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Guest Editor's Preface

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As a matter of fact, people cooperate most of the time. Individuals are remarkably good at avoiding conflict and acting or working together for their mutual benefit and for the common benefit of the group to which they belong. While also other organisms, like plants or animals, do cooperate both with other members of their own species and with members of other species, only humans are systematically cooperative to such a high degree, and only human society depends so deeply on cooperation among its members for its very existence (Bowles and Gintis 2011, Nowak 2011).

Confronted with the plain *fact* that people cooperate, scholars have faced significant difficulties in explaining why and how exactly they cooperate. The *problem* of cooperation has indeed turned out to be a surprisingly complex challenge for many different disciplines, including philosophy, economics, and behavioral sciences. Today, the study of cooperation is an active, highly interdisciplinary enterprise which draws upon the results of at least anthropology, evolutionary biology, psychology, sociology, political science, mathematics, computer science, and complex systems. As a result, it is virtually impossible to find in the literature a coherent, unified perspective explaining the nature and the many different aspects of human cooperation. Interestingly, various theoretical attempts in different fields seem to share a kind of "explanatory deficit" concerning cooperation: according to the best theories accepted in those field, individuals should *not* cooperate, or at least not to the degree to which they in fact cooperate.

For instance, as Darwin (1871) himself acknowledged, human cooperation is a puzzle for evolutionary theory, since natural selection should hinder, and not favor, cooperative or "altruistic" behavior — which is inefficient, in biological terms, as compared to non-cooperative or "selfish" strategies. Today, there are at least five different hypotheses explaining how the evolution of cooperation took place (Nowak 2006, 2012) in the first place, including a revival of Darwin's own "group selection" hypothesis (cooperation increases the fitness of groups, although reducing the individual fitness; see Sober and Wilson 1999).

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Another puzzling perspective on cooperation comes from economics. At first glance, economic theory may be regarded as *the* science of cooperation: from Adam Smith (1776) to Friedrich von Hayek (1973-79), scholars have devoted a lot of attention to the "invisible hand" mechanisms that spontaneously coordinate the "selfish" actions of many different individuals into unplanned, yet beneficial social orders. Money, languages, the law, and the market itself are all examples of cooperative social institutions which spontaneously emerge from the complex interaction among the members of society. Yet, when the micro-dynamics of human action is analyzed trough the lenses of rational choice theory – the basic tool of modern economics – spontaneous cooperation becomes inexplicable, due to the existence of social dilemmas. Social dilemmas seem to be everywhere, from the provision of public goods to the exploitation of natural resources. In all such situations, individual interest seems at odds with the desired social outcome: since each member of the group has an incentive to defect (i.e., to not cooperate), rational choice theory seems unable to explain how cooperation is indeed possible.

Asking whether — or, better, under what conditions – it is rational to cooperate, or not, is just a different way to tackle the problem of cooperation, the one favored by philosophers interested in the study of human choices and decisions. One of the central problems here, as well as in ethics and political philosophy, is how norms of cooperation, and other "pro-social" conventions and behavioral rules, emerge and spread from individual actions (cf. Bicchieri and Muldoon 2011). While most of the work in this area has been done by philosophers of science — like David Lewis (1969) and, more recently, Brian Skyrms (2004) and Cristina Bicchieri (2006) —, it took some time to apply such kind of analysis to science as an example of cooperative enterprise. Only with the work of Alvin Goodman (1999) and Philip Kitcher (1990) in the eighties, philosophers started studying in a systematic way the collective dimension of scientific and ordinary knowledge. Today's (formal) social epistemology explores different mechanisms of knowledge creation and aggregation — like consensus formation, the division of cognitive labor, the "free market" of ideas, and others – in order to assess their relevance for the aims of scientific inquiry.

The six contributions to this special issue all rely on the above perspectives to discuss different aspects of cooperation. The first two contributions, respectively by Jesús Zamora Bonilla and by Gregor Betz, Michael Baurmann, and Rainer Cramm, study the role of cooperative norms and consensus reaching practices in the process of (scientific) knowledge formation. The papers by Ruggero Rangoni and Matthias Greiff stem from the research program on the evolution of cooperation inspired by Robert Axelrod's pioneering work in evolutionary game theory. Such tradition is discussed also in the last two papers of the issue, by Hannes Rusch and Eckhart Arnold, but only to criticize, from different perspectives, both its adequacy and its methodological soundness. In the following, a brief description of the content of each paper is given.

According to a widespread metaphor, which goes back at least to John Stuart Mill (1848), scientific inquiry, and rational discussion in general, can be viewed as a free market where ideas, hypotheses, and theories are traded, and knowledge and methods emerge from the interaction of individual scientists or groups of researchers. In recent times, such metaphor gave rise to a new research program, known as "the economics of scientific knowledge" (Zamora Bonilla 2012), which applies rational choice theory, game theory, and the other standard tools of modern economics to the analysis of scientific inquiry and progress. Following this line of research, in his paper *Cooperation, Competition, and the Contractarian View of Scientific Research*, Zamora Bonilla deploys a game-theoretic reconstruction of the idea of a social contract to shed light on the nature and role of methodological norms in science. Within such approach, scientists are viewed as self-interested rational agents, which strive to maximize their own reputation, i.e., recognition by their epistemic peers in the scientific community. To this purpose, they have first to agree on what may be called a "methodological contract", specifying the rules of the "game of science" according to which achievements are acknowledged and assessed, and reputation is allocated among agents. As the author argues, such contractarian approach to scientific methodology can account for both the institutional and the cognitive aspects of scientific inquiry, thus capturing some of the best insights of both sociological and "rationalistic" philosophy of science.

As Zamora Bonilla points out at the beginning of his paper, cooperation is central in science for at least two reasons. First, because inquiry is an essentially collaborative enterprise: today, the lab, more than the single scientist, seems to be the main character of scientific research. Second, and more importantly, because science relies on *trust* among scientists, and trust is itself a form of "cognitive" or "epistemic" cooperation. In *Is Epistemic Trust of Veritistic Value?*, Betz, Baurmann and Cramm focus precisely on this kind of cooperation. The paper is a contribution to the field of what Goldman (1999) called "veristic" social epistemology, i.e., the analysis of the social and cognitive practices of scientific communities with respect to their ability of tracking the truth, construed as the main epistemic goal of inquiry. The authors apply, perhaps for the first time, a simulation-based model of opinion dynamics to the assessment of the veristic value of trust and competence ascription. Such an approach provides a fresh look to a growing research field which links models of opinion dynamics and belief merging, on the one hand, and models of truth approximation or verisimilitude, on the other hand (see, e.g., Betz 2012, Cevolani 2013).

As mentioned earlier, evolutionary biologists and economists face the problem of explaining how cooperation is possible at all, given that in many situations the incentives of individual agents pull in the opposite direction. A standard answer comes from the work by political scientist Robert Axelrod (1984), who used computer simulations to argue that spontaneous cooperation is indeed possible even within communities of purely self-interested individuals (like, for instance, the recognition-seeking scientists studied in Zamora Bonilla's paper). Axelrod – whose approach is reviewed and discussed in Rangoni's, Rusch's and Arnold's papers – showed that when individuals are repeatedly involved over time in a prisoner's dilemma (the canonical formal model of a social dilemma), simple cooperative strategies (like "I'll cooperate with you if you cooperate with me") are likely to emerge and spread in the population, marginalizing and possibly eliminating non-cooperative behavior. Axelrod's simulations provoked an enormous amount of discussion, to which the last four papers in this issue further contribute.

In *Heterogeneous Strategy Learning in the Iterated Prisoner's Dilemma*, Rangoni aims at improving simulation-based explanations of social cooperation by further investigating how cooperative strategies may spread in a population. In the standard models, at each round of interaction individuals change their own strategy just by observing the most successful strategy in the previous round, and adopting it. This is a straightforward learning mechanism, and yet a somehow simplistic one. As Rangoni suggests, more realistic models should pay attention to the specific way in which different agents learn and adopt new strategies. His proposal is based on the so-called "consumat approach", designed by Wander Jager and Marco Janssen to study heterogeneous behavioral patterns in multi-agent simulations. Applying this approach to the iterated prisoner's dilemma leads to an evolutionary dynamics characterized by different learning mechanisms for different kinds of agents. Intuitively, individuals can be more or less satisfied of their own track record and more or less willing to change their own strategy. The outcome of the simulation ran by the author is significantly different from the standard case, showing a much greater heterogeneity of behavior in the final population, where cooperative strategies co-exist with less cooperative or non-cooperative ones.

Learning is also the focus of Greiff's paper, *Learning with whom to Interact: A Public Good Game on a Dynamic Network*. A typical example of social dilemma, and the one probably most studied by economists, is the provision of public goods. The defining features of a public good are such that every one in a group is better off if the good is provided, but no one is rationally interested in contributing to its production. For this reason, according to standard game-theoretical analysis, public goods could never be produced spontaneously – i.e., without an external authority which can force each individual in the group to contribute. Yet, both historical and empirical evidence (Greiff refers in particular to Elinor Ostrom's work on self-organizing societies) shows that in many cases groups are able to provide most of the public goods they need even in absence of such an authority, thanks to a number of social norms prescribing cooperative behavior. Still, from the theoretical standpoint, the very existence of such social norms raises a "second-order" social dilemma: where do social norms come from? Since a social norm is itself a kind of second-order public good, by the same pattern of reasoning it seems impossible that it can be spontaneously created and maintained. Greiff employs a simulation-based evolutionary model to show how a group of self-interested individuals can endow itself with the social norms necessary to sustain the provision of the required (first-order) public goods. Here, learning plays a crucial role in instructing agents on how to exclude free-riders by rewarding cooperators and sanctioning defectors. The model, the author argues, can explain the emergence of norms of cooperation and hence the spontaneous provision of public goods in substantial agreement with the available empirical evidence.

This kind of simulation-based explanations of the emergence and evolution of cooperation is critically discussed in the last two papers of this issue. In *What Niche did Human Cooperativeness Evolve in?*, Rusch questions the relevance and adequacy of the prisoner's dilemma in the study of how cooperation emerged in the first place. As the author notes, the payoff structure of this game, which implies that mutual defection is the only possible outcome of interaction, is very peculiar and extremely unlikely to obtain in real-life situations. It follows that only strong empirical evidence could justify the use of the prisoner's dilemma as the canonical model of interaction in the study of the origins of cooperative behavior. Such evidence, however, is missing, given that both experimental results and evidence concerning animals and humans suggest that ancestral cooperative behavior was much more widespread than is usually assumed. In turn, this suggests that other kinds of games, allowing at least the possibility of a cooperative outcome, may provide a better explanation of how cooperation emerged in ancient human societies – an example being the "stag hunt" game studied by Skyrms (2004).

A different critique of the standard approach to the study of the evolution of cooperation is provided by Arnold in *Simulation Models of the Evolution of Cooperation as Proofs of Logical Possibilities. How Useful Are They?* The author's main thesis is that one cannot draw general empirical conclusions from theoretical simulations, and hence that it is very hard to assess the value of Axelrod-like purported explanations of social cooperation. As an example, Arnold contrasts two simulation-based explanations of social phenomena: Axelrod's explanation of the evolution of cooperation and Schelling's (1971) well-known explanation of racial segregation. Only in the latter case, Arnold argues, it is possible, at least in principle, to empirically identify the mechanisms at work in the real-world situations that the simulation aims at modeling. On the contrary, Axelrod's models provide at best a mere proof of "logical possibility", i.e., allow one to conclude that the outcome of the simulations is a possible outcome of the real-world interaction. Yet, empirical confirmation of this kind of explanations is very hard to provide and, according to the author, very unlikely to be found for Axelrod-like models. Thus, further work, and a closer look at the empirical and historical evidence, is needed in order to make the simulation-based approach to the study of social cooperation really worth pursuing.

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