Design in Complex Systems: Individual Performance versus System Efficiency

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Outline

1. Mix-game
2. Simulation condition
3. Results and discussion
4. Design in competing complex systems

1. 1 Minority game

Minority game (D. Challet, and Y. C. Zhang, *Phyisca A* 246, 407(1997)

- N: agent number,
- r: system resource r =L*N, L<1
- Agent choice: 0 (buy), or 1 (sell)
- Agent memory length m: used to record competing outcome, i.e. a bit string
- Strategy: a response, i.e., 0 or 1, to each possible bit string which represents the history of competing outcome
- Time horizon T: Agents collect the virtual points for their strategies over the time horizon
- Payoff: agents win if they are in minority group in each competition turn

1.2 Mix-game

1. Traders in financial markets

   Trend chasers: who effectively play a majority game;

   Fundamentalists: who effectively play a minority game.

2. Mix-game

   Agents divided in two groups

   Group1: agents play majority game; m1, T1, N1

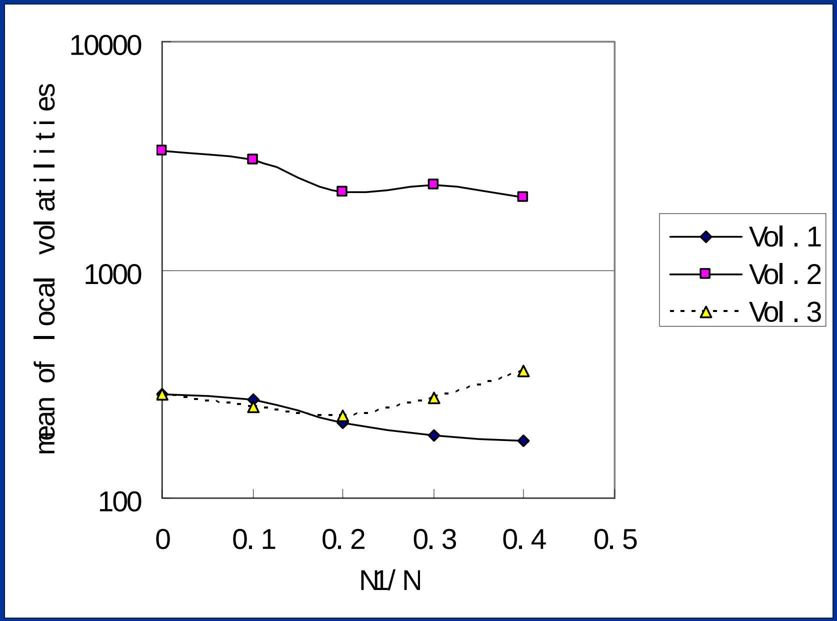
   Group2: agents play minority game; m2, T2, N2

   Total number of agents: N=N1+N2

2. Simulation condition

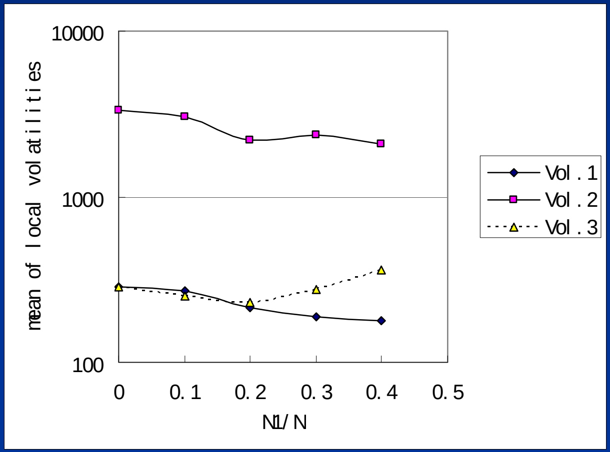
- The distribution of initial strategies of agents is randomly uniform in full strategy space (FSS) and remains unchanged during the game.
- Each agent has two strategies, i.e. s=2.
- The simulation turns are 3000.
- L is 0.5, i.e. r =0.5*N.
- N=201.

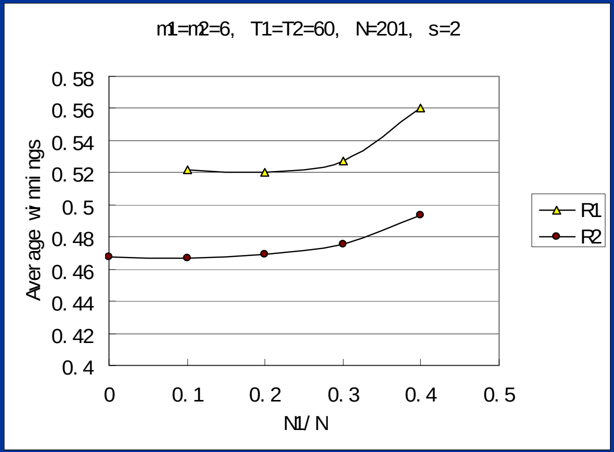
3.1 means of local volatilities vs. different N1/N



- Vol.1 : m1=m2=6, T1=T2=60;
- Vol.2 : m1=6, m2=3, T1=60, T2=12;
- Vol.3 : m1=3, m2=6, T1=12, T2=60.

3.2 Correlation among R1, R2 and Vol.1



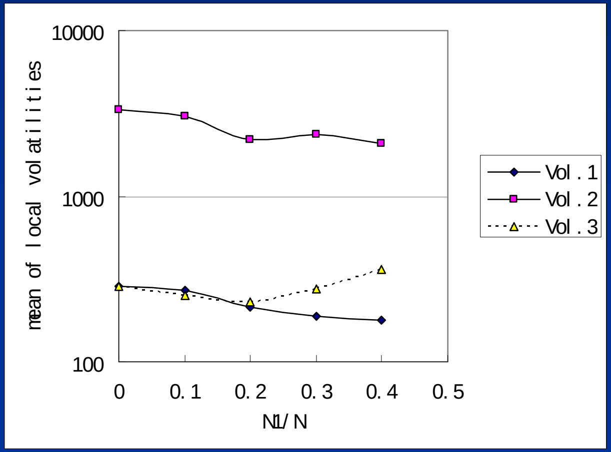


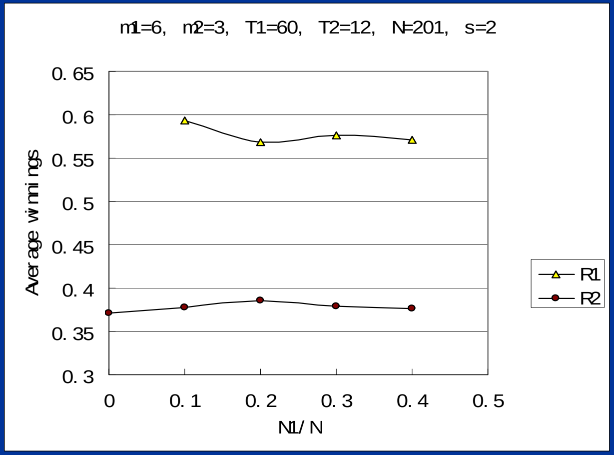
Average winnings per agent per turn

Table 1 correlations of R1, R1 and Vol.1 under the condition of m1=m2=6, T1=T2=60

Correlation	*R1*	*R2*	*Vol.1*
R1	1		
R2	0.98	1	
Vol.1	-0.63	-0.76	1

3.3 Correlation among R1, R2 and Vol.2



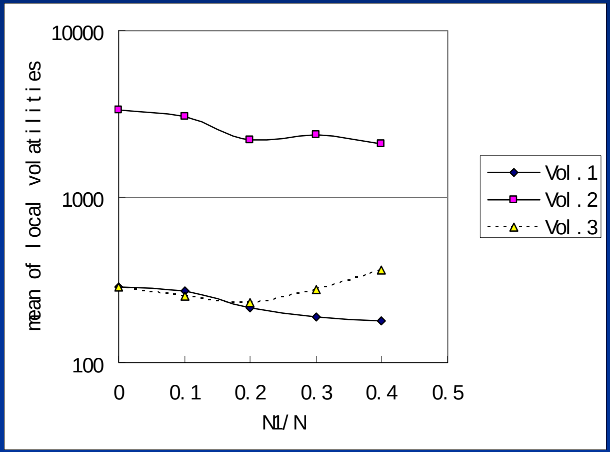


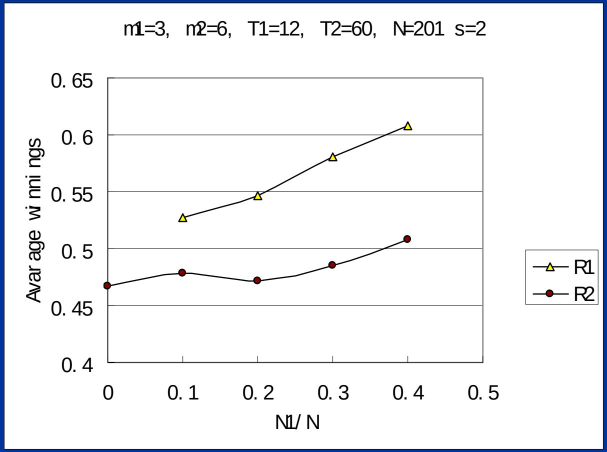
Average winnings per agent per turn

Table 2 correlations of R1, R1 and Vol.2 under the condition of m1=6, m2=3, T1=60, T2=12

Correlation	*R1*	*R2*	*Vol.2*
R1	*1*		
R2	*-0.48*	*1*	
Vol.2	*0.98*	*-0.67*	*1*

3.4 Correlation among R1, R2 and Vol.3





Average winnings per agent per turn

Table 3 correlations of R1, R1 and Vol.3 under the condition of m1=3, m2=6, T1=12, T2=60

Correlation	*R1*	*R2*	*Vol.3*
R1	1		
R2	0.87	1	
Vol.3	0.89	0.82	1

4. Design in competing complex systems

- If we want to design a system with both high efficiency of the system and high individual performance, we need to make the agents have different payoffs, the same memory lengths and a relatively large number of agents in group1.

Further reading

- Chengling Gou, *Dynamic Behaviors of Mix-game Model and Its Applications*, http://arxiv.org/abs/physics/0504001
- Chengling Gou, *Agents Play Mix-game*, http://arxiv.org/abs/physics/0505112
- Chengling Gou, *Design in Complex Systems: Individual Performance versus System Efficiency*, http://arxiv.org/abs/physics/0505178

Thanks