

AN OVERVIEW OF ALGORITHMIC AND PROCEDURAL METHODS FOR GAME BALANCING IN TOWER DEFENSE

This study aimed to analyze procedural content generation (PCG) and dynamic difficulty adjustment (DDA) as core methodologies for achieving a balanced gaming experience. Ensuring strategic balance in Tower Defense (TD) games is fundamental to maintaining player engagement and preventing early abandonment. A primary challenge is the transition from manual tuning to automated systems that adapt to player skills.

Effective balancing can be achieved through DDA systems that evaluate player performance based on the number of lives remaining and the enemy's health [3, p. 437]. By applying multipliers to status points, spawn rates, and gold income at the end of each level, the game can autonomously scale its difficulty to match the user's expertise, ensuring the player stays within the "flow" state [3, p. 435]. Furthermore, the integration of Genetic Algorithms (GA) allows for the optimization of key building blocks, including map layouts and wave compositions [2, p. 493]. GA can ensure level solvability by verifying valid paths and optimal tower placement while generating waves that respond to the player's current resources [2, p. 496].

Modern PCG frameworks emphasize the automatic generation of levels to increase replayability [1, p. 1]. These systems allow for the rapid creation of diverse environments and enemy routes, which is essential for resource-constrained development environments.

Ultimately, the synergy between PCG and DDA fosters a personalized gameplay environment that evolves with the player. This approach significantly reduces the manual workload for level designers while maintaining a high standard of strategic depth and player retention. Future implementation of these methods can lead to the creation of truly adaptive TD titles where every playthrough offers a unique and balanced challenge tailored to individual strategic thinking.

REFERENCES

1. Automatic generation of tower defense levels using PCG / S. Liu et al. *FDG '19: The Fourteenth International Conference on the Foundations of Digital Games*, San Luis Obispo California USA. New York, NY, USA, 2019. URL: <https://doi.org/10.1145/3337722.3337723> (date of access: 01.04.2026).
2. Kraner V., Fister I., Brezočnik L. Procedural Content Generation of Custom Tower Defense Game Using Genetic Algorithms. *New Technologies, Development and Application IV*. Cham, 2021. P. 493–503. URL: https://doi.org/10.1007/978-3-030-75275-0_54 (date of access: 26.03.2026).
3. Dynamic Difficulty Adjustment in Tower Defence / R. Sutoyo et al. *Procedia Computer Science*. 2015. Vol. 59. P. 435–444. URL: <https://doi.org/10.1016/j.procs.2015.07.563> (date of access: 23.03.2026).