Believable fighting characters in role-playing games using the BDI model

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Abstract: Character believability is a fundamental component of role-playing games. A believable character behaves according to its role in a realistic way, and gives the illusion of being alive. In video games, characters not controlled by the player are managed by the game itself, and while most of the desired behaviors can be scripted in advance, the combat phase requires the presence of an AI to interact with the player. Combat in role-playing games can be very complex and dynamic, with many possible battle scenarios and different player behavior, but commonly adopted AI implementations are not able to generate believable behaviors in such complex environments. The requirements needed for believable characters have been proposed in many researches, but they apply to a very broad definition of believability which is not apt for video games, especially when limited to the combat phase. For this reason we introduce a specialized set of believability requirements. On this basis, we propose a new multi-agent AI architecture to support believable combat in role-playing games. Because of its psychological foundations and affinity with the believability requirements, we adopt the BDI model as the agent mental model. An experiment aimed at evaluating the fulfillment of the requirements has been conducted using predefined combat scenarios. The analyzed data suggests that the system indeed covered the necessary requirements but with some exceptions.

1. Introduction

Role-playing games (RPG) are a game genre where the player controls one or more characters living in a fictional world[2]. Role-playing (RP) means behaving accordingly to a character's role and enacting it by using speech and actions within the game rules. In a more formal way, RP is the creation and interaction of diegeses (a fictional world or the truth about what exists in a fictional world) by the players[17]. The characters not controlled by the player are called non-playing characters (NPCs), and are acted out by a game master, who also specifies the game setting. Although there are many forms of RPGs, in this paper we will focus on off-line role-playing video games, also called computer RPG (CRPG). In these games, since there is no game master, NPCs behavior must be generated by the game itself, and the component responsible for this is generally referred to as game AI[16].

There are many CRPGs and they can be structured very differently, but in all of them we can identify a combat phase where the characters fight. Sometimes the transition is not visible (characters simply start fighting where they are), while sometimes a specific combat mode is enabled, usually bringing up its own dedicated interface to the screen. In either case, there is a clear difference between the required behaviors inside and outside the combat phase. Outside combat, characters interact with each other and with the player mainly with dialogs, quests, or by doing normal daily activities. These behaviors most of the times can be statically scripted in the game beforehand with satisfactory results[30]. For example, game designers know what a NPC can talk about at a given point in the story, what he can sell, where he will be on the map, and finally in what way he is related to a quest. As a result, the NPC behavior will stay true to his role exactly as intended, effectively simulating role-playing as if the game designer were acting for him as a player. The combat phase is a completely different matter. Often it is not known in advance which character will join the battle, what will be the state of each character, and what choices will the player make. For this reason the NPCs behavior cannot be prepared in advance, but must be generated on the fly by an appropriate AI. In our research we will focus on the problems related to the game AI during this specific phase of RPGs.

In most CRPGs the AI of the NPCs is implemented with behavior trees, or finite state machines where the state of the NPC changes in response to some designed event inside the game[8]. This is a very common practice, and not only it is quick and easy to implement but also permits to finely control the resulting behavior. The drawback is that such static algorithms cannot express the complex dynamics of role-playing[27], producing behaviors that don't follow the character's role and consequently disrupting the character believability[3]. A survey about the expectation for better NPC behavior in RPGs[1] was conducted on several gaming communities, and from the results it is clear that there is still much room for improvement about features like personality, emotions, pro-activeness, individual memory and relationships among characters.

In this paper we aim at building an architecture to support the development of a believable character AI for the combat phase

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of CRPGs. Believable characters contribute to an overall better player experience[22], [23], and having the role-playing component not only outside but also during the combat phase will improve the consistency of NPCs behavior and of game-play in general. We propose a multi-agent architecture, where each agent's internal behavior is based on the BDI model[6]. On top of this we will build a new framework dedicated to the development of a character AI able to role-play in a believable way, according to believability specifically designed for the combat phase. A decentralized system where each agent is autonomous naturally matches our research scenario, and the BDI model is one of the best approaches for developing rational agents in a believable way[19], [20]. We also aim to implement this system so that it can be effectively used in real games, meaning that ease of embedding in game engines, ease of content production and computational requirements will also be prioritized. For testing purposes a turn-based tactical RPG with rules similar to many commercial games of the same genre has been developed. An experiment based on the gamers' feedback about the behavior of the characters has been conducted. It consisted of a series of three predefined battle scenarios, each designed to evaluate specific believability requirements. By analyzing the results we could confirm how the system presented here indeed satisfied, although partially, the requirements imposed.

The paper is organized as follows. First we introduce related works inherent to RPGs, believability, and to the technologies we will use. Then, in section 3 we analyze combat believability in RPGs and specify its requirements. In section 4 and 5 we describe the system architecture and show how it is related to the fulfillment of the believability requirements. Finally in section 5, 6 and 7 we introduce the evaluation experiment, analyze the obtained data and draw our conclusions.

2. Related works

2.1 Believability

Believability is a very complex notion, and there is no generally accurate definition of it. Yet, by limiting our domain to computer games we can delineate its meaning in a way pertinent to our case. In virtual reality we can find the concepts of immersion and presence. Immersion is objective, depending on both hardware and software, and is obtained by substituting real world sensations with virtual ones[24] (in a video game we can think for example about graphics and control devices). Presence on the other hand is subjective, the psychological perception of being in the virtual environment where one is immersed[25], and it is mainly related to the environment's content. In RPGs the characters are the main focus[12], and as a consequence enhancing their believability greatly affects the presence too[27]. Bates explains how believability does not concern honesty or reliability, and how instead a believable character is one that allows the audience's suspension of disbelief[3]. In other words, a believable character is one that gives the illusion of life[28]. For video games there have been several proposals about the requirements of a believable character[9], [12], [14], [15], also depending on whether we require them to give the illusion of being alive or to give the illusion of being controlled by another player[13]. As we are targeting single-player off-line games, the former is considered together with a set of requirements thought for achieving believability during the RPGs combat phase.

2.2 Belief-desire-intention model

The belief-desire-intention (BDI) software model is a model built on Bratman's theory of practical reasoning[6], which is about resolving, through reflection, the question of what one is to do[29]. Practical reasoning comes from folk psychology, which is the natural capacity to predict human behavior, attribute mental states to humans and finally explain the behavior of humans in terms of their possessing mental states[21]. The concepts at the core of the BDI model can be naturally applied when creating human-like agents, and for this reason it has been the model of choice for rational agents. Sindlar et al. show how characters which possess unobservable mental-states like goals or who engage in social interactions cannot be built with traditional game AI programming, while instead BDI-based approaches are suitable for this purpose[23]. Although still lacking several aspects of human reasoning[18], many BDI-based agent programming languages and frameworks have been developed[4], like Jadex[7], Jason[5] or JACK[11]. Looking at the game industry though, with the notable exception of Black & White[26], there are no commercial games using BDI agents. With this in mind, we decided not use preexisting frameworks but implement our own BDI model suited for games' adoption.

3. Believable combat AI

In many TPRGs like Dungeons & Dragons[10] combat is clearly separated from the normal game-play. Before it starts, players can act freely without a predefined temporal order, and most of the actions are direct speech (for example, a player says "Guard, open the door please."), or descriptions (for example, "We go back to the tavern", or "I stand up and look him in the eyes."). Once combat triggers though, when can players act, what actions can they do, what are the results of these actions, all must follow the combat rules. To accommodate the fact that applying rules and rolling dices takes time, and to let players think about what action to execute, the normal time flow is interrupted and organized into turns. Video games are very similar, but since they can do all the necessary calculations for the player, combat can also be real-time (action RPGs).

3.1 Requirements

As stated in the introduction, a major difference with TRPG is that while players can keep on role-playing during the fight, the combat AI usually performs very poorly from that point of view. The first step to solve this problem is defining the requirements needed to achieve believable characters, and there are already many proposals about this. We chose to use the requirement set laid out by the Oz group[14], [15] as a starting point: personality, emotion, self-motivation, change, social relationships, consistency of expression, the illusion of life (appearance of goals, concurrent pursuit of goals and parallel actions, reactive and responsive, situated, resource-bounded, exist in a social context, broadly capable) and well-integrated. As believability is a very broad and complex concept it is no surprise that its requirements are so many.

It would be too complex to satisfy all these requirements, and many of them are not relevant to out case. Requirements regarding the external appearance of a character can be disregarded since they are unrelated to the AI, and while these are general requirements for any situation, in our case we are interested only in the combat phase. Especially in turn-based games, where combat is very complex and tactical, we think that the requirements specific to this phase are different and must be reconsidered.

[R1] Memory A believable character must and be able to store and retrieve information at any time. This is important for the combat phase because allows the creation of characters with different knowledge and experience, and is a prerequisite for any learning algorithm. Memory also is a means to have information not directly related to combat (story and quest choices, character's background and relationships) influence the character combat behavior so that it stays true to its role, increasing its coherency. Memory must have the three following characteristics: individual, dynamic and persistent. Individual means that each character has its own memory, completely separated from the others. Dynamic because it must be possible to add, edit or delete information. Finally, memory must be persistent in order to accumulate knowledge throughout the game (long-term memory).

[R2] Personality Believable characters should exhibit exclusive and variegate behaviors. Personality concerns how characters try to achieve goals, and is reflected in all their actions. During the combat phase it is important to leverage the limited action set available to express the uniqueness of the characters, especially if they have similar battle parameters.

[R3] Communication and cooperation Communication during the combat phase can greatly increase believability. If we look at fights in books and films, or even during role-playing gaming sessions we can see how characters engage in dialogs both with their allies and enemies. In contrast to many games where combat does not feature any meaningful communication (with real information being sent), having characters speak increases their believability because the player can see that there are real consequences to these exchanges. Finally, communication allows the characters to cooperate and compete, creating a more realistic and immersive experience.

[R4] Goals Characters should not only act in a reactive manner, but also have multiple parallel short-term and long-term goals. Goals can be individual (for example, wanting to protect someone) or shared (wanting to defeat the enemy boss). Characters motivated by goals in a manner that is visible from their actions appear more rational, increasing their overall believability.

[R5] Situatedness Believable characters should be aware of the environment they exist in, and be able to influence it through their actions. In many games characters are not really aware of the world, ignoring other characters and many other aspects of the game, while blindly executing their scripted actions. Instead, to be believable a character should always adapt to the changing environment (social context included) and behave accordingly. Environmental awareness must be obtained through the agent local senses, and not by directly accessing or sharing game information. Doing so makes the limits of the character more evident, and reinforces the its realism while preventing the player to feel cheated.

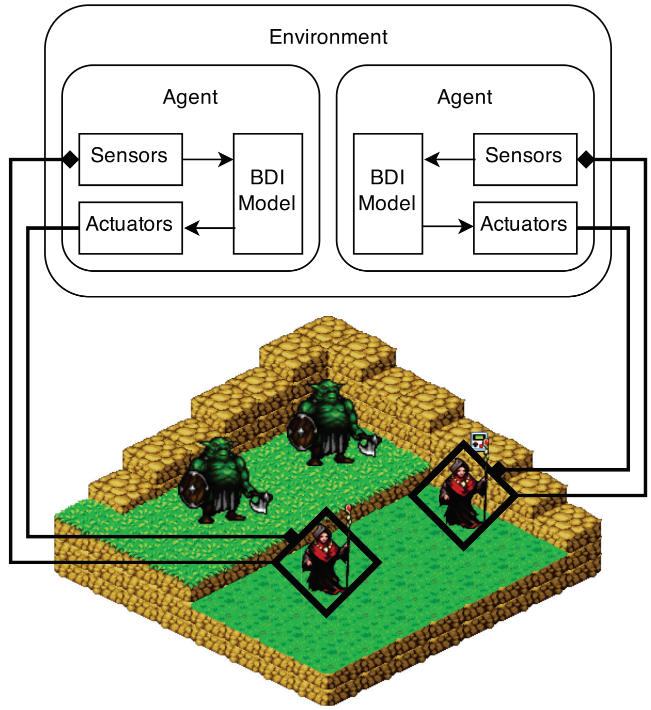

Fig. 1 Game environment, Multi-agent system and BDI model interaction.[*2]

4. System architecture

Characters need to have their own mental state, knowledge and goals, while keeping the interactions with the world and the other units limited to their local physical interfaces (no blackboard systems, which are an abstraction and can also be considered cheating by the player). This lends the AI to being implemented as a multi-agent system, where each character is controlled by an autonomous agent and the using the current game map as environment (Fig.1). The individual agent mental model is implemented following the BDI model, as it allows a natural representation of the characters internal states. We named our architecture "Yuishiki AI" (in Japanese, 唯識永合).

4.1 BDI components

In this section we will provide a detailed explanation of the main components of our BDI implementation.

4.1.1 Beliefs

Beliefs represent the character's knowledge, but are called this way because are not guaranteed to be true or consistent. They can change through time, but can also be saved and restored, work-

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ing as the character's long term memory. Beliefs are stored in the belief-base, and are created and accessed through a path similarly to files in a file system (for example, "character.status.position", or "character.items.*" for matching multiple beliefs). Contrary to many BDI implementations there is no logic programming involved, meaning no support for inference of new information or belief revision, but allowing for greater freedom about what can be stored (arbitrary data) and its memory representation.

4.1.2 Goals

A goal is a desired state which the agent is trying to reach. The goal-base is where the goal schemas are stored, indexed by name. We can then instance new goals by just passing the desired name and eventually the parameters to be bound. For example to create the goal to be in a certain place we send "be in location" and a vector containing the coordinates as a parameter. Goals can define the following optional conditions: success, failure, initial (must be true when trying to instantiate the goal), context (must stay true throughout the life of the goal) and creation (if triggers, an instance of the goal is created). Goals can set a retry flag to allow different plans in case of failure, and can set a maximum number of instances allowed at the same time (plans trying to push a goal already at its limit wait until more slots become available). Finally, goals can have a custom priority function which influences how likely they are to be actively pursued by the agent.

4.1.3 Plans

A plan is a course of action designed to achieve a certain goal, and is the building block of agent behavior. It contains a specification about which goal it can accomplish, and like goals can have additional conditions. The creation condition allows the implementation of service routines to perform actions in response of particular events, and purely reactive behavior for the agent (useful to cover corner cases that may present when developing a concrete game AI). Each plan can have an efficiency function, used to select the best plan for achieving a goal. The plan body can be arbitrary code, but has only access to the agent interface (mainly, belief-base and actuators). The plan is wrapped in a coroutine, making possible to suspend it (for example when waiting for an event or for a subgoal to complete) and interleave its execution by splitting the body in smaller steps. In addition to normal plans there can also be meta-plans. If present, these plans are used to help the agent choosing which plan to achieve a goal. Similarly to the goal-base, the plan-base holds the plan schemas for the agent to be instanced.

4.1.4 Intentions

Intentions represent actively pursued goals. They are implemented as a stacks, with plans and goals as elements (Fig. 2). When an intention is executed, the top element is updated consequently (Fig. 3):

Goal If the goal is new then must be managed by finding an appropriate plan, instancing it and pushing it on top of the stack. If it is not new then it means that the relative plan has finished, and in case of success the goal can be popped and the plan below resumed. Conversely, if the plan had failed then the goal fails too, with the exception of goals with the retry flag enabled which can try different plans before giving up.

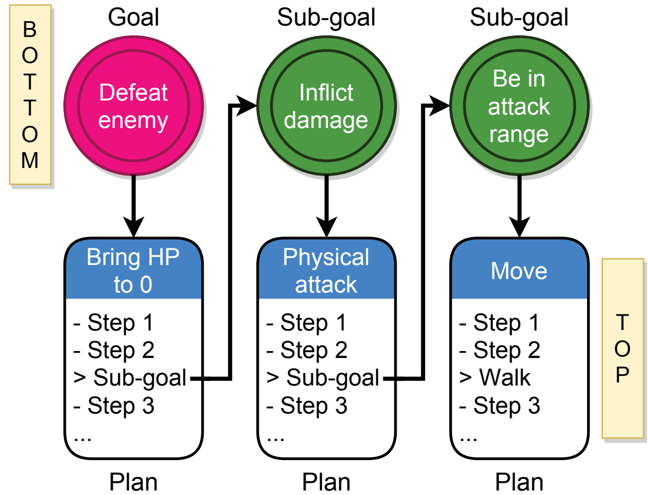

Fig. 2 Intention stack.

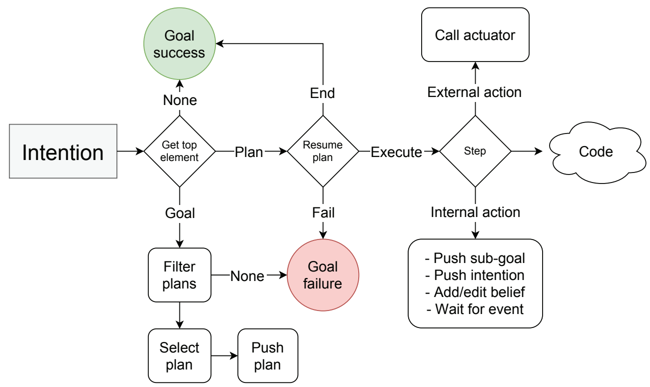

Fig. 3 Intention processing.

Plan The next step of the plan body is executed. If waiting for a sub-goal to complete it can check the success status and the attached return data. The plan can handle eventual failures in its body, or fail in turn. If it was the last step the plan is popped, and its success status and returned data are passed to the parent goal.

4.1.5 Sensors and actuators

Agents cannot interact with the game environment directly, but must do so by means of sensors and actuators. Both must be provided by the game, and are the only communication channel between game and AI.

4.1.6 BDI interpreter

When the turn of a character begins, its associated agent is updated by repeating the step function until it has no more thinking to do for that turn. A step consists in:

(1) Process all queued events. The goal-base and plan-base check for creation conditions, the intention-base sends the events to the active intentions to check conditions and update waiting plans.

(2) Select an intention. The selection function lists all the intention not in a waiting state, and sort them by the priority of the respective base goal.

(3) Execute the intention. As described before, this consists on taking the top element and processing it.

(4) If the top element was a goal, a suitable plan must be selected to achieve it. First, a list of meta-plans for the goal is retrieved. If not empty then the most efficient meta-plan is selected and pushed onto the stack. The meta-plan will then execute as a normal plan and finally select a normal plan to achieve the initial goal. If no meta-plans are present, a plan selection function takes all available plans, filters out the unavailable ones (checking their conditions) and then picks up the one with the highest efficiency.

5. BDI model and believability

Multi-agent systems and BDI models are quite appropriate to build an AI that satisfies the believability requirements stated in 3.1. In the following sections we will explain them one by one.

5.1 Memory

Memory is related to the belief-base and the plan-base, as beliefs and plans represent respectively pure information and practical information. As required, the belief and plan sets are dynamic, persistent and specific to an individual agent. By being so flexible it can be used to store any type of information, including data not combat related (character's background, past quests results) and as working memory for learning algorithms.

5.2 Personality

Personality is mainly determined by the plan-base, specifically by in how many ways a character can achieve a goal and how to choose one to execute. The former is directly related to the set of plans possessed by a character, while the latter depends on meta-plans. Even for characters with many plans in common, the way an intention evolves with its numerous branchings can produce very different behaviors in similar starting situations. Meta-plans, by their very nature, are tightly associated with a character's personality traits, and can be the key difference among characters with contrasting ways of thinking. Goals too can influence the perceived personality by having different priorities depending on the character in question.

5.3 Communication and cooperation

The BDI model is very dynamic and exchange of information is straightforward to accomplish. By adding actuators to speak and sensors to hear for example, characters can share knowledge (beliefs), give and receive orders or requests (goals) or teach other characters how to do something (plans). This lets the characters cooperate (shared goals, orders), compete (speaking and listening to the enemy) and express their internal state (intentions, goals). Depending on the game, this type of communication can be visualized (by means of chat bubbles, logs or voices) to make the player aware of it.

5.4 Goals

Goals are objects concretely represented in our BDI model, and directly related to this requirement. An agent actions are not statically scripted, but the result of the AI working out which actions need to be executed to get closer to the achievement of its goals. Behind every action there is a goal, and while playing the game this becomes more and more evident to the player. As mentioned previously, by speaking or other form of communication goals can be sent, received and declared in a way that is visible to the player.

5.5 Situatedness

In our system, agents are indeed situated. They exist in a dynamic environment which they can sense through sensor and influence through actuators. In addition, their behavior is not predetermined, but generated by intentions that branch and unfold dynamically according to the currently perceived situation. This is important because even for a simple game it is often impossible to predict all possible game states, while in our system even with a limited number of plans it is possible for the character to face a wide spectrum of situations.

6. Evaluation

The evaluation consists of a questionnaire about the behavior of the characters during combat. By means of an online form every participant reads the instructions, downloads the game and runs it in his device of choice (the supported platforms are PC, Mac, Android and Linux). The test subjects play the game, and are then asked to answer questions relative to the believability of the AI presented in this paper. Links to this form were sent to people of various sex, age and gaming experience, obtaining a sample size of 20 people (16 males and 4 females, almost all in the $[20, 35]$ years old range). There are three initial questions about games and RPGs experience to understand the demographics of the test subjects:

- How much do you play video games?
  [Never, or just a little; Sometimes; A lot]
- How much do you play role-playing games
  [Never, or just a little; Sometimes; A lot]
- How much do you play tactical RPGs?
  [Never, or just a little; Sometimes; A lot]

Both character's factions (allies and enemies) are controlled by the AI, the subject can only observe and eventually play or pause the game at any time. Instead of a single battle situation, a series of scenarios are created to split the experiment in multiple parts, each with its own questions and focusing on a specific set of believability requirements. A scenario is a playable unit that consists of one or more phases, and each phase can contain one or more stages. A stage is simply a battle situation: a set of characters, a map and the initial state of the characters (position, goals, knowledge and so on). Multiple stages inside a phase can be used to let the subject compare different battle situations, while phases are used to separate stages in a chronological order. If the same character is present in multiple phases, its internal state is saved at the end of each phase and restored at the beginning of the next.

In all scenarios enemies are always oni (a type of monster), and always with the same parameters and strength. The other characters are all ninja, and can use three different attacks: normal, flurry and power attack. While the normal attack consumes 25 AP, the other two use 50 (characters can use approximatively up to 100AP per turn) but have different bonuses and maluses. Flurry lets the character attack 4 times, but each attack has less chance of hitting and does less damage. On the contrary, power attack

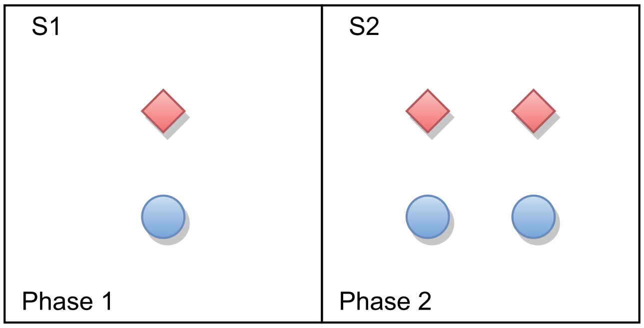

Fig. 4 Scenario 1 (2 phases x 1 stage).

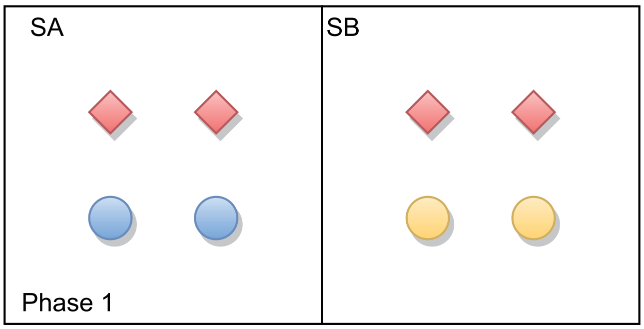

Fig. 5 Scenario 2 (1 phase x 2 stages).

does a single attack but has a bonus in both hit and final damage. Oni have high defense and armor, meaning they are difficult to hit and they take little damage. While normally the highest damage can be achieved with flurry, in this case it is the least effective attack since it almost always misses. Normal attacks hit fairly often but their damage is almost completely absorbed by the enemy defense. Finally, power attack hits less times in a turn but almost never misses and inflicts a good amount of damage (the best attack against an oni).

All questions relative to the scenarios use a five-level Likert item, where 1 means strong disagreement and 5 strong agreement. It is also required that subjects play a scenario at least two or three times (with no upper limit) before answering. The three scenarios used in our experiment are described below.

6.1 Scenario 1

This scenario is designed to evaluate the memory requirement (R1). It has two phases, each with a single stage Fig.4. In the first phase character A fights a single enemy, while in the second phase characters A and B fight against two enemies. The purpose is to show how experience influences the way character A fights the second time, compared to character B who faces that enemy for the first time. During the first phase A learns that power attack is the best attack, and in the second phase starts using that from the beginning. Character B instead takes a few turns to understand it, resulting in a less efficient way of fighting. The questions relative to this scenario are:

Q1 [R1] (About A) Do you think this character has a memory?
Q2 [R1] (About both) Do you think that the character who had already fought an oni fights differently than the one who fights it for the first time?

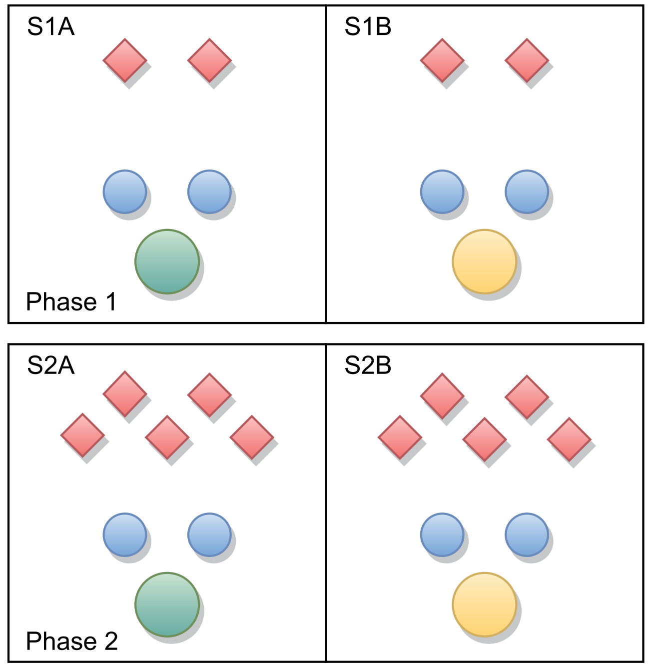

Fig. 6 Scenario 3 (2 phases x 2 stages).

6.2 Scenario 2

This scenario aims to evaluate the communication/cooperation (R3) and goal (R4) requirements. There is one phase with two stages, and in both there are two ninjas against two oni Fig.5. The difference is in the goals of the characters. Characters in the left stage do not care about the other and do not cooperate. On the right, characters share information about which attacks are not effective against an enemy. In addition, they have a goal of protecting their ally if injured, by telling him to stay away from the enemy until the fight is over. The questions relative to this scenario (asked once per stage) are:

Q3$_{a,b}$ [R3] Do you think that the characters are cooperating?
Q4$_{a,b}$ [R4] Do you think that the characters have goals?

6.3 Scenario 3

This scenario has two phases each with two stages, and aims to evaluate the personality (R2), communication (R3), goal (R4), and situatedness (R5) requirements. In each stage there are a captain and other two characters (his troops), fighting against two oni in the first phase and four oni in the second phase Fig.6. In both phases the captain on the left (A) is a good one, while the on on the right (B) is a bad one. Captain A always fights or flees together with his troops, helping them. Captain B only gives orders, keeps at distance from the enemies and flees leaving the other two ninjas to fight the four oni by themselves in the second phase.

Q5 [R3] Do you think that the characters are cooperating?
Q6 [R4] Do you think that the characters have goals?
Q7 [R5] Does each captain (left and right) adapt to the different situations of each phase (2 and 4 enemies)?
Q8 [R2] Do you think that the captain on the left and the one on the right have different personalities?

6.4 Game

A turn-based role-playing game (SRPG) has been developed for testing purposes. The map consists of an isometric grid of square tiles where characters move on (discrete coordinates).

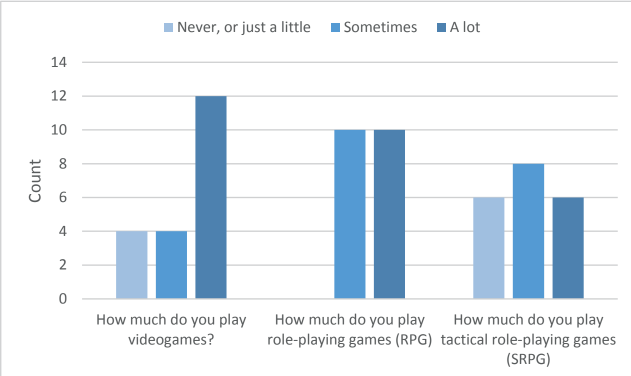

Fig. 7 Gaming experience.

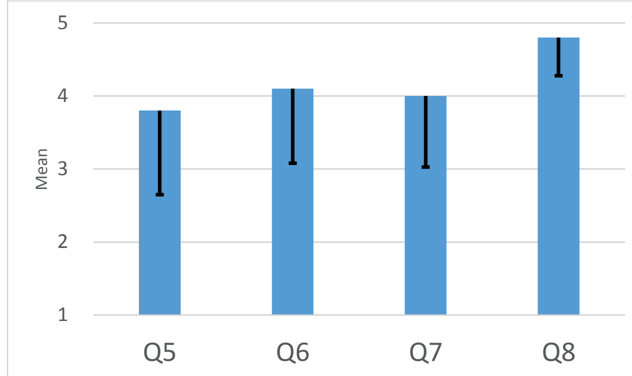

Fig. 9 Scenario 3.

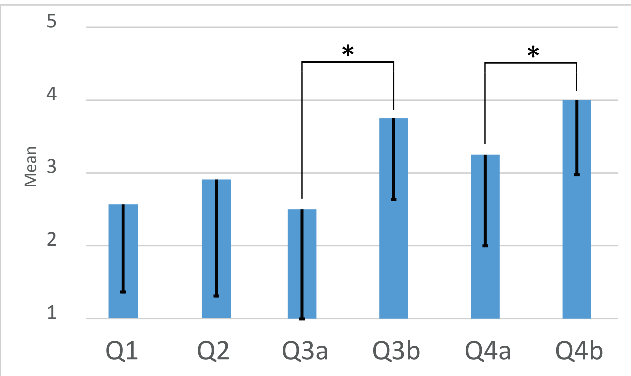

Fig. 8 Scenario 1 and 2.

Time is organized in battle turns where each character acts in a predefined order (from faster to slower), and since they can only act during their turn the AI is executed one instance at a time. In their turn characters can move, attack or use skills until they have enough action points left.

6.5 Results

As we can see from figure 7, most of the participants are accustomed to video games, and all of them have played RPGs. This is a favorable situation because many of the concepts typical of role-playing games and present in the test game will be familiar, allowing them to understand better the various battle situations. However, approximatively one third did not have almost any experience with SRPGs, and this might have had a negative influence in situations where combat gets more technical because attack strategies might be overlooked, resulting in a worse evaluation score.

6.5.1 Scenario 1

Questions about this scenario (Fig.8) have very sparse results, with low mean and high standard deviation. In Q1 answers are fairly equally distributed in the range $[1, 4]$. By looking at the comments about this question it is possible to see how the definition of memory and the expectations about the character's behavior vary from person to person, thus explaining this kind of result. For example, among the ones who commented that the character effectively remembered the oni and used the best attack skill, both low and slightly positive scores are present, meaning that this difference by itself was not enough for them to give a higher score. In Q2 instead, extremely low and high scores are both present, splitting the opinion of the subjects between who agrees and who strongly disagrees. In the comments, while someone acknowledges the differences between the way of fighting in the two characters, others complain of not seeing any difference, especially among the ones who are less familiar with SRPGs. It is probable that the difference in the attack patterns was not enough to be easily recognizable.

6.5.2 Scenario 2

Q3 and Q4 are comparison questions (Fig.8) in which we confirmed statistical significance ($p < 0.05$). With the exception of Q3a the answers converge visibly and have a much smaller deviation. From the results it is clear that characters who talk and protect each other greatly increases the feeling of cooperation and of having goals. Many subjects commented on how characters on the right stage (b) share information and seem to cooperate more than in the other stage. It is interesting to note that opposed to Q3 which changes the most, Q4 has a fairly high score even in the stage where characters don't cooperate (Q4a). This is due to the fact that just by fighting the same enemies by the same side, they are automatically perceived as cooperating. A few subjects though commented how in that stage characters did in fact simply ignore one another and not really cooperate much.

6.5.3 Scenario 3

In this scenario (Fig.9) we can observe overall positive results. Q5 and Q6 (about goal and communication/cooperation requirements) have high mean and moderate deviation. It is a case similar to Q3 and Q4, but this time there are more characters, a special character that gives orders and more possible behaviors. Thanks to this, both Q5 and Q6 are higher than Q3 and Q4 respectively. Unfortunately, while there are many supportive comments from subjects who gave a high score, there are no comments from the few who gave a low score. We can also note how the lack of two stages with different character configurations to compare (as in scenario 2) resulted in less focused and more neutral responses. Q7 and Q8 are about the captains behavior and are directly related to the situatedness and personality requirements. Results are overall positive for Q7, and exceptionally so for Q8, where almost all the participants answered with total agreement. This is probably due to the fact that the behaviors of the captains are easier to perceive, as they give orders and react to battles in very different ways. There are also many comments for Q8 about how the behavior of the captain on the right is bad, while the other one seems braver and has a better attitude towards his troops.

6.6 Considerations

The experiment went generally well, with the exception of the first scenario. As mentioned before, one of the possible causes for the low scores with Q2 is the fact that some subject could not see the differences in the attack patterns due to their lack of experience with SRPGs. Together with the results of Q1, this lead us to believe that the scenario was too simple for evaluating R1. The possible character behaviors were too few (three attack skills), and although the goal was to evaluate memory, the information that the character had to memorize was little (just the efficiency of the various attacks). The changes in character behavior were also strictly related to combat, with no cooperation, communication or special goals. While it is true that these elements may not be directly related to R1, they can certainly be used to create a more interesting scenario where memory makes a more marked difference, easier to spot and evaluate. Finally, one of the core aspects of R1, the ability of saving the characters memory and restoring it at the beginning of the consecutive battle, has been mostly overlooked by the players in this test.

Experimental results confirmed how enabling goals and cooperating behaviors in the AI comports an increase in R3 and R4, particularly when characters are numerous and the situation is more complex. For some it was difficult to see these differences clearly, but most of the subjects commented on how they felt the characters to have goals, and how they seem to fight together. Differences in the personality of characters and their ability to be aware and adapt to different situations too were clearly perceived by the subjects, who gave high scores to questions relative to R2 and R5.

Concluding, we can see how our AI fulfilled requirements R2-R5 in this experiment. R1 too was implemented correctly, but due to the simple scenario it was not outstanding enough to attain a good score. By taking the mean value of Q1 and Q2 for R1 (2.78), of Q5-Q8 for R2-R5, and putting them together it is possible to estimate the believability of the system as a whole, with a score of 3.9/5, or 72.5%. While R1 undoubtedly lowered the score, considering that believability was not easy to express during such a simple combat, we think it is a good outcome.

After conducting the experiment and analyzing the results, a number problems about the scenarios and their relative questions became evident. In future works, along with enhancements and expanded capabilities in the game AI, we plan to improve the way scenarios are laid out for evaluation. For behaviors to be more recognizable and to ease the asking of questions about believability requirements, we intend to further increase both AI contents (goals, plans, beliefs) and the complexity of the test scenarios.

7. Conclusions

In this paper we proposed a new combat AI architecture for believable characters in role-playing games. After introducing a set of believability requirements specifically for the combat phase of RPGs, we chose to adopt the BDI model on top of a multi-agent system to realize our system. After specifying all the components needed and implementing the AI, we created a sample game to conduct a questionnaire survey. Finally, we analyzed the evaluation results and confirmed a partial success in the fulfillment of the believability requirements.

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