Planet Wars RTS

Team Titans
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Agent Overview & Core Strategy

- **Team Titans**: 5 agent versions for Planet Wars RTS
- **Full Observability**: V1 (heuristic) $\rightarrow$ V2 (lookahead) $\rightarrow$ V3 (refined)
- **Partial Observability**: PartialV1 $\rightarrow$ PartialV2 (state reconstruction)
- **Core Innovation**: Multi-factor heuristic + forward simulation planning
- **Time Constraints**: 100ms real-time decision making
- **Final Submissions**: TeamTitansAgentV3 & TeamTitansPartialAgentV2

Technical Approach:

- Growth-focused evaluation (3.0) + distance optimization (2.0) + efficiency (1.0) + threat assessment (1.5)
- Forward simulation with dynamic horizon (25-100 ticks)
- State reconstruction for partial observability using GameStateReconstructor

System Design & Architecture

Full Observability Pipeline:

1. Generate source-target pairs
2. Forward simulate 25-100 ticks
3. Evaluate: (myShips - oppShips) + 10×(myGrowth - oppGrowth)
4. Select best action within 90ms

Partial Observability:

1. Reconstruct hidden state
2. Assess uncertainty metrics
3. Adapt horizon dynamically
4. Apply uncertainty factor: $u = \max(0.6, 1.0 - 0.1 \times \text{unknownPlanets})$

Key Optimizations:

- Precomputed distance matrices, dynamic horizon tuning, time-bounded search
- Conservative ship estimation with graduated uncertainty reduction

Results & Performance Analysis

Full Observability

Agent	Win Rate
V1 (Heuristic)	81.8%
V2 (Simulation)	86.5%
V3 (Final)	**99.5%**

Partial Observability

Agent	Win Rate
PartialV1	20.0%
PartialV2	**99.8%**

Baseline Agents & Testing Scale:

- **Baselines**: BetterRandomAgent, CarefulRandomAgent, PureRandomAgent, SimpleEvoAgent (EvoAgent-400-30-0.8-true)
- **Tournament Scale**: **600 games per agent** for comprehensive evaluation

Performance Highlights:

- **Near-perfect performance**: 99.5% & 99.8% win rates against all baselines
- **Consistent dominance**: Outperformed EvoAgent and all random baselines

Analysis and Insights

- **Planning Horizon Sweet Spot**: 50-75 ticks optimal balance
  - Too short: missed strategic opportunities
  - Too long: computational overhead & timeouts
- **Uncertainty Handling**: Critical for partial observability
  - State reconstruction $\gg$ conservative estimation
  - Information gathering through "attack scouting"
- **Time Management**: 90ms internal limit crucial for competition
- **Emergent Behaviors**:
  - Multi-step tactical sequences
  - Adaptive aggression based on information quality
  - Economic focus with tactical finishing
- **Parameter Robustness**: Consistent performance across 10-30 planets, variable speeds

Research Contributions & Future Directions

Research Contributions:

- **RTS Planning Framework**: Integration of heuristics with forward simulation under real-time constraints
- **Practical POMDP Handling**: State reconstruction approach that avoids full belief-state maintenance
- **Iterative Development Methodology**: Demonstrated systematic agent improvement (V1→V2→V3)
- **Uncertainty Modeling**: Graduated uncertainty factors for decision-making under incomplete information

Future Research Directions:

- **Opponent Modeling**: Move beyond passive opponent assumption
  - Minimax/expectimax planning with learned opponent models
  - Online adaptation to opponent strategies
- **Advanced Search**: MCTS and Information Set MCTS adaptation
- **Learning Integration**: Neural network evaluation functions, reinforcement learning
- **Enhanced Uncertainty**: Belief state maintenance, particle filters,