A Condition for Cooperation in a Game on Complex Networks
TOMOHIKO KONNO, Princeton University — We study a condition of favoring cooperation in a Prisoner's Dilemma game on complex networks. There are two kinds of players: cooperators and defectors. Cooperators pay a benefit b to their neighbors at a cost c, whereas defectors only receive a benefit. The game is a death-birth process with weak selection. Although it has been widely thought that $b/c > \langle k \rangle$ is a condition of favoring cooperation [2], we find that $b/c > \langle k_{\mathrm{nn}} \rangle$ is the condition. We also show that among three representative networks, namely, regular, random, and scale-free, a regular network favors cooperation the most, whereas a scale-free network favors cooperation the least. In an ideal scale-free network, cooperation is never realized. Whether or not the scale-free network and network heterogeneity favor cooperation depends on the details of the game, although it is occasionally believed that these favor cooperation irrespective of the game structure.

[1] T.K, A condition for cooperation in a game on complex networks, Journal of Theoretical Biology 269, Issue 1, Pages 224-233, (2011)
[2] H. Ohtsuki, C. Hauert, E. Lieberman, M. A. Nowak, A simple rule for the evolution of cooperation on graphs and social networks, Nature 441 (7092) (2006)

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