HoriYamaAgent: An Agent Considering the Market

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1. Overview

HoriYamaAgent is an extension of the tutorial's *BetterSyncAgent* designed for the OneShot environment. Its key additions are mechanisms that (i) adjust the number of negotiations based on the supply–demand balance and (ii) modulate that number according to the remaining quota.

2. Functions of *BetterSyncAgent*

- **First proposal.**
  - As a **seller**: offers at the maximum price.
  - As a **buyer**: offers at the minimum price.
  - The counterpart agent is selected at random.
- **Counter offer.**
  - It enumerates the power set of current counterparts and, for every subset, selects the combination whose quantity is closest to its quota; that subset is used as the counter-offer.
  - The tolerance around the quota widens as negotiation time elapses, i.e. the longer the negotiation, the looser the threshold becomes.
- **Fallback.** If no subset of the counterpart's proposals falls within the tolerance, all offers are rejected, and the agent splits the quantity still needed to meet its quota, selects a random counterpart, and issues a counter-offer at a random price.

3. Issues Addressed by HoriYamaAgent

- Ensuring offers match the agent's assigned quota more accurately.
- Removing the sole dependence on negotiation time for widening tolerance.
- Eliminating random pricing in counter-offers.

4. Proposed Solution

As illustrated in Figure 1, when the number of seller agents is high, buyers hold the advantage, and vice versa. Therefore, when the agent is in a favorable market position it can submit aggressive offers. In counter-offers, it is essential to account not only for elapsed time but also for current market conditions. Failing to do so in an unfavorable position increases the risk that negotiations end prematurely, leaving the agent short of its quota and incurring heavy penalties. Our agent therefore incorporates the seller–buyer ratio as a variable when generating offers.

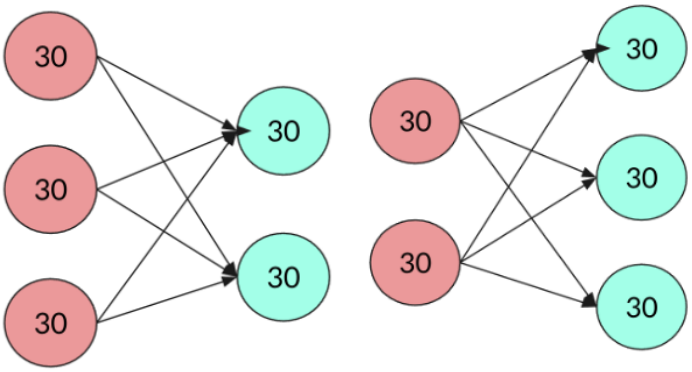

Figure 1: Typical supply–demand balance scenarios.

Notation

r	Normalised negotiation time ($0 \le r \le 1$).
n_{lines}	Total number of contract lines available to the agent.
$n_{\text{competitors}}$	Number of agents on the *same* side of the market.
n_{buyers}	Number of counterpart buyer agents available.
$n_{\text{suppliers}}$	Number of counterpart seller agents available.

Overall rule

$$\tau(r) = \underbrace{*}_{} \left(\tfrac{n_{\text{lines}}}{2}\right) r^4 \underbrace{}_{\text{time–based baseline } \beta(r)} \times \underbrace{\mu}_{\text{market factor}}$$

Market factor μ

If the agent is a *seller*

$$\rho = \frac{n_{\text{buyers}}}{n_{\text{competitors}} + 1}, \qquad \mu(\rho) = \begin{cases} 0.5 + \dfrac{0.3}{\rho}, & \rho > 1 \quad \text{(seller's market)}, \\ 1.0 + 0.5\,(1 - \rho), & \rho \le 1 \quad \text{(buyer's market)}. \end{cases}$$

If the agent is a *buyer*

$$\rho = \frac{n_{\text{competitors}} + 1}{n_{\text{suppliers}}}, \qquad \mu(\rho) = \begin{cases} 1.0 + 0.3\,(\rho - 1), & \rho > 1 \quad \text{(buyer's market)}, \\ 0.7 + 0.3\,\rho, & \rho \le 1 \quad \text{(seller's market)}. \end{cases}$$

Resulting range

$$\mu \in \begin{cases} [0.5,\ 1.5] & \text{for sellers}, \\ [0.7,\ 1.3] & \text{for buyers}. \end{cases}$$

Hence the current threshold is

$$\boxed{\tau(r) = \beta(r)\,\mu}$$

where $\beta(r) \to 0$ when $r \to 0$ and increases rapidly as $r \to 1$, while μ tightens or loosens the threshold according to real-time supply–demand imbalance.

Need-based parameter

$$\text{param}(\text{needs}) = 1.4 + \frac{4.6}{1 + \exp\!\big[1.5\,(\text{needs} - 1)\big]}$$

Note. Offers are intentionally placed slightly above the calculated need to maintain a safety buffer.

5. Discussion and Future Work

While HoriYamaAgent performs well, there is still room for enhancement:

- **Reinforcement Learning**. Use RL to tune thresholds and pricing more adaptively.
- **Incorporate more signals**. Use trading prices and other agent statistics to inform decisions.
- **Partner Matching**. Learn to match counter offers to specific partners' behavioral patterns, if allowed.

These directions can push performance beyond the handcrafted rules currently used.

6. Conclusion

HoriYamaAgent demonstrates how market awareness, strategic extra ordering, and adaptive thresholds can significantly improve agent performance in SCML-OneShot. The agent bridges the gap between rule-based robustness and adaptive intelligence, setting a foundation for more advanced negotiation agents in future supply chain simulations.