

BayesianAgent: A Bayesian Opponent-Aware Agent for the SCML One-Shot Track

Kouta Miyamoto* Rintaro Toyama Takayuki Ito

ANAC 2026 SCML One-Shot Competition

Abstract

BayesianAgent is a synchronous one-shot negotiator that combines Bayesian opponent classification with conservative quantity control. It probes early offers using alternating favorable and unfavorable prices to identify Greedy partners, then allocates quantities according to estimated acceptance rates. The agent accepts exact or near-complete subsets, prioritizes profitable partial agreements, and counters only for the remaining need. Seller-side responses avoid over-commitment and shortfall, while buyer-side offers are capped to reduce excess inventory. Target partner counts are smoothed from observed success rates, using ceiling-based safety rounding to prevent oversized offers. Classification evidence is updated from first-offer outcomes, counters, and agreement results throughout the day.

1 Introduction

The SCML one-shot negotiation problem requires an agent to coordinate several bilateral negotiations under a single daily production constraint. A good agent must not only find profitable prices but also control total signed quantity: too few agreements cause shortfall or unused capacity, while too many create inventory, disposal costs, or production mismatch. This is especially difficult because all negotiations progress concurrently and an apparently attractive single offer can become harmful when combined with other accepted offers.

BayesianAgent was designed for this concurrent setting. The agent treats the problem as two linked tasks. First, it learns which partners tend to accept opponent-favorable offers, with particular attention to Greedy-style behavior. Second, it uses these learned acceptance tendencies to decide how much quantity to request, which incoming offers to accept, and how to counter the remaining partners.

2 Strategy Overview

2.1 Opponent Classification

BayesianAgent maintains lightweight Bayesian-style evidence for each partner. The main distinction is between GreedyOneShotAgent-like partners and NonGreedy partners. A Greedy partner is useful because it often accepts offers with prices favorable to itself, even when the quantity is strategically chosen by our agent. NonGreedy partners, in contrast, are handled through empirical first-offer success rates and more conservative quantity allocation.

The agent gathers evidence from three sources. First, it records whether its own first offers are accepted, rejected, or countered. Second, it observes the quantity and price of the partner's first offer. Third, it records the result of the negotiation once an agreement or failure occurs. Prices are labeled from the opponent's perspective as good, neutral, or bad. Accepting a good-price offer with a meaningful quantity is stronger evidence of Greedy behavior than accepting a

*Corresponding author: miyamoto.kouta.55d@st.kyoto-u.ac.jp

tiny quantity, while repeatedly rejecting such offers shifts the classification toward NonGreedy behavior.

2.2 Exploration

The first few days are used for controlled exploration. During this phase, BayesianAgent alternates prices that are favorable and unfavorable to the opponent. This alternating pattern is used both in initial proposals and, for seller-side counters, in early counteroffers. The goal is not to maximize a single early agreement, but to reveal whether a partner’s acceptance depends strongly on price favorability. This information is later used to decide whether the partner should receive a Greedy-targeted offer or be treated as a success-rate-driven NonGreedy partner.

2.3 Initial Offers

When Greedy partners are detected, BayesianAgent sends them opponent-favorable offers with controlled quantities. If there is one Greedy partner, the agent offers up to a fixed cap and distributes the remaining need to the other partners. If there are multiple Greedy partners, it splits the need between the most reliable Greedy partners, avoiding large additional insurance offers that would create excess quantity.

In NonGreedy environments, the agent estimates how many partners should be targeted using observed first-offer success rates. The raw target count is

$$\lceil n \cdot \max(r, r_{\min}) \rceil,$$

where n is the number of active partners, r is the average observed success rate, and $r_{\min}$ is a safety floor. The ceiling rule deliberately rounds toward more target partners, which reduces per-partner quantity and prevents overly large offers when success rates are around the middle range. The selected target is also smoothed over days: a one-day fluctuation is not allowed to immediately change the active target count.

3 Concurrent Negotiation Response

Incoming offers are evaluated as a set rather than independently. BayesianAgent first searches for an exact subset whose total quantity matches the current need. If such a subset exists, it accepts that subset and rejects or counters the rest. If not, it checks for “good partial” offers: offers with quantity at least

$$\left\lfloor \frac{\text{need}}{\text{numberofpartners}} \right\rfloor + 1.$$

These offers are accepted first if their total does not exceed the need, and the agent then builds counters only for the remaining quantity. This ordering is important because it prevents the agent from ignoring a useful incoming offer and instead creating multiple redundant one-unit counters.

After accepted offers are fixed, the remaining need is allocated over the remaining partners. If a counter would have the same quantity as the current incoming offer, the agent accepts the current offer instead of sending an equivalent counter. This rule reduces unnecessary negotiation steps and avoids duplicated agreements when the remaining need is already covered by a one-unit offer.

4 Risk Management

4.1 Seller-Side Shortfall Control

On the seller side, over-accepting buyer offers can create shortfall penalties. BayesianAgent therefore prevents accepted subsets from exceeding the current sales need. When it needs to

counter, it allocates only the remaining quantity. If the remaining need becomes zero, all other partners receive an unneeded response rather than being offered the minimum positive quantity. This prevents the common failure mode in which a remaining need of one unit accidentally becomes two accepted one-unit agreements.

4.2 Buyer-Side Excess Control

On the buyer side, the main danger is excess input inventory. The agent caps the total offered quantity using the estimated acceptance rate. When average success is low, it still avoids unlimited scaling by applying a success-rate floor. The target-count rule described above also makes offers safer: using the ceiling of expected successful partners spreads the need over more partners and reduces the quantity of each individual offer.

4.3 Utility Guard

When there is a single remaining partner or when time-based concession moves toward the opponent’s quantity, BayesianAgent applies a utility floor. It does not move beyond the quantity for which the resulting set of offers is worse than disagreement. For sellers, this also means not increasing a counter above the remaining sales need.

5 Evaluation

We evaluated BayesianAgent through repeated local tournaments against standard one-shot agents, including GreedyOneShotAgent, RandomOneShotAgent, SyncRandomStdAgent, QuantityOrientedAgent, CautiousOneShotAgent, and CostAverseAgent. The analysis was grouped by role and by whether Greedy opponents appeared on the opposite side of the market.

The main observation was that Greedy-heavy environments require different behavior from NonGreedy environments. Seller scenarios with multiple Greedy buyers rewarded controlled Greedy probing and strict remaining-need allocation. Buyer scenarios without Greedy partners required conservative target counts to avoid excess inventory. The final agent therefore emphasizes robust quantity control over aggressive single-partner optimization.

Table 1: Summary of risk controls used by BayesianAgent.

Situation	Main Risk	BayesianAgent Response
Seller with Greedy buyers	Shortfall from over-selling	Accept at most remaining need
Buyer with NonGreedy sellers	Excess inventory	Ceiling target count and offer cap
Unknown early partners	Misclassification	Alternating good/bad price probes
One remaining unit	Duplicate one-unit deals	Zero out extra counter partners

6 Conclusion

BayesianAgent is a compact, opponent-aware one-shot agent focused on stable quantity management. Its Bayesian evidence model separates Greedy-like partners from other partners, while its concurrent response logic evaluates sets of offers before deciding which agreements to accept. The most important design principle is that every accepted offer must be considered together with the remaining need. This prevents both seller shortfall and buyer excess, and allows the agent to exploit Greedy partners without becoming overly exposed to quantity risk.

Acknowledgments

This work was supported by JSPS KAKENHI Grant Number JP 22H00533, Japan.