Towards Generative Emotions in Games based on Cognitive Modeling

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ABSTRACT

Procedural Content Generation (PCG) accomplishes feats that once would be considered magic, creating near-infinite amounts of unique levels, worlds, objects and other content for games. Yet, despite this near magical quality, generated content is often found to have a sameness to it. After a short time it loses the interest of players. Many procedurally generated games, such as *No Man's Sky*, have disappointed customers in this sense. We argue that one important cause is *generated content fails to create an emotional connection with players*. Emotions help in keeping players engaged with game content [7] and thereby improve the gameplay experience. Among the many emotions players experience in games, surprise is perhaps the most important for PCG. Surprise intensifies other emotions [9] and it lies at the origin of humor, strategy and problem solving [15]. Thus, surprise helps to increase player enjoyment and engagement with games. So far, PCG in games has produced surprise by accident of chance. PCG systems which *intentionally* create surprising moments, in a controllable way, can play an important role in increasing engagement and interest in games.

CCS CONCEPTS

• **Applied computing → Psychology**;

KEYWORDS

Surprise in games, procedural generation of emotion

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Why Existing approaches are not sufficient?

Existing approaches of player experience modeling (PEM) attempt to model emotions in games using designer's intuition [3], player physiological data [11], playing style [13] or data driven approaches [16]. However, these techniques are simplistic as they use a generic approach to model a variety of emotions such as fun, frustration and anxiety. Each emotion is inherently disparate from other as they originate in different parts of the brain [1] and are experienced differently in people [12]. Some approaches modeled surprise independently from other emotions. For example, [10] use regression models to recognize a surprising design. Additionally, [5] use a predictive model based on [4], to discover surprising weapons via a divergent search algorithm called surprise search. Contrary to these existing approaches, we look to model surprise from the perspective of cognitive science.

We advocate the use of cognitive models as the basis for generation of emotions in games because they are based on years of empirical research on how human cognition works. Using cognitive models to generate emotion provides a better scientific understanding of how cognition works. It also considers many cognitive functions (e.g. memory, attention and perception), evolution of human mind and artificial intelligence. None of the existing work in this area fully implements this vision. We propose a bottom-up approach that starts with understanding the emotion first, followed by creating a cognitive model of the emotion. This will help us in understanding the problem which is the first step towards crafting affective generative methods.

VCL: A Cognitive Model of Surprise

Surprise is widely used by game designers to create an engaging, challenging and positive experience for players. It works on the dopamine system in our brains, helping us to focus our attention and inspiring us to look at our situation in new ways [18]. One cognitive model that can be used to model surprise in games is *Expectancy Violations Theory*, which explains how unexpected behaviors in a social environment can be perceived as surprising [2]. This theory was proposed in the domain of proxemics, which is the study of the spatial requirements of humans and the effects of population density on behavior, communication, and social interaction. *Expectancy Violation Theory* postulates that three factors affect an individual's expectations or beliefs : environmental variables, interactant variables and variables related to the nature of the interaction or environmental variables [2]. Thus, a model of the future can be predicted based on the individual's beliefs that have been formed due to one of the factors mentioned above. When experience events deviate from the predicted future, an expectancy violation occurs, resulting in the individual being surprised. This captures the attention of the individual as she attempts to comprehend what occurred and modify her beliefs to come to terms with this new situation [8]. A second theory of surprise is based on the notion that players can become surprised when they are "caught off

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guard"[6]. This happens due to the difference between the sensory and the perceptual bility of human beings [17].

Based on the theories discussed above, we propose a model of surprise in video games called *VCL: Violation of Expectations, Caught Off Guard and Learning*. In VCL, surprise is defined as a sudden fleeting moment which elicits a verbal, nonverbal or physiological response from the player. This is caused either by a sudden violation of the player's established expectations or when a player is caught "off guard" (as when something which was previously unnoticed suddenly comes within the boundary of conscious perceptual ability of a player). A surprise also forces the player to re-perceive her ideas about the game and reformulate her understanding by refining her gameplay style. An activity we call "learning" in this context. See Figure 1 for a visual representation of the VCL model.

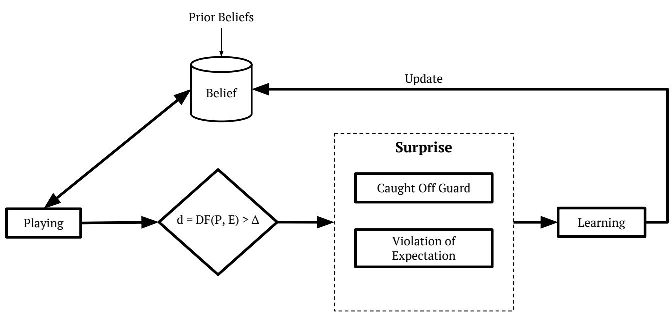

Figure 1: A diagram describing VCL. In our model, d represents the difference between the beliefs of the player P before and after a event E in the game. If d is greater than a threshold Δ then E is perceived as surprising by P.

As a player plays a game, she continuously uses her beliefs to respond to events in the game. When she encounters new events, her beliefs get updated. If the new event doesn't significantly alter the player's current beliefs, the event is non-surprising. For example, experiencing a differently colored platform in a platforming game, so long as it behaves like all other platforms, is non-surprising.

A special update occurs when a new event is sharply antithetical to the player's current beliefs. This results in the player being surprised, which can occur either due to violation of expectations or when the player is caught off guard (see the box labeled Surprise in Figure 1). For example, when the player tries to kill an enemy in Contra by jumping on them (using prior beliefs from Super Mario World, where this is a safe action), she gets killed. This event evokes a surprising reaction as it violates the expectations of the player. The surprising event results in learning, i.e, the player updates their current belief with the newly acquired knowledge (see arrow between Learning and Belief in Figure 1). For example, as a result of being killed by trying to jump on the enemy, the player learns that this strategy is not suitable for this game and needs to use an alternate strategy to kill the enemies.

As mentioned above, an event is surprising when there is a **significant** difference between the beliefs of the player before and after a given event in the game. The extent $d = DF(P, E)$ to which the event E is significant varies from player $P1$ to $P2$ [14]. In this paper, the result d of the function $DF(P, E)$ is called "Divergent Factor". If the Divergent Factor d of an event E is greater than a particular threshold Δ—which varies from player to player—then E is perceived as surprising by that player. Defining how to calculate both $DF(P, E)$ and Δ is very hard, because they depend on the experience, adaptability and personality of the player. Currently, VCL is a theoretical model, so we need to conduct empirical studies with players in order to collect insights on how to define DF.

We believe that the VCL model will help us in better understanding of the phenomenon of surprise in video games. This creates an opportunity to develop a creative system for the generation of surprising events in games, which is part of our future work. We think that this model will help to make PCG techniques more interesting, once they will be able to reason about surprise when generating content. We plan to develop such system with controllable parameters. This allows us to make a deeper contribution towards understanding and solving the problem of generating emotions in games.

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