Minority Game
Ex.3 of Advanced Intelligent Software

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Abstract

In this report, the minority game with muliti agent simulation and strategy table was investigated. The average winner number and its SD is the main measurements for performance, and it shows that the different parameteres such as table depth d and strategy number s for strategy tables may affect the performance significantly.

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1 Introduction

Minority Games originated from the El Farol Bar problem[1], and is a model used to for simulating market behaviours. The rule is that there two rooms A and B, and N (odd) participants(agents), and in each round players will choose one room independently, then the group that has fewer people will win one score, Figure 1 illuminates the game briefly. In this report, *strategy table* model is investigated to observe the game results if participants are becoming increasingly smart since Minority Game is a kind of zero-sum games, and the result may not be better much if each player becomes smart. However, if a part of players are more knowledgeable than others, they may achieve better scores.

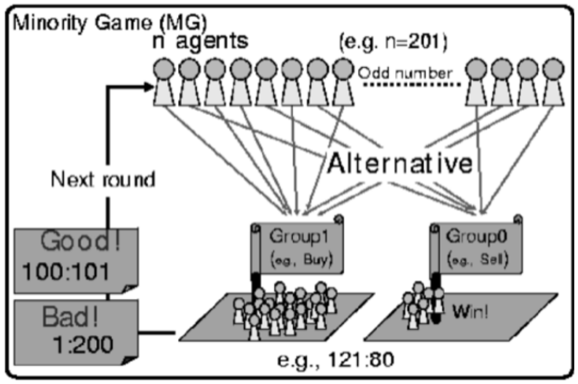


Figure 1: Minority Game[2]

2 Methodology

The basic idea of *strategy table* is that each participant will have a table mapping past game history to the next decision, which is like a human being behaviour: predicting the future from learning history. Since there are many potential tables and participants could not test all of them, so each participant may only choose s tables from the pool. In each round, the past game history whose length is d (also called memory size or table depth) would be an input of the table to choose the next decision, and each table has a weight w to determine that does this table have good prediction ability. This report will compare the game result with different round number n, memory size d and strategy table amount s. Also, the situation that different agents have different strategy table amount s are also considered.

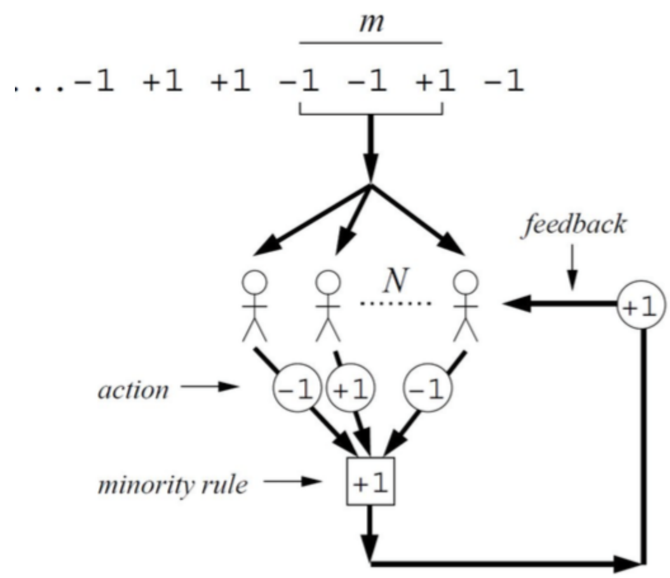
A strategy table whose table depth is 3 is shown in Figure 2a. The first three columns on the left hand side are the past history input, and the right-most column is the decision output. For example, winners in the last three rounds are $\{s, s, s\}$, then the decision would be s according to this table. If the memory size is 3, then the amount of potential tables would be $2^{2^3} = 256$, and each agent will only generate several table randomly and weigh them by their performance. In each round, the game result would act as a feedback to the strategy table, so the agent could notice which strategy table may be better according to their accuracy. Such a feedback is shown in Figure 2b. Note that the agent number n would be equal to 201 in the experiments.

2.1 Baseline: Randomly Choice (Ex.3-1)

This part is to create a baseline where every agent choose rooms independently randomly, then the average winner number could be found.

History			output
A	A	A	A
A	A	B	B
A	B	A	A
B	A	A	B
A	B	B	A
B	A	B	B
B	B	A	B
B	B	B	B

(a) A strategy Talbe



(b) Feedback and making decision with history[3]

Figure 2: Minority Game with Strategy Tables

2.2 Total Round number n (Ex.3-2)

The average number of winners in each rounds of this game are investigated. In this experiment, the memory size d is 3 , the strategy quantity for each agent s is 2 and all the initial streaky tables are generated randomly(each agent generate their own table independently). Then the game is simulated by a Python program for 100,000 rounds, and the average winner numbers and its standard deviations are recorded during this game.

2.3 Strategy quantity s and table size d (Ex.3-2)

The experiment compared the winner number for various d and s. The game also has 100,000 rounds.

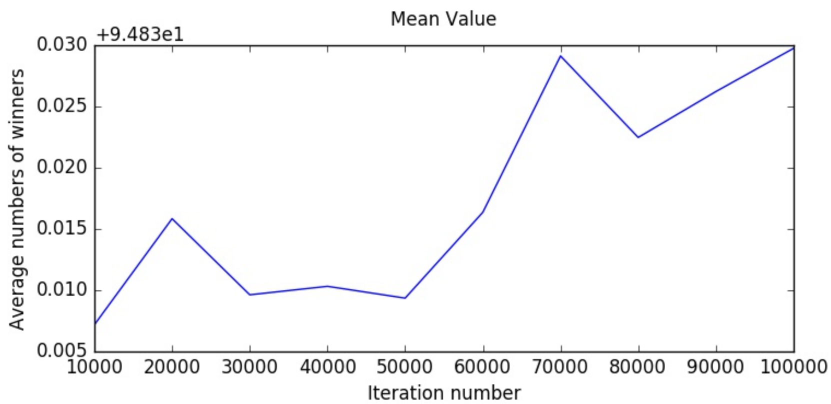
2.4 Various strategy quantity s among agents (Ex.3-4)

The agents are divided into two groups: 100 agents will has 64 strategy quantity and others only has 2 strategy quantity. Obviously, the first group are more knowledgeable and we want to know if they could earn more points from the game. Note that the memory size was 3 in this experiment, and the round number is 500,000.

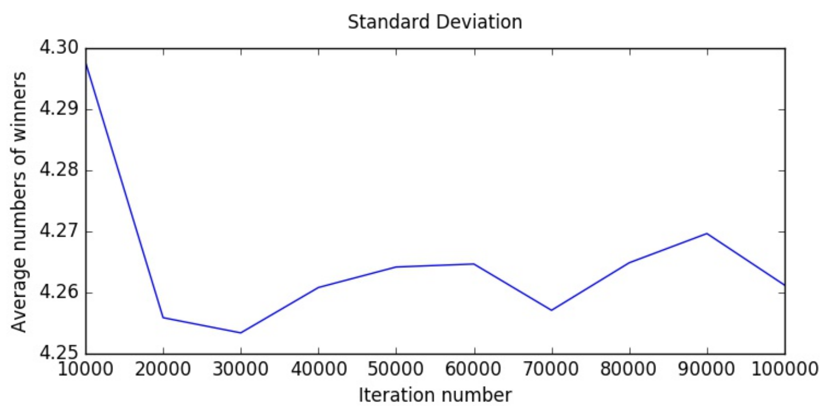
3 Results and Discussion

3.1 Baseline: Randomly Choice (Ex.3-1)

The mean and standard deviation of winner number with random choice during iterations are shown in Figure 3. The average amount 100,000 rounds are roughly 94.86 and its SD is 4.26.

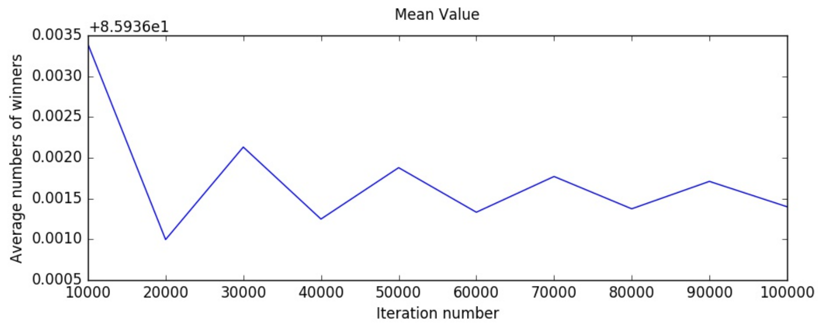


(a) mean value

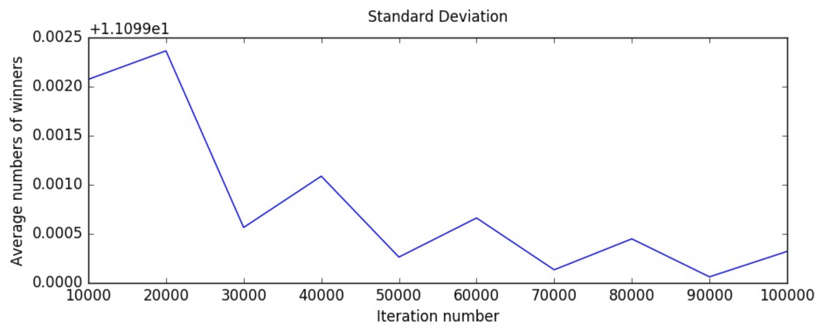


(b) SD value

Figure 3: Minority Game with Random Choice (Ex.3-1)



(a) mean value



(b) SD value

Figure 4: Performance for Strategy Table with $d = 3$ and $s = 2$ (Ex.3-2a)

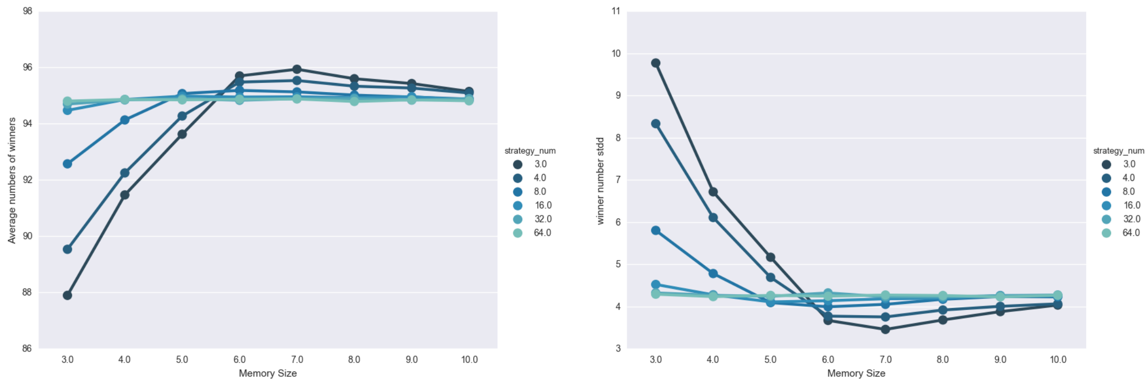
3.2 Round number n (Ex.3-2)

The mean value of average winner amount when $s = 2$ and $d = 3$ is shown in Figure 4, and the average winner number and standard deviation became a bit better during the iteration increased. However, the average winner number is only 85.94 and the SD is about 11.09 which are much worse than the random choice baseline.

3.3 Strategy quantity s and table size d (Ex.3-2)

Figure 5 shows that the performance for various memory size d and strategy number s, which indicated that the winner number increased during the memory size d increasing when $d \leq 7$, and the standard deviation also become better when $d \leq 7$. After increasing, the average winner number decreased to a number closed to the random baseline. Furthermore, Figure 5 shows that high strategy number was not useful when $d \geq 5$ since large s had worse performance in this situation. In conclusion, when d closed to 7 and s smaller than 8, the algorithm achieved better score and SD than the baseline, after that the performance were similar to the baseline but they were still better than the baseline slightly.

The reason may be that: when d is not very high, the winning history has high possibility that repeat itself, then the agent may learn more from that to achieve a better performance. Also, when d increases the possibility that get a repeated input become lower. However, when d is very low such as 3, the potential strategy table pool is too small to generate some good tables for agents. Therefore, the performance in low d is relatively low.



(a) mean value

(b) SD value

Figure 5: Performance for Strategy Table with various d s

3.4 Various strategy quantity s among agents (Ex.3-4)

The result in Figure 6 shows the total agent winning amount for different group, and the group which had higher strategy number got the better performance. However, the gap between them is not very significant because a higher strategy number may led to a result which is similar to the random base as shown in Ex.3-2, and low strategy number may have a worse performance than the random baseline, but the difference between various s value are not the big.

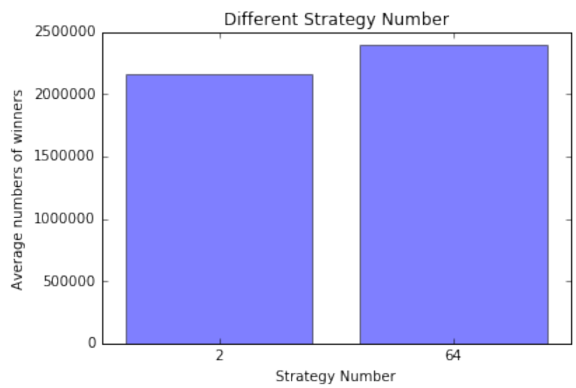


Figure 6: Performance for two agent groups have different s

4 Conclusion

This experiment investigated the minority game by agent simulation with *strategy table*, which shows that player may achieve a better performance when some players become more knowledgeable than others. However, if the whole population become smart, the performance of the whole system will like a random choice.

References

[1] D. Challet and Y.-C. Zhang, “Emergence of cooperation and organization in an evolutionary game,” *Physica A: Statistical Mechanics and its Applications*, vol. 246, no. 3, pp. 407–418, 1997.

[2] A. Namatame, T. Kaizouji, and Y. Aruka, “The complex networks of economic interactions,” *Lecture Notes in Economics and Mathematical Systems*, vol. 567, 2006.

[3] J. L. Kocevar, “MINORITY GAME,” in *Seminar in Fakulteta za matematiko in fiziko*. Fakulteta za matematiko in fiziko, Mar. 2011, pp. 1–19.