



How do big data and artificial intelligence (AI) share a symbiotic relationship, and what are the implications of these technologies for chess?

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Abstract

As a result of the digital revolution, the world started generating large and unprecedented volumes and varieties of data - more commonly recognized as big data. With data being just data until it is correctly analyzed, artificial intelligence (AI) and its technologies, once developed with the use of big data, were able to aid greatly with the extraction of useful insights from the data. This highlights the symbiotic relationship between big data and AI and its technologies - a core aspect explored extensively in the first half of the paper. That being said, in more recent times, the world has been witness to AI and its technologies integrating themselves into every aspect of our lives. Interestingly, the game of chess - historically and culturally cherished globally - has not been spared. There has been much evidence of these technologies assisting with the refinement of several aspects of the game. The latter half of the paper evaluates the aforementioned.

Key Words: Chess, Artificial intelligence (AI), Big data, Stockfish, Alphazero

Introduction

Are Robots better than humans at chess? Yes, they are!

In the year 1997, a match was held between the world's strongest chess engine of that time - Deep Blue IBM - and the world's strongest player of the time - Grandmaster Garry Kasparov. To the whole world's surprise, Deep Blue IBM was able to defeat Garry Kasparov with a score of 3.5-2.5 (Chandrasekaran, 1997). This singular win started the era where artificial intelligence (AI) machines and chess engines became an extremely Integral and important part of the game.

Over the years, the importance of big data and AI technologies for the various aspects of chess - preparation as

well as opening and playing strategies - has been apparent. The aforementioned has led to the development of chess engines such as Stockfish, that have the power to prepare players in a manner that they have a relative competitive advantage over those players who prepare for chess games without the use of a computer. In recent interviews, top player GM Hikaru Nakamura has talked about how he used Rybka (another strong chess engine) while playing against stockfish in order to fix his errors and improve his play (Klein, 2014). Additionally, a recent tweet from GM Hikaru Nakamaru stated that Bobby Fischer who was regarded as the best player of his time would lose to players of today's time just because of the help that computers provide (Serper, 2022). This statement made about 10 years ago shocked the chess audience and brought the importance of computers and chess engines to light.

While even humans are progressively getting stronger at the game of chess, it is becoming more and more evident that this is being greatly enabled by chess engines powered by years of data and some of the most advanced technology. In light of this, this research paper aims to answer the following research question: **“How do big data and artificial intelligence (AI) share a symbiotic relationship, and what are the implications of these technologies for chess?”**

The aim of this paper is to thoroughly analyze big data and AI with regard to the symbiotic relationship that they share prior to evaluating their application to the game of Chess.

Literature Review: The Interconnection of Big Data and AI

To be able to answer this research question, it is first essential to understand the concepts of big data and AI. To begin with, big data is a large collection of data that increases exponentially over time. Unlike normal data which can be stored easily, conventional data management systems are unable to store, process, and analyze these datasets. The primary reason for the aforementioned is explained by the 3 V's of big data; volume, velocity, and variety whereby big data tends to be voluminous, comes at varying velocities (referring to both the speed at which data is received and also acted upon), and is incredibly varied - coming in numerous formats such as numbers, text, audio and videos.

Big data has a fascinating history. The groundwork of big data started in the mid-20th century with the release of electronic computers. Firms and businesses started to store information digitally and written manual records were being avoided. The late 1990s was actually when big data skyrocketed in popularity because it was at this time that almost all businesses only stored data digitally and the growth of social media and online services led to vast amounts of data being created (Big Data Framework, 2024). Big data comes in three main forms - unstructured, structured, and semi-structured - as highlighted in a post published by Narayan (2023). Structured data is well organized and is quite easy for machines to process as it can easily fit into databases. Unstructured data is, on the other hand, quite unorganized and quite difficult for machines to fit into a database as it follows

an unpredictable pattern. Finally, semi-structured data isn't as organized as structured data but also isn't as disorganized as unstructured data. It was also due to the massive amounts of data being generated that the idea of data warehousing was implemented. Data warehousing is a data management system designed to store and organize large amounts of data. In the early 2010s, we saw advancements in technology leading to better and more efficient ways to store big data with many databases and technologies such as Apache Cassandra.

Another important aspect of this research paper is artificial intelligence (AI) which can be defined as technology that stimulates human intelligence. Like big data, AI also has quite an intriguing history. The man who came up with AI was named John McCarthy. He was able to devise the world's first programming language for AI which was named LISP (TENE0.AI, 2023). It slowly grew for the next few decades and its next major breakthrough was in the mid-1990s when the advancing computing power allowed for newer improved programming languages (Tableau, 2023). Ever since that time, advancements in technology have only increased and nowadays AI is at a stage where it can be implemented into daily working tasks.

AI can be divided into two main subsets: Machine learning and deep learning.

Machine learning helps computers improve and advance independently from experience without additional programming being needed. Algorithms which are lists of instructions are used to train computers making them learn and they can make decisions on their own based on the data. On the other hand, deep learning is a way that teaches computers to think like a human brain. Tasks like automating images and converting sound to text which normally need human effort can be done by computers through deep learning (Amazon, 2023).

However, what is the relation between big data and AI? As highlighted in an article published by Maryville University (2017), when the world was bombarded with massive amounts of big data due to the increasing popularity of digital storage of information and increasing computing power, it became essential to derive valuable insights from the data as this would be of the essence to the advancements and success of industries. However, the data was too big for humans to analyze. In order to tackle that problem scientists and people who worked in the IT industry found out that compressing the data into files that are more understood by the computer would save them massive amounts of time over trying to go through that much data on their own. Additionally, AI algorithms could be used to derive insight from the data. That being said, it is also crucial to understand that big data is not only positively impacted by AI but instead, AI is also positively impacted by big data - without the presence of data, the subsets of AI, i.e., machine learning and deep learning, won't be valid as there will be no data for them to learn and train from (Seth, 2023).

Introduction to Chess and Key Components of Play

Chess is a fascinating game. It is a game played between two players on a square board which is further divided into 64 smaller squares in an 8x8 grid. It is typically colored in opposing colors, most usually white and black. The goal of both players is to put the opponent's king (a crucial piece of the game) in checkmate which is a situation where a king is in danger of capture and can not escape, capture, or block the attack.

Chess has a rich and interesting history. Research indicates that chess originated from an Indian game known as chaturanga in 600 AD (Stapczynski, 2022). The game originally spread through Europe and Asia and it became worldwide known as chess around the 16th century. The main evolution of chess happened in the city of Renaissance which is located in Europe. Many rules were changed in that city and the modern-day rules of chess were applied. The title of the world's first pioneer of chess could be given to the French master, Francois Andre Phillidor, who reigned during the mid-18th century and was responsible for the development of many modern-day strategies and tactics (Stapczynski, 2022). The hike in popularity of chess was during the 19th century as the first world championship was held in 1886. Whilst the foundations of chess were set during these early years, several advancements in chess strategies and opening theories have significantly evolved the game. So, how exactly did the chess strategy and the playing style develop over the years? As per the information published in an article written by Stapczynski (2022), during the 19th century most games were played in very aggressive and attacking games as the idea of slow and defensive chess was not very popular back in the day. The peak of the attacking era was seen when Paul Morphy entered the scene as he was known for defeating his opponents with aggressive moves. The positional and slow style was first seen by William Steinitz during the early twentieth century. The positional style of chess then developed into a style called the 'hypermodern style' famously used by Jose Paul Capablanca - the third world champion of chess. This involves controlling the center of the boards with minor pieces instead of just pawns.

Furthermore, another crucial element of the game of chess is witnessed when chess players start a game and execute an 'opening'. As the name suggests, the opening consists of the starting moves played during a chess game which normally aim to challenge the center and develop pieces and can essentially decide the direction the game is going. While some openings like the King's Gambit lead to more aggressive and attacking games, other openings such as the Ruy Lopez and the Queen's Gambit lead to positional and more defensive games. Some of the very popular opening strategies include the Sicilian defense (as seen in the image on the left



wherein an asymmetrical position is created) and the Italian game (as seen on the right wherein there is quick

development of the minor pieces and a strong control on the center)

Game and opening strategy aside, the importance of preparation in the game of chess can not be ignored.

Preparation can be divided into a few parts:

Opening preparation: This is the preparation that involves studying opening theory in order to navigate the early stages of the game of chess. This is also important in order to get a comfortable position in the mid and later stages of the game. Players with good opening preparation and knowledge are able to take the game to a path that they are comfortable with while their opponents with poor opening preparation need to play an unfamiliar position and figure out the tactics from scratch (Tekeyev, 2022).

Tactical preparation: This is the practice of solving tactical puzzles and studying chess tactics. Chess games can be decided on tactics so the player who can spot and play out the tactics can easily steal the win. Usually, players will solve tactical puzzles and analyze games in order to be able to spot tactics in a real game (Tekeyev, 2022).

Preparing against the opponent: In chess, it can be really helpful to study and analyze the opponents' tendencies, behaviors, and opening choices in order to prepare against the opponents' usual tactics and traps and figure out weaknesses in their play (Studer, 2021). This can be done before a tournament or any match where the opponent is known.

The Impact of AI and Chess Engines on the Game of Chess

So, whilst big data, AI, and its technologies may seem as though they come from a very different world than chess, the application of the former to the latter enables the betterment of the game through advances that were once only hypothesized.

As mentioned earlier in the Big Data and AI section, computers can go through massive amounts of data way faster than any human can and derive insights. A similar thing happens in the game of chess. Concepts like machine learning also apply to chess engines. Chess engines are excellent at performing brute-force calculations - they generate and calculate a large number of moves and positions (Brain, 2000). Chess engines can, therefore, refine opening theories and unearth novel variations. The computer evaluation of opening positions has, as a result of information, revealed new opening ideas, sharp retreats from previously well-trodden paths, and even refutations of previously accepted opening variations. Furthermore, these engines are also capable of examining millions of positions every second, which means they can conduct a very deep and accurate analysis. This vast amount of knowledge about chess positions allows them to accurately evaluate the best move as they can analyze every possible way the game can end. Moreover, chess engines can help accurately develop counters to certain playing styles by putting light on their weaknesses and ways they can be defeated. It gradually brings chess closer to the point when the only way to play the game is with the most precise playing style, outlawing

the existence of other styles.

Moreover, AI-powered training tools are also a crucial part of the game of chess. They can achieve success through two main features - personalized feedback and targeted feedback (Aditya, 2023). In the case of personalized feedback, after analyzing a player's games, AI-powered tools offer feedback specifically for the player to their strengths and weaknesses. By showing where a player frequently goes wrong, be it tactical awareness, positional understanding, or endgame tactics, the tools help players pinpoint where they need to put their training effort. AI-powered tools can also generate targeted exercises from a player's games to address their weaknesses as soon as possible. These may be tactical puzzles to sharpen the player's eye, positional drills so that he plays from the most promising features in any position, or endgame studies to reinforce the strategic approach

Finally, some real-world examples of AI and technologies being used to enhance the game of chess include the use by Magnus Carlsen - someone recognized as the best player of all time. Carlsen uses a platform called Alphazero to do his chess preparation. It is known that he utilizes computer analysis for opening preparation and positional analysis while employing targeted exercises and personalized feedback to help enhance his game. It has been reported that Magnus plays against Alphazero many times during his practice to observe how differently the chess engine plays in comparison to the average human and how he can implement that playing style into his own game (Rios, 2023).

All of this tells us the massive impact chess engines have had on the chess world where they can refine previous strategies that developed over many years in a couple of minutes and remove strategies, tactics, and opening theories that were previously claimed to be viable.

Conclusion

As the years have gone by, chess engines powered by big data and AI, have developed and been able to refine various elements of the game of chess to levels that were once only dreamt of by humans.

As analyzed in this paper, big data and AI share a symbiotic relationship that once extended into the world of chess enables quick and deep analysis of the game and the provision of more refined reparation, opening, and playing strategies. Top players use these engines for their own chess preparation and practice to analyze common game patterns and opponent tendencies while sharpening their own games through personalized feedback. However, whilst this is a positive for the chess community in many ways, it does come with problems. Ancient chess studies and ideas are now futile as computer analysis can figure out how to play against them in seconds. Moreover, diversity from the world of chess is now being taken away - whilst chess players have reached new heights by using a collaboration of big data and AI in the form of chess engines like Stockfish and Alphazero, these engines encourage chess to become a less diverse game by forming a straightforward path to victory whereby players are encouraged to limit themselves to one specific strategy.

Considering the above, there must be some constraints placed on the extent to which technology can be integrated into the game of chess. If a balance is achieved then the technologies can continue to refine the game without taking away its essence and historical significance entirely.

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