AgentVSC for ANAC SCML Standard/Collusion Track

Ryoga Miyajma
Tokyo University of Agriculture and Technology
miyajima@katfuji.lab.tuat.ac.jp

May 2, 2023

Abstract

This report provides an explanation of AgentVSC for ANAC2023 SCML Standard/Collusion Track. AgentVSC emphasizes inventory management and effective signature strategies, aiming for a stable supply while avoiding shortfall penalties.

1 Introduction

In the SCML World, it is hard to make large profits. Actually, in the SCML2022 Standard Track, all agents had negative scores. Therefore, it is important to be committed to selling off inventory at a price higher than the costs of buying input products and producing output products.

2 The Design of AgentVSC

This section describes the design of AgentVSC, including production strategy, trading strategy, negotiation control strategy, and risk management.

2.1 Production Strategy

AgentVSC produces output products from input products at the step it buys them. In this way, the inventory quantity can be easily managed because it is ready for shipment the day after it is received.

2.2 Trading Strategy

Pre-Negotiation Component

For the negotiation of each step, the price at the maximum concession in the negotiation of buying or selling is determined by the quantity of planned inventory as of the last step of the transaction.

The maximum price for buying at step $t(0 \leq t \leq T-1)$ $p_t^{max\_for\_buying}$ is determined in Equation (1) below.

$$p_t^{max\_for\_buying} = \begin{cases} cp^{input\_product} & \text{if } t = 0 \\ \max(0.8p_{t-1}^{max\_for\_buying}, cp^{input\_product-1}) & \text{if } I_t > I_{t-1} \\ p_{t-1}^{max\_for\_buying} & \text{if } I_t = I_{t-1} \\ \min(1.1p_{t-1}^{max\_for\_buying}, ap_t^{output\_product} - p^{produce}) & \text{if } I_t < I_{t-1} \end{cases} \quad (1)$$

In Equation (1),

- $cp^{product}$ means catalog price of 'product',
- $tp_t^{product}$ means trading price of 'product' at step t,
- $ap_t^{product}$ means average contract unit price of contracts finalized by step t,
- $p^{produce}$ means the cost of producing an output product from an input product,
- I_t means the difference between the total quantity of input products of contracts finalized by step t and the total quantity of output products of contracts finalized by step t,

these definitions apply to Equation (2) and beyond.

In Collusion Track, if there are multiple AgentVSCs in the same level l, $p_0^{max\_for\_buying} = cp^{input\_product} - (p^{produce} - p_l^{min\_produce})$, where $p_l^{min\_produce}$ means the minimum $p^{produce}$ of AgentVSCs at level l.

The minimum price for selling at step t $p_t^{min\_for\_selling}$ is determined in Equation (2)

below.

$$p_t^{min\_for\_selling} = \begin{cases} tp_t^{output\_product} & \text{if } t \leq 0.25T \\ \max(tp_t^{output\_product}, ap_t^{output\_product}) & \text{if } t \leq 0.5T \\ ap_t^{input\_product} + p^{production} & \text{if } t < T-1 \\ tp^{output\_product}/2 & \text{if } t = T-1 \end{cases} \tag{2}$$

Signing Contracts

For buying contracts, AgentVSC signs all unless the total quantity of input product by finalized contracts and AgentVSC's signed contracts exceeds n_lines at the step.

For selling contracts, AgentVSC signs a combination of contracts that can be expected to increase sales effectively. First, for each $t(current\_step \leq t < n\_steps)$, AgentVSC gets target quantity q^{targ}, which is computed as the difference between the total quantity of input products of contracts finalized by $current\_step$ and executed by step $t-1$, and the total quantity of output products of contracts finalized by $current\_step$. Then, AgentVSC searches the combinations of contracts where the sum of the quantities equal q^{targ}, and among them, signs the combination of contracts that maximizes the evaluation value obtained from Equation (3) below.

$$\begin{aligned} eval(C) &= \sum_{c \in C} w \frac{p_c}{p_C^{max}} + (1-w) pr_{partner_c}, \\ w &= 0.5 - 0.5 \sin\left(\frac{current\_step}{n\_steps - 1} - 0.5\right)\pi \end{aligned} \tag{3}$$

In Equation(3),

- C means an combination of contracts, $eval(C)$ means the evaluation value of C,
- p_c means the unit price of the contract c,
- p_C^{max} means the maximum unit price of the contracts in C,
- $pr_{partner_c}$ means the signature rate of the partner of contract c.

w is a weight parameter that determines the balance between the unit price and the signature rate of the partner, with the unit price being more important at the beginning and the signature rate being more important as the simulation progresses.

In Collusion Track, for both buying and selling contracts, AgentVSC preferentially signs contracts with other AgentVSC.

2.3 Negotiation Control Strategy

Negotiation Choice

If AgentVSC requests a negotiation, the issues of ranges are below.
If buying,

- TIME : $[current\_step + 1, min(current\_step + 3, n\_steps - 1)]$
- QUANTITY : $[1, n\_lines]$
- UNIT PRICE : $[0, p^{max\_for\_buying}_{current\_step}]$

If selling,

- TIME : $[t, t]$, t means the first step that $q_t > 0$ under the condition $t > current\_step$, q_t means the difference of the total quantity of input products of contracts finalized by $current\_step$ and executed by step $t-1$, and the total quantity of output products of contracts finalized by $current\_step$.
- QUANTITY : $[q_t/n\_consumers, q_t]$
- UNIT PRICE : $[p^{min\_for\_selling}_{current\_step}, 4p^{min\_for\_selling}_{current\_step}]$

If AgentVSC is requested a negotiation, AgentVSC joins it only if it meets the following conditions for the range of the issues.
If buying,

- Maximum value of the range of the issues of TIME is more than $current\_step$ and minimum value of it is less than n_steps.
- Maximum value of the range of the issues of UNIT PRICE is less than or equal to $p^{max\_for\_buying}_{current\_step}$.

If selling,

- Maximum value of the range of the issues of TIME is more than $current\_step$ and minimum value of it is less than n_steps.
- Maximum value of the range of the issues of UNIT PRICE is more than or equal to $p^{min\_for\_selling}_{current\_step}$.

Utility Function

If buying, the utility function is Equation (4) below.

$$U(q,t,p) = \begin{cases} -1000 & \text{if } t \leq current\_step \text{ or } n\_steps \leq t \\ & \text{or } p > p_{current\_step}^{max\_for\_buying} \\ 0.25\frac{t^{max}-t}{t^{max}-t^{min}} + \frac{p^{max}-p}{p^{max}-p^{min}} & \text{otherwise} \end{cases} \quad (4)$$

If selling, the utility function is Equation (5) below.

$$U(q,t,p) = \begin{cases} -1000 & \text{if } t \leq current\_step \text{ or } n\_steps \leq t \\ & \text{or } p < p_{current\_step}^{min\_for\_selling} \\ \frac{current\_step}{n\_steps-1}\frac{q-q^{min}}{q^{max}-q^{min}} + \frac{p-p^{min}}{p^{max}-p^{min}} & \text{otherwise} \end{cases} \quad (5)$$

2.4 Risk Management

There are three major risks as below.

- surplus of output products
- surplus of input products
- other agent's bankrupt

AgentVSC never causes a surplus of output products, because AgentVSC signs contracts of output products so that the total quantity of them does not exceed that of input products of contracts finalized by then. To reduce a surplus of input products, AgentVSC makes $p^{max\_for\_buying}$ higher as inventory increases. If another agent is bankrupt, AgentVSC updates its information about finalized contracts.

3 Evaluation

This section describes the evaluation of AgentVSC. Table 1 shows the results of competing with DecentralizingAgent and BuyCheapSellExpensiveAgent. The configurations for the competition are n_steps:100, $n\_configs$:10, and running 30 simulations.

As table 1 shows, AgentVSC earns a higher score than DecentralizingAgent and BuyCheapSellExpensiveAgent.

Table 1: Result of the Standard Tournament

	AgentVSC	DecentralizingAgent	BuyCheapSellExpensiveAgent
score	0.02	−0.11	−0.99

4 Conclusion

In this report, we explained AgentVSC's strategies that emphasize inventory management. These strategies allowed AgentVSC to earn a higher score than other agents.

AgentVSC negotiates and signs contracts for output products based on finalized contracts for input products, which can lead to significant missed business opportunities. Therefore, in the future, I would like to realize a strategy whereby it finalized the contract for output products and then goes to get the contract for input products accordingly.