ANAC 2025 ~ ANL ~

a4e Agent

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Concept

➢ **Adaptation and Flexible Response** to Opponents

- Analyze the cooperation / Assessing the risks
- Update my strategy performance based on negotiating opponents

➢ **Balance** with Cooperation and Competition

- Determine target utility and strategy (**Nash / Individual / Hybrid**)
- Use adjusted acceptance thresholds for each strategy

Coordination

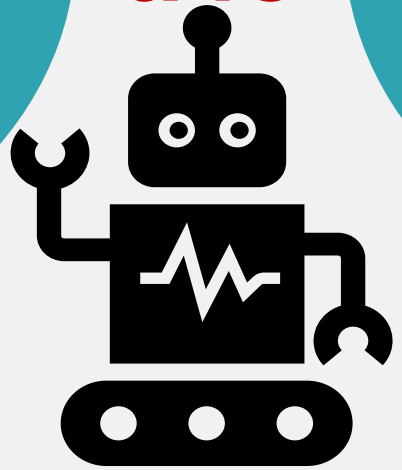
Cooperative

Nash_weight=0.2

Competitive

Individual_weight=0.8

a4e



estimate_opponent_utility

ID, Strategy, Risk, Utility_history …

adaptation_rate=0.2

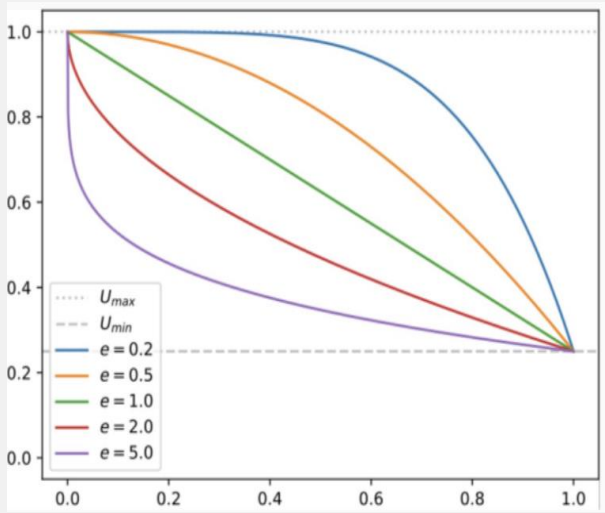
Strategy ~ Bidding ~

calc_level (based on the negotiation progress)

[Calculate the Utility Level]

- Determine [target utility / agent's aspiration level] for the current turn

  e.g high utility(strong) in the early stages, low utility(concessions) in the late one



- PolyAspiration curve (default "boulware" [e < 1])
  - Start with maximum(1.0), decrease over time
  - At the last stage, the level is 0.2 to avoid a negotiation breakdown

select_optimal_strategy (1)

T = relative_time , R = risk

- **Initial stage** (T < 0.3)

$$\begin{cases} if\ cooperative: \boldsymbol{Nash} \\ else: \boldsymbol{Individual} \end{cases}$$

- **Middle stage** (0.3 ≤ T < 0.7)

$$\begin{cases} if\ above\_RiskTH(R > 0.2): \boldsymbol{Best} \\ else \begin{cases} if\ cooperative: \boldsymbol{Nash} \\ else: \boldsymbol{Individual} \end{cases} \end{cases}$$

- **Late stage** (T ≥ 0.7)

$$\begin{cases} if\ high\_R(R > 0.5): \boldsymbol{Individual} \\ else: \boldsymbol{Hybrid} \end{cases}$$

Strategy ~ Bidding ~

select_optimal_strategy (2)

execute_nash_strategy (Cooperative) :

- Select the outcome that satisfies the **utility threshold** (95% of the current level)

- Select from the candidates with the highest **Nash product** (**my utility** × **estimate_opponent_utility**)

execute_individual_strategy (Competitive) :

- Prefer outcomes with **high utility for my agent**
  - make aggressive proposals to maximize my utility

- Target **opponent's weaknesses**
  - adjust to the opponent‘s tendency to compromise and weakness score

execute_hybrid_strategy (using weighted utilities [**nash**_weight , **individual**_ weight]) **:**

- **Adjust weights dynamically** for Cooperative opponents (favoring **Nash** outcomes)
- Select the outcome with **the highest** combined score

Strategy ~ Acceptance ~

Proposal evaluation

Calculate the utility of the current_offer / Add the **estimate_opponent_utility** to **opponent_utility_history**

respond

1. Calculate the minimum acceptable utility (effective_level) for the current turn

- Adjust the **acceptance threshold** depending on the strategy being chosen

Nash (small concessions)	**Individual** (increase demands)	**Hybrid** (nash and individual)
If the Nash product is greater than 0.4, apply a bonus (0.1×level) and lower the threshold to encourage cooperative agreement.	Increase the threshold with aggression_level($e.g.\ level \times (1 + 0.5 \times aggression)$)	Lower the threshold depending on the weighting (nash_component and individual_component)

2. Decide ACCEPT / REJECT

$$\begin{cases} if\ effective\_level > my\_utility\text{: } \boldsymbol{ACCEPT} \\ else\text{: } \boldsymbol{REJECT} \end{cases}$$

It can handle cases where the threshold is exactly met. (using **reject_exactly_as_reserved**)