Impact of Artificial Intelligence in Go Communities

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Background

March 19th, 2016 has been a day to remember for both the artificial intelligence (AI) and the Go communities. On this special day, Lee Se-dol, an 18-time world champion, generally acknowledged as the strongest Go player on earth, sat down against Google DeepMind's newly developed AI program, Alpha Go. Lee predicted a 5:0 sweep against this computer program. However, when the game came to an end, he suffered an unexpected 1:4 lost (Borowiec, 2017). According to Elon Musk, this historical match marked a milestone for a 10-year jump for AI development (Hoffman, 2016), considering the computational complexity of 10^{360} possible moves in Go to for the program to solve (Koch, 2021), a number beyond human imagination. The news also sent shockwaves through the Go communities, where this ancient game dominated by humans for over 4000 years, was suddenly grasped and dominated by a non-human 'entity that cannot be defeated' (Yoon, 2019).

After DeepMind published AlphaGo's basic principles in the science journal Nature (Silver, 2016), other teams managed to reproduce the program. AI-powered Go programs soon became accessible to Go players which led to discovery of 'novel' moves and strategies that brought a drastic development in this game (Willingham, 2023).

Introduction

AI Go programs have now become indispensable in the training and advancement of Go players, ranging from the lower to the top-level professional leagues (Kwon, 2023). However, it has also brought increased caution to Go players and tournament sponsors, stemming from a growing number of instances involving the secret and abusive use of AI in Go tournaments. Since its introduction, when higher-ranked players are defeated by 'dark horses', the winner is more likely to be suspected of illegal AI assistance during the game, rather than applauding this legendary victory (Friedel, 2023). For instance, in a less-supervised online tournament, a 13-year-old girl can easily defeat a 9-dan (highest-rank) Korean national team player with the

suggestion of her computer Go program (Park, 2020). Though more technically difficult, individuals have also discovered ways to cheat during in-person tournaments with the help of tiny cameras, earphones, and an accomplice on the other end who helps to update the board state to an AI go program (Kim, 2020). As an international sport that has become increasingly reliant on online tournaments since the onset of the COVID-19 pandemic, sponsors now face the challenge of rethinking how to conduct these events to minimize the risk of such kinds of cheating. It appears that this emerging technology has hugely disrupted the fair playing field in the Go communities within just a few years of its introduction.

Different opinions had emerged to discuss who holds the primary responsibility in such situations to help regain human control over the future development of Go. Individuals who engage in cheating are, of course, crucial parts of the play. Besides that, existing journal analyses convey the message, perhaps inadvertently, that artificial intelligence has been the primary cause of cheating in Go tournaments and the ongoing degradation of the gaming experience. However, these opinions only consider influence of AI which oversimplify the dynamics at play. These analyses often point to more punitive regulations on illegal AI usage, which, while reducing cheating, may not address the root issue of individuals' overreliance on and lack of ethics in AI usage. Instead, examining the shared influence among different parties would encourage a deeper understanding of how different factors collectively contribute to the evolution of such phenomena. It may provide insights into achieving harmonious coexistence with AI by treating it as a new element of Go communities that we can adapt to and live with.

Building upon the arguments presented above, I propose adopting this method to evaluate how different human and non-human elements within the Go communities collectively influence each other following the introduction of AI Go program. This analysis aims to observe the interactions among these elements to explore how they each and collectively contribute to the evolution of AI overreliance and ultimately lead to the disruption of existing

orders in the Go communities. To assess the case study, I draw upon evidence from interviews with professional players and journal analysis. The analysis will resort to Actor-Network Theory, where I identify various actors in the play within the case study and construct the heterogeneous network by linking these actors together. Finally, I evaluate how these actors interact with each other, leading to the current state of affairs. The choice of this specific network is grounded in the capacity of Actor-Network Theory to discern the intricate structure of Go communities. These communities are highly complex, comprised of numerous interconnected components. Utilizing this network enables us to effectively dissect these communities into their constituent parts and evaluate the relationships and interactions among various actors. This approach enables a comprehensive assessment of the complicated dynamics within Go communities which improves both the breadth and depth of our analysis.

Framework

Actor-Network Theory (ANT) examines the "science and technology in the making" (in this context, the Go communities after the introduction of AI) (Cressman, 2009). Elements that play a role in the socio-technological system such as social factors, technological artifacts, and knowledge are identified as actors which are mutually interactive. The theory treats humans and non-humans at the same level, and according to Cressman, "ANT argues that both humans and non-human actors should be understood within a network wherein their identity is defined through their interaction with other actors" (Cressman, 2009). It suggests that no actor can be singled out from the system because their identity would be null if analyzed in an isolated system where they cannot interact. The constructed network undergoes constant shifts as outcomes of interactions and changes in relations between the actors. It is worth noting that each actor itself is also a network. For example, the AI Go software, as one of the actors within the network in this context, is also a full-fledged network that constitutes actors such as software developers, users and current AI technology. This micro-network can then be

"black-boxed" by obscuring the inner complexity of this network and be treated as an actor with a certain property in the larger network of the Go communities, and this process is called *punctualization*. According to Cressman, "a network can be considered both a form and a process" (Cressman, 2009), meaning that any network can be viewed as static in a short time period but dynamic in the long term. As an example, Actors/Networks such as the Go communities and AI technology are originally unrelated, but a convergence is created between them with the introduction of AI Go software, and this process is called *translation*, where innovation is capable of constructing independent networks by combining or evolving existing ones. Evidently, in the technological world, these translation processes are brought about by scientists and engineers who conduct "an act of invention [which] is brought about through the combination and mixing of varied elements" (Cressman, 2009). Therefore, scholars treat engineers and scientists—the network builders—as primary actors to observe and evaluate throughout the network construction process.

Therefore, this paper will approach the Go communities as a dynamic socio-technical system that is continuously under translation. It comprises human actors, such as Go players and tournament sponsors, and non-human actors, such as Go tournaments, the ranking system, and Go organizations. This network, which was once relatively stable, is now undergoing disturbance and reconstruction with the introduction of AI Go programs by software developers, the network builders. The framework will allow me to identify the diverse actors within the network of the Go communities and construct the network by establishing links between these actors. The remainder of the paper will focus on assessing the individual actors and understanding how they relate and interact to bring about certain states or temporary outcomes within the system. It is equally important to note that we view this network as dynamic, meaning that after fully understanding its structure, the introduction of new actors,

changes to existing actors, or modifications to the relationships between actors could potentially alter the state of the socio-technical system.

Literature Review

> *"I think the best defense against the misuse of AI is to empower as many people as possible to have AI"*
>
> *--Elon Musk (Musk, 2015)*

Similar to Elon Musk's perspective, AI Go programs have been designed with the goal of empowering a wide range of users. Thanks to their open-source nature and user-friendly interface, these programs are accessible across the internet and had minimized the technical barriers for individuals without a tech background. According to a study led by Jimoon Kang and fellow researchers from Yonsei University, South Korea, AI has been the primary training tool for professional Go players. The most trending tool in such context is an open-source program named KataGo developed based on AlphaZero, a model that defeated AlphaGo 100:0 (Kang, 2022). It served as an equalizer for players worldwide who previously lacked access to proficient Go instructors, allowing them to explore innovative strategies and ultimately improve their performance.

However, the discussion above only presents part of the picture. As a platform for challenging human cognitive activity, professional Go tournaments explicitly ban the use of AI in game settings. This implies individuals who break this rule would gain a significant advantage over others. Unlike athletes who can be detected doping in athletic competitions through various testing methods, gathering concrete evidence to accuse Go players of AI violation is challenging. Kang's study revealed that AI-based training has transformed the moves of professional players to resemble those recommended by AI. Without catching someone cheating in the act, it is difficult to conclusively determine solely from the board state. As an example, in the Chunlan Cup, a Chinese newcomer managed to defeat the reigning world champion and was suspected of illegal AI usage due to a move that resembled an AI decision

(Friedel, 2023). Though no concrete evidence was found after active investigation, his reputation was still tainted as a result.

As part of his study, Kang also conducted interviews with several members of the Korean Go national team, inquiring how AI has influenced players' mental state. Despite boosting players' performance, AI acted more as an agent that brought frustration and a loss of motivation. Go, once regarded as "a mental or artistic activity that only humans could perform," (Kang, 2022) faced a transformation when AlphaGo, a model with mere months of training, defeated their national hero with decades of professional training. Subsequent versions of AI Go programs became synonymous with an 'undefeatable entity' in the game. Now, AI has fully replaced the role of Go teachers and game records (books of recorded game states played by Go masters in the past) among professional players. Wary of being left behind, players now primarily follow AI-devised strategies rather than crafting their own moves, which heavily diminished their subjective feeling of control over the game. Reliance on AI training has also undermined the game experience. Shin Jin-Seo, the South Korean world champion, told CNN that Go used to resemble a conversation with your opponent, where "their thoughts and intents revealed themselves with each move." However, with AI, he noted, "there's no more dialogue because I really cannot understand [its] logic," as AI agents possess the computing power to see tens of moves ahead, a scope beyond human understanding (Kwon, 2023).

To better understand the network I am investigating, I also conducted research on the structure of the Go communities. Go players unanimously adhere to a national ranking system that divides them into two sub-categories: amateur and professional. Our primary focus will be on the professional level, where players are ranked from 1-dan up to 9-dan, with 9-dan being the highest level (Dan at Sensei's Library, n.d.). The rule of promotion often follows the game record, and individuals who excel in national and international tournaments are promoted in priority. Players aiming for the professional stage begin training at a young age, dedicating all

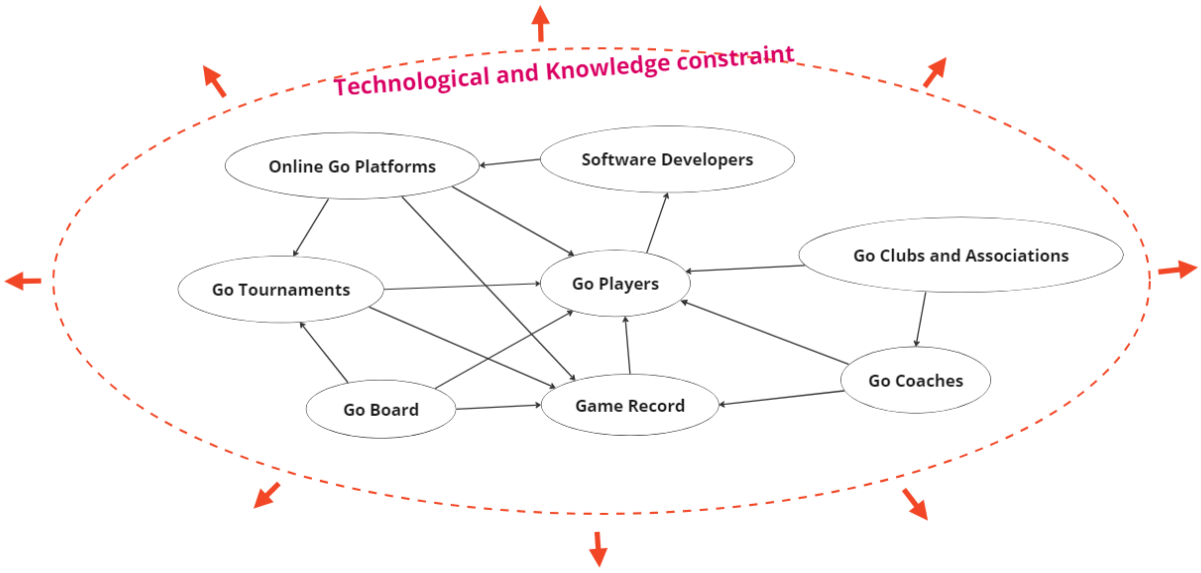
their time and effort to excel (Scanlon, 2002). Therefore, at the time they turn adults, Go becomes their primary source of income.

High-ranking Go tournaments can be quite lucrative. In addition to the significant opportunity to promote one's dan rank, the champion receives substantial financial reward. For instance, in the Samsung Cup, the winner's prize is $260,000 (Wikipedia contributors, 2023). However, the number of professional Go tournaments is limited and they are exclusive to professional players with high ranks. This highlights the significance of adopting a utilitarian mindset as a professional player and utilizing all available resources to secure victories in regional games. Only by doing so can players maximize their likelihood of qualifying for top-level tournaments in such a competitive regime.

Network Construction and Analysis

The evolution of network construction of the Go communities revolves around Go players and evolves over time, with a distinction between the times before and after the introduction of AI. Figure 1 below shows the network before the introduction of AI Go software:

Figure 1. Network of Go communities prior to the introduction of AlphaGo before 2016



Beyond the red circle lie the bottlenecks of current technology and human knowledge which are yet explored, where infinite possibilities of new actors and networks exist. Due to

technological advancements, the circle constantly expands, where new knowledge will unveil and being converted into new networks by network builders. Prior to the AI revolution, there had already been an evolution in Go due to the advent of general-purpose computers and the internet, involving the digitalization of the physical Go board and gaming platforms that serves as a basis for AI revolution later.

This prior network can be described as long-term dynamic yet short-term static, as it stabilized over millennia of Go development. The relations and interactions between each actors follow and are confined by the well-defined rules of the game and the system established by the publicly recognized Go organizations. With respect to Go itself, the game's rules are immutable, providing the foundational framework within which players must operate. The simplicity of the game rules ensures that even minor alterations potentially reshaping the entire game.

The game of Go begins with a simple physical configuration of grids known as the Go board, where black and white stones are placed consecutively according to a set of rules. Although the rules defining the game of Go are simple and straightforward, the number of grid intersections allows for a near-infinite number of possible next states after a move is made. This complexity is exactly why the game has been explored for thousands of years and new strategies are still evolving, albeit slowly.

The popularity of the game has led to the establishment of Go associations, central national agencies comprised of the most experienced, recognized, and respected professional Go enthusiasts, wielding considerable influence. Their primary focus lies in scouting and nurturing talented players, as well as promoting the game of Go. Talent scouting is conducted through Go grading examinations, where excelling in these examinations allows players to progress to higher levels until they reach professional status. Transitioning to professional status serves as the gateway to participating in the prestigious and lucrative professional Go tournaments

hosted by the associations. The rank-based rules established by these associations assign players ranks ranging from 1-dan to 9-dan based on their accumulated scores from tournaments. Being financially self-supportive requires the players to stay advance in the ranking system, as the most rewarding competitions are exclusive to top-level professionals. This ranking system, determined by tournament performance, underscores that in the professional realm of Go, merit is the sole determinant of success.

Excelling in a merit-based and intellectually competitive game like Go necessitates access to the best training opportunities, which is why Go coaches and game records have historically played such crucial roles in advancing the network. Game records consist of past unsolved game states from Go masters, providing valuable material for players to practice and develop new strategies. Well-known tournaments, where the best players gather and compete, serve as excellent yet limited sources of game records.

The coaches are typically retired top players, and during training, they serve as both teachers and opponents. New players strive to enhance their skills until they can consistently defeat their coaches. Once they achieve this milestone, they typically seek out stronger opponents to continue their improvement. This ongoing challenge helps players continually refine their skills and strategic understanding, which also explains why the best Go players concentrate in Asia—a region with the longest history of Go and the most extensive pool of talent for players to compete with and improve alongside.

The invention of general-purpose computers and the internet marked the first significant transformation in the game of Go over the past decade: as the technology circle expanded, software engineers introduced these new technological products into the network. Computers played a pivotal role by digitalizing the physical setup of the Go board, transforming it into a data and visual representation for human interaction. Simultaneously, the internet

revolutionized the game by reliably delivering a player's board state data to another player located thousands of miles away, facilitating instant feedback.

This technological advancement opened up possibilities for online Go tournaments, which greatly reduced the travel costs associated with cross-national or international tournaments. However, it also created an under-supervised environment, leading to challenges such as cheating. Despite this, little attention was initially paid to cheating in top professional games, as no computer Go algorithm had yet demonstrated the ability to defeat professional players. Current AI programs are still limited to brute force searching without the ability to abstract problems or understand them deeply. As a result, this complex game retains a natural advantage for humans over computers, despite the computational advantage computers possess. The vast volume of computational power is hindered by their limited ability to handle such a large search problem efficiently.

Therefore, the introduction of personal computers and the internet, while significant, was not powerful enough to overthrow human intellectual supremacy in this game. While it transformed the dynamic network surrounding the game of Go by weakening the relation between physical Go board and tournaments, it ultimately fell short of fundamentally altering the balance of power within the network.

The effort of the network builders did not halt, software engineers continued pushing the technological limit and finally discovered the magic of deep learning, a new way of data computation which fully yielded the computation power of AI and makes computers outperform human in this game, thus creating the revised network as shown below in Figure 2:

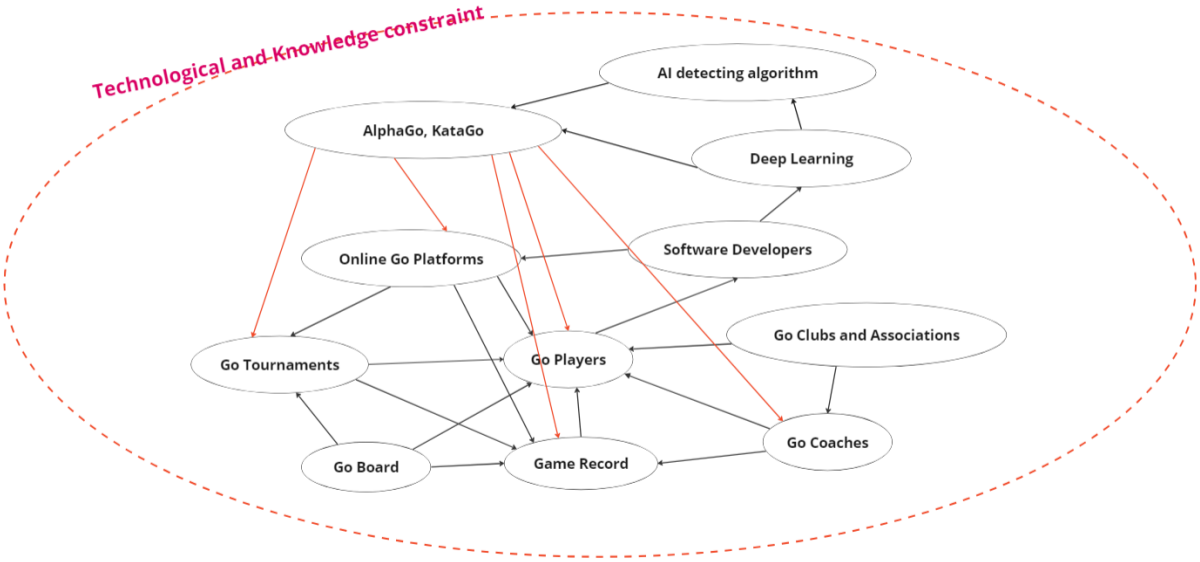


Figure 2. Network of Go communities prior to the introduction of AlphaGo before 2016

AI Go software such as AlphaGo and KataGo have surpassed top professional players due to deep learning algorithms, an AI method that simulates neural networks and enable computer to better understand and reason like humans. With the aid of processors' perfect memory and exceptional computational power, these algorithms can learn and simulate tens or hundreds of games in just a few hours. They can foresee several steps ahead in an intense game without being affected by human shortcomings like emotion and fatigue, making their moves perfectly rational according to their internal heuristics. Later turned in to software with user-friendly interfaces and great accessibility over the internet, these programs quickly creating a paradigm shift within the network as they are popularized.

AI Go software first changed the way Go players are trained. As training in Go historically involves more practice with coaches and peers of similar expertise rather than direct tutoring, AI quickly replaced the role of coaches and the need for extensive talent resources during training. When it comes to game scores, the primary source for players to develop strategies. It has historically been tournament recordings, which were scarce due to the limited number of top players. However, AI software can now simulate games themselves, often playing even better than top professional players. In just a few years, they have generated more game scores and strategies than those accumulated over the past century combined.

The competitive environment of professional Go, along with its merit-based ranking system, necessitates efficiency in training and learning. This effectively prompts players to rely heavily on AI software to explore new strategies, as it is evident that AI Go's ability to generate novel moves in a short time period far surpasses that of the smartest human brains. This reliance on AI has led to a shift in the creation of Go knowledge from human to machine simulations, and has left many Go players feeling devastated. Despite their improved performance, the loss of control over their games has still greatly impacted their self-confidence. Furthermore, the readability and understandability of new computer-generated strategies are heavily disrupted as AI-devised strategies dominate tournaments. Computers have the ability to see tens or even hundreds of steps ahead, which is distinct from human step-by-step reasoning.

For top professional online tournaments, which previously did not fear cheating because no computer could outperform humans, the times have changed. More and more players are suspected and caught cheating using AI after achieving suspicious victories over players with much higher dan levels. This issue is exacerbated by AI-assisted training, which blurs the line between human and machine play.

Instead of laying all blame on AI, it's crucial to reflect on the current merit-based Go system. This system of survival of the fittest, urges players to employ all available means to secure victory. In this highly competitive setting, some individuals gradually lose sight of the game's essence, treating it less like “a dialogue with their opponent” and more like a contest where the focus shifts to concerns about their overall score after a loss, rather than immersing themselves in the game itself (Kwon, 2023). This fosters a competitive and utilitarian mindset, particularly among professionals, who prioritize winning over appreciating the game's beauty and fostering knowledge creation. Those lacking ethical considerations may even turn to the force of AI to represent their intellect when facing opponents.

The good news is that measures are being implemented in tournaments to empower players with AI assistance in virtuous ways. Efforts to combat the unethical use of AI in tournaments are now underway, with researchers developing methods using deep learning to detect AI-assisted games. This approach is effective because a single move assisted by AI is rarely enough to secure victory; players typically follow a series of AI-informed moves to maximize their chances of winning, creating a distinctive pattern of AI assistance characteristics which can be identified and analyzed by these programs. This detection method holds promise for online tournaments as a deterrent against the illegal use of AI. However, its effectiveness is limited if players utilize AI software sporadically or employ novel cheating methods, and there is no guarantee of accuracy in such cases.

Conclusion

In conclusion, this paper has analyzed the network of the Go communities and illustrated how AI has transformed this network, leading to its current state. The analysis highlights that, alongside the influence of AI, the nature of the ranking system acts as a catalyst for the significant changes observed in the already competitive and utilitarian environment that has developed over centuries, potentially prompting players to prioritize victory over the essence of the Go game. Despite exacerbating trust issues in online tournaments, AI also has the potential to empower players and tournament sponsors as a tool to identify and combat illegal AI usage. After considering all aspects of the discussion, it is evident that the detrimental influence of AI is likely to remain confined to the professional competitive realm. For casual players, the primary objective is not simply to win but to enjoy the game. With this mindset, individuals are more resistant to AI reliance in Go and are more likely to be the ones who retain the "dialogue-like" nature of the game in the far future.

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