Coordination Approach to Find Best Defense Decision with Multiple Possibilities among Robocup Soccer Simulation Team

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Abstract

In 2D Soccer Simulation league, agents will decide based on information and data in their model. Effective decisions need to have world model information without any noise and missing data; however, there are few solutions to omit noise in world model data; so we should find efficient ways to reduce the effect of noise when making decisions. In this article we evaluate some simple solutions when making defense decisions and try to find a solution based on message-passing to coordinating agents in defense situations. Our experimental results showed that in each situation one of the agents has a better view than others, so that agent can send messages to the others and provide needed information for doing defense behavior(ex: block behavior or clear ball behavior). Finally, we implement our solution based on Agent2D, version 3 and compare that with other solutions implemented in Cyrus2014 and Marlik2013 Soccer 2D simulation teams.

Keywords: Multi-Agent coordination, Message-passing, Robocup soccer 2D simulation, Autonomous Agents, Decision Making

1. Introduction

Robocup is improving artificial intelligence, robotic and others areas by presenting some standard problems in which different technologies are combined and tested.[1] In this article we try to use co-ordination between autonomous agents in soccer 2d simulation environment and implement better strategies for defense decision.

In 2d soccer simulation league, which is a main branch of robotic science, determining game strategies are difficult because of the noise in the received world model data. Also in this environment agents are more restricted in their communication and calculation and they are less aware of the decisions of other agents; so in these years active teams in the competitions use an approach to teach their agents to find best decisions in such conditions.

In different approaches introduced so far, one can mention the use of Kalman-filter to reduce noise in data, use offline methods in learning science, and the use of learning machine to choose the best behavior.[2] In this article we try to introduce new approaches to solve problems related to decision

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making in 2D simulation environment which is considered as co-ordination and team work to achieve an objective. This approach is being used in defense decision making and its goal is to reduce noise effect in agents' decisions. To achieve this goal, some messages should be passed between the agents. Also, in this situation because of restrictions in communication, co-ordination between agents is needed and one simple way is the use of an agent that has a better view of world model running the defense algorithm and tells other agents what to do.

In the following, first communication will be discussed and then different approaches in multi-agent systems will be reviewed and compared with older methods for the same environments.

2. Communication in 2D Soccer Simulation

In this paper Agent3 project [3] has been studied. In this project and framework of2d soccer simulation, agents are allowed to send limited number of broadcast messages in each game. Simulated agents have some predefined type of messages and can send important messages to teammate agents. It should be noted that the number of messages is limited and just some near agents can hear the message rather than all teammates.

In addition to the mentioned limitations in communication between agents in simulator, in each cycle just one of the players can send the message and if two or more players send messages simultaneously, it is possible that none of the messages will be heard by other players or randomly simulator framework will choose one of the messages and send it to broadcast space.

Finally, all agents can't send messages in all cycle of games because of limitation and also during the game, play agents should check some specific conditions and then try to send message broadcast. In the other hand, agents must have effective function to check possibilities of message conflict and use function value to check the importance of the issue.

3. Defense Strategies

In soccer 2D simulation, according to the game state, agents choose one of the possible behaviors related to present state automatically. Generally, game situation can be splitted into two categories, defense and offence. In defense mode, behaviors include block, mark, tackle, and etc. Also agents check all of the possible behavior, but during his autonomy and features, should check evaluation function for all of the behaviors and choose one of the behavior that maximize this function. [4], [5]

In each state of the game, agents need to do one of the mentioned behaviors; at the same time they need to gain the game and the players' information. In 2D soccer simulation, information of the world model and other agents is too much noisy, for example team-mate agents' position is not specified exactly and this information is collected the last time that the current agents see that point.[6] So, the agents should decide based on noisy information. In the following the 3 approaches of defense strategies in noisy environment will be discussed.

3.1. Greedy Method

In this approach, the agent's determinethe defensive behaviors evaluation, according to the present state and specified state in the team formation. The agents will decide based on those evaluations and will define function evaluation based on team formation strategies. As expected error possibility is too much in this method and specifying a suitable team formation is very important. Actually this approach had not used the benefit of multi-agency in 2D soccer simulation and directly used team formation for decision making, and following the team formation, agents will select for doing each defense behavior.

3.2. Considering Players Position

Agents in 2D soccer simulation have information about the players' position in the field and other part of the world model, but according to the view angle, each player sees a part of the field in each moment and updates the information about that part, so there is noise in information and it is inaccurate. In some scenario, if an agent does not look at another agent's direction, he should decide based on his old information and inaccurate information. [7]

In this approach, each agent decided based on the current team-mate players' positions and current opponent players' positions for doing a defensive behavior. For example, to avoiding opponents from being near to our goal an eleven-cell-matrix including our players was created and each player calculated his teammates' evaluation for block behavior and chose a player with the highest value for doing defensive behavior. [6] Generally, in this approach function evaluation will be calculated by the current state of team-mates agent, ball position and opponent's positions; so, if that state is potentially un-safe state, then team-mate agents will do the best to prevent opponents to reach the goal.

This solution is a simplified problem in multi-agent environment, but when players' information is not accurate other agents' behaviors should be simulated too and when the agents' information is noisy, so simulated behaviors will not be correct and that algorithm will be based on the some incorrect information. It seems that if game's information was noise-free, this approach was suitable but according to the fact that this information is noisy the improvement of this method than the last one is not significant so we should find an approach to reduce noise effect.

Investigations show that in Robocup especially in 2D soccer simulation, teams used machine learning methods to omit noise and improve agent's decision making by offline problem solving. [8], [2] But in this article we try to use another method in decision making and with use of message-passing, reduce noise effect on the agents' behaviors.

3.3. Message-Passing

As mentioned before, previous works removed data noise and improved decision making by using machine learning and offline problem solving methods. In this paper, the approach of message passing between players considering limitations has been discussed.

As we discussed before, in the second approach, it can be understood that if agents' information from present state was accurate, each agent could solve problem considering other agents' position and game state, but since they have not a complete correct view of the game the decision could be wrong or two players may decide to do the same behavior.

First step to use message passing is tochose an agent that can decide accurately in this situation of the game [9], [10]. This agent should have a better view than other agents. In other words, this agent should have newer updates of information about world model and players position, and can decide for other agents.

In this approach, the player should be able to decide for other players, but this situation is very rare and happens in limited number of states; so in order to find a suitable player and to reduce message passing, it is needed to omit the players that can't have an effective role in defense behaviors, from effective players to make a more accurate decision.

Fig. 1. effective player and player with better view

In fig. 1, the players that are far from the ball were omitted from the effective set of players and just effective agents from yellow team will be in this set and have effect in calculations. Then among the players that could have effect on present state, the one with the better view will decide for defensive strategies and behavior should run to prevent opponent attack by each agents of yellow team. In fig. 1, it is shown that the yellow agent number 8 has the best view of other agents. In each cycle this calculation could be done so it should be as simple as possible.

$$E(agent[i]) = (3 - count\_seen\_ball) + (5 - dist\_to\_opponent) \quad (1)$$

According to formula 1, evaluation of an agent for managing other players' behavior was calculated. By considering ball poscount cycle (count of cycle that passed agents seen the ball till current time of the game), best player was chosen. According to (1) and considering the condition of positive function, values for effective agents calculated and best agent was chosen.

After the selection of the best agent to decide about other players, in the second step, that agents run the decision algorithms for each member of effective agent set and evaluate the score of each behavior for them. Then, the best agent to do each defense action is selected to maximize the score.

Briefly, in this approach, first the set of the agents who have a better view of the game and have more accurate information about world model and agents' positions and also can be effective in the defense actions is formed, then from that set one agent that has a better view of the team-mate, attackers and ball position will choose to decide for all member of that set. And finally, the message is sent to the agent who should run it to prevent action against attackers or do block action. According to section 2, all team-mate agents in near of the sender will get that broadcast message and remember that agent is called in the message will do block action and after this he will decide based on that message. For example in the Figure 1, if agent number 8 from yellow team send broadcast message to agent number 3 from yellow team to run the block action against agent 9 from blue team, agent with number 5 and agent with number 2 from yellow team will decide based on the message and with his autonomy make decision to go back faster or try to mark other opponent agents.

According to section 2, in the 2D soccer simulation, we have limitation to send messages during the game and also just one player must send message in one cycle. In this approach, we prevent sending message simultaneously but for optimizing and satisfying communication limitations, we should reduce the number of times that each agent needs to send and receive messages based on the following conditions:

- The opponent ball owner player pass
- End of TTL of sent message
- Change in function value of agents

Two conditions of the above will explain that until one of this condition happened, that message sent by one of the agents is valid and other agents can decide based on that message. For example, when agent number 8 from yellow team sends broadcast message to agent number 3 from yellow team to run block against attacker, that message will be valid until that TTL time is passed or agent number 9 from blue team pass the ball to another opponents agent.

Third parameter of that condition introduced above, is the most important parameter. This parameter points to the changing state directly and explains if the state of the game is changed, so decisions of the agents will be changed too, and when the state changed, all of three steps in this algorithm should be run again and new decision makers of the team-mates should decide about all team-mate during defense situation.

4. Experimental Results

In order to test different approaches mentioned in this paper, a team with base Agent3 and mentioned algorithms were created and tested that teams against 4 first teams of world competition in 2014. According to the test results, the average numbers of received goals in 20 games with 4 first teams of the World-Cup competition were as followed:

Table 1

Statistical results achieved from first method

Team name	Average of received goal in 20 games
Wrighteagle 2014	6
Glider 2014	3
Oxsy 2014	4
Helios 2014	7

Table 2

Statistical results achieved from second method

Team name	Average of received goal in 20 games
Wrighteagle 2014	4
Glider 2014	2.4
Oxsy 2014	2.2
Helios 2014	4

Table 3

Statistical results achieved from third method

Team name	Average of received goal in 20 games
Wrighteagle 2014	1.8
Glider 2014	0.45
Oxsy 2014	0.55
Helios 2014	0.7

As it is obvious, the second method improved and reduced the goals received by 37% in comparison to the first method, and the third method improved 82% in comparison to the first method.

5. Discussion

In this paper we introduced some simple strategies that can be used for defense decisions. Generally, we tried to solve this problem in the multi-agent environment and we didn't use any other methods that can be used in this environment, but we can combine some other methods like re-enforcement learning to optimize decision making during the game and prevent to some issue will happened in the decision making by master agent and reduce agent mistakes in the game by offline data.

6. Conclusion

In this paper, by checking different methods that were used in 2D soccer simulation environment, a new method was introduced. This new method is less complex and less expensive in comparison to older methods like machine learning, but it is not perfect. In order to avoid overhead of message passing, factors for optimizing number of messages should be defined as we define some sample condition to reduce change decision each cycle and reduce the count of the messages that will be sent totally by agents. Finally it is concluded that using messages in coordination between agents in a system is a possible way to improve algorithms in multi-agent systems.

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