An Integrated Framework for Adaptive Reasoning About Conversation Patterns

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- ACL/protocol semantics usually provided in the form of dialogue sequence patterns + logical constraints
- We describe an integrated social reasoning architecture that is capable of
  1. processing such patterns,
  2. making boundedly rational communication decisions,
  3. learning communication patterns and their strategic application from observation
- Combination of decision-theoretic utility maximisation, case-based reasoning methods, hierarchical reinforcement learning and cluster validation techniques
- Adequacy of the approach illustrated through experimental results in complex negotiation scenarios

Interaction Frames

- How can we build agents that can learn to use a given communication mechanism optimally in an open multiagent system?
- Communication mechanism usually defined through surface structure of dialogues and logical constraints that limit their applicability
- **Interaction frames** are suitable for capturing this information *and* combining it with experience about past usage

$$
\begin{aligned}
F = \quad & \Big\langle \big\langle \xrightarrow{5} \texttt{request}(A, B, X) \xrightarrow{3} \texttt{do}(B, X) \big\rangle, \\
& \big\langle \{can(B, X)\}, \{can(B, \texttt{pay}(S))\} \big\rangle \\
& \big\langle \xrightarrow{2} \langle [A/\texttt{a}], [B/\texttt{b}], [X/\texttt{pay}(\$100)] \rangle, \\
& \quad \xrightarrow{1} \langle [A/\texttt{b}], [B/\texttt{a}], [X/\texttt{pay}(S)] \rangle \big\rangle \Big\rangle
\end{aligned}
$$

- Hierarchical decision-making and (reinforcement) learning process allows for complexity reduction in communicative decision making

Experimental Results

- Empirical evaluation in
  1. simple proposal-based negotiation (where agents simply exchange proposals and counter-proposals)
  2. complex interest-based negotiation (which involves discussing the underlying reasons and assumptions for statements)
- Example for interest-based negotiation frame:

$$\Big\langle \big\langle \xrightarrow{0} \texttt{request}(A,B,X) \xrightarrow{0} \texttt{ask-reason}(B,A,\texttt{request}(X)) \xrightarrow{0} \texttt{inf-goal}(A,B,G) \xrightarrow{0} \texttt{att-goal}(B,A,\mathit{threat}(X,T)) \xrightarrow{0} \texttt{concede}(B,A,\mathit{threat}(X,T))\big\rangle, \big\langle \{\mathit{can}(B,X), \mathit{goal}(A,G), \mathit{achieves}(X,G), \mathit{goal}(A,T), \neg\mathit{achieves}(Y,T)\}\big\rangle, \big\langle \xrightarrow{0} \langle\rangle \big\rangle \Big\rangle$$

- Results show that effective social reasoning and learning is possible even under such complex communication regimes