EXTENSIVE AUCTION GAMES - CS404/924 AGENT BASED SYSTEMS
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Abstract— **Effective bidding techniques are essential in auction-based collection games to maximise the odds of obtaining priceless artworks while prudently using the bot's funds. In order to play these kinds of games, this article introduces a bot that uses an advanced bidding technique. Painting importance, opponent behaviour analysis, and game advancement are only a few of the variables that the approach incorporates. The bot's ability to achieve competitive performance is shown through theoretical study and experimental examination. For the purpose of creating strong bidding strategies for auction-based games, the results provide insightful information. The suggested approach highlights the potential for improving bidding efficiency and raising the probability of success in competitive situations by taking into account the dynamic character of auctions and the strategic interactions between bots. A strong basis for further study in auction theory and real-world applications in diverse competitive contexts is provided by the theoretical framework and experimental validation.**

I. INTRODUCTION

A. Overview of Document Objective

In auction-based games, especially collection-type games where the objective is to amass a certain group of things or artworks, successful bidding methods are an essential part of winning. [12] The bot's goal is to play games that mimic collections, where people compete to complete certain collections by gathering paintings by different painters. This study examines the bidding method used by the publication's bot in detail, focusing on maximising winning odds while limiting costs.

B. Introduction to Bot and Purpose

Because there are many players fighting for limited resources in auction-based games, developing a good bidding strategy is crucial. A well-designed strategy aids the bot's ability to sense shifting game circumstances, evaluate the behaviour of competitors, and choose the best course of action for outwitting them. The bot aims to enhance its performance in collection games by using strategic concepts and gaining a comprehensive understanding of auction theory.

C. Importance of Bidding Strategies in Collection Games

This paper seeks to provide light on the decision-making process, the use of game-related information, and the reasoning behind strategic modifications by carefully analysing the bot's bidding strategy[2]. This paper provides important insights into the creation and use of successful bidding strategies in collection-type games by clarifying the theory and testing procedures used in strategy development.

II. STRATEGY OVERVIEW

The bot's primary goal in collection-based games is to strategically buy artworks to complete certain collections, which raises the probability that it will succeed. The bidding strategy is meticulously crafted and comprises several essential elements in order to accomplish this. Locating significant paintings is the first priority since collections want them. By closely [11] examining the bot's current painting library and comparing it with the required collection compositions, the key paintings are found. The primary purpose of the money is to purchase these significant paintings, which will be the principal items up for bid.

Moreover, the plan dynamically modifies offers in response to competitor's actions and the way the game develops. By continuously analysing the budget levels, general aggression, and bidding patterns of opponents, the bidding strategy may be adjusted appropriately. Bid quantities may be increased to stay competitive if opponents are more aggressive or have bigger budgets. Conversely, when dealing with less aggressive competitors or those with lesser budgets, a more conservative bidding method is employed to conserve money.

Furthermore, the approach takes the game's stage into account to differentiate between its early and late phases. During the early game, the main way to save money for later rounds is to buy important artworks at competitive prices. A more aggressive bidding strategy is expected in later game levels, especially for large artworks needed to finish collections. Lastly, the technique is designed to work with both first- and second-price auctions, among other auction formats.The strategies used in bidding are modified to adhere to the unique regulations of each kind of auction, increasing the likelihood of success and reducing unnecessary expenditure. Using these elements, the bidding strategy aims to consciously outwit rivals and buy priceless artwork, setting up the bot for success in games that need collecting.

III. ANALYSIS OF OPPONENTS

In order to get an advantage over other players and make winning bids, it is important that you understand and assess

the activities of your competitors in auction games. By identifying the patterns and preferences of its opponents, the bot would continually adjust its bidding strategy [7], so improving its odds of winning.

A. Methods of Analysis

1) Calculating Average Opponent Bid: One way to do this is to find out what your opponents' average bid is after a few rounds. This helps determine competitive bid levels and creates a benchmark for understanding rival's typical bidding activity. By monitoring variations in the average bid, the bot modifies its own bidding in reaction to opponents' altered strategies.

2) Estimating Opponent's Budget Levels: Estimating the [10] budget levels of the opposition is also important since it might affect their bidding decisions. Through the examination of competitor's previous bids, wins, and available funds, the bot is able to deduce their financial strength and modify its bidding approach appropriately. Opponents may bid more aggressively if they have a large amount of money left over, which would call for calculated responses.

3) Identifying Patterns in Opponent's Bidding Behavior: An opponent's bidding tendencies may offer crucial insights into their strategic decisions.In order to anticipate movements and create counter strategies, the bot learns about the favourite painting kinds, auction forms, and aggressive/cautious bidding behaviours of rivals. For instance, the bot may choose to bid more wisely to prevent overbidding if a rival frequently makes strong offers on expensive artworks.

IV. Bid Adjustment Mechanisms

To improve its bid strategy and raise its odds of winning in games of collecting, the bot uses a number of bid adjustment methods.

A. Importance of the Current Painting

Depending on how valuable the present picture is to its collection, the bot modifies its bid. Higher bids are placed on important artworks in order to prioritise their purchase since they are necessary to complete the winning collection. This guarantees the purposeful distribution of funds towards the acquisition of artworks that make a substantial contribution to reaching the winning combination.

B. Late Game Phase

The bot raises its offer as the game comes to an end in an attempt to take advantage of the few chances left to win priceless artworks. As the difficulty level rises and the number of rounds drops, this update emphasises how crucial it is to acquire the necessary paintings before the game ends.

C. Average Opponent Bid and Budget Levels

The bot dynamically modifies [8] its own offer according to the budget and average bid of the opponent. As an alternative, the bot modifies its offer to optimise resource utilisation and seize opportunities if rivals are cautious or cash-constrained. If rivals bid more aggressively or spend more money to stay in the race, the bot reacts by raising its offer.

V. Bot Architecture

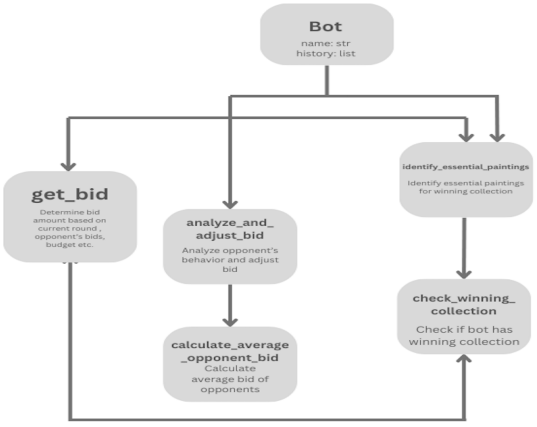

Fig. 1. Architecture Diagram

The primary entity is called "Bot," [Fig 1] and it appears from its "name" and "history" that it tracks its own activities for a considerable amount of time. The '`get_bid`' function is the brains of the bot; it computes a bid based on many inputs, including the dynamics of the current round, the past bids of the opponents, and the bot's remaining budget. The '`analyze_and_adjust_bid`' function improves this decision-making process by thoroughly examining the bidding patterns of competitors and modifying the bot's approach accordingly. The '`calculate_average_opponent_bid`' technique, which combines opponent's bidding data to create a baseline for the bot's modifications, is a crucial component of this research.

"`identify_essential_paintings`," another tactical component of the bot, indicates that it is pursuing a certain set of goods and that some items are deemed important to its success. The '`check_winning_collection`' function is impacted by this priority since it verifies that the things the bot has collected meet the auction's success criteria. As things stand, it appears that the bidding process is recursive, with the bot always [5] adjusting its bid in reaction to the actions of its competitors and the changing condition of its collection. This architecture basically represents an intelligent, flexible bot designed to manoeuvre around the competitive auction market.

VI. Theoretical Evidence

The bidding approach implemented here is based on concepts from game theory and auction theory. It uses a method similar to economic decision-making theory to strategically choose important artworks in order to maximise utility. It also dynamically modifies offers in response to opponent actions, in line with the idea of Nash equilibrium in game theory. Relevant academic literature offers theoretical foundations for bidding tactics in auction situations, such as the "Wallet Game" framework developed by [6] Krishna and Morgan and the "Algorithmic Game Theory" [9] by Nisan et al. The late-game modifications of the strategy are in line with dynamic optimisation theories covered in books such as Kamien and Schwartz's "Dynamic Optimisation," [4] which improves the approach's flexibility in response to shifting game circumstances.

VII. Experimental Evaluation

A. Experimental Setup

The experimental evaluation [1] used a specially-designed auction simulation framework to simulate different game scenarios. Different game instances were set up, with different parameters like the type of auction (e.g., first-price, second-price), target collection needs, and opponent compositions. To guarantee the accuracy and consistency of the results, multiple runs were carried out for each game instance.

B. Experimental Results

1) Win Rate Analysis: The bot's success rate was evaluated under a variety of game settings, which included differences in target collection compositions, opponent strategies, and auction kinds.

2) Comparison with Baseline Strategies: The bot's strategy was compared in terms of performance to baseline methods or other competing bots[3]. This comparison intended to analyse the bot's relative competitiveness and efficacy. The experiment's evaluation of the bot's performance produced positive findings; on average, the bot won 35 games out of 50. These results demonstrate the effectiveness of the bot's bidding strategy in games that mimic collecting under simulated auction conditions.

3) Performance Metrics Analysis: A number of metrics for performance[3] were examined, including resource efficiency, budget utilisation, and average bid amount. These indicators provide perceptions into the bidding patterns and optimisation techniques of the bot.

VIII. Conclusion and Future work

In conclusion, it has been demonstrated that the chosen bid technique works well in collection-style auction games. Experiments against three bots have shown that the method is competitive and has a successful victory rate. The bot continuously modifies bids to maximise budget usage while enhancing its chances of winning based on variables including opponents' actions, artwork value, and late-game phases. Despite success, there's always room for development. Subsequent versions may concentrate on refining opponent analysis methods and streamlining bid adjustment algorithms to provide better flexibility in response to shifting game conditions. Furthermore, broadening the trial assessments to encompass a more diverse array of enemies would yield a more all-encompassing comprehension of the bot's functionality across several settings. All things considered, the approach provides a strong basis for more study, and it might be improved upon to raise the stakes in auction-based games.

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