

11Monkeys Description

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1 Introduction

The major purpose of this research is to study cooperative planning for multi-agent systems in time-critical environment. The RoboCup simulator league is the most interesting target for our research.

In Artificial Intelligence, problem solving is to transit state from initial state to goal state. There are two types of planning, namely deliberative planning and reactive planning. The former is to find all series of action before it really acts. So deliberative planning requires much computation resources. And it has also a problem of poor adaptability to dynamic environment. On the other hand, reactive planning has a good adaptability, but in many cases, it doesn't select the best choice, and it needs more optimization. So there is a potent trade-off problem in this two types of planning.

To solve this problem, we propose three layers planning, Strategy, Group, and Individual. Strategy Layer planning determines global team strategy dependent to opponent team model. For example agents select team formation and action algorism, and it also determines a policy of management to use stamina. In Group Layer, an agent makes cooperative planning among a few teammates. In this layer agents are assigned a dynamic role, such as ball handler or support player. Dynamic role change are triggered by their own recognition of the current state, because of taking account robustness. The agent which finds a chance becomes a planner. In Individual layer, agents behave reactively according to upper layer decision, such as team formation, dynamic roles or cooperative plans.

As a result, our 11Monkeys utilizes this three layers planning and we won the championship of the simulator league Japan Open '99. And we finished the simulator league of the RoboCup'99 Stockholm in 4th place.

2 Team Development

Team Leader: Kinoshita

Team Members:

- Shuhei Kinoshita
 - Keio University
 - Japan
 - Master Student
 - attend the competition

3 Three Layers Planning Approach

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3.1 Strategy Layer

Strategy Layer covers all teammates. In this layer Agents select their formation, tactics, and decide the policy of resource management. These must be decided depending upon opponent model. Static role assignment is done in this layer. Static Role is a role set, like Goalie, Defensive Half, etc. There are many types of team styles, indeed. So we need to adapt them effectively, but this is not implemented now.

3.2 Group Layer

Group Layer planning include about three or four teammates in local state near ball. In group layer agents are assigned a Dynamic Role like, ball handler, supporter.

A agent who finds the chance, can be a reactive cooperative planner. If there are no fatal condition to execute the plan, agreement will be done, and plan in group level can be executed.

3.3 Individual Layer

Individual Layer planning covers only 1 vs. 1 state. Agent selects most suitable pre-planned module. There are fatal condition, which agents withdraw his plan in every simulation step. For example agent cannot find pass course in defense area, he makes a decision of clearing ball.

4 System

The system of each agent is represented in Fig. 1. When an agent is created, he gets a common formation and is assigned one of static role in Formation/Static Role Module. In Interpreter Module he parses many sensor information from soccer server[1]. And then he updates world model. Next in Offense/Defense, Dynamic Role Module he make a decision of offense or defense, and he get a

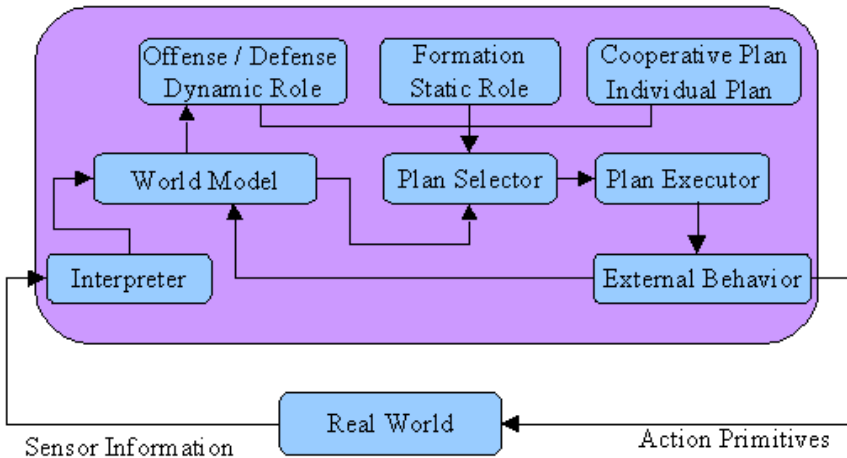


Fig. 1. Agent system

dynamic role, like ball handler. Next he selects one of abstract plan out of cooperative plans and individual plans. Then the plan is transformed into a primitive command in Plan Executor Module. At last in External Behavior Module the primitive command is sent. We uses the low level skill of CMunit'98[?, cmu]

5 Dynamic Role Assignment

Role is necessary for autonomous agents. If agents don't have any role, agents behave selfish. In many cases roles were allocated statically. It was not so flexible. We use dynamic role assignment system. We call dynamic roles as 'Player with ball' or "Player for support". In our team, dynamic role number is six. In offense mode there are three roles, and in defense mode there are also three roles. At first agents autonomously make a judgment of offense mode or defense mode. Next agent most suitable player to catch ball is allocated "Player near the ball". If in defense mode "Player near the ball" is named "First Defender". If in attack mode "Player with ball" is named "First Attacker".

Offense Mode

First Attacker	Player with Ball
Second Attacker	Player who supports First Attacker
Third Attacker	Other Players

Defense Mode

First Defender	Player near ball
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Second Defender Player who supports First Defender
 Third Attacker Other Players

That is agent selects autonomously the most suitable role of the six. He does not depend on others in making the decision. In order to take into accounts robust. The moment one player catch the ball, the others' roles automatically change.

6 Reactive Planning Mechanism

There are little time for deliberative planning, because there exists an opponent team. So an agent should select his plan reactively.

In this research, there are two steps in reactive planning.

- abstract-planning
- re-planning & plan-execution

7 conclusion

11Monkeys utilizes three layers planning and we won the championship of the simulator league Japan Open '99. And we finished the simulator league of the RoboCup'99 Stockholm in 4th place.

Table 1. The Result of 11Monkeys in RoboCup '99 Stockholm

Opponent	Affiliation	Score	Possession(%)	Side(%)
Gongeroos	University Of Wollongong, Australia	4-0	66	89
Sibiu Team	Lucian Blaga University of Sibiu, Romania	17-0	80	70
FCFoo	Link ping University, Sweden	18-0	-	73
UvaTeam	University of Amsterdam, The Netherlands	1-0	54	39
CMUnited 98	Carnegie Mellon University, USA	1-0	55	43
YowAI	University of Electro-Communications, Japan	8-0	60	39
HCIII	Link ping University, Sweden	1-0	53	37
EssexWizards	University of Essex, England	0-1	-	39
CMUnited 99	Carnegie Mellon University, USA	0-8	35	13

References

1. Itsuki Noda. *Soccer server a simulator of RoboCup* a draft distributed at IJCAI'95 Workshop: Entertainment and AI/Alife, 1995.
2. Peter Stone and Manuela Veloso. *The CMUnited-98 Champion Simulator Team*. In "RoboCup-98: Robot Soccer World Cup II", M. Asada and H. Kitano (eds.), Springer Verlag, Berlin, 1999.