LogMonitor: from player's action analysis to collaboration analysis and advice on formation

Tomoichi Takahashi

Chubu University
1200 Matsumoto, Kasugai-shi, Aichi 487 - 8501, JAPAN

Abstract. This paper describes analysis results of collaboration among players of RoboCup '98 simulator teams and on-line adversarial model analysis using LogMonitor. LogMonitor is a tool for analyzing games from logfiles and displaying statistical data such as counts of soccer plays. Evaluation of collaboration in a multi-agent system is closely related with applied domains, which make it difficult to distinguish agent's universal ability from task oriented programs. In viewing simulation soccer games, play agents' skills are evaluated from the human soccer standards. This situation is assumed to be similar to collaboration among teammates, that is evaluated from human standards.
Adding to the basic actions of the player such as shooting, kicking, etc., a 1-2 pass among teammate agents is used to evaluate teams in collaboration. LogMonitor data shows that 1-2 pass may be useful to evaluate collaboration. Experiments show that adding adversarial information is very useful to make a team more robust.

1 Introduction

Sporting games are examples of a multi-agent system. In sports, team play and team tactics as well as an individual player's abilities are important. Reviewing scorebooks gives us information about which player scored a goal, which made a shot .etc. They are very useful for coaches to rank the players and to plan strategies for upcoming games, even though similar plays are evaluated differently in different situations. Various kinds of computer-aided scoring or analyzing methods have been developed to use in human games[SoftRB].

The RoboCup simulator game is a multi-agent system which is played between player agents through network communication [Kitano98]. Teams programmed based on various paradigms participate in RoboCup, and the games are recorded as logfiles. RoboCup provides test beds for evaluating agent systems. Using logfiles, Takahashi et al. reviewed RoboCup97 teams [Taka98], Letia et al. used logfiles to extract player's action model [Ial98], and Tanaka et al. made clear changes of games from RoboCup97 to RoboCup98 [Tanaka].

It is important to evaluate the multi-agent system not only from the game results but also from collaboration among agents. In RoboCup '98, an attempt was made to evaluate soccer simulation games from teamwork, not from scores. This paper describes analysis of collaborative plays using logfiles of the evaluation league at RoboCup 98 [Cup98]. The collaboration among agents is discussed from scores and statistical values such as numbers of kicks , passes, or 1-2 pass, etc. Next, the player agent's autonomy is discussed by comparing CMUnited 98, the champion team of RoboCup 98 with our team, Kasugabito-II. Experimental games were presented, and the result showed a team composed of less autonomous agents played weal by adding information on opponent teams.

2 LogMonitor

LogMonitor [1] is a tool for analayzing RoboCup simulation games from logfiles where the positions of the ball and all players of both teams at every simulation step are written [Log]. The data in logfiles are equivalent to images displayed on the monitor.

2.1 Actions Analysis by LogMonitor

We enjoy the game by seeing CRT images and may also record the game by taking note of which agent passed the ball, the quality of the pass, etc. For recording the games by a computer in the similar ways to a human scorer, it is necessary to recognize the player's actions such as passing, kicking .etc and the ball movement from time sequence data in logfiles.

The followings are methods used to recognize actions:

kick: The ball is kicked when the following conditions are satisfied.

1. the ball direction is changed or the change of the ball's speed is greater than the decreasing rate adapted in the soccer server at consecutive $\{t_i, t_{i+1}\}$ and $\{t_{i+1}, t_{i+2}\}$.
2. at least one player is within a kickable area at t_{i+1}.

When there are more players within a kickable area, the nearest player is assumed to kick the ball.

pass: Two consecutive kicks are assumed to be a pass, when two players of the same team kicked the ball.

interception: Two consecutive kicks are assumed to be an interception, when an opposing team player kicked the second time.

1-2 pass: A player kicks the ball to a teammate, runs behind an opponent player, and receives the ball that the teammate returned.

2.2 Position Analysis by LogMonitor

Human player's abilities are measured by their running speed, run length, etc. This corresponds to the allocation of stamina, and the range of moves during a game. The positioning of players is important in teamwork. The following data on positioning are displayed:

trajectory: the plot of a player's position in time sequence,

[1] LogMonitor is gained from our Home Page.

distance: the sum of distance which players moved when `play_mode` is `play_on`,

range: the area that a player moves during a game, by averages of the positions and their horizontal/vertical variance.

3 Statistical Analysis of Evaluation Leagues at RoboCup '98

The details of evaluation and logfiles of games are available at Dr. Kaminka's homepage [Gal98]. The following are short explanations of evaluation.

- All participating teams played four half games against AT_Humbolt97, the champion team of RoboCup 97.
- Four half games are referred to as phase A, B, C and D.

  phase A : the game is played under normal conditions.

  phase B : A manager of the evaluation assigns one player other than the goalkeeper randomly. The team disabled the assigned player and compete the game with ten players.

  phase C : A member of AT_Humbolt97 assigned another player who he thought was the most valuable player other than the goalie. The team omitted two assigned players and competed the game with nine players.

  phase D : The team also omitted the goalie and competed the game with eight players.

3.1 Discussion from Scoring Points

Table 1 shows the scores of teams that participated in the evaluation league and the statistics of AT_Humbolt97 plays. The first columns are the names of the teams that participated in the evaluation league. The number under the team name is the rank in the RoboCup '98 tournament league. The second column is the phase and scores. The left score is the points the team gained and the right score is AT_Humbolt97's points.

Most teams won the game at phase A, so it can be said that the level of RoboCup '98 is higher than that of RoboCup '97 [2] . The game conditions become harder for teams as the phase changes to B, C and D. The teams are said to be robust, when their scores do not vary as the phases change. From the table,

- The higher ranked teams, such as CMUnited, won the game in disadvantageous phases, while lower ranked teams, such as Kasugabito-II which were eliminated from the tournament, gained less points in disadvantageous phases than the normal phase and lost the game.

[2] At RoboCup '99, evaluation league were held with adding new half games. Games with AT_Humbolt97 shows that the level of RoboCup '99 is higher than that of RoboCup '97 and '98.

– Some teams in the middle rank are said to be robust from the difference in points scored. For example, Isis98 won the game at phase C with a better score than phase A. CAT_Finland lost the game at phase A, but won at phase B.

We don't think there is any relation between tournament ranks and robustness in play.

Table 1. Statistic data in evaluation games

	phase		AT-Humbolt97				1-2 pass	
team		Score	K	P	I	D		AT
CMUnited-98	A	7 - 0	53	7	23	2654	2(2)	0(0)
(1)	B	6 - 0	51	6	30	2395	5(2)	0(0)
	C	3 - 0	55	11	30	2327	4(0)	0(0)
	D	3 - 0	37	8	20	2006	0(0)	0(0)
AT_Humbolt-98	A	6 - 0	76	11	36	2622	2(0)	0(0)
(2)	B	9 - 0	87	11	46	3545	2(0)	0(0)
	C	3 - 0	76	17	33	2462	1(0)	1(0)
	D	5 - 0	80	15	43	2789	0(0)	0(0)
WindmillWanders	A	5 - 0	66	10	42	2481	1(0)	0(0)
(3)	B	7 - 1	58	9	33	2884	0(0)	0(0)
	C	3 - 0	64	13	29	2629	0(0)	0(0)
	D	2 - 1	55	10	29	2199	1(0)	0(0)
Isis 98	A	1 - 0	79	30	36	1976	1(0)	0(0)
(4)	B	1 - 0	60	13	34	2771	2(0)	0(0)
	C	2 - 0	62	17	32	1857	1(0)	1(0)
	D	1 - 2	72	24	35	2378	0(0)	3(0)
Rolling Brains	A	5 - 0	82	13	53	2737	0(0)	0(0)
(5-6)	B	2 - 0	81	21	42	2624	1(0)	0(0)
	C	1 - 0	60	14	33	2163	3(0)	0(0)
	D	0 - 0	70	16	44	1994	0(0)	0(0)
Andhill	A	6 - 0	101	33	53	2931	1(1)	2(0)
(5-6)	B	5 - 1	83	21	44	2568	1(1)	0(0)
	C	3 - 1	88	25	48	2469	1(0)	2(0)
	D	5 - 0	91	26	48	2551	0(0)	0(0)
CAT_Finland	A	0 - 1	62	18	27	1659	0(0)	1(0)
(7-8)	B	1 - 0	69	17	39	1669	0(0)	0(0)
	C	1 - 1	78	24	36	2151	1(0)	0(0)

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team		Score	K	P	I	D		AT
	D	1 - 3	84	30	35	2288	1(0)	3(0)
Gemini	A	8 - 0	121	41	58	3241	0(0)	1(0)
(7-8)	B	5 - 1	104	37	50	2899	0(0)	2(0)
	C	1 - 0	119	44	52	2177	1(0)	3(0)
	D	8 - 2	107	41	45	3431	0(0)	0(0)
Aiacs	A	7 - 0	99	29	49	3008	0(0)	2(0)
(9-12)	B	0 - 0	61	17	29	2091	1(0)	0(0)
	C	6 - 1	82	24	42	2246	0(0)	1(0)
	D	4 - 4	72	24	37	2453	0(0)	0(0)
PasoTeam	A	0 - 1	68	11	44	1987	1(0)	1(0)
(9-12)	B	0 - 3	58	12	35	2175	0(0)	0(0)
	C	0 - 4	51	5	33	1996	2(0)	0(0)
	D	0 - 5	51	10	31	2164	0(0)	0(0)
AT_Humbolt-97	A	1 - 1	77	21	45	2290	1(0)	0(0)
(9-12)	B	1 - 1	80	21	43	2244	0(0)	1(0)
	C	1 - 4	81	21	49	2349	0(0)	0(0)
	D	0 - 2	80	36	34	2360	0(0)	2(1)
DarwinUnited	A	0 - 3	64	20	32	2289	2(0)	0(0)
(-)	B	0 - 6	57	16	30	2395	1(0)	1(0)
	C	0 - 3	71	23	34	2400	2(0)	2(0)
	D	0 - 1	54	16	31	1978	1(0)	0(0)
Kasugabito II	A	5 - 0	109	39	53	2807	1(0)	1(0)
(-)	B	2 - 0	78	29	37	2226	0(0)	0(0)
	C	0 - 2	81	34	35	2186	0(0)	2(0)
	D	0 - 2	81	29	38	2358	1(0)	1(0)

K=kick P=pass I=interception D=distance
AT=AT_Humbolt-97
rank(-)= eliminated from the tournament.

3.2 Discussion from AT_Humbolt97's Side

It is difficult to evaluate teams by their game scores. AT_Humbolt97 was used to normalize various team's ability. The second column is the numbers of kicks(K), passes(P), interception(I) and distance(D) of AT_Humbolt97's players. The values in Table 1 are calculated according to the methods in section 2.1.

Fig. 1 shows the changes of actions from A to B, from A to C, and from A to D. The vertical axis shows the ratio of data change from phase A and the horizontal axis is the team.

The players of the teams with less collaboration are thought to be weak in covering a disabled player, so we expect that players of AT_Humbolt97 can pass, kick and move more easily as phases changed from A to D. Against our expectation, the most vertical values of point in Fig. 1 are less than 1.0. This

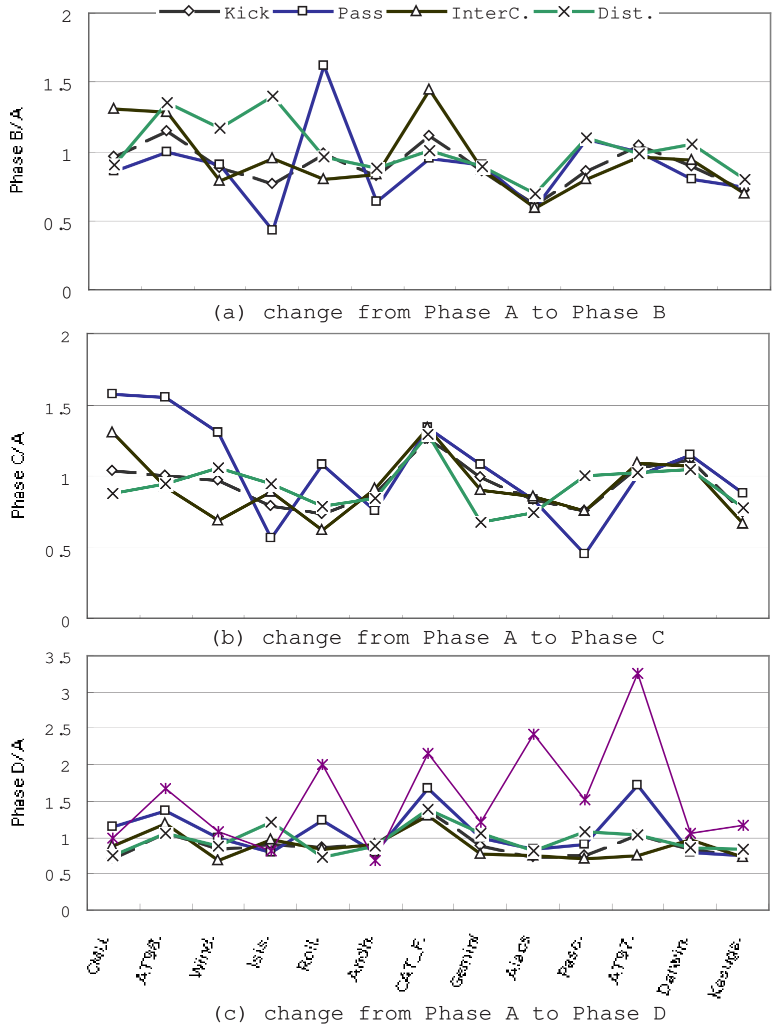

Fig. 1. Changes in actions at Phases.

means AT_Humbolt97 didn't play and move more than in phase A, and doesn't support our expectations. And the changes from phase A to B, A to C, and A to D don't show the same tendencies. For example, in the games vs. CMUnited, the number of passes of AT_Humbolt97 remained equal at phase A and B, increased 50% at phase C, and increased a little more at phase D. On the other hand, at the games vs. Kasugabito-II, they decreased in all phases following A.

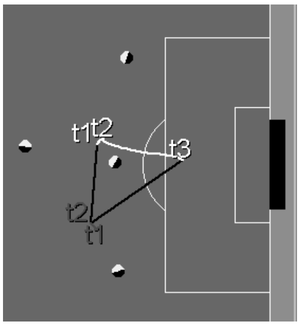

Fig. 2. 1-2 pass between CMUnited players.

3.3 Discussion from 1-2 pass as collaboration

A 1-2 pass is a collaborative actions. Fig. 2 shows a snapshot of a 1-2 pass shown at phase B of CMUnited. The white line indicates trajectories of a player who kicked the ball at t_1 and received the return pass at t_3. The black line shows the passes. The displayed players are AT_Humbolt97 players at t_1.

The last column of Table 1 is the number of the 1-2 pass. The left number is the number of 1-2 passes of teams evaluated and right number is that of AT_Humbolt97's 1-2 passes. The numbers in parentheses is the number of 1-2 passes which are connected to goals.

CMUnited players perform 1-2 passes the most at evaluations, and most of their passes scored points. AT_Humbolt97 didn't perform any 1-2 pass in games with high ranked teams, but they did in games with lower ranked teams. These findings seem to be similar to human teams that can perform well against weak teams, but perform poorly against strong teams.

3.4 Discussion of Autonomous Movement

Without communication among agents, an agent which moves by itself according to changing situations can be said to be autonomous. Fig. 3 shows the trajectories of a forward player of CMUnited 98 (left) and Kasugabito-II (right).

The figures are trajectories of the same player at phase A, B, C and D from the top. The numbers under the figure are the number of kick, distance, the variance of horizontal movement, and the variance of vertical movement.

The CMUnited player moved twice as much as the Kasugabito-II player and the range of his movement was wider. CMUnited 98 and Kasugabito-II played at preliminary games, and the score was 5-0. From the score, our Kasugabito-II played a good game. However, the CMUnited player's attack in front of the goal was superior according to the figures.

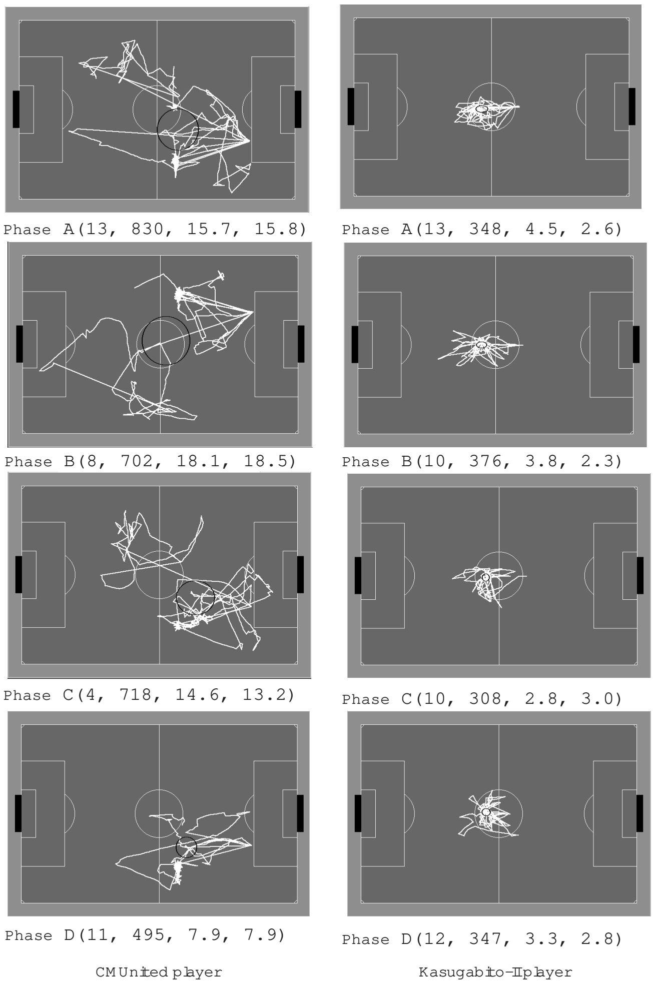

Fig. 3. Trajectories of Players.

4 Robustness and Opponent's Information

Agent programs are said to be robust when it can adapt environmental changes without hearing of the change from others. When knowing of the changes, the agent programs may modify their parameters to adapt to the changes.

4.1 Experiment for Adding Opponent's Information

At evaluation leagues, participating teams could not change their programs or parameters before the games. At regular games, the participants can modify their

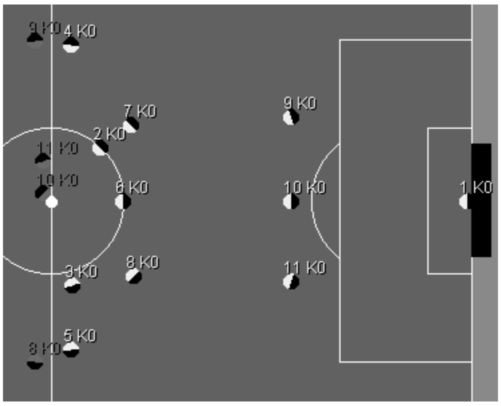

Fig. 4. Kasugabito players' initial position.

programs or tune parameters for the next game. This adjustment is equivalent to adding opponent's information gained from the previous games. We test the effectiveness of the adjustment before a game by comparing the difference of the score's between two games. One game is done with parameters modified by human, and the other games with no modifications.

experiment 1 The evaluation games between AT-Humbolt97 and Kasugabito-II were played again in our computer environment.

experiment 2 At the beginning of phase B, C and D, the initial positions of Kasugabito-II players were modified by one of our students.

Fig. 4 shows the initial positions of Kasugabito-II players in Phase A for explanation.

phase B disabled player = No.8(Defensive MF).
The No.7 player in the counter position of No.8 was moved to the center, for the purpose of defending the right and left side.

phase C disabled player = No.2 (CF).
Another forward No.3 was moved to the center, and defense positions of three attractive MDs (No.4, 5, 6) were changed 5m forward.

phase D disabled player = No.1 (goalie)
Defense positions of the center DF (No.10) was moved closer to the penalty area.

4.2 Discussion

Table 2 shows the result of the experiment games. The running environment is different from that of RoboCup98, so the values of the score are different from the values in Table 1. However, the scores in experiment 1 show a similar tendency as that shown in the evaluation games. Kasugabito-II won the game at phase A. AT-Humbolt97 became superior to Kasugabito-II as phase changed from A to D, and AT-Humbolt97 won from Phase C on. In experiment 2, Kasugabito-II continued to win the game till phase D. Judging from the scores, Kasugabito seems to have become more robust than in experiment 1.

The second column of Table 1 shows AT-Humbolt97 players' data and the last column Kasugabito-IIs' data. At phase B and C of experiment 2, the number of kicks and passes are more, and the distance is longer than in experiment 1 for both teams. At present, we cannot account for the changes in data. However, the experiments support the claim that adding the opponent's information made Kasugabito-II more robust even though the player agents were the same. This indicates that making use of opponent information as well as the agent's ability itself is important to make teams more robust.

Table 2. Results of experiments (AT-Humboldt side)

		AT_Humbolt				Kasugabito-II			
	Score	K	P	I	D	K	P	I	D
				experiment 1					
A	3 - 0	106	41	53	2553	118	27	55	2706
B	2 - 1	75	25	37	2042	72	16	34	1869
C	1 - 2	89	29	52	2265	81	17	49	2287
D	0 - 3	99	42	40	2303	81	18	34	1974
				experiment 2					
B	3 - 1	103	41	44	2333	86	20	41	2311
C	3 - 0	111	42	54	2509	103	26	51	2264
D	2 - 1	88	33	43	2249	91	20	42	1977

K=kick P=pass I=interception D=distance

5 Summary

This paper presents analysis of collaborative actions in soccer simulation games. While there are many papers on how to implement multi-agent systems, there are few on evaluation of multi-agent systems. One of the reasons is that evaluation standards depend on the applied field. In soccer simulation games, we can use many of the standards used in human soccer.

In analyzing the logfiles of evaluation games at RoboCup'98, it is clear that:

- There is no direct relation with scoring to collaboration by analyzing the data of basic soccer actions, such as kicking, passing, etc.
- The 1-2 pass is assumed to be collaborative actions among agents. The number of 1-2 passes seems to be related to the ranking of teams in the tournament.

– The difference in their autonomy between CMUnited players and Kasugabito-II players seems to be bigger than the difference of the scores of their game.
– Adjusting players' initial position made Kasugabito-II as robust as CMUnited from the standpoint of scoring.

Through these analysis results, we think it is necessary to give player agents advice on games as human coaches do. We have been developing an on-line coach agent based LogMonitor that analyzes the game on-line [kIII].

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