On the Cognitive Turn in Logic *

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According to the view of Scholz(1931/1959), from the perspective of the history of logic, it is utterly untenable that there is only one kind of logic; logic is polysemantic and can be represented by many different types. To clearly explicate the history of logic, he differentiated six logic types: the first is the classical type originated from Aristotle's formal logic. The second is the so-called extended formal logic, which consists of Aristotle's formal logical systems and some totally new elements added into it by the author of the Royal Port Logic and Lambert. These new elements are methodology, semantics and epistemology. The third is "informal logic" called by Scholz. Here, logic is practically demarcated as the instrumental theory for acquiring scientific knowledge in the widest sense. The informal logic is the residue left by removing formal logic from logic; its main advocator is Mill. Who introduced the inductive method into the theories of logic; the fourth can be named the inductive probabilistic logic; the fifth the speculative logic, such as Hegel's dialectic logic and Kant's transcendental logic; the last is the modern formal logic originated from Frege and Russell, which covers classical mathematical logic and its extended systems such as modal logic systems, and non-classical logic systems.

It is impossible to give an appropriate definition for logic on the basis of the existing logic types such that the word "logic" can only refer to the above logic types. In the other words, the notion "logic" looks like a family resemblance. New logic types, which cannot be incorporated into the existing ones, cannot be excluded by way of definition. However, the presence of the new logic types will increase the members of the logical family and enrich the sense of the word "logic".

As a result of this, we can define the turn of the development of logic, or shortly, "the turn in logic". Suppose there exists a logic type, which is either new or known. If it replaces another logic type and becomes the highlighted mainstream, this historical incidence can be dubbed "the turn in logic".

As is well known, the mainstream logic type in the history of logic was Aristotle's logic whose core is term logic. Its main task is to give rules of deduction, which can be employed in scientific researches and daily political argument. As to the future of logic Kant (1800/1974)holds that logic needs neither change nor new discovery because Aristotle exhausted the main issues of logic. But after less than 100 years, Frege(1879) initiated a turn in logic. Frege holds that clearly describing mathematical expressions, ways of reasoning and basic assumptions, and then laying the foundation

for mathematics is the fundamental target of the development of logic. As a result of the pursuit of the above goal, a series of logical systems and their meta-theories labeled "mathematical logic" have been formulated. The core of this logic is formal axiomatic systems, whose research tasks, theoretical contents, and expressive forms, etc are different from Aristotle's logic; as the modern type of formal logic, it replaced Aristotle's logic as the classical type of formal logic and became the mainstream logic in the early 20th century, which is the first significant turn in the history of logic, or, the mathematical turn in logic.

The mathematical logic developed by laying the foundation for mathematics at the turn of 19-20th century provided the computer science and its applications with theoretical basis. The development of computer science in the middle and late 20th century entered the stage of knowledge processing and intelligence simulation. It became the mainstream direction of logical research to construct logical systems to describe the features of advanced cognitive process, employ them to represent and process knowledge, and design the new type of softwares. On the other hand, the development of mathematical logic, especially that of the theory of Turing machines, inspired people to understand the human processing of information by way of the computer metaphor, which provided conditions for the research of human reasoning by psychological experimental techniques; in the 1970s(J. Laird, 1975; Braine, 1978), it finally became possible for people to judge by experimental means whether human beings reason through some logical rules and schemata. This enabled the mankind to study for the first time the forms and laws of thoughts (the advanced cognitive process) by using the scientific methods. The developments in both logic and psychology result in another turn in logic.

The so-called cognitive turn of logic refers to the transmission from the logic originated from Frege in the study for the foundation of mathematics to the logic of constructing the normative or descriptive model for the cognitive process, which is called " the logics of cognition ".

Now, the researches about the logic of cognition are developed in two traditions:

(1) The tradition of philosophy/mathematics: in this case, the so-called logic of cognition refers to the logical system constructed from the analysis of epistemological concepts and the intuitive understanding of the cognitive process such as: non-monotonous logic(Reiter, 1980), the logic of belief change (Alchourrón, C. E., Gärdenfors, P. and Makinson, 1985), and Logical Dynamics(Johan van Benthem, 1996). Although this kind of logic often has a background of computer science, its intuitive basis lies in philosophical thinking.

(2) The tradition of psychology: in this case, the so-called logic of cognition mainly refers to the logical system constructed from the psychological study of human advanced thinking. It involves two fields: reasoning and decision-making. In the field of reasoning, there is Mental Logic Theory (1991) and Mental Model Theory (J. Laird, 1983); In the field of decision-making, there is Prospect Theory(1979).

Since the human being's cognition is different from that of the ideal mathematician, the logic about it should be different from that about the idealized mathematician:

(1)   The logic about cognition should abandon the supposition of the logical omniscience and regard the imperfection of the cognitive agent's knowledge relative to the world as the important feature of knowledge, giving a close eye on studying ignorance, the uncertainty and changing style of knowledge.

(2)   The logic about cognition should also abandon Frege's anti-psychologism. Instead, it should proceed forward from the standpoint of Boole(1854), Turing(1947) and Hilbert(1927), unite with cognitive psychologists and study the forms and laws of human thinking on the basis of experiments. The psychologists' ending point is our logicians' starting point.

(3)   From mental logic theory and mental model theory, humen being's reasoning can be modeled in a manner of non-axiomalization. One question worth to mention is: under what conditions is it necessary to employ the formal axiomatized method to describe the process of cognition?

In general speaking, the logic systems in the former tradition are normative, ones in the second are descriptive. The further question to ask is whether human beings reason according to the normative models deemed reasonable by us. If the answer is yes, we could use these models to predict and control human thinking. Otherwise, it is necessary for us to analyze whether our models are false to describe human thinking or human beings systematically make cognitive mistakes. The symmetric question is whether our descriptive models are reasonable. If the answer is yes, we could obtain a cognitive theory which is both normative and descriptive. Otherwise, it is necessary for us to analyze how to correct these cognitive mistakes. Finally, we have the following research methods interactive between nomativity and descriptivity:
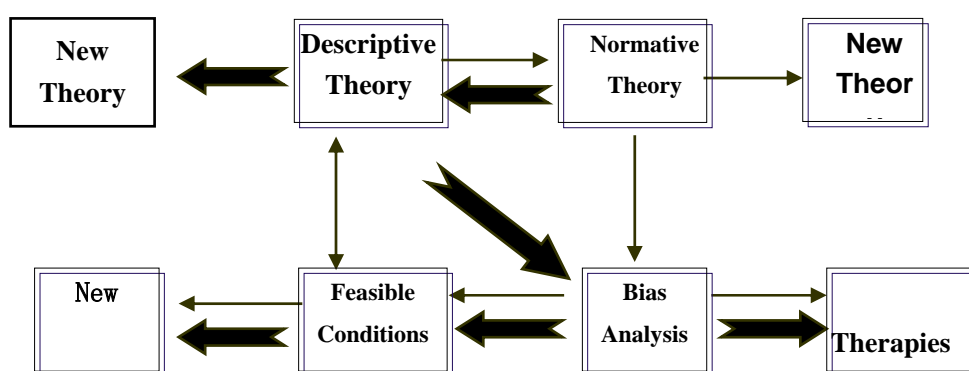
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