# AlmostEqualAgent

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## 1 Introduction

AlmostEqualAgent is an agent that inherits from OneShotSyncAgent. OneShotSyncAgent consists of an offer strategy for proposing to negotiation partners and an acceptance strategy for deciding whether to accept their proposals and negotiates synchronously with all negotiation agents.

We confirmed that SCML OneShot 2025 follows the same rules as SCML OneShot 2024, in which "quantity" is prioritized over "price" [1]. Therefore, we first conducted preliminary experiments that included base agents and past winning agents. As a result, agents that inherited OneShotSyncAgent and employed distribution strategies as their offer strategies achieved high scores. A distribution strategy is a method that determines the proposed quantity by distributing the total quantity required ($Q_{\text{need}}$) to the negotiation partners.

Based on these results, AlmostEqualAgent incorporates multiple improvements based on OneShotSyncAgent. In AlmostEqualAgent's distribution strategy, we distribute preferentially to partners who have conducted many transactions in the past while avoiding excessive imbalance in quantity. In the acceptance strategy, we treat proposals from partners as power sets (all combinations of proposals) and select the most profitable combination.

AlmostEqualAgent differs from CautiousOneShotAgent, which won in 2024, in two main points. The first is the method of distributing the quantity of transactions. In CautiousOneShotAgent, the concentrated distribution is performed from the last half of the steps. In this proposal, we analyzed how this concentrated distribution affects total quantity and devised a new distribution method(almost equal distribution). The second is the offer acceptance strategy. CautiousOneShotAgent selects the optimal one from the power set of offer combinations, emphasizing the difference from the required quantity. In this proposal, we adopted a score-based acceptance strategy that considers both quantity and price.

This report explains the almost equal distribution method in Section 2.1 and the acceptance strategy in Section 2.2, and demonstrates their effectiveness in Section 3.

# 2 AlmostEqualAgent

## 2.1 Offer Strategy

AlmostEqualAgent uses a distribution strategy as its offer strategy. In distribution strategies, total quantity are generally allocated more to partners with high cumulative quantity in the past or high transaction success rates.

The distribution strategy was also employed in CautiousOneShotAgent, last year's winning agent. However, in conventional distribution strategies adopted by CautiousOneShotAgent and others, there was a significant imbalance in distribution, with cases in which 70% of the total quantity was allocated to a single partner. Due to this imbalance, when the partner's $Q_{\text{need}}$ was small, the proposals were not accepted and negotiations failed.

Therefore, AlmostEqualAgent uses a method that mitigates distribution imbalance while maintaining a distribution strategy. Specifically, the quantity in the distribution strategy is determined by the following procedure:

1. Sort each negotiation partner in descending order of the cumulative quantity of previous transactions.
2. According to this order, allocate a total quantity of 1 to each partner.
3. Repeat step 2 until $Q_{\text{need}}$ becomes 0.

This method limits the difference in the proposed quantity between partners to at most one unit, preventing excessive imbalance while prioritizing proposals to partners who have conducted many transactions in the past.

## 2.2 Acceptance Strategy

In AlmostEqualAgent's acceptance strategy, proposals from partners are treated as power sets (all combinations of proposals), and the combination with the highest profit is selected from among them. All three top agents adopted power-set–based strategies last year, enabling synchronous evaluation of multiple partners' proposals. As a result, rational choices that maximize self-interest across the entire negotiation become possible.

However, since competition rules tend to prioritize "quantity" over "price," CautiousOneShotAgent, which won last year, prioritized quantity in acceptance decisions and compared price only when multiple proposals with the same quantity existed. In this way, price was treated as a supplementary indicator and was undervalued.

Therefore, AlmostEqualAgent introduces an acceptance strategy that considers the balance of both quantity and price. Specifically, for each combination of proposals, we calculate an evaluation score $R_{\text{score}}$ using the following procedure and determine whether to accept or make a counteroffer for the combination with the highest $R_{\text{score}}$.

1. **Scoring price and quantity**

$$P_{\text{score}} = P_{\text{total}} - P_{\text{penalty}} \tag{1}$$

$$Q_{\text{score}} = |Q_{\text{all}} - Q_{\text{need}}| \tag{2}$$

Here, $P_{\text{total}}$ is the sum of "price $\times$ quantity" for each trading partner, $P_{\text{penalty}}$ is the penalty for excess or shortage of inventory when accepting proposals, and $Q_{\text{all}}$ represents the quantity included in the combination.

2. **Score normalization**

$$P_{\text{norm}} = 0.5 + \frac{P_{\text{score}}}{1000} \tag{3}$$

$$Q_{\text{norm}} = 1.0 - \frac{Q_{\text{score}}}{Q_{\text{need}}} \tag{4}$$

3. **Calculation and selection of $R_{\text{score}}$**

$$R_{\text{score}} = \alpha Q_{\text{norm}} + (1 - \alpha) P_{\text{norm}} \tag{5}$$

We select the combination that yields the highest $R_{\text{score}}$, and accept the proposal in the combination if the score exceeds a threshold. Then we make counteroffers to the other partners using the same method described in Section 2.1. Otherwise, if the best $R_{\text{score}}$ falls below the threshold, we reject all proposals and similarly make counteroffers.

It should be noted that prices in counteroffers are always random, and the threshold decreases linearly from 0.6 to 0.3 as the negotiation time progresses.

# 3 Evaluation

In the experiments, we compare the AlmostEqualAgent scores using the top agents from SCML OneShot 2024. The comparison agents employed were SyncRandomOneShotAgent and the top three agents from last year: CautiousOneShotAgent, MatchingPennis, and DistRedistAgent.

Here, the value of $\alpha$ in Equation 5(Section 2.2) is set to 0.85.

The number of different world configurations (n_configs) is 30. The experiments were conducted for three different numbers of simulation days (n_steps): 50, 100, and 200. We used scores and their standard deviations as evaluation metrics.

Table 1 and Table 2 show the scores and their standard deviations. The proposed agent achieved the highest scores across all simulation day settings, surpassing all existing agents. Moreover, it consistently achieved the lowest standard deviations, outperforming other agents. From these results, we consider that mitigating imbalance in almost equal distribution strategies and introducing score-based acceptance strategies are methods that improve CautiousOneShotAgent.

Table 1: Experimental Results - Scores

| Agent | n_steps=50 | n_steps=100 | n_steps=200 |
|---|---|---|---|
| AlmostEqualAgent | **1.0867** | **1.0869** | **1.0728** |
| CautiousOneShotAgent | 1.0836 | 1.0821 | 1.0708 |
| MatchingPennis | 1.0720 | 1.0778 | 1.0556 |
| DistRedistAgent | 1.0799 | 1.0840 | 1.0704 |
| SyncRandomOneShotAgent | 1.0350 | 1.0414 | 1.0173 |

Table 2: Experimental Results - Standard Deviations

| Agent | n_steps=50 | n_steps=100 | n_steps=200 |
|---|---|---|---|
| AlmostEqualAgent | **0.0570** | **0.0667** | **0.0663** |
| CautiousOneShotAgent | 0.0593 | 0.0738 | 0.0697 |
| MatchingPennis | 0.0588 | 0.0683 | 0.0678 |
| DistRedistAgent | 0.0608 | 0.0682 | 0.0688 |
| SyncRandomOneShotAgent | 0.0665 | 0.0879 | 0.0940 |

# 4 Conclusion

We proposed AlmostEqualAgent for the SCML OneShot 2025. AlmostEqualAgent is a negotiation agent that adopts the almost equal distribution and a score-based acceptance strategy using power sets. We observed the weaknesses of CautiousOneShotAgent, which won in 2024, and implemented improvements to address them. As a result, AlmostEqualAgent achieved higher scores compared to the top agents of the last year.

# References

[1] Y. Mohammed, A. Greenwald, K. Fujita, M. Klein, S. Morinaga, and S. Nakadai. Supply chain management league (oneshot): Automated negotiating agents competition, 2025.