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Dynamic epistemic logic and the problem of logical omniscience

Epistemic logics are systems that allow one to reason about knowledge, belief, and related epistemic notions, such as information and justification. The most widespread type of epistemic logics in use at present are modal logics. In such systems, knowledge and belief are represented via the modal operators K and B. Formulas $K_i\varphi$ and $B_i\varphi$ should be read as "the agent i knows that φ" and "the agent i believes that φ", respectively. An agent may be a human being, a robot, a player in a game, or a computer. The use of epistemic operators allows the formal exploration of the philosophical principles. For example, the formula $K_i\varphi \rightarrow \varphi$ states that what is known is true, while the formula $(K_i\varphi \wedge K_i(\varphi \rightarrow \psi)) \rightarrow K_i\psi$ states that that knowledge is closed under known entailment, i.e. if the agent i knows φ and knows that φ implies ψ, then the agent i knows ψ.

An interest in epistemic logics was heightened when the Finnish logician Jaakko Hintikka applied the concept of so-called possible world semantics to epistemic operators. Modal epistemic logics have become not only helpful tools for the formalization of certain intuitions connected with the basic epistemic concepts, but have also become a subject of considerable interest to scientists in fields such as computer science, economics, game theory, and cognitive science. The increase of interest in epistemic logic among representatives of other scientific disciplines has led to new goals for the application of the logic of knowledge and beliefs. Epistemic logics have begun to be perceived as formal systems whose aim is to capture the phenomenon of knowledge change resulting from the flow of information between various agents. The need to develop formal systems that adequately capture the phenomenon of knowledge change led to a dynamic turn in logic.

Dynamic epistemic logics are not free of the shortcomings typical of static epistemic logics. Both make use of possible-world semantics and inherit its drawbacks. This concerns logical omniscience, i.e. the controversial assumption underlying epistemic logic built on the basis of possible world semantics, according to which the agent knows all logical truths and all logical consequences of his or her knowledge. In some applications of epistemic logic, e.g. in epistemology and game theory, representing the knowledge of agents with unlimited deductive abilities may be accepted as a justified idealization. However, in the case of representing the knowledge and information change of real cognitive agents, these assumptions are unacceptable.

The main research goal of the project is to develop a formal framework for representing knowledge change for non-omniscient agents. During the preliminary research, the dynamic epistemic logic for actual knowledge of real-world agents has been developed. The project aims to study the properties, applications, possible extensions, and alternatives of this logic. The outcome of these studies will be a significant contribution to the formal and philosophical studies on information dynamics. The results of the project may be interesting not only for logicians and philosophers but also to scholars of various disciplines, such as game theory, computer science, and cognitive science.