多智能体强化学习综述

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摘 要 多智能体系统是一种分布式计算技术,可用于解决各种领域的问题,包括机器人系统、分布式决策、交通控制和商业管理等。多智能体强化学习是多智能体系统研究领域中的一个重要分支,它将强化学习技术、博弈论等应用到多智能体系统,使得多个智能体能在更高维且动态的真实场景中通过交互和决策完成更错综复杂的任务。文中综述了多智能体强化学习的最新研究进展与发展动态,首先介绍了多智能体强化学习的基础理论背景,回顾了文献中提出的多智能体强化学习的学习目标和经典算法,其被分别应用于完全合作、完全竞争和更一般(不合作也不竞争)的任务。其次,综述了多智能体强化学习的最新进展,近年来随着深度学习技术的成熟,在越来越多的复杂现实场景任务中,研究人员利用深度学习技术来自动学习海量输入数据的抽象特征,并以此来优化强化学习问题中智能体的决策。近期,研究人员结合深度学习等技术,从可扩展性、智能体意图、奖励机制、环境框架等不同方面对算法进行了改进和创新。最后,对多智能体强化学习的应用前景和发展趋势进行了总结与展望。目前多智能体强化学习在机器人系统、人机博弈、自动驾驶等领域取得了不错的进展,未来将被更广泛地应用于资源管理、交通系统、医疗、金融等各个领域。

关键词 强化学习,多智能体系统,博弈论,多智能体强化学习,深度学习

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Overview on Multi-agent Reinforcement Learning

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Abstract Multi-agent system is a distributed computing technology, which can be used to solve problems in various fields, including robot system, distributed decision-making, traffic control and business management. Multi-agent reinforcement learning is an important branch in the field of multi-agent system research. It applies reinforcement learning technology and game theory to multi-agent systems, enabling multiple agents to complete more complicated tasks through interaction and decision-making in higher-dimensional and dynamic real scenes. This paper reviewed the recent research progress and development of multi-agent reinforcement learning. Firstly, the theoretical background of multi-agent reinforcement learning was introduced, and the learning objectives and classical algorithms of multi-agent reinforcement learning proposed in the literature were reviewed, which are respectively applied to complete cooperation, complete competition and more general (neither cooperation nor competition) tasks. Secondly, the latest development of multi-agent reinforcement learning was summarized. With the maturity of deep learning technology in recent years, in more and more complex realistic scene tasks, researchers use deep learning technology to automatically learn abstract features of massive input data, and then use these data to optimize the decision-making of agents in reinforcement learning. Recently, researchers have combined deep learning and other technologies to improve and innovate algorithms in different aspects, such as scalability, agent intent, incentive mechanism, and environmental framework. At the end of this paper, the prospect of the application of multi-agent reinforcement learning were summarized. Multi-agent reinforcement learning has made good progress in the fields of robot system, man-machine game and autonomous driving, and will be applied in the fields of resource management, transportation system, medical treatment and finance in the future.

Keywords Reinforcement learning, Multi-agent systems, Game theory, Multi-agent reinforcement learning, Deep learning

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