A Study of Basis on AI-based Information Systems: The Case of Shogi AI System "Ponanza"

Yuichi YODA
US-Asia Technology Management Center, Stanford University
521 Memorial Way, Stanford, California, U.S.A
yyoda@stanford.edu

Kosuke MIZUKOSHI
Faculty of Economics and Business Administration, Tokyo Metropolitan University
1-1 Minamiosawa, Hachioji city, Tokyo, Japan
mizukoshi-kosuke@tmu.ac.jp

Seiichiro HONJO
Department of Management of Business Development, Shizuoka University
3-5-1 Jouhoku, Naka-ku Hamamatsu city, Shizuoka, Japan
seihonjo@shizuoka.ac.jp

Abstract

The objective of this study is to deepen our understanding about the exploration of Artificial Intelligence (AI) in corporate marketing and interpret how people and society respond in their attempt to comprehend the development and actions of AI.

In this study, we discuss the case of Ponanza, an AI based system for Japanese Chess "Shogi". We conclude that Ponanza became a mystery even for its developers in their process of building this system into one capable of defeating professional Shogi players and is now open to interpretation for its developers and professionals.

In particular, when we treat AI as an extension of humans, it will be important to consider how AI and humans create knowledge and how humans can learn from AI. In the future, interaction with AI can be expected to improve human's ability to investigate "causes" and develop "reasons".

Introduction

With the spread of AI in recent years, there has been a change in the way people understand its occupational practice. Many of the occupations currently performed by humans are expected to be replaced by AI in the near future (Frey and Osborne, 2017). Not only that, but the way occupational practices are undertaken is also undergoing change. Until now, marketing research placed importance on building hypotheses and providing reasons about users' consumption behavior. In contrast, Amazon's recommendation system and Google's search engine, which use machine learning, respond to user needs based on data accumulated from the customers' buying patterns. These systems do not rely on causal relationships and work as long as there is a correlation between data (Mayer-Schönberger and Cukier, 2013). In marketing practice, there are three merits of focusing on the "result" of selections made by users in the real environment and responding to user needs through trial and error – (1) it conforms with the way of thinking of companies that focus on results, (2) it leverages the low cost of needs exploration in Internet business, and (3) it enables the company to incorporate complicated environmental factors which move dynamically when a proposal is made to the user (Yoda, Mizukoshi and Honjo, 2016). This method is expected to grow in future.

On the other hand, such result-focused practice is dissociated with existing human activity from the viewpoint of systematic understanding because it does not specify cause and effect. From the perspective of research, this leads to difficulties in constructing theories on user needs or human behavior in general. From the practical perspective, this raises difficulties because the "results" cannot be reproduced as they are limited to certain conditions and horizontal expansion of business is not easy. This study focuses on

AI that surpasses human achievements to analyze the workings of human understanding for a phenomenon and the relationship between AI and humans.

Research Method

We study the case of a Shogi program that uses AI (Shogi AI). Shogi is the best subject for studying the relationship between AI and humans because of the following three reasons - (1) it is a game with fixed rules, played in a static environment and can therefore be studied as a case separated from the complicated and dynamic environment of society, (2) professional Shogi players are considered one of the representative examples of the human intellect and (3) superiority dispute between AI and humans is already settled with Shogi AI far surpassing Shogi players.

In this study, the "case study" method as a qualitative research is adopted. Case study is an effective method for exploratory research allowing us to ask "how" and "why" of high-context phenomena beyond the control of the researcher (Yin, 1994)[4]. It is also suitable for exploratory research of unique cases. The case study approach can be conducted adhering three principles of data collection to handle qualitative data as a scientific research approach proposed, vis-à-vis data correctness such as (1) use of multiple sources, (2) use of face-to-face interview, (3) maintenance of a chain of evidence by Yin (1994).

This case study is based on an interview with Issei Yamamoto[1], the developer of major Shogi AI Ponanza, his public lectures, books and other related disclosed materials. Additionally, we requested Seiya Tomita (3-dan player in the Encouragement Meeting) of the Japan Shogi Association to accompany us during Issei Yamamoto's interview and lectures. Before and after the events, we benefitted from his expert knowledge on the thinking process involved in Shogi. We also used interview videos and books by Shogi players Yoshiharu Habu and Amahiko Satoh as reference materials for the analysis.

Case Study of Shogi AI Ponanza[2]

(1) Overview of Ponanza

Ponanza is a Shogi program that Issei Yamamoto started developing while he was studying in the University of Tokyo. As Shogi AI, it defeated a professional Shogi player for the first time on March 30, 2013. On May 20, 2017, it became the first Shogi AI to beat an active Shogi "Meijin" which is the most prestigious title of Shogi in Japan.

Yamamoto explained that as in the case of human intellectual activities, Shogi AI too requires two functions – exploration and evaluation. Exploration, here, refers to the ability to predict and correctly emulate (make a guess without adding one's subjective views or judgement) the future[3]. To anticipate the future, the computer explores a large number of situations on the board, calculates all possible moves from those situations and predicts how the game is likely to unfold. In the case of humans, this is called "reading" which means exploring (Yamamoto, 2017, Ch. 1, Sec. 3, Para.8). However, because it is difficult to completely explore all of the large number of situations due to resource constraints, computers determine the next move while marking out some highlights. This process of marking highlights is referred to as evaluation. In other words, the area of exploration is gradually reduced as needed to effectively use the limited resources (Ibid., Ch. 1, Sec. 3, Para.10-12). Yamamoto said that humans program the "exploration" part, which was a main function, and specified how the exploration was to be conducted, while the computer learns to "evaluate" by itself through the introduction of machine learning (Ibid., Ch. 1, Sec. 14, Para.1).

Table 1 Major matches between Shogi AI and Shogi players

Year	Details
2007	Exhibition match between Bonanza and Akira Watanabe, *Ryuou* (Winner)
	Bonanza made open source *partially used as reference for Ponanza too
2012	Bonkras (Winner) vs. Kunio Yonenaga, *Eisei Kisei*
2013	Ponanza (Winner) vs. Shinichi Satoh, 4-*dan* *Shogi AI's first victory over an active professional Shogi player
2014	Ponanza (Winner) vs. Nobuyuki Yashiki, 9-*dan*
2015	Ponanza (Winner) vs. Yasuaki Murayama, 9-*dan* Winner of the 25th World Computer Shogi Championship
2016	Ponanza (Winner) vs. Takayuki Yamasaki, 8-*dan*
2017	Ponanza (Winner) vs. Amahiko Satoh, M*eijin* *Shogi AI's first victory over an active M*eijin*

It can be said that the difficulty in evaluating Shogi lies in the fact that no optimum method of calculation has been found for computers yet because of the game's complexity and depth[4]. Ponanza needed a function to express the adjustments between the more than one hundred million parameters as "evaluation parameters" in order to represent the complexity of Shogi, based on three-piece relationships, including the king[5], and the turns[6]. Yamamoto said that the initial version of Ponanza improved Shogi AI to a level where it could play moves similar to about 45% of the professional Shogi players[7]. This was done by enabling the computer to adjust the values after using machine learning to acquire the game records of over 50,000 Shogi players

as training data. Machine learning based parameter adjustments by computers are faster and more accurate than manual parameter adjustments by humans. Therefore, Yamamoto decided to thoroughly train (adjust parameters) the computer for the parameter function and devoted himself to describing through a program how the computer should be trained to evaluate.

Then, on March 30, 2013, the computer defeated an professional Shogi player for the first time. The match was played against Shinichi Satoh, 4-dan, in the 2nd Den-o Sen (Electronic King Championship). The Ponanza at that time was able to explore 40 million situations in one second.

Furthermore, Yamamoto introduced reinforcement learning, which is unsupervised learning, in 2014, after working on supervised learning where Ponanza learned from game records of Shogi players[8]. In this method, the computer makes speculative searches even if the environment is unfamiliar and learns through feedbacks received about the results. Repeated feedbacks strengthen the computer's evaluation function. To be specific, it makes six to eight moves based on a probable situation, analyzes whether they led to victories and finetunes evaluation parameters. Yamamoto says that he accumulates about eight billion such situations and has eventually analyzed nearly one trillion situations. This process results in determining new Ponanza-style tactics, which refers to sequences that do not exist in games played between humans.

(2) Developer's Perspective

As Ponanza's performance improves, it is becoming more and more difficult to be explained. Yamamoto compared its mystery to "Black magic[9]." This term is accepted as a slang in the machine learning world too and refers to an umbrella term for any technique whose origin and reason for effectiveness is unknown.

When making improvements in Ponanza, every time Yamamoto thought of a new improvement, he would initiate about 3,000 automatic matches between the Ponanza on which the improvement was applied and an older version. The improvement would be implemented if the new Ponanza won 52% or more matches. However, Yamamoto says that he had no clue about the workings of the improvements that proved effective. In concrete terms, he says that he does not understand the real reason why the values fed in the program work or why a certain combination of values is effective. Yamamoto adds that he cannot analyze Ponanza's effectiveness because he does not know why it wins or loses a match, as the program's Shogi strength surpasses that of its developer Yamamoto.

As a concrete example of the black magic, Yamamoto gives the example of idle parallelization. In this method, multiple cores of the CPU separately carry out the same processing and the effective methods that each core accidently discovers are shared with the entire system. Interestingly, even experts find it difficult to explain why randomly shared methods work well. They say that their best possible explanation is that "an experiment turned out well."

To sum up, Yamamoto says that he is unable to provide an accurate explanation of why Ponanza is strong and adds that he can only make it stronger through experimentation and experience.

(3) **Shogi Players' Perspective**

In the 2nd Den-o Sen, held in April and May 2017, Ponanza became the first Shogi AI to defeat an active Meijin.

Yamamoto mentioned in the 53rd turn of the first game as an example of symbolic moves by Shogi AI. In this, Shogi AI made an exceptional move to build defense by giving up a piece to the Meijin who had no attacking pieces. This was against Shogi theory, in which players are expected to move across the board without giving up pieces to the attacking player.

The opponent, Satoh Meijin, too felt surprised that such a move was possible when he saw this happen. He said he was unable to understand the meaning of the move because he held preconceived notions such as sacrificing a pawn when the opponent has two pieces that are effective. He said that he was unable to anticipate the move. (Satoh Meijin, NHK, July 31, 2017). Moreover, Yoshiharu Habu explained "humans found it difficult to imagine a situation where a player would use a piece that is neither attacking nor defending, and even give up a pawn to the opponent who does not have one". (Habu, NHK 2017).

Satoh Meijin says that this showed that there could be best moves in Shogi that humans do not see any reason for (that humans find difficult to understand). (Satoh Meijin, NHK 2017).

Shogi AI has already surpassed Shogi players. The dispute of superiority between humans and AI has been settled as far as Shogi is concerned. However, humans, including Shogi players, have not abandoned Shogi. Shogi players are beginning to find ways to learn from Shogi AI as part of their research on the game. Tomita, who frequently participates in study groups with Shogi players, says that the Shogi players he knows are placing importance on learning positioning judgement from Shogi AI. In concrete terms, this means that Shogi players can improve their game by comparing their evaluation results with those of Shogi AI and refining their positioning judgement for each situation on the board.

Discussion

It can be said that human understanding for the logic behind Shogi AI's strength has transformed through the following three stages. In the first stage, players thought that the logic behind Shogi's strength lies within professional

Shogi players and they sought to know how Shogi AI replicates the moves made by professional Shogi players. The focal point was whether the sources of strength that they expressed in their own language could be translated into machine language. In the second stage, the logic of strength moved from professional Shogi players to Shogi AI. The developer of Bonanza discovered a method of considering the positioning of three pieces, rather than two, to determine the best move. At that time, it could be said that the translation was realized. The developer worked actively on the logic of strength which had now moved to Shogi AI and attempted to adjust parameters. In the third stage, the logic of strength was internalized in Shogi AI and came to be considered as something humans are unable to see. Shogi AI became capable of adjusting the logic of strength by itself through reinforcement learning. It was no longer clear why Shogi AI performed the way it did, and the developer's adjustments came to be considered as black magic.

The internalization of the logic of strength in Shogi AI meant that Shogi AI is superior to human Shogi players. At the same time, this also increased initiatives among professional Shogi players to learn from Shogi AI. To learn from Shogi AI and improve their own game, professional Shogi players must translate the logic of Shogi AI's strength back into their own language. It will be important once again for professional Shogi players to be able to understand and explain why their Shogi AI opponent makes certain moves.

Shogi players are tasked with learning and explaining why something worked, although they do not understand it. This gives rise to the problem of how humans deal with a phenomenon and gain an understanding of it as far as the relationship between humans and AI is concerned. By generalizing the example of Shogi AI, we find that humans are capable of taking two kinds of approaches. One is to treat AI as a physical phenomenon and the other is to deal with it as an extension to humans.

The first approach of treating AI as a physical phenomenon would mean that we just need to confirm that a certain result is produced under certain conditions, even though we do not understand the logic behind it. At this stage, it will be possible to apply AI using the phenomenon. Moreover, the current relationship between AI and humans can be interpreted as similar to the relationship between the steam engine and humans, before thermodynamics was discovered. Humans learned from the steam engines, which was produced from experience; investigated the causal relationship in its working principle and built the thermodynamics theory, thereby gaining a systematic understanding. This requires an investigation of the "cause" of a phenomena without depending on language. It can be said that from the third stage, where the logic of strength is internalized in Shogi AI, humans try to deepen their understanding in order to return to the second stage where they can intervene in its contents. However, the difficulty of determining the cause has become extremely increased and it is a big challenge for humans.

On the other hand, in the approach where AI is considered an extension of humans, humans advance their understanding of the results presented by AI while building a model and seek "reasons" as a foundation for understanding. This corresponds with acknowledging as given the third stage, in which the logic of strength is beyond human comprehension. As is evident from the comments of Shogi players, such as humans find it difficult to imagine a situation where a player would use a piece that is neither attacking, nor defending, and even give up a pawn to the opponent who does not have one (Habu and NHK, 2017), they interpret AI as a person and try to learn from it. In such a case, humans and society, not AI, ask the foundation as to "why" AI is able to produce certain results. That is why, contextual and language-based "reasons" should be expected by humans and society. The challenge here is to produce a logic to justify the foundation just like logical reasoning rather than discovering a working principle or "cause."

Various experiments in social psychology have shown that humans rationalize their actions using "reason" that are different from the "cause." For example, consumers were asked to explain the "reason" for selecting the most high-quality nylon stockings from among identical products. Although a larger number of the consumers selected stockings kept on the right side, they mentioned the difference in the quality of the stockings while explaining their reason and not the positioning (Nisbett and Wilson, 1977). Although AI does not automatically justify its actions by itself, its actions can be seen as an extension of human behavior if we consider it as a subject for seeking "reason" after the action is performed.

Moreover, when we consider AI as an extension of humans, we can also anticipate the approach the other side takes when thinking. The Organizational Knowledge Creation Theory holds that knowledge is created, shared in the organization and accumulated through the repeated process of four phases of the SECI model: Socialization, where people create or integrate tacit knowledge by sharing experience; Externalization, where people express tacit knowledge in clear concepts to convert it into explicit knowledge; Combination, where people combine concepts to build a knowledge structure; and Internalization, where people embody explicit knowledge into tacit knowledge (Nonaka and Takeuchi, 1995). During externalization in the SECI model, tacit knowledge is converted into explicit knowledge through dialogue between individuals. The concept of dialogue between two humans may be extended to imagine an interaction between AI and humans where the latter learns from the former. As an extension to that, it might be effective to try to provide an explanation to this

highly persuasive phenomenon from the acts of personified AI, using human abilities for intuition and logic. This could lead to new research questions, such as what the meaning of a dialogue with AI is or whether there is a difference between people who can learn from AI and those who cannot.

Conclusion

In this study, we analyzed the case of Shogi AI to explore how humans comprehend the performance of AI that produces results that surpass humans. There are various important social issues about AI that need to be handled. These include who is responsible for the moral obligations with respect to the results produced independently by AI and how to handle social biases that are already a part of the training data. However, these issues are based on the premise of using AI as a tool governed by humans. This study sheds light on the approaches of treating AI as a physical phenomenon and an extension of humans, and shows that these approaches give rise to problems of a different kind. In particular, when we treat AI as an extension of humans, it will be important to consider how AI and humans create knowledge and how humans can learn from AI. AI is producing better results than humans in various fields. In the future, interaction with AI can be expected to improve human's ability to investigate "causes" and develop "reasons."

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Endnotes

[1] Issei Yamamoto, Developer of Shogi Program "Ponanza", Specialty Appointed Associate Professor at Aichi Gakuin University, Research Associate at Research Center for Advanced Science and Technology of Tokyo University, Lead Engineer at HEROZ, He started developing Shogi program Ponanza while he was a student in the Faculty of Engineering, University of Tokyo. The program became the first Shogi AI to defeat an active professional Shogi player in a public match in the Shogi Den-o Sen event held in 2013. In the 2017 Shogi Den-o Sen, it defeated an active professional "Meijin" for the first time.

[2] This case study is based on Issei Yamamoto's lecture (held at Tokyo Metropolitan University Akihabara Campus) on September 22, 2017, a private interview with him on the same day and his book.

[3] Yamamoto, 2017, Ch. 1, Sec. 3, Para. 5

[4] For instance, making computer-based calculations about the quality of a situation is considered more difficult and tough to handle in Shogi than in Chess. In chess, the presence or absence of pieces on the board is directly related to how good or bad the phase is and can be represented more easily in the form of logic. However, in Shogi, the positioning of the pieces determines the quality of the situation and is therefore difficult to represent in the form of logic. (Yamamoto, 2017, Ch.1, Sec.10).

[5] Yamamoto, 2017, Ch. 5, Sec. 1

[6] Retrieved February 20th,2018, "Ponanza Document (2010) http://www.computer-shogi.org/wcsc20/appeal/Ponanza/Ponanza.pdf"

[7] Yamamoto, 2017, Ch. 1, Sec. 12, Para. 7

[8] Yamamoto, 2017, Ch. 1, Sec. 13

[9] This refers to the magic used by witches to make mysterious medicines in the world of fairy tales and fantasy. (Yamamoto, 2017, Ch. 2, Sec. 1, Para. 2)

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