Learning to generate personalised content based on human behaviour*

Vivek R. Warriar[1], Carmen Ugarte, and Laurissa Tokarchuk[2]

Cognitive Science and Game AI, School of Electronic Engineering and Computer Science, Queen Mary University of London, London, UK
{v.r.warriar[1], laurissa.tokarchuk[2]}@qmul.ac.uk

Abstract. We present an approach to personalizing algorithmically generated content based on human behaviour. This is accomplished by setting up a collaboration loop between computational models that predict user experience and algorithms that generate novel diverse content. We use features computed from human behaviour to drive both techniques. This interplay between the two is key in creating enjoyable and highly personalized experiences. We discuss our exploration across these two domains and present an approach to realizing this collaborative loop.

Keywords: User experience modelling · Procedural content generation.

1 Introduction

We investigate the relationship between human behaviour, preference prediction and content generation. This work aims to set up a collaboration loop between humans and procedurally generated content (PCG) in which the backing algorithms learn the emotional preferences of the human. This ability is key in extending enjoyable user experiences and generating personalised content. In the context of games, we are currently exploring two key aspects of this relationship: (1) player behaviour cues which are meaningful in creating highly personalised, fun experiences, and (2) the behavioural features that enable the creation of novel playable levels, which are described in sections 3 and 4 respectively. Before that, section 2 provides some background on using human behaviour to personalize content. Finally, section 5 discusses our approach to closing this collaborative loop between user experience modelling and generating content.

2 Background

Theoretical frameworks such as Experience-Driven Procedural Content Generation (ED-PCG) [1] describe techniques to generate content that is optimized a user's ideal experience. This has been applied to generate personalized game

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levels [2] or for real-time game balancing [3] of the Super Mario Bros game. The approach in ED-PCG is to use search-based algorithms that are driven by a player experience model. For example, generated game content that is more fun for the player would be assigned a higher fitness than others. Here, the choice of method to model player experience and the PCG algorithm is open to the designer. Our approach extends this relationship between experience modelling and PCG using common features which are computed from player behaviour cues and game/environment based factors. These features are used both to predict the player experience and generate game content (details in sections below).

3 Modelling User Experience

A variety of behaviour cues can be used to predict player experience. In games, player interactions form the core of these cues. As games move into the real world, either through virtual reality (VR) or augmented reality (AR) these player behaviour features become even more human-like. In AR and location-based experiences, player behaviour is measured directly by a persons physical interaction with the virtual world around them. To explore the usefulness of these different types of behaviour cues we set up an exploratory study to investigate the relationship between player movement data and emotional state. We use preference learning to model players' emotional preferences in an AR mobile game [4]. This study is used to verify our hypothesis that player physical behaviour is useful in making preference predictions. We successfully predict players' frustration and challenge level with high accuracy while all other emotional preferences tested (boredom, excitement and fun) perform better than random chance.

4 Generating Content

In parallel, we explore how player behaviour and level based features can be used to create a map of playable levels specifically tailored to the player. Evolutionary search-based techniques are popular methods for PCG in games. These algorithms attempt to find an appropriate solution, usually, appropriateness is measured by the playability of the content generated. While there exists a large number of search-based strategies to find playable and diverse game content, the current state of the art systems are limited in terms of control [2]. In general, they make no attempt at personalising content and it is challenging for them to return a set of solutions ranging from easy to difficult levels. Interestingly this is a comparatively simple task for a human game designer.

To provide human-like capabilities in procedural content design, our initial algorithm, a novel variant of the MAP-Elites algorithm, has been adapted to map the level design space of the Infinite Mario Bros game [5]. Here, we explore the impact of player behaviour based features (time of levels game-play, the number of jumps, and average speed of the avatar) on the levels found using this technique. The MAP-Elites algorithm is an illumination technique [6] that aims to return the highest performing solution for each point in a designer-defined

feature space. This technique can be used to create n-dimensional maps of game content. The various dimensions of this map correspond to player behavioural features of interest (similar to what we explore in [4]), allowing us to generate content that will target a spectrum of emotional responses from the player. In games, another variant of the MAP-Elites has been adapted for the bullet hell generation genre in the Talakat system [7] and to generate segments of the Infinite Mario Bros game levels [8]. To the best of our knowledge, this is the first known system the uses an illumination technique to generate complete and playable platform game levels with a promising level of control over the design/generation process allowing for a more controllable, personalisable and creative PCG level creation.

5 Discussion and Conclusion

From our investigation in player experience modeling and PCG using player behavior, we wish to be able to visualize player emotional preferences within the n-dimensional maps of game content by combining techniques described in [4, 5]. This will enable game designers to better analyze the complex mappings between their PCG game content, player behaviour and their emotional responses. We believe that continued investigation in order to close the collaboration loop between experience modelling and content creation will be beneficial to the domains of AI-assisted design and real-time personalization of digital content.

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