Chagamma-2004 is based on released code of UvA Trilearn-2004’s, and enhanced in communication module.

In Chagamma-2004, I’m attacking an issue to apply agent modeling for efficient communication. In speech-act theory used in FIPA’s ACL (Agent Communication Language), a sender, who intend to inform a message to a receiver, is assumed not to believe the receiver already knows the message. In order to estimate receiver’s belief, I apply agent modeling method based on hidden Markov model (HMM).

In FIPA’s specification of ACL [FIP01], the condition for a sender \( s \) to inform a message \( \phi \) to a receiver \( r \) is:

\[
B_s(\phi) \land \neg B_s(B_{\text{if}}(\phi) \lor U_{\text{if}}(\phi))
\]

In the context of soccer games, a player \( s \) should inform his plan (intention) \( I_{\text{play}} \) to a teammate \( r \) when:

- the player \( s \) wants to do \( \text{play} \), and
- the player \( s \) thinks the teammate \( r \) does not know that \( s \) wants to do \( \text{play} \).

Similarly, the condition for a sender \( s \) to ask (Call-for-Proposal) an action \( \text{act} \) to a receiver \( r \) is:

\[
\neg B_{\text{ref}}(\iota(x: \alpha(x))) \land \neg U_{\text{ref}}(\iota(x: \alpha(x))) \land \neg B_{\text{ir}}(\text{Done}(< r, \text{Inform-ref}(s, \iota(x: \alpha(x))))),
\]

where

\[
\alpha(x) = I, \text{Done}(< r, \text{act} > | \phi(x)) \Rightarrow I, \text{Done}(< r, \text{act} > | \phi(x))
\]

This means that a player \( s \) should ask a teammate \( r \) to do \( \text{play} \) when \( s \) does now know a way to let \( r \) do \( \text{play} \) without explicit communication in the soccer context. Using these conditions, we can reduce redundant communication among players.

In order to realize this efficient communication, we need a way to estimate teammate’s belief, that is, to know \( B_s(B_{\text{if}}(...)) \), \( B_s(I_{\text{if}}(...)) \) and so on. And, I’m trying to apply HMM technique for it. In my previous works [NOD03b, NOD03a], I proposed a hierarchical hidden Markov model to represent teamwork. In the model, I suppose that a player’s behavior consists of a sequence of a simple plan (intention), and a simple plan consists of a sequence of actions. Both levels
of sequences are modeled as hidden Markov model respectively, and coupled hierarchically. In addition to it, other’s intentions are coupled as a condition of state transition in high-level (simple-plan level). Figure 1 illustrate the relations between two-level HMM and between agents.

Using probabilities and likelihood calculated in the model, the agent can check conditions of communication shown in Eq. 1 and Eq. 2. In the model, an agent always estimates the likelihood of teammate’s intentions using observation. This likelihood represents the confidence of $B_s(I_r(...))$, that is, teammate’s intention in the belief of agent itself. Also, the agent can calculate the likelihood of its intention using only observation. The value represents the confidence of $B_s(B_r(I_s(...)))$, and can be used as an approximation of confidence of $B_s(B_r(I_s(...)))$.

References