A mini-course on evolutionary games

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Ever since Darwin, the theory of evolution has benefited from the interaction of ecology with economics. Evolutionary game theory belongs to this tradition: it merges population ecology with game theory. Game theory deals with conflicts of interest. The first economic applications considered rational decision makers (for instance firms competing for a market). Later, J. Maynard Smith and W.D. Hamilton applied the methodology to societies of non-rational individuals, opening up the field of biologically realistic applications. Strategies correspond to behavioral traits. Their success, or payoff, depends on the strategies of the other players, and hence on the frequencies of these strategies. If strategies are successful, they will be more likely to be copied, either through inheritance or through imitation. This in turn changes the frequencies of the strategies in the population. Evolutionary dynamics describes the feedback between the frequencies and the payoffs of the strategies. In the context of population genetics, this corresponds to frequency dependent selection.

A wide variety of behavioral traits, and also of purely morphological or physiological characters, like the height of trees or the length of antlers, are submitted to frequency dependent selection and amenable to game analysis. Such traits may portend on conflicts of interest between two individuals, for instance territorial disputes (between neighbors), the length of the weaning period (between parents and offspring), or the division of parental investment (between male and female).

But frequency dependent selection also occurs without antagonistic encounters, as when individuals are 'playing the field': the sex ratio is an example (if it is biased towards males, it pays to produce daughters, and vice versa); so is the dispersal rate (higher rates should be favored under crowded conditions) or the amount of time spent watching for predators (if most other flock members are on the lookout anyway, then it is safe to concentrate on foraging). The evolution of cooperation through reciprocation is a particularly interesting chapter of evolutionary game theory. Why should a selfish fitness maximiser bear the cost of helping an unrelated individual?

The first part of the mini-course will introduce the basic notions of game theory, such as best reply, Nash equilibrium and evolutionary stability. It describes the main aspects of game dynamics, such as replicator equations, social learning etc, always hand in hand with biologically motivated examples describing various types of conflicts of interest. They have to do with such diverse aspects as the sex ratio, the propensity to escalate a conflict, mating behavior, cooperative behavior and the evolution of virulence. A considerable part of the course will deal with social dilemmas where the interests of the individuals are bad for the community, and can lead to a decrease in reproductive fitness.

Bibliography

[1] K. Sigmund *The Calculus of Selfishness*, Princeton University Press, Princeton, 2010