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Decision-Theoretic Meta-reasoning in Partially Observable and Decentralized Settings

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Abstract
This thesis examines decentralized meta-reasoning. For a single agent or
multiple agents, it may not be enough for agents to compute correct
decisions if they do not do so in a timely or resource efficient fashion. The
utility of agent decisions typically increases with decision quality, but
decreases with computation time. The reasoning about one's computation
process is referred to as meta-reasoning. Aspects of meta-reasoning
considered in this thesis include the reasoning about how to allocate
computational resources, including when to stop one type of computation
and begin another, and when to stop all computation and report an
answer. Given a computational model, this translates into computing how
to schedule the basic computations that solve a problem. This thesis
constructs meta-reasoning strategies for the purposes of monitoring and
control in multi-agent settings, specifically settings that can be modeled
by the Decentralized Partially Observable Markov Decision Process (Dec-

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POMDP). It uses decision theory to optimize computation for efficiency in time and space in communicative and non-communicative decentralized settings. Whereas base-level reasoning describes the optimization of actual agent behaviors, the meta-reasoning strategies produced by this thesis dynamically optimize the computational resources which lead to the selection of base-level behaviors.