Moody5: Personality-biased agents to enhance interactive storytelling in video games

***Abstract*—In story-driven video games, such as Role-Playing Games (RPGs), a static and repetitive interaction with Non-Player Characters (NPCs) can negatively impact fun and immersion. On the contrary, an NPC able to show emotions and endowed with a personality that matches its behavior can keep the user engaged for a longer time, thus increasing the game's replayability. Unfortunately, this aspect is still an open issue. We propose a preliminary solution: Moody5 has been designed to help game designers create "personality-biased" agents able to interact in sensible ways in the framework of interactive storytelling. In particular, it supports the creation of agents that exploit the Goal-Oriented Action Planning technique to reach their goals but whose chain of actions is affected by their personality and emotions. To obtain this result, we have borrowed some ideas from the Big Five theory [1] and the Emotion Facial Action Coding System (EMFACS) by Ekman & Friesen [2]. Therefore, we obtain NPCs that are a proxy good enough to approximate human behavior in games. We validated the proposed solution in a narrative test scenario inspired by the Harry Potter universe. Our preliminary survey demonstrated that Moody5 could improve the gameplay experience and replay value while providing a helpful Unity plugin for game developers.**

***Index Terms*—interactive storytelling, Goal-Oriented Action Planning, believable NPCs for games, artificial intelligence techniques, Big Five theory, emotion simulation, personality traits.**

I. Introduction

Unlike traditional media, video games provide mechanisms for users to interact with the environment where the narration occurs [3], thus transforming the user from a passive spectator to an active participant. Therefore, the interactive storytelling in a video game is not necessarily linear, and unexpected twists in the plot can be triggered by the interactions between the player and some Non-Player Characters (NPCs) [4]. An NPC is an artificial character that helps the game world "come to life" [5], and that can have roles and objectives of its own.

A game is an experience designed to entertain the player and to move her emotionally, especially in story-driven games [6]. Hence, when the player is aware that her decision matters (aka they impact on the development of the plot), the replayability of the game increases, keeping the user engaged for a longer time [5], e.g., to repeat the adventure to try to reach different endings. In this perspective, the role of NPCs can become crucial [4], especially when the NPC shows a personality that matches its behavior, demonstrates awareness of its surroundings, and can express its emotions [7]. In (multiplayer) story-based games, where the narrative counts for a significant amount of the gameplay value, such as Role-Playing Games (RPGs), a static and repetitive interaction with NPCs can hinder the fun and the immersion in the game for the players. Therefore, it would be highly desirable to enhance the characters' behavior by making their interactions with the player and the game world more spontaneous, adaptive, and aware of what is happening, thus approximating human behavior. The present work aims at contributing to the resolution of the problem summarized above. In particular, we claim that it is possible to increase the believability of the behavior of NPCs by leveraging appropriate techniques of Artificial Intelligence (AI). Hence, our approach tries to mimic the effect of some emotional states in the NPCs for a story-driven game by embedding into them some aspects based on psychological personality and emotion theories. To this extent, we have designed, developed, and tested Moody5, a plugin for Unity3D, that allows the game designer to create personality-biased agents able to interact with the game world and react to emotional stimuli. In particular, the agents exploit Goal Oriented Action Planning (GOAP) to reach their goal, while they are also "personality-biased", in the sense that they include a "personality model" based on the theory of the Big Five [1] and an "emotional state" based on the studies of Paul Ekman [8]. Consequently, their behavior is affected by what is happening in their surroundings and by their personality and current emotional state, thus providing complex agents able to react to specific external stimuli. Moody5 has been thought of as a support tool for developing RPG video games; nonetheless, it could also be used for simulations in a context not related to entertainment. Last but not least, although Moody5 is still in its infancy, we needed to validate at least its overall approach. Hence, we have used it to build an RPG demo scenario set in J. K. Rowling's Harry Potter universe, and we have tested it with a sample of players, collecting some intriguing insights. The remainder of this work is organized as follows. Section II shows related works in the field analyzing the most promising psychological approaches for our purpose and the state-of-the-art works in the field of interactive storytelling and agents endowed with some personality. Section III describes Moody5 while laying out the necessary psychological foundations and AI techniques it implements. Section IV explains the test scenario and the methodology used to validate Moody5 and presents the results obtained so far. Finally, Section V concludes the work and highlights opportunities for future research.

II. Related Work

This section briefly presents several studies on personality and emotions, debating the advantages and disadvantages of

different theories for our aim. A deep analysis of these theories is out of the scope of this work; hence we will focus only on the most relevant ones. Further, a selection of recent state-of-the-art studies and commercial approaches in agent personality modeling is presented, and Moody5's contributions are highlighted.

A. Theories about Personality

The personality is a complex organization of ways of being, knowing, and acting that guarantees unity, coherence, continuity, stability, and planning for the individual's relationships with the world [9]. In the context of personality studies, two among the most relevant theories are based respectively on psychological *types* or *traits* shown by individuals [10], [11].

The "personality type" theory classifies the personality of an individual by relating it to the characteristic behavior of a species or a community [10]. One of the more notable works in the type theory is the Myers–Briggs Type Indicator (MBTI) [12]. Based on Carl Jung's [10] studies, the MBTI identifies a series of psychological characteristics that describe how an individual interacts with the world and which is her attitude toward life in general [12]. The MBTI categorizes an individual into 16 different psychological "types", obtained from the combinations among four opposite dichotomies. However, the model has some disadvantages, such as: neglecting an eventual emotional instability of an individual and adopting non-completely accurate tests for classifying the personality [13]. On the other hand, the "trait" theory is based on the assumption that individuals are naturally predisposed to manifest different types of behaviors that derive from their temperament or personality [14]. These theories conceptualize "additive personality", as they define a personality as the sum of the traits that compose it [15]. Eysenck [11] dates one of the first studies related to the theory, which defines the PEN model. In the proposed model, personalities are classified on three dimensions: psychoticism, extraversion, and neuroticism. However, Delfard & Kringlen [16] raised critics of the Eysenck theory, since while trying to demonstrate the genetic influence in personality, they obtained conflicting and inconclusive results.

In 1992, the studies conducted by [1] showed that a personality could be described through five dimensions, whose impact can be measured using an appropriate questionnaire, developed by Caprara *et al.* [9]. The model is called Five-Factor (or Big Five) and is one of the most robust and comprehensive personality models currently used in psychometric testing. In particular, it has been demonstrated that more than 80% of the personality variations are observed in those five dimensions, making the Big Five the most reliable model to measure a personality [1]. The model comprises five macro-categories (or dimensions) used to describe differences between individuals: openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism. Due to its great recognition in psychology and the additive nature typical of the trait theory, the Big Five has been chosen as the basis for modeling the personality of Moody5's NPCs. Its details and implementations are further discussed in Subsection III-A2

B. Theories about Emotions

An emotion can be defined as complex subjective experience, accompanied by intense - but usually short-lived - cognitive, behavioral, expressive, and physiological changes [17]. Among the vast plethora of theories on emotion, for our purposes, we have considered those based on the following approaches: neurophysiological, appraisal, and evolutionary.

The neurophysiological theories study the physiological mechanisms underlying the generation of emotions. They are divided into two opposite branches: peripheral and central theories. The *peripheral* theory is described by James & Lange [18], and it argues that emotions are perceived by the end of a physiological process caused by an external stimulus. However, the *central* theory counters the peripheral approach, arguing that the internal organs of the body have reduced sensitivity and response times too slow to be considered the place of origin of emotions [14]. Notwithstanding, the neurophysiological theories are incomplete since they do not consider psychological aspects in generating emotions. This was changed by Schachter [19] and his *appraisal* theory, which proposes a model that aggregates the physiological and psychological components.

Starting from the 60s, a group of psychologists developed a *psycho-evolutionary* theory of emotions based on Charles Darwin's studies. In particular, they state that emotions, manifested through facial expression, derived from natural selection [20]: Tomkins [21] considered the emotions as innate response patterns that have been developed and evolved to ensure the suitability (and survival) of individuals to the environment. Ekman & Friesen shared this observation, proposing one of the main innovations for inferring emotional states from facial recognition: the Facial Action Coding System (FACS) [8]. FACS describes the facial expression by extracting the actions of a group of facial muscles. Despite critics - claiming that there are also emotions that do not always have a unique correspondence with facial expression [22] -, Ekman & Friesen's works remain to this day one of the most diffused ways to classify emotions. In particular, Ekman & Friesen created the Emotion FACS (EMFACS) [2], a widely adopted system to infer the emotional state of an individual from his/her facial expressions. EMFACS includes six "primary emotions": joy, sadness, anger, fear, disgust, and surprise. Moody5's emotion model, described in Subsection III-A3, adopts as theoretical basis Ekman's EMFACS primary emotions [2].

C. Interactive storytelling

Interactive storytelling requires that a certain amount of the narrative elements of a story emerges from the interactions that the player has with the environment, and other characters, including NPCs [6]. Crawford [3] discusses three potential strategies for developing interactive stories for games: (i) interactions with the environment (narrative events emerge from the interaction between the player and the game); (ii)

data-based strategies (which uses libraries of story components to generate consistent combinations of events in response to user actions); and (iii) approaches exploiting natural language (allowing the user to exploit a - limited - vocabulary to interact with the game system). Recently on the game industry side, Heavy Rain (2010) and Become Human (2018) by Quantic Dream employed multiple storylines, modifying the story based on the player's choices, thus transforming the overall game experience. Life is Strange (2015) by Square Enix, instead, created a graphic adventure that lets the player rewind time to change past actions, thus modifying the development of the plot.

In the last few years, several games and works have been setting the state-of-the-art in interactive storytelling [4], [23]–[25]. In particular, Animal Crossing (Nintendo) and The Sims (Maxis, Electronic Arts 2000) use NPCs to bring out the content of a story. Each NPC in Animal Crossing has one of eight different personalities that impact habits and interests. Nevertheless, the game NPCs do not have explicit goals nor show convincing emotions, thus producing repetitive interactions. On the other hand, Sims are controlled both by the player and the AI, and they plan their actions to satisfy their physical and emotional "needs". However, The Sims' complexity is not reflected in the narrative aspect, which is largely underdeveloped. On the academic side, Cavazza *et al.* [4] studied the generation of behaviors of characters that interact with each other within a story. Each character is driven by long-term goals, achieved through a planner defined by Hierarchical Task Networks. However, the work does not analyze the personality traits of the agents, which could trigger changes in the NPCs' behavior, thus improving the player experience. Shirvani *et al.* [23], proposes a context-free representation with a simplified Big Five personality model. They describe traits using a set of aspects, as defined by DeYoung *et al.* [26] (such as defining an agreeableness trait through kindness and compassion aspects). Agliata *et al.* [25] proposes a tool that allows the creation of NPCs sensitive to changing emotions, using decision trees and genetic algorithms to add variability to the gaming experience.

The agents defined in this paper have personality traits inspired by the work of Shirvani *et al.* [23], using the Big Five model [1]. However, in Moody5, also Ekman's EMFACS emotion model [2] is introduced, and Shirvani's psychological model is simplified, allowing an average player to understand the NPCs traits better. Moody5 also uses GOAP to search for the best sequence of actions to be executed. Finally, Moody5 borrows some techniques to affect emotions from Agliata *et al.* [25].

III. Moody5

Moody5 is a framework, implemented as a Unity plugin, that helps a game designer to define personality-biased agents that interact with the game world in a narrative context. The plugin was designed to enhance the players' gameplay experience and increase the replay value, adding variability to the behavior of NPCs. Therefore Moody5's features include:

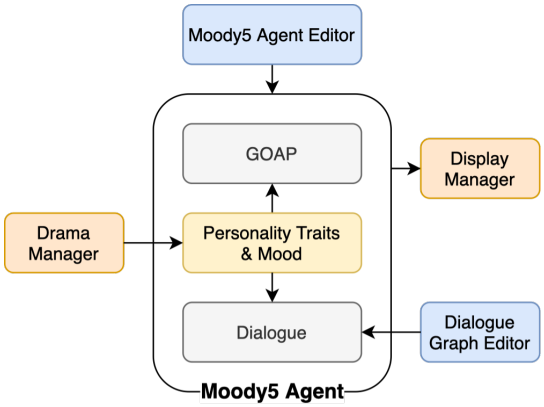

Fig. 1. Moody5 agent structure and supporting framework modules diagram.

- an editor to create NPCs with personality while helping the designer to define the agent's characteristics;
- a graphical user interface to monitor the behavior of an agent at runtime;
- a visual editor to create interactive multi-answer dialogues sensitive to variations of emotions and different personalities.

Agent's behavior is defined using a variant of the GOAP algorithm that is sensitive to the NPCs personality. Our variant includes a model based on the five dimensions of the Big Five theory, a model of transitions between Ekman's primary emotions and some ad hoc personality traits that create specific NPC behaviors. Moody5 GOAP variant is an extension of Ciadamidaro [24]. Since their solution aims at very simple NPCs for strategy games, they use GOAP with a "dynamic bias" that is sensitive only to several ad hoc traits, without considering personality or emotions. Ciadamidaro also does not provide an editor to agent creation nor a runtime agent monitoring interface. Furthermore, Ciadamidaro NPCs only interact with some game world elements, unable to affect the overall story, and without any direct dialogue-based interaction with the player.

Fig. 1 demonstrates Moody5's structure. The Moody5 Agent Editor and Dialogue Graph Editor modules allow the creation of new agents with personalities and dialogue sequences to be saved as game assets. The Agent Editor allows adding the components that define an NPC. All NPCs have a model for the transition of emotions, Big Five traits, and the option to add: a dialogue system, some ad hoc traits for the personality, and whether the agent will use GOAP. The created agent with personality can be visualized with the Display Manager at runtime. This manager also allows monitoring the actions that the agent decided to make and its personality and emotional states. Additionally, a Drama Manager module is developed to handle the generation of story events in dialogues. The generated events might serve as input to modify the behavior and the emotional state of a Moody5 agent. Hence, the agent's GOAP and dialogues were modified to include the new personality behavior and emotional mood.

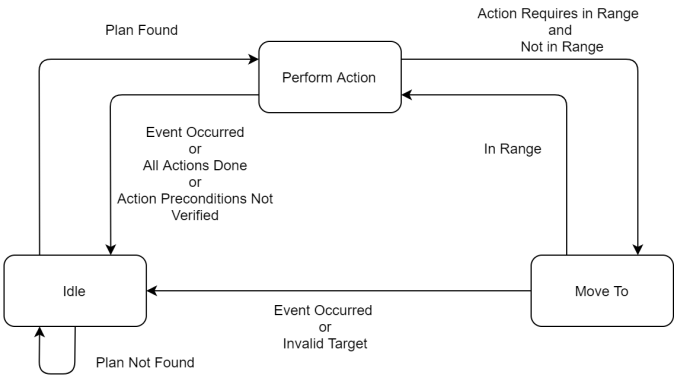

Fig. 2. Moody5's GOAP supporting FSM.

Moody5 was implemented using the Unity3D game engine and uses some of its scripting libraries, including MonoBehavior, ScriptableObject, EditorWindow, and GraphView. Additionally, RPG Maker MV (2015) by Enterbrain has been used to create sprite assets for the test scenario.

A. Moody5 Agent Structure

Moody5 defines two types of NPCs: *emotional NPCs* and *Moody5 Agents*. An "emotional NPC" is affected both by Ekman's primary emotions and the Big Five theory, plus it has some ad hoc personality traits, but it does not implement GOAP. "Moody5 agents", instead, implement also GOAP to achieve specific goals. As already described, the GOAP variant of Moody5 includes a model of the Big Five personality traits that can influence the agents' behavior (hence, triggering replanning when certain conditions occur).

1) GOAP with Dynamic Personality Bias: GOAP [27] is an AI technique, also used in video games, that allows agents to plan (and revise when needed) a sequence of actions to reach a particular goal. The sequence of actions performed by the agent depends not only on the goal but also on the game's current state and the agent's state, thus producing more convincing and believable behaviors [28]. Moody5 extended Ciadamidaro [24]'s GOAP structure by considering an agent's personality traits, which are activated when certain conditions in the game state are met. Moreover, actions have an execution cost, may alter the game state, and are represented by a set of key-value pairs. These pairs are used to define the preconditions and effects of each action and the goals of the NPCs. Additionally, GOAP is supported by a Finite State Machine - FSM (Fig. 2) composed by three states: *Idle*, *PerformAction* and *MoveTo*. When in the *Idle* state, the agent applies A* [29] to produce a queue containing the best sequence of actions that leads to the goal, considering the set of actions it can perform and the current state of the world. If it finds a plan, the agent tries to perform the actions.

Regarding handling interactions with the environment, Moody5 extends Unity's Environment Query System. Each personality trait has a set of tests used to establish events in the game world. Tests are applied within the agent's "vision" range and allow to: detect the presence of objects to which a specific tag is associated, detect collisions, calculate the distance between the agent and a target and check if they are facing each other. When one of the tests passes, it might produce a response that will change elements, such as the cost of the action that caused the event, the actions that an NPC can perform, the number of the NPCs objectives, or the cost of the path to reach a target. Each response is shaped as a numeric result normalized in a range between 0 and 1. The sum of the results returns a value that will affect the personality behavior.

2) The Big Five Theory Mechanism: The Big Five personality model defines an NPC's personality through five factors. Each factor is associated with an integer value between -1 and 1, which indicates whether a Big Five trait is positive, negative, or not active. Those factors are:

- **Agreeableness:** how able an individual is to adapt to others
- **Openness to experience:** the creativity and the variety of topics a person is interested in
- **Extraversion:** the degree of interactions and interpersonal relationships
- **Neuroticism:** the level of emotional stability of an individual
- **Conscientiousness:** the degree of organization and motivation in achieving the goals of an individual.

The behavior of an agent, defined by GOAP, changes based on the definition of the five factors. This is done by changing the cost of his actions, goals, and emotional model. The changes made by each factor are inspired by the work of Shirvani & Ware [23] and have been defined to simplify the Big Five model described in psychology. Additionally, the concept of interaction and consent is added to each action. Interaction indicates the actions that require the participation of other NPCs, while consent indicates whether or not another NPC is in favor of performing an action.

Table I shows the contributions that each Big Five trait brings to changing the behavior of a GOAP agent. The value change in cost is defined by a weight variable, between -1 and 1, considering the big five traits that impact that action cost.

3) Emotion Mechanism: The mood of an NPC is defined by a subset of Ekman's primary emotions: *joy*, *sadness*, *fear*, *anger*, and *disgust*. We simplified Ekman's mood by not considering the *surprise* emotion since it is a short-term mood that usually precedes another emotion [22], hence it would have been hardly noticeable in an NPC. Additionally, a *neutral* mood has been added to primary emotions to indicate when an NPC is not affected by any particular mood. For each mood, we have defined an activation threshold and an *intensity value* (between 0 and 10). The intensity value of an emotion increases when certain events occur. An event is generated when certain game states are met, such as: interaction through dialogues, something triggering a particular trait or specific situations in the plot. Each event may impact the NPC's mood through an emotional reaction represented by an increase in the mood intensity: a "neutral" NPC will transition to a state of emotion when the intensity exceeds the activation threshold.

TABLE I
INFLUENCE OF EACH BIG FIVE TRAIT ON THE AGENT BEHAVIOR.

Personality Trait	Influence	Negative Value	Positive Value
Agreeableness	Modify cost of actions that require the consent of other NPCs	Decreases cost of actions that do not have the consent of another NPC	Increases cost of actions that do not have the consent of another NPC
Openness to experience	Modify cost of actions that the agent is performing the first time	Increase cost of a new action	Decrease cost of a new action
Extraversion	Modify cost of actions that require interaction with other NPCs	Increase cost of actions that require interaction	Decrease cost of actions that require interaction
Neuroticism	Modify emotion transitions thresholds	Slowly emotional state transition	Faster emotional state transition
Conscientiousness	Change the number of goals an agent accomplishes when a new one is assigned	Delete the current goal and add the new one to the top of the queue.	Adds a new goal to the queue.

The emotional state will remain active for the indicated amount of time, during which no other emotions are activated. Once the effect is over, the mood of the NPC returns to a neutral state, resetting all intensity values of the moods. The activation threshold is modified by Big Five traits that are related to interactions: neuroticism, extraversion, and agreeableness [1]. A positive trait of extraversion decreases the threshold for joy. A negative trait of agreeableness decreases the threshold for anger and disgust. A positive trait of neuroticism decreases the threshold for all the moods, representing emotional instability. Each threshold is decreased by 20% of the default value for each psychological trait that affects it. Alternatively, the thresholds will increase if we consider the inverse for the traits above.

4) Effect of "ad hoc traits": Traits of Moody5 agents can be further extended with specific "ah hoc traits" which force an agent to enter an emotional state upon the activation of them, for example, to represent a phobia (e.g., an NPC owning the ad hoc trait "fear of spiders" become scared on seeing a spider). Also, emotional NPCs (not using GOAP) can have ad hoc traits, but they are used only during interactions with the player through dialogues or in story events.

5) Impact of the agent's mood on the actions it performs: In actual life, a character's emotional state is not neutral concerning how it performs a specific action (e.g., a sad character should act slower than a euphoric one). To simulate this aspect, it is possible to set a duration (in seconds) and a probability of success for each action. Those values are sensitive to the emotional state of the agent. In particular: joy will double the probability of success and is activated when a goal is achieved; anger halves the probability of success; sadness doubles the duration of an action and is activated when a goal is not reached. Fear and disgust are exceptions because they are associated with ad hoc traits. If an ad hoc trait is triggered by an external event, the agent might enter in one of those moods, interrupt the current action's execution, and searches for a new plan.

B. NPC Monitoring Interface

Verifying the correct functioning of a Moody5 NPC behavior becomes a non-trivial task since there are multiple factors to consider. For this reason, Moody5 provides an interface that allows monitoring of the properties and behaviors of each NPC. The interface was designed to be displayed at runtime, allowing monitoring the NPCs' behavior even on a project "build", thus providing a more effective alternative to the standard Unity3D console.

C. Dialogue system & Story Event

In the RPG scenario that we envisioned, the player interacts with NPCs using multiple-choice dialogues (a standard solution adopted by many RPGs). Each sentence selected by the player can impact the agent's emotional state, depending on how it has been designed and whether it triggers some ad hoc traits the agent has. The change in the agent's mood is visually represented by a change in its facial expressions, thus making the player aware that something has happened.

To add dialogues to the game scenario, Moody5 implements a simple-to-use interface based on a Dialogue Graph Editor that we have developed starting from the Node Based Dialogue System[1]. In particular, we have redefined the dialogue nodes to manage the change in emotional states and the activation of personality traits. The editor allows the creation of multiple response dialogues defined as acyclic graphs, where the nodes represent a single sentence and the edges the connections between successive sentences. In Moody5, a dialogue node consists of a sentence, up to four answers the player can give, and a mood. The transition between nodes is triggered based on the players' answers, consisting of a sentence, the triggering mood, and the ad hoc trait that will activate the mood.

Moreover, in our approach, NPCs can also be "moved" by some story events that we represent as "narrative modules" that modify the behavior of an NPC *without a direct interaction* with the game world (e.g., an incoming declaration of war could affect the mood of an agent). Narrative modules are composed of a specific event in the story, the NPC(s) involved, ad hoc traits (if any), a specific mood affected by what is happening with its intensity value, and an optional actor (represented by another NPC). When the event occurs, an ad hoc trait, if indicated, is added to the traits' list of each NPC involved, and the intensity value of the associated mood is increased. If an actor is specified, the event is told by it. In this case, too, the narration is created with the Dialogue Graph Editor. To carry out the story events, a Drama Manager module (see Fig. 1 again) is defined considering the way and the requisites in which an event can be implemented.

[1]Available at: https://github.com/merpheus-dev/NodeBasedDialogueSystem

IV. Testing Moody5

While testing Moody5, our main objective was twofold: we needed, on one hand, to verify the usability and effectiveness of Moody5 for creating personality-biased NPCs, and on the other to evaluate the player experience while interacting with such agents. Therefore we involved two different tester samples: a group of people potentially interested in using Moody5 for their projects (and thus also able to objectively evaluate the potentialities of Moody5 as a tool to support game designers' work) and a group of players. The first sample was composed of 17 people working in the video game industry and graduate students in the computer science major specializing in game development. In contrast, the second one was composed of 23 gamers and RGP lovers. Due to the COVID-19 pandemic, the evaluation tests were performed remotely using Discord.

Each test consisted of a brief explanation of Moody5 main features and a two-part evaluation. In the first evaluation part, testers were asked to use Moody5 to create an emotional and a Moody5 NPC, add ad hoc personality traits and create an "emotion-sensitive" dialogue. The second part focused on playing a proposed RPG-based test scenario, featuring some of Harry Potter's NPC characters interacting with the player and among themselves. The scenario had to be played twice, but between tests, Big Five values were changed, and ad hoc personality traits were added to give plenty of opportunities to the testers to perceive variations in the behavior of the NPCs. Testers were allowed to freely explore the environment, observe the agents preparing magic potions, and interact through dialogues. The testers used the monitoring interface to compare what they were perceiving with what was going on in the NPCs' mood. The first sample performed both evaluations, while the gamers were only involved in evaluating the playing experience. At the end of the test, the testers were invited to fill out a questionnaire composed of three sections: general information and gaming habits, plugin usability in terms of NPCs creation (only for the first group, since the second one just played), and gameplay experience.

A. Test Scenario description

The test scenario is a 2D environment with a three-quarter camera, characterized by a thematic inspired by the Harry Potter universe. Harry Potter has been selected since its main character has very recognizable and well-known personalities, thus helping to reduce the bias when players had to notice a transition in the NPC emotional state. The test scenario's map was created as a grid of square tiles, some of which are interactive objects used by NPCs as targets to perform specific actions. Testers can observe information about an NPC by activating the monitoring interface, thus comparing their perception with what is going on in the "mind" of the agent. Fig. 3 is a screenshot of the game with the monitoring interface active, showing an extrovert, neurotic Moody5 NPC being scared because of the activation of an Arachnophobia ad hoc trait. In particular, in this scenario, a Moody5 agent has to prepare a magic potion, and for this reason, it has to interact with a simple emotional NPC. The choice of the chain

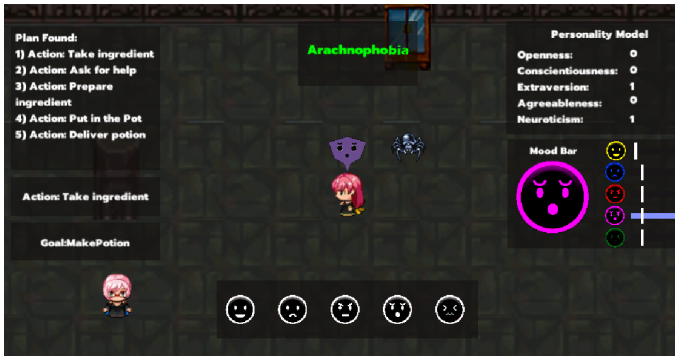

Fig. 3. Screenshot of test scenario with monitoring interface overlaid.

of actions to perform depends on the agent's Big Five current values and ad hoc traits.

Moreover, specific events are generated at regular time intervals with a predefined probability. Each event is randomly extracted from a list of available independent events and subsequently removed. This helps to introduce variations in the behavior of the agent. The players explore the environment using their characters to perform actions in the "potions classroom" and interact through dialogues with the different NPCs present in the game scenario. Dialogues can be used to talk with an agent, assign a goal to a Moody5 agent, or receive a secondary quest (mission the player has to fulfill to progress in the game). However, secondary quests are given to the player only by NPCs in a neutral or happy emotional state (otherwise, the NPC refuses to assign quests).

B. Sample composition

The first questionnaire section focused on evaluating the samples' demographics regarding gender, age, profession, time spent playing video games, and favorite game genres. Furthermore, we sought to understand the player's relation to the game and the story elements and their familiarity with the Big Five personality model and personality testing.

Our sample was primarily males (50%) followed by females (36.4%). The remaining 13.6% was composed of non-binary individuals or individuals that preferred not to answer. Most of the sample (72.7%) was 25 years or above, while only 27% was between 18 and 24. Students and workers in the video game sector composed about 60% of our sample and 86.4% spend more than 5 hours a week playing video games, with a preference for RPG, puzzle, or adventure genres. The sample's primary motivation to play a game is the story (72.7%) where 81.8% and 77.3% of respondents consider the story elements fundamental and with an impact on the game immersion, respectively. Regarding familiarity with personality-related aspects, 54.5% has previous knowledge of the Big Five personality traits, and 81.8% is interested in understanding personality assessments. Thus making this sample seem good enough to give us sensible and objective feedback.

TABLE II
PLUGIN USABILITY QUESTIONNAIRES QUESTIONS ON THE FORM OF STATEMENTS (LIKERT ITEMS).

ID	Statements (Likert items)
S2.1	As a whole, the purpose of the plugin is clear.
S2.2	The agent creation interface is helpful.
S2.3	The agent creation interface is understandable.
S2.4	Its easy to add personality traits to agents.
S2.5	Its useful to generate story events that modify the emotional state of the NPC.
S2.6	The monitoring interface is understandable.
S2.7	The editor for generating dialogues through graphs are useful.
S2.8	The interface of a dialogue node is understandable.

C. Plugin's Usability Evaluation

To have an idea of the possible bias introduced in the usability testing feedback, we investigated whether testers had previous experience with game engines and Artificial Intelligence for games. The 94.1% of the sample uses Unity3D and the 35.3% Unreal Engine. Moreover, 88.2% of the sample had experience with video game AI techniques, but only 5.8% with planning approaches, such as GOAP.

Most of the evaluation in the questionnaires has been performed using Likert scales [30]: each question was defined as a statement, and respondents specified their level of agreement or disagreement on a symmetric scale, thus capturing the intensity of their feeling for that item [30]. Table II shows the Likert items used to assess the plugin usability, while Fig. 4 illustrates the Likert scale results in a diverged stacked bar chart.

In summary, Fig. 4 the outcomes of this preliminary validation phase seem to demonstrate that the purpose of the plugin is clear (S2.1) and that the editor for agents creation helps define the structure of NPCs (S2.2). Additionally, even if the testers have struggled a bit to add ad hoc personality traits (S2.4), they appreciated the mechanism to generate story events that modified emotional states (S2.5). Testers evaluated the dialogue editor as valuable for its purposes (S2.7), but its readability could be improved (S2.8).

Finally, we evaluated whether the testers would prefer to use the character monitoring interface instead of the console for debugging behaviors. About 82% stated that they would instead use the proposed monitoring interface.

D. Gameplay Experience Evaluation

Last but not least, we analyzed the scenario with gamers to understand the effect of Moody5 NPCs' emotions and psychological traits on the overall gaming experience.

Just as before, Table III shows the Likert items used to assess the gameplay experience, while Fig. 5 illustrates the results. Overall, a firm agreement seems to be perceived in enhancing the replay value (S3.3) and the gameplay experience (S3.4). Additionally, testers could deduce Big Five personality traits without the monitoring interface (S3.2), but they have some difficulties recognizing them through the NPCs' actions (S3.1). When we asked the testers which elements contributed most to making the NPC behaviors different, we noticed that

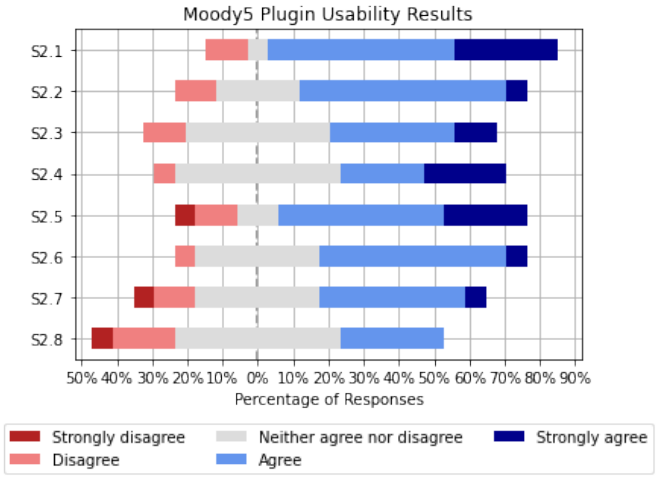

Fig. 4. Results in a Likert scale of the proposed statements on the gameplay experience questionnaire.

TABLE III
GAMEPLAY EXPERIENCE QUESTIONNAIRES QUESTIONS ON THE FORM OF STATEMENTS (LIKERT ITEMS).

ID	Statements (Likert items)
S3.1	The NPCs' personality is recognizable by the actions it takes.
S3.2	I was able to deduce an agent's Big Five personality traits mainly without using the monitoring interface.
S3.3	The gaming experience has changed between both game tests.
S3.4	The NPCs' behavioral variability improved your gameplay experience.

ad hoc behaviors had the biggest impact (45.5%), followed by the Big Five model (31.8%) and the emotional state (18.2%). Only 36.4% of testers considered the transition between emotions to be satisfactory, underlining that the number of emotion changes is insufficient (36.4%) nor the duration of the emotional state (which should be increased for 13.6% of them and reduced for the same percentage).

Notwithstanding, we also evaluated the recognition of each trait. Testers classified the difficulty of perceiving a personality trait in the following order (from the most difficult to easier one): agreeableness (62.5%), openness to experience (37.5%), neuroticism (18.8%), extraversion (12.5%), conscientiousness

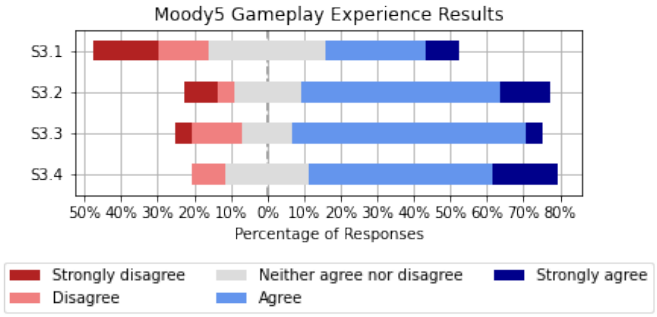

Fig. 5. Results in a Likert scale of the proposed statements on the gameplay experience questionnaire.

(12.5%). We believe that the nonrecognition of agreeableness may derive from a low rate of interactions with NPCs. To evaluate the replay value, we asked our testers if they would play the game multiple times to discover the different behaviors of the NPCs. Results showed that 81.8% would play at least twice, suggesting that Moody5 agents could greatly display replay value.

Finally, we suspect that the testers who knew the Big Five model could better understand the variations in the agents' behavior. In contrast, testers less interested in story aspects would not try to explore the game to discover the different behaviors of the characters. Both these claims will be an object of future deeper investigation.

V. Conclusion and Future Works

This paper proposes Moody5, a framework that can define personality-based NPCs in the context of a narrative game world. Our main goal was to improve the gameplay experience and increase the replay value by modifying the behavior of an NPC according to its personality. We defined a personality using a simplified model derived from Ekman's EMFACS and from the Big Five traits, which influence the agent's decisions and behavior. Moreover, since GOAP governs the agent actions, the impact of personality and emotion creates an evident variation in the NPC behavior. We conducted a preliminary validation of Moody5 involving a sample of players and industry-related workers and scholars.

The results obtained so far seem encouraging. Tester so far seems to agree on enhancing the replay value and the gameplay experience: 81.8% of them said that they would play the scenario at least twice to explore the game's variability. However, the players were sometimes unable to correctly identify a specific personality trait, while they find easier to identify emotions. Our preliminary survey also demonstrated that Moody5 has good usability. We provided a clear idea of the plugin's features and an informative monitoring interface that was chosen 82% of the time as a substitute for the standard debug console.

We are well aware that our work is still in its infancy and could benefit from further development and validation. We are planning, among other things, to develop a model for controlling the relationship between NPCs. This would improve recognizing the personality traits related to interaction, such as "agreeableness". Another possible future work could be the extension of the Drama Manager module to manage inter-relational story events and define a coherent narrative system. Finally, the dialogue editor could also be enhanced by defining different types of dialogue nodes and adding custom texts containing user-defined keywords.

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