Artificial Intelligence and Human Intelligence

— On Human-Computer Competition from the Five-Level Theory of Cognitive Science

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Abstract: It is generally accepted that the human mind and cognition can be viewed at five levels; nerves, psychology, language, thinking and culture. Artificial intelligence (AI) simulates human intelligence at all five levels of human cognition, however, AI has yet to outperform human intelligence, although it is making progress. Presently artificial intelligence lags far behind human intelligence in higher−order cognition, namely, the cognitive levels of language, thinking and culture. In fact, artificial intelligence and human intelligence fall into very different intelligence categories. Machine learning is no more than a simulation of human cognitive ability and therefore should not be overestimated. There is no need for us to feel scared even panic about it. Put forward by John R. Searle, the "Chinese Room" argument, a famous AI model and standard, is not yet out of date. According to this argument, a digital computer will never acquire human intelligence. Given that, no artificial intelligence will outperform human intelligence in the foreseeable future.

Keywords: human mind; human cognition; human intelligence; artificial intelligence (AI); cognitive science

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* Foundation item: This paper is included in "Higher−order Cognitive Studies at the Levels of Language, Thinking and Culture" (Reference number: 15ZDB017) and "Neural mechanism Studies in Human Brain's Processing of Non−literal Elements in Chinese Language" (Reference number: 14ZDB154), both of which are major programs of National Social Sciences Fund.

Recently, the human-computer competition (Lee Sedol vs. Google's AlphaGo)① has triggered heated debates in the academic circles and attracted much attention from the decision-making level of China. Regarding this event, there are a variety of views, opinions and comments. Some are insightful, while others simply miss the point. Worse still, there are views, intentionally or unintentionally, exaggerating the role and significance of machine intelligence and even publicizing the end of human history and doomsday, which is of course not to be taken seriously. Such exaggerated and shocking statements are wrong in the sense that they cannot provide a correct understanding of artificial intelligence and human intelligence particularly at the levels of language, thinking and culture.

Based on Cai Shushan's five-level division of the human mind and cognition (2015, 2016), machine intelligence (artificial intelligence) and human intelligence can be understood and differentiated at the five levels of nerves, psychology, language, thinking and culture. This is to help find correct answers and proper solutions to human intelligence's competition with artificial intelligence.

1. Five levels of human cognition

Figure 1 is a well-known disciplinary structure of cognitive science.

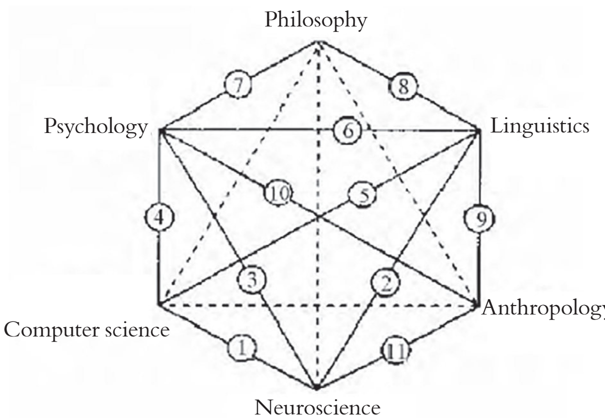

Fig. 1 Disciplinary structure of cognitive science (Pylyshyn, 1983, p.76)

This figure displays cognitive science's disciplinary structure and relationships. It does not include cognitive science's research objects or their relationships, because the research objects of cognitive science are not the above listed subjects of philosophy, psychology, linguistics, computer science, anthropology, or neuroscience. Instead, the research objects of cognitive science are the human mind and cognition. What are the connotations of the human mind and cognition? What are their relationships?

In our previous papers, published since 2015, the five levels of the human mind and cognition have been proposed. From elementary to advanced, human mental evolution undergoes the five hierarchical levels of nerves, psychology, language, thinking and culture. As human cognition is defined by the human mind (Cai, 2009), the former also has a development process comprising five hierarchical levels such that human cognition includes neural-level cognition, psychological-level cognition, linguistic-level cognition, thinking-level cognition and cultural-level cognition, which can respectively be referred to as neural cognition, psychological cognition, linguistic cognition, thinking cognition and cultural cognition. The five levels of cognition

① From March 9 to 15, 2016, Lee Sedol played the "Match of the Century" with Google's AlphaGo, losing the fivegame matches with a 4–1 score. While triggering heated debates in the academic circles, this event has also attracted much attention from relevant government authorities and the decision–making level of the Chinese Central Government. On March 15, 2016, a notice was jointly released by the General Office of the CPC Central Committee and the Ministry of Education, asking relevant experts in this field to offer advice, a precise definition of artificial intelligence and corresponding measures and solutions to the decision–making level for reference. This paper is an expansion of the adversary report submitted by the author. Based on the principles of cognitive science and the five levels of human cognition proposed by the author, this paper attempts to clarify a series of major theoretical issues, such as the essential difference between artificial intelligence and human intelligence.

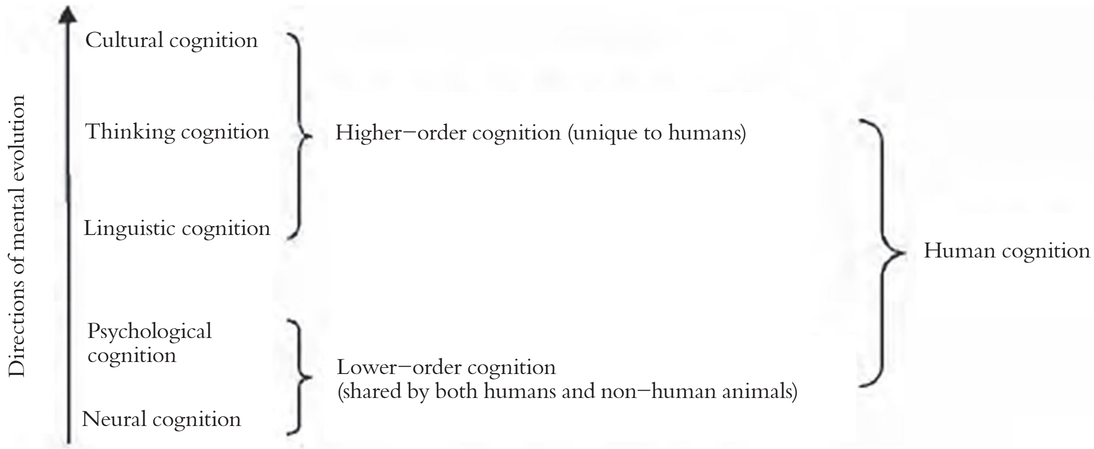

Fig. 2 five levels of human cognition

are the retentions of cognitive abilities at each stage of human mental evolution. All human cognitive activities are and must be covered by the five levels. Shared by humans and non-human animals, neural cognition and psychological cognition are of a "lower-order cognition" category, while linguistic cognition, thinking cognition and cultural cognition are unique to humans, for which they are identified as "higher-order cognition." The five levels of cognition form a sequence as shown in Fig. 2. In this sequence, lower levels of cognition form the basis for higher levels of cognition. Lower levels of cognition determine higher levels of cognition, while higher levels of cognition cover and influence lower levels of cognition (Cai, 2015).

Among the five levels of human cognition, linguistic cognition is of special significance. After all, it is language that distinguishes human cognition from animal cognition. From a perspective of evolution, the three breakthroughs of human evolution, i.e. walking upright, the utilization of fire and the development of language changed the direction of human evolution, facilitating our ancestors' transition from ape to man. Walking upright significantly expanded the scope of human activity from jungles to plains. Also, the liberated forelimbs were used for fruit-picking and hunting, thus enriching the variety of food sources. The utilization of fire enabled human beings to enjoy the meat of other animals. The intaking of foreign protein increased human cranial capacity to an unprecedented level and at the same time significantly improved human cognitive capacity. The development of language is key to human evolution. First, the adoption of ideographic symbols and words transformed human experience into cognition and developed them into culture. Since then, human evolution was no longer restricted to the genetic realm, but became a process involving language, knowledge and culture.

Second, it is language that made human thinking possible. Human language competence is manifested in its generation and adoption of abstract ideas in a metaphorical approach, and its judgment and reasoning based on such abstract ideas. Through judgment and reasoning, human beings can make decisions and perform a diversity of thinking activities concerning mathematics, physics, philosophy, literature, history, arts, etc. The entire human society is the outcome of language application and mental activity. As the renowned French mathematician, logician and philosopher René Descartes put it, "Cogito ergo sum" (I think, therefore I am), which means human thinking is a prerequisite for human existence. The Sapir-Whorf hypothesis is arguably the most important theoretical hypothesis concerning language and thought in the 20th Century. Its view that language determines thought mainly consists of two aspects. The first aspect is linguistic determinism, meaning that language determines non-language processes. It is impossible to learn the language of a different culture unless the learner abandons his or her own mode of thinking. The second aspect is linguistic relativity, which means all higher levels of thinking are dependent on language. Because languages differ in many ways, Whorf believed that speakers of different languages perceive and experience the world differently, that is, relative to their linguistic background. Within the framework of the abovementioned five levels of human cognition, the Sapir-Whorf hypothesis is fully and thoroughly interpreted.

Third, language and thinking are combined to form knowledge and knowledge can develop into culture. For non-human animals each generation, even each individual, has to gain experience independently, for which their evolution can only be gene-based. By contrast, most human knowledge comes from indirect knowledge created, accumulated and passed on by their predecessors. Because of this, human evolution goes beyond the genetic level and is more about knowledge evolution. The emergence and application of language and writing systems marked the beginning of a rapidly changing era in human history. Prior to that, human evolution, just like that of non-human animals, could only make a breakthrough per thousand years, or per tens of thousands of years.①

Fourth, the "limits of my language mean the limits of my world." Throughout the 20th Century, Western philosophy saw the successive rise of three major philosophical trends; analytic philosophy, philosophy of language and philosophy of mind, whose representatives were Ludwig Wittgenstein, Noam Chomsky, as well as John Langshaw Austin and J. R. Searle. Two of Wittgenstein's major works, *Logico–Philosophical Treatise* (1921) and *Philosophical Investigations* (1953) laid bases for analytic philosophy and the philosophy of language. These epoch-making works explored philosophy through different approaches. As Wittgenstein (2004) put it, "The 'speaking' of language is part of an activity, or form of life (p. 17)." "The meaning of a word is its use in the language (p. 31)." "Philosophy is a battle against the bewitchment of our intelligence by means of language (p. 71)." He (2009) considered all philosophies to be a "criticism of language (p. 42)." "The limits of my language mean the limits of my world (p. 85)." Therefore, "Whereof one cannot speak, thereof must one be silent (p.105)."

Fifth, language constructs social reality. *Chomsky's Syntactic Structures* (1957), R. Montague's *Formal Philosophy* (1974) and J. L. Austin's *How to Do Things with Words* (1962) respectively started the studies of syntax, semantics and pragmatics in modern linguistics. The three basic approaches of modern language research and linguistic studies have been extensively adopted by a range of subjects, such as psychology, sociology, politics and arts (Cai, 2006). John R. Searle is a world-renowned scholar in philosophy of language and philosophy of mind, who has made distinguished contributions to these two realms. Searle has had a number of related

① For more information about the impacts of human speech and language application and writing–system introduction on human cognitive capacity, please refer to Roco M C & Bainbridge W S (eds.), Cai Shushan, et al. (trans.) *Converging Technologies for Improving Human Performance: Nanotechnology, Biotechnoloogy, Information Technology and Cognitive Science*, Beijing: Tsinghua University Press, 2010: 32 (Fig. 3).

works published, including *Speech Acts: An Essay in the Philosophy of Language* (1969), *Expression and Meaning: Studies in the Theory of Speech Acts* (1979), *Intentionality: An Essay in the Philosophy of Mind* (1983), *Foundations of Illocutionary Logic* (1985), *The Mystery of Consciousness* (1997), *The Construction of Social Reality* (1995), *Mind, Language and Society: Philosophy in the Real World* (1998), *Mind: A Brief Introduction* (2004) and *Making the Social World: The Structure of Human Civilization* (2010). Through these works, he was able to develop a series of key theories concerning language, mind and cognition. Among his multiple theories are speech act theory, illocutionary logic, theory of intentionality, theory of consciousness, theories of mind and cognition, as well as theory of language-enabled social reality construction. Regarding language-enabled social reality construction, based on speech act theory, pragmatics, philosophy of language and philosophy of mind, John R. Searle proposed to use language to construct the entire human society. This enlightening theory triggered extensive concerns among scholars and people from all walks of life. In fact, regarding the language-enabled social reality construction, I once had a dialogue with Prof. Searle, who was then chairing a forum at Tsinghua University at invitation. According to Searle:

> From a perspective of social ontology, human society is constructed and keeps being passed on by language. Like DNA in the biosphere, there are universal rules in human society, which are constructed by language. The detailed differences between the human mind and non−human animal minds remain unclear. Nevertheless, there is bound to be defining features that distinguish human language from non−human animal language. Non−human animal language can be used for expression, while human language can be used for representation, i.e. the construction of social reality (Ma, 2007).

Based on the five levels of human cognition and the above analysis, we conclude that language is the basis of the human mind, that language determines human thinking and the way humans learn the world and that, "The limits of my language mean the limits of my world." Without language, humans cannot learn about the world, or do little of anything else.

2. Computer science and artificial intelligence in the eyes of cognitive scientists

Regarding cognitive science, there are two schemata. One is "subject schema" (see Fig. 1), which is designed based on the source subjects of cognitive science and is in accordance with relevant subject standards. The subject schema illustrates the relationships among the source subjects and the interdisciplinary subjects. The other is "scientific schema" (see Fig. 2), which is designed based on the five levels of human cognition and is in accordance with human cognitive processes. The scientific schema illustrates the relationships among the research objects of cognitive science.

Computer science, being one of the six major source subjects of cognitive science, is included in the scientific schema of cognitive science. Moreover, as one of the six pillar subjects based on the interdisciplinary combination of computer science and cognitive science, artificial intelligence is also a mainstream subject of cognitive science. However, neither computer science nor artificial intelligence is included in the five levels of cognitive science, i.e. the scientific structure of cognitive science. How can this happen?

First of all, when it comes to the relationships between science and subjects, science is primary and plays a decisive role, while subjects come second and are to be determined. Such a relationship between

Table 1 Corresponding relationships between the scientific structure and the subject structure of cognitive science

Level	Cognitive Form	Issue & Realm	Subject
5	Cultural cognition	self, others, society, culture, nature, evolution	cultural studies, anthropology, cultural anthropology
4	Thinking cognition	concept, judgment, reasoning, proof, decision–making, problem–solving	logic, philosophy, computer science
3	Linguistic cognition	syntactic processing, semantic processing, pragmatic processing	linguistics
2	Psychological cognition	sense, perception, notice, presentation, memory	psychology
1	Neural cognition	senses of sight, hearing, touch, smell, taste	neuroscience

science and subjects is fully demonstrated in the scientific structure of the five levels of cognitive science and the structure of the six major subjects (see Table 1).

The above analysis produces three conclusions. First, scientific relationships determine subject relationships. Just like other scientific research, cognitive science is also problem oriented. By targeting the problems concerning the five levels of cognitive science, relevant research in cognitive science developed corresponding new subjects of neuroscience, psychology, linguistics, logic & philosophy, computer science, as well as cultural anthropology. The corresponding relationships between science and subjects is listed as follows: neurocognition→neuroscience; psychological cognition→psychology; linguistic cognition→linguistics; thinking cognition→logic, philosophy & computer science; cultural cognition→anthropology & cultural anthropology. It is in the 1950s that the five levels of human cognition eventually integrated into an organic whole, marking the birth of cognitive science. Therefore, scientific issue and research are primary and play a decisive role; while the start and development of a subject come second and are to be determined. The same is also true of cognitive science, whose scientific nature determines its subject nature. In other words, the scientific relationships among the five levels of cognitive science determines the structure and the corresponding relationships of its six major subjects. In fact, the subject structure of cognitive science in Fig. 1 is a science-to-subject mapping of the five levels of cognitive science in Fig. 2. It is a pity that for a long time, during the studies in and subject construction of cognitive science, scant attention has been paid to its scientific structure, which is more primary than subject structure. Second, there is a one-to-many mapping between thinking cognition and cognitive science, giving rise to relevant subjects like logic, philosophy and computer science. This indicates that "thinking" is an important form of human cognition, for which its related research has helped develop multiple subjects. Both the thinking level of human cognition and the mapping of cognitive science-based subjects speak volumes for the importance of thinking cognition. Third, a computer is not part of a human brain or a human mind, but it is nevertheless the outcome of human minds and cognition and can in turn promote the development of human minds and cognition. Under such circumstances, the unity of opposites is achieved between artificial intelligence and human intelligence. The unity of artificial intelligence and human intelligence is demonstrated in the following two aspects. First, computer science and artificial intelligence are an external form or a tool of the human mind and cognition. Second, computer science and artificial intelligence, as a subject, can find its objects at the five levels of human cognition.

Based on the five levels of cognitive science and the mapping relationships among the cognitive science-based subjects, we concluded that both computer and artificial intelligence are designed to realize human intelligence by machine means.

To achieve the objective of artificial intelligence, we must first have a clear idea of what human intelligence is before we can correctly understand what artificial intelligence is.

Human intelligence refers to human cognitive competence manifested at the five levels of nerve, psychology, language, thinking and culture.

Artificial intelligence, on the other hand, is to simulate human intelligence by machine or other man-made means.

Concerning human intelligence, there are two key standards, or rather, models. One is Turing's model, which was proposed by Alan Turing, an English mathematician, logician, and the "father of theoretical computer science and artificial intelligence" in his Intelligent Machinery in 1948. The other is Searle's model, which was proposed in 1980 by John R. Searle, who is the American scholar specializing in the philosophy of language and the philosophy of mind.

Alan Mathison Turing

Turing's model is a design of a human-operated machine, which can play chess according to its program instructions written in a natural language (English). In nature, it is a "paper machine." It is unnecessary for an operator of this machine to learn how to play chess. All the operator must do is to move the chess pieces on the chessboard according to the program instructions. Alan Turing was optimistic about the future of artificial intelligence, believing that computers would soon exhibit distinct intelligent behavior such as answering a question raised in English and having a conversation. In 1950, Turing did the famous "Turing Test," according to which if a computer can pass a human evaluator-hosted online conversation test, it is identified as being intelligent. More specifically, if a human evaluator cannot reliably tell the machine from the human based on their answers without seeing the "test candidates," the machine is said to have passed the test. According to that standard, many current computer systems have already acquired intelligence. Examples of such intelligent systems include the chess computer "Deep Blue," which defeated Garry Kasparov in 1997; AlphaGo, which defeated Go player Lee Sedol in 2016; and many other expert systems applied in various professional domains, which are arguably as smart as human beings. In the late 1970s, some AI researchers claimed that a computer could partially, if not completely, understand a natural language. As abovementioned, John Searle is a professor at UC Berkeley, specializing in philosophy of language and philosophy of mind. He is also a member of the American Academy of Arts and Sciences and winner of the National Humanities Medal (2004). In

1980, by demonstrating a simple and much-talked-about model, he asserted that a digital computer had no chance to truly understand a natural language or human thinking. In 1999, Searle proposed his "Chinese Room" argument, which is briefly concluded as follows.

> There was a native English speaker who had no understanding of the Chinese language. He was in a closed room where there was a box of Chinese characters and a book with an English version of the computer program on how to operate those Chinese characters. The English speaker could receive Chinese characters, which he still did not understand, through a slot in the door from people outside the room. Those received Chinese characters formed questions in Chinese (input). The English speaker could process them with corresponding Chinese characters according to the program's instructions and produce Chinese characters to correctly answer those questions (output). With the help of the instruction book (computer program), the English speaker in the room passed the Turing test, even though he had no understanding of the Chinese language.①

According to Searle, this argument was to demonstrate that there was no essential difference between the roles of the computer and the English speaker in the experiment, that each simply followed a program, step-by-step, producing a behavior which was then interpreted as demonstrating intelligent conversation, and that the English speaker's inability to understand the Chinese language meant the computer would not be able to understand the conversation either.②

—This is how a cognitive scientist views artificial intelligence.

The next part of this paper is to study artificial intelligence by analyzing the five levels of human intelligence to assess the latest developments in artificial intelligence and identify the differences between artificial intelligence and human intelligence.

3. The five-level theory-based cognition of artificial intelligence and human intelligence

3.1 Neural-level cognition

In terms of neural-level cognition, the overlapping of computer science and neuroscience has given rise to two important scientific realms, neural computer science and computational neuroscience. So far, at the neural level, the development of computer science and artificial intelligence remain within the two realms. This begs the following question. Has artificial intelligence already outperformed, or at least been equal to that of human intelligence in the two realms? The answer is, "No."

In fact, what AlphaGo is now doing is nothing but simulating certain activities of the human neural system. It has just been given some quite scary names such as "neural network," "neural computer," "brain computer" and "deep mind," which in nature have nothing to do with human neural cognitive activities. In terms of neural cognitive activities (such as those concerning the senses of sight, hearing, smell, taste and touch), humans are still far ahead of computers and artificial intelligence. When it comes to sensitivity to a variety of feelings (such as happiness and sorrow), current artificial intelligence cannot even compare with some lower animals (such as insects, fish, birds and beasts).

① The Chinese Room Argument, Stanford Encyclopedia of Philosophy, http: / /plato. Stanford. edu /entries / chinese – room/.
② The Chinese Room Argument, Stanford Encyclopedia of Philosophy, http: / /plato. Stanford. edu /entries / Chinese–room/.

3.2 Psychological-level cognition

In terms of psychological-level cognition, the overlapping realm of computer science and psychology has boosted the development of computer simulation, computational psychology, etc. Again, this raises the same question in the overlapping realm. Has artificial intelligence already outperformed, or at least been equal to that of human intelligence? The answer is still "No."

In terms of the cognition concerning basic psychological phenomena such as sensory perception, presentation and memory, computer and artificial intelligence remain far behind human beings. For example, chromatic vision, an essential part of human sense of sight, also associates with temperature sense. More specifically, red, orange and yellow make people feel warm, for which those colors are categorized as warm color; while blue, cyan and green can chill viewers, for which they are categorized as cool color. But the visual and perceptual system of a computer cannot deliver such cross-channel perception. Also, perception is a psychological process, through which the human brain and nervous system reprocess sensory information to acquire an integral understanding of an object. Human perception features integrity, constancy, significance and selectivity. Suppose a man stops a bike by a tree and goes away. When he returns to the tree from another direction and sees the bike from a totally different perspective, he can still immediately recognize his bike. In the same situation, a machine cognitive system or an AI system may not be able to identify the bike.

3.3 Linguistic-level cognition

There are essential differences between computer language systems and human language systems. Human language has been developed during the process of natural evolution and therefore it falls into the category of natural language. Computer languages, however, are designed by human beings and are used to serve machine purposes only. A computer language is a formal language under the artificial language category.

There are significant differences between natural languages and formal languages. And this can be exemplified by the Chinese language, whose native speakers can easily tell which of the following items are acceptable and which are not.

(a) 吃饭。(eat rice, meaning "have a meal")

(b) 吃酒席。(eat a feast, meaning "attend a feast")

(c) 吃食堂。(eat a cafeteria, meaning "have a meal in the cafeteria")

(d) 吃桌子。(eat a table, sometimes meaning "attend a banquet")

(e) 吃教室。(eat a classroom)

(f) 吃操场。(eat a playground)

It needs to be noted that in modern Chinese, items (a), (b) and (c) are acceptable, while (e) and (f) are not. And (d) is acceptable only in some contexts. Such a discriminating capability can be easily mastered by a native Chinese speaker, but it is extremely difficult for a computer to grasp. That is because, when using a natural language, humans can process it at the three levels of syntax, semantics and pragmatics. By contrast, so far, no computer system can deliver satisfactory performance in the most primary syntactical processing of a natural language (this conclusion only applies to English). When it comes to semantic and pragmatic processing, computer systems can neither "read" or "listen" between the lines.

The overlapping realm of computer science and linguistics includes computational linguistics and natural language comprehension. Possible breakthroughs in that overlapping realm rely on the engagement of cognitive science. Human cognition, or rather, higher-order cognition, is based on linguistic cognition, which is the basis of both thinking and cultural cognition (see part 1 of this paper for more information). Humans use lively and diversified natural languages to think and form a variety of colorful human cultures. Computers, on the other hand, rely solely on monotonous and unambiguous binary language to perform all duties, including the simulation of human thinking. Between formal language and natural language lies a huge gap difficult to bridge. Such a gap, formed by different languages, becomes the dividing line between artificial intelligence and human intelligence.

3.4 Thinking-level cognition

Perhaps the key distinction between artificial intelligence and human intelligence lies in thinking-level cognition.

Whether computers have intelligence is often mistaken for whether computers can think. Such a misunderstanding is a significant deviation from the truth, although the ability to think is indeed an important part of human cognition.

The human mind and cognition is language-based and is characterized by human thinking. "Thinking" is the most advanced form of human mental activity. All human progress and achievements are nothing but outcomes of human thinking. Culture, arts, as well as scientific and technological development are without exception fruits of human thinking.① The entirety of human society is constructed by human language and thinking. French philosopher René Descartes' famous argument that "Cogito ergo sum" (I think; therefore I am) defines the relationship between thinking and existence as causality. To put it another way, because I can think, I still exist in this world. Descartes' "Mind-Body problem" is an eternal question concerning philosophy and cognitive science (Searle, 2004, pp.107-132).

Some ancient Chinese thinkers and philosophers also had brilliant views regarding "thinking." Confucius held, "Learning without thought is labor lost; thought without learning is perilous."② Mencius made a distinction between perceptual knowledge and rational knowledge (thinking) and conducted an in-depth exploration of the relationship between the two. He once said, "Human sensory organs like ears and eyes cannot 'think,' for they are prone to be deceived by external objects. Once getting in touch with external objects, they can be easily seduced by them. The human heart can think, for which it can cultivate human goodness. Without thinking and reflection, one simply cannot expect to cultivate human goodness. Given that, heart is our (most important) organ endowed by the God. Therefore, once we get a tight control of this crucial organ, other secondary organs such as ears and eyes will not easily be seduced by external objects. This is the very principle that all gentlemen should follow."③

Conception, judgment and reasoning are the basic forms of human thinking. The forming and use of abstract concepts marked the beginning of human thinking. Machines can use certain concepts according to their corresponding definitions, but can they generate and use abstract concepts on their own? That is the question. Humans can use concepts to make judgments, and use a judgment to reason. Can computers also have such an ability? Obviously, judgment and reasoning are also important measurable indicators of artificial intelligence.

On May 11, 1997, Deep Blue, a chess-playing computer developed by IBM, defeated then reigning world champion Garry Kasparov. On March 15, 2016, the human-computer competition saw the completion of the fifth of the five matches. Through a 5-hour fierce fight, South Korean 9-dan Go

① http://www.psychology4all.com/Thinking.htm.
② *The Analects of Confucius−−On Governing.*
③ *Mencius−−Gaozi I*

player Lee Sedol lost this final match to AlphaGo. Eventually, AlphaGo sealed a 4-1 victory over Lee Sedol. During the fourth match, Lee won his first victory after three straight losses by taking advantage of AlphaGo's bad moves.

AlphaGo's defeat of Lee Sedol is significantly different from Deep Blue's defeat of Garry Kasparov 19 years earlier. This is mainly because Go is much more variant and complicated than chess. Given that, AlphaGo adopts a special learning strategy and some more advanced algorithms. By contrast, Deep Blue could only do as told by the previously designed program. This may leave the impression that it was not Deep Blue, but its program designer that defeated Garry Kasparov. In this human-computer competition, however, it seems to be AlphaGo itself (i.e. artificial intelligence) that defeated Lee Sedol. AlphaGo relied on self-learning to gain "wisdom" and thus defeated a human Go player. Hence it is concluded by many that artificial intelligence has already outperformed human intelligence. Is it true?

Undoubtedly, in the fields (such as chess and Go) which rely primarily on computing and reasoning to think and make decisions, artificial intelligence has already exceeded human intelligence. Moreover, in many other fields (such as assembly-line robots) characterized by computing, reasoning and mechanical behavior, artificial intelligence, because of its higher accuracy and efficiency, has also exceeded human intelligence. One cannot help

AlphaGo's defeat of Lee Sedol

but wonder: Why people did not think artificial intelligence defeated human intelligence when robots replaced assembly-line workers and became a more powerful driving force for modern industry decades ago. Why people exclaimed that AlphaGo's defeat of Lee Sedol marked artificial intelligence's triumph over human intelligence?

Fundamentally, AlphaGo's defeat of Lee Sedol has no essential difference from Deep Blue's defeat of Garry Kasparov, or the robots' replacement of assembly-line workers. In certain realms that require special expertise, robots can perform as well as, or even better than humans. But this cannot support a general conclusion that artificial intelligence has already outperformed human intelligence. There are some realms seemingly simple but requiring great intuition, inspiration, insight and creative thinking, such as facial recognition, presentative judgment, sympathetic interaction and innovative thinking. In those realms, artificial intelligence cannot even compete with an infant. Besides, comprehensive innovation of existing knowledge is simply beyond the reach of artificial intelligence. But such ability has been repeatedly demonstrated by human geniuses throughout history. For example, Archimedes had an epiphany and discovered the physical law of buoyancy when he was taking a bath. Legend has it that an apple once fell from a tree, hitting Isaac Newton's head and helping him discover gravity. Albert Einstein derived the equation $E=mc^2$ based on calculation and conjecture.

As philosopher John R. Searle proposed his "Chinese Room" argument-based AI model, which so far has not yet been passed by any computer system (Cai, 2001). That is to say, digital computers do not really acquire human intelligence and will never acquire it (Cai, 2007). Even today, Searle's argument is not yet out of date.

3.5 Cultural-level cognition

Cultural cognition is the highest of all the five levels of human cognition and it is also a cognitive form unique to humans. Overall, human cognition is a higher-order cognition based on language and characterized by thinking and culture. Culture refers to all objects created by humans. Being man-made, culture includes physical existence, social existence and spiritual existence.

Broadly speaking, science, arts, philosophy and religion all belong to the category of culture. At various levels and from different perspectives, the abovementioned realms reflect the human mind and human understanding of the physical world and the inner world.

When it comes to cultural cognition, it seems that human intelligence still plays a dominant role that no machine or artificial intelligence can rival. In fact, a TCM (traditional Chinese medicine) expert diagnostic system has already been developed and introduced to the market. But such a system is unlikely to gain more trust than human TCM experts from patients and consumers. There is also a newly developed software system capable of creating metrical poems. Through big-data analysis, this software system can simulate the style of any renowned Chinese poet such as Li Bai to create a metrical poem as a birthday gift for a friend. Still, a metrical poem created by this system cannot compare with the original work of Li Bai. A painting created by Zhang Daqian, or a seal engraved by Qi Baishi may be priceless, while their corresponding simulations are valueless. Cao Xueqin is irreplaceable as a great writer. So is his masterpiece *Dream of the Red Chamber*. No one would think its follow-up 40 chapters created by Gao E have the same literary value as the original 80 chapters created by Cao Xueqin. An individual mind has a lot to do with one's own experience. In this sense, it is Cao Xueqin's mentality and personal life experiences that shaped what is unique about him and his *Dream of the Red Chamber*. His unique mentality and cognitive style cannot be simulated by any AI system.

4. Conclusions and brief discussion

Based on the above analysis, this paper draws on the following conclusions and makes a brief discussion.

4.1 Artificial intelligence is in constant progress, improvement and development.

Artificial intelligence came along with the invention of the computer. Therefore, the history of artificial intelligence is the same as that of the computer. Since the 1950s, AI theories and technologies have been in constant development and improvement. As abovementioned, in the 2016 human-computer competition, AlphaGo sealed a 4-1 victory over Go grandmaster Lee Sedol. AlphaGo's victory is much more impressive than Deep Blue's defeat of Garry Kasparov for two reasons. First, as a board game, Go is much more complicated than chess. The Go players take turns placing the stones on vacant points of the 361 intersections on a board with a 19×19 grid of lines. Such a structure means that there is a total of 10171 permutation-and-combination approaches on a Go board. This figure is much bigger than the number (1075) of atoms in the universe. The complexity of a computer system thus presents a challenge to AI algorithms. Second, the rules of Go are quite simple, leaving no room for AI strategies to give play to their established advantages of interpreting complicated rules and patterns and performing rapid calculations. Under such circumstances, AI strategies need to be re-designed to secure artificial intelligence's victory in a Go game. In fact, to prepare for this 2016 human-computer competition, the AlphaGo developer adopted a range of brand-new strategies, such as deep learning, neural network systems and value assessment systems. Those strategies are key to AlphaGo's victory over Lee Sedol and also demonstrate the theoretical development and technological progress that artificial intelligence has made since Deep Blue.

4.2 At all the five levels of human cognition, artificial intelligence only simulates human intelligence and is yet to outperform human intelligence as a whole.

At the five human cognitive levels of nerves, psychology, language, thinking and culture, artificial intelligence only simulates human intelligence and is yet to outperform human intelligence as a whole. The five levels of human cognition represent the capabilities and wisdom respectively retained in the human brain and cognitive system at corresponding stages of human mental evolution. Therefore, the five levels of the human mind and cognition can also be understood as the five levels of human intelligence. This paper explores the differences between artificial intelligence and human intelligence at the five levels of the human mind and cognition. Based on the above analysis, we can conclude that artificial intelligence simulates human intelligence at all five levels of the human mind and cognition (i.e. human intelligence), that artificial intelligence has yet to catch up with human intelligence at any of the five levels, and that artificial intelligence is much inferior to human intelligence in higher-order cognition, the cognitive levels of language, thinking and culture. In fact, artificial intelligence and human intelligence fall into very different intelligence categories when it comes to higher-order cognition.

4.3 Machine learning is no more than a simulation of human cognitive ability and therefore should not be overestimated.

AlphaGo's victory in this 2016 human-computer competition has produced much recognition and interest regarding its deep-learning strategy from the general public. Such a deep-learning strategy includes a neural network control system, an assessment network and a Monte Carlo tree search (MCTS) algorithm. The neural network control system predicts an opponent's moves based on its network architecture and a large number of existing samples. The assessment network calculates win rates through value assessments. The focus of the Monte Carlo tree search is on the analysis of the most promising moves, expanding the search tree based on random sampling of the search space. It is precisely the above three functions that enabled AlphaGo to come up with the best possible moves.

What exactly is the learning ability of AlphaGo? Is there any AI system already outperforming humans, or even likely to put an end to mankind? First, AlphaGo's victory should be attributed to its superb abilities of mathematics and logic. And this indicates that in certain areas relying heavily on mathematical calculations and logical reasoning, a machine may excel the left hemisphere of the human brain. But this does not mean that AlphaGo can truly understand what Go is, or that it can appreciate the art of Go. After all, a computer may be able to vividly simulate the process of human digestion, but it can never get satisfaction from enjoying a hamburger or a baozi. The same is also true of the "Go player" AlphaGo. In terms of mental and intuitive abilities, the machine lags far behind the right hemisphere of the human brain. For example, only humans can truly appreciate the beauty of music and paintings and enjoy the subtle charm of verses like "Time and time again, I searched for you in the crowd. Suddenly, I spun round and saw the very you standing amidst dim lights." No computer can process such information as well as humans.

Through special training, dogs can make use of such an ability to perform tasks like searching for drugs and explosives.

Such an ability gap is not about order of magnitude, but about the qualitative difference between humans and computers. Second, both humans and non-human animals possess learning ability. This means even lower animals can learn something in their own way. For example, mice can run a maze accurately and parrots are able to mimic human speech. Dogs are known for their acute sense of smell. Through special training, dogs can make use of such an ability to perform tasks like searching for drugs and explosives. In certain aspects, they can perform better than humans. In fact, dogs' intelligent behavior only involves stimulus response and memory and remains at neural and psychological levels of cognition. Therefore, it is of a "lower-order cognition" category. On the other hand, "higher-order cognition" such as linguistic, thinking and cultural cognition are beyond the reach of some non-human higher animals like chimpanzee, let alone "emotionless and mindless" machines. Third, artificial intelligence is the outcome of regular technical progress. In nature, machine learning is no more than a simulation of human cognitive ability. Even if machines can outperform humans in certain areas of expertise, there is no need to overestimate it or panic at it. Throughout the history of technological development, there have been a succession of machines outperforming humans. For example, compared with humans, cars run faster, trains carry more cargo, and planes can fly. "When first finding that cars can run faster than themselves, humans did not panic. Even today, running is still a popular game and Olympic gold medals in track and field still belong to human players, instead of sports cars like Ferrari. Therefore, there is no need to panic."① It is simply beyond the wildest imagination that machines should possess human emotions, fall in love and produce offspring unless they are in Hollywood sci-fi movies and new Arabian Nights.

4.4 Machines will never acquire human intelligence and therefore no machine can be expected to control or outperform humans in the foreseeable future.

John R. Searle's famous "Chinese Room" AI argument is not yet out of date. According to this argument, digital computers will never acquire human intelligence.

According to the division of artificial narrow intelligence and artificial general intelligence, all current AI systems fall into the category of artificial narrow intelligence, which enables machines to act intelligently. It is true that in certain areas of expertise, relevant expert systems have already caught up with or even surpassed human intelligence. Examples of such AI superiority includes Deep Blue, which defeated Garry Kasparov and AlphaGo, which sealed victory over Lee Sedol in 2016, and a variety of professional robots widely adopted by modern assembly lines. Those AI applications, including Deep Blue and AlphaGo, still belong to the category of artificial narrow intelligence. By contrast, artificial general intelligence enables machines to really think. It remains to be a dream only in Hollywood sci-fi movies or in the mind of its believers. So far, there is not a single machine that can truly understand human language, let alone machines that can think creatively and create a cultural life of their own.

Can humans create creatures with minds and intelligence just like the God did? The answer is "Yes." In fact, there is no lack of "lunatics" or "mad scientists" making such an attempt. J. Craig Venter, nicknamed American "Bad man of science" has successfully created what was described as

① Yin Xiangzhi, A Tentative Exploration of Deep-learning Technique, http://learning.sohu.com/20160316/n440632177.shtml.

"synthetic life" in his lab.[1] It needs to be pointed out that such a "synthetic life" is not a robot, but probably an artificial life with mind and intelligence (this issue is beyond the research scope of this paper and therefore will not be elaborated here). Unfortunately, following AlphaGo's defeat of Lee Sedol, there has been an uproar of "machine's victory over humans," which grabs the due attention from the real issue concerning human destiny.

(Translator: Wu Lingwei; Editor: Jia Fengrong)

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① Craig Venter, From Wikipedia, the free encyclopedia. Https: //en. Wikipedia.org/wiki/Craig_Venter.