Rule rather than Exception: Defeasible Probabilistic Dyadic Deontic Logic.

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We take probabilistic deontic logic [2] and make it defeasible using an argumentation method published in [3]. The specific probabilistic deontic logic we use is dyadic deontic logic [6][5][9] combined with a multi-agent variant of probabilistic logic [4]. More specifically, we will use the developed method of specifying an upper and a lower bound logic that will define the strict and defeasible rules of an $ASPIC^+$ framework [8][1]. The lower bound logic uses axiom system G of the Hansson-Lewis systems of Dyadic Deontic Logic combined with axioms for the probabilistic logic. And for the upper bound logic, the axioms of Upward and Downward inheritance introduced in [10] are added.

We consider the described framework as a framework that is used by an agent to describe specific elements of its surroundings and reason about it. The framework combines multiple operators namely: strict and defeasible implications ($\rightarrow$, $\Rightarrow$), permissions and obligations ($O(\phi|\psi)$, $P(\phi|\psi)$), agent specific probabilistic formulas ($\alpha * w_i(\phi) \geq \beta$), theory of mind formulas ($\alpha_1 * w_i(\alpha_2 * w_j(\phi) \geq \beta_2) \geq \beta_1$) and also strict and defeasible knowledge. An important question therefore is: "What is the difference between a defeasible permission and an uncertain permission?" The difference is that defeasible knowledge is debunkable while the uncertainty about something is not debunkable, if the uncertainty is not defeasible in the first place -Normally ϕ is permitted; I am uncertain whether ϕ is permitted–. Furthermore, we

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can express "normally I am uncertain whether ϕ is permitted." The work also opens up whether the framework should give preference to more certain information, i.e. $w_i(\phi) \geq 0.8$ versus $w_i(\psi) \geq 0.7$. There is more justification for ϕ than there is for ψ.

Consider the following example scenario of an agent learning about the rules of a library. The agent does not know that it is a rule to be silent in a library, and attempts to derive such rules without breaking them or explicitly asking other agents about the rules. While in the library, the agent will discover that most people are silent in the library, though that there are exceptions –for example at the checkout counter–. Furthermore, the agent will encounter an ambiguous situation in which people talk inside a room. Multiple explanations are possible in this case: it is allowed to talk inside the room, the people do not know about the rule to be silent, or the people do not care about the rule i.e. they are breaking the rule.

Furthermore, we set out to determine whether this framework is able to solve the paradox of epistemic obligation satisfyingly. A paradox of epistemic obligation goes as follows: (1) The bank is being robbed; (2) It ought to be the case that Jones (the guard) knows that the bank is being robbed; (3) It ought to be the case that the bank is being robbed [7]. The proposed solution is to consider the formulas in the knowledge base as known by the agent.

Lastly, notable future research is whether it is possible to lift syntax level probability to probability on argument level.

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