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Knowledge and Behavior in Multiagent Systems (extended abstract)

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Agent's motivations are represented as preference, utility on global states of the system. So that agent's goal consists in maximization of his utility. Maybe not all motivations can be represented in this way, however this representation is formal and allows to focus on interactions between planning, mutual (common) knowledge, and decision making. Usually Bayesian behavior is considered as the only rational agent's behavior, i.e. the behavior that maximizes the utility. In the paper we introduce several new behaviors that take into acount agent's aspiration and acceptable risk levels. We show that these behaviors have nice properties and may also be considered as rational. Bayesian behavior is frequently rejected by experiments, so that new rational behaviors are of interest. In the literature, knowledge representation is completely separated from meaning, and even models of such knowledge, like Kripke structures or knowledge structures of Fagin, Halpern and Vardi, do not indicate how such knowledge may be used. On the other hand Wittgenstein's thesis says that knowledge can not be separated from its meaning or use, i.e. the meaning of knowledge is in its use. This thesis is satisfied in the case of reactive agents, however there the structure of knowledge is trivial. In the case of deliberative agents, the knowledge is represented as sentences in some (usually undecidable) logic. Someone may say that *knowledge-based protocol* gives a meaning to such knowledge, i.e. it determines a way in which the knowledge is used in decision making. However this protocol may be arbitrary, and checking which precondition of k–b protocol is true usually takes a lot of time and sometimes is impossible. Although we also represent knowledge as sentences in some formal language, we follow the Wittgenstein's thesis and divide the set of these sentences onto small types, and encounter natural transformations between these types. Rational behavior may be viewed as a k–d protocol defined on small part of agent's knowledge (called *ground type*). On the basis of this ground type we build a hierarchical structure of knowledge types, together with transformations from higher types, in the hierarchy, into the lower types, and finally into the ground type. That is, from any knowledge type, in the hierarchy, there are transformations, by lower types, into the ground type. We introduce simple (computationally and conceptionally) representation of mutual (common) knowledge that gives simple transformation of the knowledge into actions. This representation consists in introduction of an additional agent who trades in knowledge and sends to the agents knowledge about their opponents. In the paper we consider one–shot case, i.e. agents take actions only once, although before action taking they have so called preplay period for communication and reasoning. The full version of the paper is available by `mosaic http://www.ipipan.waw.pl/teksty/mas1.ps` The one–shot case is the first step to analyze the dynamic case that is considered in the companion paper avaiable by `http:// ... /mas2.ps` There we consider paradox of common knowledge and backward induction. Since these two notions are necessary for planning and reasoning about future, there is impossible to investigate seriously the dynamic multiagent systems without explanation of the reasons that cause this paradox. We argue that there are two reasons. The first one is that if mutual (common) knowledge is between agents who are at different moments of time, then the causality principle is violated. The second reason concerns the agent's identity. Agents are one and the same person if for any moment of time they have, at this moment, the same motivations, perception, behavior, and knowledge, and this is common knowledge between them. We apply an idea from the theory of inventory models. Usually to take an optimal action now, agent need not consider all his (or even have a complete) knowledge about future and other agents. In the next turn, when again he has to take an action, he will get more knowledge from perception and communication so that he will be able to take next optimal action. This simplifies decision making process of the agent, however it requires the calculation of what minimum knowledge and cooperation is needed to find an optimal action. On the basis of this idea we build a dynamic agent's architecture, define decision process, i.e. transformations from knowledge and belief into actions, and show how agent's knowledge and belief are changed over time.