Lets Get Together: Group 9 Report

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Overview

The problem of lets get together is trying to develop a friend that will collaboratively exchange information from all the players quickly and efficiently in the fewest number of rounds. There are n players with n units of information. They share and transfer information when they are on the same square. The game ends when any one player has all the information. Given that the dimensions of the world and the number of friends vary the environment can change drastically and can contrast the results in different situations. Devising a strategy that performs well in a wide variety of scenarios requires a deep understanding of the constraints within which the friend must exist, and requires a heuristic approach in forming a strategy. Multiplayer games presented the most difficult challenge. This problem was similar to prisoner's dilemma. If all of the groups had the same algorithm, we were guaranteed that our solution would be successful in such an environment. Since it became clear that each group had a different approach, we needed to form a strategy that would be beneficial to us (in single-player), but not hurt our performance in mixed environments. We tried various approaches in solving this problem, and through experimentation we achieved what we felt was the best strategy to gather information the quickest way.

Baseline Strategy (Deepti)

Swap Prevention

The friends exchange information when they land on the same square. However as can be noted in figure 1 when two friends are standing next to each other then there is no prevention mechanism to keep them from missing each other repeatedly.

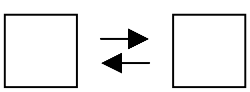

Figure 1

Swap prevention keeps the two friends from switching positions. When a friend is standing at a given position they can see orthogonally or diagonally as shown in Figure 2. The friend will then decide if they see the friend in positions1,3,5,7 then they will move toward their friend, otherwise they will stay still.

5	3	6
1		2
7	4	8

Figure 2

Timeout

We found that this strategy needed some improvisation for boards that were very small. As can be seen in figure 3, there is a possible deadlock that can occur because each friend is waiting for their diagonal friend to move towards them. Timeout will check to see if it has stayed still for five rounds and will then randomly choose a new direction to move.

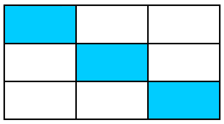

Figure 3

Won't meet again

When two friends are standing next to each other and they just exchanged their information then meeting the same friend again very soon will not be very useful and will be a waste of time. This time may be better utilized in looking for and meeting new friends.. A data structure is maintained for the number of players and their identity. The data structure updates as soon as two players meet and keeps it in the order of when they meet. The player will then choose not to meet that player again until a few players later in case that player has retrieved any new information.

E.g.
There are 10 players
Player 0 met player 1 first and has met 7 other players since then. Player 0 sees Player 1 again, so player 0 will decide to swap information with player 1 now.

Don't move away yet

When there is a group of friends standing in a cluster, as shown in figure 4, then they will choose not to move away until they have everyone's information from the cluster.

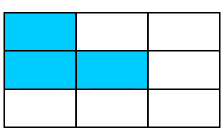

Figure 4

Most valuable player

After a certain number of rounds a player who hasn't met anyone has very valuable information. This player is designated as the most valuable player. There is a high probability that everyone is looking for this player, so this player will stay still allowing other players to come and find it. Once this player has swapped information with someone else then they will start moving again.

Player Analysis

Player 1: Herding (Peter)

Motivation

In a problem where the goal is information exchange, it is better to setup a system where the information needed may be found in an easier fashion. As a solution to this, the idea of assembling friends into moving bands of information (herds) was formed. Since all friends in a herd will have the same information, the information will be easier for other players to find.

Strategy

Each friend will move around until it encounters another friend. Once two (or gradually, more) friends meet up with each other, they form a herd. After the herd is formed, the players will spread out (2 spaces) from each other and then this herd will move in a uniform direction across the board. The herd members never stop moving and when a “free” member wants to exchange information, it needs to move towards the herd member. New players enter the herd and other members of the herd attempt to gain that information and then spread out again (while moving in a single direction). To deal with timeouts, every time the herd travels the width of the board, they all either move up or down (based on a random selection).

Analysis

The herd strategy worked well on boards with small numbers of all “herd” players. The problems arose when the number of “herd” players was higher and was amplified on large maps. One major problem was the clustering of herds. Separate herds would form and never meet with each other OR they would only meet with each other after numerous timeout events. Another problem was the difficulty associated with making sure every member in a herd had all of the information. Some herds ended up forming where all of the players would be in a single herd, but not have all of the information and loop endlessly. Efforts to combat this approach resulted in the herding strategy breaking down into a random movement strategy.

The best way to end the lack of information exchange, but keep some idea of a herd was to make a binary herd where a player would herd and then when it encountered a new player, it would leave the herd and become a free player again. This strategy resulted in no infinite loops, but the performance was significantly slower than other groups’ strategies. One major change that could have made herding successful would have been allowing communication between friends as was present in the Organisms II problem. This addition would have allowed for better coordination between the herd members and meant that herd members could advertise their states to other herd members.

Player 2: Horizontal and Vertical (Peter)

Motivation

One of the early strategies explored was having some players move in horizontal directions and some move in vertical directions. In good scenarios, the benefit of this strategy was it had a maximum bounded time for convergence.

Strategy

The implemented strategy was to have the vertical players constantly move and the horizontal players stop when they saw a trail that had been left by a vertical player. Once a vertical player intersected with them, the horizontal players would move until they found another trail. This process would repeat until all of the information had been shared. Some optimizations, such as allowing for backward movement and allowing the horizontal player to move vertically or northwest to catch a vertical player were implemented to reduce corner case times.

Analysis

This strategy is a well-defined movement scheme. Players will only move in one direction (north/south or east/west) until a condition was met to interact. As such, the number of turns required for two friends to meet in completely homogenous environments was bounded at a limit of (2xWidth)+(Length). This bound represented the maximum rounds a player on a map could go without seeing each other. However, this strategy had a few drawbacks. Sometimes all players would start in the same direction; this degenerate case would cause the bounded time limit of 2WH. These cases of all starting friends moving in the same direction or multiple vertical players on one band (and vice versa) meant the normal strategy would require modification. These adjustments of timeout detection and more intelligent trail navigation resulted in the corner cases not being infinite loops. Another problem with this strategy is in the multi-player environments where everyone has a different strategy it did not work well, leading to the idea of different multi-player strategy.

Player 3: All Directions (Deepti)

Motivation

In the above strategy there is an increasing probability that all of the players may end up choosing the same direction and running parallel when the number of players is decreased. In order to keep this from occurring, the player can choose to move in any of the orthogonal or diagonal directions. This causes more intersections and the possibility of a reduction in time.

Strategy

The implemented strategy was to randomly choose to move in any of the 8 directions and keep moving in that direction for a period of time. The players would choose to move until they found a trail from any player. This process would repeat until all of the information had been shared. The player stays at the trail for the same period of time as the horizontal vertical player. Then after n number of rounds, where n = (area of board) * 1/5, all the players start moving randomly. The random movement is begun in the case all players are running in parallel or if there is difficulty swapping all information.

Analysis

This strategy was meant to reduce the time for the worst case scenarios (2xWidth)+(Length) and possibly perform better in multiplayer games. The problem with this strategy in single player games was there were too many intersections causing the worst case scenario to actually occur more frequently. However in the multiplayer game, as expected, there was a significant reduction in the number of rounds. From this strategy, we decided to keep the idea of some fixed players and maintain a threshold before the player moves randomly.

Player 4: Some Random Some Fixed (Deepti)

Motivation
The motivation behind this player was that in the horizontal and vertical player the bounded time causes the average number of rounds to be very high on small boards. We also felt if a player is not using the horizontal/vertical strategy or some variation then these trails might not provide very useful information. Since the trails have no timestamp there is no way to know when they were left causing the player to be misled. The other fallback of trails is that in the case of random players there is a likelihood of one player chasing another endlessly. Hence we decided to go for a probabilistic and random strategy, thus leading to the idea of a player with more unpredictability.

Strategy
The strategy followed in this player is based on the probability of moving either randomly or in a fixed direction. If a player is moving in a fixed direction then the player will choose any of the 8 directions and will move in that direction again for n number of rounds, where n = area of board) * 1/5. Once the number of rounds exceeds n, then it will start moving randomly.
The other change made is that instead of staying still, the most valuable player moves in a small circle to increase the probability of meeting other players.

Analysis
We found from our own test tournaments that this player did perform much better on smaller boards because the player would not have to wait for L rounds to pass before any information was passed. One problem with this strategy is there is no way of calculating the maximum limit of rounds since the movements are more randomized. Also, there may be peaks in the number of rounds on a few boards causing the average to go up. But since the average was still lower than the horizontal and vertical players this strategy was kept. However we noticed this strategy performed poorly in comparison to horizontal and vertical player in single player on medium to large boards. In multiplayer games we found the strategy caused a considerable decrease in time because there was no way to find out whether other players are using our horizontal and vertical strategy or not. If they choose to use a more random approach then the horizontal and vertical player was at a significant loss because the horizontal player would not know it was not a vertical players trail. The random player improved this time significantly.

Player 5: All Directions Random (Bhagyashree)
Motivation
The motivation for this strategy was that player 2 and player 4 did well on two different boards. We tried to come up with a strategy to combine both the ideas from the two players. Consequently we decided to still keep the probabilistic and random strategy. We chose for the players to have a very high probability of moving in a fixed direction and reduce the probability of randomness.

Strategy
In this strategy, we try to cover the board as much as possible. A player moves in a fixed direction for a certain number of rounds. After those rounds have elapsed, it resets it directions and chooses a new fixed direction. The new direction is chosen randomly, each direction having an equal probability of being chosen. Staying put and moving randomly are also included amongst the options for fixed direction.

Analysis

Choosing a well-defined moving strategy can be useful when playing in the single player mode, since all the players use the same strategy. However in a multiplayer environment, this might be counterproductive. We cannot assume that the other players in our environment are using our strategy. At the same time, going for a completely random movement will not give better results in all the cases because the movement is not well defined. The current strategy tries to balance these two conflicting ideas. Since the player changes its 'fixed' behavior every certain number of rounds randomly, then it will not suffer by one ineffective fixed behavior. At the same time, it will derive benefit from some particular 'fixed' strategy for some time if it works well with some other player. In addition, this strategy also results in additional board coverage, hence potentially increasing the chance of meeting other players.
This strategy has the same drawback as the previous one that it is not possible to calculate an actual limit on the number of rounds.
On testing this player, the results showed the strength of the idea however when individual averages were compared it did not improve upon the numbers of either player 2 or player 4. This player became the stepping stone to player 6. We realized that the best thing to do would be to merge the players 2 and 4 to have a robust single player for small and large boards.

Player 6: Merge Player 2 and Player 4

Motivation

The motivation of this player was to have a robust single player. The results from our own mini-tournament are shown below. From the results we can infer that when the area is small we should use Player 4 and use Player 2 for other sizes.

Single Player Tournament:

The results stated are averages over 15 rounds.

	Player XY	**Player4**
Fill the board 3x3 (9)	7.642857	6.5
Small 5 own default	90.85714	76.35714
Medium, 5 own 35x35	169.7857	1167.929
Large 5 own 50x50	253.8571	1008.571
Small 10 own	63.85714	45.07143
Medium, 10 own	145.7143	252.6429
Large 10 own	231.3571	807.2857

Submission

Initially we felt that Player 6 would be the best, from the results below we see that in multiplayer it did not perform well. Since there is no way to determine the identity of each player and we can not tell if it is a multi-player or single-player environment, we also submitted Player 4.

large	
Player 4	348
Player 6	577
small	
Player 4	61
Player 6	83

Player 6 (works best in single player)
Player 4 (works best in multi player)
Hence we can infer that our ‘random and fixed combined’ strategy is beneficial in multiplayer mode and the combined player should work well in the single player mode.

Results

	Group1	Group2	Group3-1	Group3-2	Group4-1	Group4-3	Group5
1	209.221	100.486	256.518	528.57	97.726	109.791	2399.279
2	482.226	257.759	370.67	646.726	314.805	592.124	2839.415
3	1362.245	478.538	996.444	1089.558	1116.841	1209.425	3419.386
4	257.851	1437.606	809.132	1233.29	165.05	97.629	4631.023
5	240.461	141.173	775.099	1162.575	260.22	117.204	849.883
6	147.763	87.79	246.42	315.76	81.721	120.531	646.302
7	311.03	242.456	379.26	530.988	254.173	447.74	1158.569
8	853.202	594.07	641.118	860.203	632.71	926.865	1512.894
9	210.9	477.23	491.221	642.768	161.689	108.494	1216.917
10	197.57	113.073	187.283	148.672	238.919	134.006	190.189
11	89.201	78.624	70.916	87	77.459	79.167	93.174
12	238.411	215.723	214.423	231.375	223.439	219.497	237.633
13	639.114	566.644	590.642	637.171	583.274	622.585	675.349
14	137.598	158.913	141.285	151.152	145.868	105.382	206.599
15	92.941	89.358	70.179	93.544	99.825	77.614	80.974
16	71.632	70.007	69.878	69.904	70.649	68.574	71.747
17	200.627	195.357	195.218	199.445	196.296	199.414	200.243
18	512.392	508.571	496.023	534.201	509.14	518.844	512.008
19	94.707	92.307	85.542	101.064	97.43	83.946	95.488
20	71.593	70.2	66.541	74.156	72.892	67.563	69.733
21	59.61	108.38	195.36	93.21	281.66	62.58	10000
22	111.12	269.76	303.71	313.25	1065.08	197.03	10000
23	258	1409.01	1199.18	1331.63	7664.77	346.87	10000
24	475.76	111.85	3227.23	1855.66	122.72	118.18	4341.03
25	938.28	1458.42	8404.06	7700.91	797.28	162.8	5564.44
26	72.66	77.09	71.15	65.62	81.01	41.76	10000
27	180.55	198.7	263.53	257.18	358.06	146.68	10000
28	213.36	506.02	1081.58	1117	1429.12	241.45	10000
29	432.27	147.16	4668.4	2413.53	549.74	77.71	4345.72
30	9331.26	376.94	8306.38	9037.67	1655.96	81.69	3108.7
31	73.89	62.99	67.66	71.65	57.16	46.36	10000
32	150.36	178.2	237.7	233.04	275.11	99.55	10000
33	354.44	377.15	813.59	904	785.1	204.89	584.9
34	494.56	97.42	5607.01	3773.08	1156.6	47.73	4939.74
35	10000	103.35	9402.41	9907.74	961.29	53.71	563.73
36	176.92	58.41	48.71	53.89	64.64	37.12	10000
37	262.78	143.65	205.31	195.91	189.6	110.62	10000
38	489.73	322.22	661.64	808.78	582.39	260.78	10000
39	1514.13	85.22	8140.33	5583.67	746.36	44.67	4457.49
40	10000	93.55	10000	10000	466.18	46.1	275.97
41	48.96	23.88	1507.08	2000	33.46	21.22	1766.12
42	171.34	175.48	164.21	167.41	194.88	182.34	202.46
43	664.52	703.55	607.54	613.26	608.06	721.51	760.98
44							
45	365.27	214.14	317.93	361.56	309.62	205.87	365.65
46	550.96	315.73	88.95	508.27	394.74	147.05	357.54
Avg	973.587	302.0923333	1616.5436	1526.800933	582.9048	213.6147778	3616.472778

Group6	Group7	Group8-1	Group8-3	Group9-4	Group9-6	ranking
829.756	176.764	323.669	1149.991	525.528	625.402	7
1012.525	275.173	843.638	1507.153	952.019	2132.842	8
1933.949	1369.505	1272.342	1744.649	1762.549	2227.143	10
1692.224	197.594	1530.531	183.735	1067.347	714.775	7/6
89.892	130.089	305.906	211.101	194.366	346.365	5
421.003	370.033	284.778	207.847	105.241	158.975	3
732.021	728.156	428.618	528.21	400.914	918.458	5
1211.876	971.781	1216.217	945.309	1080.791	1489.385	9
673.248	177.486	560.012	228.908	532.781	572.937	8
156.514	108.63	194.672	152.689	143.816	153.307	4
79.584	81.163	79.944	80.08	81.88	80.925	10
227.064	217.25	227.604	212.151	228.123	235.06	9
617.227	597.112	664.098	580.193	601.675	700.562	6
176.181	137.783	221.61	119.427	213.812	130.017	12/3
82.538	91.115	93.01	94.413	94.854	92.308	11/7
70.211	70.823	70.844	69.681	69.008	70.5	2
199.125	200.427	200.843	189.781	193.783	202.944	2
505.641	509.313	550.46	464.045	508.022	525.176	4
92.737	94.448	96.284	88.43	91.987	95.781	3
70.436	70.222	70.063	71.775	71.803	69.155	11/3
[redacted]						
58.58	242.98	170.01	836.81	5310.96	5410.07	11
232.18	503.79	1100.41	330.01	8009.51	835.76	12/9
1147.78	1189.37	2386.43	551.46	7182.86	596.07	11/3
2533.11	449.07	2335.05	213.27	4633.87	4372.93	12/13
993.55	345.89	4177.32	300.98	1190.08	959.9	/7
43.11	181	60.94	339.58	1765.64	1681.56	11/12
168.01	151.29	580.86	123.87	5545.51	94.7	1
723.92	475.44	2093.6	373.12	5115.26	333.8	12/3
309.39	345.71	3030	144.72	1834.23	1610.52	10/9
298.19	201.07	2369.43	333.54	1071.35	901.16	7/6
37.12	65.12	50.84	37.37	64.66	84.19	7
142.63	130.45	225.15	111.37	1793.06	308.74	11/12
542.6	377.65	1279.35	285.42	1875.76	175.57	13/1
271.19	386	3944.34	133.29	435.62	369.77	7/5
129.43	69.75	498.15	252.18	776.47	859.58	8/9
36.01	72.32	40.01	37.8	48.38	49.42	5
134.54	159.63	148.03	97.66	291.08	267.65	11/12
428.25	257.04	602.93	259.88	774.88	260.74	11/3
59.91	383.18	6229.75	103.94	264.06	271.96	5/6
48.69	75.13	157.83	190.74	624.25	599.69	10/9
16.71	46.73	16.85	23.7	180.15	184.62	9/10
185.92	187.85	174.63	173	210.81	210.29	13/12
774.11	699.61	633.84	613.95	830.86	855.87	13/12
259.18	365.29	154.82	281.45	412.26	422.08	13/12
128.38	173.12	470.15	461.49	618.41	613.66	13/12
457.2498222	313.5410444	937.0191778	343.1148444	1328.450644	752.7181556	10/7

Red indicates where player 6 was in the top 6 and blue indicates where player 4 was in the top 6.

	Player 4	Player 6
multiplayer	average 465	average 600
	rank 8	rank 13
Singleplayer	average 2323	average 960
	rank 10	rank 7

As we expected in our analysis player 4 worked best in multiplayer and player 6 worked best in single player mode. We feel that having a well defined strategy would have actually performed the best in all cases. Having a randomized strategy could have caused enough peaks on large boards to cause the average to go down. Even though player 6 followed a combined strategy, keeping it with a single well defined movement strategy would have bound the results and kept the average down. However from the results we noticed that both of our players performed among the top 4 players in multiplayer mode with 8 players on the board.