Second-best decision realizes cooperation in spatial prisoner's dilemma game

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Cooperation in non-kin people is a difficult problem to explain because it is unable to resolve clearly according to the notion of Darwinian natural selection. In several theories challenging this question, the idea of indirect reciprocity [1-5] seems to be widely accepted by researchers. That theory considers that the altruistic behavior of people without kinship derives from the desire that everyone wants to be regarded as a good person and to raise his or her status. However, all people who cooperate do not always expect some rewards. Especially in a negotiation, attendees usually manage to reach an agreement by making some compromise. We often discard the best choice and select the second-best one if we want to keep a good relation. This kind of action is seemingly like a cooperative behavior and has not been dealt with by any previous researches.

From the point of view, in this research by the use of the model of agent based simulation, we studied the property of cooperation based on some compromise. When every group composed of some agents made its second-best decision, cooperation at high level was observed in the spatial prisoner's dilemma game with extended strategy expression (Figure 1). The simulation was executed in some networks (with the same average degree) of various topologies. Interestingly, the frequency of mutual defection became beyond the frequency of mutual cooperation in whole network at initial (until 50) generation, however, as the generation grew, the cooperation increased and then exceeded the defection. The system reached to highly cooperative state at the last generation regardless of the types of network (Figure 2 and 3).

It turned out by further inspection about results that there was no apparent difference in the process about the evolution of cooperation between the regular and the random. On the other hand, in the scale free network, the frequency of mutual cooperation surpassed the frequency of mutual defection faster than the other two cases, and moreover, had the highest value among the results.

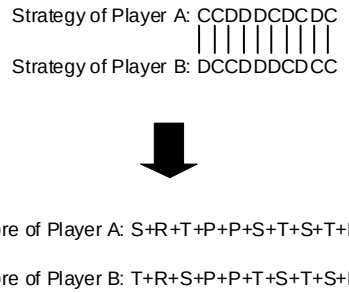

Figure 1: Illustration of the prisoner's dilemma game with extended strategy expression (sequential prisoner's dilemma game).

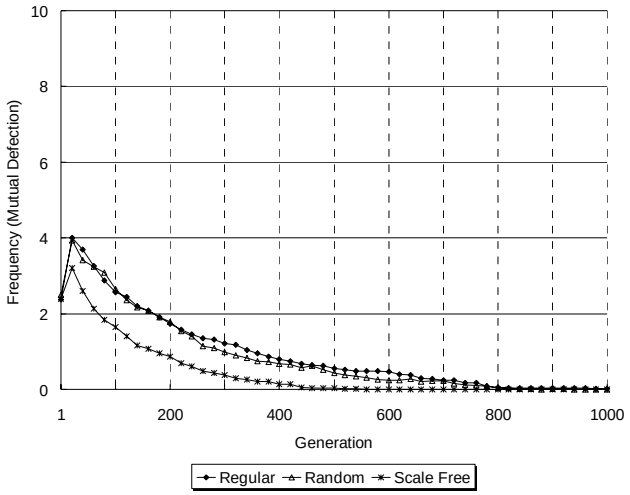

Figure 2: The average frequency of mutual defection about 3 types of network.

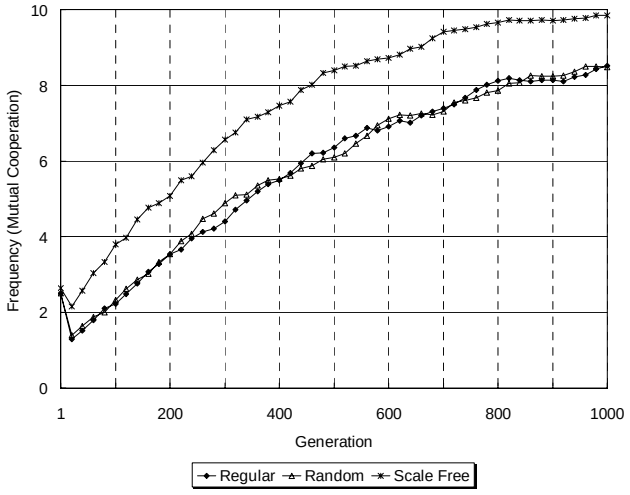

Figure 3: The average frequency of mutual cooperation about 3 types of network.

Keywords
cooperation in non-kin people, multi-agent simulation, evolutionary game, compromise in decision, spatial prisoner's dilemma game.

References

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