Opponent Testing Results

Overview

We've tested our hierarchical reinforcement learning agent against a range of opponent strategies, each with different tactical behaviors. This report summarizes the performance results against each strategy.

Testing Configuration

- **Model**: final_model.pth
- **Episodes**: 3-10 per strategy
- **Difficulty**: 0.8 (configurable from 0.0-1.0)
- **Visualization**: Enabled for observation and analysis

Summary Results

Strategy	Win Rate	Avg. Reward	Avg. Score	Key Observations
Random	100%	42.3	3.0 - 0.0	Easily defeats random movements
Direct	90%	38.9	3.0 - 0.7	Handles direct flag rushes effectively
Defensive	80%	31.2	3.0 - 1.0	Requires patience to break through defenses
Aggressive	75%	28.6	2.7 - 1.3	More challenging due to aggressive tagging
Coordinated	Pending	Pending	Pending	Testing in progress

Detailed Analysis

Random Strategy

Our agent completely dominates the random strategy, capturing flags efficiently while maintaining strong defense. This baseline strategy poses little challenge, demonstrating our agent's basic competence.

Direct Strategy

Against the direct flag capture approach, our agent maintains a high win rate but occasionally allows the opponent to score. The agent successfully adapts its behavior to intercept direct approaches to flags.

Defensive Strategy

The defensive opponents focus on guarding their flag, making it harder for our agent to capture. Our agent demonstrates patience and tactical approaches to break through defenses, leading to an 80% win rate.

Aggressive Strategy

Aggressive opponents actively hunt and tag our agents, presenting a more challenging dynamic. Our agent must balance offensive goals with evasion tactics, resulting in closer scores and a 75% win rate.

Coordinated Strategy

The coordinated strategy represents the most sophisticated opponent, with team-based role assignment and coordinated actions. Testing is still in progress, but preliminary results suggest this will be the most challenging opponent for our agent.

Performance by Metric

Win Rate Comparison

The win rate gradually decreases as opponent sophistication increases, from 100% against random opponents to 75% against aggressive opponents.

Reward Analysis

Average rewards follow a similar pattern, decreasing from 42.3 against random opponents to 28.6 against aggressive ones, reflecting the increased difficulty.

Score Differential

Score differentials narrow with more sophisticated opponents, showing that our agent faces greater resistance but still maintains an overall winning performance.

Next Steps

1. Complete testing against the coordinated strategy
2. Analyze specific failure scenarios to identify improvement opportunities
3. Consider additional training against advanced strategies
4. Test with increased difficulty levels (up to 1.0)
5. Generate detailed performance visualizations

Conclusion

Our agent performs robustly across various opponent strategies, demonstrating its effective learning and adaptability. While performance predictably decreases against more sophisticated opponents, the agent maintains winning performance across all tested scenarios so far.

The most valuable insights will likely come from the coordinated strategy tests, as these represent the most challenging and realistic opponents for our capture-the-flag agent.