Artificial Intelligence in Gaming

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ABSTRACT

Artificial intelligence (AI) is the intelligence exhibited by an artificial entity, generally assumed to be a computer. It has been involved with gaming since day one. It is progressively being widely used in the gaming industry. AI in games is commonly used for creating player's opponents. It is the foundation of all video games. Games like Nim, checkers, or chess took advantage of smart algorithms to beat human players. AI-based games are based on a finite set of actions or reactions whose sequence can be easily predicted by expert players. This paper provides an introduction on the applications of AI in different games.

KEYWORDS: games, artificial intelligence, computer games, artificial intelligence in gaming, game AI, gamification of AI

INTRODUCTION

Game developers have been programming software both to pretend like it is a human.

The origin of the application of artificial intelligence in gaming can be found in the chess games between the computer IBM AI known as Deep Blue and the Russian master Gary Kasparov in 1996. In 2016, a Google AI system AlphaGo defeated top ranked player Lee Sedol in a game match of the Chinese board game Go. These examples suggest that AI systems can be dominant in just about any kind of game we humans can think of. Gaming and AI have been bedfellows for nearly 70 years.

The games industry is one of the most lucrative industries due to the billion dollar sales of digital games. The motivations for playing digital games are varied and different for different age groups. People play digital games for several reasons, from entertainment to professional training [1].

Game developers have been employing AI in unique and interesting ways for decades. They become especially adept at using traditional techniques to achieve the illusion of intelligence. They have used AI to create art for games and push automated game design to new heights [2]. Their intent has not been to try and achieve some unprecedented level of human-like intelligence, but to create an experience that stimulates players in ways only the real world used to be capable of. The goal is to make the AI more human or at least appear to be so. Figure 1 shows a robot play a football game [3].

OVERVIEW ON ARTIFICIAL INTELLIGENCE

The term "artificial intelligence" (AI) was first used at a Dartmouth College conference in 1956. AI is now one of the most important global issues of the 21st century. AI is the branch of computer science that deals with designing intelligent computer systems that mimic human intelligence, e.g. visual perception, speech recognition, decision-making, and language translation. The ability of machines to process natural language, to learn, to plan makes it possible for new tasks to be performed by intelligent systems. The main purpose of AI is to mimic the cognitive function of human beings and perform activities that would typically be performed by a human being. Without being taught by humans, machines use their own experience to solve a problem.

AI is stand-alone independent electronic entity that functions much like human expert. Today, AI is integrated into our daily lives in several forms, such as personal assistants, automated mass transportation, aviation, computer gaming, facial recognition at passport control, voice recognition on virtual assistants, driverless cars, companion robots, etc. AI is not a single technology but a range of computational models and algorithms.

Some forms of AI that are most commonly used in different applications include the following [4,5]:

➢ **Expert systems:** They solve problems with an inference engine that draws from a knowledge base equipped with information about a specialized domain, mainly in the form of if-then rules. Expert systems are the earliest, most extensive, the most active, and most fruitful area.

- ➢ **Fuzzy logic:** This makes it possible to create rules for how machines respond to inputs that account for a continuum of possible conditions, rather than straightforward binary.

- ➢ **Neural networks:** These are specific types of machine learning systems that consist of artificial synapses designed to imitate the structure and function of brains. They are similar to the human brain. They are made up of artificial neurons, take in multiple inputs, and produce a single output. The network observes and learns as the synapses transmit data to one another, processing information as it passes through multiple layers.

- ➢ **Machine learning:** This includes a broad range of algorithms and statistical models that make it possible for systems to find patterns, draw inferences, and learn to perform tasks without specific instructions. Machine learning is a process that involves the application of AI to automatically perform a specific task without explicitly programming it. ML techniques may result in data insights that increase production efficiency. Today, artificial intelligence is narrow and mainly based on machine learning.

- ➢ **Deep learning:** This is a form of machine learning based on artificial neural networks. Deep learning architectures are able to process hierarchies of increasingly abstract features, making them especially useful for purposes like speech and image recognition and natural language processing. Deep learning networks can deal with complex non-linear problems.

- ➢ **Natural Language Processors:** For AI to be useful to us humans, it needs to be able to communicate with us in our language. Human language is complex, but AI can be trained to slowly pick up the language. Computer programs can translate or interpret language as it is spoken by normal people.

- ➢ **Robots:** These are computer-based programmable machines that have physical manipulators and sensors. Sensors can monitor temperature, humidity, pressure, time, record data, and make critical decisions in some cases. Robots have moved from science fiction to your local hospital. In jobs with repetitive and monotonous functions they might even completely replace humans. Robotics and autonomous systems are regarded as the fourth industrial revolution.

These AI tools are illustrated in Figure 2 [6]. Each AI tool has its own advantages. Using a combination of these models, rather than a single model, is recommended. AI systems are designed to make decisions using real-time data. They have the ability to learn and adapt as they make decisions.

AI IN GAMING
AI in a game can simply act as the player. The player learns to think either strategically, tactically, or reactively. The player can give his squad two kinds of orders: explicit and implicit. Most games support only explicit orders: move, attack, guard, build, etc. Unlike explicit orders, implicit orders transmit information from the player to the units and assists them in making better autonomous decisions. To influence the player to perceive the creatures as intelligent, he has to be provided more insight on their actions, intentions, thoughts, and emotions (such as joy, fear, are trust, surprise, fear, disgust, and anticipation), which are

simple to model. Autonomous behavior is hard to program manually, but it can be taught by providing examples [7].

Game playing has been an active research area in AI from the beginning.

Artificial intelligence can be used in games in various ways. AI tools are used in a wide variety of fields inside a game. AI can mimic, imitate, learn, forget, teach, and collaborate. It could be a testing tool to make your code or design more robust. It may be the unseen hand directing the whole affair. AI creates entirely new elements for the game — new levels, new rules, new environments. AI techniques can help generate intelligent, responsive behavior that molds on your reactions as a player. AI makes the game more interactive by boosting player's experience. They can adjust parameters such as speed and time.

While you are playing the game, the game is also playing you. AI is more geared towards automation. In order to give the player non-human opponents, AI is needed in almost all games. AI-based games make you feel like you are playing against another person. You will not need other human interactions when you play some of the multiplayer video games.

Designers usually identify four main player modeling subtasks that are particularly relevant for game AI [8]:
- ➢ Progress a smart and human-like NPCs (Non Person Character) to improve interaction with gamers.

- ➢ Predict human players' actions that lead to enhanced game testing and game design.

- ➢ Classify their behaviors to allow the personalization of the game.

- ➢ Discover frequent patterns or orders of actions to regulate how a player performs in a game.

APPLICATIONS OF AI IN GAMING
Modern games have advanced in multiple ways over the past decades. AI technologies such as machine learning, deep learning, neural networks, and natural language processing can produce high-quality video game and make modern games look amazing.

Figure 3 shows a typical AI game [9]. Some straightforward applications of AI in gaming include AI games, video games, virtual reality games, augmented reality games, and mobile games.

- ➢ **AI Game:** AI can be used in developing all types of games, especially for Game-AI. The Mind Game (renowned AI game) is viewed as a distinct subfield of AI and is often asked to solve fairly complex problems. Game AI is regarded as weak AI because it involves a broader range of purposes and technologies to give machines specialized intelligent qualities. In order to deliver an entertaining game for the user, thee seven objectives of game AI objectives are [10]:

1. No clear cheating: Game AI has to be active without deceit.
2. No predicting behavior: Game AI behavior should not be predictable by the user.
3. No obvious inferior behavior: Game AI should not exhibit obvious inferior behavior against the user, so that it cannot be defeated easily by the user.
4. Use of the environment: Game AI has to exploit in a smart way the characteristics of the game environment.

5. Self-correction: Game AI should be capable of correcting its behavior in order to avoid repeating mistakes.

6. Creativity: Game AI should be capable of generating novel solutions to unforeseen game circumstances.

7. Human-like behavior: The behavior exhibited by game AI should be equivalent in complexity to the human behavior.

➢ **Video Games:** Artificial intelligence has been an integral part of video games since the 1950s. If you have played a video game, you have interacted with AI. Various video games, whether they are racing games, shooting games, or strategy games, have numerous features that are affected by AI. In <u>video games</u>, AI is used to generate responsive, behaviors in <u>non-player characters</u> similar to human-like intelligence. Video game AI has revolutionized the way humans interact with all forms of technology. As far as video games are concerned, AI may be regarded as the set of techniques used to design the behavior of the "Non-Playable Characters" (NPC). In most video games, NPCs' behavior patterns are programmed and cannot learn anything from players. The main component of AI techniques that is widely used in video games is machine learning or more specifically, reinforcement learning. Game inventors dream of building video games and provide machine learning with a flexible environment for quick changes and easy customization. The most widely used AI technique in games is cheating. In AI-based video games, cheating refers to the programmer giving agents actions and access to information that would be unavailable to the player in the same situation [3]. Instead of learning how best to beat human players, AI in video games tends to enhance human players' gaming experience.

➢ **VR Games:** Virtual reality (VR) is the simulation of a real environment using visual, auditory, and other stimuli. It involves using computer technology to create a simulated environment [11]. The common method of participating in VR is through a headset. Virtual reality game is a niche category when compared to the rest of the gaming industry. Machine learning is used in the video game industry, especially in virtual reality. VR is the future of gaming. VR games (or even just regular console games) will become more immersive and dynamic. Figure 4 illustrates an example of virtual reality game that brings people together [12]. Big tech companies like Facebook, Google, Microsoft, and Sony have greatly invested in developing VR hardware and games. These companies are busy making VR more consumer-friendly.

➢ **AR Games:** AR is a variation of VR. It plays a supplemental role rather than a replacement of reality. Typical augmented reality (AR) devices include mobile phones and specially made glasses. The AR technology powered *Pokémon Go*. It took a well-established brand (Pokémon) to get consumers to give it a try. AR is taking off faster than VR because people have an appetite for games that interact with reality, not remove them from it.

➢ **Mobile Games:** Companies are already rolling out 5G for mobile devices, which make data available quickly, enable you to pull up an AR game, look through your screen, and get data on the world around you.

Other types of applications of AI in games include war games, football game, card games, shooting games, strategy games, tactical games, simulation games, serious games, racing games, online games, adaptive games, and commercial games.

EXAMPLES OF GAME AI
The following games employ AI and are interesting, clever, and novel [13]:

1. The Division's AI-driven path finding for changing cover. AI can drive mechanics that help the player get around faster.

2. Forza's Drivatar adaptive AI system. AI that mimics real people can make enemies and opponents seem more human.

3. Alien: Isolation's hunting Xenomorph. An enemy AI designed to relentlessly hunt the player as they roam about the game world.

4. The Ice-Bound Concordance's combinatorial narrative. You can use AI to tell a dramatically-satisfying story.

5. City Conquest's playtesting via genetic algorithm. AI can help you make your game better by playtesting to find dominant.

6. Testing for walk ability in The Witness. AI can do the grunt work for you in finding all the nasty problems that could frustrate players simply trying to explore your game's world.

7. The AI Directors in Left 4 Dead, Rocksmith 2014, and others. Every player is different, and AI can help ensure that everybody gets a satisfying, challenging experience.

8. With FEAR**,** the AI works in a way that it could easily fool the player into thinking they were facing a group of human players. FEAR's enemies are skilled commandos trying to put a stop to your mission.

9. AI project called Angelina, developed by Michael Cook in 2011, is capable of designing video games from scratch in a way that is surprisingly simple.

BENEFITS
Gaming is the future of entertainment. In essence, games are learning devices. Human enjoyment of games is derived from enjoying progress, mastery, proficiency, experimentation, and learning. AI is initiating a new era of smart video games. AI essentially consists of algorithms which you can tame whichever you want. AI has a rich history and has been the backbone for countless aspects of computing, gaming, and more. AI in games takes the role of a never-bored and never-boring opponent. AI serves to improve the game-player experience. AI can also be used to enhance existing games. "Video games offer the best test of intelligence we have. Combining AI with virtual or augmented reality opens the gates to add reality factor to video games.

CHALLENGES
AI is not yet capable of creating entire high-quality games from scratch. Games can be addictive to the player. Elon Musk has recently warned the world that the fast development of AI with learning capability by Google and Facebook would put humanity in danger. The gaming industry are pretty conservative and publishers or game makers need to take risks. There is the temptation of preferring to keep doing that same thing.

Perhaps the only barrier to fully utilizing AI technology in gaming is the eventual limit of money and time. A related challenge is the cost incurred in the maintenance and repair. The idea of machines replacing human beings sounds threating. If robots begin to replace humans in every field, it will eventually lead to unemployment. It is difficult to create thoroughly robust AI because its development is constrained to the scope of an individual game project.

THE FUTURE OF AI IN GAMING

The future of the application of AI technology lies in the development of video games and the ability of the technology to increase the human connection, i.e. AI that is human-like, emotional, and responsive. AI is clearly the future of gaming and the future of AI in video games would naturally point to automation. In the future, AI becomes a kind of collaborator with humans, helping designers and developers create art assets, design levels, and even build entire games from the ground up. Big tech companies such as Sony, Nintendo, Microsoft, Apple, Google, and Amazon are seizing the moment and developing gaming products.

CONCLUSION

Games have been regarded as the perfect test-bed for artificial intelligence (AI) techniques. Modern computer games often feature realistic environments by employing 3D animated graphics to give the impression of reality. State-of-the-art games can recreate real-life environments with a surprising level of detail. The demands of the gaming community and the games themselves keep evolving. For more information about artificial intelligence in games, one should consult the books in [7, 14-17] and related journals:

➢ AI Time Journal
➢ International Journal of Computer Games Technology
➢ IEEE Transactions on Computational Intelligence and Ai in Games

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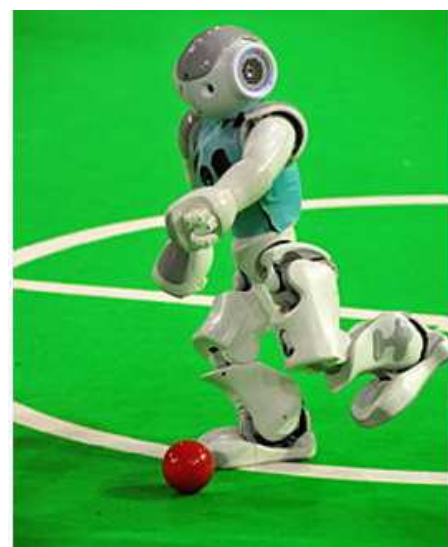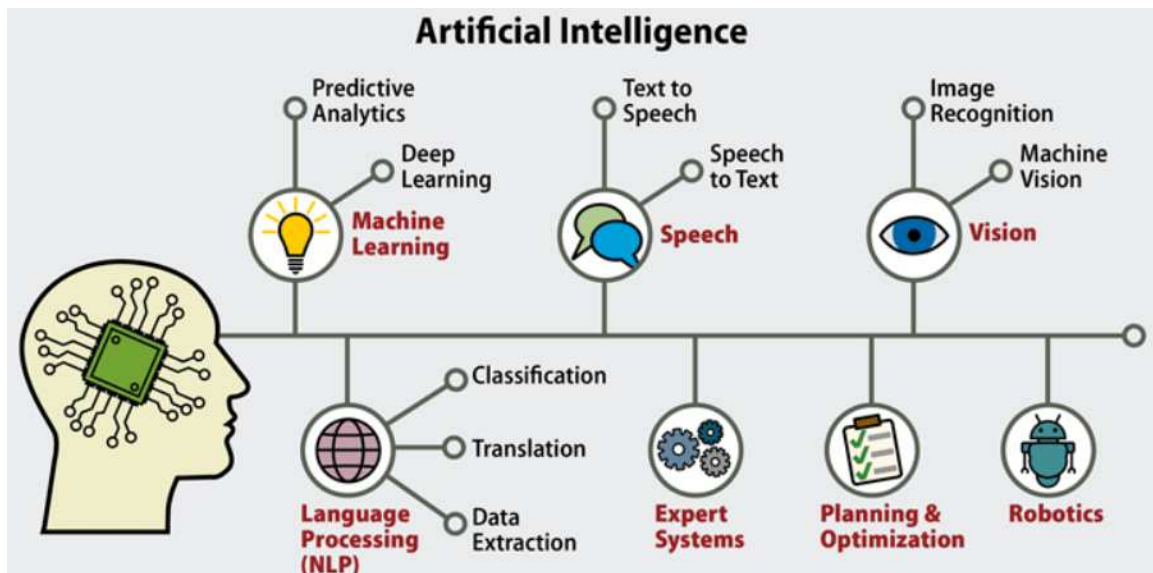
Figure 1 A robot plays a football game [3].

Figure 2 Different components of Artificial intelligence [6].

Figure 3 A typical AI game [9].

Figure 4 An example of *virtual reality game that brings people together [12]*