# Multi-Agent Reinforcement Learning and its practical applications in games: a review of the literature

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## Abstract

Multi-agent reinforcement learning (MARL) has achieved tremendous success in various artificial intelligence domains such as the gaming industry. This literature review explores the theoretical foundations, principles, algorithms, applications, challenges, and recent advancements in MARL.

Algorithms such as Q-Learning, Policy-based algorithms, SARSA, and more algorithms have laid the groundwork for MARL by providing approaches to agent decision-making and learning. Q-decomposition methods have also further enhanced MARL by decomposing the global value function into local components, allowing for efficient coordination, and learning among agents (Russel & Zimdars, 2003).

The architectures employed in MARL range from centralised to decentralised, with each influencing the coordination and decision-making processes of agents in the environment. Centralised architectures, in which all agents share a single state representation and make collaborative decisions, provide benefits in terms of global coordination and information exchange. Decentralised architectures, on the other hand, encourage agent autonomy by allowing each agent to have its own state representations and decision-making procedures. These designs, when combined with communication and coordination mechanisms, enables MARL systems to model complex interactions and achieve emergent behaviours.

Beyond the gaming industry, MARL is extensively used in a variety of domains, including multi-robot systems, autonomous vehicles, and social dilemmas. Obstacles such as credit assignment, scalability, and ethical considerations persist, emphasising the importance of continued research and innovation in the field.

It is hoped that this paper will provide valuable insights for game developers and researchers regarding MARL and its challenges and advancements.

## Review of Literature

# References

Russel, S., & Zimdars, A. L. (2003). Q-Decomposition for Reinforcement Learning Agents. *Proceedings of the Twentieth Conference on Machine Learning* .