# wangagent: A Hierarchical Agent for Automated Negotiation Competitions

Wang Xue[1*] [*] [1]School of Information Engineering, Chongqing University, China
[1476900445@qq.com]

June 10, 2025

**Abstract**

This paper presents the technical architecture of wangagent, an automated negotiation agent developed by the wangcq team. The agent adopts a hierarchical coordination design: the central decision layer optimizes multi-round negotiations via dynamic programming, while the edge execution layer generates local strategies by integrating time-based concession models with adversarial environment adaptation mechanisms. Experimental results demonstrate that this architecture exhibits strong strategic adaptability and decision stability in complex negotiation scenarios, effectively handling diverse interaction contexts and opponent behavior patterns.

## 1 Introduction

The core challenge in automated negotiation research lies in enabling agents to balance short-term gains with long-term strategies in multi-issue interactions, while responding effectively to dynamically changing opponent behaviors. Wangagent addresses this challenge through an innovative hierarchical design, decoupling global strategy planning from local decision execution. The central layer manages combinatorial optimization for multi-round negotiations, while the edge layer focuses on real-time bidding and concession strategy generation. This design ensures global strategic consistency while enhancing local decision flexibility, particularly in highly adversarial negotiation environments.

## 2 System Architecture Design

### 2.1 Central Decision Layer Strategy

The central decision layer employs a dynamic programming framework to construct a global optimization model for multi-round negotiations. By tracking the status of edge modules in real-time, analyzing historical interactions, and evaluating the current negotiation progress, it generates a utility-prioritized decision sequence and deduces the optimal issue combination via dynamic programming algorithms.

When negotiations stall, the central layer initiates adaptive strategy adjustment: a combinatorial space pruning algorithm handles high-dimensional issue scenarios to avoid state explosion, while an opponent behavior monitoring module analyzes the utility contribution patterns of incoming offers. Using a sliding window mechanism to capture temporal changes in opponent strategies, it dynamically adjusts the (our side's) bidding strategy portfolio.

For proposal handling, the central layer first determines the negotiation state: if approaching conclusion, it triggers a strategy reset; otherwise, it performs dual validation on the proposal—assessing its consistency with historical bidding patterns and the impact of acceptance on subsequent negotiations. In the late negotiation phase, the system balances concession benefits against breakdown risks to select optimal closure strategies, ensuring negotiation completeness.

[*]Equal Contribution

### 2.2 Edge Execution Layer Bidding and Concession Strategies

The edge execution layer generates negotiation bids based on a temporal utility model, integrating dynamic programming principles with stage-based concession mechanisms. It constructs multi-stage utility decay models from historical negotiation data, adjusting concession thresholds dynamically according to remaining negotiation time and observed opponent behavior patterns.

The system first employs a pre-trained behavior pattern recognizer to assess the adversarial intensity of the current negotiation. Upon detecting high-adversarial features, it activates a concession strategy model optimized for competitive scenarios—this model, informed by historical trajectories from challenging negotiations, predefines multi-gradient concession strategy spaces to facilitate rapid feasible solution discovery within time constraints.

The edge layer also incorporates an "opponent interest-oriented" search mechanism, prioritizing exploration in issue spaces that show high opponent attention based on real-time bid analysis. This approach enhances agreement probability while optimizing utility balance for both parties.

### 2.3 Edge Execution Layer Proposal Acceptance Strategy

Upon receiving a proposal, the edge layer first updates the negotiation state. Acceptance decisions follow a dual-track logic: evaluating both the proposal's utility alignment with expectations and the trend of historical bid utilities. If the current proposal's utility remains within a reasonable fluctuation range of recent averages, the acceptance mechanism is triggered, ensuring both strategic robustness and negotiation efficiency.

## 3 Experimental Validation

Comparative experiments with various typical negotiation agents demonstrate the adaptability of wangagent's hierarchical architecture. The central decision layer enables efficient global strategy coordination in multi-round negotiations, while the edge execution layer generates rational bidding strategies across different adversarial intensities. Results highlight the agent's significant strategic advantages in complex negotiation environments.

## 4 Technical Summary and Outlook

Through the design of wangagent, the team has accumulated experience in applying hierarchical architectures to automated negotiation. Future research will focus on optimizing dynamic programming algorithms for the central layer, enhancing the intelligence of edge layer concession models, and expanding the agent's generalization capabilities through a broader negotiation scenario database.

## 5 Conclusions

The wangagent proposed by the wangcq team features a "central-edge" hierarchical architecture, achieving global optimization via dynamic programming and enhancing local decision-making through temporal concession models and adversarial environment adaptation. This design demonstrates robust strategic performance in diverse negotiation scenarios, providing new insights for technological advancements in automated negotiation. Subsequent studies will further refine the architecture to improve the agent's decision-making capabilities in complex negotiation environments.