Letter to the Editor

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Explainable AI: Linking Human and Machine

AI (artificial intelligence) has changed the organization of knowledge. Many questions confused us after the combining of AI and knowledge organization; for example, should ontology be replaced by knowledge graphs? These questions have deserved serious consideration. We must face the fact that the machine has the potential to become a cognitive agent. And traditional knowledge organization only considers humans. The letter is an unformed discussion on the relationship between both knowledge systems of human and machine based on my past viewpoints (Guohua Xiao 2019a). At the same time, I point out that the explainability of AI is the key knowledge linking human and machine.

Knowledge is organized by different levels which can be seen as the mappings of the basic knowledge unit according to rule one of knowledge ontology (Guohua Xiao 2019b). Machine's basic knowledge unit can be seen as theoretical computer science. Both basic knowledge units are made of six parts (Table 1).

Languages of different levels link humans and the universe. Also, they create another knowledge system of machines. The two knowledge systems are two nodes in the knowledge ontology (Guohua Xiao 2019b): "pure technology" is machine's knowledge system, and "artificial world" is human's knowledge system. There is a one-to-one match between the two systems (Table 2).

The basic knowledge unit can be mapped to eight sub-knowledge systems (four levels, two kinds of agents). In this letter, we only discuss the level four knowledge system—intelligence knowledge systems. Machines are tools of humans. Artificial intelligence is very different from low level tools due to its ability to make decisions automatically. Many people think AI is a black box, in the sense AI can make good predictions but you cannot understand the logic behind those predictions. In some sectors, such as judicial decision and medical diagnoses, explainability of AI becomes a must. Complex tool three in Table 3 is related to explainability. I think explainable AI is the key bridge to link human and machine.

Basic Knowledge Unit	**Machine's**	**Human's**
Tools for communication	Programming Language	Symbolic Language
Tools for basic analysis	Formal Methods	Metaphysics
Complex tool 1	Algorithms: computation theory	Logic and mathematics
Complex tool 2	Algorithms: efficiency	Aesthetics
Complex tool 3	Algorithms: decidability	Statistics and decision sciences
Representation of meanings	Data Structure	Epistemology

Table 1. The structure of a basic knowledge unit.

Human VS Machine	**Machine's Languages**	**Machine's Sciences**	**Human's Languages**	**Human's Sciences**
Level 4	Industry 4.0	Artificial Intelligence	Mind	Recognition Science/ Science of Knowledge
Level 3	Industry 3.0	Computer Sciences	Brain	Social Sciences
Level 2	Industry 2.0	Electrical Sciences	Cell	Biology
Level 1	Industry 1.0	Mechanical Sciences	Matter	Physics

Table 2. The relationship between knowledge systems of human and machine.

Intelligence Knowledge System	**Machine's**	**Human's**
Tools for communication	Question Answering by Natural Language Processing, etc.	Knowledge expressed by Natural Language
Tools for basic analysis	Handcraft Pattern Recognition	Conditional Reflex
Complex tool 1	Deep learning	Intelligence
Complex tool 2	Reinforced learning	Emotional Intelligence
Complex tool 3	Statistical learning and Explainable AI	Comprehension/Enlightenment
Representation of meanings	Knowledge graph	Brian Semantic Networks

Table 3. The structure of intelligence knowledge systems.

From what has been discussed above, we can make a distinction between ontology and knowledge graphs clearly. Ontology is used in "tools for communication," and knowledge graphs are used in "representation of meanings" which can be seen black knowledge (knowledge in a black box). Correspondingly the former are white knowledge (including explicit knowledge and tacit knowledge proposed by Michael Polanyi). Both systems can have the same structures: black knowledge and white knowledge. If we (both human and machine) want to be understood, we must say (white knowledge in ontology style), not showing our neural networks (knowledge graphs). So, they have different functions and both are important. All discussions are based on the three rules of the knowledge ontology. And the relationship of knowledge discussed here will be updated in the knowledge ontology (https://github.com/knowledgeontology/KO) in the future. In the end, I thank my PhD supervisor, professor Wei Wang for supplying the opportunity of free research in Fudan University.

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