## Introduction

### Domain: Games

Artificial Intelligence (AI) has been an integral part of video games since their inception in the 1950s. In video games, AI is used to generate responsive, adaptive, or intelligent behaviors primarily in non-playable characters (NPCs), similar to human-like intelligence. AI in video games is a distinct subfield and differs from academic AI. It serves to improve the game-player experience rather than machine learning or decision making. The integration of Artificial Intelligence (AI) in the gaming industry has transformed virtual environments, enhancing player experiences through lifelike behaviors and dynamic content generation.

## Overview of AI in Games

In the year 1980 the game Pac-Man was released containing what is now considered the very early stages of AI in games (Figure 1). the game employed a basic state machine for its enemy characters, with ghosts transitioning between chasing, scattering, and frightened states. Each ghost followed a distinct rule in chase mode, lending them unique personalities. until the mid 1990's, the field of game AI remained relatively stagnant, with computer-controlled characters resembling the simplicity of Pac-Man ghosts, lacking significant advancements in sophistication. (Ian Millington, 2022)

AI, once confined to the realms of enemy character behaviors, has now become an influential force in modern game development. Its influence permeates every aspect of the gaming experience, introducing layers of complexity that enhance the immersive nature of virtual environments. The transformative shift in AI over the past decade is marked by the rise of deep learning, driven not by academic breakthroughs but by the practical application of neural networks, notably empowered by increased computing capabilities.

AI in games primarily serves three fundamental functions: character movement, decision-making on movement, and tactical or strategic thinking, with many diverse approaches converging to meet these common requirements (Ian Millington, 2022). a brief look into some of the most important aspects of AI in games will be listed below.

1. Pathfinding Algorithms:

Pathfinding is a critical aspect of game AI that enables non-player characters (NPCs) to navigate through the game world. The goal of pathfinding algorithms is to find the most efficient route from point A to point B. At the heart of dynamic character movement lies pathfinding algorithms. A\* (A-star), Dijkstra's algorithm, and Depth-First Search (DFS) are the digital pathfinding methods guiding Non Player Characters (NPC) through the virtual realms of games. These algorithms are not just mathematical formulas, they are the foundation of seamless exploration, ensuring that characters traverse diverse landscapes with a natural fluidity while remaining true to their goals and keeping the illusion of immersiveness real. Figure 2 Showcases how a pathfinding is applied to Enemy NPCs to predict their possible movement outcomes towards the player character.

RPG games like Fire Emblem developed by intelligent systems and published by Nintendo has been using Pathfinding algorithms since 1990 in their first release: Fire Emblem: Shadow Dragon and the Blade of Light (1990), and each subsequent game has improved on the AI that handles pathfinding right up to their newest release in 2023 Fire Emblem Engage. The integration of advanced pathfinding algorithms ensures characters navigate challenging terrains seamlessly.

2. Terrain Generation: Terrain generation in games refers to the process of creating the game environment or ‘world’. This could include everything from the landscapes and weather systems to the placement of buildings and objects. AI can be used to procedurally generate these terrains, creating unique and dynamic environments for each play through. The locations on which most of the gaming narrative unfolds is no longer static but a living, breathing entity shaped by terrain generation algorithms. Some notable techniques include Perlin noise and cellular automata, similar to virtual sculptors these techniques can craft terrains with jagged mountain ranges, meandering rivers, and sprawling valleys.

The result is a dynamic location that responds to the player's every action, creating unique and ever-changing levels of visual splendor filled with exciting and strategic challenges. Figure 3 showcases how a natural looking terrain can be procedurally generated. Procedural terrain generation, as seen in games like "Minecraft" and "No Man's Sky," leads to the creation of vast and diverse landscapes. The result is a dynamic and immersive gaming experience where players can explore unique and procedurally generated worlds.

3. Procedural Content Creation: Procedural Content Creation (PCC) is a method of creating game content algorithmically rather than manually. In other words, developers create algorithms that generate game content on the fly. This could include anything from level design and object placement to narrative events and dialogue. PCC allows for a vast amount of content to be created with minimal input from developers, making it ideal for open-world games or games with a high degree of replayability. It also ensures that each player’s experience is unique, as the content they encounter will be different each time they play. The storytellers of virtual worlds are no longer bound by predefined narratives.

When it comes to AI in games, Procedural Content Creation is a popular area of research. Deep learning methods have been applied to generate game content directly or indirectly, such as levels, maps, character models, and textures 1. AI algorithms can assist in creating game assets, such as textures, 3D models, and animations. This accelerates the development process, allowing designers to focus on more creative aspects while AI handles repetitive tasks. Additionally, AI can help generate questlines, dialogues, and story elements

As we explore the various of AI in games, we uncover not just a technological advancement but a reimagining of the very essence of interactive entertainment. In conclusion, AI has revolutionized the way we design and play video games. It has allowed for more complex and realistic game worlds, more intelligent and believable NPCs, and a more personalized and dynamic gaming experience. As AI technology continues to advance, we can only expect its role in video game development to grow.

The overview presented here is just a glimpse into the intricate combination between AI algorithms and creative expression that defines the modern gaming experience, a testament to the limitless possibilities that game developers are privileged to have and use. the Next chapter will explore some of the key aspects of AI pathfinding and touch briefly on Procedurally generated terrains.

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