Spatial Reciprocity and the Evolution of Cooperation

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Abstract

Martin Nowak has proposed spatial reciprocity as a potential explanation for the evolution of cooperation. Spatial reciprocity occurs in spatially structured games when the strategies of successful players are copied by their neighbours; this reduces the effectiveness of defection, since a highly successful defector will soon find itself surrounded by copycat defectors whom it cannot exploit.

It seems plausible that spatial reciprocity could contribute to the evolution of cooperation. However, in his exploration of this phenomenon, Nowak uses a payoff structure which is not consistent with a true Prisoner's Dilemma. Nowak reduces the number of variables involved in his simulations by assuming the punishment for mutual defection is a "very small positive payoff" approaching zero; he considers this payoff to be equal to zero for the purposes of the model. The sucker's payoff is also set at zero. Thus, a player who faces a defector receives a payoff of zero, no matter what it does; defection is not a strictly dominant strategy.

There are non-zero punishment payoffs which maintain the effectiveness of spatial reciprocity as a cooperation-generating mechanism in Nowak's game; however, there is a limit beyond which this effect is lost. Some ways of setting three payoffs in the Prisoner's Dilemma preclude the generation of cooperation through spatial reciprocity, no matter which (allowable) value is chosen for the fourth. An understanding of the limiting conditions for spatial reciprocity is essential to a complete account of its effectiveness as a cooperation-generating mechanism. In this paper, I explore these conditions.

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