Logic and the simulation of interaction and reasoning: Introductory remarks

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Logic and the Simulation of Interaction and Reasoning: Introductory Remarks.

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Abstract. This introductory note provides the background for the symposium *"Logic and the Simulation of Interaction and Reasoning"*, its motivations and the 15 papers presented at the symposium.

1 INTRODUCTION

In the past years, logicians have become more and more interested in the phenomenon of interaction. The area "*Logic and Games*" deals with the transition from the static logical paradigm of formal proof and derivation to the dynamic world of intelligent interaction and its logical models. A number of conferences and workshops such as the LOFT ("Logic and the Foundations of Game and Decision Theory") series, the 7th Augustus de Morgan Workshop in London [November 2005; [1]], the Royal Academy Colloquium 'New perspectives on Games and Interaction' in Amsterdam [February 2007]) have been dealing with logic in game and decision theory and dynamic logics with announcement and action operations. Fruitful technical advances have led to deep insights into the nature of communicative interaction by logicians.

This new direction of logic has quickly gained momentum and support. In 2006, a Marie Curie Research Training Site GLoRiClass ("Games in Logic Reaching Out for Classical Game Theory") was opened in Amsterdam, providing graduate student training for a large number of PhD students. In 2007, the European Science Foundation has recognized this direction as one of the foremost research developments for the European science community and created a collaborative research platform called "LogICCC – Modelling intelligent interaction". Later in 2007, a new book series entitled "*Texts in Logic and Games*" was launched by Amsterdam University Press.

While these interactive aspects are relatively new to logicians, on a rather different level, modelling intelligent interaction has been an aspect of the practical work of computer game designers for a long time. Pragmatic questions such as 'What makes a game/storyline interesting', 'What makes an reaction natural', and 'What role do emotions play in game decisions' have been tackled by practicing game programmers. The practical aspects of computer gaming reach out to a wide interdisciplinary field including psychology and cognitive science.

So far, there are only a few cross-links between these two communities. A number of logicians have applied logical methods for concrete games, such as van Ditmarsch's analysis of Cluedo [2], Sevenster's analysis of Scotland Yard [6, 7], and the new TACTICS project of van Benthem and van den Herik (represented at this symposium by the joint paper by Schadd, Winands, van den Herik, and Aldewereld).

Our symposium will explore the possibilities of joining the theoretical approach to interaction and communication with the practical approach to simulating behaviour. We would like to include purely logical aspects, cognitive and psychological aspects (including empirical testing of formal models), and pragmatic aspects.

2 A CASE FOR LOGIC

In § 1, we mentioned that questions such as 'What makes a game/storyline interesting', 'What makes an reaction natural', and 'What role do emotions play in game decisions' are relevant for game programmers and designers.

For more combinatorial games, such as strategic board games, the first question can be phrased as 'What technical properties of a game make it fun to play?'. In order to be enjoyable, a board game should neither be too complicated (as it would become frustrating) nor to simple (as it would become boring). A number of games that are played in practice have been found to be **NP**-complete[2]. Could it be that this technical notion from theoretical computer science is a good indicator for when a game is interesting?[3]

A different type of modelling can be found in interactive games, for instance the computer role playing games, in which the human player plays the role of some fictitious personality interacting with artificial agents, the so-called "non-player characters" (NPCs).

In these games, modelling interaction and behaviour becomes central and it is here that modern logic techniques such as dynamic logic, epistemic logic and variuous approaches to multi-agents systems could become useful.

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[2] For instance, Minesweeper [3], Sudoku [8], Battleships [5], and Scotland Yard [6, 7]

[3] Personally, I think that this is rather unlikely, as **NP**-completeness is a property of a family of games parametrized by some number, typically the size of the game board, whereas the games that are actually played are always of one fixed parameter and thus oblivious to the fact that the family itself is **NP**-complete.

Logicians have developed logics in which we can formally reason about states of knowledge, states of belief, intentions, actions, consequences of our actions and combinations of all these. As an example consider the paper [4] by Eric Pacuit and the present author in which backwards induction techniques are used to analyse a typical TV soap opera storyline of a love triangle, deceit, false assumptions about other people, and disappointment in terms of a "game of changing and mistaken beliefs".

Typical applications of a logic of knowledge, belief, intention and action could be as follows, and we would very much like to see models for this being developed as a consequence of this symposium:

Scenario 1.

In a strategic computer game, the human player plays a developing population. Certain skills (including battle skills) are developed according to a skill tree (for instance, building a cannon can only be done after one of the artificial agents became a smith).

Modelling the intentions and actions of the opposing (computer-played) populations could be done by reasoning in some modal system that assesses the battle strength of the human-played population based on knowledge of their development stage. News of the sighting of a smith brought to the leader of the opposing population could be read as an increase in the likelihood that the human-played population has developed a cannon (and thus figure prominently in the reasoning of whether the computer-played population should attack or not).

Scenario 2.

In a computer role playing game, one could implement situations in which NPCs try to outmaneuver the human player. For instance, an NPC X might intend to kill NPC Y and gain some valuable object currently in the possession of Y.

Meeting the human-played agent, X wishes to find out how much the human-played agent knows about Y and what their relationship is. Based on this information, X would now try to trick the human-played agent into going and killing Y. This would require subtle communication skills of X, keeping in mind his own preferences and goals without giving them away. Such a communication could be modelled in a logic of knowledge, belief, agency and intention.

The scope of our symposium is wider than the two classes of games presented in this section (strategic board games and interactive computer games). Logic can play a role in all situations where interaction and behaviour are simulated, such as artificial pets (as in the paper *Theory and Practice of Social Reasoning: Experiences with the iCat* by Frank Dignum), analysis of human behaviour in game situations (as in the presentation *An experimental study of information mechanisms in the trust game: effects of observation and cheap talk* by Jürgen Bracht or the paper *Private Information and Inference about Inference* by Sobei Hidenori Oda, Gen Masumoto, and Hiroyasu Yoneda), automatised reasoning about diagrams (as in the paper *How can machines reason with diagrams?* by Mateja Jamnik) and others. The most accurate description of the scope of the symposium is the collection of presented papers that the reader can find in this volume.

3 THE SYMPOSIUM AND ITS STRUCTURE

Our symposium has a largely exploratory character: researchers from many different areas should get together to share the fundamental ideas and approaches of their respective fields. In order to get a proper representation of the fields involved, we decided to invite a number of speakers, generously funded by the Marie Curie Research Training Site GLoRiClass. Our invited speakers are Thomas Ågotnes (*Bergen, Norway*), Rafael Bordini (*Durham, England*), Frank Dignum (*Utrecht, The Netherlands*), Mateja Jamnik (*Cambridge, England*), and David Ethan Kennerly (*Los Angeles CA, United States of America*). We had invited two more speakers (Steffen Huck and Eric Pacuit) who had to cancel their trip for personal reasons. The registration fees, travel and accommodation expenses of the invited speakers were generously funded by the Marie Curie Research Training Site GLoRiClass.

Figure 1. Marie Curie Research Training Site GLoRiClass "*Games in Logic Reaching Out To Classical Game Theory*"

In addition to the invited speakers, the symposium attracted a large number of submissions from various communities (multi-agent systems, applied logic, experimental game theory, and others). All submissions (including the submissions of the invited speakers) were lightly refereed by the members of the programme committee and some external referees, keeping in mind the exploratory character of the symposium. We did not expect new research contributions, but interesting ideas for collaboration, and this is how the papers of the symposium have to be understood.

Programme Committee.

- Stefania Bandini, *Milan*
- Johan van Benthem, *Amsterdam* & *Stanford CA*
- Cristiano Castelfranchi, *Rome*
- Bruce Edmonds, *Manchester*
- Jaap van den Herik, *Maastricht*
- Wiebe van der Hoek, *Liverpool*
- Benedikt Löwe, *Amsterdam*
- Yoav Shoham, *Stanford CA*
- Keith Stenning, *Edinburgh*
- Rineke Verbrugge, *Groningen*

List of all presentations in alphabetic order.

- Thomas Ågotnes: *Logics of Interaction, Coalitions and Social Choice.*
- Rafael Bordini: *Simulating Rational Goal-Directed Behaviour Using a Logic-Based Programming Language for Multi-Agent Systems*
- Jürgen Bracht: *An experimental study of information mechanisms in the trust game: effects of observation and cheap talk*
- Jan Broersen: *Interpreting Product Update as Reasoning about Observations and Meta-Observations.*
- Flavio S Correa da Silva, Giuseppe Vizzari, Alessandro Mosca: *Coupled MMASS: A Formal Model for Non-deterministic Multi-agent Simulations*
- Louise Dennis, Bernd Farwer: *Gwendolen: A BDI Language for Verifiable Agents*
- Frank Dignum: *Theory and Practice of Social Reasoning: Experiences with the iCat*
- Mateja Jamnik. *How can machines reason with diagrams?*
- Ethan Kennerly: *Open Problems in Simulation and Story Analysis*
- Alessandro Mosca, Giuseppe Vizzari, Matteo Palmonari, Stefania Bandini: *A Perception Oriented MAS Model with Hybrid Commonsense Spatial Reasoning*
- Anton Nijholt: *Don't Give Yourself Away: Cooperative Behaviour Revisited.*
- Sobei Hidenori Oda, Gen Masumoto, Hiroyasu Yoneda: *Private Information and Inference about Inference*
- Maarten Schadd, Mark Winands, Jaap van den Herik, Huib Aldewereld: *Addressing* **NP***-Complete Puzzles with Monte-Carlo Methods*
- Vincent Wiegel, Jan van den Berg: *Experimental Computational Philosophy: shedding new lights on (old) philosophical debates*
- Andreas Witzel, Jonathan A. Zvesper: *Higher-Order Knowledge in Computer Games*

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