Policy-Value Network for Budget Constrained Sequential Multi-Item English Auction

— Machine Learning Project —

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Contents

Abstract

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1 Introduction

In fantasy football leagues, player selection often occurs through an auction mechanism in which participants bid for multiple players sequentially while managing a limited budget. This setting can be formally modeled as a *budget-constrained sequential multi-item English auction*, where each agent must strategically allocate resources across rounds, balancing between immediate opportunities and long-term goals.

Traditional auction theory provides analytical insights into single-item or simultaneous multi-item settings, but real-world fantasy football drafts introduce additional complexity. Agents must reason dynamically under uncertainty, learning optimal bidding policies as new information (such as opponents' remaining budgets or players' availability) unfolds.

Recent advances in artificial intelligence, particularly in reinforcement learning, have demonstrated how *policy–value networks* can learn to approximate optimal strategies in complex sequential decision problems. Inspired by models such as AlphaZero, this work proposes to apply a policy–value approach to auction environments, enabling agents to make data-driven and adaptive bidding decisions.

The objective of this study is to explore how a policy–value network can be designed, trained, and evaluated within the fantasy football auction framework. The research combines concepts from auction theory, machine learning, and game theory to provide a computational perspective on strategic resource allocation under constraints.

2 Background and Related Work

This section will review the theoretical foundations of English auctions, budget constraints, and sequential decision-making, as well as related work in deep reinforcement learning and auction design.

3 Modeling the Auction Environment

Describe the auction setup, bidding rules, and constraints. Define the state space, actions, and reward functions.

4 Policy–Value Network Architecture

Explain the neural network design, input representation, and training algorithm.

5 Experiments and Results

Summarize simulation setup, performance metrics, and comparison with baseline bidding strategies.

6 Discussion and Future Work

Discuss findings, limitations, and possible extensions such as incorporating opponent modeling or real fantasy football data.

7 Conclusion

Conclude with the main insights on how policy–value methods can enhance bidding efficiency and fairness in sequential auction environments.

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