Rational Agents by Reviewing Techniques

Josep Lluís de la Rosa, Bianca Innocenti, Israel Muñoz and Miquel Montaner

Institut d'Informàtica i Aplicacions
Universitat de Girona & LEA-SICA
C/Lluís Santaló s/n
E-17071 Girona, Catalonia
{peplluis, bianca, imunoz, mmontane }@eia.udg.es

Abstract. This paper describes the research in a new Rogi Team conceived by simulation in Java. It is a development of ideas for rational agents that co-operate and use revision of exchanged information and consensus techniques.

1 Introduction

This research is implemented in JAVA. Next it will be applied to real platform of robots and especially to the 11x11-soccer server. A type of rational agents is implemented by techniques inspired from consensus techniques [Chi 92] and according to new trends of agents research [Jennings 98] for emergent co-operation design.

2 Rational Agents

2.1 Reactive Decisions

In a first step of reasoning, every agent decides a private action. This first decision is considered a BELIEF of the Agent0 language [Shoham 93]. This belief depends on local environment configuration defined by two parameters: distance player-ball (DPB), and distance player-goal (DPG). The belief contains a degree of certainty.

"*Fig. 1*a" shows an example of configurations of robots and the ball in the field. Decisions are SHOOT at 'Zone 1', GET at 'Zone 2', and FORW or BACK at default 'Zone 3' depending on DPG value. Thus, reactive reasoning is the following rule:

```
BEL ( AgentX, DPB, ZONE2 ) ⇒
INFORM ( to_any_agent, AgentX, SHOOT, 0.8 )
```

Similarly, at 'Zone 3' in point 'M' (see *"Fig. 1b"*), reasoning would be the following:

```
BEL ( AgentX, DPB, ZONE3 ) ∧ BEL ( AgentX, DPG,FAR ) ⇒
INFORM ( to_any_agent, AgentX, FORW, certainty )
```

M. Veloso, E. Pagello, and H. Kitano (Eds.): RoboCup-99, LNAI 1856, pp. 632–637, 2000.

where 'certainty' is a value obtained by fuzzy inference by operating the certainties of ZONE3 ∧ FAR Agents communicate their beliefs (INFORM in terms of AGENT0 language) to the playmates. Thus reactive reasoning creates rough intentions.

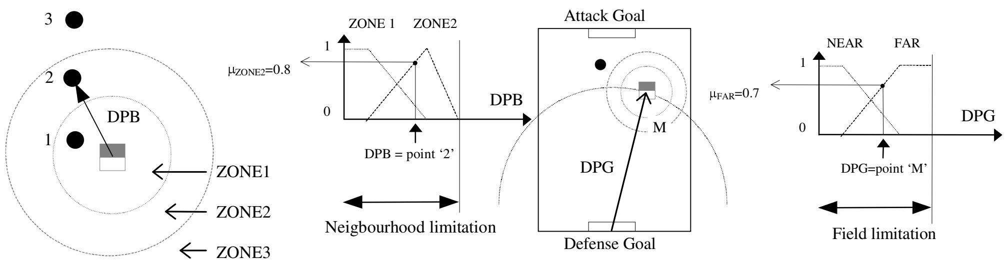


Fig. 1: Reactive beliefs of agents by fuzzy sets (a) DPB, (b) both DPB and DPG variables

2.2 Rational (Co-operative) Decisions

Rational reasoning in the sense of [Busetta 99] is implemented by communicating the former reactive beliefs. It begins with a REQUEST (a communication) action, so that every agent can know the beliefs set that contains the reactive belief, the certainty of this belief and the identification of the player *(reactive_belief, certainty, ID_player)* of all other playmates. Therefore, when two playmates realise they have conflictive beliefs then the certainty of their beliefs is taken into account and one of the playmates changes its mind by reconsidering its former reactive beliefs.

"Fig. 2" shows a situation where both Agent1 and Agent2 belief they can *GET the ball*. After REQUEST each other, Agent1 will change its belief because its DPB parameter brings lower certainty than those obtained by Agent2.

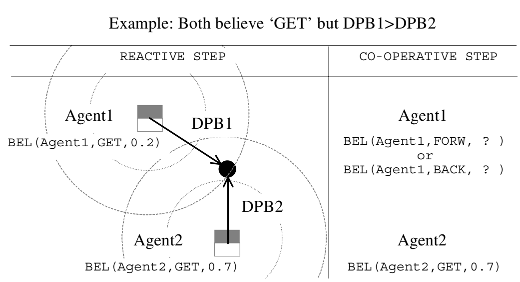


Fig. 2 Example of rational decision

Note that the exchange of beliefs and their certainties requires of revision [de la Rosa 92a]. This means that the subjective certainties associated to beliefs that are incoming from other agents have to be filtered (reviewed) at every agent. This process of revision is developed using extra knowledge about the co-operative world by means of some perception of quality and reliability of mates and of oneself [de la Rosa 92b, 93] [Acebo 98]. This reasoning procedure could be expressed as:

```
INFORM ( Agent2, Agent1, BEL ( Agent2, SHOOT, 0.7) ) ∧ BEL (
Agent1, SHOOT, 0.2 ) ⇒ BEL ( Agent1, SHOOT, f(0.7,0.2) )
```

where $$f(c1,c2)=\begin{cases} 0 & , c1>c2 \\ c2 & , \text{otherwise} \end{cases}$$

In the example of figure 2 since f (c1, c2) = 0 then Agent1 will change its belief to FORW or BACK action using the here described rules.

3 Implementation of the Team in the Javasoccer

COMMUNICATION of AGENTS' BELIEFS. When players already have their reactive beliefs about possible actions to do, then this belief is communicated to the playmates. Next, every agent reviews the incoming certainty of the incoming beliefs.

3.1 Communication of beliefs

In the initialisation phase a broadcast communication channel is open. An Enumeration object is used to send beliefs. This object has two attributes: one is a emitter player's identifier, and the second attribute is the belief and certainty to send.

Every player receives the beliefs from the others. The incoming certainty of beliefs, *certesa_company* is reviewed by means of the following rules that contain the perception of every agent of the community of agents in the co-operative world. This is implemented in prestige and necessity rules. This couple of parameters, defined as follows, describes the perception of the co-operative world, that is the perception that every agent has of the rest playmate agents:

The Prestige operator is implementable when using probabilistic $P_{ij}(\varphi) = P_{ij} * \varphi$, or Sugeno's $P_{ij}(\varphi) = \min(P_{ij}, \varphi)$ implementation of the **and** operator.

3.2 Conflicts

This is the set of conflicts that agents should solve by means of the rational decision.

Player \ Mate	SHUT	ATACK	GO TO BALL	CALL BACK
SHUT	Conflict	Conflict	Conflict	
ATACK	Conflict	Conflict	Conflict	
GO TO BALL	Conflict	Conflict	Conflict	Conflict
CALL BACK			Conflict	Conflict

Alternative possible actions ATURAR (stop), DEFENSAR (defence), COBRIR (?), etc… aren't conflictive in this example. In the case of no conflict then every agent decides to convert the reactive belief into an action.

3.3 Rational decision implementation in Java

An algorithm called consensus [de la Rosa 92] [Chi 92] that recovers the perception of the co-operative world develops the reviewing process. The formulas are implemented using probabilistic implementation of the **and** logical connective.

```
if ( decisions[decidit] * consensus[RobotID] <
            certesa_company * consensus[id_company] )
  {   // lets change the belief of this agent
   }
```

4 Methods for Changing Perception of the Co-operative World

Java implementations of our rational agents show trends of better behaviour of the overall play of the teams, but there are still some lacks, as for example conflicts between defenders and goal keepers, are not properly solved. Our improvement (novelty) is to modify the perception of the co-operative world to make the consensus algorithm more adaptive to changing environments: every agent modifies its perception of the co-operative world. Two methods are proposed: (1) a positional method and (2) a reinforcement method for *winners in conflicts* to increase persistence.

4.1 Method 1: positional method.

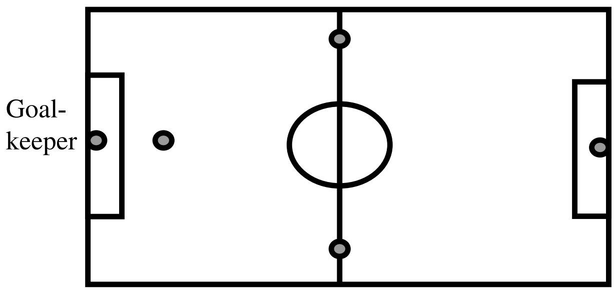
Players are specialised. One possible effect of their specialisation is that they prefer to stay in certain position in the playground. Agents will take advantage of this feature and will modify their vision of the co-operative world by assigning the values of prestige and necessity according to positions of players.

For example, the perception of the co-operative world from a forward-player could be: *'I have big necessity of the middle-forward players and not much necessity of the goal-keeper'*. However, this perception has to be completed by more information according to the positions of the other playmates. This is the assignment of the prestige and necessity parameters:

a) The Necessity N is calculated as follows: *'We have the more necessity of information provided by a playmate when the closer of his positional area we are'*. For instance, a forward-player that helps in defence will take into account more the beliefs of goalkeeper and defenders than of others and himself.

b) The Prestige P is assigned as follows: *'The more prestige I have when the closer to my specific position I am'*. For example, a forward-player that is waiting for the ball in its position has big prestige.

Results of the method 1 Collisions in decisions are reduced compared to non-adaptive perception of the co-operative world but not eliminated. Prestige is assigned within the interval [0.5, 1] because every playmate deserves minimum credibility. Necessities vary in the interval [0, 1] but normally are low. Here follows that the behaviour of agents is as follows: when a player is far from the ball it will be passive or conservative and when the ball is closer it will be more active and aggressive.



4.2 Method 2: a positional method with reinforcement of winners in conflicts.

Necessity

This is understood as the confidence any agent has on its own possibilities. This is an auto-perception. Necessity could be thought as the need of going to the ball an agent has. For example, if a defender sees the ball in the attack zone (in the opponent field) then the necessity of this player could be very low because it is not its responsibility to go to fetch the ball. This necessity will be different depending upon the perception of the world that every agent contains because of its specialised view and role.

For example, necessity of going to the ball could be maximum (1) if the ball is placed in the defence half field within the scope *d* distance from the origin. Progressively this necessity decreases towards the opponent half field till 0.

Prestige

Prestige is the perception of the co-operative world. It is the confidence on other playmates. Prestige that a player *i* is seen from a playmate *j* is based on using the necessity that player *j* has of going to the ball. This prestige, that it is initialised at a random value (0.5), will change during the game at every conflict:

- The agent that has to modify its belief because of a conflict, and happens that its reviewed certainty is lower than the reviewed certainty of the playmate. We write down the identifier of the playmate who won the conflict and its decision.
- At any moment again the agent has to modify its belief because of a conflict, then it will consider whether the conflict is with the same previous playmate. In

this case, if the conflict is solved in the same way as previously then reinforcement learning will be used, to reinforce, by means of modifying the prestige, the persistence of the rational decisions of the agents.

Results of method 2. The improvement of this method is significative and highly adaptive. Almost collisions in terms of co-operative decisions are eliminated.

5 Results

- The exchange of beliefs and application of consensus algorithm for rational reasoning improved the performance of the team by reducing the collisions.
- The change of each agent's perception of the co-operative world improved the exchange of beliefs and minimised the number of collisions almost to null.
- Prototyped is in Javasoccer. An 11x11 official RoboCup soccer simulator will be available this summer.
- The results of this research in Javasoccer are being applied to the real implementation of small-size RoboCup and FIRA robots and fields specifications.

(The results are downloadable from web page http://rogiteam.udg.es/robots/simulation.html)

6 References

[Acebo 98] Acebo E., Oller A., de la Rosa J. Ll., and Ligeza A., "Static Criteria for Fuzzy Systems Quality Evaluation", in Tasks and Methods in Applied Artificial Intelligence, Vol. 2, pp: 877-887, *Lecture Notes in AI Nº1416*, Angel Pasqual del Pobil, Jose Mira and Moonis AI Eds. Springer, 1998.

[Busetta 99] Busetta P., Rönnquist R., et al., "JACK Intelligent Agents-Components for Intelligent Agents in Java", *Agentlink Newsletter*, No.2, pp. 2-5, January 1999.

[Chi 92] K. Chi Ng and B. Abramson, "Consensus Diagnosis: A Simulation Study", *IEEE Transactions on Systems, Man, and Cybernetics*, Vol. 22, nº 5, September/October 1992

[de la Rosa 92a] de la Rosa J. Ll., and Delgado A. "Fuzzy Evaluation of Information Received from other Systems", *Proceedings of the IPMU'92*, pp. 769-778, Palma de Mallorca, July 6-10, 1992, ISBN 84-7632-142-2

[de la Rosa 92b] de la Rosa J. Ll., Serra I., and Aguilar-Martin J., "Outline of a Heuristic Protocol among Cooperative Expert Systems", *IEEE on Systems, Man, and Cybernetics*, Vol. 2 pp:905-910, ISBN 0-7803-0720-8, CHICAGO (USA) Septembre 1992

[de la Rosa 93] de la Rosa J. Ll., Ignasi Serra and Josep Aguilar-Martin, "Applying a Heuristic Co-operation Framework to Expert Control", *IEEE International Symposium on Intelligent Control*, Chicago, August 25-27, 1993, ISBN 0-7803-1206-6

[Jennings 98] Jennings N., Sycara K., and Wooldridge M. "A Roadmap of Agent Research and Development", *Autonomous Agents and Multi-Agent Systems*, Kluwer Academic Publishers. Vol. 1, n. 1, pp. 7-38, 1998.

[Shoham 93] Shoham Y. "Agent-oriented programming", *Artificial Intelligence*, vol. 60 (1), pp.51-92, 1993 & *Technical Report STAN-CS-1335-90, Computer Science Department*, Stanford University, Stanford, CA, 1990.