Introducing Dialogue-Act Framework for Multi-Agent LLM Negotiation

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Paper & Poster

Background & Motivation

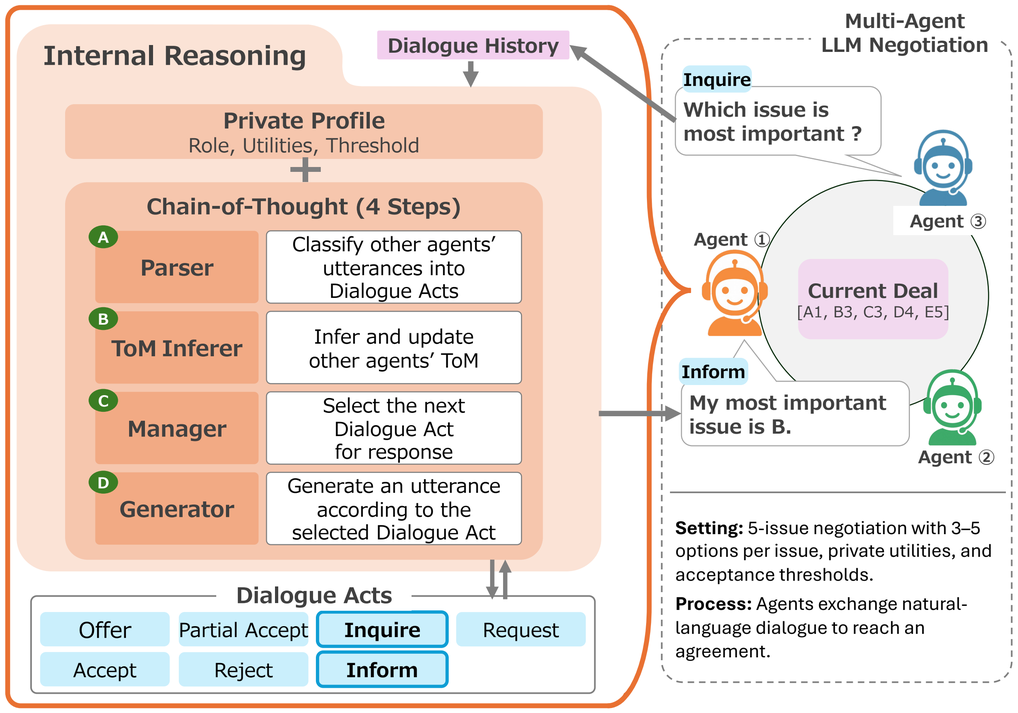
- **Negotiation** is a challenging testbed for **multi-agent coordination**.
- Resolving preference conflicts requires strategic reasoning and **Theory of Mind**.
- We propose a Dialogue-Act framework that enables **explicit preference exchange** in natural language.
- **Big picture:** enabling human-like negotiation via belief-guided language.

Dialogue Acts

- Dialogue Acts make **negotiation intent** explicit during interaction.
- Utterances are structured into acts such as Offer, Inquire, and Inform.
- This enables explicit **preference exchange** and reasoning.

❶ **Offer**	Propose a complete Deal
❷ **Accept**	Accept the proposed Deal
❸ **Partial Accept**	Partially accept the Deal
❹ **Reject**	Reject the Deal
❺ **Inquire**	Ask a question about preferences
❻ **Inform**	Provide a preference or constraint
❼ **Request**	Directly ask a concession

Framework Overview



- Agents generate their next response to others via a **4-step CoT** reasoning.

A) Parser: Converts an utterance into a Dialogue Act.

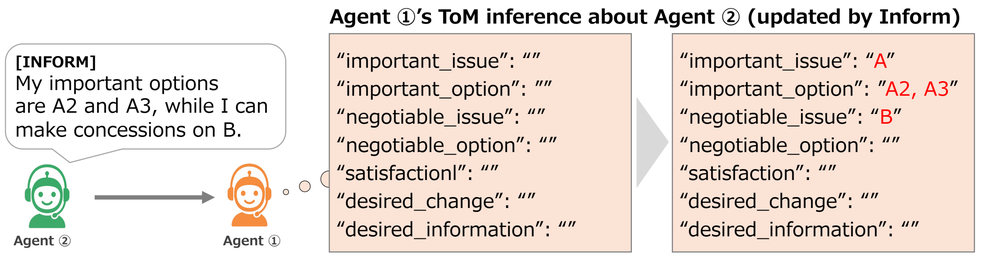
B) ToM Inferer: Updates ToM beliefs about others.

C) Manager: Chooses the next Dialogue Act based on ToM beliefs and profile.

D) Generator: Produces natural language output for the selected act.

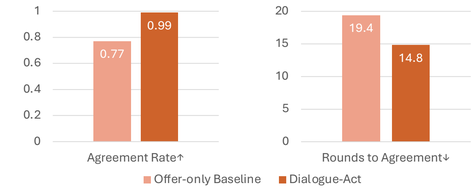
ToM State & Updates

- Agents maintain an explicit, JSON-like **first-order ToM** state during internal reasoning.
- The state **is incrementally updated** from others' utterances (especially Inform and Request) and referenced during action selection.



Results

- Natural language interaction enables more **efficient agreement formation** compared to offer-only interaction.



Future Directions

- Improving **agreement quality** (e.g., Pareto optimality, Nash product).
- **Higher-order ToM** for modeling others' reasoning, enabling more deliberate negotiation actions (with cost concerns).
- **Strategic use of ToM** for guiding action selection.