Game Theory

In much of social life, the best course of action depends on what others do. Choosing to commute by car rather than by train depends on traffic, and traffic depends on how many other commuters choose to drive. Finding a spouse depends on what you want and how attractive you are, and how attractive you are depends on what your potential spouses want. ‘Game theory’ provides a powerful language to model social phenomena like these, in which people respond to the choices of others.

The game theorist builds simple mathematical models in order to understand the complex dynamics linking individual choices and group-level properties, dynamics that are difficult to predict without mathematics. Consider residential patterns. Do segregated neighborhoods imply that people are racist? Perhaps. But segregation can also emerge even if people want to live in integrated neighborhoods, so long as they slightly prefer being in the majority. The problem is that everyone can’t simultaneously live in integrated neighborhoods and be in the majority. As individuals move to relatively integrated neighborhoods in which they are in the majority, neighborhoods can become more and more segregated. It’s hard to predict this kind of dynamic without building a model.

There are two traditions in game theory, classical and evolutionary. ‘Classical game theorists’ assume people are ‘rational’ in the sense that choices maximize ‘utility’, which might be anything from money to leisure. After setting up the model, the game theorist seeks the ‘Nash equilibrium’: a set of strategies, each of which is a best response to the other strategies. At the equilibrium, no one can improve by acting differently. For example, when neighborhoods become totally segregated in the residential choice model, no one can do better by moving.

‘Evolutionary game theorists’ assume individuals follow a specific ‘strategy’, a behavioral prescription that doesn't imply that individuals strategize in a rational manner or that they strategize at all. The modeler also specifies the pattern of interaction. The simplest assumption is ‘random interaction’, meaning that an individual’s strategy doesn’t influence the kinds of opponents she encounters. Interactions can also be ‘assortative’ (i.e., interactions are non-random with respect to strategy). Evolutionary forces, be they natural selection or cultural processes, change the frequencies of different strategies, favoring those with higher ‘fitness’, which might be the genetic or cultural contribution to future generations. The game theorist seeks the ‘evolutionarily stable strategy’ (ESS): a strategy which, when common, has higher fitness than any other strategy occurring at low frequency.

This encyclopedia entry emphasizes evolutionary game theory, which originated in biology and is now popular in the social sciences. Classical game theory is a ‘static’ framework in the sense that individuals are assumed to consider all possibilities, including others' deliberations, resulting in everyone simultaneously playing her best response. One problem is that games often have 'multiple equilibria'. Societies can, for example, be organized in an egalitarian or a hierarchical manner. The static framework of classical game theory cannot explain how and why societies transition from one arrangement to another. Evolutionary game theory provides a 'dynamic' framework, explaining not only best responses ('equilibria') but also how social institutions change ('equilibrium selection').

The 'Hawk-Dove model' provides an introduction to evolutionary game theory that illustrates the way game theorists approach problems and offers insight into the logic of animal conflict. In the 1960s biologists puzzled over animals engaging in low-cost, ritualized contests over resources. Such ritualized contests contradict the caricature of natural selection as a "survival of the fittest" in which the strong triumph over the weak. Many biologists championed 'group selection', arguing that groups in which animals fought to the death would go extinct, leaving behind only groups that resolve conflict through ritual. The problem is that natural selection usually acts at the level of individuals, not groups. The Hawk-Dove model provided conceptual clarity, showing how ritualized contest can result from 'individual selection'.

The model assumes pairs of individuals meet at random and allocate some resource. There are two strategies: 'Hawk' always contests the resource; 'Dove' shares with another Dove but concedes to a Hawk. Since a Hawk always beats a Dove, it's tempting to predict that Hawks will replace Doves in the population. But the outcome is not that simple. If the resource benefit exceeds the fighting cost, Hawks indeed replace Doves. But if the resource cost exceeds its benefit, the population settles down to a mix of Hawks and Doves. When Doves are common, Hawks mostly meet Doves and do well. However, as the population of Doves decreases, Hawks increasingly meet other Hawks and engage in costly contests. Doves do better by avoiding costly fights.

At the 'mixed equilibrium', fights erupt whenever two Hawks meet. Even though everyone would be better off if everyone played Dove, selection acting on individuals favors a mix of Hawks and Doves. This illustrates an important lesson. Self-interested behavior can lead to collectively bad outcomes. Such 'social dilemmas' characterize many of our pressing problems like corruption, over-harvesting natural resources, and pollution. The outcome of these dilemmas depends on the pattern of interaction. With assortative interaction (e.g., Doves selectively interact with Doves), group-benefit can trump self-interest because cooperation is channeled to cooperators and denied to free riders. Assortment, which can be generated through kin-biased interaction (i.e., 'kin selection') or behavior-biased interaction (e.g., 'reciprocity'), is the key to understanding the 'evolution of cooperation'.

Returning to animal conflict, the model so far says that some individuals fight and others do not. But animal conflict seems to be resolved by ritualized contest. When a model's predictions match reality, the hypothesized process may give rise to the observed pattern in the real world. When the predictions are way off, we've left something important out of the model. So far, we've assumed a symmetry between players. If individuals vary in fighting ability, the 'Assessor' strategy is an ESS. Assessors use ritualized contests to size up their opponents and fight only when they are sure to win. Fighting ability, an asymmetry correlated with contest outcomes, provides a convention that efficiently allocates resources with few fights. Assessor, arising through individual selection, achieves a higher average payoff than a mixture of Hawks and Doves.

A convention that privileges bullies isn't the only possibility. Ownership, an asymmetry uncorrelated with contest outcomes, is another. The 'Bourgeois' strategy plays Hawk when finding the resource first and Dove when second. Like Assessor, Bourgeois is an ESS that efficiently allocates resources without fighting. This result may explain the origin of informal property rights. But the model has another ESS, one in which individuals play Dove when owner and Hawk when intruder! According to the model, this anti-Bourgeois strategy is as likely an outcome as Bourgeois. In nature, Bourgeois seems common; the alternative convention does not. What might be missing from the model?

See also Economic anthropology; Evolutionary anthropology; Gene Culture Co-evolution; Human Behavioral Ecology; Rational Choice Theory

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