Also, t is defined as the current

time. On the list below, we explain each of this levels more specifically.

TABLE III
MENTAL STATES AND ITS RELATED FACTORS.

Mental State	Trust Level Influence
Anger	Influences negatively (-1)
Fear	Influences negatively (-1)
Trust	Influences positively (+1)
Disgust	Influences negatively (-1)
Joy	Influences positively (+1)
Sadness	Influences negatively (-1)
Surprise	Influences positively (+1)
Anticipation	Influences negatively (-1)

$$tLvl_{t+1} = tLvl_t + pLvl \times mentalFactor \quad (1)$$

- Trust Level: It is a float value, from 0 to 1, that represents how trustful the player is to that specific character, always starting equals to 0.5, representing uncertainty.
- Discrimination Level: It is a float value, from 0 to 1 (percentage), that influences the NPC trust level.

B. Modeled cultures

Each race presented in the game is interpreted as a different culture, with its own characteristics. These four different cultures are described as follows:

1) Humans: In the game context, humans have a low dignity value, but are still polite. They care a lot about wealth and time, having this attributes in a low value. They are less individualists than collectivists and more emotional than rational beings.
2) Roligats: They are an impolite race, which cares a lot about dignity. Always worried with time and wealth, they have these values really high. As other characteristic, this race has a high prejudice level against other races, but mainly against humans. They are collectivists and more emotional than rational. The big difference between this race and humans, besides the politeness, is their aggressiveness. Therefore, these individuals have a high neuroticism value, influencing bad emotions to emerge.
3) Atropolitans and Magmorfs: Both races have cultural characteristics randomized differently each time a new game begins.

C. Playing as a human character

Let's imagine a situation in which the player tries to sell an item to NPC, interacting with this NPC for the first time. The action of approaching him/her, depending on his/her personality, may make him/her keep walking (neutral emotion) or walk in a lower speed, almost stopping (surprise emotion). NPCs can also run worried (anticipation emotion), but just if the player has already encountered them, which is not the case here, and they reacted in a way that decreased their trust level towards the player, or their discrimination level towards humans affected the situation negatively.

The player can also offer an item to a NPC. If his/her discrimination level does not influence his/her reaction, he/she can decline it right away or ask the player how much does it cost. If he/she accepts the player's first offer, the interaction ends there, otherwise he/she may decline it or offer a lower price. Each reaction will depend on his/her current emotion and personality.

Besides that, there is also NPC's cultural dimension values that may influence the result of the situation. For instance, if his/her time value is 0.2, this means that he/she will spend just 20% of the time limit (arbitrary value that exists for each different type of interaction, being 3 minutes for a sale operation), which is 36 seconds. This results in the NPC leaving the player when the time spent during the conversation equals the limit time.

D. Non Playable Characters Behavior

When a NPC reacts to a player action, he changes his mental state, a value that represents his current emotional state, i.e. the value based on the most influent emotion. As shown by Table IV, each mental state is related to a NPC behavior.

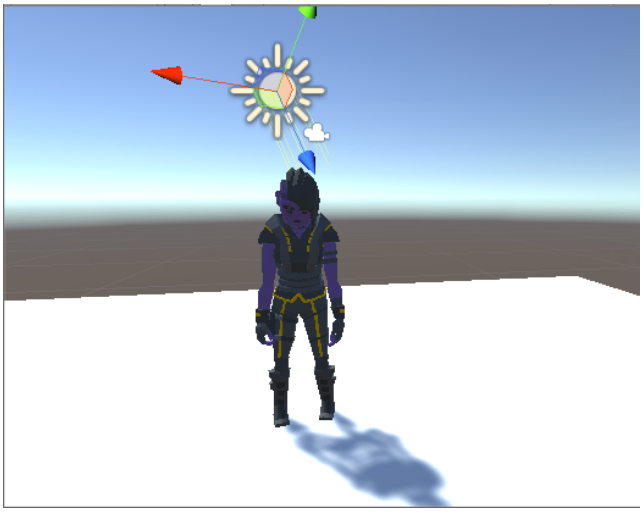

Fig. 4. The *Sadness* mental state of an NPC automatically changes the posture and animation of this NPC.

As our game is a 2D RPG, it was really difficult to find a way to show emotions like sadness or joy in a NPC. Therefore, we created a 3D application inside the game, in which 3D models would react based on the proposed mental states. For instance, if the current mental state is *Sadness*, the NPC would react like in Fig. 4. To change the current mental state, the user must press the correspondent key (shown in IV), making the NPC transit between animations.

V. COMBINING PERSONALITY, EMOTIONS, AND CULTURE

This section presents the complete model integrating the three models defined in the previous sections: the modified 4-axis emotion model, the OCEAN personality model, and the proposed culture model. The interaction flowchart in Fig. 5 illustrates how the personality traits and culture dimensions are

TABLE IV
MENTAL STATE AND NPC'S BEHAVIOR.

Mental State	Behavior in Game	3D Animation (Key)
Fear	Run Away	Terrified (3)
Anger	Shoot in player's direction	Yelling (4)
Trust	Follows player for 5 seconds	Thankful (8)
Disgust	Run Away	Loser (7)
Joy	Follows player for 5 seconds	Happy (1)
Sadness	No reaction	Sad Idle (2)
Surprise	No reaction	Surprised (5)
Anticipation	No reaction	Excited (6)

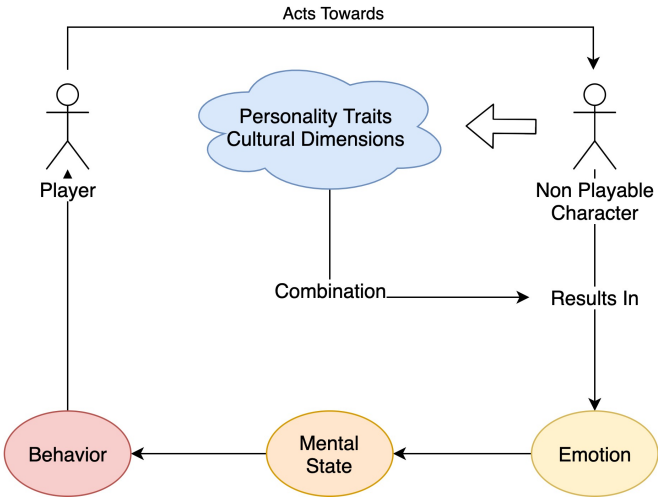

Fig. 5. Player-NPC interaction chart.

combined, resulting in a mental state, which is then translated into a specific behavior. The following sections explain the various types of relationships and influences.

A. Emotions, Proxemics and Cultural Dimensions influence in Behavior

As stated by S. D. Lane, "emotions involve not only thoughts, psychological states, and biological processes but also behavioral propensities. Still others maintain that emotions are socially constructed and learned. Despite disagreement regarding the influence of cognition, psychology, and behavior, most research suggest that emotions are feelings we experience that result from the interaction of psychology, cognitions, and social experience and that they significantly affect how we communicate with others and interpret others' communication."

Thus, we can conclude that emotions have direct influence in communication and behavior. That's why in *Future Falls*, for each different player action towards the NPC, there is a set of possible resultant emotions related to it, as shown in table V. Each one of the four emotions have a range of Cultural Dimension Factor associated. This ranges are, respectively: $[0, 20)$, $[20, 50)$, $[50, 70)$ and $[70, 100]$.

To choose which of the four resultant emotions will be used, we decided to check NPC's cultural factor (CF), which is

TABLE V
PLAYER'S ACTIONS AND THE RESULTANT NPC'S EMOTIONS, BASED ON THE CULTURAL DIMENSION VALUE RANGE.

Player's Action	Emotions for each cultural factor range
is_attacking	Rage, Outrage, Despair, Terror
is_shooting	Annoyance, Pessimism, Disapproval, Apprehension
is_harming	Anger, Contempt, Unbelief, Fear
is_injured	Anger, Disapproval, Pride, Joy
is_giving_item	Joy, Optimism, Hope, Trust
is_stealing_item	Sadness, Shame, Remorse, Disgust
is_giving_money	Admiration, Love, Sentimentality, Ecstasy
is_stealing_money	Grief, Dominance, Awe, Loathing
is_social	Distraction, Anxiety, Delight, Interest
is_personal	Anticipation, Cynicism, Curiosity, Surprise
is_intimate	Vigilance, Aggressiveness, Submission, Amazement
is_talking_politely	Boredom, Envy, Pride, Serenity
is_not_talking_politely	Pensiveness, Guilt, Morbidness, Acceptance

TABLE VI
PLAYER'S ACTIONS AND THE RELATED CULTURAL DIMENSION.

Player's Action	Cultural Dimension
is_attacking	dignity
is_shooting	collectivism
is_harming	collectivism
is_injured	trust_level
is_giving_item	wealth
is_stealing_item	wealth
is_giving_money	wealth
is_stealing_money	wealth
is_social	dignity
is_personal	dignity
is_intimate	dignity
is_talking_politely	politeness
is_not_talking_politely	politeness

calculated using (2). This equation considers the Cultural Dimension Value (CD_Value), multiplying it by the complement value of Rationality ($100\% - R\_Value$), and take this result's geometric mean as the factor itself. This Cultural Factor is used to decide which range to consider, i.e. which of the four emotions. We decided to get the complement of the rationality, because if a NPC is 90% rational, it means his/her behavior won't be heavily influenced by emotions. In this case, as the complement value is 10%, the chosen emotion will be the weakest of the four.

In table VI, each action is related to a specific attribute. For instance, if the player is attacking a NPC, we should verify if the NPC's cultural factor, calculated using dignity and rationality's compliment in this case, is: bigger than 0.7, choosing for the "Terror" emotion; between 0.7 (included)

and 0.5, choosing for the "Despair" emotion; between 0.5 (included) and 0.2, choosing for "Outrage" emotion; and less or equal to 0.2, choosing for "Rage" emotion.

$$CF = \sqrt{CD\_Value * (1 - R\_Value)} \quad (2)$$

The proxemics model, however, was just used to influence how NPCs will interpret player's approach. The areas shown in Fig. 3 were implemented as circular triggers. For instance, if the player approaches the public area, nothing will happen. If the player steps into the NPCs social, personal or intimate spaces, the following player actions are triggered, respectively: is_social, is_personal and is_intimate.

B. Personality Influence in Emotions

As stated by Revelle and Scherer, "Personality is the coherent patterning of affect, behavior, cognition, and desires (goals) over time and space. Just as a full blown emotion represents an integration of feeling, action, appraisal and wants at a particular time and location so does personality represent integration over time and space of these components [29]. A helpful analogy is to consider that personality is to emotion as climate is to weather. That is, what one expects is personality, what one observes at any particular moment is emotion." [30]

With this statement, allied with a study done by Mohammad and Kiritchenko, we can prove that emotions can help to identify personalities [31], and personality traits can influence emotional behavior. However, we couldn't find a theory that directly related Plutchik's Wheel of Emotion and OCEAN theory, as their were easier models to correlate, resulting in table VII and VIII.

TABLE VII
PERSONALITY TRAITS INFLUENCING POSITIVE EMOTIONS.

Fear	Trust	Joy	Surprise	
-1	1	1	-1	O
0	0	0	0	C
0	1	1	1	E
0	1	1	1	A
1	-1	-1	1	N

TABLE VIII
PERSONALITY TRAITS INFLUENCING NEGATIVE EMOTIONS.

Anger	Disgust	Sadness	Anticipation	
0	-1	-1	-1	O
-1	0	1	1	C
0	0	1	-1	E
0	-1	0	-1	A
1	1	1	1	N

Each emotion, as explained before, is composed by four values, representing each axis of the simplified Plutchik's Model. During the game's implementation, each emotion was represented by an array, with four positions. The NPC's personality was also represented as an array of five positions, each one representing an OCEAN value, respectively.

Nevertheless, we needed to find a way to combine the personality values with emotion values, deciding if they would influence positively, negatively or not influence at all. Thus, we decided to use the factor tables VII and VIII proposed by Baffa et al. [12].

Although the previous step resulted in the event emotion (EE), it will be used just to generate a new emotion (NE), based on (3). Therefore, each i position of the new emotion will be the sum of the multiplication of three values: event emotion in position i; the personality in position j; and the factor in line j, column i. Then, this value is divided by five, as it was a sum of five values that vary from -1 to 1, resulting in the average value.

$$NE_i = \frac{\left(\sum_{j=1}^{5} EE_i \times p_j \times factor_{ji}\right)}{5}, i \in [1, 4] \quad (3)$$

After that, this new emotion will be added to NPC's current emotion (CE), but *clamping* the values to fit in range [-1, 1]. This step's calculation is represented in (4), in which t represents the current time.

$$(CE_i)_{t+1} = (CE_i)_t + Clamp(NE_i, -1.0, 1.0) \quad (4)$$

However, the values from the resultant current emotion may be mixed, not representing any of the listed emotions. To solve this problem, we decided to extract the most influent emotion from the current emotion, following the logic listed below:

1) Iterate through the current emotion values and find the biggest one (comparing absolute values);
2) Iterate again through the emotion values, comparing each one to the biggest value. If they are equal, the influent emotion receives this value, otherwise receives zero.
3) Iterate through the influent emotion values, rounding its values following some rules:
   a) If there are two values bigger than zero, they both will be considered 0.5;
   b) Otherwise, it will respect the following rules:
      i) If $Value <= 0.1$, $Value = 0$;
      ii) If $Value <= 0.3$, $Value = 0.2$;
      iii) If $Value <= 0.5$, $Value = 0.5$;
      iv) If $Value > 0.5$, $Value = 1.0$;

C. Mental State Influence in Trust Level

As stated before, this most influent emotion is used to decide which is the current NPC's mental state. This attribute is used to decide which behavior the NPC will have, based on the current most influent emotion (table IV). As shown by table IX, each mental state relates to a set of emotions. If the NPC has not been affected by player's action, his mental stated will be *Neutral*, i.e. the current emotion has its four values equal to zero.

Now that the mental state was defined, we must decrement or increment NPC's trust level based on it. Therefore, we must

TABLE IX
AVAILABLE MENTAL STATES AND ITS RELATED EMOTIONS.

Mental State	Related Emotions
Anger	Rage, Anger, Annoyance, Outrage, Envy, Aggressiveness, Dominance
Fear	Apprehension, Fear, Terror, Guilt, Awe, Despair
Trust	Acceptance, Trust, Admiration, Hope, Submission
Disgust	Loathing, Disgust, Boredom, Unbelief, Contempt, Shame
Joy	Serenity, Joy, Ecstasy, Optimism, Love, Sentimentality, Morbidness, Pride
Sadness	Grief, Sadness, Pensiveness, Disapproval, Remorse, Pessimism
Surprise	Distraction, Surprise, Amazement, Delight, Curiosity
Anticipation	Vigilance, Anticipation, Interest, Anxiety, Cynicism

TABLE X
MENTAL STATES AND ITS RELATED FACTORS.

Mental State	Trust Level Factor
Anger	-1
Fear	-1
Trust	+1
Disgust	-1
Joy	+1
Sadness	-1
Surprise	+1
Anticipation	-1

define what are the mental factors (-1 or 1), that will influence the trust level, as seen in (1). This relation is shown in table X. If the mental state is *Neutral*, this factor is zero.

VI. CONCLUSION

Since the beginning of this research work, our main goal was to create a 2D game that could simulate cultural behavior in some level. Therefore, we used well-known models and theories, that allied with some equations and methods for artificial intelligence, resulted in a complex logic, which would just relate to NPCs behavior.

We developed an Role Playing Game, which focuses on the player's actions and the NPC's reactions. The main goal remains the same: maximize the average of the NPC's trust level. However, some actions needed to be simplified, like the item/money exchange, which was reduced to a button in the action menu, or even the player and NPC conversation, also reduced to a "point and click" action (seen on Fig. 6).

We decided to focus on the NPC behavior, as the goal was to test the model, and see if these theories together would result in something relevant. Finally, we decided to divide our application in two Unity scenes: (1) the first scene is a game, in which the player would interact and try to win the game (reach 80% or above in the average trust level), or just have fun discovering the possible interactions; (2) the other is a scene where a 3D model would react to specified key commands, simulating a player action, resulting in a behavior more expressive that the ones in the first scene.

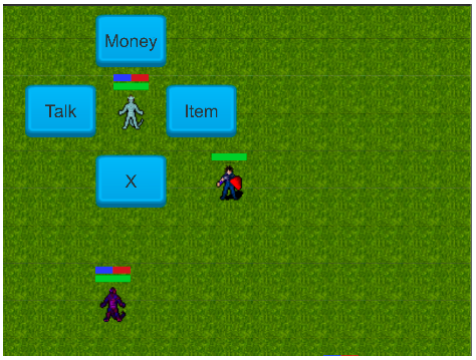

Fig. 6. Interactive game menu.

In comparison the work by Baffa *et al.* (2017) [12], our model contemplates every emotion from Plutchik's Wheel of Emotion as shown in table IX, while they limited the possible emotion outcomes in the game implementation. Moreover, instead of fixed personalities, as they have cited in *Section VIII (Results)* of their paper, we preferred to use random personalities, which combined with the new cultural dimensions, prejudice level and proxemics factors, created even more possible interactions and suprising outcomes during Future Falls' gameplay.

VII. FUTURE WORK

Even though our work presents an unique approach to culture simulation in RPGs, there are still lots of other ways to specify cultural behaviors of game characters. For instance, we could use other cultural dimensions and other definitions of culture (e.g., Schimitz [32]). Also, we could study more deeply how culture characteristics can be mapped into a game. Furthermore, we need to improve the way the characteristics are represented (i.e., something better than simple values from 0 to 1). A possible approach to this later problem is to use one function for each different characteristic, like what was done in [13], applied to a video game context.

Moreover, other emotion and personality theories could be used, as other projects like *FAtiMA* did, using the OCC theory [33] to influence virtual agents behavior, making it generic to use even appraisal theories [34]. This approach was used in a game called *FearNot!* [35]. Other questions can also be investigated, such as the exploration of stronger relations in the way personality and emotions affect people's cultural dogmas. In this later context, we can explore how virtual agents change their personalities depending on an important event, or even change their social beliefs, affecting their future actions.

During the design of our model, we thought a lot about how we could make the *prejudice level* influence the interactions between the player and the NPCs. This characteristic should not be related to an individual, but to the current global situation of the region in which this individual lives. For instance, characters may discriminate a culture that they never interacted with before, but they can learn with their first experience and change their own discrimination value.

In the level of Procedural Content Generation (PCG), the system could automatically build cities, dungeons, and other buildings, depending on cultural values (like time, wealth and individualism) and region characteristics (like weather and constant natural disasters). This type of approach would open a different and innovative style of PCG.

Some questions like: "Can players notice the different behaviors performed by NPCs?", or "Can users identify the emotions and cultural behaviors the NPCs are performing?" were also raised during the experiments. To answer them and validate the model in a more precise way, we would need to perform a survey with users, evaluating player experience itself. These validations would be even more valuable if we turned our 2D game in a 3D one, where the player could see the NPC reactions through animations, as an extension of the 3D Application implemented.

Our research work brought new solutions related to NPCs behaviors in RPGs based on cultural characteristics and raised lots of useful questions. Also, we think that our results can contribute to research in video game narrative and worldbuilding. Furthermore, our model can simulate other types of virtual agents, not limited to video games.

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