Team ChaGamma-2004

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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 ϕ to a receiver r is:

$$\mathbf{B}_s(\phi) \wedge \neg \mathbf{B}_s(\mathbf{Bif}_r(\phi) \vee \mathbf{Uif}_r(\phi)) \tag{1}$$

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

- the player s wants to do *play*, and
- the player s thinks the teammate r does not know that s wants to do *play*.

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

$$\begin{aligned} &\neg \mathbf{Bref}_s(\iota(x : \alpha(x))) \wedge \neg \mathbf{Uref}_s(\iota(x : \alpha(x))) \\ &\wedge \neg \mathbf{B}s\mathbf{I}r\mathbf{Done}(< r, \text{Inform-ref}(s, \iota(x : \alpha(x))) >), \end{aligned} \tag{2}$$

where

$$\alpha(x) = \mathbf{I}_s\mathbf{Done}(< r, act > |\phi(x)) \Rightarrow \mathbf{I}_r\mathbf{Done}(< r, act > |\phi(x))$$

This means that a player s should ask a teammate r to do *play* when s does now know a way to let r do *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 $\mathbf{B}_s(\mathbf{B}_r(...)), \mathbf{B}_s(\mathbf{I}_r(...))$ 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

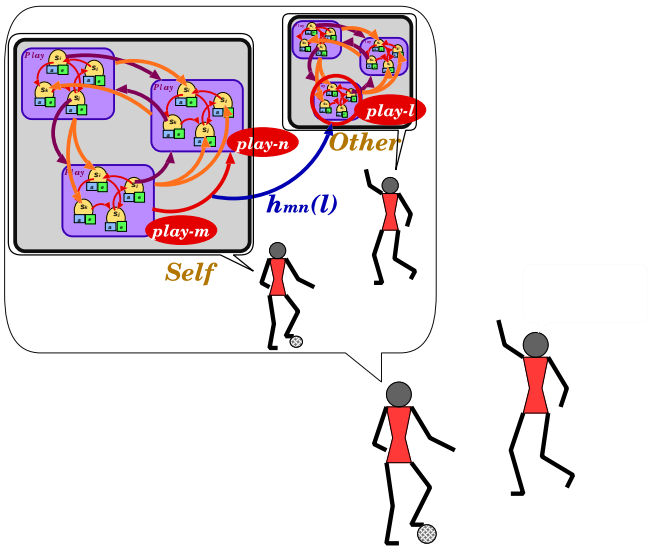

Fig. 1. Hierarchical Hidden Markov Modeling for Team-play in Multiple Agents

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 likelyhood 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 likelyhood of teammate's intentions using observation. This likelyhood represents the confidence of $\mathbf{B}_s(\mathbf{I}_r(...))$, that is, teammate's intention in the belief of agent itself. Also, the agent can calculate likelyhood of its intention using only observation. The value represents the confidence of $\mathbf{B}_s(\mathbf{B}_s(\mathbf{I}_s(...)))$, and can be used as an approximation of confidence of $\mathbf{B}_s(\mathbf{B}_r(\mathbf{I}_s...)))$.

References

[FIP01] FIPA, Geneva, Switzerland. *FIPA Communicative Act Library Specification*, Jan. 2001. Document number XC00037 (`http://www.fipa.org/`).

[NOD03a] Itsuki NODA. Hidden markov modeling of team-play. In *Proc. of IJCAI-2003*, pages 1470–1472. Morgan Kaufmann, Aug. 2003.

[NOD03b] Itsuki NODA. Hidden markov modeling of team-play synchronization. In *Proc. of RoboCup 2003*, Jul. 2003.