

Chapter 5

Understanding and Implementing Adaptive Difficulty Adjustment in Video Games

Tremblay Jonathan
LIARA, Canada

Bouchard Bruno
LIARA, Canada

Bouzouane Abdenour
LIARA, Canada

ABSTRACT

This chapter begins with an introduction to different concepts evolving around the adaptive difficulty in video games (i.e. problematic definition, existing models of dynamic difficulty adjustment, evaluating the player's experience, transposing the player's skills into numerical values, using these numerical values as seeds for the difficulty level, etc.). Further on, this chapter covers the implementation of a novel adaptive model and the validation of such a model. This model uses a normal distribution system (ELO ranking) to determine the player's skill level and then adapt the difficulty to their needs. In order to validate this model, 42 players play-tested two versions of the game, one with adaptive difficulty and one without any difficulty adaptation.

INTRODUCTION

The great video game companies such as Nintendo, Microsoft and Sony have succeeded in opening up the video game market to a wider audience of players (Pelland, 2009). This audience is

composed of non-experienced and experienced players that share the same games. This reality has brought new challenges to game companies and game designers, such as making the game stimulating and interesting for this wider range of players. To reach all of them, the game has to provide the right amount of challenge for their skill level, as a game that is too hard or too easy

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is frustrating for them (Csikszentmihalyi, 1990). Also, one faculty of game, mainly used by serious games, is the capability of games to teach the player using game mechanics (the player's actions) (Koster 2004). In this serious context, it is crucial that the game is able to reach a wider audience, for example in the classroom the game would be played by experienced players and neophytes alike. Therefore, it is important for the player's experience that the challenge meets their expectations, as their enjoyment and learning results are closely related to the challenge. A classic approach to this conundrum is to let the player choose their difficulty level (easy, normal, hard, etc.) at the beginning of the game, without even trying it. Without any clear standard definition for difficulty, the player could easily choose the wrong level expecting the game to be something that it is not. This would lead the player to leave the game as they are experiencing frustration in the form of boredom and/or anxiety (Schell, 2008). Also, giving one unique level of difficulty is not really a proper solution, though it is a widespread one. Unique challenges are mostly interesting for a narrow range of players depending on their skill levels. Nevertheless, a well developed learning curve can bring many players, but the majority to the same point (Rolling & Adams, 2003).

To address this issue, some researchers and commercial video games such as *Max Payne* from *Remedy Entertainment* or *Left 4 Dead* one and two from *Valve* have built different models to dynamically adapt the difficulty of the game based on the player's performance or intensity level. One of the main challenges regarding difficulty is the subjective factor that stems from the interaction between the player and the challenge. The perceived difficulty is also not a static property: it changes with time as the player learns the game skills (Goetschalckx, Missura *et al.*, 2010). One of the major issues in this particular field is that the proposed approaches or games often do not offer any implementation explanations or guidelines for the dynamic difficulty model used. For example,

the work of (Lindley & Sennersten, 2008) where they present an adaptive approach using gameplay schema that recognizes the player's actions and based on them adapts the gameplay to the player's preferences. In this particular example, the model is essentially theoretical and experienced in a non-realistic context. From this context it is nearly impossible to determine its actual effectiveness and bring to light the problems that had not been taken into account in the design. Nevertheless, experimentation and testing remain the best way to assure the robustness of a dynamic system.

Other works propose models that have been implemented and tested such as (Hunicke & Chapman, 2004), where they present a computational model using normalization distribution to evaluate the player's skill level. A different approach proposed by (Chen, 2006) introduces a game design process leaving the player with the control of the difficulty of the game during gameplay. These types of work are essential for the comprehension and the elaboration of dynamic difficulty in games, for they give us an indication of how to implement and/or design their models. These works also provide discussion on their implementation and testing. They focus on how their models interact with the game but do not include deep explanations on the impact their model might have on the player.

The goal of this chapter is precisely to address this important issue that has been raised. This chapter has two distinct parts. At first the different concepts revolving around an adaptive model will be presented; such as the provenance of pleasure for the player in video games and their understanding of the difficulty and in game challenge. From there, a novel adaptive model for dynamically adjusting, in real-time, the difficulty level of a game according to the players' performance in order to enhance their gaming experience will be presented. The foundation of this model relies on a computational approach for Dynamic Difficulty Adjustment (DDA) (Hunicke & Chapman, 2004) and an extension of our previ-

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