From Logical Information Model, to Logical Information Network, to the realization of Artificial General Intelligence (AGI)

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If you believe that probability theory and machine learning are the true essence of artificial intelligence, or you insist that mathematical logic is the whole of logic, please stop reading anymore.

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Since the concept of "artificial intelligence" (AI) was proposed at the Dartmouth conference in 1956, the development of artificial intelligence has experienced several climaxes. The most famous of these are symbolism from the 1950s to 1980s, and connectionism, which started intermittently in the 1980s and suddenly became hot in the 2010s until today.

Symbolism, represented by knowledge base and expert system, focuses on knowledge management. Connectionism, represented by machine learning and neural networks, lays emphasis on knowledge reasoning and prediction. Symbolism is mainly based on predicate logic in mathematical logic, which is also called symbolic logic, hence the name of symbolism. And it is also called logicism. And connectionism has its roots in the theories of neural networks and probability.

Mathematical Logic

Unlike traditional logic which is represented by Aristotle's deductive logic, mathematical logic takes abstract mathematical symbols as a tool to study logic. It should be said that the emergence of mathematical logic paradigm has fundamentally changed the research of logic. It causes the research to deviate from the original and overall goal of logic, which is to provide normative models for reasoning processes in general. Instead, most of its work focuses on mathematical reasoning, especially theorem proving.

Therefore, from the very beginning of its emergence, mathematical logic was regarded as the authentic logic by the mathematicians who pursued it, more authentic than traditional logic. In the following one or two hundred years, with the continuous development of the discipline and a large number of applications in the fields of communication and computer, mathematical logic

far surpassed traditional logic in terms of both the discipline status and attention. So that even in other areas of logic other than mathematical reasoning, mathematical logic is still widely regarded as a norm.

There is no doubt that computable logical symbols are needed in the fields of computing science and information science, but it does't work for human thinking. Psychologists have shown that the reasoning process of human daily thinking is not an abstract symbolic form system. The purpose of artificial intelligence is to build a "thinking machine" that thinks like human beings. Its application is not limited to the scope of mathematics or its extension of disciplines, but to formalize the reasoning processes such as real-world reasoning, everyday reasoning or commonsense reasoning. The limitations of mathematical logic in everyday reasoning, and the differences between it and the reality of human thinking, determine that it cannot provide a normative model for universal reasoning.

Probability Theory

Probability theory is a branch of mathematics which studies the quantitative law of random phenomena. It is also a very important method of inductive logic.

Probability theory is the logical basis of connectionist artificial intelligence system reasoning. Every inference made by the system is to infer different possibilities of various outcomes based on existing data, so as to select the result with the highest or the most consistent probability. Such prediction method may be applicable to some reasoning scenarios with relatively clear and fixed rules or conditions, and can also obtain prediction results with high accuracy. However, everyday reasoning of human thinking is not always in line with these scenarios after all. When faced with scenarios of different patterns, or when the rules or conditions of such scenarios have changed (for example, there are some differences between the real world scene and the training scene of machine learning), the results of such prediction methods are often not ideal.

In short, connectionism, which is based on probability theory, only adopts the methodologies limited to the category of inductive reasoning, while ignoring the key role that deductive logic can play in the process of knowledge reasoning and acquisition and in creating topological relationships among knowledge information. Therefore, it gives people some impressions such as "the reasoning results are uncertain and unexplainable", "this is not like the way of human thinking", and so on.

Traditional Logic

Mathematical logic is a combination of western traditional logic and mathematics.
The western traditional logic can be traced back to the period of ancient Greece more than 2000 years ago. However, after the emergence of mathematical logic in the 18th and 19th century, traditional logic was widely criticized by mathematical logicians. One of the important reasons is

that the study of traditional logic always exists only in the scope of philosophy, which is not very practical and difficult to be directly applied to the research of natural science.

On the other hand, despite thousands of years of development, traditional logic has not formed a complete system. Mathematics, which also started in the period of ancient Greece, had more or less formed some rigorous axiom systems in geometry, algebra, set and other sub-fields when mathematical logic appeared. But logic still had only a small-scale and imperfect system like Aristotle's "major premise, minor premise and conclusion" thousands of years ago, and the rest are mostly various of different and scattered thoughts of philosophers. Even there are still considerable divergences in the similarities, differences and relationships between the most basic concepts such as "argument", "reasoning" and "inference".

New Logicism

To figure out the reasons for the limitation of traditional logic and the rapid rise of mathematical logic from behind, One of the most important should be the difference relationship of concreteness and abstraction between the two disciplines logic and mathematics. Concreteness and abstraction are relative. For physics, chemistry and other natural sciences, mathematics is abstract. But for logic, mathematics is relatively concrete. Mathematics studies abstract things, but it studies with the tools of representable numbers, symbols, mathematical formulas and so on. The abstract things studied by logic are the rules and forms of reasoning, which exist intangibly in the derivation and proof process of mathematical formulas or other disciplines. As a result, it is more abstract, and more difficult to be understood and studied.

I think that in order to build a more perfect axiom system of logic, we should first clearly distinguish "real logic" into two parts: basic logic and applied logic.
Basic logic, or called meta logic, is some basic elements needed in the study of logic, mainly focusing on the relationships between logical elements such as "concept", "proposition" and "argument". These elements and their relationships are inevitably involved in all reasoning paradigms, reasoning rules, or disciplines that apply these reasoning rules.
And applied logic is a variety of paradigms of logical rules and reasoning rules, which is mainly seen in the combination with other disciplines. For example, mathematical logic means a separate discipline that is created by mathematicians' combining the numbers and symbols commonly used in mathematics with the logical rules of applied logic, rather than the product of the natural development of logic. And the current traditional logic research can be basically regarded as the combination of various components in linguistics and applied logic. It's just not separated and independent for thousands of years.

For the more universal artificial general intelligence, it should be based on basic logic, rather than purely applied logic such as mathematical logic or traditional logic. Coupled with the basic elements in the field of information science related to knowledge management and prediction, it can become a new combination of logical model and information model. That is "logical information model", which can provide universality for artificial general intelligence.

It can be used as a new basic model of knowledge representation to develop a new generation of knowledge base. When it is combined with the corresponding norms of applied logic, the corresponding expert system or prediction system can be formed. When it can adaptively adjust and switch between different norms of applied logic, artificial general intelligence will be achieved. The norms of applied logic here can be the symbolism paradigm of mathematical logic, the connectionism paradigm of machine learning, or even the unique everyday reasoning paradigm of each of us.

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*New generation of knowledge representation model (**Logical Information Model**)*
*-> New generation of knowledge base (**Logical Information Network**)*
*-> Artificial General Intelligence (**AGI**)*

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