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Intelligent Economic Simulation:Genetic Agents and RL-Based Policy Optimization

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Abstract: *This paper presents GAO-RL (Genetic Agent Optimized Reinforcement Learning), a hybrid economic simulation framework that integrates Genetic Algorithms (GA) with Reinforcement Learning (RL)[2][17] in an Agent-Based Modeling (ABM)[11][12]environment. Traditional models lack adaptability, while existing Multi-Agent Reinforcement Learning (MARL) [2][5] approaches suffer from scalability and weak theoretical grounding. GAO-RL bridges this gap by combining the exploratory efficiency of GA with the policy stability of RL, anchored in theBewley–Aiyagari model of macroeconomics.*

The framework models an economy with households, firms, a central bank, and a government, each pursuing distinct objectives. Genetic agents enable diverse behavioral exploration, while PPO-based RL agents ensure stable policy optimization. This synergy produces a more realistic and interpretable simulation of dynamic economic systems, offering a robust foundation for data-driven economic policy design and optimization.

Keywords: Genetic Agent, Agent-Based Modeling (ABM), Multi-Agent Reinforcement Learning (MARL), Genetic Agent Optimized Reinforcement Learning (GAO-RL), Economic Simulation, Policy Optimization

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