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Prospects for multi-agent collaboration and gaming: challenge, technology, and application

Key words: Multi-agent; Game theory; Collective intelligence; Reinforcement learning; Intelligent control

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Motivation

1. Multi-agent systems, which aim to understand complex environments and adaptively make decisions to compete with humans or other agents, have become hot topics in both academia and industry.

2. Although many aspects of multi-agent systems have been reviewed, recent surveys focus on either a sub-domain, such as cooperative multi-agent systems, or specific methods, such as deep reinforcement learning.

3. In this study, we spotlight several new research directions that are comparatively underexplored in existing reviews and hope to provide some insights for future multi-agent collaboration and gaming research areas.

Main idea

1. We introduce some open issues and challenges in this area.

2. We provide an outlook on technical directions that may bring some insightful thinking of these research challenges.

3. We bring some prospects of the application areas for multi-agent collaboration and gaming.

Challenge

1. It is still an open issue with great challenges to construct a more realistic multi-agent environment.

2. Different from single-agent systems, multi-agent systems naturally consist of multiple agents with various sensors. The collaboration of different agents is a major task that cannot be ignored.

3. Multi-agent gaming requires an understanding of adversary behaviors in addition to competitive environments and the ability to adaptively make decisions to achieve the task targets or obtain higher scores than competitors.

Technology

1. There has been tremendous success in computer vision and computer graphics. Computational simulation technologies, such as Digital Twin and Metaverse, have been developed to construct three-dimensional environments that can reflect real objects and physical user interactions.

2. The collaboration of multiple perceptions is another research direction for multi-agent systems.

3. Transfer learning and multi-task learning are considerable methods for improving the generalization performance and adaptively transferring the knowledge from one task to another in multi-agent gaming.

Application

1. The control of swarm robotic systems or unmanned aerial vehicles is a prominent application area.

2. Another application area attracting wide attention is the game artificial intelligence (AI).

3. There are also many industrial applications, such as energy management, urban traffic control, and sport AI.

Conclusions

1. We briefly introduced some open issues and task challenges from three major perspectives: the multi-agent environment, collaboration, and gaming.

2. We provided an outlook on the technical directions that may bring some insightful thinking of the research challenges.

3. We provided an outlook on the multi-agent collaboration and gaming application areas.