

# Clustering Behavior in Multi-Agent Reinforcement Learning

Clustering-TorchRL Team

# Motivation

- Multi-agent coordination is a fundamental challenge in reinforcement learning
- Emergent clustering behavior appears in many real-world systems
- Reinforcement learning provides a framework to study cooperative dynamics

# Project Goals

- Implement a custom multi-agent environment
- Train agents using PPO
- Ensure reproducibility and modularity
- Provide a clean and configurable experimentation pipeline

- Grid-based environment named AntSorting
- Multiple agents act simultaneously
- Shared state and cooperative reward structure
- Environment parameters configurable via Hydra

# Learning Setup

- Proximal Policy Optimization
- TorchRL framework
- Centralized training
- Decentralized execution
- Shared policy among agents

# System Architecture

- Environment module
- Agent module
- Algorithm module
- Training and evaluation pipeline
- Logging and metrics

# Configuration and Experiments

- Hydra manages all configurations
- Easy parameter overrides
- Support for experiment sweeps
- Reproducible results

# Reproducibility

- Dockerized execution
- Version-pinned dependencies
- Platform-independent setup
- Single-command execution

- Smoke tests for environment and pipeline
- Metric validation
- Ensures stable execution

# Team Contributions

- Project architecture and environment design
- Algorithm implementation and configuration
- Testing and debugging
- Documentation and reproducibility

# Challenges

- Dependency management
- Multi-agent training stability
- Docker build size and performance

# Outcomes

- Successful training of cooperative agents
- Fully reproducible workflow
- Modular and extensible codebase

# Conclusion

- Demonstrated a complete MARL pipeline
- Applied reinforcement learning concepts in practice
- Built a reproducible and configurable system