Artificial Intelligence in Video Games

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Artificial Intelligence, Fall 2011
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December 8, 2011
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Artificial Intelligence in Video Games

Introduction:

Artificial intelligence in video games isn’t quite the same as artificial intelligence form an academic sense, which consists of deduction, reasoning, problem solving, learning, perception, natural language processing among others. However, artificial intelligence in video games has gained a lot of interest in recent years. The field has grown in the video game industry in a fashion similar to the way that gaming graphics grew in years past. In fact, artificial intelligence in video games is often likened to Moore’s Law, “[The artificial intelligence in] in video games seem to get twice as complex in some ways every eighteen months. As these games get more complex, they also get more interesting and engaging (Wexler, p. 2).” In general artificial intelligence in video games is seen as a technique that creates trickery and essentially hoodwinks the player into thinking s/he is interacting with intelligent and independently thinking, learning, and reacting agents.

This paper will discuss artificial intelligence in video games: what types of artificial intelligence are implemented commonly and the importance of artificial intelligence. It will also take a closer look at a number of popular games on the market with varied representations of artificial intelligence, and will conclude with a look at artificial
intelligence in the future: where artificial intelligence is lacking in video games, what the next stage of artificial intelligence will be, and what advantages and challenges it will bring.

**What is Video Game Artificial Intelligence:**

Most people, upon hearing the words artificial intelligence, think of android and humanoids – perhaps images of C3PO or Robocop are called to mind. The general idea of artificial intelligence is that of freethinking and learning robots that can act and think as humans do – maybe even better. These conceptions about artificial intelligence very well may be valid, but not so much in the case of artificial intelligence in video games. From a gaming perspective, the behavior of entities (i.e. agents, non-player characters (NPCs), even the player's character) is of more concern than the thinking of entities when looking for, gauging and developing intelligence (Anderson, p.2). Behavior is more tangible and visible. And it can be dealt with and observed in gaming as opposed to thinking. Designing game intelligence around the concept of behaviorism seems to be very fitting since it “concentrates on the analysis [and development] of stimulus-response mechanisms (Anderson, p.2).”

There are many definitions of artificial intelligence that are in circulation. The dictionary defines it as, “the study of the modeling of human mental functions by computer programs (Anderson, p.2).” This definition is quite evident in games like *Halo*, *Counterstrike*, and *The Sims* where the NPCs are designed to emulate detailed human tendencies in their respective settings, such as: survival instincts (i.e. taking shelter, jumping on objects, fleeing), teamwork, and in some unique cases insanity. Others choose to define artificial intelligence as “…the ability of a system to adapt to its environment through learning (Anderson, p.2).”
This definition is given merit by its representation in games like Black & White, where a god-like deity has dominion over a creature (an NPC) and is tasked with training it. The creature learns the tendencies of the player and its environment, associating bad behaviors with punishments received from the player as well as mimicking the behaviors of surrounding creatures, and sometimes preempting actions before the player has instructed to do so.

Regardless of the definition for artificial intelligence that one chooses to buy into, the overwhelming goal of it’s presence in video games is to provide the player with game immersion and replayable challenges. This is why artificial intelligence in video games is viewed as more of a pseudo-artificial intelligence in comparison to the academic sense of artificial intelligence. Even though it implements many of the traditional artificial intelligence techniques like: finite state machines, fuzzy state machines, neural nets, decision trees, and evolutionary techniques among others, “it centers on the appearance of intelligence and good gameplay…[using] workarounds and cheats are acceptable and in many cases, the computer’s ability must be toned down to give human players a sense of fairness (Wikipedia – Artificial Intelligence, p.1).” For this reason, “some might argue, that in the case of artificial intelligence in games, the term artificial stupidity might be a better description for the level of intelligence that is found there (Anderson, p.6).”

“Video game artificial intelligence isn’t about intelligence. It’s about creating a realistic, [immersive], and fun experience (www.giantbomb.com, Artificial Intelligence, p.3).” The true purpose of artificial intelligence in video games is to pull the player into the game by giving the illusion that the characters the player interacts with are truly intelligent and human like.
Types of Artificial Intelligence:

There are a number of artificial intelligence techniques that are used in games. Some techniques are used more commonly and effectively than others. But with the demand for more realistic, interactive, and complex games, the techniques are constantly developing and changing in order to deliver to players more effective and immersive gameplay.

- **Symbolic Artificial Intelligence** – Symbolic artificial intelligence was developed from early research in the artificial intelligence field. A group of mostly engineers and computer scientists concerned themselves with developing artificial intelligence by “defining a set of common-sense rules through which real-world problems could be solved (Anderson, p.5).” A programmer implementing symbolic artificial intelligence would need to identify and develop algorithms for solving particular problems. That way programs could be built containing this knowledge base. The program(s) could then implement search strategies according to defined rules in order to find an applicable and appropriate solution (Anderson, p.5).” This is the type of artificial intelligence you find associated with games like chess, in which solutions (best moves) can be determined by searching through rules and previous and current conditions.

- **Scripting Artificial Intelligence** – Scripting artificial intelligence is the most commonly used form of game artificial intelligence today. It can be thought of as a simple if…then statement (www.giantbomb.com, Artificial Intelligence, p.1). Scripting artificial intelligence is well represented in older video games like 007: Golden Eye or The Legend of Zelda series, where certain conditions led to specific NPC reactions. For example, in
certain levels of *Golden Eye*, merely walking into a room or past a window, even if seemingly unnoticed, resulted in an onslaught of bullets, grenades and the arrival of more attackers. In some cases, walking into a room sounded an alarm instantly. A generic example of scripting artificial intelligence would be, “IF the player ducks behind a wall, THEN wait for four seconds and throw a grenade ([www.giantbomb.com](http://www.giantbomb.com), *Artificial Intelligence*, p.1).”

- **Random Scripting Artificial Intelligence** – Random scripting is quite similar to the above-mentioned scripting, but is slightly more dynamic and was developed in order to provide a little more variety to gameplay ([www.giantbomb.com](http://www.giantbomb.com), *Artificial Intelligence*, p.1). This form of artificial intelligence can be viewed as an if…then…or statement, such that a fitting generic example could be, “IF the player ducks behind a wall, THEN wait four seconds and throw a grenade, OR rush the wall guns blazing, OR find higher ground and shoot over the wall ([www.giantbomb.com](http://www.giantbomb.com), *Artificial Intelligence*, pp. 1-2).”

- **Behavioral/Character Based Scripting Artificial Intelligence** – This is a type of artificial intelligence that gives NPCs the ability to behave in a particular manner toward players based on the NPC’s character type and qualities ([www.giantbomb.com](http://www.giantbomb.com), *Artificial Intelligence*, p.2). For example, “if a soldier NPC is deemed defensive, its likelihood of doing a particular action could be tweaked as 25% of grenade attacks, 5% rushing, and 70% of taking cover. On the contrary, if the NPC is aggressive, 40% grenade attacks, 45% of rushing, and 20% of taking cover ([www.giantbomb.com](http://www.giantbomb.com), *Artificial Intelligence*, p.2).” This form of artificial intelligence is displayed well in a game like *Quake*, where a
player may find himself rushed by an NPC, and then later encounter an NPC who flees from the player. This could be based off levels of health of the player and the NPC.

- **Situational Awareness** – This form of artificial intelligence “is a more advanced form of artificial intelligence scripting ([www.giantbomb.com](http://www.giantbomb.com), *Artificial Intelligence*, p.2)” and is common in a lot of today’s first person shooter combat games like *Halo*. Situational awareness enables “scripted actions to appear more dynamic and realistic and adds a dimension of believability ([www.giantbomb.com](http://www.giantbomb.com), *Artificial Intelligence*, p.2).” This helps to immerse the player into gameplay by causing the player to buy into the agents’ humanness. “Examples may be subtle effects like brushing a hand along a wall while walking past it, or more complex problem-solving behaviors like an NPC escaping from a trap set by the player, using objects in the game environment ([www.giantbomb.com](http://www.giantbomb.com), *Artificial Intelligence*, p.2).” In *Halo* NPCs can be seen lifting up objects like a box or boulder in order to search for the player they recently lost sight of. Or in *NBA 2K10* a player may wipe sweat from his brow just before shooting a free throw late in a close game, possibly indicating the pressures of a close game.

- **Pathfinding** – Pathfinding is essentially getting an NPC from point A to point B. More than that, “you also have to keep in account where the player is, if he’s firing, should the NPC fire when he moves or move as fast as possible [across the field] ([www.giantbomb.com](http://www.giantbomb.com), *Artificial Intelligence*, p.2).” Programmers implementing pathfinding then need to take a step back and make sure that the NPC’s path seemed believable. If one has ever played older versions of the *NBA Live* series by EA Sports,
they have probably experienced the unrealistic pathfinding of players. Occasionally, an NPC and even the player makes one swift move and manages to cover a distance equivalent to the distance from the free throw line to the goal, sometimes going through defenders to score. Pathfinding relates to scripting in that “scripting tells the NPC where ‘B’ is and pathfinding gets the NPC there (www.giantbomb.com, *Artificial Intelligence*, p.2).”

- **Emergent Artificial Intelligence** – This is a form of artificial intelligence in which “the game, [and the NPCs] actually learn from [the player’s] actions (www.giantbomb.com, *Artificial Intelligence*, p.2).” Emergent artificial intelligence is used heavily in games like *Black & White*, where the player’s NPC creature learns from the parenting of the player. The creature can associate behaviors as good or bad, can learn tendencies of the player and can often preempt the player’s actions.

- **Rubber Band Artificial Intelligence** – This is a moniker that is associated with artificial intelligence that is used in games for the purpose of “boosting a competitive feel (www.giantbomb.com, *Artificial Intelligence*, p. 2).” Rubber banding is commonly found in racing game like *Mario Kart* or *Need for Speed*. When the player pulls away substantially from the opponent NPCs, “the NPC driver receives speed boosts and better handling that is unavailable to the player in order to remain competitive (www.giantbomb.com, *Artificial Intelligence*, p.2).” Often times the player will experience a CPU controlled player “make up a fifteen second gap in three seconds. Rubber banding is the reason why an NPC in *Mario Kart* can go from 8th to 1st and back again in
the span of one lap (www.giantbomb.com, Rubber Band AI, p.1).” Rubber banding can be found in gaming genres outside of racing. In games like Madden NFL and NBA Jam, rubber banding is the culprit behind unblitzable quarterbacks and considerably lower shot and dunk percentages for the player when a CPU controlled team is losing by a substantial number of points (www.giantbomb.com, Rubber Band AI, p.1).

**Cheating Artificial Intelligence** – In game artificial intelligence, “cheating refers to the programmer giving agents access to information that would be unavailable to the player in the same situation (Wikipedia, p.5).” In the game Civilization, “at high difficulty settings, the player must build his empire from scratch, while the computer’s empire receives additional units at no cost and is freed from most resource restrictions (Wikipedia, pp.5-6).” This form of artificial intelligence is probably what prevents most people in the field from viewing gaming artificial intelligence in the same light as artificial intelligence in the academic sense. “The ability to legitimately solve some artificial intelligence problems in games by cheating creates an important distinction. For example, inferring the position of an unseen object from past observations can be a difficult problem when artificial intelligence is applied to robotics. But in a [game] an NPC can simply look up the position in the game’s scene graph (Wikipedia, p.3).”

**The Importance of Gaming Artificial Intelligence:**

Game artificial intelligence is important for a few reasons. Good gaming artificial intelligence, like that present in games like Halo, Counterstrike, and Black & White, provide new dimensions of realism and immersion to the player experience. Even more important
than computer graphics, artificial intelligence in games is the impetus behind adding complexity and believability to the characters that populate virtual game worlds (Anderson, p.7) Anderson claims that the natural, human like appearance of NPCs in games is “a crucial factor for the success and popular acceptance of a [video] game…and this [ideal] has now become more important than ever (Anderson, p.7).” Today’s players expect, more than ever before, the ability to interact with their gaming environments and to see their characters and NPCs do things that they themselves would do in the same situation and even some things they wouldn’t do or even think of. They expect to see NPCs lift up objects when searching for a player, or to listen for a players footsteps or gun shot, and determine where they are hiding because that’s what they would do. To the player, it seems natural and realistic. Players expect to see the signs of intelligence in the same way that they expected to see smooth, detailed and accurate graphics in games past.

Game artificial intelligence also plays an important role in the replayability of video games. Craig Furness, author of *What Does AI Offer Video Games*, likens video games to a film that is rarely watched twice. “Only if it really appealed as one of the greats (Furness, p.1)” might one watch – or in the case of games – play it again. Furness denounces that the common goal in game design circles is that “replayability can be had with only the addition of new game modes and content (Furness, p.1).” This content could be unlockable decorations, maps, mini games, or secrets. Furness argues that the average gamer won’t return to the game to experience the breadth of these extra features. Furness offers artificial intelligence as a viable solution. “Every bit of the player’s in-game experience will be interacting with at least some part of the artificial intelligence. The player gets to experience it all during the
course of the game (Furness, p.1).” Furness continues, proclaiming that the experience only improves when the player returns for a second try at the game because the artificial intelligence provides “[interesting] sub-quests, changed personalities in agents, and above all, new circumstance with each new play (Furness, p.2).”

Finally, artificial intelligence in video games is important to enhancing the field of artificial intelligence as a whole. “As game environments become more complex and realistic, they offer a range of excellent test beds for fundamental artificial intelligence research (Microsoft Research, p.1).” Researchers believe that video games and artificial intelligence research can both provide benefits to each other. “From a research point of view, video games offer fascinating toy examples that capture the complexity of real-world situations, while maintaining the controllability and traceability of computer simulations (Microsoft Research, p.1).” Game developers’ efforts in making more realistic and life-like games, by giving NPCs the ability to perceive and deduce given their environment or current state, and to learn from the player and surrounding NPCs, provides artificial intelligence researchers with the “benefit of access to benchmarks that accurately reflect real-life problems (Microsoft Research, p.2).”

Examples of Artificial Intelligence in Games

The Sims 3:
Interaction with Environments – Agents in *The Sims 3* interact with their environment in a unique way. The objects that make up the virtual world are referred to as “annotated”, and it is deemed “one of the most interesting artificial intelligence features of the popular game (Anderson, p.9).”

The use of a smart environment makes it so that the agents in *The Sims 3* don’t really have to know much about their environment because the objects they interact with will essentially identify themselves and their functionality.

![Figure 1](source: www.google.com) The agent doesn’t need to know what a refrigerator is or does because the object itself will convey this to the agent.
Happiness Scale – The designers of *The Sims 3* created an intriguing method for how the agents make decisions on what things to do, and in what order. They created a “happy scale” that functions a lot like a topographical map for the agent. The terrain of the environment changes based on the emotional and physical needs of the agent that need to be satisfied.
Figure 3 – (Source: Under the Hood of Sims) The agent is hungry and the area of the environment that contains an object that satisfies hunger has the highest elevation. Indicating to the agent that he should head in that direction.

Figure 4 – (Source: Under the Hood of Sims) Now that hunger is resolved its elevation decreases. Lonely now is priority and map reflects the area of the environment that will satisfy this need is the most elevated.
Free Will – Developers gave the agents the ability to experience free will – a feature that gives the agents the awareness “to do what they decide to do when [the player] leave them to their own device (www.simprograms.com, p.1).” This feature allows the true traits and human like behaviors of the agents to be expressed.

Figure 5 – (Source: Under the Hood of Sims) The agent has satisfied hunger and loneliness, and the happy scale reflects the need that remains to be satisfied most.

Figure 6 – (Source: www.google.com) Because they aren't controlled by the player, free will allows the agents' true attributes, based off their genes and traits, to be displayed. This agent has the “insanity gene” and the agent choking herself expresses it. With free will enabled, this gene is fully expressed.
Halo II:

Halo II is touted as having the best combat oriented artificial intelligence. “The enemy’s battlefield savvy is one of the most impressive aspects of the game (HowStuffWorks, p.1).” Designers of this game give the agents the ability to perceive their world, and make decisions based off those perceptions using simulated senses (HowStuffWorks, p.1). Players generally make themselves known to NPCs when they enter the NPC’s space and are visible, and when they make a sound, such as shooting their gun. For this reason, designers have simulated vision, hearing and tactile knowledge and have tied it to a memory structure that enables the agent to simulate having memories and recalling events that occurred and

Figure 7 – (Source: www.google.com) Toggle and adjust free will feature in preferences.
making decisions based off that information (HowStuffWorks, p.2). For example an agent can make the decision to retreat, when it counts the people in the room as 6 and recalls from the memory structure that only one other member in the room is a friend (HowStuffWorks, p.1). “So at every level of the hierarchical tree, those decisions about what the most appropriate thing to do is made based on the knowledge of what is [perceived] from the world…(HowStuffWorks, p.3).”

Similar to the annotated environment found in *The Sims 3*, the agents interact with tagged objects in their environment to determine if an object exists, and if so, if it’s good cover, liftable, able to be climbed, or kicked away swiftly when running (HowStuffWorks, p.4). The agent knows these [tag] values and picks the location that offers the value it needs for the current situation…But if these cover objects are destroyed or moved, [then] the tag changes. This how the agent knows they can no longer seek cover at that point in space. The cover tag is attached to the object, not the space (HowStuffWorks, pp. 4-5).”

Lastly, game developers note that one of the games biggest artificial intelligence related improvements is in the agents’ ability to communicate with each other and tactfully team up and work together to defeat the player. The NPCs actually post requests for joint behavior to nearby NPCs and wait for a response. For example “if an agent sees a moving vehicle being driven by another NPC, it can post a request to that agent asking for a ride. The driver, if he accepts the post, will stop, turn around and pick up the requestor (HowStuffWorks, p.6).”
Figure 8 – (Source: www.google.com) Agents in vehicle together attacking opponent.

Figure 9 – (Source: www.google.com) Agents in vehicle together attacking opponent.
Artificial Intelligence in Future Games

Where Artificial Intelligence is Lacking:

Artificial intelligence in video games has made tremendous strides in recent years, but still lacks in certain areas, and there are problems that future ventures in game artificial intelligence will want to address. As characters in video games develop more humanness and life-like characteristics: navigation, movements, gestures, blinking, gazing, and dialogue to a name a few, the artificial intelligence will have to “keep pace with the incredibly detailed, high-polygon models (Rabin, p.1).” Also, there is still a need for improvement in the way that agents interact with their environment. Some games like Halo II have begun to capture this element of artificial intelligence quite well. Unlike a human player who can navigate the field almost freely: taking cover in order to reload, using nearby objects for cover, charging the opponent when are wounded or reloading, “the NPCs must be programmed for all the possible scenarios. This severely limits its ability to surprise the player (Wikipedia, p.5).”

The Next Stage of Artificial Intelligence in Video Games:

With video game artificial intelligence gaining much momentum in recent years, and holding much importance in the success, popularity and replayability of games, there’s a lot to be expected from game artificial intelligence in the future.
3D gaming seems to be in the discussion. This would involve realistic human characters and would draw upon artificial intelligence that could identify languages from a repository of languages and use them for interactions and storytelling (Radoff, p.1). Emotional intelligence is another aspect of game artificial intelligence that’s expected to make an appearance in the future. Emotional intelligence explores the ability for game agents to express empathy and to interpret emotions. “Computers have a long way to catch up. Ultimately, this will mean that computers will need to interpret body language and other organic signals to develop emotional intelligence (Radoff, p.1).”


Appendix A

This appendix includes information that was very interesting during the researching of my paper topic, but didn’t have an appropriate place within my paper. The topics range from future artificial intelligence to interesting and unique game components. Please enjoy.


[https://www.simprograms.com/4735/sims-3-vip-blog-artificial-intelligence-in-the-sims-3/].
