Comparing the Credibility of Experiential Knowledge and Algorithms in Decision-Making Processes

Nanami Kuwahara, Takayuki Fujimoto

***Abstract*—**When people face difficult problems, they tend to rely on advice derived by algorithms to solve them. This is evident in how people readily trust and depend on algorithms when in an unfamiliar area or when dealing with generally complex issues. For example, this can be seen in the use of car navigation systems. Even on known routes, it is not uncommon for people to people follow alternate paths suggested by navigation systems, resulting in inefficient driving. Today, it is difficult for us to resist information presented by algorithms. Therefore, this research focuses on the relationship between humans and algorithms, examining under what conditions dependence on algorithms occurs. This was tested through automobile driving experiment.

***Index Terms*—**Artificial Intelligence, Car navigation systems, Credibility of algorithms, Human experiential knowledge

I. Introduction

A. Background

When facing difficult tasks, it is common for people to rely on advice from others or existing data to make judgments. Digital technology plays a major role in our modern society, and there is an increasing tendency to defer various judgments to computers by utilizing devices like smartphones. For example, when interpreting academic papers in English containing technical terminology, users not proficient in English may utilize automated translation services to better comprehend the papers. Also, in online shopping, purchase history analyses are performed to provide product recommendations. Furthermore, content generated by AI like ChatGPT is sometimes regarded as not only more efficient, but also of higher quality than what we can produce ourselves.

However, there are concerns about people becoming overly dependent on artificial intelligence and blindly trusting its judgments. Certainly, it is groundbreaking that papers previously requiring tedious translation can now be read in one's native language just by copying and pasting text. However, this does not necessarily make the effort and process of translating each sentence by hand redundant. Rather, exerting this effort could improve users' language skills and comprehension. Thus, while computer technology (AI) advancements have improved efficiency and convenience, there are cases where people overly rely on machines, trusting them beyond their own capabilities.

This tendency also applies to internet searching. Previously, when looking up information online, it was generally recommended that we do not take things at face value, but that we emphasize verification, consideration, and skepticism. Recently, however, there has been a trend towards misunderstanding online information as an unquestionable truth, along with a loss of ability and skills to verify information.

This paper focuses on car navigation systems as an example of relying on machines for choices and decision-making. Typically, car navigation systems propose routes calculated by the route search algorithms of each product or application. However, the routes "recommended" by these navigations are not necessarily the "optimal" ones for the driver. If route searches are performed for the same origin and destination for all drivers, usually the same route is shown. In other words, user-specific factors are not considered regardless of whether it is the first or multiple route searches. Furthermore, the outputted route may not suit the user's preferences and requirements. Each driver has their own route selection criteria, whether it prioritizes efficiency or preferring less crowded roads. Reflecting these choices requires the use of applications tailored to individual needs.

Additionally, some drivers cannot remember routes even on roads they have traveled many times, feeling anxious and frequently performing route searches. Furthermore, there are cases of persistent dependence on machines without cultivating the ability to find optimal routes themselves. On the other hand, there are also drivers who do not need car navigation, and prefer to reach destinations under their own power without using navigation.

As illustrated above, the development of digital technology and artificial intelligence in modern society influences people's judgements and decision-making, and it is clear that some people have become overly dependent on machines. Therefore, this study uses "car navigation systems" to examine the impact algorithms have on humans in order to understand people's dependence on machines and the relationships involved.

Manuscript received November 26, 2023.

Nanami Kuwahara is with the Graduate School of Information Sciences and Arts, Toyo University, Kawagoe, Saitama 350-8585, Japan (e-mail: kuwahara.nnm@gmail.com).

Takayuki Fujimoto is with Information Sciences and Arts, Toyo University, Kawagoe, Saitama 350-8585, Japan (e-mail: Fujimoto@toyo.jp).

B. Purpose

Coexistence with computers and algorithms has become indispensable in modern society. Our daily lives are becoming increasingly dependent on algorithms, from simple to complex problems. In recent years, there are cases where we rely on computers even for easy problems that we previously dealt with on our own. For example, we may be quick to look up simple matters, like an omelet recipe or how long to boil broccoli, instead of figuring it out intuitively and experientially as anyone could do. Our lifestyles are overly reliant on the information algorithms provide, even in situations requiring human experience and intuition.

This paper hypothesizes that we, living in an age dominated by algorithms, tend to trust the results calculated by algorithms over our own, presumably more reliable, experiences. and verifies this through simple experiment.

This study compares routes selected by subjects based on experience versus routes derived by car navigation system algorithms in driving situations. It compared which routes were more effective for the subjects in terms of convenience and rationality.

Furthermore, it compared the differences in driving feel between experiential and algorithmic routes, and examined awareness of algorithms and their use.

II. Related Research

This chapter describes the current state of analogous studies related to the credibility of algorithms, approaches to navigation systems when driving, and other relevant topics. It then discusses the novelty and significance of the present research.

A. Humans rely more on algorithms than social influence as a task becomes more difficult

Research from the University of Georgia has shown that people tend to trust algorithms more than other humans when tackling difficult tasks. In this experiment, subjects were given the task of counting the number of people in photos. They were provided with two options - advice from an algorithm and the average from other subjects. The results showed that as task difficulty increased, subjects relied more on the algorithm's advice, demonstrating greater trust in algorithms over other humans. This phenomenon was evident when the task was perceived as objectively difficult or when computers were thought to excel at counting problems.

The present study compared human and algorithm behavior for difficult human tasks. The results suggested that as tasks become more difficult, humans are more likely to trust algorithms. However, overconfidence in AI and algorithms also carries potential risks. There are concerns that dependence on algorithms increases in situations that are challenging for humans, such as requiring specialized knowledge or processing large amounts of data.

Therefore, the authors hypothesized and investigated something different from this research. We considered that individuals' overreliance and overconfidence in algorithms exist even for simple tasks. Thus, we planned an experiment giving subjects simple tasks and providing algorithm advice. Through this experiment, we will investigate the degree to which people trust algorithms.

B. Current Car Navigation Applications

Currently, various route guidance application services like Google Maps and Waze are provided. These systems utilize accumulated user data to analyze mobility histories and trends for improving navigation accuracy. Beyond simple route guidance, algorithms are incorporated that record actual traveled routes and propose similar routes for next times. The algorithms present multiple routes deemed "optimal" for everyone and provide navigation.

On the other hand, improving navigation system accuracy through big data utilization can also lead to unexpected route guidance for drivers. For example, when prioritizing arrival at the destination, Google Maps may suggest routes that are legally passable but difficult for vehicles. Also, around destinations it may recommend approaching from a back entrance rather than the main one, or require researching the current position when deviating from set routes, possibly confusing drivers. While car navigation applications are convenient, they have issues like inability to guide accurately to entrances and susceptibility to signal conditions.

III. Experimental Method

When people drive to unfamiliar places, car navigation systems are helpful for them. On the other hand, once they get used to using navigation systems on a regular basis, many end up searching for routes even in familiar areas by force of habit. It is likely that a considerable number of people think that there may be slightly faster or time-saving routes. This senses probably arises from our excessive expectations towards information provided by algorithms.

This experiment compares the route based on the driver's own experience (hereinafter "Experience Route") and the route recommended by the car navigation system algorithm (hereinafter "Algorithm Route"). We examine the analysis in respect of both the participants' subjective evaluations and actual time required for the routes. One vehicle and the car navigation function of Google Maps are used for the experiment.

Target subjects are the people who regularly drive. This is because people who do not usually drive may lack of sufficient experience. The use of Google Maps aims to avoid difference caused by subjects' owned navigation systems and unify the map application for each subject.

In this experiment, differences in traffic conditions between routes will not be taken into account. While traffic volume fluctuates with weather, time slot or which day of the week, equalizing conditions completely is difficult. The ultimate purpose is not to compare travel times, but to compare the subjects' impressions of the routes. Because of this, slight differences in traffic volume are acceptable. Beforehand, subjects are noted that they are to try to reach the destination as promptly as possible.

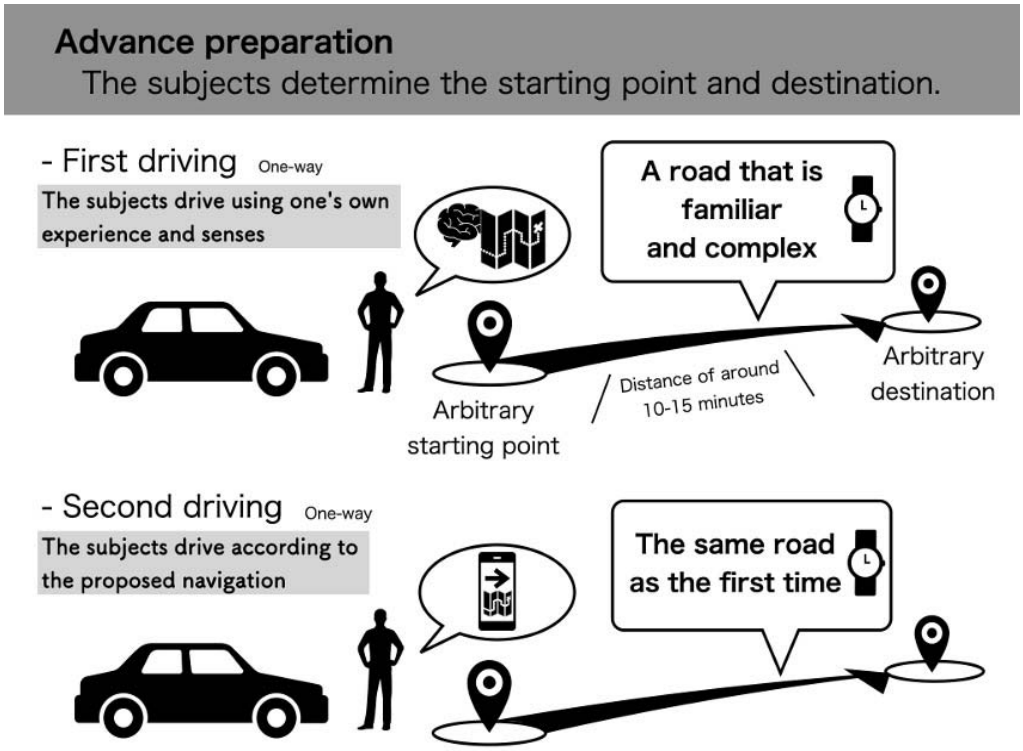

Fig.1. Driving Experiment Protocol

The specific flow of the experiment is as follows: First, subjects set a starting point and destination in a region that they regularly drive around. The subjects are to select a destination where multiple routes are possible to reach. In line with this, the subjects are to avoid simple destinations and routes involving only single road. Next, the subjects drive Experience Route and record the driving time and the actual route on a map based on their experience and intuition. Then, subjects drive and record the Algorithm Route for the same starting point and destination. If multiple routes are suggested by the navigation, the one with the earliest estimated arrival time will be selected.

The estimated required time to travel from starting point to destination is set to be at least 10 minutes. It is because differences in route selection may not appear, if the in-between distance is too short.

IV. Experimental Results

Driving experiment were conducted with five subjects using their owned vehicles. Since "driving" involves subjective judgments like individual ability and experience, the drive times of each subject were at first measured and compared. Next, after driving two different routes, each of the subjects evaluated impressions toward those routes.

A. Driving Times

The results of the measured driving times are shown in Table 1. The first try is the driving Experience Route based on the subject's experience, and the second try is the driving with the instructions for Algorithm Route suggested by car navigation systems. Comparing the driving times of both routes (Figure 2), with four out of five subjects, Algorithm Route took longer than the Experience Route. When driving the Experience Route, most subjects could reach the destination faster than the Algorithm Route. The biggest time difference between the two kinds of routes is 6 minutes 24 seconds as for the case of Subject 3. Also, regarding differences in other cases, Subject 1 has a 5 minute 35 second, Subject 2 has 1 minute 20 seconds, and Subject 5 has 6 minutes 12 seconds. with those cases, Experience Route was also quicker than the Algorithm Route. However, only with the case of Subject 4, he recorded a shorter driving time for the Algorithm Route, with a difference of 2 minutes 20 seconds. In any case, there was 1 to 6 minutes difference in driving times between the Experience Route and Algorithm Route.

Table 1 Driving times for Experience Route and Algorithm Route

	Experience Route	Algorithm Route	Difference
Subject 1	35'40"	41'15"	-5'35"
Subject 2	19'17"	21'00"	-1'20"
Subject 3	13'19"	19'43"	-6'24"
Subject 4	12'20"	10'00"	+2'20"
Subject 5	17'36"	23'48"	-6'12"

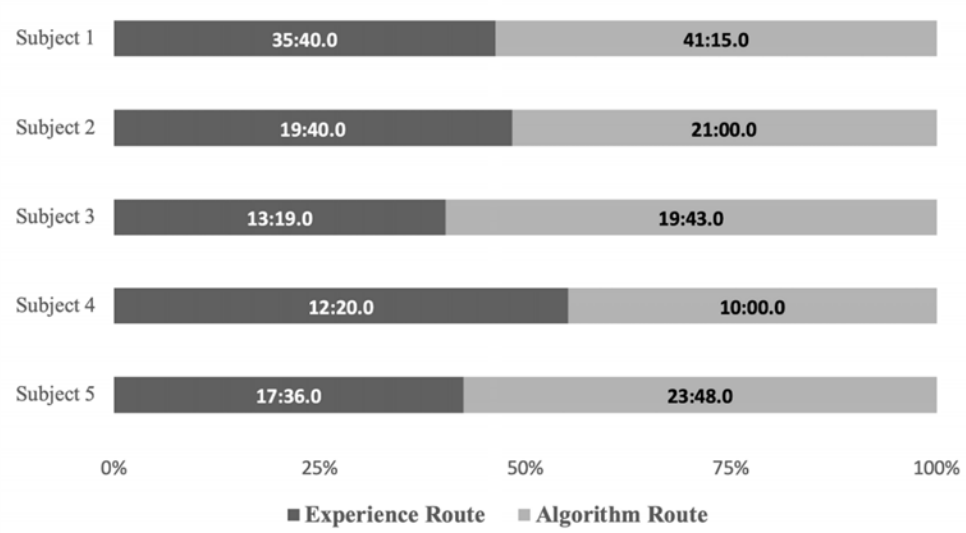

Fig. 2. Experience Route vs. Algorithm Route: Driving Times

B. Impression Evaluations

In addition to measuring driving times of the two different routes, impression evaluations were conducted for the Experience Route and the Algorithm Route. The subjects were asked to provide free-form responses about their thoughts and impressions of the two kinds of routes after driving them. As hints for their responses, there were presented two topics: 1.) comments on their thoughts while driving each route and 2.) which route they would want to take in the future for the same destination. The evaluation results are shown in Table 2.

Subject 1 arrived at the destination faster when taking the Experience Route. In daily life, Subject 1 intentionally deviates from main roads and uses backroads to avoid traffic jams and waiting for the traffic lights to change. Subject 1 does not think the recommended routes from the car navigation system are necessarily optimal or fastest, and answered he/ she would not use the system in local areas. The given reason was that navigation sometimes suggests roads with heavy traffic and many traffic lights, but Subject 1 wants to drive based on his/ her own experience according to on-the-spot traffic conditions. However, Subject 1 added that Subject 1 would follow navigation instructions depending on the situation.

Subject 2 also had a shorter driving time with the Experience Route comparing with the Algorithm Route. Subject 2 said that he/ she initially thought that he/ she could arrive faster by following the navigation instructions. However, Subject 2 was guided to multiple unexpected roads and felt difficulty in actual driving. Subject 2 drove the Algorithm Route with questions and arrived later than driving with the Experience Route. Subject 2 reported that the navigation instructions did not match his/ her actual driving situation.

Subject 3 had the biggest difference in arrival times between the Experience Route and the Algorithm Route. Subject 3 felt the Experience Route was a fast, reassuring route. In contrast, he/ she felt uneasy while driving the Algorithm Route, having to check the roads each time the navigation gave instructions. Besides, while the Experience Route was complex with many pedestrian-control signals, the Algorithm Route consisted of main streets with fewer traffic lights. Due to decreased trust in car navigation systems from past experiences, Subject 3 responded that he would like to continue selecting the Experience Route for future car rides.

Among the five subjects, Subject 4 was the only one with a shorter Algorithm Route driving time, versus the Experience Route. However, Subject 4 insisted that normally Subject 4 can arrive faster with the Experience Route. He/ she explained that it is possible to take “routes by the roads which are not registered” that is not suggested by navigation, and this enables the Experience Route to be quicker. However, this time, Subject 4 did not take the possible fastest route as Experience Route, it resulted in a later arrival.

Subject 5 arrived at the destination faster when driving the Experience Route compared to the Algorithm Route. According to Subject 5, the Algorithm Route suggested roads that he/ she drove for the first time. He reported that what was outstanding with Algorithm Route, traffic on the guided roads started getting congested while driving, and the route took more time than the Experience Route. Therefore, Subject 5 responded that he/ she would continue using Experience Route rather than the Algorithm Route in the future.

Looking at the impression evaluations by the five subjects, there were many affirmative responses for Experience Route. On the other hand, regarding the Algorithm Route, the subjects had negative impressions like uneasiness or short of expectations. Some described that they did not want to drive Algorithm Route for the same destination in the future. Some subjects seemed to be skeptical about Algorithm Route: algorithmic suggestions from the beginning, and they reported that they drove the recommended route with questions. While major responses expressed concerns about Algorithm Route, there was also a response indicating the possibility of simply following it. As a result, at least for local areas, the desire to

drive without relying on algorithms was indicated.

TABLE II IMPRESSION EVALUATIONS OF THE TWO KINDS OF ROUTE

Subject 1	The navigation instructions may not avoid crowded roads or the roads with few signals (, which means narrow roads). It is often quicker to take the routes, which are different from the routes suggested by the navigation system. If the traffic volume is not so heavy, I may follow the suggested route. Otherwise, I would probably just drive adaptively on the spot.
Subject 2	The navigation showed me a route different from the one I know, and initially it seemed like it would be faster. But when I actually followed it, there were multiple confusing points, for example, the difficult roads to pass through with my car and back streets, so I ended up having trouble to smoothly drive at times. If there is no those difficulty, the suggested route might be faster, but the route was actually complicated in reality, taking more time than expected.
Subject 3	The Experience Route gave me more a sense of relax and speed. With the Algorithm Route, I had to check at each fork of a road, thinking "is this the right way to go?" or "can I really arrive at my destination taking this way?" Although I thought I would finally arrive, following the navigation, I felt a little uneasy because I am used to take the Experience Route by habit. So, I think I'll continue to use the Experience Route in the future. In terms of road differences, the Experience Route was clearly worse roads. I took my Experience Route going through residential areas. On the other hand, the navigation route was almost made of only wide streets. I don't remember the exact number of signals which I have seen, but I think the navigation route had fewer (the Experience Route had many pedestrian-control signals). In the past, Google Maps navigation guided me on extremely dangerous roads without consider the balance of road and car width. From that experience, I usually try to take more familiar roads when it is possible.
Subject 4	I think my own route is faster. Although I didn't do it this time, usually I take a shortcut through supermarket parking area to avoid heavy traffic, so I think I can arrive faster with my own route, than with the navigated route.
Subject 5	The roads guided by the navigation were ones I drove for the first time. The navigation route was not crowded when I just departed, but it started getting crowded as I kept going, and it actually took 6 minutes more than my usual route.

V. DISCUSSION

From the results, it was found that people feel uneasy and skeptical when guided on roads that they have no experience with. In particular, as to Subject 2 and Subject 3 seem to have dissatisfaction towards the Algorithm Route and car navigation systems. The Algorithm Route did not seem to make arrival time earlier because the navigation systems simply suggested the "fastest routes" without considering the size of the driven car or the driver's driving skills. Furthermore, it became clear that the subjects felt anxiety about entrusting all driving judgments to the algorithm. Navigation use is suitable when heading to unfamiliar destinations. On the other hand, when the drivers have a little knowledge on roads to a destination, such as in local areas, navigation instructions should not be necessarily followed.

Subject 1's reported that he/ she incorporated his/her own driving style into the Algorithm Route after autonomously judging road congestion. It suggests the possibility of merging the Experience Route and Algorithm Route. Even under the condition one never knows whether a route is good or bad before actually driving it, the way to use navigation while drawing on one's own experience, can work as an alternative choice. For example, Subject 5 was guided to unfamiliar roads that he/she had never driven before, and it resulted in a longer driving time of the Algorithm Route. Even with unknown roads that he/she did not know traffic tendency, congestion could have been possibly avoided, if he/ she could made most advantage of experience and sense as to driving.

Furthermore, Subject 4's response indicates that drivers may use their own unique driving routes beyond the scope of car navigation, utilizing unregistered places and alleys or taking a shortcut. It seems that drivers' experience and judgement complementing the information that is not input to car navigation can produce better results.

In summary, regarding the impression evaluations by the five subjects, it appears that they directly recognized the importance of taking a flexible judging approach based on their own experience and on-the-spot circumstances rather than completely relying on navigation systems. The subjects determined that simply following navigation is not the optimal choice, because of changing traffic conditions on moment-to-moment basis, and from their individual driving experiences. In other words, 'better driving' requires driver experience and his/ her autonomous judgement depending on each situation, instead of just simply depending on navigation without questioning. Some subjects raised question about the algorithmic suggestions after actually comparing the Experience Route and the Algorithm Route in this experiment, while others considered previous instances of trusting the algorithm with unsuccessful results. This experiment results demonstrate that incorporating human experience and judgement, which is not just pursuing algorithms, can yield better outcomes. Additionally, it is thought that balance between algorithm use and human sensation is essential to the judgements for efficient driving.

VI. Conclusion and Future Works

In the experiment of this study, the subjects drove their own route based on driving experience, and an algorithm route suggested by car navigation, and authors compared their impressions toward the two kinds of routes. The research aim was not to evaluate navigation performance, but to clarify how users utilize navigation. The focus of this experiment is not 'system performance improvement,' but the driver's autonomous judging ability.

By exploring people's tendencies when they face algorithm results, 'what kind of applicable potentials algorithm-use has' was demonstrated. By evaluating subjective post-drive impression in addition to driving time, we could analyze their route selection tendencies from different perspectives.

While there are algorithms everywhere in people's daily life, we need to reconsider their role, and deliberately select the way to utilize them. The proliferation of Large Language Models (LLMs) and other technologies has enabled people to solve complex problems easier. However, in response to the rise of these technologies, humans need to be more conscious of experience and intuition than ever before.

Future works mainly indicate to maintain 'capabilities inherent to human' in the face of increasing reliance on algorithms. The driving experiment results confirm that humans' skills based on experience, intuition, or judgement cannot be replaced by algorithms. Such capabilities should be valued highly. To that end, regular opportunities to leverage experience or intuition in daily life are in need. For example, as to driving, gradually accumulating experience and sharpening sense from local areas is considered natural.

In this way, as future works, we are required to create mechanisms, methods, and environments that can foster and maintain human experience and senses. These days algorithms potentially can be used to replace even simple human tasks. Retaining "humanness" will be a crucial factor to coexist with algorithms.

References

[1] E. Bogert, A. Schecter, R. T. Watson. (April 2021). Humans rely more on algorithms than social influence as a task becomes more difficult. *Scientific Reports*. 11(8028). pp.1-9. Available: https://doi.org/10.1038/s41598-021-87480-9

[2] M. Schemmer, P. Hemmer, N. Kühl, C. Benz, G. Satzger. (April 2022). Should I Follow AI-based Advice? Measuring Appropriate Reliance in Human-AI Decision-Making. *arXiv:2204.06916*. pp.1-10. Available: https://doi.org/10.48550/arXiv.2204.06916

[3] T. Katase, "Development of a Trust Scale for Artificial Intelligence (AI) and Examination of its Reliability and Validity - Cohort analysis of gender and age by national Web survey -," *Research Repor*t of *the Japan Society for Educational Technology*, 2021, vol.3, pp.172-179, Available: https://doi.org/10.15077/jsetstudy.2021.3_172

[4] S. Takeuchi, Cooperative Game AI benefiting from Advice, *The 21st Game Programming Workshop 2016*, 2016, pp.21-27, Available: http://id.nii.ac.jp/1001/00175299/

[5] J. Ito, J.Howe, Whiplash: How to Survive Our Faster Future, *Grand Central Publishing*. 2016

[6] R. Kanzaki, R. Nakajima, A. Inoue, R. Tanaka, M. Kojima, Effect on reliability given by consideration of artificial intelligence judge, *The 33rd Annual Conference of the Japanese Society for Artificial Intelligence*, 2019. Vol.33, pp.1-4, Available: https://doi.org/10.11517/pjsai.JSAI2019.0_2G5J1301

[7] K. Nakamura, Toward Unification of explainability and Uncertainty for Artificial Intelligence, *Special Interest Group on Fundamental Problems in Artificial Intelligence*, 2023, pp.29-34, Available: https://doi.org/10.11517/jsaifpai.125.0_29

[8] S. Kurohashi, Information Credibility Criteria Project, Artificial Intelligence (November 2008), Vol. 23, No. 6, pp.783-790, Available: https://doi.org/10.11517/jjsai.23.6_783

[9] S. Nakamura, Trustworthines Analysis of Web Search, Artificial Intelligence (November 2008), Vol. 23, No. 6, pp. 767-774, Available: https://doi.org/10.11517/jjsai.23.6_767

[10] H. Oiwa, Y. Suhara, H. Awashima, Toward resolving decision-making biases for deploying artificial intelligence technology, The 31st Annual Conference of the Japanese Society for Artificial Intelligence, 2017, Vol. 31, pp. 1-4, Available: https://doi.org/10.11517/pjsai.JSAI2017.0_1E1OS24a4

[11] Y. Kuniyoshi, On the Future of Al and Human/Society, *Journal of Science and Technology Studies* (September 2018), No. 16, pp. 15-29, Available: https://doi.org/10.24646/jnlsts.16.0_15

[12] A. Ema, K. Nagakura, T. Fujita, Questionnaire Survey Investigating Trust in Medical AI, *The 34th Annual Conference of the Japanese Society for Artificial Intelligence* (2020), Vol. 34, pp.1-2, Available: https://doi.org/10.11517/pjsai.JSAI2020.0_4N3OS26b01

[13] R. F. Kizilcec, How Much Information? Effects of Transparency on Trust in an Algorithmic Interface, *CHI '16: Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, May 2016, pp.2390-2395, Available: https://doi.org/10.1145/2858036.2858402

[14] T. Miller, Explanation in artificial intelligence: Insights from the social sciences, *Artificial Intelligence*, February 2019, Vol. 267, pp.1-38, Available: https://doi.org/10.1016/j.artint.2018.07.007

[15] R. Confalonieri, L. Coba, B. Wagner, T. R. Besold, A historical perspective of explainable Artificial Intelligence, *WIREs Data Mining and Knowledge Discovery*, October 2020, Vol. 11, No. 1, pp.1-21. Available: https://doi.org/10.1002/widm.1391

[16] T. Araujo, N. Helberger, S. Kruikemeier, C. H. de Vreese, In AI we trust? Perceptions about automated decision-making by artificial intelligence, *AI & SOCIETY*, January 2020, Vol. 35, pp.611-623. Available: https://doi.org/10.1007/s00146-019-00931-w

[17] T. Nishida, Information and Communication Technology for augmenting human and society potential The Role of artificial intelligence, *Journal of Information Processing and Management*, November 2014, Vol.57, No. 8, pp.517-530, Available: https://doi.org/10.1241/johokanri.57.517

Nanami Kuwahara became a Member (M) of IAE in 2023. She was born in Japan in 1998, on July 21. She received the B.S. degree in informatics from Toyo University, Tokyo, Japan in 2021. She received the M.S. degree in informatics from the Graduate School of Information Sciences and Arts, Toyo University, Tokyo, Japan in 2022. She is currently in her second year of the Ph.D. program at the Graduate School of Information Sciences and Arts, Toyo University, Tokyo, Japan.

Since 2023, she has been a Part-Time Lecturer with Toita Women's College, Tokyo, Japan and Shukutoku University, Chiba, Japan. Her research interests include social networking systems and media design.

Ms. Kuwahara is a Member of IEEE.