Logical Aspects of the Diversity of Agents

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Motivation.   With the development of different types of multi-agent systems a number of new questions considering the variety of agents came into being. By the variety of agents we understand the logical diversity that results from various attempts to develop formal systems capable of modeling actions, reasoning and behaviour of actual ration agents. The question is mostly studied in two branches of contemporary philosophical, i.e. modal logic: in epistemic logic and numerous action models (including other theories making use of epistemic and dynamic modalities). The roots of the logical problem of agent diversity lie in the idea that various agents might have different knowledge and beliefs, as well as use diverse rules of inference. That is the reason why the question has arisen quite recently, as it was traditionally believed that logical laws represent some universal norms using which everyone arrives at the same conclusion given the identical premises. Thus, there was no need to introduce any agents representing the subject of inference.

However, if we aim at modeling real agents, we are faced with the fact that normally they are limited in numerous resources, for instance, in case of imperfect or fallible information.

Three groups of intellectual competences of agents.   In the present paper we outline our attempt to analyse logical features of cognitive presumptions of rational agents studied and modeled in various logical theories. We propose three groups of intellectual competences (logical parameters) that might vary with different agents:

I **Epistemic,**This group of cognitive presumptions contains the following types:

   a Epistemic competences proper, which represent knowledge of agents about the state of affairs, other agents and their presumptions;

   b Doxastic, i.e. agents' beliefs;

   c Agents abilities influencing the way they obtain, keep and change their information, particularly, their knowledge and beliefs.

II **Goal**, that are related to the concept of practical reasoning. This group of cognitive presumptions contains goals, intentions and desires of agents that are modeled in the framework of BDI logic;

III **Deductive.** By this group of presumptions we understand non-model logical systems that form the basis of agents' reasoning (inferences). Depending on the system that an agent uses, he might have different understanding of truth and logical consequence. As an example we can imagine three agents relying on three different basic logics, like classical, intuitionistic and minimal logic. These presumptions influence agents' reasoning that may result in a situation where two agents achieve different sets of propositions after the identical change in their data base, for instance after a public announcement of some formula φ.

The parameters mentioned in I a and I b represent a configuration of a particular model where knowledge and beliefs are defined; whereas I c is related to properties of frames. In our classification we also pay attention to various parameters of epistemic compentencies. Following [6] we define them as follows:

a *inferential power*, i.e. the ability to make all necessary proof steps. The feature is usually associated with the disputable formula of logical omniscience: $K(\varphi \rightarrow \psi) \rightarrow (K\varphi \rightarrow K\psi)$;

b *introspection* i.e. the ability to make statements about one's own epistemic condition. The formulae encoding this feature: (i) $K\varphi \rightarrow KK\varphi$, (ii) $\neg K\varphi \rightarrow K\neg K\varphi$;

c *observation*, i.e. different powers for observing events (limitations on the observation capacity usually give rise to so-called 'imperfect information');

d *memory*, i.e. limitations on the the number of storing information;

e *revision policies*, i.e. different types of revision and upgrades, from the conservative to the radical one.

Conclusion.   In the present paper the integrated classification of cognitive agent types is proposed with respect to formal theories modeling rational behaviour, including reasoning. The classification specifies and systematizes various approaches to the understanding of the idea of agent diversity that are implicitly or explicitly presupposed in logical formalisms aimed at analysing agents' knowledge and beliefs, their intellectual capacities, as well as rational justification of their actions. This classification might serve as a conceptual ground for the solution of the problem of agent diversity in logical systems. We formulate the hypothesis that epistemic and goal-oriented parameters represent some sort of a superstructure built over the interpretation of deductive parameters of rational agent's behaviour.

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