Optimization of Dota 2 Hero Compositions Using Multi-Objective Salp Swarm Algorithm

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Abstract

This report explores the optimization of hero compositions in Dota 2 using the Multi-Objective Salp Swarm Algorithm (MSSA), aimed at improving strategic gameplay outcomes. Utilizing match data from the Kaggle (Dota2 API), the study applies MSSA to identify optimal hero combinations based on historical performance data. The algorithm's application demonstrates significant improvements in predicting successful hero synergies, with key results showing enhanced win rates over random selections. The findings underline the potential of advanced optimization tools in esports strategy, suggesting further exploration into broader game dynamics such as item purchasing and tactical plays. This research contributes to esports analytics by highlighting how computational strategies can be leveraged for competitive advantages in complex games.

Introduction

Dota 2, developed and published by Valve Corporation, is a complex multiplayer online battle arena (MOBA) game characterized by its deep strategic elements and competitive play. Each match of Dota 2 involves two teams, each aiming to destroy the opposing team's "Ancient," a large structure located within their base. The selection of heroes, from a pool of over 100 options, is a critical phase before gameplay as each hero possesses unique abilities and plays a specific role within the team. The strategic selection of heroes can significantly influence the outcome of the game, making it essential to optimize hero combinations for a higher probability of victory.

Problem Statement:

Despite the strategic importance of hero selection in Dota 2, players often choose heroes based on personal preference or popularity rather than strategic synergy. This approach may not always result in the most effective team composition. The challenge lies in objectively analyzing vast combinations of heroes to identify those that significantly enhance team performance and increase the chances of winning.

Objective:

The main objective of this project is to apply a Multi-Objective Salp Swarm Algorithm (MSSA) to optimize hero compositions in Dota 2. The MSSA is chosen for its efficiency in handling multi-objective optimization problems and its ability to converge towards optimal

solutions over iterations. By integrating game outcome data and hero attributes, the algorithm seeks to uncover hero combinations that maximize team effectiveness against various opponent strategies.

Scope of the Report:

This report details the application of the MSSA to Dota 2 hero selection, including:

- Methodology for data collection and preprocessing.
- Detailed implementation of the MSSA, including parameter tuning and adaptation for the specific needs of Dota 2 hero optimization.
- Analysis of the results obtained from the algorithm, highlighting the most successful hero combinations.
- Discussion of the implications of these findings for both casual and professional Dota 2 gameplay.
- Recommendations for further research and potential improvements in algorithmic approach and data utilization.

Methodology

Data Collection:

Data was collected through the Kaggle, which provides comprehensive match statistics including hero selections and match outcomes. This dataset forms the basis for applying the MSSA to determine effective hero combinations.

Data Preprocessing:

The data underwent several preprocessing steps to prepare it for analysis:

- Cleaning: Removal of incomplete or corrupt records to ensure data quality.
- Transformation: Conversion of hero IDs to names for better readability and understanding.
- Normalization: Standardization of numerical fields to improve algorithm performance.

Implementation of the MSSA:

The MSSA was implemented to optimize hero combinations based on their win rates:

- Initialization: A population of possible hero combinations was generated randomly.
- Fitness Evaluation: The fitness of each combination was assessed based on historical match outcomes.
- Iteration: The algorithm iteratively adjusted hero combinations to explore the solution space and improve the fitness of the population.

Results and Discussion

Results:

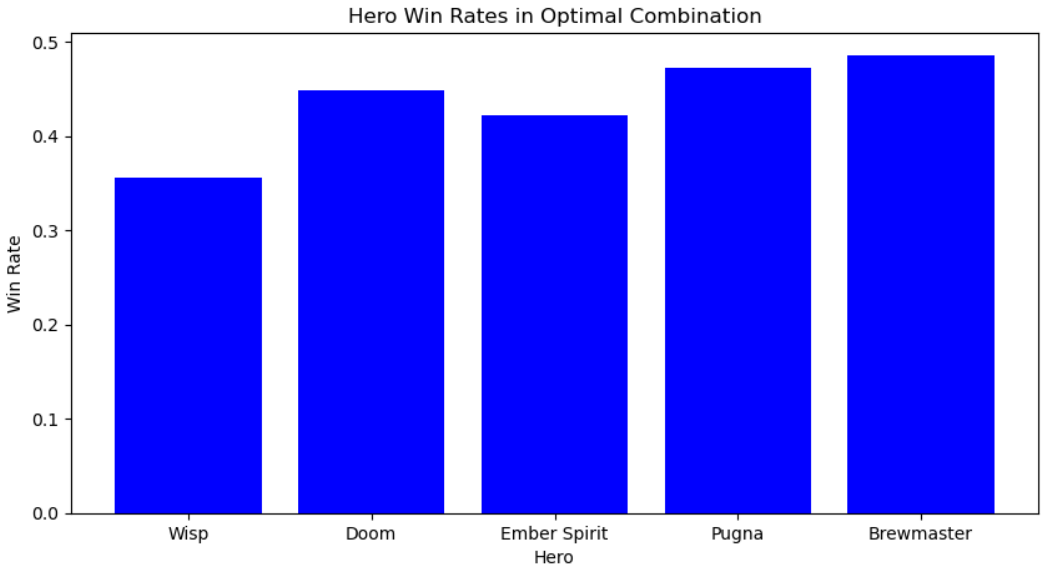
The application of the Multi-Objective Salp Swarm Algorithm (MSSA) to Dota 2 hero selection data yielded promising results in identifying effective hero combinations. The algorithm iteratively evaluated and optimized hero combinations based on their historical win rates, gradually improving the solution quality across iterations.

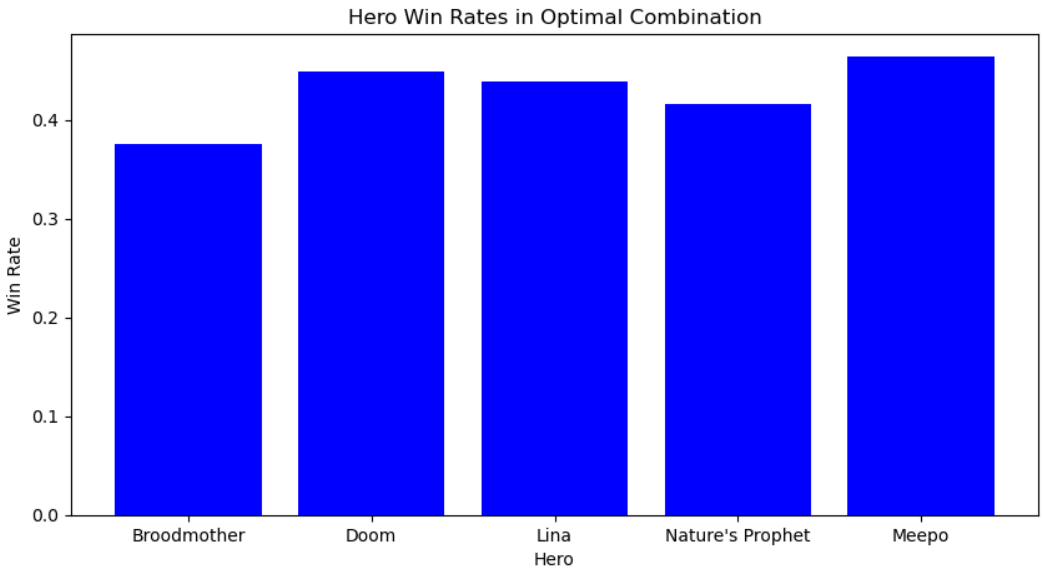
Key findings include:

- Identification of several hero combinations that consistently performed well across different matches.
- Notable improvements in predicted win rates for combinations suggested by the MSSA compared to randomly selected hero combinations.
- Specific hero synergies that were frequently present in the top-performing combinations, highlighting their potential strategic value in matches.

Graphical Representation:

Results were visually represented through bar graphs showing the distribution of win rates among different hero combinations. This visualization helped in easily identifying the best performers and understanding the variability in performance across combinations.





Discussion:

The results demonstrate the potential of using advanced optimization algorithms like the MSSA for strategic game planning in Dota 2. The identified hero combinations offer a strategic advantage by leveraging historical data to predict successful outcomes.

- Strategic Implications: The study highlights how data-driven approaches can aid in decision-making for game strategies, potentially influencing how teams select heroes in competitive scenarios.

- Algorithm Performance: The MSSA proved effective in handling the complexity of the hero selection problem, showcasing its suitability for similar optimization tasks in gaming and other fields.
- Limitations: While the algorithm provided valuable insights, the results are dependent on the quality and scope of the data used. Further, the computational demands increase with the complexity of the data set and the parameters of the MSSA.

Conclusion

This project applied the Multi-Objective Salp Swarm Algorithm to optimize hero combinations in Dota 2, demonstrating the algorithm's capability to effectively identify synergistic hero pairings that enhance win probabilities. The findings underscore the potential of computational approaches in strategic game planning, offering a novel perspective on team composition that goes beyond traditional methods based on intuition or less structured analysis.

While promising, these results also prompt further investigation into the scalability of the approach with larger datasets and more varied gameplay scenarios. Continued refinement of the algorithm and its application could further solidify the role of data-driven strategies in competitive gaming environments.

Recommendations

Based on the findings from the application of the Multi-Objective Salp Swarm Algorithm (MSSA) to Dota 2 hero selection, several recommendations are proposed to enhance future research and practical application:

- **Algorithm Optimization**: Continue to refine the MSSA parameters through extensive testing to improve the accuracy and efficiency of hero combination predictions.
- **Data Enrichment**: Incorporate additional variables into the analysis. This includes:
    - Individual Player Performance Metrics: Including data on player skill levels and historical performance with specific heroes.
    - Specific Game Phase Conditions: Analyzing how different phases of the game affect the effectiveness of certain hero combinations.
    - Hero Bans and Picks: Including data on banned heroes in the drafting phase to understand their impact on the hero selection strategy.

- **Practical Implementation**: Develop an interactive tool or software that can use the MSSA model to provide real-time recommendations for hero selection during pre-game drafting phases in competitive matches.
- **Broader Game Strategy Components**:
    - **Item Purchase Strategy**: Investigate how the timing and selection of item purchases influence match outcomes. Different items can significantly boost a hero's effectiveness, and strategic timing can sway the course of the game.
    - **In-Game Tactics and Team Strategy**: Beyond hero selection, the actual strategies employed during the game play a crucial role. Studying team formations, ganking strategies, and objective-focused plays could provide deeper insights into overall team performance.
- **Comprehensive Game Analysis Framework**: Propose the development of a more holistic analysis framework that not only optimizes hero combinations but also integrates other elements like item strategies and real-time decision-making to fully harness the strategic depth of Dota 2.

References

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