

# Evolutionary computation scientists find social norms required for the transition to cooperative societies

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A research team led by Hitoshi Yamamoto from Rissho University clarifies what role the diversity of social norms can play in the process of evolving cooperation by means of evolutionary computation methods. The team revealed social norms that are required in the transition from non-cooperative to cooperative societies, yet are not needed in the maintenance of cooperative societies. The study was carried out by collaborating with colleagues Isamu Okada (Soka University), Satoshi Uchida (RINRI Institute), and Tatsuya Sasaki (University of Vienna). The results of the study were published in *Scientific Reports*.

People sometimes cooperate with others at their own expense without expecting anything in return. The evolution of cooperative behavior can be understood by considering a mechanism in which a positive evaluation of present [cooperation](#) is shared with others, and the cooperating person receives cooperation from a third person at some future time. This mechanism is generally referred to as indirect reciprocity.

For indirect reciprocity to work, it is necessary to have norms that distinguish good people from bad people so that cooperation is selectively directed to good people. The point is that different people often have different norms, which can lead to different images of the same person. "Little is theoretically known about effects of the norm diversity on achieving a cooperative society," says Yamamoto.

To address this issue, the team applied principles of game theory and developed a "norm ecosystem" model in which individuals with different norms interact through helping games. Yamamoto and colleagues calculated the evolution of norms through a genetic algorithm, an evolutionary computation method that represents solutions as sequences of numbers (genes) and applies genetic operations such as selection, mutation, and crossover to obtain a solution that has a high degree of fitness.

The results showed that non-cooperative norms spread through society first. Then, a new temporary norm becomes dominant, allowing the complex judgment that "noncooperation with bad persons is good and cooperation with bad persons is bad." At the same time, cooperation begins to spread in society. Finally, cooperation is maintained in a state of balance in which several cooperative norms coexist.

The team also proposed the Norm Knockout Method, a new analytical method for investigating the features of norms. The method is a variation on a technique known as gene knockout, which is used in the field of genetics. In norm knockout, a particular norm is removed, or "knocked out," from society, and the role of that norm can be inferred from the differences that result. Yamamoto found that when either the strict norm "only cooperating with good persons is good" or the simple norm "cooperative behavior is good and non-cooperative behavior is bad" is knocked out, cooperation no longer evolves.

These two norms play an important role in the emergence of cooperation, but they are not favored once a cooperative [society](#) is established. Yamamoto and colleagues refer to such norms as "unsung-hero norms."

"Our results suggest an answer to the puzzling question of how cooperation can emerge in the presence of free riders and are expected to be helpful in the design of a [cooperative society](#) based on indirect reciprocity," says Yamamoto.

**More information:** Yamamoto H, Okada I, Uchida S, Sasaki T. 2017. A norm knockout method on indirect reciprocity to reveal indispensable norms. *Scientific Reports* 7:44146. [DOI: 10.1038/srep44146](https://doi.org/10.1038/srep44146)

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