MARL Cooperative Navigation of Multi-Robot Systems

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Multi-Agent Reinforcement Learning or MARL for short is a subfield of reinforcement learning that focuses on reinforcement learning of multiple agents in the same environment.

Unlike single-agent reinforcement learning, which can only interact with its environment, in the multi-agent setting, agents would be able to interconnect with other agents like what humans do naturally in our society, such as competing with each other where all agents seek to accomplish a goal over the other agents, cooperate where agents would work together to achieve a common goal or some sort of combination of both. And in our project, we would like to explore the idea of cooperation of multiple agents.

Cooperative AI[[1]](#footnote-1) using MARL has gained increasing attention over the years and radiates through a wide range of impactful fields, such as the AI Economist[[2]](#footnote-2) which aims to improve equality and productivity with AI-Driven Tax policies, the study of sequential social dilemmas which require multiple agents to learn policies that implement their strategic intentions[[3]](#footnote-3) and the study of reputation in cooperative systems[[4]](#footnote-4) to name a few, all of which can be integrated well into the study of strategic games and society protocols.

However there still remains a gap in the study of cooperative navigation problems of multi-robot systems, where the multi-robot system would together ascertain each other’s position, and then plan and follow a route or set up common protocols to achieve a common goal. This is a very interesting problem to tackle that can be useful in practical applications such as setting up protocols for multiple robots to do security patrolling[[5]](#footnote-5), collaborative exploration and navigation in difficult terrains to setup more effective rescues, collaborative navigation of warehousing robots for more energy efficient route and action planning and more.

Therefore, we have decided to incorporate Professor Musolesi’s speciality in MARL for autonomous systems and Professor Kanoulas’ expertise in perception and learning for robotics together and propose the research topic of cooperative navigation strategies of Multi-agent Reinforcement Learning agents for multi-robot systems. We aim to run full simulations in various simulated scenarios and also deploy onto physical robots to study a wide range of cooperative navigation problems and explore their potential practical applications.

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