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BOOK OF ABSTRACTS

Smart Containers with Bidding Capacity: A Policy Gradient Algorithm for Semi-Cooperative Learning

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Abstract. Smart modular freight containers - as propagated in the Physical Internet paradigm - are equipped with sensors, data storage capability and intelligence that enable them to route themselves from origin to destination without manual intervention or central governance. In this self-organizing setting, containers may autonomously place bids on transport services in a spot market setting. However, for individual containers it might be difficult to learn good bidding policies due to limited observations. By sharing information and costs between one another, smart containers can jointly learn bidding policies, even though simultaneously competing for the same transport capacity. We replicate this behavior by learning stochastic bidding policies in a semi-cooperative multi-agent setting. To this end, we develop a reinforcement learning algorithm based on the policy gradient framework. Numerical experiments show that sharing solely bids and acceptance decisions leads to stable bidding policies. Real-time system information only marginally improves performance; individual job properties suffice to place appropriate bids. Furthermore, we find that carriers may have incentives not to share information with the smart containers. The experiments give rise to several directions for follow-up research, in particular the interaction between smart containers and transport services in self-organizing logistics.

Keywords: Self-Organizing Logistics, Smart Containers, Multi-Agent Reinforcement Learning, Bidding, Policy Gradient