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CONFLICT: Agents in Conflict Situations

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To my parents, César and Márcia Campos

Resumo

O objectivo desta dissertação é abordar o problema de como modelar agentes que se envolvem em situações naturais de conflito, inspirado em cenários do mundo real. Para tal, propomos que processos emocionais são um ponto importante para transmitir certos aspetos de situações de conflito, tais como, emergência e escalamento. Além disso, tencionamos popular um jogo educacional, para a resolução de conflito, com esses agentes. De forma a atingir este objectivo, investigámos teoria de conflito em Sociologia. Depois, revimos jogos sérios, nos quais analisámos os seus objectivos e como foram atingidos. Com isto, propomos um modelo de conflito aonde os agentes observam a situação, realizam assunções e, por fim, actuam sobre a situação. Este modelo foi implementado numa arquitectura de agentes orientada a emoções. A seguir, foi integrado num jogo de resolução de conflito, o jogo *Dream Theatre*. A integração foi suportada por uma *framework* de simulação de mundo. Com isto, realizámos uma experiência para avaliar a eficácia do nosso modelo. A experiência consistiu em testes preliminares e uma avaliação final entre grupos. Em ambas, os participantes tinham de visualisar um video gravado de um utilizador a interagir com o jogo *Dream Theatre*. Os resultados da avaliação final foram coerentes com a nossa hipótese, que afirma que agentes com um processo de decisão baseado numa arquitectura orientada a emoções proporcionam uma exibição credível de manifestações evidente de conflitos.

Abstract

The objective of this dissertation is to address the problem of how to model agents that engage in natural conflict situations, inspired by what happens in real world scenarios. For such, we propose that emotional processes are a key aspect to convey conflict situations' aspects, such as, emergence and escalation. Further, we intended to populate an educational conflict resolution game with these agents. To achieve this, we investigated conflict theory in Social Psychology. Then we reviewed serious games, where we analysed their purposes and how they were achieved. With that, we proposed a conflict model, where the agent observes a situation, then makes assumptions about it and finally behaves towards it. This model was implemented in a emotionally-driven agents' architecture. Then, it was integrated in a conflict resolution game demonstrator, the *Dream Theatre* game. The integration was supported by a world simulation framework. With this, we conducted an experiment to assess our model's effectiveness. The experiment consisted in preliminary tests and a final between groups evaluation. In both, participants had to watch a recorded video of a user interacting with the *Dream Theatre* demonstrator. The final evaluation results were consistent with our hypothesis, which states that agents with a decision-making process which stems from a emotion-oriented architecture will provide a believable display of overt manifestation of conflicts.

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Palavras Chave
Keywords

Palavras Chave

Conflito
Resolução de Conflito
Escalamento de conflitos
Emoções
Credibilidade
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Keywords

Conflict
Conflict Resolution
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Chapter 1

Introduction

Over the past few years, there has been a great increase of investigation in the AI field of Multi-Agents systems (MAS). Particularly, in the field of synthetic characters, researchers are aiming towards reaching perfect behaviours' simulation, either individually or in societies. The character's capability to look "real" is denominated as believability.

On this research, we investigate on how to imbue synthetic characters with human-like behaviours towards conflict situations. Therefore, increasing their believability.

In our existence, it is most common to encounter others that share different motivations and different interests. This characteristic of our existence leads to disagreements between individuals and therefore, conflict.

Conflict is present in the everyday basis of an individual, because it is a natural part of human life [26]. It is known that conflict is present in many different scenarios of social organisations, such as schools, workplaces and even at home.

In our society, conflict is mostly viewed as negative act, an inconvenient or dysfunctional situation that needs to be eradicated [32]. However, Pallarés (1982, cited in [32]) stated "conflict itself is not bad, although people reply it in ways that result in a harmful outcome".

Conflict resolution is a range of methods for confronting and coping with conflict, however, proper resolution is not trying to dissolve conflict, but taking it as a natural and inevitable situation. It needs to be properly conducted, in a just and peaceful way, in order to create a good learning experience [32]. In which, several authors ([31] and [43]) point that these experiences affect children's maturation, thus facilitating or retarding the course of development.

With this, researchers would agree that conflict resolution education has become a very important part on individual's personal development, particularly in students ([19], [20], [26] and [32]). Conflict resolution education programs proved to have a positive impact on students' behaviour, such as: decreasing violent behaviours; creating safe and constructive learning environments; and increasing psychological aspects.

On the other hand, over the years, there has been several research on developing new teaching tools that motivate and engage today's children. Information technologies and computer and video games have show to be a great tool for teaching, educating and raising awareness about subjects on students [1][45][46]. This is due to the fact that video and computer games are natural parts of today's popular culture; and that players become deeply engaged and motivated with what they're doing when they're playing.

Educationally driven games have been uprising in the game industry and in the education field, described as serious games [46]. Serious games are games in which the primary purpose is providing training, advertising, simulation or education; and not only pure entertainment.

Several serious games followed the approach of integrating autonomous synthetic characters to affect the user's engagement and empathy towards the game's characters ([4] and [40]). This aspect allows games to create unscripted scenarios, in which the characters autonomously adapt to these scenarios and provide the user with an engaging and believable experience.

Motivated by the conflict resolution education and the uprising of serious games for teaching children, the SIREN project [58] is an interdisciplinary European project, with the intent of developing an adaptive serious game for teaching conflict resolution. This project aims at creating a new game type: a "conflict-resolution game" (CRG). Its purpose is to teach players about conflict resolution methods, so that knowledge can be conveyed to other domains. The proposed CRG will be a multiplayer and collaborative serious game, which focuses on methods for conflict resolution on adaptive scenarios, using adaptive approaches to generate conflict scenarios [11].

The research presented in this document is integrated with the SIREN project.

1.1   Problem

In this research, we are concerned about the non-playable characters (agents) that will populate the serious game. In order to do that, a rather general problem that we try to handle is stated as follows:

> How can we create autonomous agents, for a serious game, that are able to identify
> social conflict situations with other agents and handle them in a believable way?

Our research focuses on agents' behaviours towards conflict between themselves and how this aspect affects agents' believability. Our approach to solve this problem will be by investigating what are the most important characteristics of human interactions within a conflict situation. We will aim particularly at what causes conflict, its protagonists, its effects in individuals and how it can be resolved. Within the latter referenced aspect of conflict, we are particularly concerned about which strategies individuals use to handle conflict and what factors makes them use such handling mechanisms and what makes conflicts escalate.

Based on the several aspects of conflict identified in the previously described investigation, we will develop a model for conflict that will be integrated in the architecture of an agents' society, providing the agents with the ability to recognise conflicts and handle them autonomously. We will also integrate our agents in a simple serious game scenario that will be populated with the agents' society. Thus, with this research we will try to prove the following hypothesis:

> If the agents' decision-making process stems from an emotion-oriented architecture,
> their behaviours will be based on emotional grounds and intensity, which will play
> an important role in overt manifestations of conflict and users may recognise such
> behaviours as believable.

Additionally, note that this problem does not focus on agents' ability to resolve conflicts. This investigation does not aim in modelling agents' strategies to act with and towards other

agents in order to achieve a certain goal. What we intend to model is the emotional influence in conflict emergence and escalation, by affecting agents' behaviours.

Further, as conflict is quite a broad subject, throughout this document we will specify which aspects of conflict will be considered for our research.

1.2 Document Outline

For better understanding the subject of this research, **Chapter 2** investigates conflict definitions and ways of parametrizing it, according to several authors. We explore handling approaches towards conflict and the underlying factors that may lead individuals to such approaches. Further, we present the impact of emotions in conflict situations, which tend to magnify conflict situations, denominated as conflict escalation. With that, we explore the outcomes resulted from badly handled and well-handled conflicts, as their affect on individuals and their relationships. Finally, by following studies, it will also be analysed the types of conflict and the impact of conflict resolution programs in school environment.

After this first investigation, in **Chapter 3**, we review and analyse the related work to this research, which is divided into three major areas: games for education and awareness; games with social interaction; and games that involve conflict. With these reviews we will compare and analyse these systems, where we will point out the relevant aspects for our research.

Based in the conflict theory, **Chapter 4** proposes a model for conflict behaviours. In order to better understand our model, we begin by presenting our definition of conflict. With that, we describe our model in terms of how agents appraise a conflict situation, how they take assumptions on the situation, how they feel about it and how they behave towards it. Additionally, we describe our modelling of two personalities and their behavioural traits towards conflict situations.

With the proposed model, in **Chapter 5** we describe how this model was integrated in a conflict resolution game. First, we describe how the agents with our model were implemented in an emotional agents' architecture. Next, we describe the conflict resolution game and the prototype's implementation. After that, we present the overall system, which integrates our agents in the conflict resolution game. Finally, we present a scenario example of the conflict resolution game populated with our agents.

In order to evaluate our model, in **Chapter 6**, we present the conducted experiment and the analysis of its results.

To conclude, **Chapter 7** summarises the work developed for this research, some conclusions and future work for the investigation.

Chapter 2

Theory of Conflict

Conflict is studied by several research areas, such as Applied Mathematics, Economy, International Relations, Industrial Relations and Social Psychology [26]. In this research we follow the conflict perspective from the studies of Social Psychology. Therefore, in this section, we discuss the theories of conflict that influenced our approach on this research.

In this Chapter, we begin by defining conflict under the perspective of several authors. After that, we explore how individuals approach conflicts and what drives individuals to follow such approaches. Further, we also explore how individuals communicate in conflict situations. Next, we regard the role of emotions in the conflict process. Following this, we assess the escalation of conflict situations and what leads individuals to such processes. With that, we look at the outcomes from conflict situations. Moreover, we explain how negative outcomes motivated researchers to apply conflict resolution education in schools. Finally, we present some concluding remarks on the subject.

2.1 Definitions of Conflict

We assume that conflict can be generally defined, by Jares' (2002, cited in [26]) approach, as "kind of situation which people, or groups, search or idealise opposite goals, conflicting values or divergent interests". However, there seems to be no general accepted definition of conflict in the literature.

On a more managerial perspective of conflict, Thomas [49] defines it as "the process which begins when one party perceives that another has frustrated, or is about to frustrate, some concern of his".

Following this definition based on party's perception of frustration, Kriesberge [22] defines the term "social conflict" as a sequence of interactions between parties. Social conflict arises when "two or more persons or groups manifest the belief that they have incompatible objectives" [22]. This manifestation can be characterised by attacking the other party or proclaiming a change in the other party. Also, the belief of incompatible goals refer to one or more parties thinking that the others obstruct their goals in someway.

Similarly, Castelfranchi [10] defines "full social conflict", which exists when "there is the subjective awareness of the competitive situation". This means that even though parties follow incompatible goals, they may be not aware of this incompatibility between them. On the other

hand, there may also exist the parties' wrong belief of incompatibility, because of wrong beliefs towards others' goals and plans [10].

Shantz (1987, cited in [11]) states that several authors define conflict in terms of an initial aggressive move by a first party, in which a second party responds with a counter-move. Also, Xie et. al. study [57] in teenagers' aggressive behaviours on conflict situations, presented that aggressive behaviours are mostly reported as initiating acts.

Regarding the components that define conflict, Laursen & Collins (1994, cited in [24]) associate conflict with a play or a novel, which is constituted by a protagonist and an antagonist, a theme, a complication, rising action, climax (or crisis) and the conclusion, being respectively associated as conflict's participants, topic, initial position, behaviours, resolution and outcome.

In her research, Luís [26] followed Jares' (2002) approach to define conflict, in which it consists on four elements: its cause or source; its protagonists; the context in which the conflict occurs; and its process or the way protagonists handle it.

Also, in his work, Thomas (1976 cited in [33]) states that a "dyadic conflict will be considered to be a process which includes the perception, emotions, behaviours, and outcomes of the two parties".

Following Moore (1998, cited in [26]), conflicts can emerge by the following causes:

- **Relation** – when there are strong negative emotions, bad perceptions or stereotypes, flawed communication or constant negative conducts.

- **Interests** – based on issues of resources, such as time, money, physical resources, and others; on the way a conflict should be resolved; and psychological aspects, such as perceptions of respect, honesty, trust, and others.

- **Values** – when someone imposes his or hers own values to others and there is a difference on beliefs, life styles, ideologies or religions.

- **Information** – based on a lack of information, bad information or misinterpretation.

- **Structural** – due to external forces that affect the conflict's disputants. Can be time pressures, low resources, possession, unequal distribution of resources, and so on.

This research will aim specifically at conflicts of interests. The definition of conflict of interests from Deutsch (1973, cited in [19]) distinguishes it from competition, aggression, influence and dominance. Often, in disputes with extreme behaviours, conflict may be confused with these concepts. Although competition and aggression generate conflict, not all occurrences of conflict create competition or aggression. Influence and dominance deal with affecting others in desired ways and one-way influences, respectively.

The conflict's protagonists can be individuals, groups, parties or entities. Based on the way they are involved in the conflict, protagonists can be either **direct**, when they are directly to the causes of the conflict; and **indirect**, when they are not directly related to the causes, but they can intervene on the conflict and influence the conflict's result (Jares, 2002, cited in [26]). Conflict can be classified according to its protagonists as follows (Seijo, 2003; Fachada, 2006; cited in [26]):

- **Intra-personal conflicts** – affect only the individual and result from internal dilemmas of the protagonist.

- **Inter-personal conflicts** – affect two or more individuals and result from differences between them, resources' limitations or differences in the individuals' roles.

- **Intra-group conflicts** – affect only the group and result from disagreements inside it.

- **Inter-group conflicts** – affect two or more groups and results from differences between them.

- **Organizational conflicts** – affect structured organizations such as schools, companies and others.

In this research, we focus only on conflict of interests between two or more individuals (inter-personal).

Further, conflicts are also influenced by their context, which can be a physical, social or cultural context [26]. Johnson & Johnson [19] also state that the context of conflict can be either cooperative or competitive. In a cooperative context, protagonists search for common long-term solutions for the conflict, that satisfies all involved, other than the short-term self-oriented solutions implied on protagonists by the competitive context. Therefore, in a cooperative context, there is open and honest communication, which is also more frequent, complete and accurate. On the contrary, in a competitive context there is misleading communication, in order to achieve one's interests, and sometimes communication is avoided.

The process of conflict is defined by the way protagonists drive the conflict situation, their behaviours towards it and how they resolve it. The ways protagonists can handle conflict are described on the next section.

2.2 Conflict Handling

The way protagonists handle conflict influences how the conflict unfolds and its results. In the literature, three major concepts can be distinguished: conflict prevention, conflict resolution and conflict management. In their work, Swanström & Weissman [47] present an extensive overview of several authors' definitions of these concepts, in which no single definition can be attributed to each concept. However, for our research, we follow Swanström and Weissman's general definitions as follows [47]:

- Conflict prevention – procedures used in a early or pre-stage of the conflict, in order to prevent or solve disputes before they evolve into active conflicts.

- Conflict resolution – a set of approaches used to attempt resolution of the underlying incompatibilities of a conflict, including attempts to get the parties to mutually accept each others' existence. Also, negotiation is an important concept related to conflict resolution. Negotiation is a common way of resolving conflicts, which is portrayed by a discussion between two or more parties [53].

- Conflict management – measures that focus on limitation, mitigation, and/or containment of a conflict, without necessarily solving it.

For the purposes of our current investigation, we will only focus on conflict resolution. Generally, in the social psychology literature, conflict resolution strategies are described by a typology of five behavioural categories, delimited by combination of high or low concern for self or others [7].

2.2.1 Conflict Resolution

Several typologies can be found in the literature [12][36][49]. However, in this research, we follow the *Thomas-Kilmann Conflict Mode Instrument* (TKI) [42].

Inspired by *The Managerial Grid* (Blake & Mouton, 1964, cited in [49]), Thomas & Kilmann developed the TKI, a taxonomy that generalizes the approaches for handling conflict, beyond the managerial style and the underlying values by the former model. The TKI model presents five conflict handling approaches: accommodation, avoiding, competition, collaboration and compromise. These approaches are classified by the underlying dimensions of assertiveness and cooperativeness, presented in Figure 2.1. The dimensions of assertiveness and cooperativeness are phrased as intentional terms, in which assertiveness refers to the extent to which protagonists try to achieve their own goal and cooperativeness refers to the extent of protagonists trying to satisfy the concerns of others.
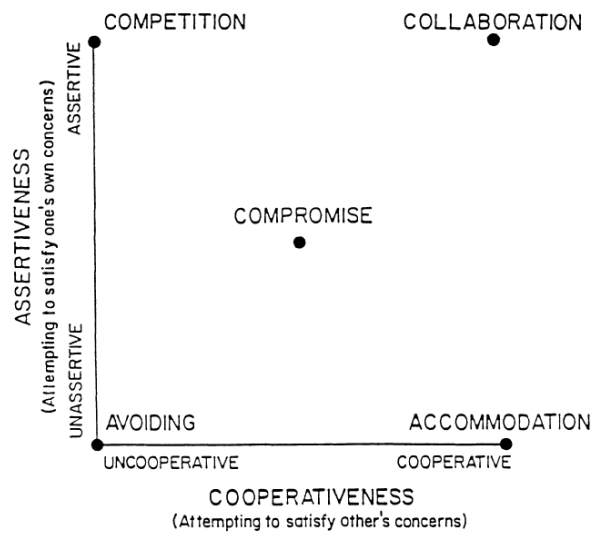
Figure 2.1: Two-dimensional taxonomy of TKI's conflict handling modes classified by cooperativeness and assertiveness dimensions [42][49].

The conflict handling approaches are the strategic intentions of the conflict's protagonists, what they are trying to accomplish in satisfying own and other's goals. These approaches are described as follows [26][42][49]:

- **Accommodation** – high cooperativeness and low assertiveness – In this approach, a protagonist sacrifices his or her own needs, in order to accommodate the other party's goals.

The protagonist concerns on satisfying only the others' needs, thus being the contrary of competition.

- **Avoiding** – low cooperativeness and low assertiveness – As the name states, avoidance occurs when the protagonist tries to avoid or post-pone the conflict by ignoring it. The personal needs and the others' needs are not important.

- **Collaboration** – high cooperativeness and high assertiveness – It is described by trying to achieve an agreeable solution for the problem between the conflicting parts, in order to satisfy the protagonist's goals and the others' goals. This approach tries to reach an win/win situation.

- **Compromise** – medium cooperativeness and medium assertiveness – Its purpose is that both parties give up some part of their goals in order to establish an agreement. There are no winners or losers in this approach.

- **Competition** – low cooperativeness and high assertiveness – In this approach, protagonists try to maximize their own goals at expense of others, thus creating a win-loose situation.

On this model, Thomas [49] adds that the goals of conflict handling and the functionality of the conflict handling mode also depend on two dimensions:

- **Target Beneficiary** – The target which the protagonists choose to benefit. Protagonists choose if they try to optimize the welfare of one party (partisan choice), both protagonists (joint-welfare choice) or the larger system of which the protagonists belong (systemic choice).

- **Time Frame** – Describes if the protagonists' goals on the conflict situation are short-term or long-term. With short-term goals, protagonists focus only on coping with the present situation and try to achieve the best result, according to the present situation. On long-term goals, protagonists focus on building desirable futures and try to achieve the best possible result, planning to achieve this on the future.

According to Jares (2002, cited in [26]), the five approaches for handling conflict correspond to two categories: the protagonists that address conflicts and the ones that choose to avoid it. Thus, collaboration, compromise, competition approaches belong to the first category, while accommodation and avoiding belong to the latter category, although he states that when accommodation is not chronic, it may be described as an approach for addressing conflict.

Further, these approaches can be labelled by two types of approach, regarding the parties' purposes:

- **Integrative approach** - A party that commits to an integrative approach tries to maximize the gains of all involved parties, including itself.

- **Distributive approach** - In this approach, the main focus of a party is its own goal, therefore its actions are aimed only at maximizing it.

Even though we covered conflict resolution strategies, it is also important to regard the communication between parties while handling conflict situations.

2.2.2 Communication Behaviours

According to Raider et. al. [37], in an ideal negotiation, participants communicate each others' perspectives and achieve an understanding. However, in real life situation this does not happens. As often people are pushed to their limits, their communication behaviours deteriorate.

To assess this problem, Raider et. al [37] developed a communication framework to use in workshops, the AEIOU model for communication behaviour. This model identifies five communication behaviours, verbal and non-verbal [37]:

- **Attacking** – specifies behaviours perceived by the others' as hostile or unfriendly, such as: threatening, insulting, blaming, criticising without being helpful, and others. Also includes hostile tone of voice, facial expression or gestures.

- **Evading** – is identified by avoiding aspects of the problem. It can be characterised by two types of evasion: hostile and friendly. Hostile evasion considers: ignoring, not responding, leaving the scene. On the other hand, friendly evasion regards: postponing difficult problems for later, and taking time to think or gather information about the problem.

- **Informing** – considers behaviours that explain one's perspectives to others in a non-attacking way, which can inform one's: needs, feelings, values, positions or justifications.

- **Opening** – is similar to informing behaviours, however it considers the others' perspectives, as it comprises behaviours such as questioning others and understanding their perspective in a neutral way.

- **Uniting** – summarises behaviours that regard the relationship between participants. These behaviours are characterised by maintaining the right tone for cooperation.

2.3 Conflict and Emotions

As we mentioned before, conflict can be defined as a situation where parties search or idealise opposite goals, conflicting values or divergent interests [26] and that it begins when a party perceives that another is frustrates or is about to frustrate their concerns [49].

These perceptions of incompatibilities or frustrating moves from other parties tend to elicit emotions and leads to conflict [7][28]. Further, the intensity of the elicited emotions implies the importance of the party's concern [28]. Such emotions are critical aspects that influence an individual's subjective experience of the conflict, as they influence the parties' perceptions of conflict and their conflict handling approaches [7].

Following this, regarding children, Miller and Olson [31] state that "a child's emotional intensity during a conflict may partially determine whether the interaction functions to promote problem-solving strategies and social skills, or whether it creates emotional havoc among the peers involved in a dispute". Further, the authors point that high emotional intensity may lead a child to be unable to settle down and use proper social interaction.

Under the scope of the SIREN project, Ingram's et. al. [18] study assessed the emotions elicited in conflict situations between children. From the spectrum of emotions: angry, sad,

sorry, scared, surprised, happy, and normal[1]; the study reported that child students often feel angry and sad. Other emotions such as happiness, normal were noticed sometimes. In contrast, occurrences of sorry or scared were scarce.

Similarly, Miller and Olson's [31] study on children's emotional expressiveness obtained similar results. Further, this study reported that children who initiated conflicts were more prone to display gleeful taunting (intense inappropriate positive affect). While children that did not initiate the conflict presented more displays of anger and mild negative affect.

On their work, Aureli and Smucny [2] verified that the experienced emotional states by parties depend on their position or perspective in the conflict situation. Usually, parties who perceive fair conflict resolution tend to elicit more positive emotions, such as happiness. In contrast, the others which perceive the contrary tend to show more negative emotions [2].

In addition, on their study on conflict between children at schools, Ingram et. al. [17] identified conflict's participants as perpetrators and victims. This study reported that positive emotions (such as, happiness) were often reported in perpetrators, while victims often feel negative emotions.

In the literature of conflict, several authors [6][7][28][44][53] agree on the effects of positive and negative affect in individuals, during conflict situations. Positive affect in individuals is usually portrayed as a catalyst to integrative approaches towards conflict, as it promotes individuals' creativity, problem solving and preference for cooperation. On the contrary, negative affect has proven to narrow individual's repertoire of actions [25], predisposing the individual to more competitive and distributive strategies.

Focusing on a more precise aspect of conflict, Barry et al. [6] reviewed studies of emotions in negotiation. On their work, the authors distinguish emotions from mood, in which they point that emotions are directed to a specific situational stimuli (such as, events, people or things), whereas mood does not. Additionally, emotions are of short-duration, where mood is more enduring and pervasive.

Further, Barry's et al. [6] overview indicates that negotiators' moods predict the outcome of the negotiations. Negotiators with good mood are more inclined to achieve higher joint gains, whereas bad moods have shown to result in lower joint gains. Also, negotiators who face an "opponent" with good mood have proven to be more cooperative and achieve better outcomes, which contrast with an "opponent" with bad mood.

On his overview in interpersonal effects of emotions in conflict and negotiation, Kleef [53] points out that individual's emotions conveys information to others parties. This information can portray the individual's feelings, social intentions and orientation towards the relationship with involved parties. Worcel's et al. study [56] in adolescents' social interaction reported that emotional expressiveness were often reasons for initiating conflicts.

Given that emotions impact conflict resolution, by predisposing an individual towards certain behaviours [7], authors [25][28][39] point out the importance of controlling such emotions. However, controlling does not mean to completely ignore or mitigate emotions, as these strategies might be destructive to the individual [25][39]. Further, Maiese [28] states that when emotions are not properly controlled, they may lead conflicts to escalate.

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[1]The author refers to "normal" emotions when child students used the following words to express their feelings: "don't care", "fine", "not much", or "ok" [18].

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2.4 Conflict Escalation

Conflicts are not static situations, they are dynamic in terms of the intensity of the situation [47]. When the conflict gets worse, we say that it escalates. Thus, according to Kriesberg [22] "escalation is expressed in increasing the intensity of the means of conflict". When it reaches the turning point (*climax*) and the magnitude of the situation decreases, we say that de-escalates.

Swanström and Weissman [47] propose a conflict life-cycle (Figure 2.2), which consists of three stages (early, mid, and late), two phases (escalation and de-escalation) and five conflict intensity levels (stable peace, unstable peace, open conflict, crisis, and war).
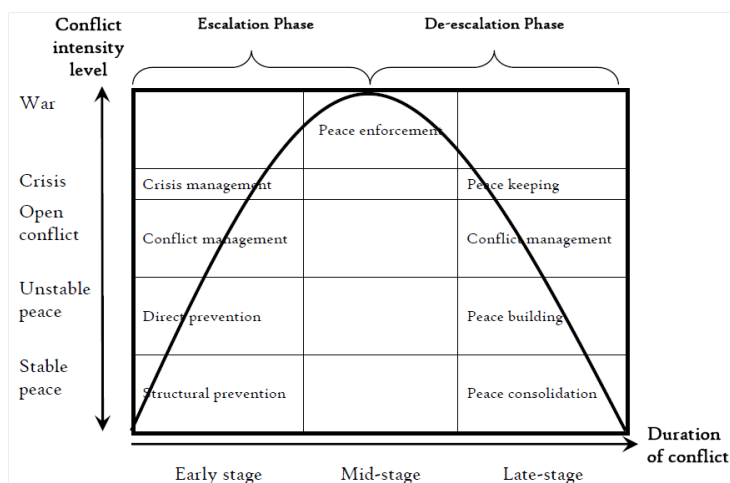
Figure 2.2: Model of the conflict life cycle (taken from [47]).

Furthermore, Maiese [27] points out other models for escalation, such as, the aggressor-defender model. In the aggressor-defender model, the "aggressor" party is the one who begins to approach the situation with mild tactics and then move to harsher tactics, if the mild did not work. This model's limitation is that escalation moves in a single direction, where the "defender" is always reacting to the "aggressor" moves. Therefore, circular processes represent escalation better [27], such as the conflict life-cycle.

According to Pruitt [35], people may evolve their behaviours from a less extreme tactic to a more extreme tactic due to the fact that if a less extreme tactic failed, a more extreme may work. Another reason can be due to people becoming angrier at the situation, which lead them to become more aggressive.

Following this, Pruitt [35] depicts the "biased punctuation" phenomenon, where participants of a conflict situation perceive others' actions as the cause of the discussion. For example, consider the sequence of behaviours [35]: $A \rightarrow B \rightarrow A \rightarrow B \rightarrow A$, where A specifies party A's behaviour and B specifies party B's behaviour and $\rightarrow$ denominates perceived causation. Assuming that both parties "suffer" of biased punctuation, both will punctuate the sequence of behaviours differently. Party A's perception of the sequence is: $A, B \rightarrow A, B \rightarrow A$. In contrast, party B's perception is: $A \rightarrow B, A \rightarrow B, A \rightarrow B, A$.

Thompson et. al [50] points out that this phenomenon occurs usually to people's tendency to oversimplify conflict situations. This is characterised by people forming judgments and attitudes

without much deliberation. Hence, faulty perceptions about cause-and-effect occur.

Furthermore, Thompson's et. al. [50] work assesses judgment biases in individuals, such as the previously mentioned. From the several biases and its effects presented in their work, we point out the biased effect of conflict exaggeration, where people tend to see others' ideals as more extreme than they are. For example, exaggerated perceptions of differences between participants in a conflict usually incline participants to be more pessimist about finding a common ground [50].

However, it is not clear in the literature what makes an individual more prone to escalation and what drives one to more aggressive tactics [35]. Nevertheless, we may say that escalation is driven by inner triggers [22], that is, emotions that weight one's current goals and assess the affective value of the situation [25].

2.5   Conflict Outcomes

As the conflict processes unfolds, different outcomes may be generated to the involved parties. According to the outcome, it is possible to identify three patterns of conflict [24]:

- **Coercive or destructive conflicts** – Coercive or destructive conflicts create antagonistic relationships and include negative impacts, tactics for coercion, power assertive resolutions and unbalanced outcomes.

- **Constructive conflicts** – Constructive conflicts are achieved when: the outcome is balanced, so it satisfies all protagonists; the relationships are improved; tactics for cooperation are used; and the protagonists ability to constructively solve future conflicts is improved.

- **Unresolved conflicts** – Unresolved conflicts gives no clear resolution or outcome and may vary in impact and tactics.

On their work, Laursen & Hafen [23] hypothesise non-linear patterns of association between the number of conflicts and the type of the outcomes from it. The authors relate this association with the quality of the relationship between conflict's protagonists, which can be good (or supportive) or poor (or unsupportive) quality.

In good-quality relationships, they assume that avoiding conflicts brings a significant amount of detrimental outcomes. Therefore, the presence of conflicts is beneficial. However, there is a maximum degree of conflicts in which the rate of detrimental outcomes rise and the beneficial outcomes decrease.

For poor-quality relationships, avoiding conflicts shows the least presence of detrimental outcomes and the highest presence of beneficial outcomes. With the increase of the number of conflicts, the rate of detrimental outcomes rises and the rate of beneficial outcomes lowers almost to none.

The authors also related the type of a conflict outcome with the ratio of destructive conflicts in the total number of conflicts.

Generally, outcomes in poor-quality relationships are always worse than outcomes in good-quality relationships. Both relationship types show an increase of detrimental outcomes and a decrease of beneficial outcomes when the proportion of destructive conflicts rise. After a certain

ratio of destructive conflicts in the total of conflicts, detrimental outcomes increase rapidly almost at a exponential rate and beneficial outcomes decrease rapidly. In poor-quality relationships, the proportion of destructive conflicts in which beneficial outcomes are almost none is lower than on good-quality relationships.

With detrimental outcomes, conflicts can bring up negative traits on individuals. In particular, coercive conflicts can be stressful. According to Laursen & Hafen [23], conflict may bring cyclic negative thinking, which together with anger and anxiety, raises the risk of depression and affective disorders, and overtime, can bring coercive interpersonal processes that interfere with normal socialisation. Violence and hostility can be generated by disagreements that get out of hand. Conflict may also isolate and alienate by interfering on supportive functions of relationships.

Benefits can also be extracted from conflict situations. Since conflict can provide opportunities for developing self-expression and enhancing interpersonal collaboration skills, it can enhance mental health and social adjustment to a certain level [23].

The negative impact of poorly managed conflicts on school environment motivated several researchers to work on programs and educational tools to teach conflict handling to students. We address this issue on the next section (Section 2.6).

2.6   Conflict Education in School Environment

As any social organization, schools are no exception to the emergence of conflicts. Motivated by the rise of violence in schools [19], researchers from many fields (conflict resolution, advocates of non-violence, anti-nuclear-war activists and members of the legal profession) developed programs to teach students on how to handle conflicts.

Conflict resolution education (CRE) models and teaches a wide range of processes, practices and skills that help to avert, manage constructively and resolve peacefully individual, interpersonal and institutional conflict [32][20]. CRE programs are not always the same or do not use always the same models for intervention, however they share the same basic principles. In these programs, conflict is assumed to be a natural and inevitable dimension of human existence and if properly handled, it might create an important experience for personal development. Hence, learning skills for conflict resolution must be an opportunity for individuals to build more positive and peaceful solutions for conflicts.

As an example of conflict teaching mechanisms, some part of Kreidler's [21] work focus on helping children to identify when conflicts begin and how/why they escalate. This is due to the fact that many children only notice that they are in a conflict situation once it escalates.

Following the reviews of Johnson & Johnson [19] on CRE programs in schools on the 1990's, it was possible to verify a behavioural difference between students that were affected by conflict resolution training and the students that were not. The results of these studies provided enough evidence to conclude that conflict resolution and peer mediation programs decreased discipline problems, violence, referrals, detentions and suspensions. After conflict resolution programs, teachers, principals and parents reported that students were more able to handle conflicts constructively and independently, thus reducing time spent by teachers and principals on resolving students' conflicts.

A more earlier review, by Jones [20], concluded that CRE programs are also capable of increasing students' academic achievement, positive attitudes towards school, assertiveness, co-operation, communication skills, healthy interpersonal and intergroup relations, constructive conflict resolution at home and school and self-control; and decreasing students' aggressiveness, discipline referrals, drop-outs rates and suspension rates.

2.7 Concluding Remarks

In this Chapter, we reviewed literature of conflict in terms of Social Psychology. We started by reviewing definitions of conflict from several authors, from which we point out Thomas' [49] definition, where conflict is defined as "the process which begins when one party perceives that another has frustrated, or is about to frustrate, some concern of his" and Castelfranchi's [10] definition of "full social conflict", which exists when "there is the subjective awareness of the competitive situation". We will regard these definitions further on Chapter 4. Moreover, we stated that our research focus on interpersonal conflicts of interest.

After that, we presented Thomas and Kilmann taxonomy [49] that generalizes the approaches for handling conflict, which are accommodation, avoidance, competition, collaboration and compromise. These approaches are underlined by dimensions of assertiveness and cooperativeness. This taxonomy will be revisited in Chapter 4.

Additionally we presented AEIOU communication model, which generalizes communication behaviours towards conflict as: attacking, evading, informing, opening and uniting. These communication behaviours will inspire our model as presented in Chapter 4.

Further, in our review on emotions in conflict, we pointed that individuals' perceptions of incompatibility elicit emotions [7], in which these emotions incline individuals to follow certain behaviours. Where negative affect incline individuals to more competitive and distributive strategies, and positive affect drives individuals to problem solving and preference for cooperation. Such behavioural inclinations may even drive conflict situations to escalate. These aspects will be considered in Chapter 4.

Given the way that participants drive the conflict, different outcomes may result. Due to destructive outcomes in conflict amongst children and teenagers, conflict resolution educational has been applied in school in order to better educate children on conflict awareness and proper handling.

Chapter 3

Related Work

In this Chapter we review some related work to this research. In the following Sections, we present games used for educative purposes, after that we review a game that involves social interaction and, finally, we review games that involve conflict situations.

3.1 Games for education and awareness

As we stated previously in the Introduction, in this research we will populate an educational conflict resolution game with agents. Hence, in this Section we review two serious games with different focus: one for raising awareness on general population and the other for teaching students about a subject, in which the first does not use autonomous agents and the latter does. As a result, we will be able to identify the key aspects where an agents' system influences positively an educational game.

3.1.1 FloodSim

Floodsim [38] is a serious game that aims at increasing awareness of issues about flooding policy and citizen engagement in the UK. The objective of the game is to impersonate a flood policy strategist, who was hired to take measures to prevent and diminish flooding effects in a period of three years.

In each year, the player must choose different strategies to handle flooding issues, dealing with different aspects of flooding policies and problems. On the first year, the player has to choose between different barrier strategies, which regions to apply these on, and how many funds to allocate on maintenance. At the second year, the player decides on building plans and communications plans (education, warning systems and grants). In the third and final year, it is needed to choose plans on drainage systems and emergency systems. Within a pre-defined budget, the player must select strategies against flooding for each region of the UK (Figure 3.1). In each strategy it is presented its advantages and drawbacks. Players can access each region's available statistics (such as population density, economic output and flood risk) to plan their strategies.

The selected strategies are tested under random weather conditions and the results of the strategies' effects are presented at the end of each year. The results simulate how the cities'

population and its economy were affected by the weather conditions, and consequently by the chosen strategies to minimize its effect (Figure 3.1).

Figure 3.1: FloodSim's screenshots. On the left image we have the interface for strategies selection, with the strategies on the left side and the UK regions' map on the right side; and on the right image we have the feedback on the chosen policies' results.

Floodsim was meant to be simple, short, easy to play, not very realistic and detailed so it could be aimed at the general public.

Floodsim was played all over the world, but only the UK residents were selected for analysis and interviews. With the data gathered it was possible to verify that the majority of the feedback was positive, stating that the game was good and informative. In addition, it was possible to check that players considered *Floodsim* to be accurate in terms of portraying the risks of flooding and the strategies available for prevention. In contrast, few, but considerably enough players stated that the game was too simplistic. Yet, was considered an accurate source of information by others.

To get better feedback from players, interviews were scheduled with some players. This method allowed researchers to get a better insight on players' experience and also allowed them to understand if the game raised the players' awareness on flooding issues and what can be done.

From the interviews two main opinions were concerned. The interviewees with a general knowledge evidenced that their awareness on flooding problems had increased to a basic level. On the other hand, interviewees who had a detailed knowledge about floods showed that the game was a basic representation of a very complex issue, though that was one required aspect of *Floodsim*.

The results of this research suggest that to design a serious game it is needed a careful consideration on what level of awareness about a subject it is suppose to instil in players, if it is a basic, intermediate or advanced level, and if the game will have a societal impact.

In conclusion, *Floodsim* did not increase the players' understanding substantially and measuring flooding problems' awareness is a particularly difficult task. According to the researchers, an approach to get better results would be incorporating pedagogical components, such as guiding the player with game-based learning activities or providing timing help, making it easier to evaluate the learning and the awareness achieved on players.

3.1.2 CRYSTAL ISLAND

CRYSTAL ISLAND [40] is a narrative-centred learning environment (NLE) developed to teach eight-grade microbiology to middle school students, using the 3D platform for Half-Life 2.

Narrative-centred learning environments (NLE) combine commercial games technology, intelligent teaching systems and rich narrative structures in order to provide effective and engaging learning experiences. The use of stories offers an immersive environment for perceptual, emotional and motivational learning opportunities.

Playing the role of Alyx (Figure 3.2), players have to discover the source and the cause of an outbreak that is plaguing the research station. Due to the tension created by rumours, that it was one laboratory member's fault, the player must also discover if it was someone's fault. Therefore, the player must explore the world (research camp, underground caves and others), pick up and manipulate objects, take notes, view posters, operate laboratory's equipment and interact with other characters while forming questions, generating hypotheses, collecting data and testing hypotheses.

Figure 3.2: *CRYSTAL ISLAND*'s screenshots, showing the main character, Alyx (in the left screenshot), and the game environment (on the right).

In *CRYSTAL ISLAND*, players must solve four problem scenarios. The first two problems aim on pathogens (viruses, bacteria, fungi and parasites) and the player's objective is to gather information by interacting with pathogen expert characters, analysing books and viewing posters. The third problem requires players to compare and contrast their knowledge on four types of pathogens. In the last problem, the player completes a "fact sheet", with information related to the plague. In addition, once it is completed and verified by the camp nurse, the player must complete the final problem concerning an appropriate treatment plan for the diseased members.

To better understand the game, the following scenario exemplifies *CRYSTAL ISLAND*'s behaviour. Assume that while the players' are interacting with the virtual agents in the story-world and learning about diseases, they discover that some of the research station members' became ill. Given this, they learn that infectious diseases are transmitted from one organism to another. After the introduction on infectious diseases, players learn from the camp nurse that the source of this illness might be related with food items eaten by the ill members. Some virtual

characters are capable of helping to identify these food items and symptoms relevant to the problem, and other characters provide helpful microbiology information. Through series of tests, players discover that the source of the disease comes from a milk container that was contaminated by bacteria. Combining this information with their knowledge about the ill members' symptoms, players deduce that the disease is *E. coli*. Finally, the players report their findings to the camp nurse and plan a treatment method. By discovering that the source was *E. coli*, the chance of being the fault of a research camp member is excluded and the diseased members are treated correctly.

The NLE's interactive nature forces it to cope with a wide range of players' actions. Hence, a major challenge of NLEs is maintaining the coherence and pedagogical effectiveness of a learning experience and, at the same time, allowing significant available actions for the player. It is most critical to develop computational models that can reason about players' actions within the narrative, adapt and re-plan narrative events according to players' actions and provide robust, believable interactions with the virtual agents.

CRYSTAL ISLAND has two models of narrative: one for tutorial planning and one for narrative planning. The tutorial planner supports learning by generating tutorial strategies. The narrative planner generates plot elements, sequencing plot elements into coherent and engaging stories and directing the characters' actions and story-world's events. The narrative-centred learning experience is managed by a director-agent, which has access to: narrative's objectives, story-world's state and student's state.

Characters' generated dialogue must take into account characters' traits (such as personality, motivations and preferences), must consider narrative context and history and must robustly manage the possible interactions. To handle the large number of possible interactions that may result in dialogue, *CRYSTAL ISLAND* uses a probabilistic unification-based dialogue generation architecture which considers multiple sources of information.

Emotion is critical for both narrative and learning. Primary work on *CRYSTAL ISLAND* focused on data-driven approaches to affect recognition and affect expression. Data-driven models of affect recognition are trained and validated through a corpus of students data collected during interaction with the environment, and then induced by supervised machine learning techniques.

CRYSTAL ISLAND also included empathetic virtual agents. The empathy modeller was based on observations of human-human social interactions.

It was also available for players a feature for note-taking. Besides the functionality for players to register important information, this feature broadened the information available for research. In this case, it was possible to investigate the differences of learning rates between players who took notes through the game and the ones that did not.

3.2   Games with social interaction

Some scenarios of conflict emergence and some conflict handling strategies involve a significant communication component. With that, we review a game with an agents' computational model based on social interactions.

3.2.1 The Prom

The Prom is a social interaction based game, in which the player manages the social life of a group of high school students. By creating friends, enemies and controlling who is "in" and who is "out" of the friends' group, *The Prom* creates dramatic, provoking and funny situations. Each character has distinct personalities represented by their interests, needs, traits, social networks and social status.

In each stage, the player has to reach certain social status by performing the proper social interactions. Therefore, the challenge of this game is for the player to manipulate the social space, in order to obtain the right conditions for reaching a certain social state on the level. For this, the player selects two characters and which action to perform, where the first selected character performs the action and the second is the action's target (Figure 3.3).

Figure 3.3: The Prom's interface shows the level objective, which social actions are available for Robert (yellow selection) to choose to interact with Edward (green selection) and menu options to check on Robert's Social World.

The Prom is integrated with *Comme il Faut 2* (CiF2) [30], an extended version of *Comme il Faut* (CiF) [29], a computational model based on social interactions which allows autonomous agents to socially interact between themselves. Its design goal is to represent and reason about certain social situations, taking into account the diverse behaviours that result from different personalities on similar roles.

We begin by describing CiF and then we describe CiF 2 additions to its former version.

CiF has two main categories of system entities: data representations of character knowledge and process representations. The former consists on social games (the representation of social interaction between characters), personality descriptions and social state. The latter corresponds to goal setting, intent forming, social game negotiation and performance realization.

Social games consist in social interactions between characters, which aim at changing the social state within and across the participants. Characters perform social games to attain functional state changes, so they can meet their objectives. Socials games include a dependency graph of events to determine the sequence of events that happen throughout the social game. Each of these events consist in the list of participating characters, temporal properties, actions

performed by characters, functional world change and the social facts affected by the event.

In order to achieve a good performance in the variation of behaviours resulted from social interactions, characters are described with personalities. The character's personality description affects the process of choosing: which social games to initiate and to participate; what roles to perform; and which paths to take in the social games dependency graph. Personality description contains the character's: initial social state, traits, preferred social games and social state to be reached.

The social state represents: the current social state and the history of social events. The basic units on social states are social facts, which can be basic needs facts or a social status facts. Basic needs facts determine the impact of an event on a character's basic need, by associating the character with a basic need and a numeric impact value. Social status facts are represented by a character, a fact and a target; and determine binary relationships between characters. The current social status is represented by an array of references to each of the characters' goal levels of basic psychological needs and a list with the social status facts that are affecting characters.

Comme il Faut was initially focused on individuals and their psychological needs. However, through the development process, it was concluded that social games based only on psychological needs were unintuitive and hard for players to understand. As a result, *Comme il Faut 2* [30] was developed as an extended version that also focus on representing characters' social status and the relationship between them.

In CiF 2, characters' personality was added with three new elements: character's world history, cultural placement and the current state of the social environment.

The characters' world history is defined through the social facts database, which is a vector of social facts (any interaction or event that happens and changes the game world), where each consists in: the social status that the social game is affecting; the initiator of the social game; the target character; the third party involved (if any); the title of the social game; a vector of topics (dialogues) that were used in the social game; a vector with the choices made in the social game (social games that were chosen to be played after this one); the time when it took place.

The cultural placement is defined by the entries in the cultural knowledge database, which represents characters' personalities and similarities between them. Its entries link certain objects of the story world with how it is evaluated and interpreted by all characters.

The characters' state in the social environment is determined by the Social Network dimension (added in CiF 2), which defines the relationship between any two characters.

In *The Prom*, the social actions available for the player come from the goal setting of CiF 2 (Figure 3.3). However, some of these actions might not result on the desired social outcome. Some social actions might not be available for user selection, because these actions would not be suitable given the characters' individuality, which is defined by their personalities, socials statuses and needs.

CIF 2 enhances the gameplay experience by providing the game with characters that have their own needs, traits, social statuses, social networks, social history, results and effects of social games.

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3.3   Games with conflict

In this section we review games that portray social conflicts. We can distinguish these games by: a game that used conflict on the game's context and a game that explored conflict in the form of bullying.

3.3.1   Global Conflict: Palestine

Global Conflicts: Palestine (*GC: Palestine*) [8] is a prototype developed to address the issue of the Israeli-Palestinian conflict, where the player plays as a journalist that arrived to the Middle East and has to gather information for writing an article (Figure 3.4). To get that information, the player needs to gain the trust of the characters' (through practical questions), in order to approach them with critical questions for the journalist's research. The game's challenge is to maintain the neutrality within both sides, because it becomes harder to keep ties after each mission, and the player must obtain the different views of the conflict. The personal stories from both parties involved in the conflict were the main focus of the game.

Figure 3.4: Global Conflict: Palestine's screenshot showing the reporter obtaining information from a character.

To evaluate the prototype, fifty-one high school students, with mixed backgrounds were asked to play *GC: Palestine*. These students had lessons about the Israeli-Palestinian conflict four weeks before playing *GC: Palestine* and also a short lecture to revisit this topic right before playing it.

The results of the evaluation showed that the realism in personal stories, from both the conflicting parties, was the primary strength of the game, making the game a respectful material for learning. In general, the results were very positive: half the students indicated they learned

more than the usual on a normal course and a third of the students stated they learned the same as a normal course.

Related to the learning qualities of *GC: Palestine*, students acknowledge that the game made them understand better the perspectives of the conflict, as they relate the game topics with what they learned from the lectures. The true personal experiences on the stories made students feel attached to the stories, making them understand the conflict better and created a stronger engagement, often seen in games, although this engagement was not challenge based.

For future revision, the researchers concluded that the factual knowledge on the game should be lowered to make the game simpler and emphasize on the personal perspectives on the conflict.

3.3.2 FearNot!

FearNot! [3][16][59] is a learning system that has been developed to help children develop strategies to cope with school bullying, aiming to change students' behaviour and knowledge about bullying through social immersion, which is supported by: believable characters, autonomous agents, stories and non-scripted drama.

The educational game provides a virtual school populated by autonomous virtual agents (synthetic characters), which represent the most significant roles in bullying situations, such as bullies, victims, assistants, bystanders and defenders. Through the virtual school environment, the software enables children to explore bullying situations in a non-threatening environment, where they are encouraged to take responsibility of the victim character, by giving advices and helping in decision making (Figure 3.5).

Figure 3.5: *FearNot!*'s bullying scene, where John, the victim (on the right), is being hassled by a bully (on the middle) and an assistant (on the left).

Children act as *invisible friends*, meaning that themselves are not actually present in dramatic episodes, but they can advise and support the victim character. This role as spectator enables an emotional distance and security for both bullies and bullying victims. The user's interaction with the virtual bullying aims at triggering empathic reactions on the user, leading to understand the thoughts and feelings of the virtual victim. Empathy is also enhanced

through similarities between user and virtual character. Therefore, *FearNot!*'s characters create an empathy with the user through affective and cognitive processes.

Due to the episodic nature of bullying, *FearNot!* took an episodic approach. Episodes are generated by a narrative agent facilitator [4], which decides the characters and the location. At each episode, in which children act as a spectator during the virtual bullying scenes, the victim character turns to the user for help and advice on handling the bullying situations. These advices influence the virtual victim's behaviour towards the bullying situation, thus changing the outcome of it. Hence, the story of each episode emerges from the different interactions between the agents. The agents' actions are selected by *FAtiMA* [15], an emotion-driven architecture, which we address in detail further in this section.

The studies on *FearNot!*'s effectiveness on children showed that [54]: characters evoked the intended empathic reactions on users (victims were the most likeable and the bullies were the least likeable); users considered the generated storyline to be enjoyable and believable, however, the pacing was considered too slow; users acknowledged *FearNot!* as believable and useful in primary schools.

Overall, these evaluations concluded that *FearNot!* was successful on engaging and providing the user with a enjoyable and believable experience, while at the same time addressing the subject of bullying issues and how to confront them.

FAtiMA

Motivated by the advantages of believable characters on virtual learning environments, *FAtiMA* (*FearNot!* Affective Mind Architecture) [15] is an emotion and personality driven architecture of autonomous agents. Its goal is to achieve virtual characters that are believable and evoke empathic reactions on users.

FAtiMA's concept of emotion is based on the OCC (Ortony, Clore & Collins) theory of emotions [34]. OCC is a cognitive based theory, which structures emotions in a hierarchical organization for emotion types. An emotion type defines a category of emotions that are similar in terms of intensity and manifestation. When a emotion type is referred, all the emotions that belong in it are also referred.

According to the model, emotions are defined as valenced reactions to events, which can be positive (e.g. Joy) or negative (e.g. Distress and Fear). The association of the characters' emotions with events is determined by appraisal functions, which are subjective to characters' goals, standards and attitudes. An emotion's intensity value depends on the situation that triggered it. This value determines how strong the emotion is. Further the intensity weakens along time, according to a determined decay rate, until it reaches a minimum value. When that value is reached, the emotion is removed from the system's repository of emotions.

In addition, the model also represents mood. Mood is an overall valence which considers all current emotions on an agent and determines if a character is in a good or bad mood. It also influences how events affect emotions, in which an agent: with good will experience more positive emotions and with bad mood will experience more negative emotions.

Also following the OCC model, agents' personalites in *FAtiMA* consist in: a set of goals, a set of emotional reaction rules; character's action tendencies; and the emotional dispositions

(thresholds and decay rates for each emotion type).

The set of goals consists in active-pursuit goals and interest goals. The active pursuit goals are goals that the character tries to achieve by pursuing it, whereas the interest goals are goals that the agent has, but does not employ effort to achieve it.

The emotional reaction rules represent the character's standards and attitudes. It influences how the character appraises generic events. Therefore, the rules are very dependent of character's personality.

Action tendencies are very important to the character's believability, they represent the character's reactive actions, in which he performs impulsively according to its personality. As an example, in *FearNot!*, due to the victim character fragile personality, it expresses sadness by starting to cry, however, the bully character may handle sadness in a different way.

The emotional thresholds determine the character's resistance to a certain emotion. By this, it means that when an emotion is appraised, if the intensity does not surpass the threshold, the character will not "feel" this emotion. However, if the intensity surpasses the threshold, the emotion is added to the character's emotional state with an new intensity value, that is determined by the difference of the initial intensity value with the threshold value.

The decay rates are also independent values for each character. With the emotional thresholds and decay rates, *FAtiMA* makes it possible to create characters that have the same goals, but react differently to the same events, by having different thresholds and decay rates.

FAtiMA's architecture presents two layers (see Figure 3.6: a reactive layer, that manages the character's emotion generation and action tendencies; and a deliberative layer, responsible for the characters' plan-based behaviour.
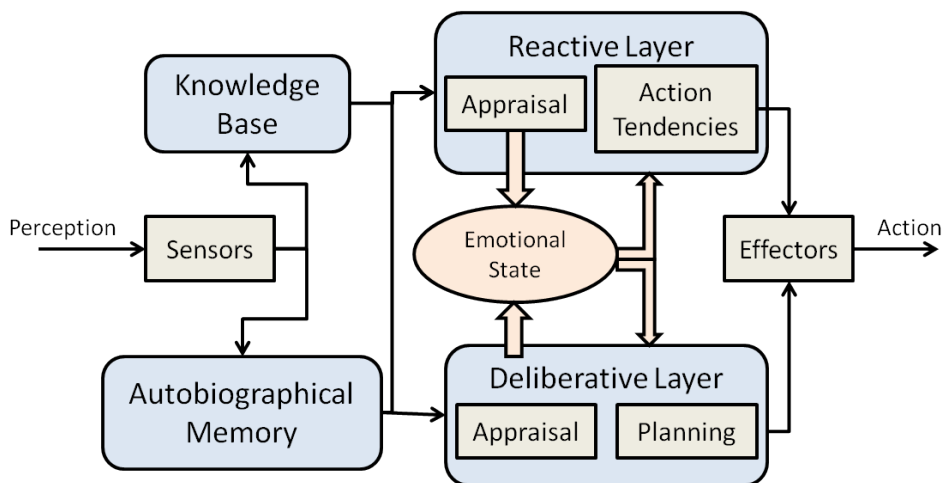
Figure 3.6: FAtiMA agents' architecture.

In the deliberative layer's appraisal, each character has a set of active-pursuit goals. These goals are triggered on certain conditions, so whenever a new perception from the environment is received, the deliberative layer verifies all deactivated goals to verify if any of them was activated. If a goal is triggered, then an intention is created, consisting on the plans to achieve that goal and the initial hopes and fears based on the goal's importance. This intention is then added to the intentions structure. Finally, the deliberative layer reasons on which of the intentions to deliberate on, by verifying the intention that generate the strongest emotions on the agent.

Characters also have a set of interest goals that defines the conditions that characters want to maintain or protect. This conditions are verified whenever a new action is added to a plan, in order to find conflicts between them. These conflicts are denominated inter-goal threats.

With the selected intention, the focus process takes into account the best plan built and generates the following prospect based emotions: hope of success, or the hope of achieving the intention; fear of failure, or the fear of not being able to achieve the intention; and inter-goal fear, which is the fear of not being able to maintain an interest goal, due to inter-goal threats in a plan.

The final step of the deliberative appraisal verifies if the active goals succeed or fail. If so, more prospect based emotions are generated if the planner is not able to plan: Satisfaction, Disappointment, Relief and Fears-Confirmed.

With experiments on *FearNot!* [54], it was possible to conclude that *FAtiMA* is efficient on creating believable characters that evoke the right empathic perceptions on users, by providing agents with emotions and personality.

3.4   Comparative Analysis

With the work reviewed in the previous Sections, we analyse to which extent does an agent system influence educational games. Starting with the work presented in Section 3.1, we find important to compare the effectiveness of a serious game without autonomous agents (*Floodsim* [38]) with a serious game populated with autonomous agents (*CRYSTAL ISLAND* [40]).

CRYSTAL ISLAND showed several features that are critical for a engaging gaming experience. The integration of autonomous characters and generated narrative, *CRYSTAL ISLAND* provides users with unscripted dialogues that took into account characters' personalities and unscripted stories. With that, we can point out that *Floodsim* would benefit from integrating autonomous agents in it. Judging from some users' feedback on the game, which they stated that *Floodsim* was too simplistic and address a few range of the real issue of floods, the incorporation of autonomous agents would allow the game's helping characters to appraise the users knowledge on flooding issues, thus raising or lowering the difficulty level of the challenges, by, for example, adding influence factors to the flooding policies. Other than this, *Floodsim* would also raise its player's engagement and motivation levels by having helping characters that show unscripted helping information, based on players' mistakes or factors that players are not taking into account when choosing policies.

Regarding the reviewed games which approached conflict teaching to children, each one addressed conflict as follows (see Table 3.1):

- *The Prom* – focused on relationship conflicts, where the user had to manage social relationships by taking actions that will balance the social world. Conflicts emerged due to characters' distinct personalities (interests, needs, traits, social networks and social status). Further, the user is directly involved in the conflict, as he may cause and resolve it.

- *Global Conflict* – concerned conflicts of values (the Israeli-Palestinian conflict), where players had to frame the perspective of both conflicting parties. To do so, players need to

maintain neutrality with both sides. Given the intractable aspect of the conflict portrayed by this game, the player role is merely to gather information of both sides, as the player does not interfere with the situation.

- *FearNot!* – handled conflicts of relations in the context of bullying, where the user takes responsibility for a victim of bullying and has to help him make decisions. Conflicts happened due to the bully's unreasonable perception and conduct towards the victim. The bully's actions towards the victim elicit emotions in both of them. The player's role is to advice the victim character on how to handle such situations, thus, this advices influence how the victim will behave on the next bullying episode, hence the user is indirectly involved in the conflict. These advices may improve or deteriorate the victim's ability to confront the bully. Therefore, we can assume that whenever the victim learns to effectively confront the bully, the conflict de-escalates. In contrary, deteriorating advices may escalate the conflict.

			Conflict		
Game	**Type**	**Player Involvement**	**Emotional influence**	**Escalation**	**De-escalation**
The Prom	Relation	Yes - Direct	No	No	No
GC: Palestine	Values	No - Perspective taking	No	No	No
FearNot!	Relation	Yes - Indirect	Yes	Yes	Yes

Table 3.1: Comparison of conflicts portrayed in *GC: Palestine*, *The Prom* and *FearNot!*.

Chapter 4

Conflict Model

With our overview of conflict in social psychology (Chapter 2), we are able to propose an agents' model of interpersonal conflict of interests, which can be integrated in an educative conflict resolution game.

Usually, when facing emergent conflict situations, due to incompatible goals, agents' societies rely on the agents' architectures to find ways to cooperate with the parties involved. However, in this research we follow a different approach, by trying to recreate real life conflict situations, based on social interaction and emotional affect.

According to researchers, emotion has a significant role in conflict situations [7][53][25][31] and that conflicts escalate [27][35][55][56]. With such, as we intend to recreate conflict situations that occur in real life, we are not deeply focused on competition or objective conflicts (conflicts generated by incompatible goals) [10], however, we are aware that agents should act in a rather "emotional way" and that conflict situations escalate.

Hence, we propose a conflict handling model for agents, where emotions affect their behaviours towards the conflict situation (Figure 4.1). Our model bases itself in FAtiMA's emotional model for agents [15] and in Tessier's et al. agents' conflict handling action model [48].
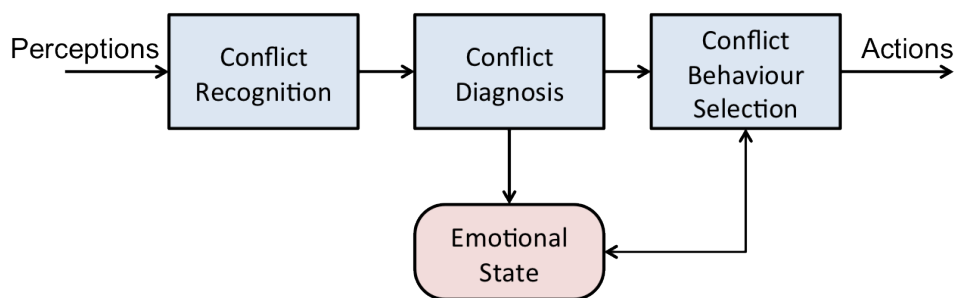
Figure 4.1: Conflict handling model.

In a nutshell, from the perceptions, we intend to identify events that frustrate the agent's intentions and goals through conflict recognition (CR). If such event is detected, CR classifies the conflict and specifies its importance. After that, conflict diagnosis (CD) uses this output together in order to analyse the conflict situation. From this analysis, emotions are generated and sent to the emotional state. Furthermore, the CD also sends a conflict description to the

conflict behaviour selection (CBS). In which, CBS selects which approach to use towards the conflict situation, taking into account the agent's emotional state and the conflict description.

In this Chapter, we begin by describing our model's definition of conflict. After that, we explain our conflict model, in which we present the conflict recognition (CR), conflict diagnosis (CD) and the conflict behaviour selection (CBS).

4.1 Conflict Definition

Before we begin to describe our conflict model, we need to state our definition of conflict. Reminding the definitions we reviewed in Section 2, our definition of conflict steams from Thomas [49] in which conflict is "the process which begins when one party perceives that another has frustrated, or is about to frustrate, some concern of his".

Inspired by Laursen & Collins (1994, cited in [24]) view on conflict as a play or a novel (p. 6), our definition of conflict is constituted as follows:

- Ps – declares the participants involved in the conflict situation.

- T – indicates the topic in which the conflict situation revolves. In this case, as we aim to model conflicts of interest, the topic specifies the resource in which the participants are striving for (e.g., the last cookie or a role in a theatre play).

- Bs – contains the set of events regarding behaviours performed by participants throughout the conflict (e.g., conversations, physical interactions or emotional expressions).

- O – describes the outcomes from the conflict situation, i.e., how each participant was affected with this conflict situation. The set of outcomes help to determine if the conflict was destructive (when the majority of outcomes are negative), constructive (when the majority of outcomes are positive) or unresolved (when there is no clear resolution or outcome) [24].

Furthermore, we inspire in Castelfranchi's [10] definition of a "full social conflict", which he states that it exists when "there is the subjective awareness of the competitive situation". This means that even though agents follow incompatible goals, they may be not aware of this incompatibility between them. On the other hand, there may also exist the agents' wrong belief of incompatibility, because of wrong beliefs towards others' goals and plans [10].

With so, our agents will verify potential situations of incompatibility, and therefore conflict, due to their subjective beliefs from perceived actions of other parties. Additional ways of conflict perception and awareness will be discussed for future work in Section 7.1.

Also note that, in this work, we aim at modelling interpersonal conflicts of interests. Thus, our conflict situations will rise between two or more agents, when there is a resource that only one or few can obtain it and one believes other party will obstruct such resource.

Before going further with our description, consider the following example situation, which we will refer throughout this Chapter:

In a classroom, children students need to choose a book to read for a school assignment. Each book can only be assigned to one student. Given this, two students, A

and B are eager to read the same book, *book X*. And, by teacher's command, students pick the books orderly, by alphabetical order. Thus, A is the first to pick a book. Undoubtedly, A picks *book X*. Once B sees that A chose *book X*, B immediately says a bad remark to A.

4.2   Conflict Recognition

Inspired by Tessier's et. al model [48], the conflict recognition step (CR) receives perceptions as input and verifies if this input gives rise to potential conflict or affects current conflicts.

When CR receives perceptions as input, such perceptions will be checked for raising potential conflicts or being towards a current conflict. For such, the CR regards actions or events that affect a certain concern of the agent, whether it affects such concern somehow.

If such an event is found, the CR will classify the conflict, according to its type [48]. As we intend to model interpersonal conflicts of interest, the conflict classification indicates the interest involved (e.g., *book X*).

Furthermore, the CR step specifies an importance factor to the conflict, which states the urgency of the conflict [48]. Regarding conflicts of interest, this factor reflects how much the party desires to obtain the interest which is at stake in the conflict situation.

4.3   Conflict Diagnosis

The following step in our model, conflict diagnosis (CD), uses as input the CR's output – conflict classification and importance factor – together with other information, such as information from the environment context and the knowledge base (e.g., social relations) [48]. This analysis will evaluate how the agent believes that the perceived event will affect his concerns (positively or negatively).

If the analysis determines that the event frustrates the agents' concerns, emotions may be elicited [7][28]. Hence, our conflict model integrates an emotional model inspired in FAtiMA's model for emotional agents [15] and OCC theory of emotion [34].

Before moving further with the CD description, we need to describe our definitions of emotional reaction, emotion and emotional state. With such, as we inspire in FAtiMA's model for emotional agents [15] and OCC theory of emotion [34], we define an emotional reaction as a pair $\langle Ev, AV \rangle$, where:

- Ev – describes the event which generated the emotional reaction (e.g., "*A* chose *book X*").

- AV – holds the set of appraisal variables: desirability, desirability-for-other and praiseworthiness [14]. Desirability represents how pleased or unpleased the appraising agent is with the event [34]. Hence, the variable's value is positive if pleased or negative if otherwise. Desirability-for-other represents the same as the previous, however it represents how the agent believes that this event pleases or unpleases the other, regarding the other's goals and plans [34]. And finally, praiseworthiness determines how praiseworthy or blameworthy a certain event is for the agent, according to his standards [34]. Thus, its value is positive

if praiseworthy or negative if blameworthy. Following our previous example situation, regarding B, we can assume that the event "A chose *book X*" is undesirable for self (negative desirability), desirable for the other (positive desirability-for-other) and he believes it to be blameworthy (negative praiseworthiness).

Following that, emotion is defined as a valence evaluation of an event, which we describe as a 4-tuple $\langle Ev, E_{type}, E_{valence}, E_{intensity} \rangle$, where:

- Ev – describes the event that elicited this emotion.

- E_{type} – denotes the type of the emotions being expressed (e.g., distress).

- $E_{valence}$ – indicates this emotion's valence, which can be positive or negative, according to the emotion type. For example, a distress emotion has negative valence, whereas a joy emotion has positive valence.

- $E_{intensity}$ – specifies the emotion's intensity, as scalar non-negative value, in which the higher the value, the more intense an emotion is.

Finally, we define emotional state as a pair $\langle Ems, Mo \rangle$, where:

- Ems – holds the set of emotions that the agent is feeling at the time.

- Mo – indicates the agent's Mood, which represents an overall valence of the agent's emotional state. Mood also influences and is influenced by other emotions, in which, negative emotions may decrease mood's value and positive emotions may increase mood's value. On the other hand, agents with bad mood feel more negative emotions, whereas, in the case of good mood will experience more positive emotions [15].

With the emotional aspect defined, we now proceed to define our concept of social relation. For the purposes that we aim to achieve with this model, we simplified the social relations, as we believe that exploring much further with this subject falls off from this research's scope.

On Section 2.5, we presented Laursen & Hafen's [24][23] hypothesis on relation quality and conflict. However, as stated, we do not want to go deep into this subject, we intend to recreate simple situations between friends or "un-friends". Besides, improvements to this aspect will be discussed in Section 7.1. With such, we define social relations as a 3-tuple $\langle I_1, I_2, GR \rangle$, where:

- I_1 and I_2 – defines the respective individuals.

- GR – defines a boolean value that indicates if these two individuals have a good relation. For the current version of our model, we assume that individuals' actions does not affect this value, i.e., individuals' actions will not affect their relationship.

We intend to make social relations influence only on how individuals are affected by certain events performed by their friends and how they perform behaviours towards friends. Following our situation example, if A and B were friends. B probably would not say bad things at A. Instead, B would try a more pacific approach.

With these definitions, we can now proceed on describing the CD process of conflict analysis. Inspired by FAtiMA agents' model [15] process of appraisal and emotion generation, the CD can be defined as a 3-step process, which consists in:

1. analyses the conflict event and generate a conflict description;

2. generates emotional reactions from the conflict analysis;

3. generates emotions from the emotion reactions and integrates into the emotional state;

In **step 1**, the output from CR (conflict classification and importance factor) is used to analyse the conflict event, regarding the other party involved. This analysis takes into account the relationship between the agent and the other party. From this analysis, a conflict description is generated, where it is depicts: the classification, the importance factor and the parties' relationship.

Next, **step 2** generates the emotional reactions regarding the agent's perception of the event's effect towards his concerns. Inspired by Thompson's et. al. work [50], our model assumes that agents' perception of events towards the conflict is subjective to their beliefs and may even be biased. Hence, conflict situations may be exaggerated in which others' actions may be always seen as unreasonable.

In our model, the agents' subjective perception is specified by their "personalities". Our concept of "personality" is inspired by FAtiMA's model [15], where the agent's "personality" defines the individual's emotional affection by the conflict situation (emotional dispositions and emotional reactions) and his behaviours towards it (action tendencies and goals). More precisely, the subjective perception of the conflict event is supported by the emotional reactions, where the agents' perception is defined by the appraisal variable values (desirability, desirability-for-other, and praiseworthiness).

Next, **step 3** follows FAtiMA' emotional model [14] to generate emotions from the determined emotional reactions. Further, before the emotions are sent to the emotional state, the agent's mood is considered, as it affects and is affected by these emotions [34]. A good mood increases the intensity of positive emotions and decreases the intensity of negative emotions, whereas, a bad mood does the opposite. On the other hand, positive emotions raise the agent's mood, whilst negative emotions lower it. After this, emotions are integrated in the emotional state.

4.4 Conflict Behaviour Selection

With the conflict description sent from the CD and the agent's updated emotion state, the conflict behaviour selection (CBS) selects which actions will be performed towards the conflict situation [48].

In this step, an agent's emotional state deeply affects how the agent will select his actions, where the emotional state of participants will lead them to create escalating situations.

Reminding our review on the effects of emotions in conflict (Section 2.3), several authors [6][7][28][25][44][53] state that negative emotions are linked to less cooperative approaches. From this line of thought, our model assumes that negative emotions will affect negatively the agents'

approaches towards the conflict. However, our model does not regard the effects of positive emotions.

This means that, considering TKI's taxonomy [49] (presented on Section 2.2.1), agents' values of assertiveness and cooperativeness are affected by the agents' emotional state. For example, an agent becomes less cooperative as he gets more frustrated with the conflict situation.

Further, we believe that the way the emotional state affects agents' assertiveness and cooperativeness depend on their behavioural predisposition towards conflict. For the current investigation, we propose to model two types of behavioural predisposition.

4.5   Conflict Behaviour Predispositions

We inspired in Raider's et al. AEIOU model for communication behaviours [37] (Section 2.2.1), regarding *Attacking* and *Evading* behaviours. Also we take into account the Thomas & Kilmann taxonomy [49], regarding the levels of cooperativeness and assertiveness in each personality.

We decided to model the *Attacking* and *Evading* personalities, as we believe that these behaviours are more likely to generate escalating situations, resulting from the destructive outcomes that such behaviours will bring to the conflict. Hence, these are defined as follows.

4.5.1   *Attacking* Behaviour

Agents with the *Attacking* behaviour follow a destructive path to cope with the conflict [37]. These agents are inclined to have high assertiveness and low cooperativeness. Thus, following only Competition approaches [49] (see Section 2.2.1), regarding that this type of agents only wants to benefit himself.

Further, agents with this kind of behavioural predisposition are not inclined to change their assertiveness and cooperativeness as their emotional state worsens. However, their actions may progress from a low level of aggressiveness to an extreme. For example, as the agents' emotional state worsens, their actions may progress as follows: lesser insult, criticise negatively, harsh insult, and threat.

Our current investigation only aims to model simple behaviours, in order to demonstrate escalation. We are aware that several kinds of aggressive behaviours can be present in destructive conflict situations [57]. However, we aim to model only verbal aggressions. A broader and more detailed set of behaviours will be developed in future work (see Section 7.1), as we intend to model behaviours resulted from a cultural probe study in schools [11].

Regarding Conflict Diagnosis (CD), we assume that *Attacking* agents portray most of others' actions, towards the conflict situation, as obstructive to their goals. Hence, even if another agent tries to approach the conflict situation in a constructive manner, the *attacking* agent will perceive other's moves as unreasonable [50].

From this, negative emotions will be elicited and, consequently, the emotional state will worsen. On the other hand, others' actions that demonstrate withdrawal towards this agent's interest are analysed as desirable.

Hence, we can summarise how the *Attacking* agents find others' approaches reasonable, towards the conflict situation, in Table 4.1.

Resolution approach	Accommodation	Avoiding	Collaboration	Competition	Compromise
Reasonable	Yes	Yes/No	No	No	No

Table 4.1: *Attacking* personality's analysis of other's approaches towards the conflict situation.

Note that, the agent does not need to specifically determine which of the TKI's [49] approach the other agent's follow. However, the agent must consider unreasonable if the other's moves regard: some type of negotiation, which may lead to giving up part of the interest (Compromise or Collaboration); and the obstruction of the interest (Competition or Avoiding, if the other's Avoiding moves will not allow the agent to achieve the interest). On the contrary, the *Attacking* personality agent considers as reasonable any moves in which the other withdrawals the shared interest (Accommodation or Avoiding, if the other's Avoiding moves still allows this agent to achieve the interest).

Following our situation example, assume that B is an agent modelled with *attacking personality*. Once A chooses *book X*, B's CD will generate negative emotions towards this event and will generate the conflict description as: "A, who is not my friend, chose *book X* and this obstructed my goal". After this, with the conflict description and the agent's updated emotional state, B's CBS will decide to act aggressively, by insulting A. Despite any possible constructive approach from A towards the situation, B will always analyse these moves as undesirable. Thus, B's emotional state will worsen, leading him to become even more aggressive with his behaviours, until the other takes a withdrawing action, such as, giving up on *book X* and choosing another.

4.5.2 *Evading* Behaviour

On the other hand, an agent with *Evading* behaviour may avoid participating in conflict situations and the behaviours are also affected differently as the emotional state worsens. We assume that this kind of agents initially have medium cooperativeness and medium assertiveness. However, as the emotional state worsens, the cooperativeness and assertiveness drops.

With that, in an initial state, this agent may try to resolve the conflict through Compromise, in which the agent may follow an Opening communication behaviour [37]. However, the build up of negative emotions leads the agent to become less cooperative. Therefore, the agent will be inclined to use more Avoiding approaches, followed by hostile evasions and withdrawing his interests (characterised by the Evading behaviour [37]). Even though the agent may follow an Opening behaviour at the start, the predominant behaviours in agents with this personality are Evading behaviours.

Furthermore, similar to the *Aggressive* personality, the intensity of the *Evading* behaviours escalate as the agent's emotional state worsens. For example, in this case, the agent's Evading intensity progress as follows: ignore the situation, sacrifice own's goals to avoid further involvement and leave the scene.

Regarding the others' actions, the *Evading* personality's Conflict Diagnosis (CD) is more inclined to accept cooperative approaches towards the conflict. Negotiating an agreeable solution or sacrificing goals in order to achieve a common solution is preferred. In Table 4.2, we describe how this kind of agents find reasonable the others' moves towards the conflict situation.

As opposite to the *Aggressive* personality, the *Evading* personality finds reasonable others'

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Resolution approach	Accommodation	Avoiding	Collaboration	Competition	Compromise
Reasonable	Yes	Yes/No	Yes	No	Yes

Table 4.2: *Evading* personality's analysis of other's approaches towards the conflict situation.

moves towards negotiation and goals sacrifice in order to establish an agreement (Collaboration or Compromise). However, similar to the previously mentioned personality, other's withdrawal is reasonable (Accommodation or Avoiding, if other's Avoiding moves still allows the agent to obtain the interest). Finally, obstructing moves towards the interest are unreasonable (Competition or Avoiding, if the Avoiding move obstructs the agent's goals).

Moving back to our situation example, consider that A is an agent modelled with the *Evading* personality. After A got *book X* and perceives B's insult towards him, A's CD will generate a conflict description such as: "B, who is not my friend, insulted me after I got *book X* and I did not liked that this happened". With such, A's CBS decides to use an Opening communication behaviour, such as, asking B to explain his action. Taking into account that B finds this type of moves towards himself as undesirable, his emotional state will worsen. Hence, B will progress to a more aggressive behaviour, for instance, by saying a harsh insult. When A appraises such action, his CD will generate enough negative emotions to worsen his emotional state to a point where his cooperativeness and assertiveness will drop. Hence, A will begin to avoid the conflict situation. However, B will keep on aggressively approaching the situation, which will worsen even more A's emotional state. The escalating avoidance approaches of A will lead him to give up on his interest or even leave the scene.

4.6 Concluding Remarks

In this Chapter, we presented our conflict model. The conflict dynamics specified by the model tries to capture the essence of Thomas' definition of the phenomenon, in which conflict is defined as "the process which begins when one party perceives that another has frustrated, or is about to frustrate, some concern of his". Therefore, first the agent has to perceive that some action performed by any other agent frustrated (or is going to frustrate) its goals, then the event is diagnosed not only according to its congruence to the agent's goals, but also other contextual elements (e.g. social relationships). Finally, a behaviour is selected in line with the state of the world, the agent inward beliefs and his emotional state. To sum up, an agent initially observes, then makes assumptions and finally communicates with others.

Furthermore, we defined two behaviour predispositions towards conflict inspired by the AEIOU model of communication [37].

Chapter 5

The Dream Theatre Game

Now that we defined our conflict model, in the previous Chapter, we will now describe how it was implemented. Furthermore, we present the demonstrator application, which we implemented in order to integrate and evaluate our agents, the *Dream Theatre* game.

Dream Theatre is an educational game that focus at teaching some conflict resolution skills to children, aged 9 to 11. The game setting consists in a theatre company, where the user/child needs to select the adequate cast for each theatre play. However, in this selection process, cast members may share the desire for the same roles, in which this may lead to conflict situations between actors. Thus, the user needs to help actors with their conflict situations, in a way that the cast is satisfied, or else it will affect the play's performance.

The current version of *Dream Theatre* presented in this document represents a prototype demonstrator for the SIREN project [11], which depicts some main ideas for the game and implementation design for the overall system. This demonstrator does not represent the final version of the product.

However, the demonstrator's version in this document will already be populated with characters controlled by an agents' architecture. All the characters' minds are modelled by an agent architecture, integrated with our conflict model, where emotions are generated from the situations created by the user or other characters. These emotions take influence on characters' behaviour, thus affecting how they behave on certain situations due to their current emotional state.

With such, this Chapter begins by describing how we integrated our conflict model on the agents' emotional architecture, FAtiMA [15], and how we modelled different conflict-oriented personalities. We also present a simple illustrative example of the agents' interactions, in order to better understand how conflict situations emerge. After that, we describe the Dream Theatre demonstrator and how it was developed with Unity3D[1]. Following this, we present the overall system, where we describe how the agents' architecture was integrated in the Dream Theatre demonstrator, by using a world simulation framework, ION Framework [52].

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[1]Unity3D – `http://www.unity3d.com`

5.1 Agents' Minds

In Chapter 4, we presented our conflict model for agents. Now, we will describe how it was implemented, by integrating it in FAtiMA's architecture for emotional agents [15] (Figure 5.1). No significant changes were made to FAtiMA's architecture, as we took advantage of the reactive appraisal process and the deliberative planning process to implement our conflict model in the agents. Therefore, the model was implemented as follows.
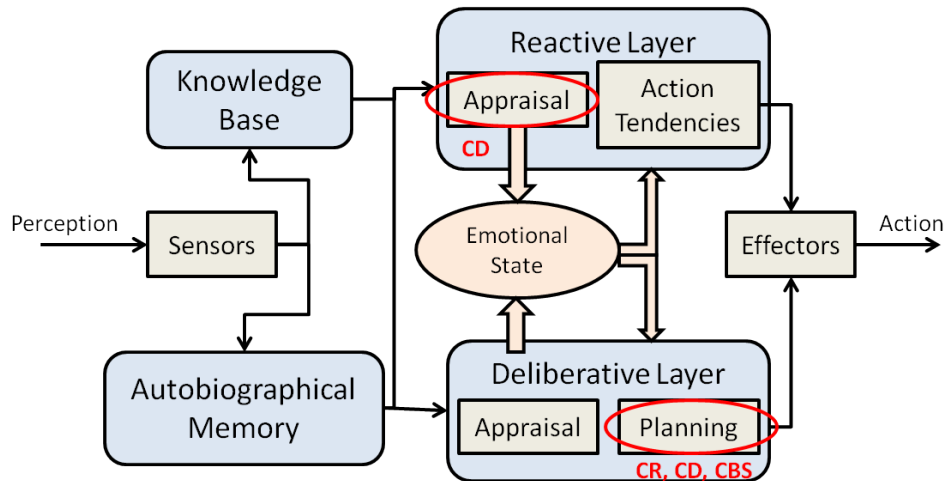
Figure 5.1: Agents' implementation in FAtiMA's architecture (diagram from [14]), where the circle notations represent where each conflict model's step was implemented.

5.1.1 Conflict recognition and diagnosis

On integrating our conflict model in FAtiMA agents' minds architecture, we found plausible to simplify some of the model's aspects. The *conflict recognition* (CR) was integrated into *conflict diagnosis* (CD) due to the fact that we used FAtiMA's deliberative layer to implement these steps from our conflict model.

To begin with, the CR is defined by a set of active-pursuit goals in FAtiMA's deliberative layer. In FAtiMA, active-pursuit goals are goals that the agents actively try to achieve [15]. The agents plan on achieving such goals whenever they are activated, i.e., when the goals' preconditions are satisfied. The active-pursuit goals' parameters are presented in Table 5.1.

Attribute	Description
ID	The goal identifier name.
Pre-conditions	A set of conditions that determines when the goal becomes active.
Success conditions	A set of conditions used to determine if the goal is successful.
Failure conditions	A set of conditions used to determine the goal automatic failure.

Table 5.1: FAtiMA's active-pursuit goals parameters [14].

In the CR's active-pursuit goals definition, the pre-conditions must define the situation in which a certain action is directed to a certain interest of the agent. Furthermore, in the success

conditions must specify the "internal action"[2] which will cause the CD step.

In the following excerpt of the agents' authoring XML files, we exemplify an active-pursuit goal for the conflict analysis.

```xml
<ActivePursuitGoal name="AnalyseGrantGoal([target],[perception],[role])">
    <PreConditions>
        <NewEvent occurred="True" subject="*" action="Grant" target="[target]"
            parameters="[role]"/>
    </PreConditions>
    <SucessConditions>
        <NewEvent occurred="True" subject="[SELF]" action="AnalyseGrant"
            target="[target]" parameters="[perception],[role]"/>
    </SucessConditions>
</ActivePursuitGoal>
```

In this goal, the pre-conditions determine that this active-pursuit goal is only active whenever a "Grant" action occurs. Thus, if such happens, FAtiMA's planner will plan to achieve the success conditions [15], which in this case is to perform the "AnalyseGrant" "internal action".

The CD step is supported by FAtiMA's deliberative planner, which will plan to perform the "internal action" (FAtiMA's deliberative planner process' description can be found in [14]). For this, it is specified a set of actions that determine the analysis of the event, where each action presents the conflict description.

The following XML excerpt presents the specification of an "AnalyseGrant" action, which describes a situation where a friend got the agent's desired role.

```xml
<Action name="AnalyseGrant([target],someone-took-my-desired-role,[role])">
 <PreConditions>
  <Property name="[target]" operator="!=" value="[AGENT]"/>
  <NewEvent occurred="True" subject="User" action="Grant" target="[target]"
      parameters="[role]" />
  <Property name="[AGENT](desiredRole)" operator="=" value="[role]"/>
  <Property name="[AGENT](friend,[target])" operator="!=" value="True"/>
 </PreConditions>
 <Effects>
 </Effects>
</Action>
```

The action's first argument ("[target]") specifies the other party involved in the event towards the conflict. Next, the second argument contains the conflict description ("someone-took-my-desired-role") which considers the CR's *importance factor* ("my-desired-role") and, in the third argument, the *classification* with the interest at stake ("[role]"). Also, this analysis considers that the other party is not friend of the agent.

With the conflict description, an emotional reaction must be generated, according to how the agent agent believes that the event will affect his interest. By taking advantage of FAtiMA's reactive appraisal [15], this step of the CD is defined by a set of emotional reactions directed to the conflict descriptions from the "internal actions". In FAtiMA's architecture, emotional reaction's parameters are defined as presented in Table 5.2.

Next, we present an example of two emotional reaction definitions. The first one corresponds to the agent perceiving that he got his desired role. The second corresponds to when someone takes the agent's desired role.

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[2]We use the term "internal action" to specify an agent's action which is not visible to others, only to the one who performs it.

Parameter	Description
Event	The event that caused the emotional reaction.
Desirability	Scalar value between -10 and 10. A negative value indicates that the event is perceived as undesirable for the agent, and a positive value indicates that the event is desirable.
Desirability-for-others	It is the same as desirability, however it depends on a presumed desirability of the event for other agent [34].
Praiseworthiness	Scalar value between -10 and 10. A negative value indicates that the agency element in the event violates an agent's standard, and a positive value indicates that the event upholds an agent's standard.

Table 5.2: FAtiMA's emotional reaction parameters [14].

```xml
<EmotionalReaction desirability="6">
 <Event action="AnalyseGrant" target="SELF" parameters="i-got-my-desired-role,*"/>
</EmotionalReaction>

<EmotionalReaction desirability="-5" desirabilityForOther="9">
 <Event action="AnalyseGrant" target="*" parameters="someone-took-my-desired-role,*"/>
</EmotionalReaction>
```

Regarding the value on the desirability-for-other appraisal variable, as we explained previously in our conflict model (p. 33), our agents do not have knowledge of others' goals and plans. Hence, our agents' appraisal variable of desirability-for-others does not take into account if the other agent achieved his concerns. For example, consider the second emotional reaction presented above, the agent who appraises this event will only take into account as if the role was given to himself. Therefore, the desirability-for-other value corresponds to how the appraising agent would find this event desirable.

After the emotional reaction is triggered, FAtiMA's appraisal process generates the emotions [14], following OCC's theory of emotions [34]. This process consists in two major steps. The first generates potential emotions and the second will send these emotions to the emotional state. The potential emotions' parameters are defined as follows, in Table 5.3.

Parameter	Description
Event	The event that generated the emotional reaction.
Base Potential	Scalar value, between 0 and 10, that represents the potential intensity of the emotion.
Type	Enumerate that represents the emotion type, according to OCC model [34]. The possible values that we consider in this work is: Joy, Distress, Pride, Shame, Admiration, Reproach, Happy-For, Resentment, Gloating and Pity.
Valence	Specifies if emotion corresponds to a positive or a negative emotion. It is positive if the emotion is: Joy, Pride, Admiration, Happy-for or Gloating. And it is negative for all the other types.

Table 5.3: FAtiMA's potential emotion parameters [14].

The first step on this process is to determine a base potential according to a set of rules for each type of emotion [14]. Following the OCC theory of emotions [34], FAtiMA agents' emotions

are determined as follows:

Well being emotions

This type of emotions depends only on the *desirability* appraisal variable. If the desirability value if positive, then a Joy emotion is created, otherwise it is created a Distress emotion. The base potential value for this type of emotions is calculated as follows [14]:

$$BasePotential = |Desirability|$$

Fortune-of-Others Emotions

These types of emotions are generated if *desirability-for-other* appraisal variable's value is different from 0, and are generated by combining the values of desirability and *desirability-for-others* values, as presented in Table 5.4.

Desirability	Desirability-for-other	
	Positive	Negative
Positive	Happy-for	Gloating
Negative	Resentment	Pitty

Table 5.4: Fortune of Others emotions according to *desirability* and *desirability-for-others* [14].

The base potential for these emotions are given by the following formula [14]:

$$BasePotential = \frac{|Desirability| + |Desirability\text{-}for\text{-}other|}{2}$$

Attribution Reaction

These reactions depend only on the *praiseworthiness* appraisal variable. In which, actions performed by the appraising agent will rise Shame or Pride emotions. On the other hand, actions performed by others will generation Admiration or Reproach emotions. Table 5.5 presents this matter.

Praiseworthiness	Action's Subject	
	Self	Other
Positive	Pride	Admiration
Negative	Shame	Reproach

Table 5.5: Attribution Reaction emotions according to *praiseworthiness* and action's subject [14].

The base potential for this type of emotions is calculated through the following formula:

$$BasePotential = |Praiseworthiness|$$

Mood

With the generated emotions, the second step of the emotion generation process sends these emotions to the emotional state. However, these emotions are not sent to the emotional state until they are applied to the current mood. In which, Mood is a scalar value between -10 and 10, where negative values represent a bad mood and high values represent a good mood. The emotion's base potential if calculated, according to its valence, as follows [14]:

$$Potential = \begin{cases} BasePotential + Mood \times MoodInfluence, \text{for positive valence emotion} \\ BasePotential - Mood \times MoodInfluence, \text{for negative valence emotion} \end{cases}$$

Mood influence corresponds to a scalar value between 0 and 1 that represents how mood influences certain types of emotions.

On the other hand, emotions also influence mood. Where, good emotions raise the agent's mood and bad emotions lowers the mood. From empirical tests, Dias et al. [14] determined that emotions influence mood by 10% of their potential intensity. This influence is determined by the following formula [14]:

$$Mood = \begin{cases} Mood' + EmotionPotential \times 0.1, \text{for positive valence emotion} \\ Mood' - EmotionPotential \times 0.1, \text{for negative valence emotion} \end{cases}$$

Final Intensity

Finally, an emotion is added to the emotional state only if its intensity surpasses the defined threshold for that emotion. The emotional thresholds are defined in the agent's personality as a set of emotional thresholds for each emotion [15].

Thus, the emotion's final intensity is calculated by subtracting the emotional threshold, according to the formula [14]:

$$Intensity = EmotionPotential - EmotionaThreshold$$

Now that we described the emotion generation process, we proceed to explain the *conflict behaviour selection*.

5.1.2 Conflict Behaviour Selection

In a nutshell, the *conflict behaviour selection* step is defined as a set of active-pursuit goals towards the conflict situation, where emotions influence which goals the agent will be capable of activating.

As we stated previously, in our model's description (Chapter 4), we aim at modelling behaviour which is affected by the agents' emotional states. With such, for this version of the agent's minds implementation, we use agents' moods as the key emotional affect to influence behaviours. However, this assumption can be quite arguable, as we could model conflict behaviours related to specific emotions, such as anger or fear [25][31]. However, as mood is a pervasive affect that defines a general disposition state of an individual, we believe that this emotional aspect is more suitable to influence characters' behaviours towards conflict.

In the following XML excerpt of the authoring files, it is demonstrated an aggressive goal towards the conflict situation. This goal is activated when an "AnalyseGrant" action occurs and its analysis (stated in the action's arguments) describe that "someone" (not a friend) took his desired role. Furthermore, this goal will only be activated if the agent's mood is between the defined mood range ($[-2.0, 2.0[$) stated in the third and fourth pre-conditions. If such goal is activated, the agent will plan on saying an insult to the agent who took his desired role.

```xml
<ActivePursuitGoal name="Insult([target])">
 <PreConditions>
    <Property name="[target]" operator="!=" value="[SELF]"/>
    <RecentEvent occurred="True" subject="[SELF]" action="AnalyseGrant"
      target="[target]" parameters="someone-took-my-desired-role,[role]" />
    <Property name="[target](givenRole)" operator="=" value="[role]"/>
    <MoodCondition operator="LesserThan" value="2.0"/>
    <MoodCondition operator="GreaterEqual" value="-2.0"/>
 </PreConditions>
 <SucessConditions>
  <NewEvent occurred="True" subject="[SELF]" action="Say" target="[target]"
      parameters="insult" />
 </SucessConditions>
</ActivePursuitGoal>
```

5.1.3 Implemented Behaviours

Reminding our definition of the conflict model, in Section 4.5, we conceptually defined two behavioural predispositions towards conflict situations, the *attacking* and *evading* behaviour predispositions. These behavioural predispositions were implemented as "personalities" in the FAtiMA architecture [15], which consist in the set of goals, emotional reactions and action tendencies.

For the purposes of the *Dream Theatre* demonstrator, we implemented action tendencies to demonstrate characters' emotional expressions towards the situation. Both behavioural predispositions have the following emotional expression:

- **Happiness** – is triggered whenever an event towards the conflict elicits a "Joy" emotion.

- **Sadness** – in contrast, is triggered whenever an event towards the conflict elicits a "Distress" emotion.

- **Over-frustrated** – is triggered whenever an event towards the conflict leads the agent to a "boiling point". This point is achieved when the agents' mood is high and an event towards the conflict generates a "Distress" emotion.

With that, we now describe the behavioural predispositions are implemented as follows.

Attacking Behaviour

The *Attacking* behaviour has a set of aggressive behaviours towards the situation of conflict. In Table 5.6, we present the *Attacking* agents' emotionally-driven behaviours to approach a conflict situation. Each one represents a group of active-pursuit goals, which can be activated if agents' emotional states are in those mood ranges. The values for the mood ranges were determined by empirical tests with the FAtiMA architecture.

43

Emotionally-driven behaviour	Mood(m)	Description
Do not mind	$m \geq 0$	Agent performs a rather "neutral" behaviour towards the situation.
Insult other	$-2 < m < 0$	Agent uses insults towards other agents.
Criticize negatively other	$-4.0 < m \leq -2.0$	Agent uses destructive critics towards other agents.
Threaten other	$m \leq -4.0$	Agent threatens the other to withdraw from the threatening agents' concern.

Table 5.6: *Attacking* agents' set of behaviours, according to mood's values.

Further, besides the emotional action tendencies defined previously, the *Attacking* behaviour has an additional emotional expression. We inspire in Miller and Olson's [31] study on children's emotional expressiveness in peer conflicts, where children who were inclined to initiate conflicts usually expressed gleeful taunts. These emotional expressions are characterised as inappropriate positive affects in the context of teasing [31]. Therefore, regarding the context of our scenario, whenever the *Attacking* agent perceives that his aggressive attacks led another agent to withdraw from a concern, the *attacking* agent will express a gleeful taunt.

It is also important to explain that this agent's emotional reactions are manipulated, so that the agent finds very undesirable the others' attempts to approach the conflict. Hence, the more the conflict situation prolongs, more aggressive the agent will be, as others' actions will only deteriorate his emotional state. An illustrative example of the specification of emotional thresholds and emotional reactions of an *Aggressive* agent is defined in Appendix A.1.

Evading Behaviour

In contrast, the *Evading* behaviour agent has a set of less aggressive behaviours towards a situation of conflict. As we referred, in Section 4.5.2, *Evading* agents may initially have constructive approaches towards the conflict situation, however, if the emotional state deteriorates, this agent will begin to follow evasive approaches. Following that, Table 5.7 points out *Evading* agents' emotionally-driven behaviours. The values for the mood ranges were determined by empirical tests with the FAtiMA architecture.

Emotionally-driven behaviour	Mood(m)	Description
Do not mind	$m \geq 0$	Agent performs a rather "neutral" behaviour towards the situation.
Ask why	$-3.0 < m \leq 0$	If approached by another agent, this agent will try to ask the reason for such behaviour.
Do not respond	$-5.0 < m \leq -3.0$	Agent does not fight back aggressive moves towards himself (e.g., deny a critic or a insult towards himself).
Give up	$-8.0 < m \leq -5.0$	Agent gives up desired interest, in order to avoid any more involvement in the conflict.
Leave scene	$m \leq -8.0$	Agent final withdrawal, in which he leaves the scene.

Table 5.7: *Evading* agent's behaviours, according to mood's values.

Similarly to the *Aggressive* agent, this agent's emotional reactions were authored for this agent to find undesirable aggressive attacks from others towards himself. In Appendix A.2 we illustrate an example of this agent's emotional thresholds and emotional reactions authoring.

5.2   Dream Theatre demonstrator

The Dream Theatre demonstrator (Figure 5.2) was inspired by a conflict resolution card game, which was used as a throw-away prototype for the SIREN project [58].

When playing Dream Theatre, in every week, the child is challenged with a new "production" and needs to select adequately his/her cast, and assign adequately the roles to the actors. The user has a set of possible virtual actors/characters to assign the roles, and needs to do so, trying to optimise the final performance results. The only problem is that the virtual characters may not accept the assignment made by the user, and conflicts may occur between the agents. Thus, the child's role is to manage the conflict, advice the agents, and try to do so in a manner that the conflict is resolved, otherwise, if the emotional states of the agents are very negative, at the end, the performance results will not be good.

The virtual characters in the cast have a set of characteristics. In particular, they have preferences for roles (for example, some may prefer to be a "Hero", whereas others may prefer to be a "Villain"). As the player grants roles to characters, conflict situations emerge when characters share the desire for the same role. They also have social relations (friendship relations, allowing for in-group and out-group situations), and proficiency.

Figure 5.2: Dream Theater's screenshot, from players' perspective, in which can be seen some of the cast members and their thermometer indicators, role objects and the exit door (in the right background).

5.2.1 User Interaction

Similar to the approach followed on FearNot! [16], in Dream Theatre, users act as an invisible entity. With that, they do not get directly involved in the conflict situations, as the characters do not take any actions towards users or blame their actions (e.g. blaming the user for his/her actions). With this, we believe that the emotional security provided to child users allows them to explore new conflict resolution techniques, which they would not be capable of using on virtual situations that place them as participants.

As for the user interaction with the game, we focused on simplifying it as much as possible. Thus, our game needs only mouse interaction. Further, we decided that all the actions performed by the user, towards the characters, should be issued by using the objects represented in the scenario, rather then using graphical user interfaces (GUIs).

To achieve that, we implemented the *drag-and-drop* interaction paradigm for assigning/dismissing roles to/from characters and firing them from the theatre company. Therefore, the main actions which the user can performed are achieved by interacting with the following elements of the game (represented in Figure 5.2):

- *Role objects* – are objects that represent certain roles, such as the main actor roles or backstage roles. For the current implementation of the demonstrator, *role objects* are boxes with the role name printed on their sides. Therefore, in order to assign a certain role to a character, the user drags the correspondent *role object* to a character, or vice-versa.

- *Exit door* – represents an element that is used to dismiss characters from roles or fires characters from the theatre. Characters are dismissed from roles by dragging a character, with an assigned role, into the *exit door*. On the other hand, characters are fired from the theatre company when they have no assigned role and are dragged to the *exit door*.

Furthermore, users can also interact with characters by hovering the mouse pointer above them. This action allows users to visualize information about the character, as pictured in Figure 5.3. Next, we describe which information is presented and how it is displayed.

5.2.2 Character Information

Inspired by the card game throw-away prototype [9], characters are defined by their different characteristics, as shown in Figure 5.3. Besides their name and gender, each character has the following visible information:

(a) **Proficiency** – determines the character's skill with acting. The proficiency value can increase throughout the game, as the characters gain experience with each play that they perform.

(b) **Desired Role** – indicates which role the character is interested at the time, which might change throughout the game. However, in this demonstrator's version, we simplified this feature, so that the desired role remains the same as the favourite role. We intend to further develop this feature in future work (see Section 7.1, for more details).

(c) **Favourite Role** – as the name states, defines characters' favourite role. Even though it is quite similar to the desired role, the character's favourite role is not intended to change throughout the game.

(d) **Interest** – defines character special interests, such as: music, photography and fashion. these relate to the available positions in secondary/backstage roles for the theatre plays, respectively: sound technician, lighting technician and wardrobe/props designer.

(e) **Thermometer** – The thermometer represents the character's level of anger. The thermometer analogy was inspired from Kreidler's techniques to teach children about conflict [21], in which children have to paint the thermometer according to how angry they felt with the conflict situation. The higher the thermometer level is, the angrier they felt. This indicator is always visible (though this feature was integrated after some preliminary tests in the demonstrator, as presented in Section 6.1), as it hovers the characters (see Figure 5.2). With such, it is possible to witness the thermometer rising as the conflict situation unrolls.

Figure 5.3: A character's information cloud, which describes (translated from Portuguese): (a) proficiency, (b) desired role, (c) favourite role, (d) interest and (e) thermometer.

Besides the characters' information that we presented, characters also express emotional responses to certain events in the game, as follows.

5.2.3 Emotion Expression

The integration of this work with the SIREN project [58] influenced some graphical aspects of the *Dream Theatre* demonstrator. Serious Games Interactive provided the characters' 3D models and the scenery stage (see Figure 5.2).

Further, characters were provided with a few animations: idle postures and talking animations. Therefore, in order to show characters' emotional expressions, we used graphical icons to represent the emotional expressions (see Figure 5.4). These graphical icons were used to express the following:

(a) **Happiness** – is displayed whenever a character is satisfied with the user's actions, i.e., if the user's grant or dismiss actions please the characters' goals. For example, if a character is granted with his favourite role or when someone is dismissed from this character's favourite role.

(b) **Sadness** – in contrast to the previous expression, this expression is used whenever the character is not pleased by the user's actions. As an example, when the character is granted with a role he is not interested in or when someone else is granted with this character's favourite role.

(c) **Over-frustratred** – is used to display characters' over-frustration feeling, whenever they surpass their "boiling point", as we mentioned before in the agents' implementation (Section 5.1).

(d) **Gleeful taunt** – is specially displayed by characters modelled with the *Attacking* personality, as we presented in Section 5.1 (page 43). A character displays this emotional expression whenever they perceive that another has given up the character's favourite role. Inspired by Miller and Olson's [31] work on emotional expressiveness in conflict situations among children, we define this expression as a inappropriate positive affect in the context of teasing, which we represent as a smirking smile.

Figure 5.4: Characters' emotional expressions (from left to right): (a) Happiness, (b) Sadness, (c) Over-frustrated and (d) Gleeful taunt.

With the description of the game elements, in the following Section, we present the demonstrator's architecture and its implementation.

5.2.4 Demonstrator's Architecture

The Dream Theatre demonstrator application was developed in Unity3D game development tool, in which the scripts were developed in $C\#$. Given that the Unity3D paradigm is quite unique, before we proceed to explain the demonstrator's architecture, we believe that is important to present a brief description of the Unity3D paradigm.

In a nutshell, Unity3D's game development paradigm is based on *Scenes*, *Game Objects* and *Components* [51]. *Scenes* contain and structure the several *Game Objects* that build a certain scenario on the game (for example, *Scenes* can be used to contain the setup of different levels of a game or menus). *Game Objects* are abstract containers for pieces of functionality, the *Components*. On the other hand, *Game Objects* can also contain other *Game Objects*, which allows hierarchical organization. Finally, *Components* are the building blocks of Unity3D, as they are attached to *Game Objects* and may represent visible entities (e.g., graphical models),

cameras, lights, scripts and others. Furthermore, *Components* can also indicate dependencies with other *Components*. With this, a *Component* with dependencies cannot be attached to a *Game Object* that does not already contain those dependencies attached.

Regarding our demonstrator's implementation, only two *Scenes* were used: one for the main menu and another for the stage scenario with the characters. We will only focus on the latter *Scene's* implementation. This *Scene* contains four main important types of *Game Objects* (see Figure 5.5): the *Level Manager*, the *GUI* (graphical user interface), the *Interactive Objects*, and the *Characters*.
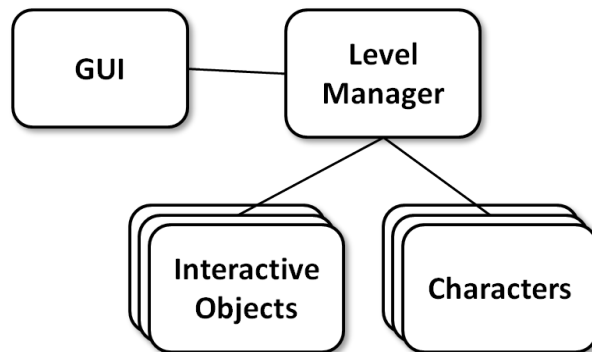

Figure 5.5: Demonstrator's main *Game Object* architecture.

The *Level Manager Game Object* has no visible entity, its purpose is to manage and maintain most of the game's information. It loads new levels, determines which characters are present in certain levels, and maintains the level state (e.g. if all roles were assigned).

The *GUI Game Object* is responsible for presenting the game's interface, regarding menus and other game state information (e.g. week counter). It communicates with the *Level Manager* to issue commands and obtain game's information.

Interactive Objects Game Objects represent the role objects, which are used to assign roles to characters, and the exit door, which is used to fire characters from the theatre company. Each one of the *Interactive Objects* is represented by a visible entity *Component* (3D Mesh), and script *Components* for animation and user interaction purposes.

The *Characters' Game Objects* are the most complex elements on the game. In order to reduce some of the development complexity, we divided the character's functionalities in three modules, which are represented by three *Game Objects* (see Figure 5.6). Therefore, a "father" *Game Object* defines the *Character* by comprising the following three "children" *Game Objects* (following Figure 5.6):

- *Character Graphics* – stores the character's graphical representation, such as the character's model and the animations.

- *Character Controller* – responsible for the domain complexity, it manages the access to the character's game information, handles user input towards the character and manages animations and other graphical aspects of the character (such as, the characters' information balloon).

- *Character Behaviour* – is responsible for the character's "thought" process. Hence it can be assumed as the character's artificial intelligence module. This module accesses the *Character Controller* to perform character's behaviours. Regarding the demonstrator's current implementation, it contains the scripts used to establish the connection with the FAtiMA agent's mind. We will regard this matter in the following Section.
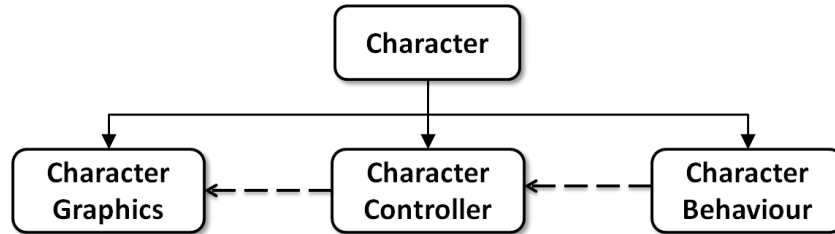
Figure 5.6: Character *Game Object* contains three children *Game Objects* with specific functionalities: *Character Graphics, Character Controller* and *Character Behaviour*.

Furthermore, as this modular approach allows us to divide the character in three different aspects of its functioning: domain complexity (character's and application's information), graphical representation (character's model and animations) and artificial intelligence (character's "thought" process); we can easily change any one of these modules, since they are meant to be loosely coupled.

In the following Section, we describe the overall system that integrates the FAtiMA agents' minds with the Dream Theatre demonstrator.

5.3 Overall System

Even though we presented the agents' minds architecture and the demonstrator, we still do not know how these two modules communicate with each other. Thus, in this Section we will describe the overall system. As we can see in Figure 5.7, three main modules compose the overall system: agents' minds, world simulation and realisation engine. We already presented the first and the last modules in the previous Sections. However, we still need to describe the world simulation, which integrates these two modules.

Figure 5.7: Dream Theatre demonstrator's overall system is composed by three main modules: the agents' minds, in FAtiMA's agents architecture, the world Simulator, in ION Framework, and the demonstrator, developed in Unity3D.

5.3.1 World Simulator

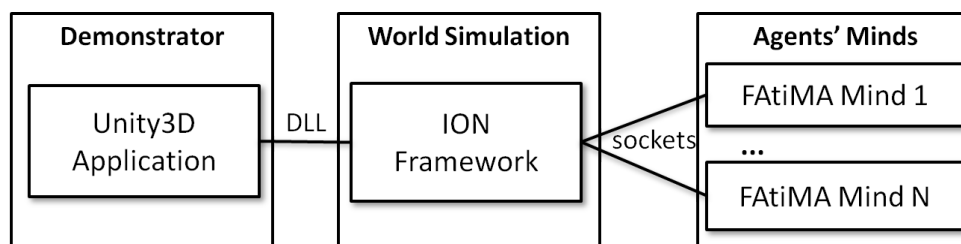The world simulation module, as we stated earlier, functions as the integration layer between the demonstrator and the agents minds. On the other hand, the world simulator, provided by the ION Framework [52], also aims at providing means to simulate dynamic environments.

This approach creates a certain level of abstraction between the agents' minds and the demonstrator modules. Hence, it facilitates the migration of FAtiMA agents' minds to other graphical engines. FAtiMA has already been integrated in several engines, such as, *Never Winter Nights 2*[3] [14], *Ogre 3D*[4] [4][5], and others.

ION Framework

To achieve this, the ION framework [52] provides the means to simulate dynamic environments. To do so, it identifies four basic elements: *Entities*, *Properties*, *Actions*, and *Events*. *Entities* populate the simulation universe. They can have *Properties* and change the world through the use of their *Actions*. As the ION Framework model is based on the Observer pattern, *Entities* register to *Events*. In which, these *Events* are raised whenever any change to the world occurs. For example, if a *Property* is changed, an *Action's* state changes (such as, when it starts or stops), or an *Entity* enters or leaves the simulation.

The simulation is processed in a discrete step manner. The world manipulation insures that, at a given simulation step, the same information is available to all elements in the simulation. To achieve that, in Figure 5.8, we present a simple flowchart of the simulation's update cycle. Any changes to *Properties* or changes to an *Action's* state are treated as requests to the simulation. When such requests are processed, if any changes to the world occur, an *Event* is raised. This *Event* is then propagated to whoever registered to be noticed of such *Event*, and only after that the simulation can proceed to a next update cycle.
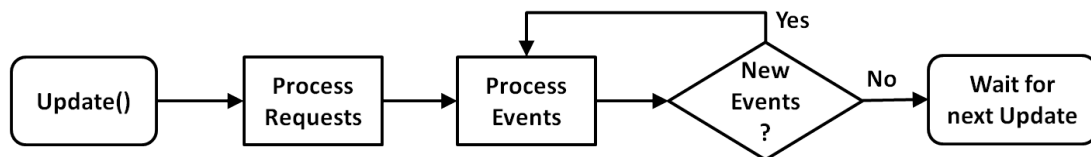
Figure 5.8: Flowchart of the ION Framework's update cycle [52].

With this brief description of the ION Framework, we proceed to describe how it was integrated in Unity3D.

ION Framework in Unity3D

The ION Framework is integrated in Unity3D by adding the ION Framework's DLLs or source files (in C#) directly into Unity3D's application assets. Further, this integration is supported by script *Components* (in C#) whose purposes are to define the *Entities*, *Properties* and *Actions* and maintain a link with those elements in the ION simulation (see Figure 5.9).

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[3]*Never Winter Nights 2* - http://www.obsidianent.com/
[4]*Ogre 3D* - www.ogre3d.org
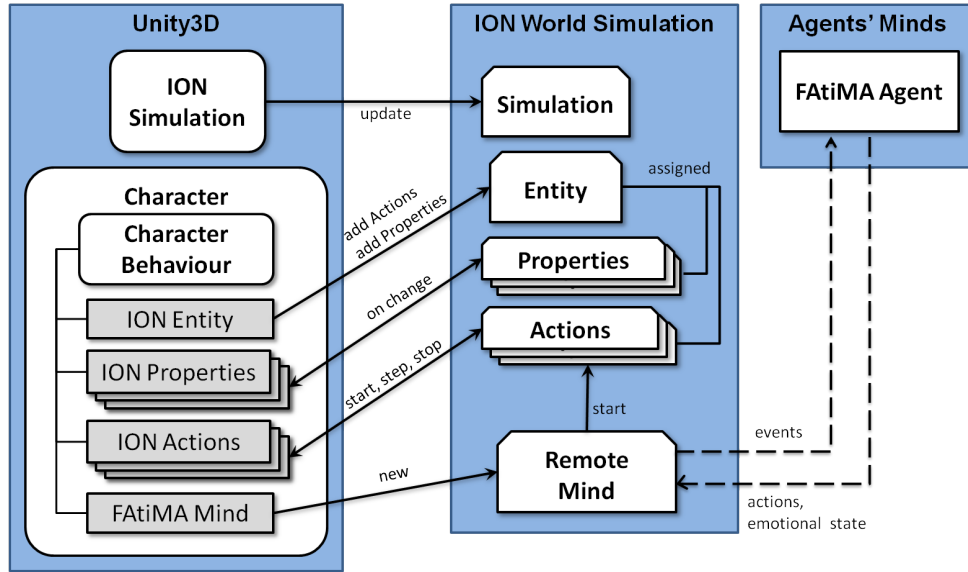
Figure 5.9: Communication details between: Unity3D character's script components and ION simulation elements; and between those elements and a FAtiMA agent. The solid arrows define communication through functions, while the dashed arrows signify communication through socket messages.

Therefore, we can design the simulation's environment by attaching these *Components* to *Game Objects*, each works as follows:

- *ION Entity* – creates and adds an *Entity* element to the simulation. An Entity can be any character, object or even the user's representation, i.e., if the user can perform actions towards the simulation, he also needs to be represented, which is the case of our demonstrator. Furthermore, this script also takes care of associating to the Entity all the *Properties* and *Actions* that are attached in the same *Game Object*.

- *ION Property* – creates a *Property* element in the simulation and defines the event handler for when the *Property* value is changed. This script requires an *ION Entity* script already attached to the same *Game Object*.

- *ION Action* – is an abstract class which creates an *Action* element in the simulation and defines three abstract event handlers: *OnStart*, *OnStep* and *OnStop* (see Figure 5.10). *OnStart* and *OnStop* event handlers, as the name states, are called whenever the actions starts and stops, and *Action OnStep* is called with each simulation update, after *Action OnStart* finishes. These event handlers' behaviours are implemented in the *ION Action* subclasses. This script requires an *ION Entity* script already attached to the same *Game Object*.

Besides the scripts to design the simulation's environment, we also need the script that issues update commands to the simulation, the *ION Simulation* script (see Figure 5.9). This script also needs to be attached to *Game Object* in order to be active in the Unity3D's application.

The current implementation of this script issues an update to the ION simulation at each Unity3D update cycle, which is synced to the frame rate [51].
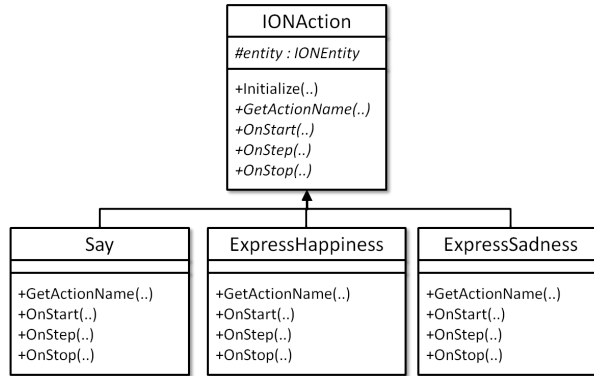
Figure 5.10: UML of an illustrative hierarchy of the *ION Action* script. *Say*, *ExpressHappiness* and *ExpressSadness* are subclasses of *ION Action* which implement the event handler functions: *OnStart*, *OnStep* and *OnStop*.

Next we present how these components communicate with the FAtiMA agents' minds.

5.3.2 Integrating Agent's Minds

FAtiMA agents' minds are linked to their respective graphical representations, in Unity3D, through their representations in the ION simulation (see Figure 5.9). For such, besides the scripts we mentioned previously that handle the connection between ION simulation and Unity3D, characters need an additional script attached to their *Game Objects*: the *FAtiMA Mind* script.

This script launches the FAtiMA agent's mind process and connects it with the correspondent representation, in the ION simulation. For that, the *FAtiMaMind* script creates the *Remote Mind* element in the ION simulation, which registers to all the world events, such as, when an *Entity* enters or leaves the simulation, an *Action* being performed, or a *Property* value changed. With that, the *Remote Mind* reports all these *Events* to the FAtiMA agent mind (see Figure 5.9).

In order to communicate with the FAtiMA agent's mind, the *Remote Mind* establishes a socket communication with it. Therefore, all the registered events that occur in the simulation are transformed into FAtiMA events and then sent to the agent's mind.

On the other hand, the actions that the agent will perform (by action tendencies or deliberated actions) are sent to the *RemoteMind* (see Figure 5.9). These actions are parsed and generated into *Action* start requests to the simulation. Furthermore, regarding the Dream Theatre demonstrator, we found the need to also send emotional state information, which is used to calculate the thermometer level for the characters. The emotional state information is represented by a *Property*.

5.3.3 User's Representation

Besides the characters' representations in the ION simulation, the User also needs a representation. As we presented earlier, the User performs actions towards characters, such as, granting roles, dismissing from roles or dismissing from the theatre company (p. 46).

Given this, these actions need to be processed in the ION simulation, in order for the *Remote*

Agent elements to receive events regarding the actions and transmit them to the FAtiMA agents' minds. Hence, the User needs an *ION Entity* representation in the ION simulation together with the *ION Actions* which define his actions towards agents (Figure 5.11).
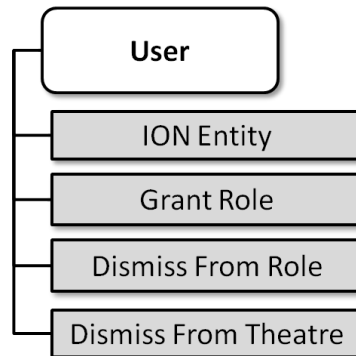
Figure 5.11: User's *Game Object* that contains the ION script *Components* which specify the User's representation in the ION simulation.

Therefore, whenever the User performs an action (grant, dismiss from role or dismiss from theatre) in the demonstrator, the corresponding *ION Action* will be requested to start in the ION simulation.

5.4 Complete Scenario

Now that we described all the aspects of the Dream theatre demonstrator, the agents' architecture, the application and the system that integrates these two aspects, we can now present an example of a complete scenario of the working system.

In this Section, we begin by introducing the illustrative scenario, where we describe each character. After that, we describe scenario process, which begins with the user's action that triggers a conflict situation between the characters.

5.4.1 Scenario Description

Consider that, the theatre company is planning to perform a play where only two roles need to be performed, the "Hero" and "Villain" roles. Further, at the time, two members, Andy and Bob, form the theatre company. Each character is characterised as follows:

- Andy – is a beginner in the theatre company, his proficiency level in theatre is **2**. Regarding the current play, he is interested in performing the **"Hero"** role.

- Bob – in contrast with Andy, this character is a bit more skilled in theatre, hence his proficiency level is **3**. However, role-wise, Bob shares the same desire as Andy, the **"Hero"** role.

Both characters are imbued with FAtiMA agents' minds integrated in which our conflict model is integrated. More precisely, Andy's mind is modelled with the "Attacking" personality, where its emotional thresholds and some emotional reactions are specified in Appendix A.1. On

other hand, Bob's mind is modelled with the "Evading" personality, his emotional thresholds and some emotional reactions are defined in Appendix A.2. Note that, initially, the user has no knowledge of each characters' personality. Further, both characters start with an "empty" emotional state. Their mood value is 0 and no emotions are currently active in the emotional state.

5.4.2 Scenario Process

As the demonstrator starts, the user inspects the characters' information. By noticing the proficiency levels, the user considers that Bob is the most qualified for the role, as Bob's proficiency is higher than Andy's. Hence, the user decides to assign the role to Bob. This action will then be appraised by the characters, which will behave as follows.

As soon as Bob appraises this action from the user, FAtiMA's deliberative layer will activate the correspondent active-pursuit goal to analyse the event, "AnalyseGrantGoal" (see p. 39). Upon the goal's activation, FAtiMA's planner will select the "AnalyseGrant" action correspondent to the situation, which will determine the following conflict description: "Bob, i-got-my-desired-role, Hero". With this, FAtiMA's appraisal will trigger the emotional reaction `E-em1` (see Appendix A.2). This emotional reaction will elicit a Joy emotion in Bob, which will trigger the "ExpressHappiness" action tendency. Thus, Bob will display a Happiness emotional expression (see (a) in Figure 5.4). Further, this emotion will affect Bob's mood positively.

In the same way, Andy's deliberative layer will activate the active-pursuit goal to analyse the event, "AnalyseGrantGoal" (see p. 39). With the goal activation, FAtiMA' planner will select the "AnalyseGrant" action that will result the following conflict description: "Bob, someone-got-my-desired-role, Hero". In contrast to Bob's reaction, the FAtiMA's appraisal will trigger the emotional reaction `A-em2` that will trigger Distress (negative desirability) and Resentment (negative desirability and positive desirability-for-other) emotions. With this, contrary to Bob, Andy will display a Sadness emotional expression (see (b) in Figure 5.4). Furthermore, Andy's mood is negatively affected by these emotions, which will affect his behaviour as follows.

After analysing the event, Andy will deliberate on how to approach it. Given that his mood was negatively affected by the previous event, an aggressive goal to approach the situation will be activated. Assume that Andy's mood will activate an *Insult*-based goal (see Table 5.7). Upon activation, FAtiMA's planner will create a plan to insult Bob. With this, Andy will perform the insult towards Bob.

With this aggressive action from Andy, Bob's analysis of this event triggers the `E-em4` emotional reaction, which elicits "Distress" and "Reproach" emotions. These emotions affect negatively Bob's mood, thus influencing his behaviour towards the situation. However, Bob's current mood still allows him to confront the situation with a rather cooperative by activating an "Ask why" goal. Hence, Bob will ask Andy the reason for his insult.

Although constructive, Bob's action towards Andy is perceived as unreasonable by Andy. Hence, it will elicit negative emotions in Andy, worsening his already negative mood. With this, harsher goals towards the conflict are activated. Therefore, Andy will perform an action more aggressive than the previous.

In the other hand, Andy's more aggressive behaviour will deteriorate Bob's mood even more,

leading his behaviours to evasive moves. This escalation of deteriorating moods and aggressive moves will drive the conflict to an extreme.

With Andy's escalating aggressive behaviours, Bob will end up reaching his "boiling point" (see p. 43). Thus, he triggers the "Over-frustrated" emotional expression (see (c) in Figure 5.4). Further, the high negative level of mood forces Bob to cope by activating a "Give up" goal. With this goal activation, Bob will end up quitting the role that was granted to him. When Andy perceives Bob forfeiting the role due to his attacks, he will display a "Gleeful taunt" emotional expression (see (d) in Figure 5.4).

After witnessing this sequence of destructive interactions, the user will have to deliberate on how to solve this conflict situation. Regarding that his last action leads Andy to attack Bob and this cancelled his action, as Bob forfeited, the user must choose a different strategy. Also, the user must concern that the characters' emotional states are now deteriorated. Thus, if a renewed conflict emerges, the situation will be even worse than the previous.

5.5   Concluding Remarks

This purpose of this Chapter was to explain how we implemented the agents and the system that they populate. To begin with, we described how we implemented the conflict model in FAtiMA agents' architecture [15], by taking advantage of its reactive and deliberative layers. Further, we presented the *Dream Theatre* game and how we implemented the demonstrator. With that, we described the overall system that integrates our agents with the demonstrator, through a world simulation framework, ION [52]. Finally, we presented an illustrative example of a user interacting with the *Dream Theatre* demonstrator and the agents functioning.

Chapter 6

Evaluation

In this Chapter, we describe how we tested our hypothesis concerning the effect of agents with an emotion-oriented architecture in the believability of conflict situations. We begin by describing the preliminary tests conducted, to a small group of participants, in order to obtain a first impression of how participants perceived the conflict situations that emerged from our conflict behaviours' model. The feedback from these tests was taken into concern to develop the final evaluation. Concerning the final evaluation, first it is described its overall structure and the manipulation between test conditions. After that, we describe how we measured our model's effectiveness, how we analysed the obtained results and a discussion about the results. Finally, we present some concluding remarks.

6.1 Preliminary Tests

As we described previously in Chapter 5, we developed a functional prototype of a conflict resolution game, *Dream Theatre*, in order to populate it with characters imbued with our conflict model (see Chapter 4).

Hence, we wanted to get a first impression from users about the conflict game demonstrator. However, with this first experiment, our main focus was to assess if users understood graphical cues that address that project the characters' internal state and their behaviours.

We performed this experiment with four participants (ages between 20-30). After interacting with the *Dream Theatre* demonstrator users' feedback was quite positive. However, a few minor corrections were made due to the feedback. First, users believed that the drag-and-drop system needed to be a bit improved. In the version they tested, whenever the user dragged a character or a role object, a GUI text appeared with the name of the element being dragged. However, users' believed that when they dragged that element over another element, a text with a brief description of the action should appear. For example, when a role object is dragged above a character it should appear "Give X role to Y", where X is the role name and Y is the characters' name. Therefore, we implemented this feature.

Other minor graphical corrections were also made, such as, correcting the time which emotional expressions and speech act balloons were visible, in order for users for perceive and understand these aspects easier.

With these corrections, we performed preliminary tests on our experiment, before moving

forwards with the final evaluation of our conflict model. Our aim with this preliminary experiment was to estimate participants' perception of the conflict emergence and escalation, and the characters' behaviours towards the conflict.

6.1.1 Method

In order to obtain an estimation of the above mentioned aspects, we performed preliminary tests with a small set of participants. The tests consisted of a first version of the questionnaire, where participants had to read some introductory information about the experiment, watch a recorded video of a user interacting with the *Dream Theatre* demonstrator, answering a questionnaire regarding what they saw on the video and, finally, answer a few questions about the experiment and give any comments about it.

Eleven participants (ages ranging from 20 to 40) cooperated in our preliminary experiments, where three of these participants had already interacted with our demonstrator in the previously mentioned first impression test. However, there were no significant differences in the results and the feedback between these participants and the others who did not interacting with the *Dream Theatre* demonstrator.

Our experiment consisted in two different conditions of our recorded videos: one with our emotionally-driven conflict model and another with a non-emotionally driven model. In order to better understand our preliminary experiment, we give a brief explanation of the scenarios portrayed in the videos. A more detailed description of each condition is provided further ahead in this Chapter.

The scenarios' presented in the videos are similar to the complete scenario described previously in Section 5.4). In each scenario, the user is faced with the responsibility to plan a theatre play. The current play only has two roles, "Hero" and "Villain", to be performed and the theatre company has two members available, Andy and Bob. Hence, the user needs to choose which one will perform which role. By verifying each character's information, the user notices that both desire the same role, "Hero". However, the user decides to give the role to Bob, as he has a higher proficiency than Andy. Therefore, the user grants the role to Bob. After this action, each condition shows a different sequence of interactions between the agents, as follows.

If characters follow the emotional model, when Andy perceives that Bob got the "Hero" role, he will be upset, thus he will start the discussion with an insult towards Bob. In turn, this insult will make Bob upset. However, he still finds himself emotionally capable of asking the reason for such insult. Andy will appraise this move by Bob as unacceptable. Hence, he becomes even more upset, which will drive him to use a more extreme behaviour towards Bob. This spiral of emotional degradation and aggressive behaviours will lead Bob to finally give up on performing the "Hero" role.

On the other hand, if characters do not follow the emotional model, they remain "neutral" throughout the whole discussion. Therefore, when Andy perceives the "Hero" grant to Bob, he will approach Bob by questioning him. Without being affected by this question, Bob simply states his reason. The discussion will then unroll until Andy requests the role from Bob, where the latter refuses such request.

Two videos were recorded, where each one presents each condition presented above. There-

fore, two questionnaires were prepared, one with the video presenting the emotional model and another questionnaire with the non-emotional model. Some of the participants collaborated in both questionnaires.

We obtained important feedbacks from the participants. Note that, with these preliminary tests we did not gather statistic data, as we are more interested in participants' feedback regarding the experiment. Further, iterative changes were made to the experiment structure based on participants' feedback.

6.1.2 Feedback

An important set of feedbacks was retrieved from the preliminary tests. First, participants found difficult to perceive the characters' thermometer rising. Participants who had already tested the demonstrator previously pointed this fact straight away. On the other hand, participants who did not test the demonstrator previously did not noticed the thermometers rising, thus they disregarded this feature which helps to identify characters' emotional states. This issue occurred due to the fact that this demonstrator's version only showed up the characters' thermometer when the user checked the information cloud (Figure 5.3) and, in the video, the character information cloud was visualised few times (not the necessary to perceive the rising of thermometers).

Hence, to solve this problem, we implemented the thermometer to be always visible (as represented in Figure 5.2). Therefore, it is easier to perceive the thermometers rising.

Next, regarding the non-emotional condition (SM), participants argued that even though characters' did not express emotional expressions, it was possible to make assumptions about characters' behaviours or emotional states due to their speech acts. Even though we tried to create a neutral conversation, participants found that some speech acts seemed aggressive. Two participants even stated that Bob seemed slightly dominant and Andy seemed submissive and a bit of a beggar. We believe that this assumption was made regarding the fact that Bob was the one who got the role, and Andy's speech consisted of persistent requests (in a neutral tone), where Bob denied all these requests (also in a neutral tone). Thus, this interaction of request (from Andy) and denials (from Bob) might have lead participants to perceive that Bob had some kind of power and that Andy was being submissive.

To diminish this assumption on the characters' behaviours, we made several iterations with different speech acts for the agents in the non-emotional condition (SM). In the end, from this empirical testing, we got a neutral conversation between the two characters (as presented in Appendix B.1.2).

Finally, some minor feedbacks were also concerned, such as: the introductory text needed some more images explaining graphical aspects from the demonstrator; the user interactions recorded in the videos were too fast; and participants often mistaken characters' identities, as their clothes' colours were grey and light-blue. Therefore we: added screenshots of the graphical aspects (characters, character information cloud and role object) and a brief description for each one (see Appendix B.2); recorded again the videos with slower user interactions; "dressed" characters with more distinguished colours, green and blue.

After the preliminary tests and the retrieved feedbacks, we made the previously mentioned

corrections and changes, and proceeded to the statistical evaluation of the model.

6.2 Evaluating the Conflict Model

Motivated by the fact that most multi agent systems only regard conflict as a goal incompatibility or collaborative problem between agents [10], our research is more focused on the real life aspect of conflict simulation between agents. Further, as we intend to create synthetic characters to populate an educational conflict resolution game, the characters' believability in conflict emergence and conflict handling behaviours is important.

To achieve such goal, we developed a prototype of an educational conflict resolution game, *Dream Theatre*, which is populated with agents that are imbued with a conflict model. This model is based in an emotional system, FAtiMA [15], and we claim that this emotional process is essential to convey concepts as conflict emergence and escalation. Therefore, we tried to assess whether people recognise a conflict interaction by evaluating its participants' behaviours, contributions and outcomes.

6.2.1 Objective

This experiment was designed to to validate our hypothesis presented in the Introduction of this document.

> *If the agents' decision-making process steams from an emotion-oriented architecture, their behaviours will be based on emotional grounds and intensity, which will play an important role in overt manifestations of conflict and users may recognise such behaviours as believable.*

To corroborate our hypothesis, we developed a conflict resolution game's demonstrator, which is populated with agents. These agents are imbued with a model that supports conflict emergence and handling, driven by emotions. It is our belief that the emergence and handling of conflict situations are more believable when the emotional process affects the characters' behaviours.

6.2.2 Procedure

A total of 80 participants (20 females, 60 males aged 14-48)[1] took part in the experiment, which was available through an online questionnaire. We distributed invitations for the experiment through email (institutional mailing lists) and social networks.

In this experiment, it was required that participants watched a recorded video of a user interacting with the *Dream Theatre* demonstrator. The scenario portrayed in the video was described by an introductory text, where it was also explained the graphical elements presented in the video. The scenario presented in the video was similar to the one presented in Section 5.4.1, where the user gives a role to Bob, as he is more proficient than Andy. From this, a sequence of interactions occurs between Andy and Bob. The interactions performed by characters in the video are influenced by the test conditions, which participants were randomly assigned to.

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[1]Although the age range it is not the same as the target population for the learning game, with this experiment we wanted to assess participants' perception of conflict as a result of the characters' behaviours.

6.2.3 Test Conditions

For our experiment, we performed a between-groups evaluation, in which one group of participants was exposed to a condition and another group of participants was exposed to another condition. Each participant was randomly assigned to a certain condition by the online questionnaire's system. Hence, participants were exposed to the following test conditions.

Emotional or Full Model condition

This condition represents how the characters behave when following our conflict model, where the emotional process affects their behaviours. Therefore, we name it emotional condition or full-model condition (FM). The sequence of interactions portrayed in this condition is similar to the one presented in Section 5.4.1. Hence, characters behave according to their emotional state and their predisposition for certain behaviours.

When the user grants the role to Bob, characters will appraise this event and evaluate it according to the conflict model. Bob will perceive this event as stimulating to this interests, thus positive emotions will be generated. Further, these emotions will trigger the emotional reaction of expressing happiness. On contrary, Andy will perceive this event as frustrating to his concerns. Therefore, negative emotions are elicited, triggering the emotional reaction to express sadness. Following this, with the deteriorated emotional state, Andy will approach Bob with a minor aggressive behaviour, by insulting him. After that, Bob asks for the reason of such insult, which will further aggravate Andy's frustration, leading him to follow with a more aggressive behaviour, a destructive critic towards Bob's proficiency in the role. Even though Bob's emotional state is deteriorating, he still responds to Andy by denying the critic. This last action leads Andy to become even more irritated and thus, he attacks Bob with an insulting critic. This last attack drives Bob to his emotional limits. Hence he tries to evade from further discussion by abandoning the "Hero" role and agreeing with Andy's critics. When Andy perceives this, he taunts over the situation with a gleeful smirk.

The characters' interactions demonstrated in this condition is detailed in Appendix B.1.1.

Non-emotional or Simplified Model condition

In this condition, the agents' architecture was manipulated to shutdown the emotional process. Thus, characters do not elicit emotions from events. Hence, the emotional states are not affected. Therefore, characters' behaviours will maintain "neutral" throughout the situation. This condition serves as baseline to probe our hypothesis, by comparing it with our emotionally-driven conflict model (FM).

The interaction between characters in this condition is quite different from the first. As no emotional process is used in this conditions, characters maintain themselves "neutral" throughout the situation. When Andy perceives that the "Hero" role was given to Bob, he tackles this decision by questioning Bob about how he got that role. From that, Bob responds to Andy's question by simply stating what he was the chosen one. With this, Andy states that he also wanted the role, in which Bob acknowledges this statement and replies that, however, he mentions that the role is his now. Following that, Andy asks if Bob could give the role to him, where

Bob denies such request.

The detailed sequence of interactions for this condition is described in Appendix B.1.2. Note that, the "neutral" interactions performed by characters were empirically determined, in order to diminish participants' assumptions, as we explained earlier in the Preliminary Tests.

6.2.4 Structure

Besides the introduction text and images, and the video which participants had to watch, the questionnaire (presented in Appendix B.2) can be abstractly divided in four sets of questions (see Figure 6.1). Further, the questionnaire ends with two demographic questions: age and gender.
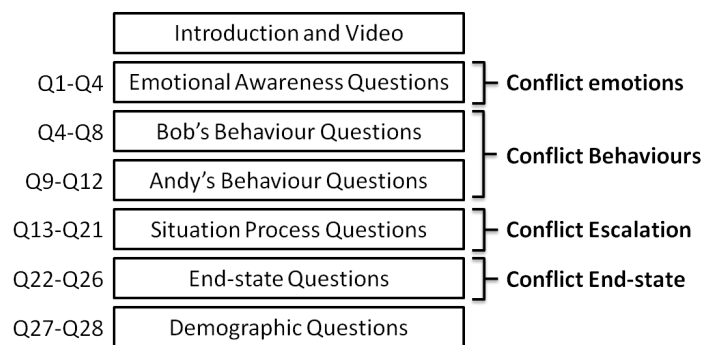
Figure 6.1: Final experiment structure.

1st Set – Emotional Awareness Questions

This first set of questions address participants' emotional awareness of characters' emotional state (questions Q1 to Q4). The first two questions (Q1 and Q2) address each character's emotional state after the user's action (granting the role to Bob). The following questions (Q3 and Q4) assessed characters' emotional state in the end of the discussion.

2nd Set – Characters' Behaviours Questions

The following set of questions evaluated participants' perception of characters' behaviours (questions Q5 to Q12). The first four (Q5 to Q8) were directed to Andy's behaviour, while the following four (Q9 to Q12) were addressed to Bob's behaviour.

3rd Set – Situation Process Questions

Next, the third set of questions asked participants were probed about the situation process (questions Q14 to Q21). For that, the first five answers determined how much did participants perceive that the situation worsened (Q14 to Q17) and how much did they perceive that the situation got better (Q18 to Q21).

4th Set – End state Questions

Finally, participants were asked about the end state of the situation (questions Q22 to Q26). The first two questions (Q22 and Q23) assess the participants' perception of the praiseworthiness of characters' behaviours. Following this, the next two questions (Q24 and Q25) asked participants if they believe that characters should improve their behaviours. Finally, participants were asked if they believe that is probable that another discussion may happen in the future.

6.2.5 Measures

With the aforementioned questions, we intended to measure participants' perception of certain aspects concerning the conflict situation portrayed in the recorded videos, such as: the emotions elicited at the start and the end of the situation, the characters' behaviours towards the situation, the conflict escalation and de-escalation process and the end-state of the situation. These measures were probed as follows.

Conflict emotions

With this measure, we aimed at achieving results for exploratory reasons, where we asked participants to point characters feeling through the following questions: how did Andy feel when the role was granted to Bob; how did Bob feel when the role was granted to him; how did Andy feel in the end of the conflict; and how did Bob feel in the end of the discussion.

We based on Kreidler's work [21] for assessing children's levels of frustration through a thermometer representation that comprised the following emotions (from less intense to most intense): "bored", "irritated", "angry", "furious", "enraged". Further, we assessed "happy" emotion and an option for stating that the participant did not understand which emotion the character was feeling.

Conflict behaviours

To assess this measure, we adapted the set of questions from a self-serving questionnaire on conflict behaviour and escalation [13]. This particular questionnaire already has a well-defined structure and measures for evaluating one's own behaviour once in a conflict. Adding to that, the statements offer a static and objective view of conflict and the escalation process in a "narrative way". However, we aim to address this measures in a third-person perspective.

Therefore, we evaluated this measure by asking participants to rate each characters' behaviour through 5-point likert scales, which address to what extent each character's behaviours was [13]:

(a). Hostile or Friendly (1 - *very hostile* to 5 - *very friendly*);

(b). Competitive or Collaborative (1 - *very competitive* to 5 - *very collaborative*);

(c). Frustrating or Stimulating (1 - *very frustrating* to 5 - *very stimulating*);

(d). Evil-minded or Good-hearted (1 - *very evil-minded* to 5 - *very good-hearted*).

Conflict escalation process

To determine this measure from participants, we continued with the self-serving questionnaire on conflict behaviour and escalation used in De Dreu's et. al. [13] study. We based on the set of measures used to obtain a process-oriented index of conflict escalation. Therefore, through 5-point likert scales, we measured participants' perception of escalation and de-escalation, by asking participants' ratings on [13]:

(a). To what extent did parties obstruct each other;

(b). To what extent did frustration increase;

(c). To what extent did the atmosphere worsen;

(d). To what extent did parties work out an ideal solution;

(e). To what extent did parties come closer;

(f). To what extent were ideas explored.

Each measure is rated from 1 - *not at all* to 5 - *very much*.

Conflict end-state

Similar to the previous measures, we inspired in De Dreu's [13] study to measure participants' apprehension of the end-state of the conflict escalation. However, some measured variables from the self-serving questionnaire were not assessed by our experiment. The self-serving questionnaire measured: the chance of a renewed conflict, if there was a stalemate, and if there was an integrative solution. From these measures, we do not regard the second and the last.

First, in the scenarios demonstrated by the recorded videos, due the conditions that each video demonstrates, the outcome is different (in the FM condition, Bob gives up the role; and in the SM condition, Bob stays with his role). Hence, we believe that measuring this variable would not give us proper results. Also, measuring if an integrative solution was achieved also will not return proper results, given that in both conditions no solution between the characters is even considered.

With this in consideration, from the self-serving questionnaire, we only regarded to measure the change of renewed conflict. Further, for exploratory reasons, we wanted to assess participants' view on the reasonableness of characters' behaviours and if participants believe that characters need improvements to such behaviours.

These measures were rated by participants through 5-point likert scale, from −2 - *totally disagree* to 2 - *totally agree*.

6.2.6   Results

The collected data from the experiment was analysed using the Mann-Whitney test to compare the difference between the two conditions (agents with the emotional-driven model and agents without the emotional process).

1st Set – Conflict emotions

Given our intentions with this measure, the result did not provide a significant result, as some problems where found with this set of questions. Hence, we will not analyse these results.

2nd Set – Conflict Behaviours

As we explained previously, the second Set of questions rates the agents' behaviours towards the situation. To begin with, questions Q5 to Q8 correspond to the (a) to (d) variables of the conflict behaviour measures (p. 63) directed to Andy's behaviour. After that, questions Q5 to Q8 relates to the same variables addressed to Bob's behaviour.

First, we address Andy's behaviour. Table 6.1 summarises the results obtained for the participants rating of Andy's behaviour and presents the differences between the two conditions (FM and SM). Further, Figure 6.2a displays a graphical visualisation of the statistics described in the Table 6.1.

| Question | 2nd Set - Andy's Behaviour Measure | Descriptive Statistics | | Mann-Whitney |
		FM ($N = 40$) Mdn[Quartiles]	SM ($N = 40$) Mdn[Quartiles]	
Q5	(a) hostile or friendly	$1[1, 2]$	$3[2, 3]$	$U = 298.500$ $p < 0.001$ $r = -0.565$
Q6	(b) competitive or collaborative	$1[1, 2]$	$2[2, 3]$	$U = 455.500$ $p < 0.001$ $r = -0.390$
Q7	(c) frustrating or stimulating	$2[1, 3]$	$2[2, 3]$	$U = 647.000$ ns
Q8	(d) evil-minded or good-hearted	$1[1, 2.5]$	$3[2, 3]$	$U = 365.500$ $p < 0.001$ -0.488

Table 6.1: Mann-Whitney statistics for participants' perception of Andy's behaviour within the two conditions (FM and SM).

Taking a look at the results, from Q5, users' considered Andy's behaviour in the FM condition significantly ($p < 0.001$) more hostile ($Mdn = 1.5$), in comparison with the result from the SM condition ($Mdn = 3$). The same happened in Q7 and Q8, where his behaviour was found significantly $p < 0.001$ more competitive ($Mdn = 1$) and evil-minded ($Mdn = 1$) in the FM condition, comparing to the SM condition ($Mdn = 2$ and $Mdn = 3$). However, Q7 there were no significant differences in the participants' perception of Andy's frustrating behaviour between the FM condition and SM conditions.

Despite that, the obtained results are consistent with its internal drives to follow a destructive path in a conflict interaction, modelled in the FM condition. In the SM condition, Andy's neutral attitude contributed for results distributed in the middle of the scale (see Figure 6.2a).

On the other hand, Table 6.2 specifies the results gathered for participants' perception of Bob's behaviour and it presents the difference between the FM and SM conditions. Figure 6.2b represents those results graphically.

Bob's attitude was considered to be more constructive. In Q9, Q10 and Q12 of the FM condition, selected values go towards the other extreme of the scale ($Mdn = 4$, $Mdn = 4$, $Mdn = 4$), compared to Andy's score. Further, Bob was considered significantly ($p < 0.001$)

| | | Descriptive Statistics | | |
Question	2nd Set - Bob's Behaviour Measure	FM ($N = 40$) Mdn[Quartiles]	SM ($N = 40$) Mdn[Quartiles]	Mann-Whitney
Q9	(a) hostile or friendly	4[3, 4]	3[2, 3]	$U = 375.500$ $p < 0.001$ $r = -0.470$
Q10	(b) competitive or collaborative	4[3, 4]	2[1, 2]	$U = 287,000$ $p < 0.001$ $r = -0.566$
Q11	(c) frustrating or stimulating	3[2, 3]	3[2, 3]	$U = 793.500$ ns
Q12	(d) evil-minded or good-hearted	4[3, 4.5]	3[2, 3]	$U = 428.000$ $p < 0.001$ $r = -0.421$

Table 6.2: Mann-Whitney statistics for participants' perception of Bob's behaviour within the two conditions (FM and SM).

more friendly than the SM condition ($Mdn = 3$, $Mdn = 2$, $Mdn = 3$). Despite the significant ($p < 0.001$) differences between the two conditions, the non-emotional condition (SM) has provoked more responses towards the destructive side of the spectrum. We believe that such responses were due to participants' subjective view on Bob's neutral posture towards the conflict situation. On the SM condition, in contrast to FM, Bob did not give in to Andy's actions. Therefore, participants might have perceived this as being competitive, as we can see in Q10 ($Mdn = 2$) of the SM condition, where participants have reported a more competitive behaviour in Bob compared to the FM condition ($Mdn = 4$).

Nevertheless, the results are consistent with Bob's initially cooperative behaviour modelled in the FM condition.

(a) Box-plot for Andy's behaviour
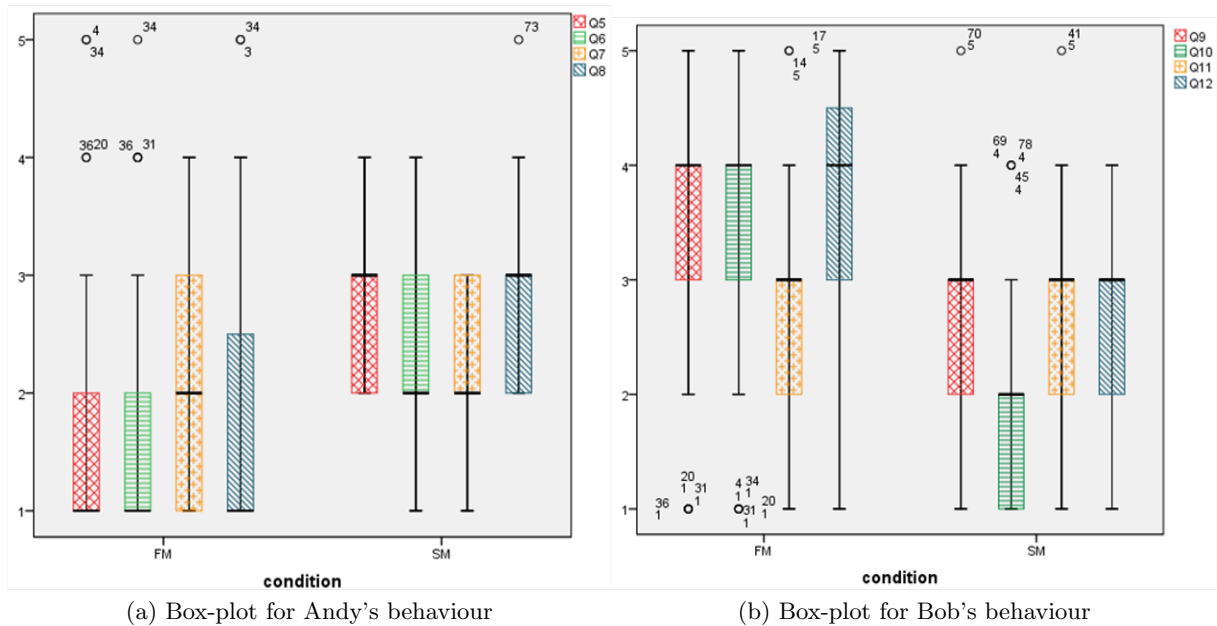

(b) Box-plot for Bob's behaviour

Figure 6.2: Blox-plots that describe how people perceive characters' behaviours within the two conditions (FM and SM).

3rd Set – Conflict Escalation

The third Set of questions assesses the escalation (questions Q13 to Q17) and the de-escalation (questions Q18 to Q21) processes of the conflict situation. First, questions Q13 and Q14 are adapted to the context of the scenario to determine the (a) variable from the conflict escalation measurement (p. 6.2.5), where Q13 regards to Andy frustrating Bob and Q14 regards Bob frustrating Andy. Similarly, Q25 and Q16 are also adapted in order to assess the (b) variable, regarding Andy and Bob's increase of frustration, respectively. Finally, questions Q17 to Q21 relate to the variables (c) to (f).

Starting with the escalation process measurement, Table 6.3 contains the results and it compares condition FM with condition SM. In Figure 6.3a, we represent these results in a graphical form.

| Question | 3rd Set - Escalation Measure | Descriptive Statistics | | Mann-Whitney |
		FM ($N = 40$) Mdn[Quartiles]	SM ($N = 40$) Mdn[Quartiles]	
Q13	(a) To what extent did Andy obstruct Bob	$5[4, 5]$	$1[1, 2]$	$U = 109.500$ $p < 0.001$ $r = -0.766$
Q14	(a) To what extent did Bob obstruct Andy	$2[1, 2]$	$4[2.5, 5]$	$U = 284.000$ $p < 0.001$ $r = -0.572$
Q15	(b) To what extent did Andy become more frustrated	$3[2, 4.5]$	$4[3, 5]$	$U = 623.000$ ns
Q16	(b) To what extent did Bob become more frustrated	$4[3, 5]$	$1[1, 2.5]$	$U = 232.000$ $p < 0.001$ $r = -0.627$
Q17	(c) To what extent did did the atmosphere worsen	$5[4, 5]$	$4[3, 4.5]$	$U = 368.500$ $p < 0.001$ $r = -0.503$

Table 6.3: Mann-Whitney statistics for participants' perception of conflict escalation within the two conditions (FM and SM).

As expected, the results obtained from this set of questions were quite expressive. First, in question Q13, participants significantly ($p < 0.001$) reported that Andy frustrated Bob more in the FM condition ($Mdn = 5$), compared to the SM condition ($Mdn = 1$). In contrast, in question Q14, Bob was significantly ($p < 0.001$) rated as less frustrating in the FM condition ($Mdn = 2$), then in the SM condition ($Mdn = 4$).

Next, in Q15, no significant difference was detected between conditions regarding Andy's increase of frustration. This was quite expected given that in both conditions, Andy could not achieve the role. However, in the FM condition, it was not expected so many ratings in the middle of the scale ($Mdn[Quartiles] = 3[2, 4.5]$). We believe that this ratings were due to participants' interpretation of Andy's gleeful smile, as this emotional expression may have conveyed to participants that he achieved his goals.

On the other hand, in Q16, the significant ($p < 0.001$) difference between Bob's increase of frustration in the FM ($Mdn = 4$) and the SM ($Mdn = 1$) conditions was as predicted. Since Bob opted out of performing the role in the FM condition, due to reaching the limits of his emotional control, participants could easily perceive an increase in his level of frustration. In contrast, Bob's neutral posture throughout the SM condition demonstrated no signs of frustration increase.

Finally, as we forecasted, in Q17, participants' ratings of the atmosphere worsening were

significantly ($p < 0.001$) different between the FM ($Mdn = 5$) and the SM ($Mdn = 4$) conditions. This result is consistent with our process of conflict escalation, which emerges from the emotional states' deterioration.

Moving on to probe participants' perception of conflict de-escalation, the gathered results of participants' ratings are described in Table 6.4 and graphically represented in Figure 6.3b.

Question	3rd Set - De-escalation Measure	Descriptive Statistics		Mann-Whitney
		FM ($N = 40$) Mdn[Quartiles]	SM ($N = 40$) Mdn[Quartiles]	
Q18	(d) did characters work out an ideal solution	$1[1, 2]$	$1[1, 2]$	$U = 771.500$ ns
Q19	(e) did characters come closer	$1[1, 1]$	$1[1, 1.5]$	$U = 637.000$ ns
Q20	(f) did characters search for a common way out	$1[1, 2]$	$1[1, 1.5]$	$U = 772.000$ ns
Q21	(g) did characters explore new ideas to solve the situation	$1[1, 2]$	$1[1, 1.5]$	$U = 732.000$ ns

Table 6.4: Mann-Whitney statistics for participants' perception of conflict de-escalation within the two conditions (FM and SM).

As we can see from the results of questions Q18 to Q21, no significant differences were reported between conditions. This result demonstrates that participants' perception is coherent with conflict process demonstrated in each condition. Following the FM condition, since the sequence interactions are emotionally-driven and the interactions performed by characters deteriorated each others' emotional states, the conflict only tended to escalate to an extreme intensity, no de-escalation occurred. On the other hand, in the SM condition, the interactions were not affected by the emotional process. Hence, the characters maintained a "neutral" discussion. Therefore, no conflict escalation or de-escalation processes were demonstrated.

4th Set – Conflict End-state

The final Set of questions (Q22 to Q26) presented in our questionnaire aimed at measuring participants' perception of the conflict end-state. The first two questions from this Set (Q22 and Q23) assessed participants' belief of the reasonableness of characters' behaviours. After that (Q24 and Q25), participants stated if they believe that characters' should improve their behaviours. Finally, it was asked for participants to rate their belief on the chance of renewed conflict between characters.

For this measures, Table 6.5 summarises the results of participants' ratings, where Figure 6.4 displays these results graphically.

To begin with, in Q22, the result on participants' rating of the reasonableness of Andy's behaviour was significantly ($p < 0.001$) different between FM ($Mdn = -2$) and SM ($Mdn = 0$) conditions. The result of this measure in the FM condition ($Mdn = -2$) demonstrated that our emotionally-driven conflict model was able to portray behaviours destructive enough for participants to rate them as not being reasonable, compared to "neutral" behaviour represented in the SM condition ($Mdn = 0$).

On the other hand, Bob's ratings of reasonable behaviour were not as conclusive as Andy's

(a) Box-plot for conflict escalation
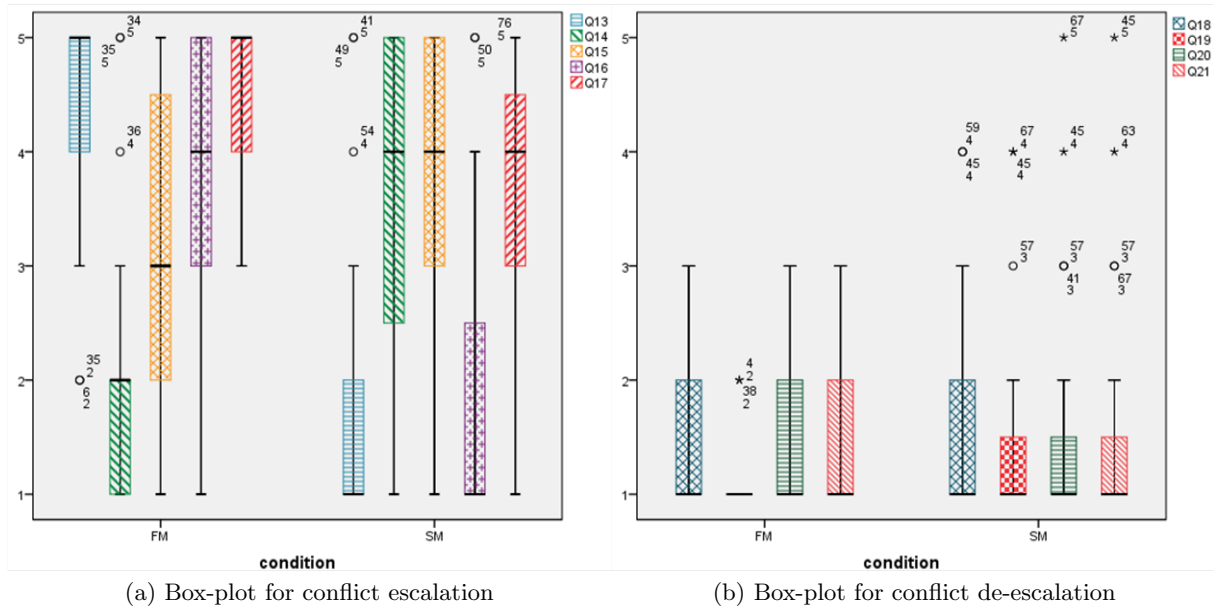(b) Box-plot for conflict de-escalation

Figure 6.3: Blox-plots that describe how people perceive the process of escalation and de-escalation of the conflict (FM and SM).

ratings. No significant difference was found in Q23 between the FM and SM conditions ($Mdn = 0$ and $Mdn = 0$). We believe that such results may be due to the duality of Bob's behaviours in the FM condition. Given that in the FM condition, initially, Bob's behaviours towards Andy's increasingly aggressive attacks might be rather constructive, as the conflict escalates to an extreme, Bob starts to lose some emotional control and copes with this by following a more evasive behaviour (see Section 5.1.3, p. 44). Therefore, we assume that this duality lead participants to rate Andy's reasonable behaviour in the middle of the scale, in the FM condition. Further, in the SM condition the ratings in the middle of the scale are due to Bob's "neutrality" throughout the situation, in the SM conditions.

Moreover, in Q24, participants pointed that Andy's behaviour in the FM condition needed improvement. A significant ($p < 0.001$) difference was found between this result in the FM condition ($Mdn = 2$) and SM condition ($Mdn = 1$). This result is coherent with the result of Andy's reasonable behaviour rating.

Regarding Bob, in Q25, the results were not conclusive concerning participants' view on behavioural improvement. There was no significant difference between FM ($Mdn = 1$) and SM ($Mdn = 1$) conditions. Similar to our beliefs for Bob's rating of reasonable behaviour (Q23), we posit that the result in the FM condition is due to the duality in Bob's behaviours. Therefore, the result for Q24 in the FM condition had a wide discrepancy ($Mdn[Quartiles] = 1[-0.5, 2]$).

Finally, in Q26, participants' ratings on the possibility of a renewed conflict situation did not provide a significant difference between the FM ($Mdn = 2$) and the SM ($Mdn = 1.5$) conditions. This result was quite unexpected. Taking a look at each condition, even though the result for the FM condition was as expected, the SM condition also had the same score. Hence, we have to discard the argument that participants rated that there was a high probable chance of renewed conflict due to the conflict escalation portrayed in the FM condition.

| Question | 4th Set - End-state Measure | Descriptive Statistics | | Mann-Whitney |
		FM ($N = 40$) Mdn[Quartiles]	SM ($N = 40$) Mdn[Quartiles]	
Q22	Andy's behaviour was reasonable	$-2[-2, -2]$	$0[-1, 1]$	$U = 297.000$ $p < 0.001$ $r = -0.585$
Q23	Bob's behaviour was reasonable	$0[0, 1]$	$0[-1, 1]$	$U = 662.500$ ns
Q24	Andy needs to improve his behaviour towards this situations	$2[2, 2]$	$1[0.5, 2]$	$U = 389.000$ $p < 0.001$ $r = -0.505$
Q25	Bob needs to improve his behaviour towards this situations	$1[-0.5, 2]$	$1[0, 2]$	$U = 737.000$ ns
Q26	There is a chance for Andy and Bob to discuss again	$2[1, 2]$	$1.5[1, 2]$	$U = 724.500$ ns

Table 6.5: Mann-Whitney statistics for participants' final remarks on the conflict situation within the two conditions (FM and SM).
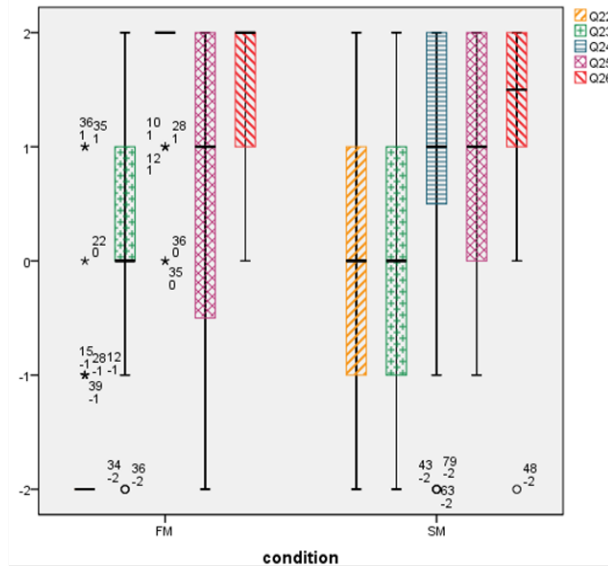
Figure 6.4: Blox-plots that describe participants' final regards about the conflict within the two conditions (FM and SM).

6.3   Concluding Remarks

The purpose of this Chapter was to describe how we probed our research hypothesis. To do so, we presented how we conducted preliminary tests. In which, we tested our conflict resolution game demonstrator in order to assess if the graphical aspects and user interaction was perceptible, where a few graphical aspects were corrected. After that, we performed preliminary experiments where a small group of participants were exposed to variations of scenarios based in Section 5.4.1 in order to obtain feedback from the participants. From this experiment's feedback, we noticed that participants made assumptions on characters' behaviours due to the speech acts performed in the non-emotional condition of our scenario. To solve this, we conducted empirical tests in order to find the most neutral set of speech acts for characters for the SM condition.

After that, we described the final evaluation where the previously mentioned feedback was

considered. Our main goal with the experiment was described as assessing the effectiveness of agents modelled by an emotional-architecture, provided with escalating behaviours, to simulate believable occurrence and resolution of conflict situations. With that, it was presented our procedure of exposing 80 participants to our scenario. In order to evaluate our hypothesis, we conducted a between-groups experiment with two conditions: emotionally-driven model or full model (FM), and a non-emotionally driven model or simplified model (SM). The latter condition was stated to be our control condition.

Further, by comparing the results from the FM and SM conditions, we achieved some conclusions. First of all, in the measurement of characters' conflict behaviours, significant ($p < 0.001$) differences where found between conditions in terms of characters' ratings of: *hostility vs. friendliness*, *competitiveness vs. collaboration* and *evil-minded vs. good-hearted*. The respondents' ratings were consistent with the characters' behaviours modelled in the FM condition, Andy was rated to the destructive side of the scale (hostile, competitive and evil-minded), whereas Bob was rated to the other extreme of the scale (friendly, collaborative and good-hearted).

Additionally, in the measurement of conflict escalation, Andy's escalating aggressive behaviour in the FM condition lead participants to rate that he was frustrating Bob significantly ($p < 0.001$) more than in the SM condition, where he shows a "neutral" posture towards the situation. However, his increase of frustration did not show a significant difference between conditions. In the other hand, Bob's cooperation and further evasion towards the escalating intensity of the situation, conveyed to responders that he frustrated Andy significantly ($p < 0.001$) less than in the SM condition. However, Bob became significantly ($p < 0.001$) more frustrated in the FM condition, rather than in the SM condition. Further, in the FM condition participants reported that that he atmosphere became significantly ($p < 0.001$) worse in the FM condition. Finally, as expected the measurement of conflict de-escalation did not present any results, regarding that no de-escalation was demonstrated in both conditions.

Taking a look at the end-state of the conflict, our exploratory measures presented the experiment with some insightful results. First, participants found Andy's behaviour significantly ($p < 0.001$) more unreasonable in the FM condition, than in the SM condition. On the other hand, Bob's behaviour reasonableness did not show any significant difference between conditions. In both, participants did not agree or disagree about Bob's reasonable behaviours. Given that for the SM condition, we can justify this result with Bob' "neutral" posture, in the FM condition we associate this result with the duality in Bob's behaviour. After that, only Andy was rated as needing improvement to his behaviour significantly ($p < 0.001$) more in the FM condition, than in the SM condition. Finally, no significant ($p < 0.001$) difference was found about reports of probable renewed conflicts between conditions. This showed that even though no escalation was demonstrated in the SM condition, participants strongly agreed that a renewed conflict was probable.

Concluding what we saw in the results, the emotionally-driven (FM) condition provided a more believable conflict situation, compared to the non-emotional (SM) condition, which supports our hypothesis. In the FM condition, characters' emotionally-driven behaviours provided participants with a better perception of the characters' behaviour towards conflict. Further, in the FM condition, the characters' escalating behaviours influenced by their emotional state con-

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veyed the clear perception of conflict escalation. Lastly, from our exploratory measurements of the conflict end-state, participants found Andy's behaviour to be significantly ($p < 0.001$) more unreasonable and needed improvements in the FM condition, compared to the SM condition.

Chapter 7

Conclusion

As we argued in the beginning of this document, conflict is natural to human life, as it is present in our everyday basis [26]. However, conflict is mostly seen as a negative act that needs to be eradicated. Contrarily, researchers have proven that embracing conflict in a constructive way serves as a tool for constructive personal growth [26], especially in young ages [21]. For that, conflict resolution education has been applied in schools in order to teach students about conflict and how to handle it constructively [19].

Concerning education, new teaching tools have been researched, such as, serious games. This kind of games have been used for raising awareness [38], teaching about subjects [40], how to deal with bullying [4], and others.

Motivated by this, the SIREN project intends to create a series of conflict resolution games to teach children on how to deal with conflict situations [11]. Our contribution for this project concerns the creation of a conflict resolution game that is populated with autonomous virtual characters.

Hence, with this research we aim to assess the following problem:

How can we create autonomous agents, for a serious game, that are able to identify social conflict situations with other agents and handle them in a believable way?

Which we tried do solve this problem with the following hypothesis:

If the agents' decision-making process stems from an emotion-oriented architecture, their behaviours will be based on emotional grounds and intensity, which will play an important role in overt manifestations of conflict and users may recognise such behaviours as believable.

In order to achieve this hypothesis, we investigated theory of conflict in social psychology. From this we demonstrated especial regard to Thomas' [49] definition of conflict as "the process which begins when one party perceives that another has frustrated, or is about to frustrate, some concern of his" and Castelfranchi's [10] definition of "full social conflict", which exists when "there is the subjective awareness of the competitive situation".

Further, we reviewed educational games for raising awareness on general populate [38], teaching children about a subject [40] and games that involve conflict in the matter of: social interactions [30], intractable conflicts [8], and bullying [4]. However, from the reviewed games, only

FearNot! [4] assessed emotion in the conflict situations, which is supported by FAtiMA architecture of emotional agents [15].

With the conflict theory review, we implemented an agents' model that comprises emotional affect in the conflict handling process. In a nutshell, our model consist of the agent perceiving if an event is directed to his concerns, where such perception will elicit emotional affect according to how the event is perceived to obstruct or stimulate the concern. Finally, behaviours are selected in line with the state of the world, the agent inward beliefs and his emotional state.

To demonstrate our model, we implemented a conflict resolution game's demonstrator, *Dream Theatre*. This demonstrator was populated with synthetic characters modelled by our conflict model in an emotional agents' architecture, FAtiMA [15].

In order to prove our hypothesis, we performed a between groups experiment with 80 participants. Each participant was randomly assigned to one of two test conditions. One condition supported our conflict model, where agents' behaviours are emotionally-driven, we called it *emotionally driven* or *full-model* (FM) condition. Another condition, which served as a control condition to test our hypothesis, imbued agents with a variation of our model where the emotional process was deactivated, we called it *non-emotionally driven* or *simplified-model* (SM) condition.

With the experiment's results, we compared both conditions to assess if our model's condition (FM) issued better perceptions of the conflict situation, compared to the *simplified-model* (SM) condition. From the result's analysis, we confirmed that in the FM condition, participants had a better perception of the characters' behaviours towards conflict, and their roles in the situation. Further, in the FM condition, the characters' escalating behaviours influenced by their emotional state conveyed the clear perception of conflict escalation. These results where consist with your hypothesis.

Nevertheless, our conflict model opens several opportunities for future work.

7.1 Future Work

Even though we achieved expressive results that confirm our hypothesis, several aspects can be explored for further improvement. As we referred throughout the description of our conflict model, several aspects were left open for exploratory reasons:

- To begin with, social relationship influence in conflict situations need to assessed. In the current version of our model, we defined a simple binary relation between characters. However, more complex social networks can be implemented, inspired by the CiF model [30]. Further, the influence of conflict in social relationships can also be assessed, given that we did not focused in this aspect on our model. Such influences can stem from Laursen and Hafen's [23] work.

- Further, authors have proven that personality traits influence characters' tendencies for certain behaviours towards conflict [41]. In our current model, we defined two behavioural predispositions towards conflicts. More dynamic approaches to model personalities in conflict situation have been considered, such as, using the Five-Factor model [44] to determine characters' tendencies for cooperativeness and assertiveness.

On the other, under the scope of the SIREN project [11], the *Dream Theatre* demonstrator also has elicited some concerns for future work:

- To begin with, it has been considered several strategies for the user to mediate the conflicts between characters, such as, talking with a character or talking with several characters.

- Regarding the graphical aspects, improvements to characters' animation have also been considered, as we aim to express characters' emotional state through body expression.

- Further, user modelling has also been considered. With this, we aim to determine users' models by assessing their actions towards the conflict resolution. For example, determine if a user is more concerned about the well being of the cast members, or if the user is more concerned about achieving a good performance in the theatre play. With this information, we intend to manipulate the game in order for the user to explore different strategies.

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Appendix A

Personality Authoring

A.1 *Aggressive* Personality Authoring

```
Emotional Thresholds
 Joy: 3
 Distress: 1
 Happy-for: 3
 Resentment: 1
 Gloating: 1
 Pity: 3
 Pride: 1
 Shame: 3
 Admiration: 2
 Reproach: 1

Emotional Reactions
 A-em1: i-got-my-desired-role
  desirability: 7
  desirability-for-other: n/d
  praiseworthiness: n/d

 A-em2: someone-got-my-desired-role
  desirability: -7
  desirability-for-other: 7
  praiseworthiness: n/d

 A-em3: give-up-desired-role
  desirability: -5
  desirability-for-other: n/d
  praiseworthiness: -5

 A-em3: someone-gave-up-my-desired-role
  desirability: 6
  desirability-for-other: -7
  praiseworthiness: 0

 A-em4: ask-why-towards-self
  desirability: -4
  desirability-for-other: n/d
  praiseworthiness: -3
```

A.2 *Evading* Personality Authoring

```
Emotional Thresholds
 Joy: 1
 Distress: 1
 Happy-for: 2
 Resentment: 2
 Gloating: 4
 Pity: 1
 Pride: 1
 Shame: 1
 Admiration: 1
 Reproach: 3

Emotional Reactions
 E-em1: i-got-my-desired-role
  desirability: 7
  desirability-for-other: n/d
  praiseworthiness: n/d

 E-em2: someone-got-my-desired-role
  desirability: -7
  desirability-for-other: 7
  praiseworthiness: n/d

 E-em3: give-up-desired-role
  desirability: -3
  desirability-for-other: n/d
  praiseworthiness: -3

 E-em3: someone-gave-up-my-desired-role
  desirability: 6
  desirability-for-other: -7
  praiseworthiness: 0

 E-em4: insult-towards-self
  desirability: -4
  desirability-for-other: n/d
  praiseworthiness: -3
```

Appendix B

Experimental Evaluation

B.1 Interactions of the evaluation's scenario

In this Section, we describe the sequence of interactions displayed in our evaluation's scenario, which was shown to the evaluation's participants. This sequence identifies user's interactions towards the characters (check characters' information, grant role) and the characters' interactions, such as their emotional expressions and actions towards others.

We present the interactions for the two conditions: emotional condition (FM) and non-emotional condition (SM), as presented in Chapter 6. Given that the experiment was made in Portuguese, the following interactions are translations to English.

B.1.1 Emotional condition (FM)

1. *User checks Bob's character information.*

2. *User checks Andy's character information.*

3. *User gives "Hero" role to Bob.*

4. *Bob displays "Happiness" emotional expression* (see (a) from Figure 5.4).

5. *Andy displays "Sadness" emotional expression* (see (b) from Figure 5.4).

6. Andy says: "Bob, you are stupid!"

7. Bob says: "Why did you insult me, Andy?"

8. Andy says: "I think you are bad for that role, Bob!"

9. Bob says: "I am better than you say, Andy."

10. Andy says: "Bob, you are a fool!"

11. Andy says: "I think I would be better in that role, Bob!"

12. *Bob displays "Over-frustrated" emotional expression* (see (c) from Figure 5.4).

13. Bob says: "I do not want the "Hero" role anymore..."

14. *Bob leaves the "Hero" role.*

15. Bob says: "Ok, Andy, you are better than me..."

16. *Andy displays "Gleeful taunt" emotional expression* (see (d) from Figure 5.4, p.48).

B.1.2   Non-emotional condition (SM)

1. *User checks Bob's character information.*

2. *User checks Andy's character information.*

3. *User gives "Hero" role to Bob.*

4. Andy says: "I do not know how you got that role, Bob."

5. Bob says: "I was chosen, Bob."

6. Andy says: "But I wanted it too, Bob."

7. Bob says: "Ok, but the role is mine now, Andy."

8. Andy says: "Let me have that role, Bob."

9. Bob says: "No, Andy."

B.2   Questionnaire

In this Section, we present the questionnaire used for the final evaluation (see Section 6.2). The questionnaire is written in Portuguese. Hence, we will present it in English. After that, we present the full questionnaire used, in Portuguese.

B.2.1   Questionnaire in English

After the introductory text with some figures displaying the important aspects to consider in the videos, the underlined text "Clique aqui para ver o Video." (in Portuguese) represents a link where the video is presented.

Following that, the sets of questions presented to participants follow the same sequence described in Section 6.2.4.

1st Set – Classify the characters' emotional state in the following questions

1. How did Andy feel when the role was granted to Bob?

2. How did Bob feel when the role was granted to him?

3. How did Andy feel in the end of the discussion?

4. How did Bob feel in the end of the discussion?

2nd Set – Classify the characters' behaviours, according to the following scales
Andy's behaviour was:

5. Very hostile (1) – ... – (5) Very friendly

6. Very competitive (1) – ... – (5) Very cooperative

7. Very frustrating (1) – ... – (5) Very stimulating

8. Very evil-minded (1) – ... – (5) Very good-hearted

Bob' behaviour was:

9. Very hostile (1) – ... – (5) Very friendly

10. Very competitive (1) – ... – (5) Very cooperative

11. Very frustrating (1) – ... – (5) Very stimulating

12. Very evil-minded (1) – ... – (5) Very good-hearted

3rd Set – Classify the following affirmations, according to the following scales

13. Andy obstructed Bob to achieve his desired role.

14. Bob obstructed Andy to achieve his desired role.

15. Andy became more frustrated.

16. Bob became more frustrated

17. The atmosphere between characters became worse.

18. Characters tried to reach an ideal solution.

19. Characters became closer.

20. Characters tried to search a common way out.

21. Characters explored ideas to solve the situation.

4th Set – Classify the following affirmations, according to your level of agreement with each one, following the presented scale

22. Andy's behaviour was reasonable.

23. Bob's behaviour was reasonable.

24. Andy needs to improve his behaviours towards these situations.

25. Bob needs to improve his behaviours towards these situations.

26. There is a chance for Andy and Bob to discuss again.

B.2.2   Full Questionnaire

In the following page, we present the full questionnaire (in Portuguese).

Este questionário é anónimo, tem uma duração aproximada de **10 minutos**.

Introdução

Imagine um cenário de um jogo, onde existe um grupo de teatro escolar composto por crianças.

Neste momento, está a ser planeada uma peça de teatro, em que existem 3 papéis principais e 3 papéis de backstage. Por isso, cabe ao jogador escolher quem fica com qual papel.

Cada criança é caracterizada pelo seu nível de proficiência no teatro, um papel desejado, um papel favorito, um papel de interesse (em que este último define o papel de backstage adequado para a personagem) e um termómetro que indica o nível de stress.

Embora duas personagens possam desejar o mesmo papel, apenas é possível atribuí-lo a uma.

Neste questionário será mostrado um video que mostra um jogador a interagir com o jogo.

| Figura 1 - Uma criança. | Figura 2 - Balão de informação da personagem. | Figura 3 - Objecto que representa um papel para a peça de teatro. |

Clique no link abaixo para assistir ao video. Neste video encontra-se o Bob (à esquerda, de roupa verde) e o Andy (à direita, de roupa azul).

Veja o video atentamente e preste atenção às interacções entre os personagens e aos gráficos que mostram informação dos mesmos.

Clique aqui para ver o Video.

Depois de ter assistido ao video, responda às seguintes questões com base no que viu no video.

Classifique o estado emocional dos agentes nas perguntas seguintes

1.   Como se sentiu o Andy quando o papel foi atribuido ao Bob? *

☐ Feliz ☐ Aborrecido ☐ Irritado ☐ Zangado ☐ Furioso ☐ Enraivecido ☐ Não tenho a certeza

2.   Como se sentiu o Bob quando o papel lhe foi atribuido? *

☐ Feliz ☐ Aborrecido ☐ Irritado ☐ Zangado ☐ Furioso ☐ Enraivecido ☐ Não tenho a certeza

3.   Como se sentiu o Andy no fim da discussão? *

☐ Feliz ☐ Aborrecido ☐ Irritado ☐ Zangado ☐ Furioso ☐ Enraivecido ☐ Não tenho a certeza

4.   Como se sentiu o Bob no fim da discussão? *

☐ Feliz ☐ Aborrecido ☐ Irritado ☐ Zangado ☐ Furioso ☐ Enraivecido ☐ Não tenho a certeza

Classifique o comportamentos dos personagens de acordo com as escalas indicadas.

O comportamento do Andy foi:

5.   **Muito hóstil** (1) -- (2) -- (3) -- (4) -- (5) **Muito amigável** *

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

6.   **Muito competitivo** (1) -- (2) -- (3) -- (4) -- (5) **Muito colaborativo** *

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

7.   **Muito frustrante** (1) -- (2) -- (3) -- (4) -- (5) **Muito estimulante** *

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

8.   **Muito mal-intencionado** (1) -- (2) -- (3) -- (4) -- (5) **Muito bem-intencionado** *

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

O comportamento do Bob foi:

9.   **Muito hóstil** (1) -- (2) -- (3) -- (4) -- (5) **Muito amigável** *

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

10.   **Muito competitivo** (1) -- (2) -- (3) -- (4) -- (5) **Muito colaborativo** *

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

11.   **Muito frustrante** (1) -- (2) -- (3) -- (4) -- (5) **Muito estimulante** *

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

12.   **Muito mal-intencionado** (1) -- (2) -- (3) -- (4) -- (5) **Muito bem-intencionado** *

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

Classifique as afirmações seguintes, de acordo com a escala indicada.

Nada (1) --- (2) --- (3) --- (4) --- (5) **Muito**

13.	O Andy impediu o Bob de conseguir o papel desejado. *	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
14.	O Bob impediu o Andy de conseguir o papel desejado. *	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
15.	O Andy ficou mais frustrado. *	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
16.	O Bob ficou mais frustrado. *	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
17.	O ambiente entre os personagens tornou-se mais pesado. *	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
18.	Os personagens trabalharam para chegar a uma solução ideal. *	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
19.	Os personagens tornaram-se mais próximos. *	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
20.	Os personagens procuraram uma solução que beneficie ambos. *	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
21.	Os personagens exploraram novas ideias para resolver a situação. *	○ 1 ○ 2 ○ 3 ○ 4 ○ 5

Classifique as afirmações seguintes, de acordo com o seu nível de concordância com cada uma, utilizando a escala indicada.

Discordo totalmente (-2) -- (-1) -- (0) -- (1) -- (2) **Concordo totalmente**

22.	O comportamento do Andy foi correcto. *	○ -2 ○ -1 ○ 0 ○ 1 ○ 2
23.	O comportamento do Bob foi correcto. *	○ -2 ○ -1 ○ 0 ○ 1 ○ 2
24.	O Andy precisa melhorar o seu comportamento face a estas situações. *	○ -2 ○ -1 ○ 0 ○ 1 ○ 2
25.	O Bob precisa melhorar o seu comportamento face a estas situações. *	○ -2 ○ -1 ○ 0 ○ 1 ○ 2
26.	Existe possibilidade do Andy e o Bob voltarem a discutir. *	○ -2 ○ -1 ○ 0 ○ 1 ○ 2

27.	Sexo *	○ Feminino ○ Masculino
28.	Idade: *	○ Menos de 14 ○ Entre 14 e 18 ○ Entre 19 e 23 ○ Entre 24 e 28 ○ Entre 29 e 38 ○ Entre 39 e 48 ○ Mais de 49

* = Input is required