XenoSotaAgent

An agent submitted to the ANAC 2025 SCM league

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Outline

OTSUKA Lab.

1. Introduction

- **Goal in Supply Chain Management(SCM)**
  - Minimization of penalties (e.g., excess inventory, contract violations)
  - Maximization of profit

- **Challenges**
  - Transparency of partners
    - Each agent negotiates with its own independent strategy
    - For efficient contract formation, data on past negotiation patterns and agreement tendencies are required
  - Uncertainty of demand and supply
    - The ability to adjust allocation and contracts appropriately is essential
    - Forecasting errors may lead to excess inventory or contract violations, resulting in penalties
  - Securing stable profit
    - Negotiations involve multiple factors (quantity, delivery time, and unit price) that are intricately interrelated
    - If proposal and concession strategies are poorly designed, it may lead to unfavorable contracts and unstable profits

2. Proposed Method

- **Three Key Components**

  1. **Partner Scoring**
     - Record offer history
     - Evaluate partners quantitatively using success rate and agreement utility
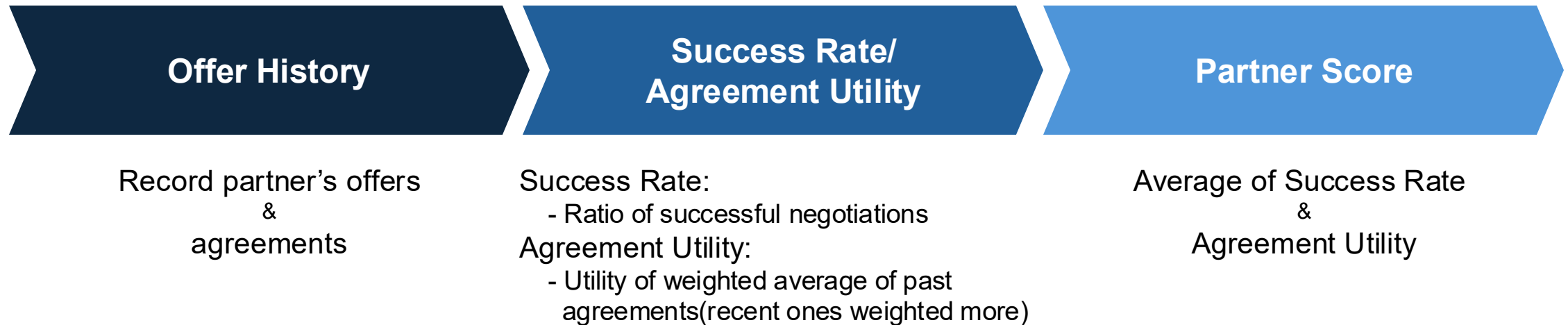
  2. **Allocation Strategy**
     - Allocate target contracts considering inventory, production capacity, and partner scores
     - In early steps, secure more buy contracts to reduce the risk of stockouts

  3. **Concession Strategy**
     - Evaluate quantity, delivery time, and unit price using a utility function
     - Generate optimal offers based on utility and make strategic concessions as negotiation rounds progress

3.1 System Design: Partner Scoring

- **Key Idea**
  - Quantify partner reliability and reflect it in negotiation strategies

- **Usage**
  - Used in allocation and proposal strategies
  - Prioritize contracts with reliable partners

- **Process**

Offer History	Success Rate/ Agreement Utility	Partner Score
Record partner's offers & agreements	Success Rate: - Ratio of successful negotiations Agreement Utility: - Utility of weighted average of past agreements(recent ones weighted more)	Average of Success Rate & Agreement Utility

3.2 System Design: Allocation Strategy

- **Key Idea**
  - Allocate daily needs efficiently based on inventory, capacity, and partner scores
- **Details**
  - Determine available supply for the day from inventory and production capacity
  - Assign target contracts to each partner according to partner scores
  - Avoid bottlenecks in the early stage of the simulation
    - Since inventory starts at zero, contract fulfillment is unstable in the initial steps
    - Secure more buy contracts(about twice as usual) in early steps to stabilize inventory
- **Role in Agent**
  - Avoid penalties caused by stockouts
  - Prioritize contracts with reliable partners
  - Reduce the risk of contract violations

3.3 System Design: Concession Strategy

- **Key Idea**
  - Based on a utility function, gradually reduce the acceptance threshold in each negotiation round and make stepwise concessions

- **Role in Agent**
  - Ensure stable profit while reducing the risk of negotiation failure
  - Reflect multiple factors(quantity, delivery time, unit price) under a unified utility-based framework

- **Concession Flow**
  1. Best Offer
     - The offer with maximum utility for the agent
  2. Acceptable Offer
     - The minimal offer that still satisfies the acceptance threshold in the current round
  3. Base Offer
     - A practical offer created by combining Best and Acceptable offers(element-wise)
  4. Least Concession Offer
     - An offer derived from Base by changing one issue only, minimizing the utility drop(used for concession rounds)

3.3 System Design: Concession Strategy

Figure 1: Utility Change of Best, Acceptable, Base, and Least Concession Offers
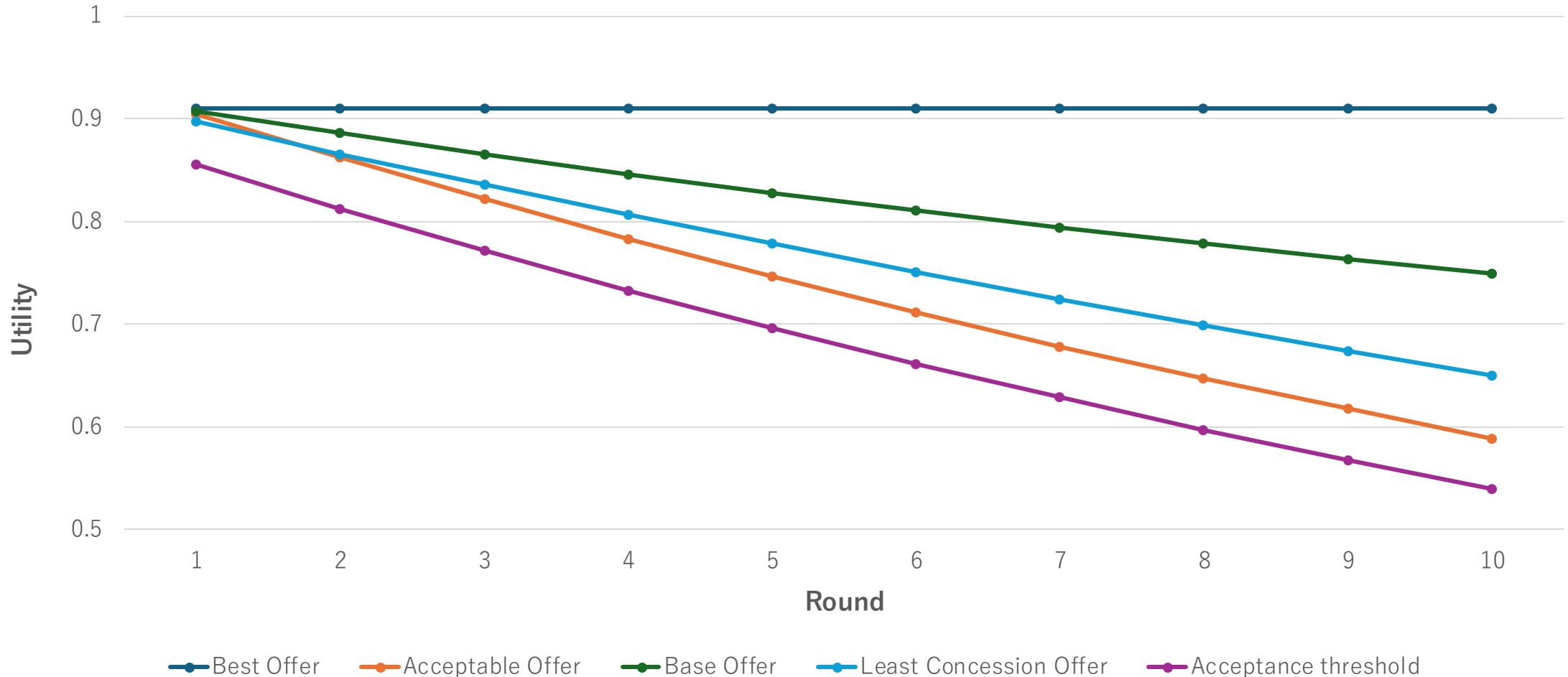
4. Experimental Results

- **Experimental Setup**
  - Environment:
    - SCML 2025 Standard
  - Conditions:
    - step = 10, process = 3, config = 4
  - Baselines:
    - SimpleSyncAgent: A basic agent with simple negotiation rules
    - ProactiveAgent: An agent with proactive behavior including randomness
  - Metric:
    - Comparison of each agent's score in terms of Mean / Std / Min / Max

4. Experimental Results

- ## Results

  - XenoSotaAgent significantly outperformed the baselines with higher average score

  - Achieved stable performance with a smaller variance

  - Reached a higher maximum score than ProactiveAgent

  - Minimum score was lower than SimpleSyncAgent, showing occasional downturns

Table1: Results table

Agent	Mean	Std	Min	Max
XenoSotaAgent	**1.15**	**0.17**	0.53	**1.54**
SimpleSyncAgent	0.63	0.26	**0.72**	1.00
ProactiveAgent	0.67	0.40	-0.65	1.46

5. Conclusion

- **Discussion**
  - Partner Scoring, Allocation Strategy, and Concession Strategy contributed to stable profits
  - Still room for improvement in reducing performance downturns and enhancing stability

- **Future Work**
  - Enhance stability and flexibility by improving the utility function and introducing adaptive learning