Abstract

The Game Refinement (GR) theory, widely employed for assessing the enjoyment and intricacy of games, is herein examined through the lens of audience perception. This theory delves into the cognitive information processes occurring in our minds while engaging in strategy games, in adherence to the principles set forth by Newton's laws. Its central focus is on the uncertainty surrounding game outcomes, employing abstraction to dissect game components and assess the progression of game information based on achievements and game duration.

The quantification of this progression leads to the measurement of informational acceleration, akin to Newton's second law ($F = ma$), wherein informational acceleration correlates with mental force and excitement. Changes in acceleration significantly impact game dynamics, especially in high-stress scenarios, and can be rectified using "jerk" values derived from acceleration readings. In this context, a comprehensive exploration of various physical factors influencing psychological experiences in gaming is conducted.

This study prominently emphasizes the intersection of physical and psychological elements by depicting the progression of game information within our minds. By establishing reasonable informational jerk values associated with the success rate and informational acceleration of the game process, the development of game refinement theory enhances the overall player experience.

The concept of "jerk", signifying a sudden change in acceleration, is a fascinating phenomenon experienced by humans and possesses practical applications in mechanical

and engineering domains, such as elevator rides. The paper forges a connection between the logistical model of game progression and "jerk" measurements, particularly in games with incomplete information, typified as AD values (representing addiction and the propensity for repeated gameplay).

To investigate the implications of AD values concerning GR metrics and its extension, the motion in mind model, several popular card games, including Wakeng, Doudizhu, Winner, Big Two, and Tien Len, are utilized. Self-playing simulations conducted by artificial intelligence (AI) agents validate these findings with empirical data, yielding valuable insights into game design and gameplay experiences.

Players of varying skill levels may encounter and endure diverse reward frequencies denoted as N and jerk values during the progression of game information. Thus, an exploration into the interplay between the player's performance level (k), reward frequency (N), and jerk values is undertaken.

The inherent game risk, often represented as "m" is a well-acknowledged factor. To overcome these challenges, players must skillfully devise strategies. Exceptionally skilled players can navigate uncertainties with ease, characterized by a game velocity represented as $\vec{v_0} = 1 - m$.

However, players possess differing abilities, resulting in varying levels of proficiency in dealing with uncertainties. Prior research employs "k" as a measure of performance, where higher values indicate lower performance. For imperfect players, the game velocity can be calculated as $\vec{v_k} = (1 - km)\vec{v_0} = (1 - km)(1 - m)$.

In the realm of reinforcement learning, "N" often signifies the "number of steps" or "time steps", representing the interval for acquiring rewards. In games with perfect information, players possess complete knowledge of moves, while imperfect information games entail partial insights or educated guesses. In such instances, "N" can symbolize the number of actions considered during decision-making, akin to the Monte Carlo Tree Search algorithm.

In this study, the Game Refinement (GR) theory is explored from the perspective

of the audience. The theory focuses on the cognitive processes that occur while playing strategy games, emphasizing the uncertainty of game outcomes and how it affects player experience. It introduces the concept of "jerk" to measure sudden changes in acceleration in games. The study investigates the relationship between "AD" values, representing addiction and repeat gameplay, and GR metrics in various card games. Additionally, it delves into the interplay of player performance (k), reward frequency (N), and unpredictability (AD) in gaming. This research provides valuable insights into game design and gameplay experiences.

Keyword: *Game refinement theory*;*Motion in mind*;*Perfect information game*;*Imperfect information game*;*Card game*;*Jerk*;*Addiction*;