Report from Dagstuhl Seminar 11101

Reasoning about Interaction: From Game Theory to Logic and Back

Edited by
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Abstract

This report documents the program and the outcomes of Dagstuhl Seminar 11101 "Reasoning about Interaction: From Game Theory to Logic and Back".

The notion of interaction is crucial in several disciplines, including social science, operational research, and economics. Two frameworks are most prominent in the formal treatment of interaction: game theory and mathematical logic. Quantitative analysis is usually conducted using models and tools of game theory. At the same time, logic provides vocabulary and methods to study interaction in a qualitative way.

The aim of the seminar was to bring together researchers who approach interaction-related phenomena from different perspectives (and with different conceptual tools). We hoped that, by synergy and exchange of expertise, a more integrative view of interaction could be obtained. In particular, we focussed on how interaction between individual entities (be it humans, robots and/or virtual creatures) can lead to emergence of social structures, collective behavior, and teamwork - and, ultimately, help all involved parties benefit from cooperation.

Seminar 06.–11. March, 2011 – www.dagstuhl.de/11101
1998 ACM Subject Classification I.2 Artificial Intelligence, F.4.1 Mathematical Logic, I.2.4 Knowledge Representation Formalisms and Methods
Keywords and phrases Game Theory, Logic, Mechanism Design, Security, Cooperation, Model Checking, Rationality, Knowledge
Digital Object Identifier 10.4230/DagRep.1.3.1
Edited in cooperation with Nils Bulling

1 Executive Summary

Jürgen Dix
Wojtek Jamroga
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The group (48 participants from 13 countries) convened in Dagstuhl in March 2011, for a five day meeting.

The aim of the seminar was to bring together researchers who approach interaction-related phenomena from different perspectives (and with different conceptual tools). We also wanted to identify potentials for coordination, and to discuss general models and methodologies for future research.

Of particular importance was the choice of the participants and the areas they working in, namely: (1) classical game theory, (2) mathematical logic, and (3) economics. While there are some relations between these areas, we felt that more work should be done on the overlapping parts to make tools and methods from one area available in the others (if possible).

In particular, we wanted to find answers to the following questions:

- Are existing models of interaction adequate? Can models used by different disciplines be integrated in a meaningful way?
- How can we use game-theoretical concepts to construct logics that support strategic reasoning? What are the necessary features of such logics?
- How can epistemic-logic reasoning and definitions lead to the definitions of new solution concepts is strategic-form games?
- How can epistemic and strategic logic be adapted to the empirical findings from game theoretic laboratory experiments, manifesting bounded rationality of a variety of types?
- How can issues of computational complexity be addressed vis-a-vis the demand for efficiency/optimality in the design of economic mechanisms under asymmetric information?

The seminar resulted in making the first step towards answering these questions. We did not obtain the ultimate formal answers, especially in the sense of enabling implementation in the form of ready-to-use tools and methodologies. However, researchers with different background shared their views on how games and multi-agent systems can be modeled and reasoned about, which led to several discussions on fundamental questions (like: *what features/concepts are indispensable when analyzing interaction between agents?*). In particular, the issue of whether probabilities (and, more generally: quantities) are necessary to give good account on how agents interact was hotly debated.

The results of the seminar were somewhat constrained by the unbalanced composition of participants. We had invited equally many researchers from computer science (especially computational logic) and economics (game theory). However, while most computer scientists accepted our invitation, the same did only a few economists. This is probably due to the fact that Dagstuhl seminars have an extremely high reputation within computer science, but they are relatively unknown in other disciplines. In consequence, the synergy between different views of interaction occurred only partially. In our opinion, it was especially fruitful on the basic level. That is, economists and computer science logicians learned about the basic models and patterns of analysis used in the other discipline. Even more importantly, they exchanged views on what *research questions* are relevant and viable when analyzing game-like interaction. Most synergy occurred within the subgroup of participants coming from the community of *modal logic in computer science.* Talks on modal logic-related topic triggered intensive discussion and ideas for joint research which are currently being pursued by several participants.

We thank the Dagstuhl staff for a very fruitful and interesting week. We are planning a special issue (in Annals of Math and AI) as a concrete outcome of the seminar. Moreover, it was a general consensus that a follow-up seminar would be highly interesting – this time with more specific topics being the focus. The follow-up is currently in the planning phase.

2 Table of Contents

3 Overview of Talks

3.1 Modal Logic and Strategic Interaction in Multi-agent Systems (overview talk)

Thomas Ågotnes (University of Bergen, NO)

A recent trend in logic for multi-agent systems and social mechanisms is logics for coalitional ability, interpreted in game-like structures. In this overview talk I give an overview of some of the most popular basic frameworks and extensions that have been proposed in order to increase their expressiveness.

3.2 Belief revision in dynamic games

Giacomo Bonanno (University of California – Davis, US)

URL http://www.econ.ucdavis.edu/faculty/bonanno/PDF/pbe_2.pdf

We investigate belief revision in dynamic (or extensive-form) games in accordance with the the postulates of the so-called AGM theory of belief revision (developed by Alchourrón, Gärdenfors and Makinson, 1985). We show that consistency with the AGM theory requires that the players' ex ante beliefs and disposition to change those beliefs be rationalizable by a total pre-order on the set of histories, which we call a plausibility order. When an information set is reached, the player's revised beliefs are given by the set of most plausible histories among the ones that constitute the information set; furthermore, the player chooses an action with positive probability if and only if that action maintains the plausibility of the history at which it is taken.

If we add the assumption that the players have a common prior; (that is, common initial beliefs and a common disposition to revise those beliefs) then we obtain a solution concept for dynamic games which is intermediate between subgame-perfect equilibrium and sequential equilibrium and captures the idea of applying Bayes; rule whenever possible; (on and off the equilibrium path(s)).

3.3 Modal Logic for Reasoning in Game Situations

Jan M. Broersen (Utrecht University, NL)

Main reference Modelling Attempt and Action Failure in stit Logic, Jan Broersen, Proceedings of Twenty-Second International Joint Conference on Artificial Intelligence (IJCAI 2011), 2011.

The solution concepts of game theory describe possible equilibria for agent interactions, under specific uniform assumptions about the rationality of these agents. Logics for games often take this same general 'outsider' perspective; they are used to characterize equilibria and aim at reproducing game theoretic results as logic theorems. In my talk I propose to take an 'insider' perspective to logic for games. Our aim could be to design logics that model the reasoning of agents involved in taking decisions in game situations. We should leave open the possibility that different agents reason according to different logics (decision rules). By means of an example I will show that this leads to fundamental questions about the modeling of opponent reasoning, the projection of reasoning into others, and the interaction of projected reasoning with an agent's 'native' reasoning. I will briefly discuss probabilistic stit logic as an example of a logic that takes the inside perspective of reasoning in game situations. As a corollary of the proposed view, I will suggest to look at notions of Nash-action and Pareto-action.

3.4 Programming normative mechanisms

Nils Bulling (TU Clausthal, DE)

Joint work of Dastani, Mehdi
Main reference Nils Bulling and Mehdi Dastani, Verification and Implementation of Normative Behaviours in Multi-Agent Systems, Proceedings of the 22nd International Joint Conference on Artificial Intelligence (IJCAI), July, 2011 (to appear).

The environment is an essential component of multi-agent systems, which is often used to coordinate the behaviour of individual agents. Recently many programming languages have been proposed to facilitate the implementation of such environments. This paper is motivated by a programming language that is designed to implement environments in terms of normative concepts such as norms and sanctions. We provide a formal analysis of programmed normative environments based on concepts from mechanism design. By doing this we relate normative environments to implementation theory setting the stage for studying formal properties of normative environments such as whether a set of norms implements specific normative choice function in specific equilibria. This allows, for example, to analyse whether groups of agents are willing to obey the rules specified by a normative system.

3.5 Strategy synthesis for multi-agent systems

Jan Calta (HU Berlin, DE)

Joint work of Calta, Jan; Shkatov Dmitry; Schlingloff Holger
Main reference Jan Calta and Dmitry Shkatov and Holger Schlingloff, Finding Uniform Strategies for Multi-agent Systems, LNCS, pages 135–152, volume 6245
URL http://dx.doi.org/10.1007/978-3-642-14977-1_12

We can specify desired computations of a multi-agent system with temporal properties that these computations satisfy. An executable strategy for an agent is a function assigning an action of the agent to a state of the agent. Thus, a strategy for a coalition of agents in a multi-agent system can be seen as an algorithm that enforces only system computations satisfying given properties.

The executable strategies for a given property and a multi-agent system can be synthesized using an approach based on global model checking. We focus on the synthesis of an executable strategy in two settings. In the general setting, the multi-agent system is composed of agents with different abilities and divided into coalitions of agents and the properties of the system computations are expressed in Alternating-time Temporal Logic. In the restricted setting, the multi-agent system is homogenous and the properties of the system computations are expressed in Linear Temporal Logic. We discuss how the restrictions on the agent interaction and available information influence the synthesis of the strategies.

3.6 Binary Aggregation

Ulle Endriss (University of Amsterdam, NL)

Joint work of Grandi, Umberto; Endriss, Ulle;
Main reference U. Grandi and U. Endriss. Lifting Rationality Assumptions in Binary Aggregation. Proc. 24th AAAI Conference on Artificial Intelligence (AAAI-2010), 2010.
URL http://www.aaai.org/ocs/index.php/AAAI/AAAI10/paper/view/1592

Binary aggregation deals with situations where several individuals each make a yes/no choice regarding a number of issues and these choices then need to be aggregated into a collective choice. Depending on the application at hand, different combinations of yes/no may be considered rational. We can use an integrity constraint, modelled in terms of a formula of propositional logic, to define the set of those rational choices. Important frameworks of social choice theory, such as Arrovian preference aggregation and judgment aggregation, can be cast as binary aggregation problems, for specific choices of integrity constraints. In this talk, I presented some of our recent work on the interplay of the propositional language used to express integrity constraints and the axiomatic properties of aggregation procedures that can be guaranteed to respect those constraints, and I showed how this general perspective not only is helpful to understand binary aggregation itself, but also has applications in both preference and judgment aggregation.

This is joint work with Umberto Grandi (Amsterdam).

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Lifting Rationality Assumptions in Binary Aggregation.
Proc. 24th AAAI Conference on Artificial Intelligence (AAAI-2010), 2010.

2 U. Grandi and U. Endriss.
Binary Aggregation with Integrity Constraints.
Proc. 22nd International Joint Conference on Artificial Intelligence (IJCAI-2011), To appear in 2011.

3.7 On the Dynamics of Information and Abilities of Players in Multi-Player Games: a preliminary report

Valentin Goranko (Technical University of Denmark, DK)

I will discuss first steps towards a more realistic treatment and logical formalization of the abilities of players to achieve objectives in multi-player games under incomplete, imperfect, or simply wrong information that they may have about the game and about the course of the play. In this talk, after some motivating examples I will introduce a variation of the multi-agent logic ATL as a logical framework for capturing the interplay between the dynamics of information and the dynamics of abilities of players. This framework takes into account both the a priori information of players with respect to the game structure and the empirical information that players develop over the course of an actual play. It associate with them respective information relations and notions of 'a priori' and 'empirical' strategies and strategic abilities. I will briefly discuss the problem of model checking of statements formalized in the new logic under different assumptions about the abilities of the players to observe, remember, and reason.

3.8 A dynamic logic of normative systems

Andreas Herzig (Université Paul Sabatier – Toulouse, FR)

Joint work of Herzig, Andreas;Lorini, Emiliano; Troquard, Nicolas
Main reference Andreas Herzig, Emiliano Lorini, Nicolas Troquard. A dynamic logic of normative systems. Proc. IJCAI 2011
URL http://www.irit.fr/~Andreas.Herzig/P/Ijcai11.html

We propose a logical framework to represent and reason about agent interactions in normative systems. Our starting point is a dynamic logic of propositional assignments whose satisfiability problem is PSPACE-complete. We show that it embeds Coalition Logic of Propositional Control CL-PC and that various notions of ability and capability can be captured in it. We finally show how the logic can be extended in order to represent constitutive rules which are also an essential component of the modelling of social reality.

3.9 Abstraction for Model Checking Modular Interpreted Systems over ATL

Michael Koester (TU Clausthal, DE)

I present an abstraction technique for model checking multi-agent systems given as modular interpreted systems (MIS). MIS allow for succinct representations of compositional systems, they permit agents to be removed, added or replaced and they are modular by facilitating control over the amount of interaction.

Specifications are given as arbitrary ATL formulae: One can therefore reason about strategic abilities of groups of agents. The technique is based on collapsing each agent's local state space with handcrafted equivalence relations, one per strategic modality. Performing model checking on abstractions (which are much smaller in size) rather than on the concrete system which is usually too complex saves space and time.

3.10 Conditional Equilibrium Outcomes via Ascending Price Processes

Ron Lavi (Technion – Haifa, IL)

Joint work of Fu, Hu; Kleinberg, Robert D.; Lavi, Ron
URL http://ie.technion.ac.il/~ronlavi/papers/CE.pdf

A Walrasian equilibrium in an economy with non-identical indivisible items exists only for small classes of players' valuations (mostly "gross substitutes" valuations), and may not generally exist even with decreasing marginal values. This paper studies a relaxed notion, "conditional equilibrium", that requires individual rationality and "outward stability", i.e., a player will not want to *add* items to her allocation, at given prices. While a Walrasian equilibrium outcome is unconditionally stable, a conditional equilibrium outcome is stable if players cannot choose to drop only *some* of their allocated items.

With decreasing marginal valuations, conditional equilibrium outcomes exhibit three appealing properties: (1) An approximate version of the first welfare theorem, namely that the social welfare in any conditional equilibrium is at least half of the maximal welfare; (2) A conditional equilibrium outcome can always be obtained via a natural ascending-price process; and (3) The second welfare theorem holds: any welfare maximizing allocation is supported by a conditional equilibrium. In particular, each of the last two properties independently implies that a conditional equilibrium always exists with decreasing marginal valuations (whereas a Walrasian equilibrium generally does not exist for this common valuation class).

Given these appealing properties we ask what is a maximal valuation class that ensures the existence of a conditional equilibrium and includes unit-demand valuations. Our main technical results provide upper and lower bounds on such a class. The lower bound shows that there exists such a class that is significantly larger than gross-substitutes, and that even allows for some (limited) mixture of substitutes and complements. For three items or less our bounds are tight, implying that we completely identify the unique such class. The existence proofs are constructive, and use a "flexible-ascent" auction that is based on algorithms previously suggested for "fractionally subadditive" valuations. This auction is slightly different from standard ascending auctions, as players may also decrease prices of obtained items in every iteration, as long as their overall price strictly increases.

3.11 Playing games in large multi-agent simulations

Viliam Lisy (Czech Technical University, CZ)

Joint work of Lisy, Viliam; Bosansky, Branislav; Jakob, Michal; Pechoucek, Michal
Main reference Viliam Lisy and Branislav Bosansky and Michal Jakob and Michal Pechoucek: Adversarial Search with Procedural Knowledge Heuristic. In The Eighth International Joint Conference on Autonomous Agents and Multiagent Systems, AAMAS 2009

We investigate creating plans (sequences of actions) for agents acting in a shared environment towards achieving their own, often mutually exclusive goals. We focus on using our techniques in simulations of various kinds of (military) operations in physical world.

I will identify the problems we face in creating rational agents for those scenarios. The problems include limited modeling power of the available approaches and computational demands of the existing algorithms.

In order to overcome these problems, it is necessary to rely on a significant amount of hand-coded (or automatically learned) domain specific knowledge. This fact has been recognized in the field of planning and led to invention of HTN or TLPlan. I will present our method for using domain specific procedural knowledge in game playing.

3.12 From Individualistic to Social Rationality in Strategic Games: a Logical Analysis

Emiliano Lorini (Université Paul Sabatier – Toulouse, FR)

I propose a modal logic that enables to reason about different kinds of rationality in strategic games. This logic integrates the concepts of joint action, belief, individual preference and group preference. The first part of the talk is focused on the notion of individualistic rationality assumed in classical game theory: an agent decides to perform a certain action only if the agent believes that this action is a best response to what he expects the others will do. The second part of the talk explores different kinds of social rationality such as fairness and reciprocity. Differently from individualistically rational agents (alias self-interested agents), social rational agents also consider the benefits of their choice for the group.

Moreover, their decisions can be affected by their beliefs about other agents' willingness to act for the well-being of the group. The analysis also considers team-directed reasoning, i.e. the mode of reasoning that people use when they take themselves to be acting as members of a group or a team

3.13 Secure interaction and security protocols

Sjouke Mauw (University of Luxembourg, LU)

Quoting the late Roger Needham: "Security protocols are three-line programs that people still manage to get wrong." Given the famous history of the Needham-Schroeder protocol, Roger Needham clearly knew what he was talking about.

In this overview talk, I will sketch some of the pitfalls in security protocol design by showing examples from three areas: secrecy protocols, authentication protocols, and non-repudiation protocols.

3.14 Imperfect Information and Intention in Non-Repudiation Protocols

Matthijs Melissen (University of Luxembourg, LU)

Introduction

Repudiation [1] means the *denial* of an entity of having participated in all or part of a communication. When Alice sends a message m to Bob, we can distinguish *non-repudiation of origin* (NRO), which expresses that Alice cannot deny having sent m, and *non-repudiation of receipt* (NRR), which expresses that Bob cannot deny having received m from Alice. Proof of the origin of a message or receipt is provided by digital signatures obtained through a *public key infrastructure*, part of which is a *certificate authority* which links public keys to user identities. An important difference between non-repudiation protocols and most other security protocols is that in non-repudiation protocols, the information that the agents have acquired at the end of the protocol run should not only convince the agent itself, but also serve as a proof towards external agents (such as a judge). Applications of non-repudiation include contract signing and certified e-mail [2]. In this abstract, we show why it is important to take (imperfect) information and intention into account when modelling non-repudiation.

Fair exchange and imperfect information

It is often desirable to have a guarantee of fair exchange [3] of non-repudiation. For example, when Alice sends message m to Bob, it should hold that Alice receives her NRR if and only if Bob receives his NRO. One way to formally verify such constraints is by means of ATL [4], a modal logic of strategic ability. In ATL, the formula $\langle\langle A\rangle\rangle\Diamond\varphi$ stands for "Group of agents A has the ability to make sure that at some point in the future φ holds". Kremer & Raskin [1] use the following formula to express one of the conditions of fairness:

$$\Phi \equiv \neg\langle\langle Bob\rangle\rangle\Diamond(\mathsf{NRO} \wedge \neg\langle\langle Alice\rangle\rangle\Diamond\mathsf{NRR})$$

This formula is supposed to express that Bob should not be able to obtain his NRO at some point while at the same time making Alice unable to obtain her NRR. However, in [1], Φ is interpreted in the basic version of ATL which implicitly assumes perfect information.

That is, agents are assumed to know precisely the current global state of the system, including the local states of the other agents.

Obviously, the assumption is wrong for communication protocols in general (if everybody knows everything, no communication is needed).

Moreover, in the specific case of non-repudiation protocols, it can be the case that – even if Alice has a way of behaving that causes her to obtain her NRR – the behaviour cannot be represented as an executable strategy because it requires executing different actions in situations that look the same to her.

And even if she has an executable strategy, she may be unaware of having it, and unable to identify it [5]. For example, one can construct a protocol in which Alice needs to send a different message depending on whether Bob did or did not receive some other message. Alice is not aware of messages being received by Bob, so although she has a perfect information strategy, she is not able to follow it.

Conversely, it is also possible that Bob has a perfect information strategy to put Alice at a disadvantage, but the strategy cannot be executed under imperfect information. Thus, it can both happen that a protocol satisfying Φ is clearly unfair, and that a protocol is intuitively fair while satisfying $\neg\Phi$. This problem needs to be addressed by interpreting specifications in the appropriate version of ATL with imperfect information [6].

Intention

In many applications, the notion of non-repudiation is not sufficient. Recall that NRO means that the sender cannot deny having sent message m. However, often we require that the sender cannot deny having *intended to* sent m.

When Alice is presented with NRR signed by her, it is clear that she is the origin of the message. However, she can claim that she never executed the protocol in question, and that in fact NRR resulted from another protocol, in which m was used as a random string without meaning. For example, NRR could be interpreted in one protocol as “I am the originator of the message ‘I owe you money’”, while in a second protocol it is merely used as a confirmation that the participant is still on-line. In this situation, we know that one of the parties cheated: either Bob forced Alice to run the second protocol, or Alice lies about never having executed the first protocol. However, it is not possible to find out which of both parties is the culprit. We call an attack like this a *virtual multi-protocol attack*, as it is not necessary for Alice to actually execute any part of the second protocol; merely the existence of a protocol that could result in the same evidence is sufficient.

In general, for each NRR resulting from a non-repudiation protocol, it is possible to construct another protocol where the message NRR has a different interpretation. Note that adding flags to each message that indicate the purpose of the message does not work, as it is not possible to guarantee that flags are unique across protocols. Note furthermore that the same problem occurs for NRO.

The above problem can be solved by making sure that the certificate authority does not only link public keys and user identities, but additionally stores the exact protocol (and version) for which the key will be used with. Note also that this registration needs to be happening in the physical world, as an electronic registration leads to a bootstrapping problem: the registration authority needs to have non-repudiation of origin, because otherwise the agent whose key is registered could later deny having registered her key.

Conclusion

We have studied the security requirement of non-repudiation. Often, fair exchange of non-repudiation needs to be guaranteed. When modelling this property formally, it should be taken into account that agents in a protocol have imperfect information, and therefore a model that takes this into account should be used. Furthermore, we indicate that in many applications the notion of non-repudiation is not sufficient, as the parties are required to send their messages *intentionally*. This can be solved by letting the certificate authority store the exact protocol for which a key will be used.

Acknowledgements

This work was supported by the FNR (National Research Fund) Luxembourg under projects S-GAMES, C08/IS/03 and GMASec - PHD/09/082.

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3.15 Simultaneous Ad Auctions

Dov Monderer (Technion – Haifa, IL)

Joint work of Ashlagi, Itai;Monderer, Dov; Tennenholtz Moshe
Main reference Ashlagi, Itai;Monderer, Dov; Tennenholtz Moshe, Simultaneous Ad Auctions, Mathematics of Operations Research, Vol. 36, No. 1, February 2011, pp. 1-13.
URL http://dx.doi.org/10.1287/moor.1100.0475

Two models for a pair of simultaneous ad auctions, A, B, are discussed:

(i) single-campaign advertisers, which participate in a single ad auction, and (ii) multi-campaign advertisers, which participate in both auctions. We prove the existence and uniqueness of a symmetric equilibrium in the first model. Moreover, when the click rates in A are point-wise higher than those in B, we prove that the expected revenue in A is greater than the expected revenue in B in this equilibrium. In contrast, we show that higher click-rates do not necessarily imply higher revenues in the second model.

3.16 Mission planning: Logic and game theory in multi-robot applications

Peter Novak (Czech Technical University, CZ)

I presented a research project towards study and implementation of a temporally extended multi-agent planner. The core idea revolves around using tools and techniques developed for reasoning about temporal modal logics for computing multi-agent plans. The main motivation for the mission planner is the actual need in many, especially military and defense domains, such as e.g., planning for tactical missions in urban operations, rescue operations, undersea anti-submarine warfare missions, or port guarding. I discussed use of position logic and algorithmic game theory could assume in such a planning problem.

3.17 Reasoning with Plans under Imperfect Information

Eric Pacuit (Tilburg University, NL)

Joint work of Pacuit, Eric; Simon, Sunil

Various combinations of temporal logics, epistemic and doxastic logics, and action logics have been used to reason about (groups of) agents in social situations. A key issue that has emerged is how best to represent and reason about the underlying protocol that governs the agents' interactions in a particular social situation. In this paper, we propose a PDL-style logic for reasoning about protocols, or plans, under imperfect information.

Our paper touches on a number of issues surrounding the relationship between an agent's abilities, available choices and information in an interactive situation. The main question we address is under what circumstances can the agent commit to a protocol or plan, and what can she achieve by doing so?

3.18 The Power of Knowledge in Games

Rohit Parikh (City University of New York, US)

We develop a theory of the interaction between knowledge and games.

Epistemic game theory is of course a well developed subject But there is also a need for theory of how some agents can *affect* the outcome of a game by affecting the knowledge which other agents have and thereby affecting their actions.

We concentrate on games of incomplete or imperfect information, and study how cautious, median seeking, or aggressive players might play such games. We provide models for the behavior of a knowledge manipulator who seeks to manipulate the knowledge states of active players in order to affect their moves and to maximize her own payoff even while she herself remains inactive.

3.19 Neighbourhood structures in large games

Ramaswamy Ramanujam (The Institute of Mathematical Sciences – Chennai, IN)

Joint work of Paul, Soumya; Ramanujam, R.

We study repeated normal form games where the number of players is large and suggest that it is useful to consider a neighbourhood structure on the players.

The game proceeds in rounds where in each round the players of every clique play a strategic form game among each other. Based on what a player observes, i.e., the strategies and the outcomes in the previous round of the players visible to her, the player may switch strategies in the same neighbourhood, or migrate to another neighbourhood. We show that given the initial neighbourhood graph and the types of the players in a simple modal logic, we can effectively decide if the game eventually stabilises. We also prove a characterisation result for games for arbitrary types using potentials. We then offer some applications to the special case of weighted co-ordination games where we can compute bounds on how long it takes to stabilise.

3.20 Epistemic, Strategic ATL* with Explicit Strategies

Henning Schnoor (Universität Kiel, DE)

Strategic logics have been used successfully to reason about game-like situations such as multi-agent systems. An important aspect of a game is the amount of information available to each player. We discuss a variation of the standard strategic logic ATL with knowledge-related aspects. In particular, we require that players are able to identify strategies for a given goal, and we allow formulas to explicitly reason about strategies.

3.21 Efficiency Levels in Sequential Auctions with dynamic Arrivals

Ella Segev (Ben Gurion University – Beer Sheva, IL)

Joint work of Lavi, Ron; Segev, Ella

In an environment with dynamic arrivals of players who wish to purchase only one of multiple identical objects for which they have a private value, we analyze a sequential auction mechanism with an activity rule. If the players play undominated strategies then we are able to bound the efficiency loss compared to an optimal mechanism that maximizes the total welfare. We have no assumptions on the underlying distribution from which the players' arrival times and valuations for the object are drawn.

Moreover we have no assumption of a common prior on this distribution.

3.22 Logics for social choice and perspectives on their software implementation

Nicolas Troquard (University of Essex, GB)

Joint work of Troquard, Nicolas; van der Hoek, Wiebe; Wooldridge, Michael
Main reference to appear in Journal of Philosophical Logic
URL http://arxiv.org/abs/1102.3341

In this talk, I will present a logic to reason about voting procedures, proposed in a common work with W. van der Hoek and M. Wooldridge. I will discuss some perspectives on its software implementation and try to assess its practicality. I will also make a short demonstration of a prototype.

3.23 Turning Competition into Cooperation and Cooperation into Competition

Paolo Turrini (Utrecht University, NL)

Joint work of Goranko, Valentin; Grossi, Davide; Jamroga, Wojtek; Turrini, Paolo
Main reference Goranko, V., Jamroga, W., Turrini, P.: Strategic Games and Truly Playable Effectivity Functions Proceedings of the 10th international conference on Autonomous Agents and Multi-Agent Systems (AAMAS 2011) Taipei, Taiwan (to appear)
URL http://www2.imm.dtu.dk/ vfgo/papers/GJTcamera-ready-final.pdf

The work presented relates strategic games, object of study of non-cooperative game theory, and effectivity functions, object of study of cooperative game theory. It consists of two parts:

- The first part, joint work with Valentin Goranko and Wojtek Jamroga, shows that a believed correspondence between strategic games and a class of effectivity functions, known as Pauly's Representation Theorem, is not correct as it stands. A proof of this fact is presented and an alternative correspondence established.

- The second part, joint work with Davide Grossi, presents a weakening of the classical relation between strategic games and effectivity functions and study the reciprocity among players as precondition of coalition formation.

3.24 A Proof System for Message Passing

Jan van Eijck (CWI – Amsterdam, NL)

Joint work of van Eijck, Jan; Sietsma, Floor
Main reference work under submission

We propose a framework for message passing that combines the best properties of dynamic epistemic semantics and history-based approaches. We assume that all communication is truthful and reliable.

Our framework consists of Kripke models in which we keep a history of messages that have been sent. We introduce an update operation for message sending, with a corresponding action modality. With this update we can study the exact epistemic consequences of the sending of a message.

We define a class of models that is generated from initial Kripke models by means of message updates, we axiomatize our update modality, and we give examples of how the framework can be used to prove properties of message passing systems.

4 Open Problems

The discussion between different groups of researchers remained mostly on fundamental level. In consequence, besides open technical problems, we also identified some entry points to more fundamental research. Here is the list of main problems that have been posed and/or emerged during the seminar:

- Are quantitative probabilities necessary to analyze interaction? How can they be used in logic-based approaches?

- How can logical descriptions be helpful in quantitative analysis of games?
- What is the relation between different views of interaction (static vs. dynamic, a priori vs. runtime)
- What is the exact relationship between models and methodologies from noncooperative game theory, coalitional game theory, and some theories from social science (especially dependency theory)?
- What is the formal relationship between knowledge and power? Can it be characterized using a suitable logical language?
- Are game logics useful in analysis of security protocols? What features are necessary to extend the existing game logics like ATL to obtain a sufficiently expressive language?
- How can very large games be modeled and solved effectively?

5 Panel Discussions

We had three panel discussions. The first one was on *Strategic Analysis*. We discussed the following questions:

1. Why is *logic* important for *game theory*? Or is it?
2. Why is *probability* so rare in logic of *game theory*?
3. The *zoo of logics*: Is there a common framework?
4. *Logics of games* vs. *games of logic* (game semantics, game-based verification).

The second discussion was on *Algorithms and Complexity*:

1. *Complexity*: Is it just theory and of *no practical use*?
2. Are there any *specific features* of complexity analysis for *games*?
3. Can we really use *game theory* and *logics of games* (despite complexity obstacles)?

The final discussion treated *Applications*:

1. Can we really use game theory and logics of games *out of academia*?
2. Are existing *models of interaction* adequate?
3. Can models used by different disciplines be *integrated* in a meaningful way?

The discussions identified a number of meeting points between the main disciplines (logic, game theory, applications). The need for common framework is strong, not only between logic and game theory, but also one that unifies different logic-based approaches. Modal logic seems to be *lingua franca* in the latter case, but there are many variations of modal logic being used, and the exact relationship between them is unclear.

In order to *use* the frameworks being developed in logic-based as well as economics approaches to interaction, efficient algorithms are essential. It has been also pointed out that classical complexity theory – while useful – often gives misleading estimations of the "real" complexity that one faces in applications. Studying *average complexity* (instead of worst-case complexity) can be a good way out, though average complexity is usually much harder to establish.

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