

Design and Evaluation of an Automated Negotiation Agent Using Multi-Criteria Partner Evaluation and a Profit-Oriented Acceptance Strategy

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1 Introduction

ANAC (Automated Negotiating Agents Competition) is an international competition that evaluates the performance of automated negotiating agents. One of its competition categories, the SCML (Supply Chain Management League) OneShot track, is a competition in which each agent negotiates simultaneously with multiple counterparts in each step to complete the procurement and sale of products. Since inventory cannot be carried over from one day to the next, and disposal costs are incurred immediately for over-procurement while shortage penalties are imposed for under-procurement, the central challenge lies in optimally distributing order quantities across multiple negotiation partners under limited information. Whether a partner will accept a proposal, or at what price they will compromise, is unknown in advance and can only be inferred from past negotiation history.

2 Design of Existing Agents

In this study, we used Rchan, a top-performing agent in the ANAC 2025 SCML OneShot competition, as our baseline. Rchan is characterized by partner selection based on cumulative agreed quantity and acceptance decisions that focus on the gap between the required and actual quantity.

However, cumulative agreed quantity alone cannot distinguish a partner's willingness to cooperate from their tendency to make price concessions, and acceptance decisions do not directly account for the costs of rejection or shortage penalties.

Therefore, in this study, we designed IsobeAgent, which introduces multidimensional partner evaluation and profit-based acceptance decisions.

3 Agent Design

IsobeAgent employs a proposal strategy based on partner evaluation using three metrics, and a profit-oriented acceptance strategy.

3.1 Proposal Strategy: Partner Evaluation Using Three Metrics

IsobeAgent evaluates partners by updating three metrics—activity score $A(p)$, price compromise rate $C(p)$, and average transaction volume $Q(p)$ —via an exponential moving average (EMA) updated each day.

The weight $w(p)$ for the quantity allocation to each partner p is calculated as

$$w(p) = (0.6A(p) + 0.4C(p)) \left(0.5 + 0.5 \frac{Q(p)}{Q_{\max}} \right), \quad (1)$$

where $Q_{\max}$ denotes the maximum average transaction volume among all partners. Using this formula, the algorithm prioritizes partners with whom it is easier to reach an agreement and who offer more favorable prices, while allocating larger quantities to partners with higher transaction volumes.

Furthermore, the algorithm generates multiple allocation candidates and promotes exploration by favoring allocation candidates that have been used less frequently. Toward the end of the negotiation, the algorithm stops exploring and prioritizes the certainty of reaching an agreement.

3.2 Acceptance Strategy: Profit-Based Acceptance Decisions

The IsobeAgent uses the value obtained by subtracting production costs, shortage penalties, and disposal costs from the revenue gained through acceptance as the evaluation value for its acceptance decision. This enables situation-dependent acceptance decisions that take into account both shortage risk and disposal risk.

While the acceptance threshold for the evaluation value is relaxed as the negotiation progresses, buyers relax their thresholds more rapidly toward the end of the negotiation than sellers do. This asymmetry reflects the fact that buyers face stronger incentives to avoid shortage penalties when negotiations end without securing the required quantity.

Table 1: Average score for the tournament ($n_{\text{steps}} = 50$, $n_{\text{configs}} = 5$)

Agent	Average score
IsobeAgent(Proposed Method)	1.0495
Rchan(ANAC 2025 Winner)	1.0874
CautiousOneShotAgent(ANAC 2024 Winner)	1.0897
DistRedistAgent	1.0728
EpsilonGreedyAgent	1.0667
MatchingPennies	1.0734
CostAverseAgent	1.0520

4 Experimental Results and Discussion

We conducted experiments against six types of existing agents shown in Table 1, using the average score across five tournaments with $n_{\text{steps}} = 50$ and $n_{\text{configs}} = 5$ as the evaluation metric.

As shown in Table 1, the proposed method failed to outperform existing top-performing agents. The main reasons for this are likely that the hyperparameters related to the EMA smoothing coefficient and acceptance threshold were not sufficiently optimized, and that partner evaluations were unstable in the early stages of each simulation. Furthermore, a single acceptance criterion based on profit may not have been flexible enough to respond to sudden changes in market conditions.

5 Conclusion

In this study, we proposed IsobeAgent, an automated negotiation agent that combines partner evaluation based on three metrics—activity score, price compromise rate, and average transaction volume—with an acceptance strategy that takes profit into account.

Moving forward, in addition to parameter optimization, we will consider improving the initialization method for partner evaluation and introducing an acceptance strategy that switches acceptance thresholds depending on whether the market is in a surplus or shortage situation.