# Artificial Intelligence in Gaming

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EAVP 6 | SAICE

**Abstract**

As a child, I've always had an enthusiastic approach towards robotics. I still remember after watching for the first time Transformers, I wanted to turn into one of those robots and save the human race and planet earth from Megatron, the king of the bad robots. It was high time to turn those lovely childish thoughts into something more concrete and realistic. I would break my toys and take out all the different components and tinker with them all day long. The satisfaction I would get after tinkering without even making anything in particular couldn't be explained through words. As I said, I couldn't make anything as I would find it really difficult, until I was introduced to a programmable microcontroller called Arduino. With the help of this little beast, I had created a smartphone-controlled car and an obstacle avoiding robot at the age of 16! Slowly my interest shifted to the humanoid robots which I would watch on YouTube. I was really curious to know and learn how those robots functioned like us humans. That was the first time I came across the term "Artificial Intelligence" which drove me to do a thorough research about this topic and finally understand it well enough to give a presentation to my classmates and a few elderlies. As AI is a vast topic and at the same time, I love to play video games, I thought "why don't I speak about artificial intelligence in gaming?"

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# 1 Introduction

We breathe... but how many times do we think about it? There's a constant flow of blood in our body, but are we really aware of it, and do we give it enough credit for keeping us alive? Similarly, in our daily lives in the modern world AI is the breath, is the blood, but likewise we don't value it enough. Can we imagine our lives today without our phones, without the internet? Don't we behave like a fish out of water when our Wi-fi, or cellular data stops working? We take complete advantage of all that is provided to us, through the display monitor of our laptops for example, but have we ever bothered thinking about the intelligence without whose help it would be impossible to access what we do? That intelligence, is none other than AI itself.

One of the most common places where we encounter AI is in video games. Have you ever thought how or who controls the bots who are trying to finish you off while playing a shooting game or who is your rival in a racing game? For most people the answer will be 'no'. It is very common, as we get deeply involved playing the game itself, that we forget to ask 'who, why, or what' makes these games so interesting and so addictive? Can artificial intelligence be the answer to these questions?

# 2 AI and Games

## 2.1 A brief background

The first working digital computers were developed in the late 1940s or early 1950s. In 1948, the first program for a game of chess was written on a piece of paper and executed by hand as computers weren't sufficiently powerful enough. It was none other than Alan Turing, one of the founding fathers of computer science and artificial intelligence who acted as the computer, using the algorithms while playing against his friend.

Why chess? Well, it is played by many people. The rules are simple to write in English and in computer code. It's a very elegant game and is taken very seriously. We cannot cheat as the whole board is exposed in front of both the players. We can learn a lot just by playing the game and improve our thinking capacity.

At the beginning of research into AI, chess was an important problem to work on. It was inconceivable that anyone could be really good at chess without being truly intelligent. Judging the board positions, understanding your opponent's thinking and predicting his moves? It seems that you require more intelligence to play this game rather than many other games. It was natural to assume that if we constructed a program that was a master chess player, we would have solved the problem of artificial intelligence. So, people got to work.

While Turing was the first person to execute a chess-playing program, many other researchers took it up as an important topic. Chess and other board games, grew into a vibrant subfield of AI research. The IBM computer scientist Arthur Samuel in 1958 invented the first version of what is now called reinforcement learning in order to make a Checkers-playing program learn from experience.

When the first chess-playing program was developed, many thought that a computer program could never beat a master-level human as it was merely a coded program by humans whereas, humans have intelligence. During decades of research, chess-playing software kept getting stronger and stronger, in no small way due to the availability of faster processors and larger memory


Figure 1: DeepBlue vs Garry Kasparov

sizes. The software got better and soon from beating a beginner, it could beat masters.

In 1997, IBM's DeepBlue (chess playing computer) won against the world champion, Garry Kasparov. This event was a starting point of the debate about the meaning of intelligence and artificial intelligence now that machines had conquered Chess. But most observers concluded that DeepBlue wasn't really intelligent as it was simply run by an algorithm and it was nothing compared to a human brain.

### 2.2 How a Computer Plays Chess

The approach almost all Chess-playing programs take is known as the minimax algorithm. This is actually a very simple algorithm. It is typically used in a two-player game. The goal of the algorithm is to find the optimal next move. It is based on the zero-sum game concept. If one player wins, the other has to lose.[1]

Go is a game similar to chess, only simplified, as there's only one type of pawn. On the other hand, it has got a bigger number of moves compared to a chess board as it is played on a 19x19 grids board whereas a chess board is played on a 8x8 grids board. It was definitely harder for the same program that beat the master of chess to beat the master of Go. This time DeepMind's AlphaGo beat Lee Sedol, known as the world's best Go player and won 4-1.

Can we say AlphaGo is intelligent? Most people say no as it's just an algorithm. This brings up several important questions: Does something need to function like the human brain in order to be called intelligent? And do you need to be intelligent in order to play games well?

## 2.3 How much thought goes into playing a game well

> Why do you play games? To relax, have a good time, lose yourself a bit? Perhaps as a way of socializing with friends? Some might take it as some sort of brain exercise. But let's look at what you are really doing.

Let's take the example of the most common games. Chess, Angry Birds and Super Mario Bros.

*You plan.* While playing chess, you keep planning a sequence of several moves that will make your opponent lose its pieces and eventually checkmate them.

In Super Mario Bros., you are planning which path to take, the higher path, which brings more reward but is riskier, or the safer lower path. You are also planning to venture down that pipe that might bring you to a hidden treasure chamber, or to continue past it, depending on how much time you have left and how eager you are to finish the level.

In Angry Birds, you are planning where to throw each bird to achieve maximum destruction with the fewest birds. Each bird has some speciality so we need to use them to their fullest.

You think spatially. As chess is played on a 2 dimensional grid, the cells which are neither occupied by white or black pieces are empty. Those who have played chess a number of times can see the opportunities and threats directly as they look at the board. In Super Mario Bros., you need to estimate the trajectory of jumps to see whether you can pass gaps and bounce off enemies, which means seeing the jump in your mind's eye before you execute it. You also need to estimate whether you can get through that small aperture with your current size (Mario can change size) and whether that path over there leads anywhere.


Figure 2: Super Mario Bros.

In Angry Birds, you also need to estimate trajectories, sometimes very complicated ones that involve bouncing and weird gravity and whether the bird can pass through some small openings.

*You predict the game and your opponent.* In chess, one keeps predicting the opponent's moves. But in the case of Angry Birds and Super Mario Bros. we cannot predict as we aren't playing against a human opponent.

*You assess yourself.*"Know yourself," said Socrates. He was probably not talking about Chess and certainly not about Angry Birds, but really, knowing yourself is an invaluable asset when playing games. Overestimating your skill will make you play recklessly and most likely lose; underestimating your skill means that you will not attempt that risky strategy that could have won the game for you.

In sum, we use many different forms of intelligence when we play games, more or less all the time. This sounds like a lot of hard work. It's amazing that playing games actually relaxes you, but it does.[2]

### 2.4 How games challenge and push our mental limits

You keep building your skills as you play. While playing a game, it certainly doesn't feel as though you are taking a class, and if it does, it's a bad game. But still you keep improving. Try playing an easy level of chess, the one that beat you roundly the first time you tried and now? Piece of cake.

Good games are designed to teach you how to play them. It's fun and interesting while we are learning. Once you stop learning and having fun, you lose interest and end up quitting the game. On the other hand, you wouldn't like a super hard game where you cannot progress at all. A well-designed game is accessible and deep. It offers you a long, smooth progression of difficulty where you can keep learning as you play.

To sum up, games do challenge our brain in many ways. Good games keep increasing their difficulty and go on adding new challenges. There are games which we keep going back to play because they challenge our brains in multiple ways. So, we definitely use our intelligence to play games. At the same time, we saw that some software beat the best chess and Go players in the world, while seemingly not being intelligent. So how come intelligence is needed for humans to play games but not for machines to play them? What's going on here? It is time to reveal what we mean by *artificial intelligence* and by *intelligence*.

# 3 What is Artificial Intelligence?

AI is short for "artificial intelligence," and "artificial" is a straightforward concept, we need to define "intelligence." Many people have defined intelligence but they are presented quite differently from each other. In fact, there are so many definitions that it is hard to even get an overview of all of them.

## 3.1 The Turing Test

Imagine you are chatting online with two people, on some social platform. Now one of these people is an AI software and the other one is a human. Your task is to find out which is which or who's who? You can ask anything to your text partner but they are not required to answer truthfully, especially if you ask whether they are a computer.

This test was proposed in 1950 by Alan Turing. During his time, there weren't any actual general-purpose computers. He was talking about teleprinters. Turing was addressing the question, "Can a machine think?" One way of finding out was to see whether it could win what he called "the imitation" what is known today as the "Turing Test."

If you couldn't distinguish the human from the computer several times, does that mean it was intelligent? Some people think that if a computer could pass the Turing test, it would be intelligent. Others disagree, even if it passes the Turing test several times.

## 3.2 Intelligence: humans vs computers

A common answer is, "It can't be intelligent because it's a computer." It's quite difficult listening to these answers without objection. "Why is that a computer cannot be intelligent whereas a human can?" Some people say that the term "intelligence" can only be applied to humans. Then let's come up with another word such as "intelligence" except it is not arbitrarily confined to humans. Others reply that computers cannot be intelligent as they are made up of transistors and silicon components whereas humans are made up of living, biological cells. "Why is it that to be intelligent we need to be made up of biological cells?" Some says that computers cannot be intelligent

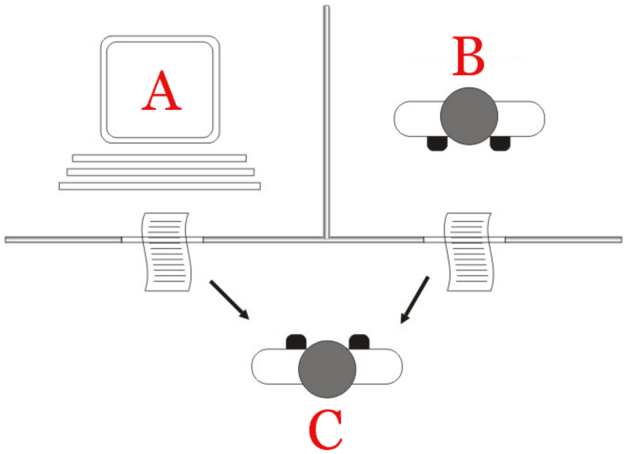


Figure 3: Turing Test

as they were programmed by humans. They should've learnt by themselves and gone to school with other students.

Again, how do you know intelligence cannot be programmed? How do you know that this computer who just fooled you into thinking it was a human, wasn't programmed? All you know is that it was smarter than you.

There are a couple of good objections too. Communicating through text isn't the only way we humans stay in touch with each other. We communicate through the tone of our voice, facial expressions and body language. This type of interview isn't quite natural. Some people handle a written interview quite terribly but are otherwise perfectly competent human beings. Being able to answer eloquently to questions doesn't guarantee that you can tie your shoelaces, decide what you want to eat, comfort your loved ones or even play a game. Yet all of these activities seem to require intelligence of some kind.

## 4 Humans and machines - where we stand today

The idea of taking something that a human can do and task the computer with doing the same is appealing. If a computer is intelligent, then it's supposed to be able to do everything a human can do. Humans appear to implicitly be the only (or highest) measure for intelligence. From the perspective of computers, are humans intelligent?

### 4.1 Where machines excel

Humans would, compared to a computer, seem quite stupid in many ways. Ask a human to raise 2,605 to the power 526, or to calculate the average age in a population of 300 million and watch him crack his head for years. It's ridiculous. It shouldn't take more than a few seconds unless you're a human who would take years and have made a number of errors.

Humans have almost no memory either. Ask one of your friends to tell you your phone number and see how many know it by heart. You can simply ask him what he ate for lunch two days ago. Humans talk about "goldfish memory," but from a computer's point of view, the human and the goldfish aren't that apart, capability-wise.

At this point, many readers might protest that I'm being unfair as I'm choosing tasks that computers excel at and ignoring those where humans have an advantage, such as motor control and pattern recognition. Computers can compete with some humans by landing a jet plane, flying a helicopter, or even driving a car on-road and off-road, obeying all the traffic regulations. Many humans can't even do that.

### 4.2 Where humans *currently* excel

Speaking of pattern recognition, it's true that humans can recognise the faces of their friends with quite high accuracy. But then, humans have only a of hundred friends at most. The face recognition software that Facebook uses can tell millions of people apart.

Now let's take another activity that humans should be good at: playing games. Games were invented by humans to entertain themselves. So, humans should excel at playing games, right? Well not really. As we have seen, computers are one step higher than humans mostly in all classic board games. As we will see later, computers perform very well in many video games as well. We should also remember that all the games on which we compare humans and computers were designed by humans for humans. Therefore, they are particularly well suited to human cognitive strengths. It would be very easy to invent games that were so complicated that only computers could play them. Computers could even invent such games for themselves. So, compared to humans, computers seem to be doing quite well indeed. At least, if you ask the computers. It all depends on what you measure.

> Some humans would object that this comparison is absurd because it's humans who build and program computers. Therefore, any intelligence the computers have should be attributed to their human creators. But that is a dangerous argument for humans to make, because in that case, any intelligence that humans might have is not really their own but actually belongs to the process of evolution by natural selection that created them.[3]

From the last few pages, I'm sure that you're not convinced that you are less intelligent than a computer. Clearly there was something missing. The examples I've been giving so far are about some specific tasks where a computer is good and a human is bad when intelligence is the ability to perform well in a large variety of situations. Being very good at a single thing is never enough for intelligence. Therefore, humans are more intelligent than computers. A chess-playing program cannot land a jet plane, nor can a face recognition program play Angry Birds. Humans are very good at adapting to a very wide range of situations and problems, whereas computer programs are suited for a particular kind of situations and problems they are programmed for.


Figure 4: Personal voice assistance considered as *“Weak”* AI

### 4.3 Narrow AI, General AI and Artificial Super Intelligence

- *Narrow AI:*
  - Artificial Narrow Intelligence (ANI) also known as “Weak” AI is the AI that exists in our world today. ANI can perform a single task – whether it’s checking the weather, or playing a game of poker. They can only pull information from one specific data-set and as a result they don’t perform outside of the single task they were designed to perform.
  - Every machine intelligence that surrounds us today is Narrow AI. Google Assistant, Google Translate, Siri, Cortana are all examples of Narrow AI. We might not assume that they are “weak” because we can interact with them, but the reason we call them “weak” is because they are nowhere close to having human-like intelligence. They lack the self-awareness, consciousness, and genuine intelligence to match human intelligence.
  - As humans, we have the capacity to assess our surroundings and have emotions. The AI that exists around us lacks that flexibility. Even something as complex as a self-driving car is considered Weak AI, except that a self-driving car is made up of multiple ANI systems.[4]

Figure 5: WALL-E

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- *General AI:*
  - Artificial General intelligence or “Strong” AI refers to machines that exhibit human intelligence. They are expected to reason, make judgements, plan, be innovative and creative. In other words, it performs any given task a human can. We still do not have this sort of AI today but we’ve met them in movies such as WALL-E and other sci-fi movies where the robots are driven by emotion and self-awareness.
  - Currently, machines are able to process data faster than we can. But as human beings, we have the ability to think abstractly and come up with creative ideas. This type of intelligence makes us superior to machines. It’s natural to us as we are sentient creatures, but it’s very difficult to replicate it in machines.
  - But for machines to achieve true human-like intelligence, they will need to be capable of experiencing *consciousness*. [5]

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- *Artificial Super Intelligence:*

  – (ASI) will surpass human intelligence in all aspects—from creativity, to general wisdom, to problem-solving. Machines will be capable of exhibiting intelligence that we haven't seen in the brightest amongst us. This is the type of AI that many people are worried about, and the type of AI that people like Elon Musk think will lead to the extinction of the human race.[6]

## 5 How exactly does AI work in a video game?

Most of the video games feature something like nonplayer characters (NPCs). These could be opponents, allies, or something else. The NPCs are controlled by the computer and we refer to them as the “AI” of the game.

Artificial intelligence can be many things, but for now let’s use that name for whatever controls the NPCs in video games. How exactly does the AI work in a video game? Behold a little dramatization.

Let’s take an example of an enemy in a FPS game. He looks like a typical low ranked terrorist and is given a specific task by failing to protect the boss at the end of the level, unless the player really messes up, of course. As always, this particular enemy is spawned in the same place and at the same time of the game. Let’s assume his mind is divided in six different states.

*State 0: Guard*

*State 1: Take cover*

*State 2: Stay in cover*

*State 3: Fire from cover*

*State 4: Attack player*

*State 5: Die*

The architecture of the enemy’s mind is called a finite state machine because it is organized as a finite number of states, where each state contains instructions for how to behave in that state. All the NPCs in that game share that same architecture.

We observe that from state 0 to 4, the NPC is constantly running toward a position. This is accomplished using A*algorithm, which is a pathfinding algorithm. In other words, it is a method for finding the shortest path from point A to point B. The algorithm explores all the possible positions and tracks down the most promising one.

The finite state machine architecture and the A* algorithm play the most important role in most games and they are widely used in robotics and self-driving cars. This enemy doesn’t have any name of its own as is quickly forgotten as the player advances in the game.

Here is a list of things this enemy cannot do:

- Figure out that you're hiding behind a wall for an hour instead of assaulting it, and so thinking of ways to get you out of your hiding and flanking you.
- Throw pebbles at you until you come out of your hiding spot.
- Call for backup.
- Feel fear.
- Have a talk with you on daily life.
- Play a game of chess with you.
- Make a cup of coffee.

It's not that it's impossible to make this enemy do each of these tasks except, perhaps feeling fear. To make it do them, we (human designers) need to write a code.

## 5.1 What If video games could evolve by themselves?

Let's step into the future and assume that we have a far advanced version of AI. Imagine that you're playing a video game of the future. You're playing an open world game and you're free to roam wherever you want and pursue game objectives in any order you feel like. For example, you can think of *Grand Theft Auto*. Instead of accomplishing an objective, you decide to drive for four hours. You hop in a car and start driving. On the way, the game makes up the landscape as you go along, and finally you end up in a city that no human player has ever visited. You get to meet new people and get new challenges to accomplish. You talk to the people and they reply to you naturally. These lines are not recorded by actors but are generated in real time by the game itself.

Within the open world games, there are other games that you could play. For example you could go and play poker in a casino. Whatever rules, mechanics and content are necessary for these subgames, the game engine

Figure 6: Grand Theft Auto

invents them on spot. It also learns which aspects of it you're good at, as well as which part you lack the skills. Based on this, the game adapts to you and gives you more stories or challenges that you'll like.

Although the game is endless and continuously adapts to your changing tastes, you might still want me to play something different. So why not design and make your own game? Clearly you might be thinking that's impossible because back in 2019, groups of professional designers used to work for years to develop a high-profile game. But right now you're in the future! We have advanced AI! You have the option to simply switch the game engine to edit mode and start sketching your own game idea. You can add your own storyline, a character, your own imaginary place and many other things that you would like to add. If you have a few things imbalanced in the game then the game engine will suggest a few changes. You can keep sketching and the game engine will turn that sketch into detailed code. You can yourself play that game later or even make artificial players play the way you would play.

## 5.2 Evolutionary algorithms and AI

Just the way human beings evolve, even computer programs evolve as time passes by and they are know as *evolutionary algorithms.* For evolution to work, you need three ingredients: *variation, heredity,* and *selection.*

- ***Variation:***
  - We have a population of different computer programs, and they're different in their source code and do different work.
- ***Heredity:***
  - We could also combine the source code from two parent programs, taking some pieces from one and some from the other, to create an offspring program in a process known as *crossover*.
- ***Selection:***
  - We observe how well a program does in what it has been told to do, and then assign higher fitness to those that perform some task better. The task could be anything you want it to be, from painting a picture to even playing a game. Over sufficiently many generations, programs then move from hopeless, to better, to good, and to excellent. To make this happen, we need a fitness function. As the word says, it keeps the program fit.

## 6 What is a Neural Network?

As you are reading this booklet, the very same brain that sometimes forgets why you walked into a room is magically translating these pixels into letters, words, and sentences — a feat that puts the world's fastest supercomputers to shame. Within the brain, thousands of neurons are firing at incredible speed and accuracy to help us recognize text, images, and the world at large. A neural network is a programming model that simulates the human brain.

### The Birth of an Artificial Neuron

> Computers have been designed to excel at number-crunching tasks, something that most humans find terrifying. On the other hand, humans are naturally wired to effortlessly recognize objects and patterns, something that computers find difficult.[7]

The paragraph above brought up two important questions in the 1950s:

"How can computers be better at solving problems that humans find effortless?"

"How can computers solve such problems in the way a human brain does?"

In 1957, Frank Rosenblatt explored the second question and invented the Perceptron algorithm, which allowed an artificial neuron to simulate a biological neuron. The artificial neuron could take in an input, process it based on some rules, and fire a result. In other words, it could learn by trial and error, just like a biological neuron.

### Neural Networks Today

Recently, with the development of high-speed processors, neural networks finally got the necessary power to blend in with human life. Today, the applications of neural networks have become widespread from simple tasks like speech recognition to more complicated tasks like self-driving vehicles.

Neural networks are ridiculously good at generating results but also mysteriously complex. It's quite complex the way they make their decisions and that makes it difficult to say what makes them so accurate.[8]

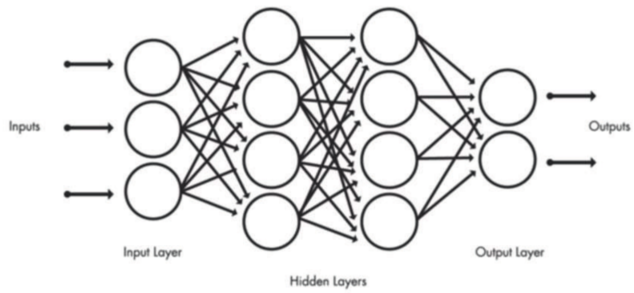


Figure 7: Neural Networks

# 7 How games interact with humans

## 7.1 Can games learn from us?

From the previous chapters, we have seen that we can learn from games. Now let's turn this statement around. Can games learn from us? And if so, what can they learn? Can we develop an algorithm that learns about us while we are interacting with games?

When you play a game, you are constantly supplying information to the game. For example, you communicate with other players via text, you keep making choices, you deal with enemies and of course, how good or bad you are at finishing the levels. Also, the type of character you choose to play with.

As we have known computers to be great at storing and processing information, it's perfectly possible for a computer game to store all the inputs given by us, and with the help of their clever algorithm, they can analyze it. These days, nearly all the devices we play games have an internet connection. So it's very simple for the game to analyze the way we are pursuing the game and can send them all the data to the servers of the company that made the game. Once it's sent, the game developer can run a few algorithms on the data and can find out things about the players who played the game.

But what can a game learn from us?

Just like we learn from playing games, they too learn from us how we play. By seeing the histories of players of how they've played the game, it's possible to find out what each player does in every situation. After gathering all the information, we can create an AI that plays the game like an average player would play. But at the same time there are problems too. What if you want to know about a specific situation a player would go through at a certain point during the game? The list of all the situations a player has encountered can grow extremely long. It doesn't just learn from one player but perhaps hundreds or millions. It would become impossible to find out exactly what we are looking for as it would take us years.

Luckily, it turns out that you can use the backpropagation algorithm to train neural networks to predict what the player would do. It's the same as learning to drive a car with trials and error. The difference is that in the case of driving car, we use reinforcement learning.

*Reinforcement learning*: is all about reward. You get points for your actions. In the case of driving a car, you need to stay in a lane, drive in the speed limit, signal where you're supposed to, etc...

At the same time, you can lose points if you cross speed limits, drive recklessly and other rules disobeyed on the road.

Coming back to our main point, when learning to play the game like a human, each instance would be composed of the features describing a situation the player agent was in and what action the player took in the situation. So to reproduce this list, we need to train the neural networks with the *backpropagation algorithm*. With the help of the backpropagation algorithm, we can train the neural networks to predict what action the player would have taken in each situation, usually with very good accuracy and the advantage of this is that the neural networks are much faster and smaller compared to the long list of situations and actions used to train them, as it's simpler to 'ask' the neural networks then to go through the long list.

## 7.2 Games adapt to player types

It is very important for the game developers to know who is playing their games and how they are they playing it. Whether good or bad, or in which

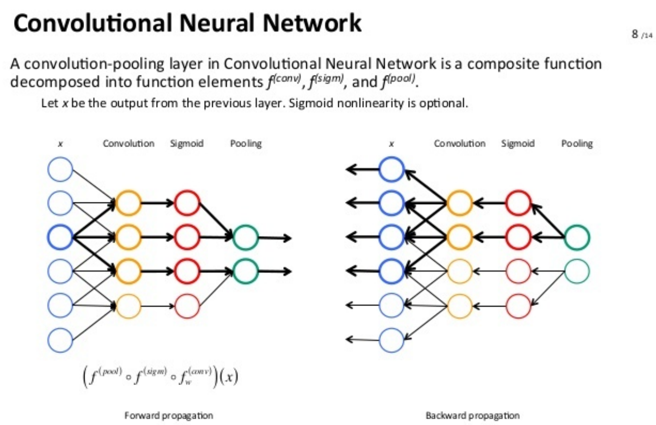


Figure 8: Backpropagation Algorithm

places they are having trouble to finish the given mission. After accomplishing one level, all the data goes to the developer. In 2019, most of the games do this.

Let's take the example of the popular game called PUBG. Now obviously, not all the players will be proceeding with the game in a similar way. We can divide the players in different groups.

*Achiever:* those who don't like to reveal themselves in the battleground and mostly hide in buildings or behind the bushes.

*Explorer:* the ones who generally travel from cities to cities and like to collect power ups from the buildings and air supplies.

Lastly, *Killers:* who enjoy causing harm to other players and aren't scared while roaming the cities openly in search of players to kill.

Obviously this typology works best for specific online multiplayer games. Not all the games need to have the same typology as it's irrelevant to have player groups like achiever or explorer in a game of chess or Angry Birds. Different typologies are needed for different games and luckily with today's technology, it's possible for games to learn player typologies from players.

While it is useful to know what types of players play your game, it is

Figure 9: Minecraft

also very important to know what the players are going to do in the game. Usually, you want your players to stay and play your game as long as possible, because later that happy player will go and recommend the game to his friend and he'll buy it. In most free to play games, there might be *in-app purchases* for upgrades to keep playing. For the developer it is essential to be able to predict which players will stay with the game and which might stop playing it. In addition, as a game developer, you may simply be interested in understanding your players.

### 7.3 How neural networks inside games learn our personality traits

So far, we have seen that the game can learn from your playing and what type of player you are. But after all, you're still a full fledged human being with emotions, dreams, friends and habits. You are still you even when you momentarily turn into Mario, or the different angry birds. Now the question is, does anything of the rest of you reflect in the game you're playing? What can the game learn about the real you by analyzing how you play?

Let's take the example of the game Minecraft. It is an independent game. In other words, you can roam around freely in the game. You can build anything you want. Be it buildings, monuments or even your own custom made weapon. There are some missions to accomplish but it's completely up to you to whether finish them or merely ignore them.

Back in 2011, there was a test done by a group of AI programmer in gaming. Data was extracted from 100 minecraft players and they were divided in five different categories. People who are *curious* in real life tend to explore the large parts of the game world. Those who are motivated by *saving* tend to use cheap and simple materials in the buildings and tools they construct. *Vengeful* people quit the game and restart either from the earlier save or completely from the beginning. The people who like *independence* in real life, refused to do the quests in the games story-line. Lastly, those who like tranquility built significantly more fences around their dwellings.

### 7.4 The different roles AI can play within games

Let's investigate the different roles AI can play in games, trying to find examples from games that use AI in such a way that you need to interact with and understand it to play the game well.

- ***AI is Visualized***
  - In order to play the game well, the player needs to understand the AI system to predict what the NPCs will do.
- ***AI as Role Model***
  - The algorithms that underlie NPC behavior are relatively simple and easy to predict, as we saw. So instead of making the NPCs more human-like, why don't we do the opposite? In 2009, a game called *Spy Party* was launched. It's a two-player game. There's a group of NPC in a room and only one of them is a human player who's trying his best to behave like the rest of the bots in the room. The second human player needs to find out the other human player well hidden in the crowd.
- ***AI as Trainee***
  - How cool it will be to train an AI bot right! In 2001 there was a game invented called *Black and White*. In this game the players are the villagers in a village and there's a monstrous creature that comes to the village. The objective of the players are to train the monster to behave properly and help them in their daily work.

It's a little like training a dog without understanding very much of what actually goes on in the dog's head.

- ***AI is Editable***
  - There are games where you can directly edit the instructions for the algorithms that control the behavior of a NPC. We can manually edit the neural networks defining what we want the bot to do. It's hard to understand the structure of the neural networks for humans so the editing mode is not for everyone. But for those few players, editing the neural networks is an engaging puzzle game in itself.
- ***AI is Guided***
  - Nowadays there are games where you need to act as a guide or manager for the agents, giving them high-level commands or guiding them through operations they cannot perform by themselves. A great example would be *The Sims*. These are life simulator games where you guide a family of characters as they go about their life.

This is just a small subset of many possible ways in which AI can be used in visible roles within video games.

## 8 Conclusion

*Games provide the best benchmarks for AI because of the way they are designed to challenge many different human cognitive abilities, as well as for their technical convenience and the availability of human data. We have only begun to scratch the surface of game-based AI benchmarks.*

*AI is the future of games. We now have much more capable AI methods than just a few years ago, and we are rapidly learning how to best apply them to games. The potential roles of AI in games go far beyond providing skillful opponents. We need to adapt our ways of thinking about game design to fully harness the power of advanced AI algorithms and enable a new generation of AI-augmented games.*

*Games and AI for games help us understand intelligence. By studying how humans play and design games, we can understand how they think, and we can attempt to replicate this thinking by creating game-playing and game-designing AI agents. Game design is a cognitive science; it studies thinking—human thinking and machine thinking.*[9]

## References


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