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# Increasing Scalability in Algorithms for Centralized and Decentralized Partially Observable Markov Decision Processes: Efficient Decision-Making and Coordination in Uncertain Environments



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Abstract
As agents are built for ever more complex environments, methods that consider the uncertainty in the system have strong advantages. This uncertainty is common in domains such as robot navigation, medical diagnosis and treatment, inventory management, sensor networks and e-commerce. When a single decision maker is present, the partially observable Markov decision process (POMDP) model is a popular and powerful choice. When choices are made in a decentralized manner by a set of decision makers, the problem can be modeled as a decentralized partially observable Markov decision process (DEC-POMDP). While POMDPs and DEC-POMDPs offer rich frameworks for sequential decision making under uncertainty, the computational complexity of each model presents

an important research challenge. As a way to address this high complexity, this thesis develops several solution methods based on utilizing domain structure, memory-bounded representations and sampling. These approaches address some of the major bottlenecks for decision-making in real-world uncertain systems. The methods include a more efficient optimal algorithm for DEC-POMDPs as well as scalable approximate algorithms for POMDPs and DEC-POMDPs. Key contributions include optimizing compact representations as well as automatic structure extraction and exploitation. These approaches increase the scalability of algorithms, while also increasing their solution quality.