ISSN: 2710-0588

The Application Status and Development Trend of Cloud Computing Technology in Chess

Yizheng Wang

Beijing Chaoyang Foreign Language School, Beijing, 100012, P.R.China

*Corresponding author's e-mail: markwang2021@outlook.com

Abstract

With the rapid advancement of computer technology, renowned chess engines have timely updated and iterated, incorporating state-of-the-art technologies such as cloud computing, machine learning, deep learning, and neural networks. These technologies assist players in studying historical matches and improving their playing abilities and skills. This article focuses on the current status of integrating cloud computing technology with chess. It analyzes the developmental background and performance characteristics of different chess engines, explores the guiding principles and underlying logic of mainstream engines in analyzing chess games, and examines the current application status and future trends of cloud computing technology in chess. Furthermore, the article provides personal perspectives and suggestions regarding existing challenges and future directions of development.

Keywords

Cloud Computing; Chess Engine; Stockfish; AlphaZero; PGN.

1. Introduction

With the rapid advancement of computer technology, the application of computer engines in chess has garnered widespread attention. These engines not only play a crucial role in players' training and game analysis but also hold significant importance for researchers exploring the relationship between human wisdom and computer intelligence. The current chess engines, through tight integration with cloud computing technology, possess the characteristics of 5Vs: (1) Volume: Chess engines can digitize the vast number of historical games preserved by humankind, analyze them using comprehensive chess databases, and provide guiding suggestions for the next move in a game. By combining with advanced computer technologies like cloud computing, the engine can upload game data to the cloud in real time, allowing professional players and amateur enthusiasts from around the world to share data, resulting in a massive user base and usage scale. (2) Velocity: The engine provides real-time suggestions, helping players quickly identify the key to break the deadlock. The user interface is user-friendly, facilitating rapid strategy selection. (3) Variety: The engine offers diverse guidance and suggestions. In addition to providing what it considers the best move at each step, the engine also offers alternative strategies and potential moves, enabling players to explore multiple options and learn through trial and blunder. (4) Value: Cloud-based computer engines, with the assistance of cloud computing technology, can effectively aid players in pre-game preparations and post-game analysis, improving their playing skills and performance. Furthermore, they can upload game data to the cloud, enriching databases and sharing them with other users, thus holding significant social and economic value. (5) Veracity: Compared to traditional guidance methods, the current engines integrated with cloud computing provide more practical and efficient suggestions. By accessing databases of rational game moves, they reduce the reliance on irrational and mechanistic enumeration of moves, thereby enhancing the

ISSN: 2710-0588

quality of suggestions. This article focuses on the working principles, limitations, and future development directions of cloud computing-based chess engines, aiming to provide insights and research directions for the development of intelligent analysis technologies in the next generation of board games.

2. Development of Chess Engines

2.1. Pre-Computer Era - El Ajedrecista Automaton

The first true automatic chess computer appeared in 1912. It was an automaton called El Ajedrecista, created by Spanish inventor Leonardo Torres Quevedo. El Ajedrecista was a machine designed to play endgame scenarios. It consisted of a white king and rook, while the black side had only a king. The machine would check the black king's moves (controlled by a human) and could detect illegal moves. The bottom of the chess pieces had a metal web, and the pieces were placed on a chessboard embedded with internal circuits that encoded the positions of the pieces on the board. When the black king was manually moved, the algorithm would calculate and execute the next best move for the white side. [1].

2.2. Equality Era - Deep Blue

IBM (International Business Machines Corporation) developed the first version of the Deep Blue chess engine in 1985, and it gained worldwide fame after defeating world champion Garry Kasparov in 1997. Deep Blue had two matches against the chess world champion Kasparov in 1996 and 1997. However, the breakthrough came in 1997 when Deep Blue successfully defeated Kasparov, becoming the first computer program to defeat a world chess champion. Since then, the gap between chess engines and human players has significantly narrowed.

As of June 1997, Deep Blue was ranked 259th in the world supercomputer rankings. The machine played against Kasparov for a normal duration of a game. Deep Blue had a database called the "extended book," which stored 700,000 games played by International Chess Grandmasters (GM). This database allowed the system to quickly retrieve hundreds of thousands of games played by top chess players and analyze them to determine practical moves in the current position. Deep Blue's success relied on its powerful computational capabilities and sophisticated logical principles. Here is an example:

1) The number of times a move has been played. A move frequently played by Grandmasters is likely to be good.

2) Relative number of times a move has been played. If move A has been played many more times than move B, then A is likely to be better.

3) Strength of the players that play the moves. A move played by Kasparov is more likely to be good than a move played by a low-ranked master.

4) Recentness of the move. A recently played move (usually played knowing prior games) is likely to be good, an effect that can in some cases dominate the second factor.

5) Results of the move. Successful moves are likely to be good.

6) Commentary on the move. Chess games are frequently annotated, with the annotator marking strong moves (with “!”) and weak moves (with“?"). Moves marked as strong are likely to be good; moves marked as weak are likely to be bad.

7) Game moves vs. commentary moves. Annotators of chess games frequently suggest alternative moves. In general, game moves are considered more reliable than commentary moves, and are thus likely to be better. [2].

Deep Blue was a parallel computing computer system with its program written in the C programming language, running on the AIX operating system. As an independent computer system, Deep Blue had specially designed hardware and software for chess computation and

ISSN: 2710-0588

analysis. The 1997 version of Deep Blue had a computing speed of 200 million positions per second, twice as fast as its 1996 version. The emergence of Deep Blue was not only a technological feat but also a historic record of the confrontation between humans and intelligent computers on equal footing.

2.3. The Revolution of Neural Networks and the Era of Diverse Chess Engines: Commercial and Popular Chess Engines

At the end of 2017, engineers from DeepMind introduced an engine that astonished both the chess and computer communities-AlphaZero. AlphaZero was a revolutionary chess engine that incorporated numerous human-like concepts within its neural network analysis mode. Analysis of the AlphaZero neural network revealed its ability to partially reconstruct human chess concepts, something unprecedented before. AlphaZero employed the concept of "concept activation vectors," encompassing various concepts from evaluation function components from the Stockfish engine to specific board patterns. [3] Researchers measured the occurrence of relevant information across the layers of the neural network during training using a simple concept probing method, resulting in detailed "what-when-where" plots. Furthermore, the evolution of AlphaZero's gameplay was studied by comparing its training process with human historical games and variations between different training runs. The research findings indicated that while there were some similarities, AlphaZero did not replicate human history entirely, exhibiting distinct characteristics in opening choices and move diversity. [4,5].

Cloud computing technology provided AlphaZero with immense computational power and extensive storage resources, accelerating its learning and evolution process. The elasticity and scalability of cloud computing allowed for efficient execution of such computationally intensive tasks in distributed computing environments, expediting AlphaZero's upgrade iterations. [6,7].

Apart from AlphaZero, another chess engine, Stockfish, has also garnered widespread attention. Currently, Stockfish is one of the most powerful cloud-based chess engines available to the public. As an open-source engine, Stockfish enjoys broad support from the entire chess community. Users can upload their game data to the cloud and benefit from real-time analysis using cloud-based data. Stockfish incorporates neural network technology, specifically the NNUE (Efficiently Updatable Neural Network) function evaluation, to enhance its ability to evaluate chess positions. This technology enables Stockfish to make more precise decisions and calculations during gameplay. [6,8,9].

Table 1. Characteristics of mainstream open-source chess engines

Engine Name	Language	Supported Platforms	Speed (N/s)	Algorithm Principle
Stockfish	C++	Windows, Mac OS, Linux, Android	5.5M	Alpha-Beta search algorithm
Lc0	C++	Windows, Mac OS, Linux	100k-10M	Monte Carlo tree search
Komodo	C, C++	Windows, Mac OS, Linux, Android	Unknown	Alpha-Beta search algorithm
Shredder	C	Windows, Mac OS, Linux, Android	Unknown	Alpha-Beta search algorithm
Fritz	(C++)	Windows, Mac OS, Linux, Android.	2.3M-3.2M	Alpha-Beta search algorithm
Rybka	C++	Windows	1M	Alpha-Beta search algorithm
Houdini	(C++)	Windows	Unknown	Alpha-Beta search algorithm
HIARCS	Unknown	Windows, Mac OS	Unknown	Alpha-Beta search algorithm

The exceptional computational power of the Stockfish engine is closely tied to the utilization of cloud computing technology: (1) Elasticity and Scalability of Cloud Computing: The Stockfish engine can dynamically allocate and adjust computing resources based on actual demands, rapidly providing the required computational capabilities for large-scale tasks. (2) Virtualization Technology: Cloud computing engines leverage virtualization techniques to abstract physical computing resources into virtual resources, enabling multiple users to share

ISSN: 2710-0588

the same pool of physical resources. The table below presents statistical information about mainstream chess engines. [6-8].

3. Limitations and Insights of Chess Engines

Chess engines powered by cloud computing have made significant progress in advancing the game of chess into a new era. However, current chess engines on the market vary in their analytical capabilities, and the user experience and clarity of interfaces of highly capable chess engines still need improvement. Therefore, the key focus of future chess engine development should shift from enhancing algorithmic capabilities to improving user experience.

3.1. Current Limitations of Chess Engines

3.1.1. Compatibility

Although contemporary chess engines mostly employ cloud computing technology, they have poor compatibility with each other. This poses challenges for players using engines on different operating systems. Players need to invest additional time and effort to adapt to and switch between different engine environments.

3.1.2. Data Transmission and Security

Cloud computing stores data on servers provided by third parties, which raises concerns about unauthorized access or data leakage for chess engines involving sensitive information. For example, in the 2023 World Chess Championship held in Kazakhstan, Chinese chess player Ding Liren and his assistant were exposed for using alternate accounts on the lichess platform, resulting in the leakage of game strategies and opening preparations. Therefore, ensuring data security and privacy protection is an important issue to address in cloud computing technology for chess engines.

3.1.3. Computing Speed and Accuracy

Although regular chess engines can provide diverse move suggestions, there are potential issues. These engines typically retrieve data from the cloud to analyze chess positions from different games, and provide move recommendations based on the analysis results. However, if players do not strictly adhere to the move recommendations derived from the analysis of the same game, it may lead to inaccuracies. In such cases, the so-called current best move may not yield the desired outcome. Additionally, some engines depend on the stability and reliability of cloud service providers. If there are failures, maintenance, or service interruptions from the cloud service provider, it may result in the chess engine not functioning properly, thereby affecting the user experience of players.

3.2. Reflections and Suggestions for the Next Generation of Chess Engines

To overcome these limitations, the development of chess engines needs to strive towards super-cloud computing and high-level intelligence. The following are specific suggestions to optimize data retrieval and improve data filtering thresholds:

Optimize the method of data retrieval to ensure that players can easily and efficiently transfer game data between engines on different operating systems, enhancing compatibility and user convenience. One possible approach is to use Portable Game Notation (PGN) as a standardized data recording format. Considering the strong compatibility of PGN, chess engines can support direct import and export of PGN files, enabling players to easily exchange game data between different engines. [10] Engine developers can ensure compatibility of their engines with the mainstream PGN standard, allowing players to use common PGN editors or software to create, edit, and share game data.

Provide more stringent data filtering mechanisms to ensure that move suggestions are derived from consistent analysis data, reducing misleading and uncertainty. Additionally, engines can

ISSN: 2710-0588

offer more detailed move suggestion information, including the underlying reasoning and evaluation basis, to help players better understand and apply the suggestions. Engines can choose to analyze and suggest moves based on high-quality and reliable data sources to minimize misleading and uncertainty. Furthermore, engines can employ meticulous data filtering criteria to ensure that only data meeting specific conditions is used for analysis and suggestions, providing more accurate and reliable move recommendations while reducing potential misleading. When providing move suggestions, engines can offer detailed explanations and evaluation grounds, explaining why a particular move is considered the best choice and providing evaluation basis specific to the current game situation.

4. Conclusion

In conclusion, this study has revealed the significant role of cloud computing technology in chess and explored its potential in the field of chess applications. With the continuous advancement of cloud computing technology, computer engines will continue to play a crucial role in chess, providing players with powerful tools and platforms to further the development of the game. Cloud computing technology offers convenient platforms for players to engage in online games and analysis with opponents from around the world, anytime and anywhere. However, we should also address the challenges related to security, reliability, and optimization in the application of cloud computing technology in chess. This article has presented relevant ideas and suggestions in this regard. The era of superhuman chess engines has arrived, and the key lies in making these intelligent cloud minds accessible to the public. It is hoped that this paper provides valuable insights for research and practice in the field of chess.

Acknowledgments

I would like to express my sincere gratitude to Professor Yi Ke and teaching assistant Dong for their guidance throughout the duration of this research. I am also grateful to my alma mater, Beijing Chaoyang Foreign Language School. The rigorous academic atmosphere at CYFLS has been instrumental in the completion of this research. Lastly, I would like to express my heartfelt gratitude to my family, especially to my father, for their support and invaluable guidance throughout my academic journey. Their trust in my abilities and their constant encouragement have been a source of inspiration and motivation.

References

[1] George, W.A. (1998) Chess and machine intuition. Intellect Ltd.

[2] Campbell, M. (1999) Knowledge discovery in deep blue. Communications of the ACM, 52(11): 65-67.

[3] McGrath T., Kapishnikov A., Tomašev N., et al. (2022) Acquisition of chess knowledge in AlphaZero. PNAS, 119(47): 2+10.

[4] Takeuchi, S., Kaneko, T., Yamaguchi, K., et al. (2007) Visualization and adjustment of evaluation functions based on evaluation values and win probability. Association for the Advancement of Artificial Intelligence, 859.

[5] Maharaj, S., Polson, N., Turk, A. (2022) Chess AI: Competing paradigms for machine intelligence entropy. https://www.mdpi.com/journal/entropy.

[6] Vigneron H. (1982) Monty newborn: Chess and computers. Computer Science Press.

[7] Silver, D., Schrittwieser, J., Hassabis, D. (2020) AlphaZero: Shedding new light on chess, shogi, and Go. Deepmind, 1-4.

[8] Chess.com. (2021) Chess engine | Top 10 engines in the world. https://www.chess.com/terms/chess-engine#lc0.

ISSN: 2710-0588

[9] Lc0. (2018) GUIDE: Setting up Leela on a Chess GUI. https://lczero.org/blog/2018/09/guide-setting-up-leela-on-chess-gui/.

[10] Chesscom. (2018) Depth and nodes - computer chess. https://www.chess.com/forum/view/general/depth-and-nodes-computer-chess.