

Chapter 20

Game AGI beyond Characters

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ABSTRACT

Artificial General Intelligence has traditionally used games as a testbed to develop domain-agnostic game playing techniques. Yet games are about more than winning. This chapter reviews recent efforts that have broadened the ways Artificial Intelligence (AI) is used in games, covering: modeling and managing player experiences, creating novel game structures based in interacting with AI, and enabling AI agents to make games. Many of the techniques used to address these challenges have been ad hoc approaches to solving specific problems. This chapter discusses open challenges in each of these areas and the potential for cognitive architectures to provide unified techniques that address these challenges.

INTRODUCTION

Artificial General Intelligence (AGI) in games has traditionally emphasized control over characters within virtual environments. Yet game experiences depend on the coupling of characters with their environments and players. Recent trends in games have begun to target a broader array of AI applications. *Left 4 Dead* and *Dark Spore* employ an AI director to manipulate the game environment in real time to adjust player experience. *Black & White* and *Prom Week* engage players directly in teaching an intelligent system or manipulating “social physics” as core gameplay mechanics. And Procedural Content Generation (PCG)—the automated creation of game content like levels—has emerged as a core technique in popular games spanning *Spelunky* through *Diablo III*, making AI-driven content creation a growing interest across AAA and independent game creation.

These considerations have recently led many researchers to consider alternative applications of AGI in games beyond embodied agents within virtual environments. Rather than simulate the intelligence of non-player characters within a virtual environment, researchers are considering ways more general and autonomous agents can create gameplay experiences. Traditional character AI has been “weak AI” intended to provide adversaries designed for a single task, using techniques such as planning in *F.E.A.R.* (Orkin, 2005), behavior trees in *Halo* (Isla, 2005), or finite state machines in *Pacman* (Pittman, 2011). Research efforts on applying “strong AGI” to games have aimed to create intelligent adversaries in games

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like *Quake* (J. E. Laird, 2001) that engage in the full process of gathering visual information, processing that information, learning, and acting in the game environment. Most efforts, however, have aimed at highly controllable agents amenable to specific game designs with low computational demands. By approaching AGI from the perspective of agents that are core to gameplay there are new opportunities for AGI architectures that tackle the holistic problem of creating games for a variety of player experiences. Taking game AGI beyond characters has the potential to make AGI relevant to a broader range of game design concerns while enriching the knowledge and reasoning processes AGI is capable of.

This chapter reviews new avenues for AGI in games, highlighting emerging areas and discussing the potential for cognitive architectures and games to contribute to one another. Three primary topics are discussed, reviewing existing work as well as challenges and future directions for growing the areas and integrating AGI and cognitive architectures. *Player Experience Modeling and Management* highlights ways intelligent systems can model player experiences in a game to inform people making games about a game design and game environments that are automatically tailored to individual players. *AI-based Games* explores ways to make interaction with a general, autonomous intelligent system the core of gameplay, including learning techniques, social simulations, and strong AGI adversaries. *Game Creation* discusses ways to enable intelligent systems to augment and automate the process of creating part or all of games autonomously, simulating the intelligence of human creators to structure a game environment to create a game experience. By addressing AGI concerned with creating player experiences the chapter highlights opportunities for AGI to tackle the challenges of how designers and players reason about games as a whole.

The chapter first briefly reviews artificial general intelligence with an emphasis on existing cognitive architectures and their primary game application in game playing. Next is a discussion of three major avenues for AGI in games beyond characters: (1) systems for modeling and shaping player in-game experience; (2) approaches to making AGI the core of gameplay; and (3) applications of AGI to support and automate the creation of games. The chapter closes by discussing overarching challenges for game AGI beyond characters and encourages further work to model and augment the game design process. By reviewing these areas and their open challenges and directions this chapter provides an understanding of the state of AGI applications targeted toward creating gameplay and exposes opportunities to contribute to this growing area.

BACKGROUND

Researchers in AGI have developed cognitive architectures to model many forms of human knowledge, reasoning, and learning (Chong, Tan, & Ng, 2007; Duch, Oentaryo, & Pasquier, 2008). Cognitive architectures address the challenge of using multimodal information for complex, human tasks, ideally in a domain-agnostic fashion. Broadly speaking, cognitive architectures can be divided among three approaches: symbolic, subsymbolic, and hybrid models (Duch et al., 2008). Symbolic architectures emphasize the use of top-down, declarative representations of system knowledge in terms of atomic symbols. Well-known symbolic architectures include Soar (State, Operator, and Result) (J. Laird, 2012) and ICARUS (Langley & Choi, 2006). Subsymbolic architectures employ distributed representations that cannot be directly analyzed, such as neural networks, and aim to represent biological processes that underpin cognition. IBCA (Integrated Biologically-Inspired Cognitive Architecture) exemplifies this approach by modeling distributed information processing in the brain (O'Reilly & Munakata, 2000).

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