Believable and Effective AI Agents in Virtual Worlds: Current State and Future Perspectives

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ABSTRACT

The rapid development of complex virtual worlds (most notably, in 3D computer and video games) introduces new challenges for the creation of virtual agents, controlled by artificial intelligence (AI) systems. Two important subproblems in this topic area which need to be addressed are (a) believability and (b) effectiveness of agents’ behavior, i.e., human-likeness of the characters and high ability to achieving their own goals. In this paper, the authors study current approaches to believability and effectiveness of AI behavior in virtual worlds. They examine the concepts of believability and effectiveness, and analyze several successful attempts to address these challenges.

Keywords: AI Agents, AI for Games, Behavior Capture, Artificial Intelligence (AI), Believability, Learning by Observation

INTRODUCTION

What is a Virtual World?

Virtual worlds provide a basis for many popular video and computer games (e.g., Half-Life, The Sims), “life simulators” (e.g., Second Life, Entropia Universe), and virtual military training grounds (e.g., Virtual Battle Space). The use of such worlds becomes more and more widespread, as typical hardware is now able to perform realistic 3D real-time rendering, and the coverage of broadband Internet connection constantly increases. Furthermore, virtual worlds get new applications, most notably in the area of education and “serious games.” One can note, for instance, the existence of “virtual classrooms” in Second Life.

It is interesting to note that while the term “virtual world” is commonly used, only few authors provide its precise definition. Bell (2008) tried to combine previous definitions, found in the literature, into the following formula: “a synchronous, persistent network of people, represented as avatars, facilitated by networked computers.” This definition, though, ignores an important observation: modern virtual worlds can be inhabited not only with human-controlled
characters, but also with AI-based virtual agents, serving as non-participating world’s “native population,” hostile opponents or friendly teammates. Furthermore, it is still unclear what kinds of computer-generated environments qualify for the name of “virtual worlds”. The work by Mitchell (1995) “From MUDs To Virtual Worlds” suggests a clear distinction between MUDs (Multi-User Dungeons, text-based multiplayer games) and virtual worlds. Mitchell notes the lack of immersion, caused by limited visual capabilities of MUDs, and suggests that virtual worlds should combine MUD-styled gameplay with vivid 3D graphics. Though the discussion of features that turn a virtual simulation into a virtual world are beyond the scope of this paper, it is natural to presume that “a world” should possess certain high degree of complexity and audiovisual interaction, not found in simpler computer-simulated environments.

Virtual World’s AI-Controlled Inhabitants

As noted by Bell, the primary population of a virtual world is constituted by real people, represented as human-controlled agents or avatars. A world can be also inhabited by computer-controlled agents, also known as NPCs (non-player characters). Their role depends on the nature of the given world: serving as elements of the world’s setting (Milward, 2009), being used for research purposes (Friedman, Steed, & Slater, 2007) or even being completely prohibited as violating the intended world’s configuration (Blizzard, 2010).

The case of our interest is AI systems that can substitute human players or even pretend to be humans. This scenario is very common in the domain of computer games: if you play a computer chess match, fighting game, or a soccer tournament, you naturally assume that it is possible to choose either human- or computer-controlled opponent. Complex computer games and virtual worlds demand high-quality AI systems, able to control characters satisfactorily. The success of such AI is determined by the (human) users of a virtual world or a computer game. The factors that contribute to the overall user satisfaction are not obvious: successful AI systems are not necessarily the strongest game characters.

Consider the simplest example: in the classic Pac-Man game a human player has to eat all the “pills” located on the level, avoiding computer-controlled ghosts. It is not hard to program “optimal ghosts” that easily capture the protagonist; however, a player will be doomed to defeat in such a game, making the whole game project unenjoyable and thus unsuccessful. The same problem arises in chess, since the best AI systems are able to play at grandmaster level, while not all human participants are eager to compete with grandmasters all the time.

With games being the way in which many people around the world are learning how to use computers, and one of the primary reasons people spend time on computers, questions regarding how to improve the quality of the virtual worlds (and the AI agents in them) is an interesting challenge and opportunity for our field. This paper is focused specifically on the analysis of the current state of affairs and possible further directions in AI agents’ development for virtual worlds.

This paper is organized as follows. We begin with an overview of the research regarding what makes games fun and engaging, or “fun factors,” then looking specifically at how AI Agents in Virtual worlds can contribute to or distract from these factors, and the overall success of that game. We then examine what it is that makes AI agents “believable” and “effective”, and address what are the practical challenges that exist in AI development of these characteristics? We outline some of the potentially promising experimental approaches to AI development (including what testbeds can be used, how to test believability, what research projects have contributed to creating believable behavior, and what research projects have contributed to creating effectiveness). Using the background of the existing research, we then look at a specific case study of the same: a 3D boxing video game environment. Through this case study, we experiment with and research
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