



Background & Motivation

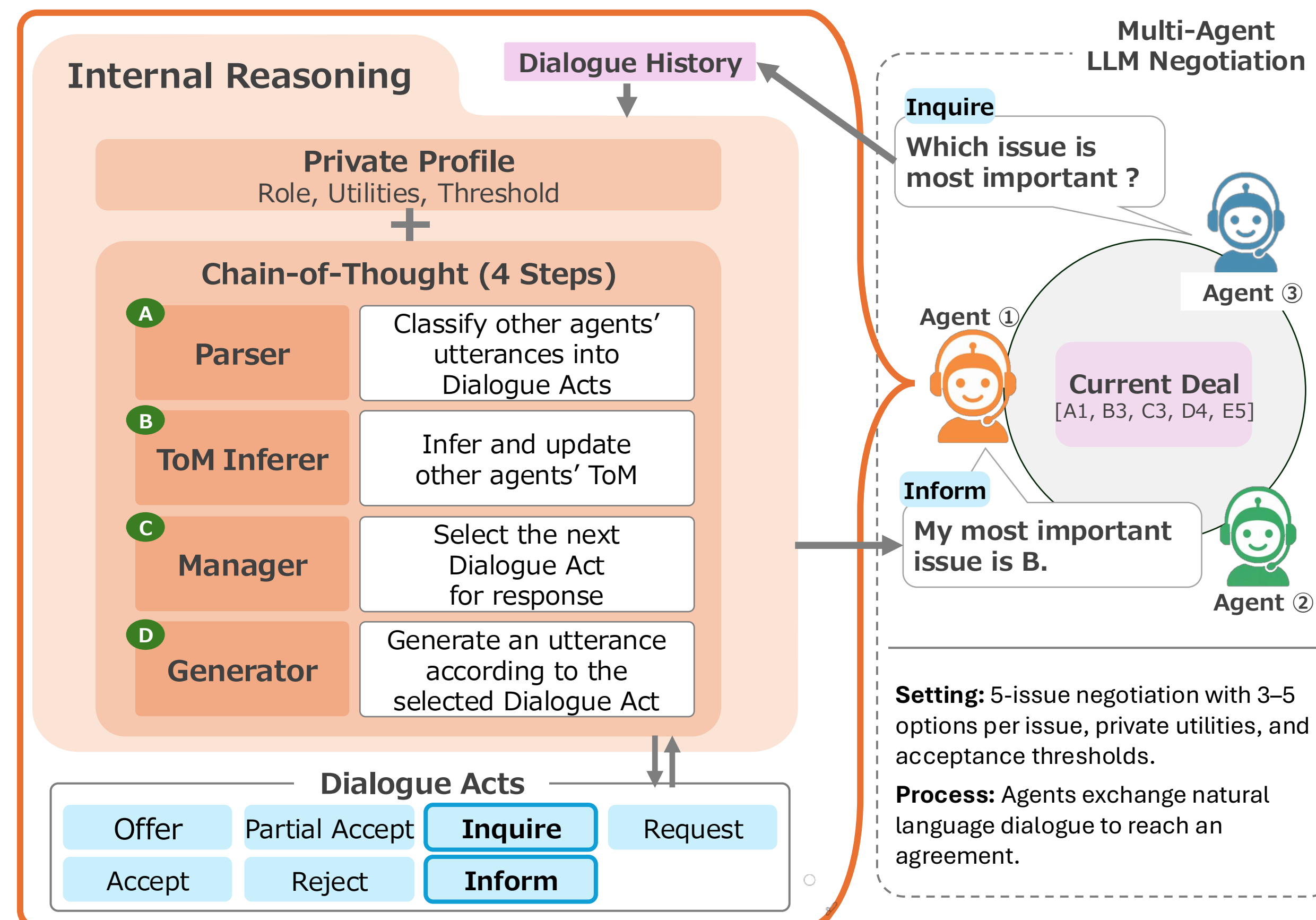
- **Negotiation** is a challenging testbed for **multi-agent coordination**.
- Resolving preference conflicts requires strategic reasoning and **Theory of Mind**.
- We propose a Dialogue-Act framework that enables **explicit preference exchange** in natural language.
- **Big picture**: enabling human-like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

1	Offer	Propose a complete Deal
2	Accept	Accept the proposed Deal
3	Partial Accept	Partially accept the Deal
4	Reject	Reject the Deal
5	Inquire	Ask a question about preferences
6	Inform	Provide a preference or constraint
7	Request	Directly ask a concession

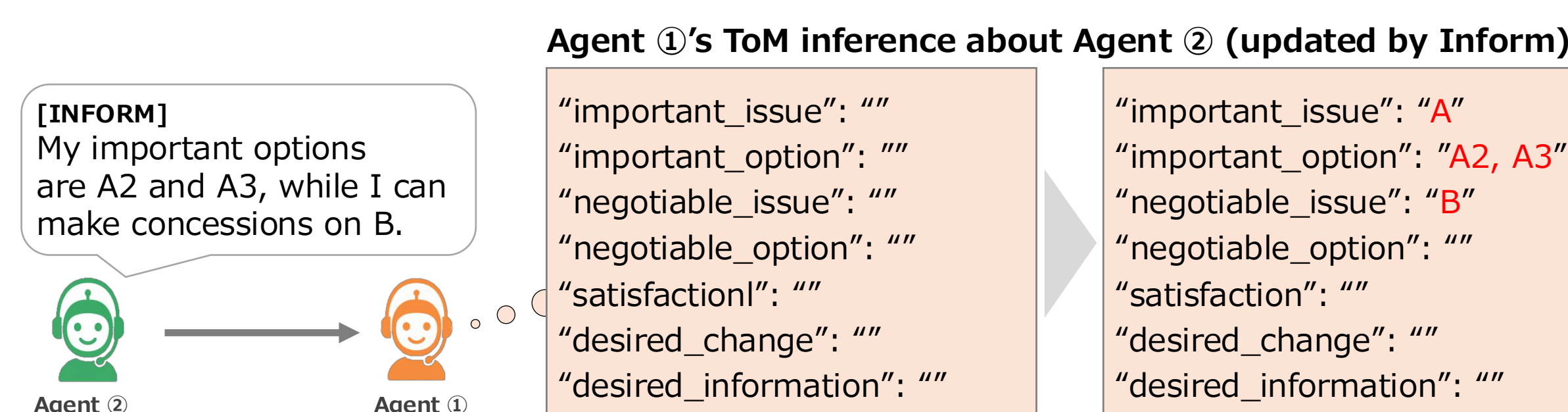
Framework Overview



- 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.

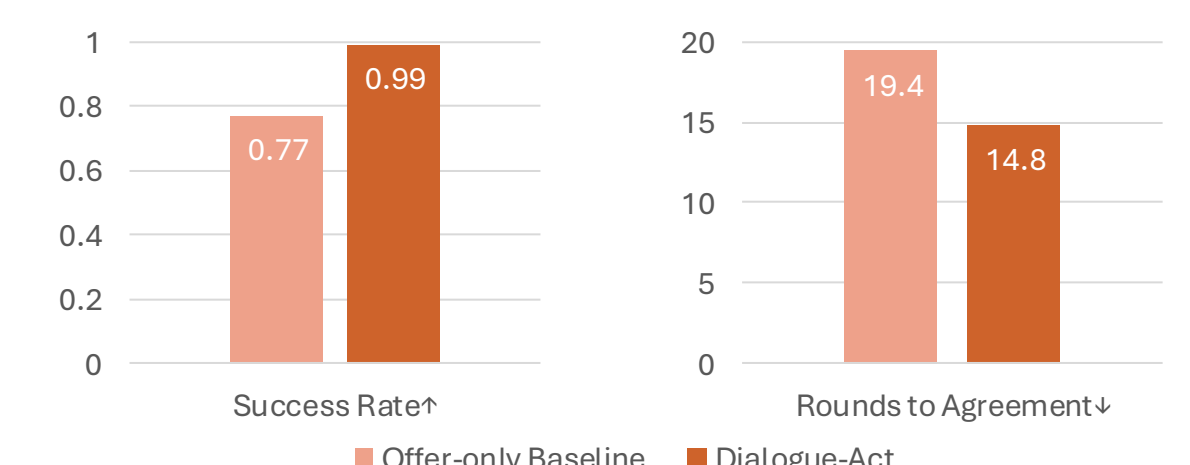
ToM State & Updates

- 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.