Scientists develop model that adjusts video game difficulty based on player emotions

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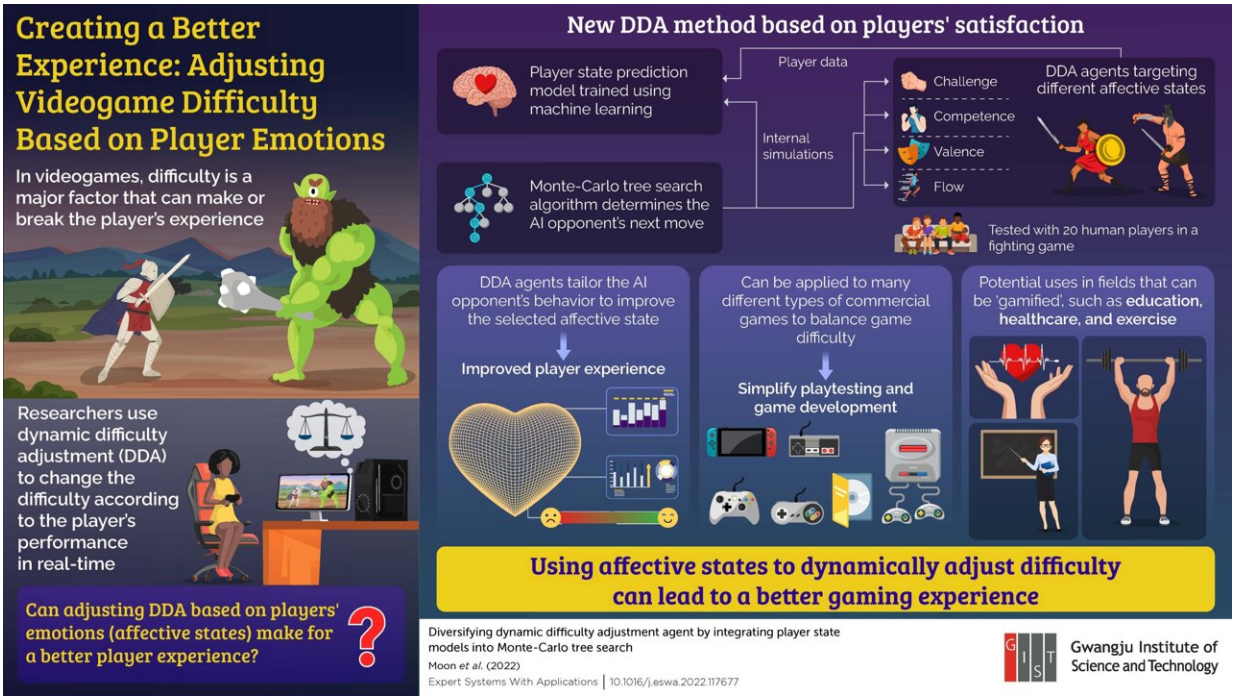

The novel approach to dynamic difficulty adjustment (DDA) takes into account the player's emotions during gameplay instead of the player's performance to provide a better player experience. Credit: Gwangju Institute of Science and Technology

Difficulty is a tough aspect to balance in video games. Some people prefer video games that present a challenge whereas others enjoy an easy experience. To make this process easier, most developers use dynamic

difficulty adjustment (DDA). The idea of DDA is to adjust the difficulty of a game in real time according to player performance. For example, if player performance exceeds the developer's expectations for a given difficulty level, the game's DDA agent can automatically raise the difficulty to increase the challenge presented to the player. Though useful, this strategy is limited in that only player performance is taken into account, not how much fun they are actually having.

In a recent study published in *Expert Systems With Applications*, a research team from the Gwangju Institute of Science and Technology in Korea decided to put a twist on the DDA approach. Instead of focusing on the player's performance, they developed DDA agents that adjusted the game's difficulty to maximize one of four different aspects related to a player's satisfaction: challenge, competence, flow, and valence. The DDA agents were trained via machine learning using data gathered from actual human players, who played a fighting game against various artificial intelligences (AIs) and then answered a questionnaire about their experience.

Using an algorithm called Monte-Carlo tree search, each DDA agent employed actual game data and simulated data to tune the opposing AI's fighting style in a way that maximized a specific emotion, or "affective state."

"One advantage of our approach over other emotion-centered methods is that it does not rely on external sensors, such as electroencephalography," says Associate Professor Kyung-Joong Kim, who led the study. "Once trained, our model can estimate player states using in-game features only."

The team verified—through an experiment with 20 volunteers—that the proposed DDA agents could produce AIs that improved the players' overall experience, no matter their preference. This marks the first time

that affective states are incorporated directly into DDA agents, which could be useful for commercial games.

"Commercial game companies already have huge amounts of player data. They can exploit these data to model the players and solve various issues related to game balancing using our approach," says Associate Professor Kim. Worth noting is that this technique also has potential for other fields that can be "gamified," such as health care, exercise, and education.

More information: JaeYoung Moon et al, Diversifying dynamic difficulty adjustment agent by integrating player state models into Monte-Carlo tree search, *Expert Systems with Applications* (2022). DOI: 10.1016/j.eswa.2022.117677

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