LitaAgentYR: Functional Modules and Strategic Logic

Lita

June 14, 2025

Abstract

LitaAgentYR is an autonomous negotiation agent designed for the multi-round supply-chain scenario of SCML 2025. By tightly coupling inventory planning with negotiation heuristics, the agent maximises profit while meeting contractual demand and treats shortage penalties as opportunity costs. We present its modular architecture (inventory, procurement & sales, concession tactics, opponent modelling, adaptive parameters) and how these modules interact in each simulation day. Key innovations include a three-tier procurement policy, time & quantity sensitive concessions, Pareto-improving counter-offers, Bayesian opponent modelling, and daily self-tuning of risk parameters.

1 System Architecture & Daily Loop

The simulation runs for T rounds; let t be the current round and $\tau = t/T \in [0, 1]$. As $\tau \to 1$ the agent concedes more to avoid the penalty c_p. Four major modules interact:

1. Inventory Manager — tracks stock, plans production, computes shortages.
2. Strategy Module — sets profit targets and price bounds.
3. Negotiation Module — dispatches incoming offers and applies heuristics.
4. Opponent Model — online logistic regression for each partner.

At the *beginning* of each day the agent ingests exogenous contracts, updates shortages (today' s Δ_{emer} and total Δ_{plan}), then re-tunes profit margin $\rho_{\min}$, bargain threshold β, and over-procurement factors. At the *end* of the day it executes production & delivery, updates market-price estimates, records negotiation success rates, and prints a daily report.

2 Procurement Strategy

Demand is split into **Emergency**, **Planned**, and **Optional** tiers. Let the true unmet demand be N; the agent places orders totalling $(1 + \delta)N$ where $\delta_{\text{emer}} = 1.0$ for emergency needs, $\delta_{\text{plan}} = 0.6$ for planned needs, $\delta_{\text{opt}} = 0.9$ for opportunistic stockpiling. A supplier offer with price p is accepted immediately if

$$p < \beta\, \bar{p}_{\text{market}}, \qquad \text{and stock after acceptance} \le \delta_{\text{opt}} \times \text{future demand},$$

where β is the dynamic *bargain threshold*. Supplier ranking and quantity allocation spread risk across partners.

3 Sales Strategy

For any buyer offer $(q, p_b, t_{\text{deliv}})$ the agent checks:

$$q \le P(t_{\text{deliv}})_{\text{free}} \quad \text{and} \quad p_b \;\ge\; c_{\text{unit}}\big(1 + \rho_{\min}\big),$$

where $P(t)_{\text{free}}$ is free capacity on day t and c_{unit} = avg. raw-material cost + processing cost. If capacity is tight ($P(t)_{\text{free}}/P < \lambda$) a surcharge η is added to $\rho_{\min}$. Otherwise the agent counters with a Pareto offer (raise price, or reduce quantity, or defer t_{deliv}).

4 Negotiation Heuristics

Dynamic reservation price for procurement:

$$R(\tau) = \min\big\{P_{\text{target}} + \tau^k (c_p - P_{\text{target}}),\ c_p\big\},$$

$k > 1$ delays large concessions. Counter-offer step: $\Delta p = \alpha\, \delta_{\text{opp}}$ subject to $p_{\text{new}} \le R(\tau)$. When stalemated, the agent proposes *quantity-for-discount* or *delay-for-discount* packages that stay on the Pareto frontier.

5 Opponent Modelling

Per partner logistic model $\sigma(w_0 + w_1 x)$ with $x = +p$ (supplier) or $x = -p$ (buyer) is updated online; reservation estimate $p^* = -w_0/w_1$ guides counter-offers. Historical success rate and average deal price feed reliability adjustments to profit targets.

6 Inventory & Production

Given supply contracts S and demand contracts D, a greedy JIT planner computes production y_t so that $\sum_{t \le \tau_i} y_t \ge d_i$ for every demand $(d_i, \tau_i) \in D$, while $y_t \le P$ (capacity) and $\sum_{s \le t} s_s - \sum_{u < t} y_u \ge y_t$ (material balance). Daily shortages $\Delta_{\text{emer}}(0)$ and cumulative shortages $\Delta_{\text{plan}}(t)$ drive procurement tiers.

7 Adaptive Tuning

- ρ_{min} lowered if stock $\gg$ demand; raised if stock $\ll$ demand.
- β lowered (harder to trigger optional buys) when inventory is ample, raised when inventory is scarce.
- δ_{emer}, δ_{plan} increase when recent procurement success $< 30\%$, decrease when $> 70\%$.

8 Conclusion

Through the synergy of inventory-aware planning, data-driven negotiation, and adaptive parameter control, LitaAgentYR pursues an efficient profit-versus-risk trade-off in complex supply-chain negotiation.

9 Appendix: Function Call Graph

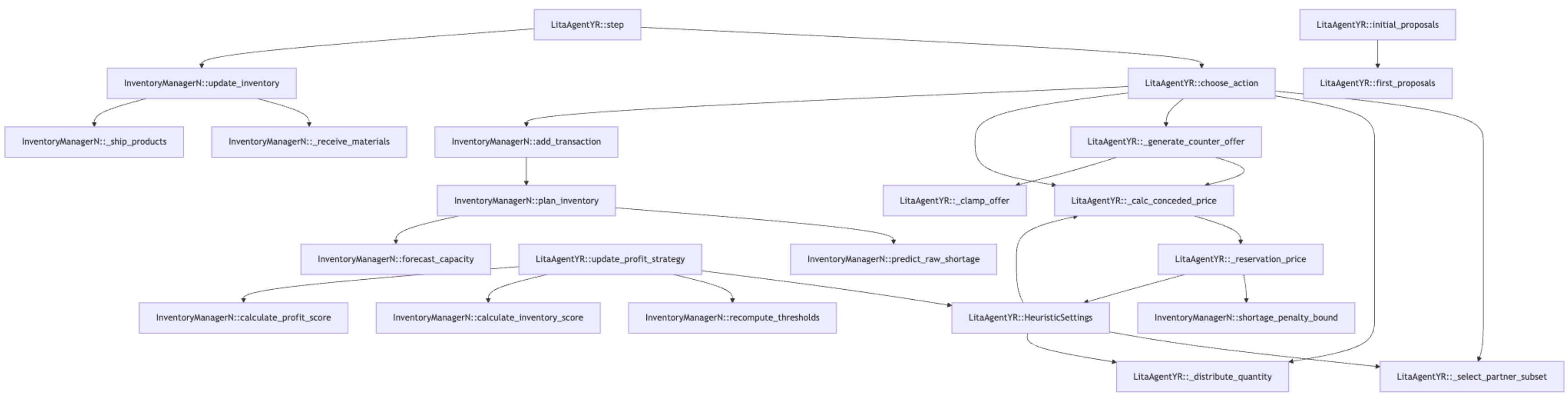

Figure 1: Function Call Graph