AgentVSC for ANAC SCML2023 Standard/Collusion Track

Ryoga Miyajima
Tokyo University of Agriculture and Technology
Katsuhide Fujita Lab.

Contents

Background & Concept

- Background
  - In SCML World, it is hard to make a large profit.
    - In SCML2022 Standard Track, all agents had **negative** scores.

- Concept
  - Committing to reduce the loss
    - Inventory control by adjusting the pricing conditions
    - Selling strategy based on finalized buying contracts

Production Strategy

- Produce at the same step when input products are arrived

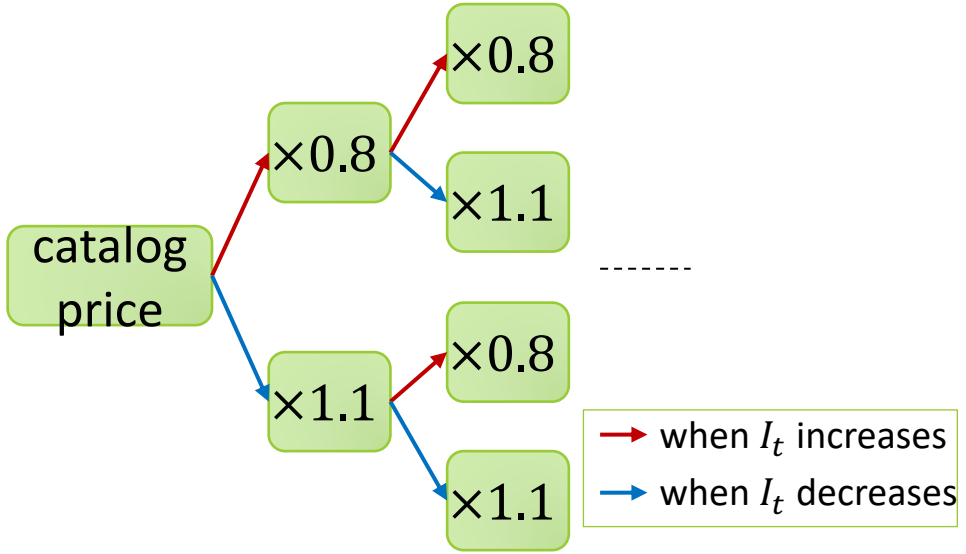
  → Easier inventory control

Trading Strategy : Price Control(1/2)

Determine the unit price at the maximum concession in negotiations

- The highest unit price for buying ($p_t^{max\_for\_buying}$)
  - Initial value is the catalog price of the input product($cp^{input\_product}$)
  - More **bullish**($\times 0.8$) when the expected inventory at the final step (I_t) increases
  - More **bearish**($\times 1.1$) when it decreases

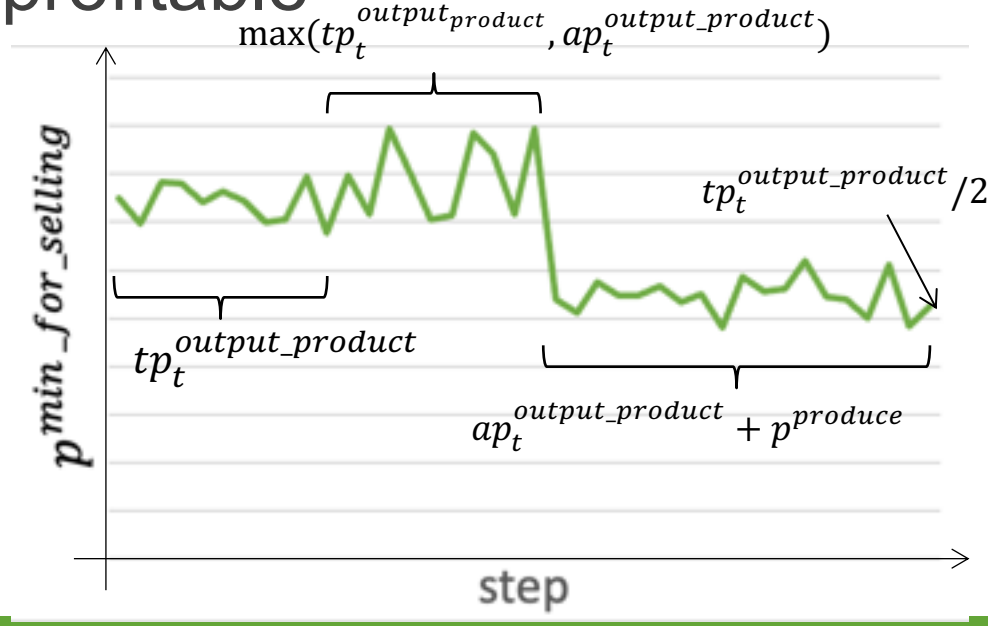
$$p_t^{max\_for\_buying} = \begin{cases} cp^{input\_product} & \text{if } t = 0 \\ \max(0.8p_{t-1}^{max\_for\_buying}, cp^{input\_product-1}) & \text{if } I_t > I_{t-1} \\ p_{t-1}^{max\_for\_buying} & \text{if } I_t = I_{t-1} \\ \min(1.1p_{t-1}^{max\_for\_buying}, ap_t^{output\_product} - p^{produce})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



Trading Strategy : Price Control(2/2)

- The lowest unit price for selling ($p_t^{min\_for\_selling}$)
  - For the first half, the reasonable price based on the trading price of the output product and the average price of my finalized selling contracts
  - For the other half, the price just barely profitable

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



Trading Strategy : Singing Contracts(1/3)

- Singing Contracts for buying
  - Signing it unless the production limit per step is exceeded
  - Prioritize the contracts with the lower unit price

Trading Strategy : Singing Contracts(2/3)

- Singing Contracts for selling
  - Signing a combination of contracts expected to increase sales effectively
  - for each $t(current\_step \leq t < n\_steps)$,
    1. Get the target quantity q^{targ}, which is the difference following quantities:
       - total quantity of input products that is finalized contracts executed by step $t-1$
       - total quantity of output products that is finalized contracts
    2. Select a combination of selling contracts according to following conditions
       - All execution dates are step t and the sum of quantities equals q^{targ}
       - Selecting the one that maximizes the evaluation value ($eval(C)$) shown in the next page

Trading Strategy : Singing Contracts(3/3)

$$eval(C) = \sum_{c \in C} w \frac{p_c}{p_C^{max}} + (1 - w) pr_{partner_c},$$

$$w = 0.5 - 0.5 \sin((\frac{current\_steps}{n\_steps - 1} - 0.5)\, \pi)$$

- C: a combination of selling contracts
- p_c: unit price of contract c
- $pr_{partner_c}$: singing rate of the partner of contract c

- Using this evaluation value,
  - unit price being more important at the beginning
  - the opponent signing rate being more important as the steps progress

  in signing selling contracts

Negotiation Control Strategy : Neg Choice (1/2)

- Request negotiations
  - Buyer
    - TIME : $[current\_step + 1, \min(current\_step + 3, n\_steps)]$
    - QUANTITY : $[1, n\_lines]$
    - UNIT_PRICE : $[0, p_{current\_step}^{max\_for\_buying}]$
  - Seller
    - TIME : $[t, t]$
      - t means the first step that $q_t > 0$ $(t > current\_step)$
      - q_t is calculated in the same way as q^{targ} on the previous 2 pages
    - QUANTITY : $[q_t / n\_consumers, q_t]$
    - UNIT_PRICE : $[p_{current\_step}^{min\_for\_selling}, 4p_{current\_step}^{min\_for\_selling}]$

Negotiation Control Strategy : Neg Choice (2/2)

- Respond the negotiation requests
  - TIME
    - The maximum value is more than $current\_step$
    - The minimum value is less than n_steps
  - UNIT_PRICE
    - Buyer
      - The minimum value is less than or equals to $p_{current\_step}^{max\_for\_buying}$
    - Seller
      - The maximum value is more than or equals to $p_{current\_step}^{min\_for\_selling}$

Negotiation Control Strategy : Utility Function

- Utility Function for buyer

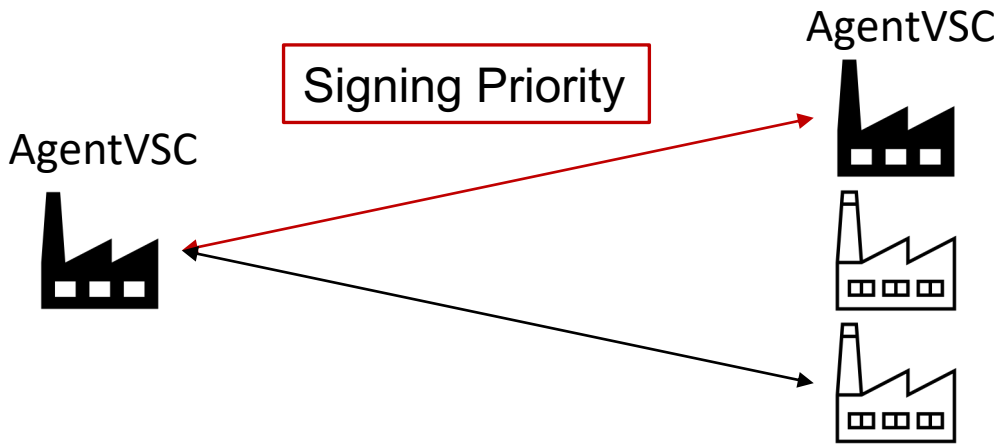
$$U(q,t,p) = \begin{cases} -1000 & \text{if } t < 0 \text{ or } n\_steps \leq t \\ & \text{or } p > p_{current\_step}^{max\_for\_buying} \\ LinearUtilityFunction(0,-0.25,-1) & \text{otherwise} \end{cases}$$

- Utility Function for seller

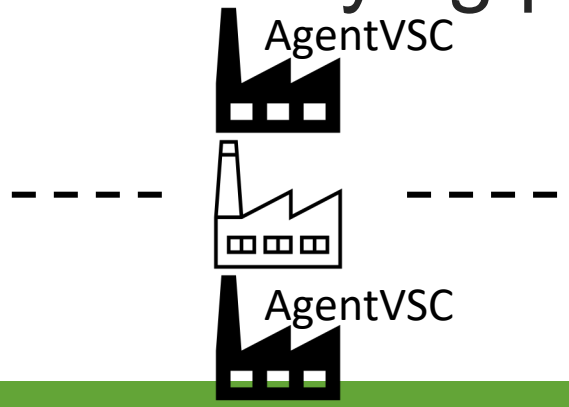
$$U(q,t,p) = \begin{cases} -1000 & \text{if } t < 0 \text{ or } n\_steps \leq t \\ & \text{or } p < p_{current\_step}^{min\_for\_buying} \\ LinearUtilityFunction\left(\frac{current\_step}{n\_steps-1}, 0,1\right) & \text{otherwise} \end{cases}$$

Strategy in Collusion Track

- Prioritize signing of contracts with AgentVSC



- Lower buying prices for factories with the high production costs



$$p_0^{max\_for\_buying} = cp^{input\_product} - (p^{produce} - p_l^{min\_produce})$$

- $p_l^{min\_produce}$: The minimum producing cost of AgentVSCs at level l