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LOGIC AND THE FOUNDATIONS OF THE THEORY OF GAMES AND DECISIONS: INTRODUCTION

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We have gathered in this and the next issue a selection of papers presented at the Fourth Conference on 'Logic and the Foundations of the Theory of Games and Decisions' (LOFT4), which took place in Torino at the International Center for Economics Research (ICER) in July 2000. The LOFT conferences have been a regular biannual event since 1994. With the exception of the first conference, which was hosted by the Centre International de Recherches Mathematiques in Marseille, the LOFT events have taken place at ICER and would not have been possible without ICER's generous support and hospitality.

The central theme of the LOFT conferences is the application of logic, in particular modal epistemic logic, to foundational issues in the theory of games and individual decision-making. The conferences have attracted prominent researchers from a variety of disciplines: computer science, economics, game theory, logic, mathematical psychology, philosophy and statistics. Epistemic considerations have been central to game theory for a long time. For example, work has been done on the role of beliefs in refinements of Nash equilibrium since the 1970s and much has been written on common knowledge and common belief since Aumann's seminal papers during that time. The expression *interactive epistemology* has been used in the game-theory literature to refer to the analysis of what individuals involved in a strategic interaction know about facts concerning the external world as well as facts concerning each other's knowledge and beliefs. What is relatively new is the realization that the tools and methodology that were used in game theory are closely related to those already used in other fields, notably computer science and philosophy. Modal logic is the common language that has made it possible to bring together different professional communities and the purpose of the LOFT conferences is to facilitate interdisciplinary exchanges and collaboration. Topics that fall within the LOFT umbrella

include epistemic and temporal logic, theories of information processing and belief revision, models of bounded rationality, nonmonotonic reasoning, theories of learning and evolution, etc. The reasons motivating the game theorist's and economist's interest in epistemic logic may differ from those in other disciplines. However, the insights gained and the methodology employed in one field can benefit researchers in a different field. Indeed, new and active areas of research have sprung from the interdisciplinary exposure provided by the LOFT conferences. The papers collected in these two issues of the *Bulletin of Economic Research* reflect the interdisciplinary composition of the participants in the LOFT conferences and the cross-fertilization that has taken place among different fields.[1]

Alexandru Baltag introduces the notion of *epistemic action* to describe changes in the information states of the players in a game. In general, epistemic actions can take several forms: information gathering, exchange of messages, information hiding, misinformation, etc. The author proposes a logical language for describing the interaction between information states and actions in a game.

The article by **Johan van Benthem** is an excellent illustration of the objective of an interdisciplinary forum like the LOFT conference: making progress by comparing different ways of looking at the same things across scientific communities. In his paper van Benthem brings a logician's perspective to the language of game theory. He proposes looking at games in two ways: at the level of *action* (i.e. extensive games) and at the level of *outcomes* (somewhat like, but not quite the same as, strategic-form games). He points out the need for two different logical languages and discusses the issues that arise naturally in the two contexts.

Giacomo Bonanno investigates the relationship between information, knowledge and belief. Information is modelled as possibilities consistent with signals received from the environment. Knowledge is obtained by reasoning about the signals received as well as those that might have been received but were not. The difference between knowledge and belief lies in the fact that knowledge is based exclusively on information, while beliefs might not be fully justifiable on the basis of the available information.

Hans van Ditmarsch's article is a clear example of the interaction between logic and game theory. He introduces *knowledge games* where

[1] Collections of papers from previous LOFT conferences can be found in a special issue of *Theory and Decision* (vol. 37, no. 2, 1994, edited by M. Bacharach and P. Mongin), the volume *Epistemic Logic and the Theory of Games and Decisions* (edited by M. Bacharach, L.-A. Gérard-Varet, P. Mongin and H. Shin and published by Kluwer Academic, 1997), two special issues of *Mathematical Social Sciences* (vols. 36 and 38, 1998, edited by G. Bonanno, M. Kaneko and P. Mongin) and a forthcoming issue of *Games and Economic Behavior*.

moves consist of information exchanges, such as showing a card to another player. He characterizes knowledge games and defines a general language for the description of the corresponding dynamics of epistemic states.

Mario Gilli's article deals with the notion of rational learning in strategic situations where the players have private prior beliefs and private information. He analyses the behaviour of Bayesian players both in repeated games and in recurrent games when they are uncertain about the behaviour of their opponents and the game they are playing.

Marc Pauly uses the notion of *effectivity frame* to model what groups of agents can achieve by coordinating their actions in a dynamic context. He shows that the notion of effectivity frame has broad application: it can be used to model extensive games, nondeterministic processes and voting procedures.

Freek Stulp and **Rineke Verbrugge** examine the problem of the reliable transmission of information from a sender to a receiver when the communication medium is imperfect, in the sense that bits of information may be deleted or may be received in the wrong order. They focus on the properties of the transmission control protocol (TCP) which is widely used in today's Internet. They show that, although interactive knowledge of arbitrary depth is achievable, common knowledge can never be achieved.

The guest editors would like to thank Gianni De Fraja, the Managing Editor of the *Bulletin of Economic Research*, for devoting two special issues to LOFT4 and ICER for funding and hosting the conference. The papers went through a thorough refereeing and editorial process. We thank the referees for their invaluable help and the authors for their cooperation during the revision process.