Growing interest on the study of emotion in the behavioral sciences has led to the development of several psychological theories of human emotion. These theories, in turn, inspired computer scientists to propose computational models that synthesize, express, recognize and interpret emotion. This cross-disciplinary research on emotion introduces new possibilities for digital games. Complementing techniques from the arts for drama and storytelling, these models can be used to drive believable non-player characters that experience properly-motivated emotions and express them appropriately at the right time; these theories can also help interpret the emotions the human player is experiencing and suggest adequate reactions in the game. This chapter reviews relevant psychological theories of emotion as well as computational models of emotion and discusses implications for games. We give special emphasis to appraisal theories of emotion, undeniably one of the most influential theoretical perspectives within computational research. In appraisal theories, emotions arise from cognitive appraisal of events (e.g., is this event conducive to my goals? Who is responsible for this event? Can I cope with this event?). According to the pattern of appraisals that occur, different emotions are experienced and expressed. Appraisal theories can, therefore, be used to synthesize emotions in games, which are then expressed in different ways. Complementary, reverse appraisal has been recently proposed as a theory for the interpretation of emotion. Accordingly, people are argued to retrieve, from emotion displays, information about how others' are appraising the ongoing interaction, which then leads to inferences about the others' intentions. Reverse appraisal can, thus, be used to infer how human players, from their emotion displays, are appraising the game experience and, from this information, what their intentions in the game are. This information can then be used to adjust game parameters or have non-player characters react to the player's intentions and, thus, contribute to improve the player's overall experience.

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Chapter 0

Emotion in Games

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Introduction

A general trend in mainstream digital games has been to invest heavily on state-of-the-art physics, graphics and sound (e.g., Battlefield 3[1]). However, research shows that physics, graphics and sound quality are but one of the many factors influencing player experience (e.g., [49]). Another trend has attempted to draw from the experience in the movie industry to improve story telling in games. This has led to considerable improvement in the quality of the characters and stories in recent games (e.g., Max Payne 3[2], Uncharted 3[3]). Nevertheless, despite considerable progress in physics, graphics, sound and storytelling, most games still tend to be essentially linear, feel scripted and break player immersion due to non-believable character behavior. This chapter proposes a way to tackle these limitations in one critical aspect of the player experience: emotion. Games have the ability to elicit all sorts of emotions in players and this is one of the main reasons people seek games (e.g., [59]). Complementing techniques from the arts for drama and storytelling (e.g., [29]), this chapter proposes a psychology-based framework

[1] Battlefield 3, Electronic Arts, 2012.
[2] Max Payne 3. Rockstar Games, 2012.
[3] Uncharted 3: Drake's deception. Naughty Dog, 2011.

to help game designers elicit emotion in players, simulate emotion in non-player characters, and interpret the players' emotions.

Indeed, in recent decades, the behavioral sciences have experienced growing interest in the study of emotion and this has led to the development of several psychological theories of human emotion (for general reviews see [14], [15], [52]). These theories, in turn, inspired the development of a new field called *affective computing*, which focuses in developing computational models that synthesize, express, recognize and interpret emotion [10], [56], [68]. This cross-disciplinary work on emotion introduces new possibilities for digital games. Effectively, these theories and models provide a framework to systematically create situations that elicit appropriate emotions in the player; drive believable non-player characters that experience properly-motivated emotions and express them at the right time; and, interpret the emotions the human player is experiencing and suggest adequate reactions in the game. The goal of the chapter is, thus, to review relevant psychological theories of emotion and computational models of emotion and discuss their implications for games.

We give special emphasis to appraisal theories of emotion [28], undeniably one of the most influential theoretical perspectives within computational research [56]. In appraisal theories, emotions arise from cognitive appraisal of events (e.g., is this event conducive to my goals? Who is responsible for this event? Can I cope with this event?). According to the pattern of appraisals that occurs, different emotions are experienced and expressed. Appraisal theories, therefore, provide a psychological foundation game developers can use to systematically express emotions in games and elicit emotions in players. Complementary, reverse appraisal has been recently proposed as a theory for the interpretation of emotion [20], [21], [39]. Accordingly, people are argued to retrieve, from emotion displays, information about how others' are appraising the ongoing interaction, which then leads to inferences about the others' intentions. Reverse appraisal can, thus, be used to infer how players, from their emotion displays, are appraising the game experience and, from this information, the players' beliefs, desires and intentions. Knowledge about the players' mental states can then be used to adjust gameplay so as to optimize the players' overall experience.

Appraisal Theories of Emotion

According to appraisal theories (for a recent survey see [28]), people are constantly judging the events in the surrounding environment (e.g., the game world) with respect to one's beliefs, desires and intentions (e.g., the player's goals in the game). These judgments, or *appraisals*, are subjective and are constantly checking whether relevant events are present and if so, whether these events are beneficial or harmful to the individual's goals, who or what caused them, whether social norms have been broken and, how capable is the individual to cope with the consequences of the events. According to the pattern of appraisals that occurs, different emotions are experienced (e.g., through physiological sensations [50], [73], expressed (e.g., through facial or vocal cues [44], [74]) and corresponding action tendencies are elicited (e.g., flight when experiencing fear [33]). For appraisal theorists, thus, "emotions" consist of several components including the configuration of appraisals and their correlates in the central and peripheral nervous systems.

Though several appraisal theories have been proposed [30], [48], [66], [72], [73], there tends to be agreement on the underlying appraisal dimensions. The most basic dimension is perception of *novelty* (with respect to the current level of habituation), which tends to occur in a highly automatic fashion. Novel stimuli draw attention and mobilize resources to determine whether ongoing activity can continue or adaptive action is required. The next appraisal dimension relates to *goal significance*, i.e., whether the event is relevant to the individual's goals or not. Goal significance is usually subdivided into the appraisals of *conduciveness* and *certainty*. Conduciveness refers to whether the event is consistent with the individual's goals or not. Conducive events lead to positively valenced emotions and obstructive events to negatively valenced emotions. Certainty refers to the probability of the event actually occurring. This is particularly relevant for the so-called *prospective* emotions (e.g., hope and fear), where both the probability of the event occurring and its consequences are in doubt. A third appraisal variable is *agency*, i.e., who or what is responsible for the event. Agency is critical to distinguish, for instance, anger (other-blame) from guilt (self-blame). A fourth appraisal variable refers to *coping potential*, i.e., the evaluation of one's ability to deal with the situation. Coping potential is, in turn, subdivided into three appraisals: *control*, *power* and *adjustment*. Control refers to how well an event or its outcomes can be influenced or controlled (by the self, others or nature). If the situation is controllable, the outcome depends on one's own power to exert control or to recruit others to help. Adjustment concerns the individual's capacity to adapt to changing conditions in the environment, which is particularly important if the individual has no power over the situation. Finally, the last appraisal, *norm compatibility*, recognizes that people live in a social context and assesses how much the event conforms to society's norms. This dimension is particularly relevant for *moral* emotions (e.g., pride or guilt), whereby one assesses one's own behavior with respect to the values or norms in one's social group. Table 1 summarizes how these appraisals relate to a few typical emotions namely joy, sadness, anger and guilt. In general, predictions tend to be consistent across theories: joy occurs when the event is conducive to one's goals; sadness occurs when the event is obstructive to one's goals; anger occurs when the event is obstructive to one's goals, is caused by another agent and one has power/control over it; guilt occurs when the event is obstructive to one's goals, is caused by the self and is not norm compatible. Understanding the antecedents of emotion, i.e., the appraisal variables, is important for game designers as these variables can be manipulated–by generating appropriate events in the game world or behavior in non-player characters–to elicit intended emotions in the player.

[Table 1 about here]

A basic premise in appraisal theories is that emotion is a continuous process, whereby the environment is continuosly appraised and one's reactions to the events can lead to further "re-appraisals" [48]. This view contrasts with categorical theories of emotion that posit the existence of a limited number of "basic" emotions (e.g., [25]). Appraisal theories argue emotions consist of simpler components that correspond to the appraisals and their physiological correlates. The implication is that emotional experience is a process that changes in time as events are appraised and re-appraised. Indeed, some researchers have argued that discrete emotion categories (e.g., hope, fear or anger) are folk-psychological concepts (e.g., [3]) and there are no specific brain regions or circuits that correspond to these basic emotions [54]. Appraisal theories, therefore, provide a framework for eliciting and understanding a multitude of emotions and emotional states in games that go beyond a basic set of categorical emotions. Another premise in appraisal theories is that appraisals can occur at different levels (e.g., sensorimotor, schematic and conceptual levels [51]) and that processing at different levels can interact. This means appraisals need not occur consciously such as, for instance, the case of detection of novelty. Other more complex appraisals, such as assesment of certainty or expectation, can at first occur more deliberatively and, with learning become more automatic. However, appraisal theories are compatible with the idea that different appraisals differ in complexity and that more complex appraisals (e.g., assessment of norm compatibility) require more deliberation (e.g., [13]). Accordingly, emotions that require assessment of more complex emotions (e.g., pride or guilt) are known to develop later in an individual's life [53]. These degrees of appraisal can, thus, be explored by game designers to systematically simulate emotions that differ in complexity by virtue of the underlying appraisals (e.g., deeper characters appraise events using the complete set of appraisals, whereas shallow characters appraise the same events using only more automatic appraisals).

Finally, since emotion displays reflect one's goals through the appraisal process, it was recently argued that people could infer from emotion displays *other* people' beliefs, desires and intentions by reversing the appraisal mechanism [20], [21], [39]. According to this proposal, people retrieve from emotion displays information about how others are appraising the ongoing interaction and, this information about appraisals then leads to inferences about others' intentions (Figure 1). Effectively, in a recent study, Scherer and Grandjean [87] showed that people were able to retrieve information about appraisals from photos of facial expression of emotion. Hareli and Hess [39] also showed that people could, from expressed emotion, make inferences, from emotion displays, about someone's character. For instance, a person who reacted with anger to blame was perceived as being more aggressive, self-confident but also as less warm and gentle than a person who reacted with sadness. Moreover, Hareli and Hess showed that these perceptions were mediated by perceived appraisals. In another experiment, de Melo et al. [20] showed that people's decision to cooperate in the prisoner's dilemma–a decision making task commonly used to study emergence of cooperation–was influenced by the emotion displays of the counterpart. Effectively, the results showed people were more willing to cooperate with a counterpart that displayed cooperative emotions (e.g., a smile after mutual cooperation) than one that displayed competitive emotions (e.g., a smile after exploiting the participant). In a follow-up experiment, de Melo et al. [21] further established that expectations of the counterpart's cooperation were mediated by perceptions of how the counterpart was appraising the ongoing interaction. This result suggests that people were in fact retrieving, from emotion displays, information about the counterpart's appraisals (e.g., from a display of anger people inferred that the counterpart found the outcome obstructive and was blaming the participant for it) and that this information about appraisals was then leading to inferences about the counterpart's mental states, namely its likelihood of cooperation. In summary, reverse appraisal is a general theory for reading other people's beliefs, desires and intentions from emotion displays. Reverse appraisal, thus, has important implications for games in that, if the players' emotions can be recognized (for a recent survey on the affect recognition literature see [10]), it provides a framework for interpreting the player's mental states from their emotion displays.

[Figure 1 about here]

Computational Models of Emotion

Following the interest in the behavioral sciences, recent decades have seen an explosion of interest in affective computing, i.e., research in computational models that can synthesize, express and recognize emotions [10], [56], [68]. The driving forces behind this surge have been potential applications in human-computer interaction, artificial intelligence and psychological research. Applications in human-computer interaction build on the idea that emotions serve important social functions such as communicating ones's intentions, desired courses of action, expectations and behaviors [31], [45], [46], [63], [65]. For instance, displays of anger coerce actions in others and enforce social norms, displays of guilt convey an apology and elicit reconciliation after some transgression, and displays of sadness elicit support from others. The idea, thus, is to realize such functions in computational systems for the purpose of enhancing interaction with humans. A particularly relevant line of research for games tries to simulate these functions in *virtual humans* (or, in the context of games, non-player characters), i.e., anthropomorphic characters that have virtual bodies and can express themselves through them in the same way people do [38]. Acknowledging that people can treat virtual humans like other people [64], [70] and that people can be influenced by them [7], [8], researchers attempted to create virtual humans that display emotions in ways that are consistent with displays people show in daily life (for a survey see [4]). Whereas these studies have tended to focus on the social effects of emotion expression, the computational models of emotion reviewed here provide the mechanism for how and when such emotions should be synthesized. Regarding applications to artificial intelligence, emotion has been argued to be a critical component of intelligent systems a while ago [62], [79], [80] but it was only recently that researchers began incorporating emotion into their models. Many systems have, now, attempted to simulate emotion synthesis, the majority of which based on appraisal theories of emotion [6], [23], [36], [83]. Some systems have, further, explored the cognitive impact of emotion, in particular, its role in juggling multiple competing goals [36], [75], [76], [81]. Finally, computational models of emotion can be essential tools in the development and testing of psychological theories. Psychological theories are often described at an abstract level and through informal (natural language) descriptions. Computational implementation of such theories enforces detail in that the structures and processes of the theory must be explicitly formalized. Computational models can also be used to run simulations that are hard or unethical in vivo (e.g., ablating components of the model and testing behavior). All these applications of computer models of emotion have important implications for the simulation and interpretation of emotion in games. However, before discussing them, we shall present a general framework for computational models of emotion.

Marsella, Gratch and Petta [56] propose a framework to understand and compare computational models of emotion based on appraisal theories of emotion, undeniably the most influential theoretical perspective in this literature [5], [9], [23], [26], [27], [32],

[34], [35], [36], [55], [69], [71], [78], [81]. The framework is structured according to several components as shown in Figure 2:

- *Player-environment relationship*. This component represents the relationship between the (real or hypothetical) environment and the agent's beliefs, desires and intentions. As an example, this component is implemented as decision-theoretical planning representations in EMA [36];
- *Appraisal-derivation model*. This component is responsible for transforming some representation of the player-environment relationship into a set of appraisal variables. For instance, if an agent's goal is potentially thwarted by some external action, an appraisal-derivation model should be able to automatically derive appraisals that this circumstance is undesirable, assess its likelihood, and calculate the agent's ability to cope, i.e., by identifying alternative ways to achieve this goal. As an example, ALMA [34] implements this component as a set of rules authored by a domain developer, whereas EMA [36] provides a series of domain-independent inference rules that derive appraisal variables from syntactic features of the player-environment relationship (e.g., if the effect of an action threatens a plan to achieve a desired state, this is undesirable);
- *Appraisal variables*. Different models adopt different sets of appraisal variables, depending on their reference appraisal theory. For example, many use the variables proposed by Ortony, Clore and Collins [66] including AR [27], EM [71], FLAME [26] and ALMA [34]. Others favor the variables proposed by Scherer [73] including WASABI ([6]) and PEACTIDM [55];

- *Affect-derivation model*. This component maps between the appraisal variables and an affective state which can be represented as a discrete emotion label, a set of discrete emotions, a point in a continuous dimensional space, or some combination of these factors. For example, AR [27] maps appraisal variables into discrete emotion labels, WASABI ([6]) maps appraisals into the Pleasure-Arousal-Dominance dimensional representation of emotion [60], and ALMA [34] does both simultaneously;
- *Affect-intensity model*. This component specifies the strength of the emotional response resulting from a specific pattern of appraisals. This component is usually tightly connected to the affect-derivation model, though it is conceptually different. Intensity calculation can resort to a subset of the appraisal variables (e.g., intensity can be derived from the conduciveness or certainty appraisal variables);
- *Affect*. Affect is a representation of the agent's current emotional state. This could be a discrete emotion label, a set of discrete emotions, a point in a dimensional space, or a combination of these possibilities;
- *Affect-consequent model*. This component maps affect (or its antecedents) into some behavioral or cognitive change. Consequent models can be separated into *behavior consequent* models that summarize how affect alters the agent's behavior and *cognitive consequent* models that determine how affect alters the nature or content of cognitive processes. As an example, EMA [36] implements both kinds of consequences: *problem-focused coping* attemps to mitigate negative emotions by actively changing features in the environment that led to the initial undesirable appraisal; *emotion-focused coping strategies* like wishful thinking, distancing and

resignation, mitigate negative emotions by, instead of changing the environment, altering the agent's beliefs, desires and intentions, respectively.

[Figure 2 about here]

The continuous nature of the appraisal process is represented by a cycle whereby the player-environment relationship leads to appraisals that lead to affect which, then, results in behavioral and cognitive consequences. These affective consequences, in turn, affect the player-environment relationship thus, leading to new appraisals (or "re-appraisals" [48]) and the cycle re-starts.

This framework has several implications for the simulation and interpretation of emotion in games. The most obvious application is for the simulation of believable emotions in non-player characters, which can then be expressed using one of many modalities (e.g., face or voice). However, this framework can also be used by designers to elicit emotion in the player by manipulating the underlying appraisals. In the study of theory of mind–i.e., the study of how people make inferences about others' beliefs, desires and intentions–this is akin to *simulation theory* [16], where one uses one's own mental mechanisms to predict the mental states of others. In the case of game design, the computational model of emotion can be used, by forward simulation, to test which emotions might be elicited in the player if certain features in the game world, which are relevant for appraisal, are changed. An alternative view on theory of mind, referred to as *theory theory* [11], argues people form a commonsense theory, akin to a scientific theory, about someone else's mental states. Other people's mental states can, thus, be viewed as unobservable theoretical posits invoked to explain others' behavior. In this sense, a theory of mind consists of a set of causal rules that relate external stimuli to inner states (e.g., perceptions and beliefs) and inner states to actions. In emotion interpretation, this view is aligned with reverse appraisal (see previous section), whereby people, from emotion displays, infer about the others' appraisals, which then lead to inferences about the others' intentions. In the case of games, reverse appraisal can be implemented by running the aforementioned framework in reverse (i.e., backwards simulation) and, thus, be used to infer mental states of players from information about their emotion displays, provided it is possible to recognize the player's emotions.

A Framework for Emotion in Games

A key difference between games and other media (e.g., movies) is *interactivity*. The game world and non-player characters adapt to the players' moves and the player reacts to the changes in the world. For the purposes of this chapter, we can look at this interaction abstractly as a cycle where the game world and characters elicit emotions in the player and, in turn, the world and characters adapt to the player's emotional reactions (Figure 3). In this context, we discuss how appraisal theories and the framework for modeling emotion presented in the previous section can be used to accomplish three things: (1) Systematically elict emotions in players by manipulating features in the game world and characters in a way that influences how players appraise the ongoing interaction; (2) Create characters that express believable emotions by endowing them with an appraisal-based model of emotion; and, (3) Interpret the players' emotions during gameplay and infer their mental states from such emotional expressions.

[Figure 3 about here]

Eliciting Emotion in Players

Appraisal theories can help game designers understand how emotions occur in nature and, thus, how game worlds and characters should act or react to elicit desired emotions in players. Indeed, behavioral and computer science scholars have already been using games to study emotion for a while [37], [43], [83], [84], [85]. For example, Wehrle and colleagues [84], building on Scherer's [73] appraisal theory, used game scenarios where character and world objects were manipulated to create prototypical antecedents (i.e., appraisals) for emotions of interest. Successful elicitation of emotions was verified by recorded facial expressions and physiological measures. Fear/anxity was elicited by manipulating power and controllability by changing the size of the maze, number of enemies and available options to cope with the challenges; pride was elicited by having a non-player character congratulate the player on the accomplishment of an important game task (conducive goal and attribution of agency to the participant); surprise and reproach by having a non-player character, which had been helping the player up to that point, betray the player (obstructive goal and attribution of blame to the non-player character); and so on. As an example of a multi-player game, Gratch and colleagues [37] had participants engage in the Battleship board game with human confederates. The confederates were given an unfair advantage by placement of a hidden camera that could reveal the participants' strategy ahead of time. By manipulating, through the confederates, the participants' perceived likelihood of success (i.e., assessment of the certainty appraisal) and the outcome of the game (i.e., assessment of the conduciveness appraisal), participants reported experiencing positive and negative emotions such as joy, sadness, hope and fear. In general, game designers can use a computational model of emotion to anticipate how changing the features in the world and characters will impact player experience. The idea is to simulate–in the forward direction, i.e., from appraisals, to affect, to consequences–how changes in the game world will be appraised with respect to the (expected) player's beliefs, desires and intentions.

Simulating Emotion in Non-Player Characters

Bates [2] emphasized how important it is for agents (or, non-player characters) to express emotion appropriately in order to be *believable*. Believability is an illusive concept, coming from the arts, that is usually associated with the characters' ability to make people empathize and believe in their adventures and misfortunes and, essentially, "suspend their disbelief" as the story unfolds [82]. Achieving believable characters is particularly challenging because games are interactive and the story can unfold non-linearly thus, removing some of the control from game developers. Isbister [41] points out that a solution to this challenge is developing characters that are firmly grounded on psychological theories of human behavior so that, independently of how players come to encounter these characters, they will always behave in ways that are natural and believable. Here, we argue that appraisals theories are a solid foundation for synthesizing emotion in believable characters. Synthesized emotion can then be expressed using any of a multitude of modalities (e.g., [17], [18]; [19]).

To exemplify how computational models of emotion can drive behavior and emotion expression in non-player characters we discuss two games that educate people on how to deal with sensitive social situations (Figure 4). Carmen Bright Ideas [58], [57] is a psycho-social health intervention game that seeks to improve the social problem solving skills of mothers of paediatric cancer patients (see Figure 4, top). These mothers, aside from the child's illness, might face additional problems at work due to having to take time off to care for the sick child and, at home with the other children feeling neglected. The game teaches these mothers a method to help address such problems. In the game, players interact with Carmen, a mother of a sick child. Carmen is attending a session with a clinician who is teaching her how to handle her stressful social problems. In this session, players can influence what Carmen is thinking, by clicking on "thought balloons", which in turn impact her internal emotion model and therefore her subsequent behavior. The emotion model is based on Lazarus' appraisal theory [48], a theory on the causes of emotion as well as how people cope with emotional stress. Essentially, if people appraise they have control, they will cope by taking action to address the cause of stress; if people feel they don't have control, they will cope by avoiding thinking about the situation, engaging in wishful thinking that the problem will go away or resigning and letting the situation run its course. The game provides a safe environment for real mothers to explore alternative ways to cope with similar situations and see the consequences of their choices. According to the players' choices, Carmen will appraise, using the emotion model, her situation differently and that in turn leads to the experience of emotions (as displayed in the face and posture) and choice of appropriate coping strategies. The emotion model is, therefore, critical to make Carmen's expressions and actions believable. FearNot! [1], [23] is another pedagogical game that teaches children how to deal with bullying (see Figure 4, bottom). In this game, the player watches one non-player character bully another character. The victim then approaches the player and asks for advice on how to deal with the bully. In this case, the non-player characters' emotion models are based on Ortony et al.'s [66] appraisal theory, which defines rules that map appraisals into several discrete emotions. Experienced emotion then leads to either emotion-focused or problem-focused behavior [48]. In one game scenario, Luke (the bully) insults John (the victim). Since John appraises this event to be very undesirable and since he feels he has little control over the situation, he experiences intense fear and sadness and starts crying. John, then asks the player for advice. If the player suggests to "go talk to the teacher", John now appraises that he has more control over the situation and this leads to the experience of confidence and a display of a smile. This example shows, again, how players' interactions with non-player characters can affect these characters' emotion models which then lead to believable expressions of emotion and behavior.

[Figure 4 about here]

Interpreting Emotion in Players

The last two subsections discussed how emotion can be elicited in the human player; this subsection closes the loop and focuses on interpreting emotion in the player and dicusses its consequences for games. Affect recognition–i.e., recognizing emotion in humans, from one or more modalities (e.g., face, voice, gesture or posture)–is a very active area of research and it is beyond the scope of this chapter to review it; however, the reader is directed to several existent reviews: Calvo and D'Mello [10] provide a general review of the literature; Pantic and Rothkrantz [67] and Sebe, Cohen, and Huang [77] focus on recognition from the facial and audio channels; Zeng et al. [86] also review the audio-visual channel but focusing on spontaneous expressions, whereas Pantic and Rothkrantz [67] and [12] address recognition of posed expressions (by actors). Our focus here is, having recognized the player's emotions, what are the consequences for game design? First, recognizing the player's emotion can be used to (continuosly) check that the strategies used to elicit emotion in the player (as described in the previous two subsections) are having the intended effect. Verification might be necessary because individual [47], [85] and cultural [28], [61] factors are known to influence how people appraise events and experience emotion. For these same reasons, emotion recognition can be useful in learning a *model* of the player's affective style. The idea is to adapt a general appraisal model, by using machine learning techniques, to the specific player (e.g., learn weights for the most prevalent appraisal variables and appraisal-to-emotion rules). Finally, through reverse appraisal it is possible to infer, from recognized emotions, how the player is appraising the ongoing interaction and, from this information, the player's mental states. Information about the player's affective style and mental states can then be used to adapt gameplay so as to enhance the player experience in some way (e.g., if the player is experiencing anxiety/fear in a particular situation, an ally non-character player could try to increase the player's sense of control, through dialogue, so as to mitigate this emotion; alternatively, the game could learn the characteristics about the situation that are succeeding in causing this emotion and, then, for dramatic purposes, apply them to new situations). Achieving a computational implementation of reverse appraisal can be accomplished by running a usual appraisal model (Figure 2) in the reverse direction (i.e., from emotion expressions, to perception of the others' appraisals, to perception of the others' goals), or by following a data driven approach (e.g., de Melo et al. [22] use data from empirical studies on the impact of emotion expressions in people's decision making to learn a Bayesian model that associates emotion displays with probabilities about the others' mental states).

General Discussion

This chapter discussed how appraisal theories of emotion and computational models of emotion based on these theories can be used in games to elicit desired emotion in players, simulate believable emotion in non-player characters and, interpret emotion displays in players to infer their mental states. These methods can be viewed as complementing existent techniques coming from the arts where, like in movies, the artist carefully designs situations, dialogues and stories to optimize the emotional and dramatic effect (e.g., [29]). The advantages of using a psychological approach to modeling emotion in games are believability and flexibility. Psychological theories capture how humans behave in nature and, therefore, can be used to synthesize realistic behavior in game characters and understand the player's emotions. Because these theories capture the underlying causes of behavior, they are more robust to the non-linear nature of storytelling in games; thus, independently of how players come to interact with the game characters and world, the simulated behavior will always be plausible. For instance, appraisal theories are ideal to simulate emergent emotional behavior in artificial life games (e.g., The Sims[4]) or role-playing games (e.g., The Elder Scrolls V: Skyrim[5]).

Integration of psychological theories in games requires important changes that affect all stages of the development process [41]. In the case of emotion, at the very least,

[4] The Sims, Electronic Arts, 2000.
[5] The Elder Scrolls V: Skyrim, Bethesda Game Studios, 2011.

game designers should become knowleageble of appraisal theories and corresponding computer models of emotion. Ideally, the game development team should include an affective computing expert that, not only keeps up with the constantly evolving state-of-the-art in psychological theories and computer models of emotion but, understands how such models of emotion can be used to elicit and understand the emotions of players. It is, therefore, critical that game studios realize that developing high-quality graphics, phyisics and sound assets, as well as hiring writers that specialize in (essentially linear) techniques for storytelling and character development, is not sufficient for interactive, inherently non-linear, games; resources and money should also be devoted to the development of game engines that are motivated by proper psychological theories, in particular appraisal theories of emotion, which support flexible and natural emotion in non-player characters and interpretation of the human player's emotional experience.

Finally, the standard appraisal computational model presented in this chapter can be modified or extended in several ways. First, whereas a full-fledged computational model (Figure 2) could be used to generate human-like behavior in critical non-player characters, simpler versions of the model could be used for less important characters (e.g., background characters could use an appraisal model based on a small subset of appraisals). Second, the appraisal framework can be modified to reflect personality characteristics of non-player characters (e.g., shallow or younger characters disregard appraisals that lead to moral emotions such as guilt). Third, sometimes human-like behavior is not the goal such as when modeling the behavior of, for instance, an alien race. Again, in such cases, the appraisal theories can be adapted (e.g., adding new appraisals and appraisal-to-emotion patterns) to create behavior that, though not human-like, can be understood by a human player. Fourth, van Reekum and Scherer [85] point out that individual differences might influence appraisal such as speed of processing, thouroughness, completeness, degree of cognitive effort, and habituation with stimuli. Other personality traits can also affect appraisal (e.g., optimism-pessimism and neuroticism could affect perception of control). In such cases, appraisal theories could be extended to account for personality; for instance, Doce et al. [24] extend the Ortony et al. [66] appraisal theory with the Big Five personality trait taxonomy [42]. Finally, though appraisal theorists argue that the relationship between appraisals and emotions is universal [28], cultural factors may influence how events are appraised and which appraisal-to-emotion patterns are more prevalent [31]. In this case, appraisal theories can be, once again, extended to account for culture; for instance, [1] presents an appraisal model that integrates with Hofstede's [40] taxonomy of cultural dimensions.

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