VRG25-019 - Multi-Player Artificial Intelligence

Abstract

Human intelligence develops in social settings where cooperation and competition intersect, enabling us to make complex decisions. Similarly, modern AI systems rely on competing objectives to refine their performance through iterative learning. Yet, many AI systems today fall short when applied to real-world, multi-player scenarios beyond simple proof-of-concept setups. The core challenge lies in developing advanced solution concepts that not only track how strategies evolve over time but also ensure reliable learning in complex, data-driven environments.

MultiPlayerAI focuses on three intermixed main goals, (1) Better Optimization for Multi-Player Games, (2) Building Foundational Equilibria Frameworks for Dynamic Multi-Player AI Systems, (3) Advancing Multi-Player AI, Especially multi-agent reinforcement learning (MARL) and Socially-Conscious Agents.
The project is structured in five working packages, as follows.

- Aims to develop algorithms and theoretical guarantees of provable global convergence to a (local) solution--a currently open problem in game optimization.
- By focusing on dynamic solutions that capture how agents learn and adapt over time while aligning their incentives with evolving strategies, this project aims to open new frontiers for using AI in competitive, multi-agent settings.
- As training competing large (language) models is computationally expensive, this project develops computation–, communication–, and sample–efficient game optimization methods.
- Leveraging breakthroughs in reinforcement learning and deep learning, MultiPlayerAI seeks to bridge the gap between theoretical advancements and practical applications.
- Another key focus of the project is designing learning dynamics and data-driven models that prioritize social welfare, fostering cooperation when it benefits the greater good. The findings of this project have the potential to revolutionize fields like finance, economics, resource management, and autonomous systems, where multi-agent interactions are critical. Overall, by addressing fundamental challenges in multi-player AI, MultiPlayerAI aims to unlock new possibilities, amplifying AI's positive impact on society and paving the way for more adaptive, resilient, and socially beneficial AI systems in the future.

Scientific disciplines:
Machine learning (50%) | Theoretical computer science (50%)

Keywords:
Multi-Player AIOptimization Game Theory

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Further links to the persons involved and to the project can be found under
https://www.gmbh.wwtf.at/funding/programmes/vrg/VRG25-019/